
FASTR Documentation

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Contents

1	FASTR Documentation	3
1.1	Introduction	3
1.1.1	Philosophy	3
1.1.2	System overview	3
1.2	Quick start guide	5
1.2.1	Installation	5
1.2.2	Configuration	6
1.2.3	Creating a simple network	6
1.2.4	Running a Network	9
1.3	User Manual	9
1.3.1	Tools	10
1.3.2	Network	12
1.3.3	Data Flow	15
1.3.4	DataTypes	20
1.3.5	Execution	21
1.3.6	IOPlugins	22
1.3.7	Secrets	22
1.3.8	Debugging	22
1.3.9	Naming Convention	27
1.3.10	Provenance	28
1.4	Command Line Tools	29
1.4.1	fastr cat	29
1.4.2	fastr dump	29
1.4.3	fastr execute	30
1.4.4	fastr extract_argparse	30
1.4.5	fastr prov	30
1.4.6	fastr run	31
1.4.7	fastr test	31
1.4.8	fastr trace	32
1.4.9	fastr verify	32
1.4.10	fastr webapp	33
1.5	Resource File Formats	33
1.5.1	Config file	33
1.5.2	Tool description	36
1.6	Resource Reference	36
1.6.1	CollectorPlugin Reference	36

1.6.2	ExecutionPlugin Reference	38
1.6.3	FlowPlugin Reference	41
1.6.4	IOPlugin Reference	41
1.6.5	Interface Reference	46
1.6.6	Target Reference	48
1.7	Development and Design Documentation	50
1.7.1	Sample flow in Fastr	50
1.7.2	Network Execution	53
1.7.3	Secrets	55
1.8	Changelog	57
1.8.1	UNRELEASED	57
1.8.2	1.2.2 - 2017-08-24	58
1.8.3	1.2.1 - 2017-04-04	58
1.8.4	1.2.0 - 2017-03-15	59
1.8.5	1.1.2 - 2016-12-22	60
1.8.6	1.1.1 - 2016-12-22	60
1.8.7	1.1.0 - 2016-12-08	60
2	FASTR User reference	61
2.1	Fastr User Reference	61
3	FASTR Developer Module reference	65
3.1	fastr Package	65
3.1.1	fastr Package	65
3.1.2	configmanager Module	77
3.1.3	datatypes Module	79
3.1.4	exceptions Module	89
3.1.5	plugins Module	95
3.1.6	version Module	115
3.1.7	Subpackages	116
4	Indices and tables	241
	Python Module Index	243

FASTR is a framework that helps creating workflows of different tools. The workflows created in FASTR are automatically enhanced with flexible data input/output, execution options (local, cluster, etc) and solid provenance.

We chose to create tools by creating wrappers around executables and connecting everything with Python.

Fastr is open-source (licensed under the Apache 2.0 license) and hosted on bitbucket at https://bitbucket.org/bigr_erasmusmc/fastr

For support, go to <https://groups.google.com/d/forum/fastr-users>

To get yourself a copy, see the *Installation*

The official documentation can be found at fastr.readthedocs.io

The Fastr workflow system is presented in the following article:

Hakim Achterberg, Marcel Koek, and Wiro Niessen. “Fastr: a workflow engine for advanced data flows in medical image analysis.” *Frontiers in ICT* 3 (2016): 15.

Fastr is made possible by contributions from the following people: Hakim Achterberg, Marcel Koek, Adriaan Versteeg, Thomas Phil, Mattias Hansson, Baldur van Lew, Marcel Zwiers, and Coert Metz

Introduction

Fastr is a system for creating workflows for automated processing of large scale data. A processing workflow might also be called a processing pipeline, however we feel that a pipeline suggests a linear flow of data. Fastr is designed to handle complex flows of data, so we prefer to use the term network. We see the workflow as a network of processing tools, through which the data will flow.

The original authors work in a medical image analysis group at Erasmus MC. They often had to run analysis that used multiple programs written in different languages. Every time a experiment was set up, the programs had to be glued together by scripts (often in bash or python).

At some point the authors got fed up by doing these things again and again, and so decided to create a flexible, powerful scripting base to easily create these scripts. The idea evolved to a framework in which the building blocks could be defined in XML and the networks could be constructed in very simple scripts (similar to creating a GUI).

Philosophy

Researchers spend a lot of time processing data. In image analysis, this often includes using multiple tools in succession and feeding the output of one tool to the next. A significant amount of time is spent either executing these tools by hand or writing scripts to automate this process. This process is time consuming and error-prone. Considering all these tasks are very similar, we wanted to write one elaborate framework that makes it easy to create pipelines, reduces the risk of errors, generates extensive logs, and guarantees reproducibility.

The Fastr framework is applicable to multiple levels of usage: from a single researcher who wants to design a processing pipeline and needs to get reproducible results for publishing; to applying a consolidated image processing pipeline to a large population imaging study. On all levels of application the pipeline provenance and managed execution of the pipeline enables you to get reliable results.

System overview

There are a few key requirements for the design of the system:

- Any tool that your computer can run using the command line (without user interaction) should be usable by the system without modifying the tool.
- The creation of a workflow should be simple, conceptual and require no real programming.
- Networks, once created, should be usable by anyone like a simple program. All processing should be done automatically.
- All processing of the network should be logged extensively, allowing for complete reproducibility of the system (guaranteeing data provenance).

Using these requirements we define a few key elements in our system:

- A `fastr.Tool` is a definition of any program that can be used as part of a pipeline (e.g. a segmentation tool)
- A `fastr.Node` is a single operational step in the workflow. This represents the execution of a `fastr.Tool`.
- A `fastr.Link` indicates how the data flows between nodes.
- A `fastr.Network` is an object containing a collection of `fastr.Node` and `fastr.Link` that form a workflow.

With these building blocks, the creation of a pipeline will boil down to just specifying the steps in the pipeline and the flow of the data between them. For example a simple neuro-imaging pipeline could look like:

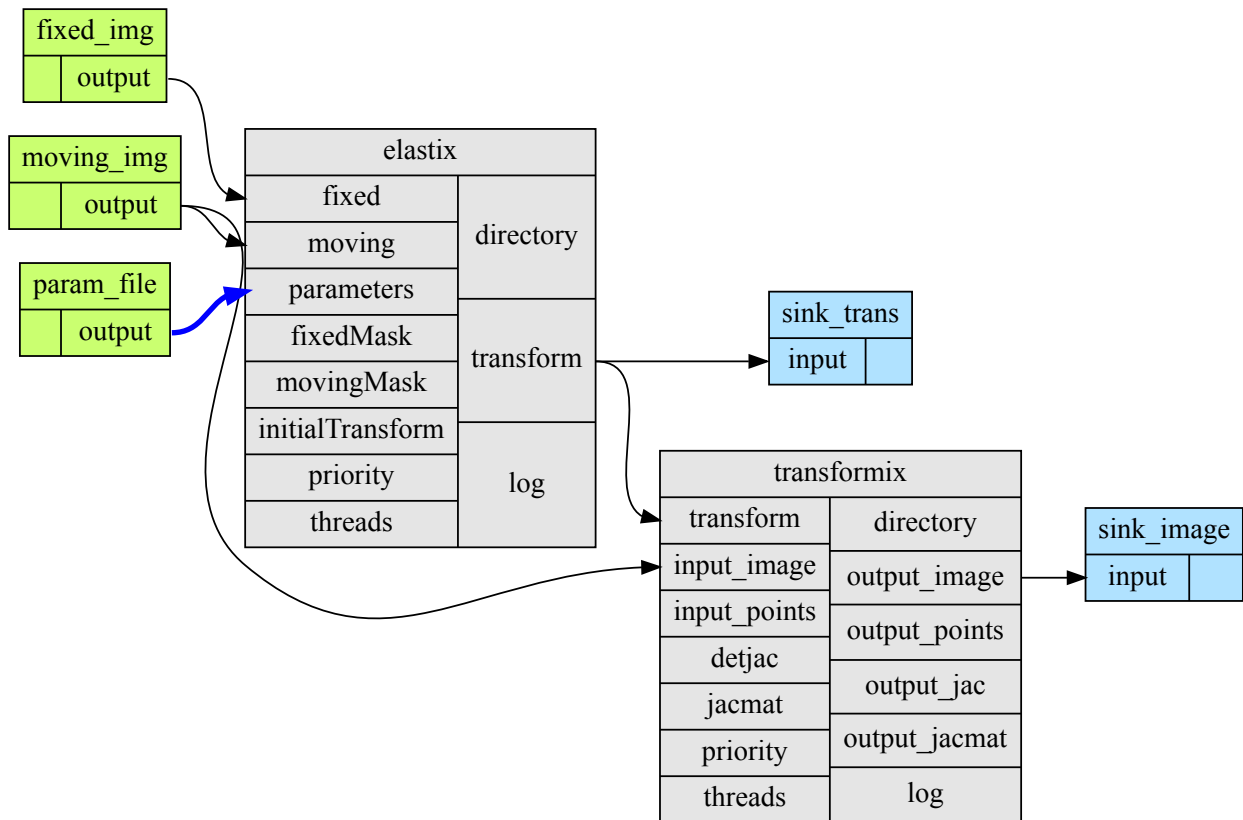


Fig. 1.1: A simple workflow that registers two images and uses the resulting transform to resample the moving image.

In Fastr this translates to:

- Create a `fastr.Network` for your pipeline
- Create a `fastr.SourceNode` for the fixed image

- Create a `fastr.SourceNode` for the moving image
- Create a `fastr.SourceNode` for the registration parameters
- Create a `fastr.Node` for the registration (in this case elastix)
- Create a `fastr.Node` for the resampling of the image (in this case transformix)
- Create a `fastr.SinkNode` to save the transformations
- Create a `fastr.SinkNode` to save the transformed images
- `fastr.Link` the output of the fixed image source node to the fixed image input of the registration node
- `fastr.Link` the output of the moving image source node to the moving image input of the registration node
- `fastr.Link` the output of the registration parameters source node to the registration parameters input of the registration node
- `fastr.Link` the output transform of the registration node to the transform input of the resampling node
- `fastr.Link` the output transform of the registration node to the input of transformation SinkNode
- `fastr.Link` the output image of the resampling node to the input of image SinkNode
- Run the `fastr.Network` for subjects X

This might seem like a lot of work for a registration, but the Fastr framework manages all other things, executes the pipeline and builds a complete paper trail of all executed operations. The execution can be on any of the supported execution environments (local, cluster, etc). The data can be imported from and exported to any of the supported data connections (file, XNAT, etc). It is also important to keep in mind that this is a simple example, but for more complex pipelines, managing the workflow with Fastr will be easier and less error-prone than writing your own scripts.

Quick start guide

This manual will show users how to install Fastr, configure Fastr, construct and run simple networks, and add tool definitions.

Installation

You can install Fastr either using `pip`, or from the source code.

Installing via pip

You can simply install fastr using `pip`:

```
pip install fastr
```

Note: You might want to consider installing `fastr` in a [virtualenv](#)

Installing from source code

To install from source code, use Mercurial via the command-line:

```
hg clone https://<yourusername>@bitbucket.org/bigr_erasmusmc/fastr # for http
hg clone ssh://hg@bitbucket.org/bigr_erasmusmc/fastr # for ssh
```

If you prefer a GUI you can try [TortoiseHG](#) (Windows, Linux and Mac OS X) or [SourceTree](#) (Windows and Mac OS X). The address of the repository is (given for both http and ssh):

```
https://<yourusername>@bitbucket.org/bigr_erasmusmc/fastr
ssh://hg@bitbucket.org/bigr_erasmusmc/fastr
```

To install to your current Python environment, run:

```
cd fastr/
pip install .
```

This installs the scripts and packages in the default system folders. For windows this is the python site-packages directory for the fastr python library and Scripts directory for the executable scripts. For Ubuntu this is in the /usr/local/lib/python2.7/dist-packages/ and /usr/local/bin/ respectively.

Note: If you want to develop fastr, you might want to use `pip install -e .` to get an editable install

Note: You might want to consider installing fastr in a [virtualenv](#)

Note:

- On windows python and the Scripts directory are not on the system PATH by default. You can add these by going to System -> Advanced Options -> Environment variables.
 - On mac you need the Xcode Command Line Tools. These can be installed using the command `xcode-select --install`.
-

Configuration

Fastr has defaults for all settings so it can be run out of the box to test the examples. However, when you want to create your own Networks, use your own data, or use your own Tools, it is required to edit your config file.

Fastr will search for a config file named `config.py` in the `$FASTRHOME` and `~/.fastr/` directories. If both config files contain values for a single setting, the version in `~/.fastr/` has priority.

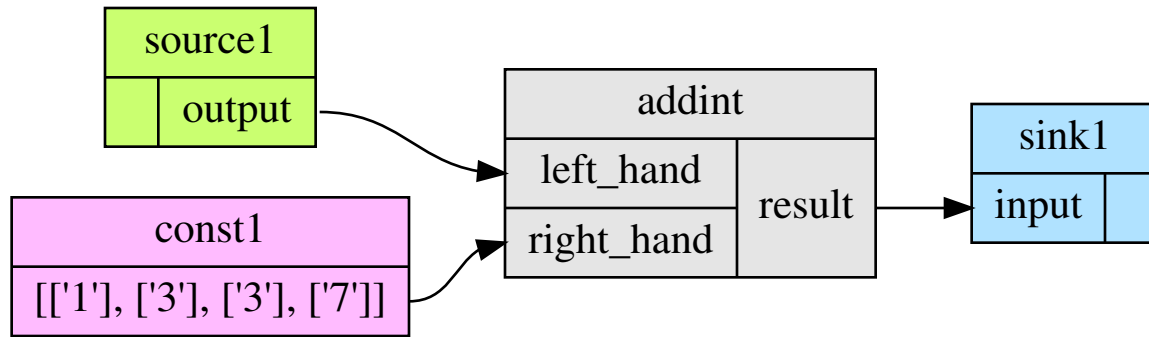
For a sample configuration file and a complete overview of the options in `config.py` see the [Config file](#) section.

Creating a simple network

If Fastr is properly installed and configured, we can start creating networks. Creating a network is very simple:

```
>>> import fastr
>>> network = fastr.Network()
```

Now we have an empty network, the next step is to create some nodes and links. Imagine we want to create the following network:



Creating nodes

We will create the nodes and add them to the network. The easiest way to do this is via the network `create_` methods. Let's create two source nodes, one normal node, and one sink:

```
>>> source1 = network.create_source('Int', id='source1')
>>> constant1 = network.create_constant('Int', [1, 3, 3, 7], id='const1')
>>> sink1 = network.create_sink('Int', id='sink1')
>>> addint = network.create_node('AddInt', id='addint')
```

The functions `Network.create_source`, `Network.create_constant`, `Network.create_source` and `Network.create_sink` are shortcut functions for calling the `SourceNodeRun`, `ConstantNodeRun`, `SinkNodeRun` and `NodeRun` constructors and adding them to the network. A `SourceNodeRun` and `SinkNodeRun` only require the datatype to be specified. A `ConstantNodeRun` requires both the datatype and the data to be set on creation. A `NodeRun` requires a `Tool` template to be instantiated from. The `id_` option is optional for all three, but makes it easier to identify the nodes and read the logs.

There is an easier way to add a constant to an input, by using a shortcut method. If you assign a list or tuple to an item in the input list, it will automatically create a `ConstantNodeRun` and a `Link` between the constant and the input:

```
>>> addint.inputs['right_hand'] = [1, 3, 3, 7]
```

The created constant would have the id `addint__right_hand__const` as it automatically names the new constant `$nodeid__$inputid__const`.

In an interactive python session we can simply look at the basic layout of the node using the `repr` function. Just type the name of the variable holding the node and it will print a human readable representation:

```
>>> source1
SourceNodeRun source1 (tool: source v1.0)
  Inputs      |      Outputs
-----
              |  output   (Int)

>>> addint
NodeRun addint (tool: AddInt v1.0)
  Inputs      |      Outputs
-----
left_hand  (Int) | result   (Int)
right_hand (Int) |
```

This tool has inputs of type `Int`, so the sources and sinks need to have a matching datatype.

The tools and datatypes available are stored in `fastr.toollist` and `fastr.typelist`. These variables are

created when `fastr` is imported for the first time. They contain all the datatype and tools specified by the xml files in the search paths. To get an overview of the tools and datatypes loaded by `fastr`:

```
>>> fastr.toollist
ToolManager
Add          v0.1          : /home/hachterberg/dev/fastr-develop/
↳ fastr/fastr/resources/tools/add/v1_0/add.xml
AddImages    v0.1          : /home/hachterberg/dev/fastr-develop/
↳ fastr/fastr/resources/tools/addimages/v1_0/addimages.xml
AddInt        v0.1          : /home/hachterberg/dev/fastr-develop/
↳ fastr/fastr/resources/tools/addint/v1_0/addint.xml

>>> fastr.typelist
DataTypeManager
AnyType      : <class 'fastr.datatypes.AnyType'>
Boolean      : <class 'fastr.datatypes.Boolean'>
Directory    : <class 'fastr.datatypes.Directory'>
Float        : <class 'fastr.datatypes.Float'>
Int          : <class 'fastr.datatypes.Int'>
String       : <class 'fastr.datatypes.String'>
```

The `fastr.toollist` variable contains all tools that Fastr could find during initialization. Tools can be chosen in two ways:

- `toollist[id]` which returns the newest version of the tool
- `toollist[id, version]` which returns the specified version of the tool

Creating links

So now we have a network with 4 nodes defined, however there is no relation between the nodes yet. For this we have to create some links.

```
>>> link1 = network.create_link(source1.output, addint.inputs['left_hand'])
>>> link2 = network.create_link(constant1.output, addint.inputs['right_hand'])
>>> link3 = network.create_link(addint.outputs['result'], sink1.inputs['input'])
```

This asks the network to create links and immediately store them inside the network. A link always points from an Output to an Input (note that SubOutput or SubInputs are also valid). A SourceNodeRun has only 1 output which is fixed, so it is easy to find. However, `addImage` has two inputs and one output, this requires us to specify which output we need. A normal node has a mapping with Inputs and one with Outputs. They can be indexed with the appropriate id's. The function returns the links, but you only need that if you are planning to change a link. If not, it is possible to use a short-hand which creates a link but gives you no easy access to it for later.

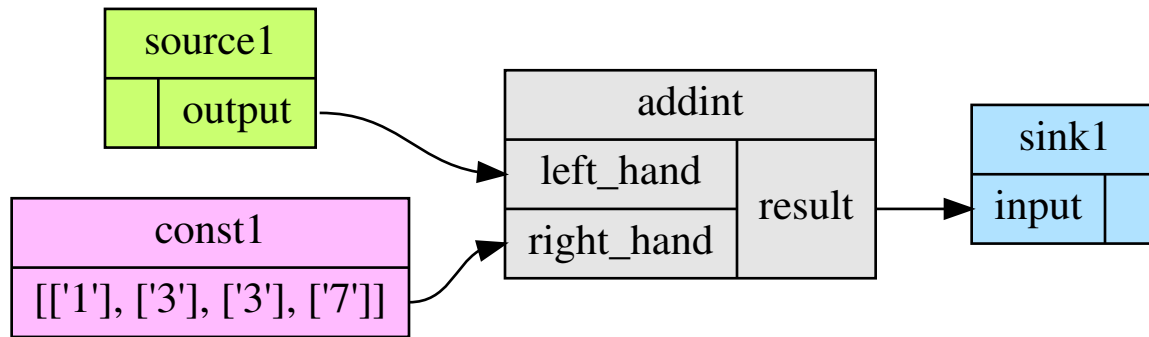
```
>>> addint.inputs['left_hand'] = source1.output
>>> addint.inputs['right_hand'] = constant1.output
>>> sink1.inputs['input'] = addint.outputs['result']
```

Create an image of the Network

For checking your Network it is very useful to have a graphical representation of the network. This can be achieved using the `Network.draw_network` method.

```
>>> network.draw_network()
'/home/username/network_layout.dot.svg'
```

This will create a figure in the path returned by the function that looks like:



Note: for this to work you need to have graphviz installed

Running a Network

Running a network locally is almost as simple as calling the `Network.execute` method:

```
>>> source_data = {'source1': {'s1': 4, 's2': 5, 's3': 6, 's4': 7}}
>>> sink_data = {'sink1': 'vfs://tmp/fastr_result_{sample_id}.txt'}
>>> network.execute(source_data, sink_data)
```

As you can see the execute method needs data for the sources and sinks. This has to be supplied in two `dict` that have keys matching every source/sink id in the network. Not supplying data for every source and sink will result in an error, although it is possible to pass an empty `list` to a source.

Note: The values of the source data have to be simple values or urls and values of the sink data have to be url templates. To see what url schemes are available and how they work see [IOPlugin Reference](#). For the sink url templates see `SinkNodeRun.set_data`

For source nodes you can supply a `list` or a `dict` with values. If you supply a `dict` the keys will be interpreted as sample ids and the values as the corresponding values. If you supply a `list`, keys will be generated in the form of `id_{N}` where N will be index of the value in the list.

Warning: As a `dict` does not have a fixed order, when a `dict` is supplied the samples are ordered by key to get a fixed order! For a `list` the original order is retained.

For the sink data, an url template has to be supplied that governs how the data is stored. The mini-language (the replacement fields) are described in the `SinkNodeRun.set_data` method.

To rerun a stopped/crashed pipeline check the user manual on [Continuing a Network](#)

User Manual

In this chapter we will discuss the parts of Fastr in more detail. We will give a more complete overview of the system and describe the more advanced features.

Tools

The *Tools* in Fastr are the building blocks of each workflow. A tool represents a program/script/binary that can be called by Fastr and can be seen as a template. A *Node* can be created based on a *Tool*. The Node will be one processing step in a workflow, and the tool defines what the step does.

On the import of Fastr, all available *Tools* will be loaded in a default *ToolManager* that can be accessed via `fastr.toollist`. To get an overview of the tools in the system, just print the `repr()` of the *ToolManager*:

```
>>> fastr.toollist
AddImages          v0.1      : /home/hachterberg/dev/fastr/fastr/resources/tools/
↳addimages/v1_0/addimages.xml
AddInt             v0.1      : /home/hachterberg/dev/fastr/fastr/resources/tools/
↳addint/v1_0/addint.xml
```

As you can see it gives the tool id, version and the file from which it was loaded for each tool in the system. To view the layout of a tool, just print the `repr()` of the tool itself.

```
>>> fastr.toollist['AddInt']
Tool AddInt v0.1 (Add two integers)
      Inputs      |      Outputs
-----|-----
left_hand  (Int)  | result  (Int)
right_hand (Int)  |
```

To add a *Tool* to the system a file should be added to one of the path in `fastr.config.tools_path`. The structure of a tool file is described in *Tool description*

Create your own tool

There are 4 steps in creating a tool:

1. **Create folders.** We will call the tool ThrowDie. Create the folder `throw_die` in the folder `fastr-tools`. In this folder create another folder called `bin`.
2. **Place executable in correct place.** In this example we will use a snippet of executable python code:

```
#!/usr/bin/env python
import sys
import random
import json

if (len(sys.argv) > 1):
    sides = int(sys.argv[1])
else:
    sides = 6
result = [int(random.randint(1, sides))]

print('RESULT={}'.format(json.dumps(result)))
```

Save this text in a file called `throw_die.py`

Place the executable python script in the folder `throw_die/bin`

3. **Create and edit xml file for tool.** See *tool definition reference* for all the fields that can be defined in a tool.

Put the following text in file called `throw_die.xml`.

```

<tool id="ThrowDie" description="Simulates a throw of a die. Number of sides of
↳the die is provided by user"
    name="throw_die" version="1.0">
    <authors>
        <author name="John Doe" />
    </authors>
    <command version="1.0" >
        <authors>
            <author name="John Doe" url="http://a.b/c" />
        </authors>
        <targets>
            <target arch="*" bin="throw_die.py" interpreter="python" os="*" paths='bin/
↳' />
        </targets>
        <description>
            throw_die.py number_of_sides
            output = simulated die throw
        </description>
    </command>
    <interface>
        <inputs>
            <input cardinality="1" datatype="Int" description="Number of die sides" id=
↳"die_sides" name="die sides" nospace="False" order="0" required="True"/>
        </inputs>
        <outputs>
            <output id="output" name="output value" datatype="Int" automatic="True"
↳cardinality="1" method="json" location="^\RESULT=(.*)$" />
        </outputs>
    </interface>
</tool>

```

Put throw_die.xml in the folder example_tool. All Attributes in the example above are required. For a complete overview of the xml Attributes that can be used to define a tool, check the [Tool description](#). The most important Attributes in this xml are:

```

id      : The id is used in in FASTR to create an instance of your tool, this
↳name will appear in the toollist when you type fastr.toollist.
targets : This defines where the executables are located and on which platform
↳they are available.
inputs  : This defines the inputs that you want to be used in FASTR, how FASTR
↳should use them and what data is allowed to be put in there.

```

More xml examples can be found in the fastr-tools folder.

4. **Edit configuration file.** Append the line [PATH TO LOCATION OF FASTR-TOOLS]/fastr-tools/throw_die/ to the the config.py (located in ~/.fastr/ directory) to the tools_path. See [Config file](#) for more information on configuration.

You should now have a working tool. To test that everything is ok do the following in python:

```

>>> import fastr
>>> fastr.toollist

```

Now a list of available tools should be produced, including the tool throw_die

To test the tool create the script test_throwdie.py:

```

import fastr
network = fastr.Network()

```

```
source1 = network.create_source(fastr.typelist['Int'], id_='source1')
sink1 = network.create_sink(fastr.typelist['Int'], id_='sink1')
throwdie = network.create_node(fastr.toollist['ThrowDie'], id_='throwdie')
link1 = network.create_link(source1.output, throwdie.inputs['die_sides'])
link2 = network.create_link(throwdie.outputs['output'], sink1.inputs['input
↔'])
source_data = {'source1': {'s1': 4, 's2': 5, 's3': 6, 's4': 7}}
sink_data = {'sink1': 'vfs://tmp/fastr_result_{sample_id}.txt'}
network.draw_network()
network.execute(source_data, sink_data)
```

Call the script from commandline by

```
$ python test_throwdie.py
```

An image of the network will be created in the current directory and result files will be put in the tmp directory. The result files are called fastr_result_s1.txt, fastr_result_s2.txt, fastr_result_s3.txt, and fastr_result_s4.txt

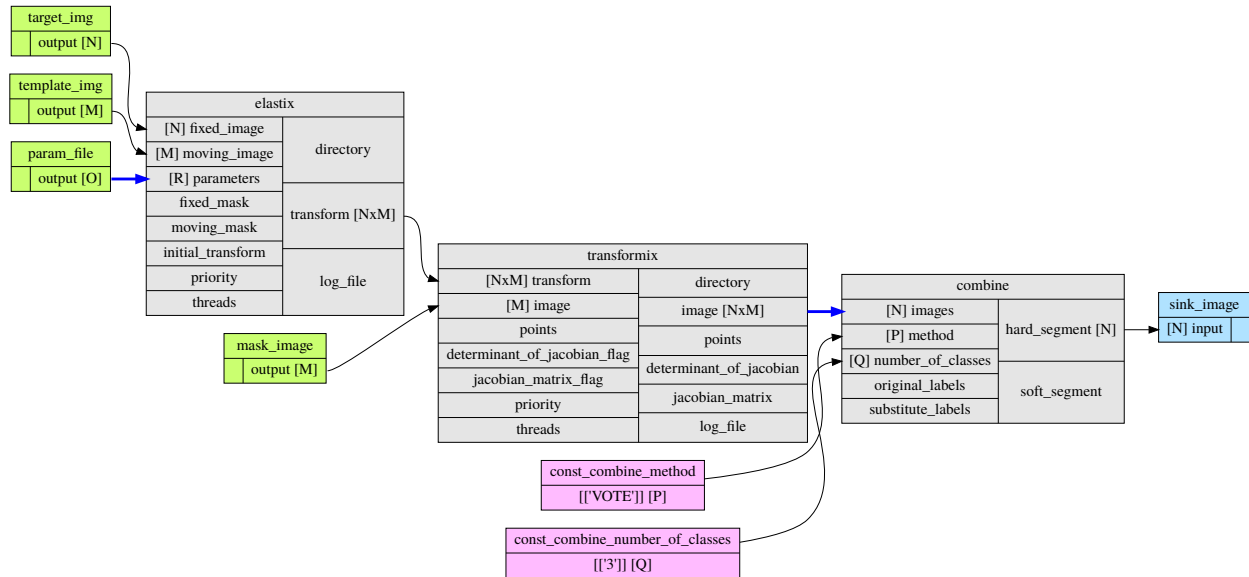
Note: If you have code which is operating system depend you will have to edit the xml file. The following gives an example of how the elastix tool does this:

```
<targets>
  <target os="windows" arch="*" bin="elastix.exe">
    <paths>
      <path type="bin" value="vfs://apps/elastix/4.7/install/" />
      <path type="lib" value="vfs://apps/elastix/4.7/install/lib" />
    </paths>
  </target>
  <target os="linux" arch="*" modules="elastix/4.7" bin="elastix">
    <paths>
      <path type="bin" value="vfs://apps/elastix/4.7/install/" />
      <path type="lib" value="vfs://apps/elastix/4.7/install/lib" />
    </paths>
  </target>
  <target os="darwin" arch="*" modules="elastix/4.7" bin="elastix">
    <paths>
      <path type="bin" value="vfs://apps/elastix/4.7/install/" />
      <path type="lib" value="vfs://apps/elastix/4.7/install/lib" />
    </paths>
  </target>
</targets>
```

vfs is the virtual file system path, more information can be found at [VirtualFileSystem](#).

Network

A *Network* represented an entire workflow. It hold all *Nodes*, *Links* and other information required to execute the workflow. Networks can be visualized as a number of building blocks (the Nodes) and links between them:



An empty network is easy to create, all you need is to name it:

```
>>> network = fastr.Network(id_="network_name")
```

The *Network* is the main interface to Fastr, from it you can create all elements to create a workflow. In the following sections the different elements of a *Network* will be described in more detail.

Node

Nodes are the point in the *Network* where the processing happens. A *Node* takes the input data and executes jobs as specified by the underlying *Tool*. A *Nodes* can be created in a two different ways:

```
>>> node1 = fastr.Node(tool, id_='node1', parent=network)
>>> node2 = network.create_node(tool, id_='node2', stepid='step1')
```

In the first way, we specifically create a *Node* object. We pass it an *id* and the *parent* network. If the *parent* is *None* the *fastr.curent_network* will be used. The *Node* constructor will automatically add the new node to the *parent* network.

Note: For a *Node*, the tool can be given both as the *Tool* class or the *id* of the

tool.

The second way, we tell the *network* to create a *Node*. The *network* will automatically assign itself as the *parent*. Optionally you can add define a *stepid* for the node which is a logical grouping of *Nodes* that is mostly used for visualization.

A *Node* contains *Inputs* and *Outputs*. To see the layout of the *Node* one can simply look at the *repr()*.

```
>>> addint = fastr.Node(fastr.toollist['AddInt'], id_='addint')
>>> addint
Node addint (tool: AddInt v1.0)
      Inputs      |      Outputs
-----
left_hand  (Int)  |  result   (Int)
right_hand (Int)  |
```

The inputs and outputs are located in mappings with the same name:

```
>>> addint.inputs
InputDict([('left_hand', <Input: fastr:///networks/unnamed_network/nodelist/addint/
↳inputs/left_hand>), ('right_hand', <Input: fastr:///networks/unnamed_network/
↳nodelist/addint/inputs/right_hand>)])

>>> addint.outputs
OutputDict([('result', Output fastr:///networks/unnamed_network/nodelist/addint/
↳outputs/result)])
```

The *InputDict* and *OutputDict* are classes that behave like mappings. The *InputDict* also facilitates the linking shorthand. By assigning an *Output* to an existing key, the *InputDict* will create a *Link* between the *InputDict* and *Output*.

SourceNode

A *SourceNode* is a special kind of node that is the start of a workflow. The *SourceNodes* are given data at run-time that fetched via *IOPugins*. On create, only the datatype of the data that the *SourceNode* supplied needs to be known. Creating a *SourceNode* is very similar to an ordinary node:

```
>>> source1 = fastr.SourceNode('Int', id_='source1')
>>> source2 = network.create_source(fastr.typelist['Int'], id_='source2', stepid=
↳'step1')
```

In both cases, the source is automatically assigned to a network. In the first case to the `fastr.current_network` and in the second case to the `network` used to call the method. A *SourceNode* only has a single output which has a short-cut access via `source.output`.

Note: For a source or constant node, the datatype can be given both as the *BaseDataType* class or the id of the datatype.

ConstantNode

A *ConstantNode* is another special node. It is a subclass of the *SourceNode* and has a similar function. However, instead of setting the data at run-time, the data of a constant is given at creation and saved in the object. Creating a *ConstantNode* is similar as creating a source, but with supplying data:

```
>>> constant1 = fastr.ConstantNode('Int', [42], id_='constant1')
>>> constant2 = network.create_constant('Int', [42], id_='constant2', stepid='step1')
```

Often, when a *ConstantNode* is created, it is created specifically for one input and will not be reused. In this case there is a shorthand to create and link a constant to an input:

```
>>> addint.inputs['value1'] = [42]
```

will create a constant node with the value 42 and create a link between the output and input `addint.value1`.

SinkNode

The *SinkNode* is the counter-part of the source node. Instead of get data into the workflow, it saves the data resulting from the workflow. For this a rule has to be given at run-time that determines where to store the data. The information about how to create such a rule is described at `SinkNode.set_data`. At creation time, only the datatype has to be specified:

```
>>> sink1 = fastr.Sink('Int', id_='sink1')
>>> sink2 = network.create_sink(fastr.typelist['Int'], id_='sink2', stepid='step1')
```

Link

Links indicate how the data flows between *Nodes*. Links can be created explicitly using on of the following:

```
>>> link = fastr.Link(node1.outputs['image'], node2.inputs['image'])
>>> link = network.create_link(node1.outputs['image'], node2.inputs['image'])
```

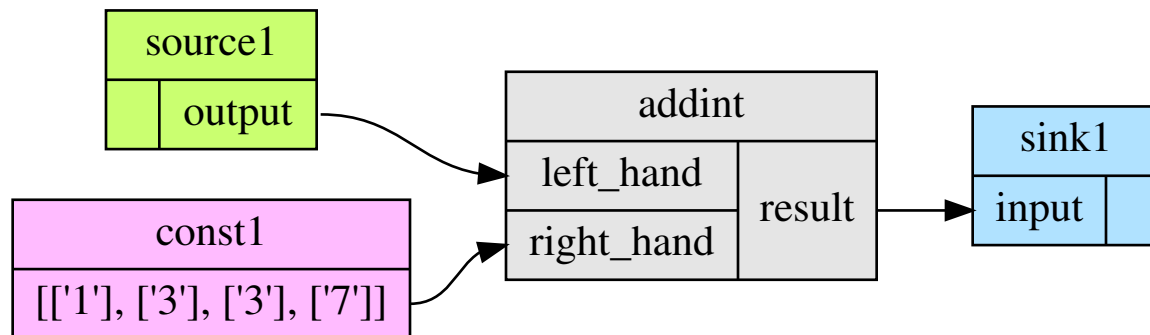
or can be create implicitly by assigning an *Output* to an *Input* in the *InputDict*.

```
# This style of assignment will create a Link similar to above
>>> node2.inputs['image'] = node1.outputs['image']
```

Note that a *Link* is also create automatically when using the short-hand for the *ConstantNode*

Data Flow

The data enters the *Network* via *SourceNodes*, flows via other *Nodes* and leaves the *Network* via *SinkNodes*. The flow between *Nodes* goes from an *Output* via a *Link* to an *Input*. In the following image it is simple to track the data from the *SourceNodes* at the left to the *SinkNodes* at right side:



Note that the data in Fastr is stored in the *Output* and the *Link* and *Input* just give access to it (possible while transforming the data).

Data flow inside a Node

In a *Node* all data from the *Inputs* will be combined and the jobs will be generated. There are strict rules to how this combination is performed. In the default case all inputs will be used pair-wise, and if there is only a single value for an input, it will be considered as a constant.

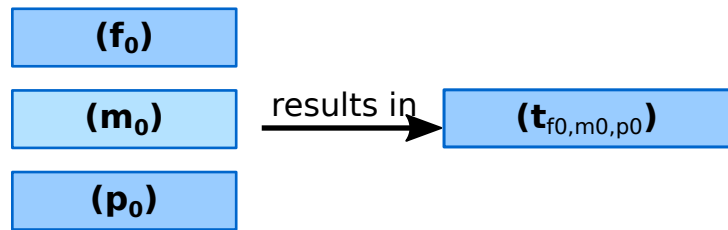
To illustrate this we will consider the following *Tool* (note this is a simplified version of the real tool):

```
>>> fastr.toollist['Elastix']
Tool Elastix v4.8 (Elastix Registration)
```

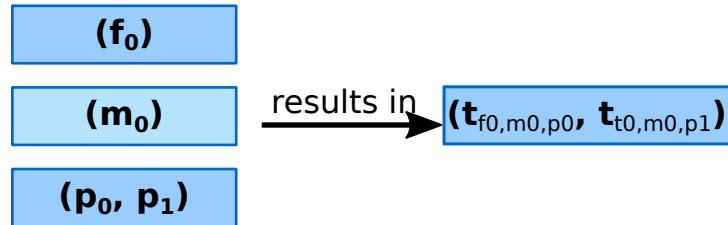
Inputs			Outputs
-----			-----
fixed_image	(ITKImageFile)		transform_
→ (ElastixTransformFile)			
moving_image	(ITKImageFile)		
parameters	(ElastixParameterFile)		

Also it is important to know that for this tool (by definition) the cardinality of the transform *Output* will match the cardinality of the parameters *Inputs*

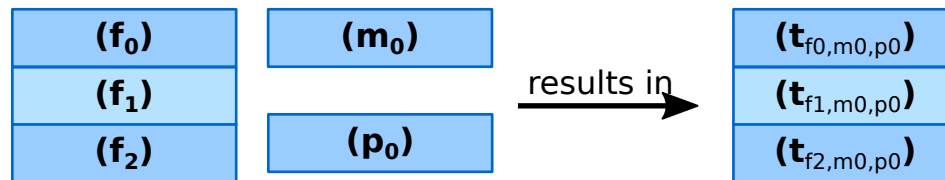
If we supply a *Node* based on this *Tool* with a single sample on each *Input*, there will be one single matching *Output* sample created:



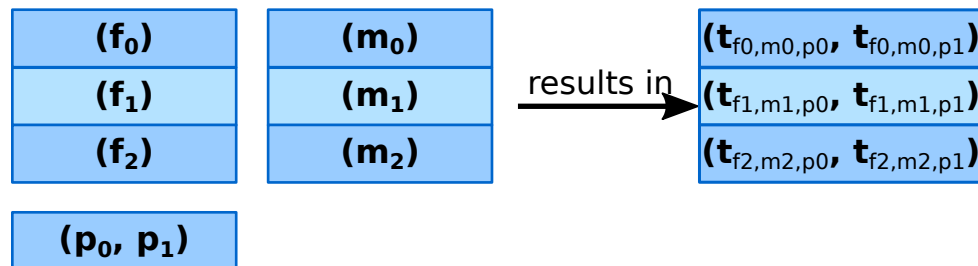
If the cardinality of the parameters sample would be increased to 2, the resulting transform sample would also become 2:



Now if the number of samples on fixed_image would be increased to 3, the moving_image and parameters will be considered constant and be repeated, resulting in 3 transform samples.



Then if the amount of samples for moving_image is also increased to 3, the moving_image and fixed_image will be used pairwise and the parameters will be constant.

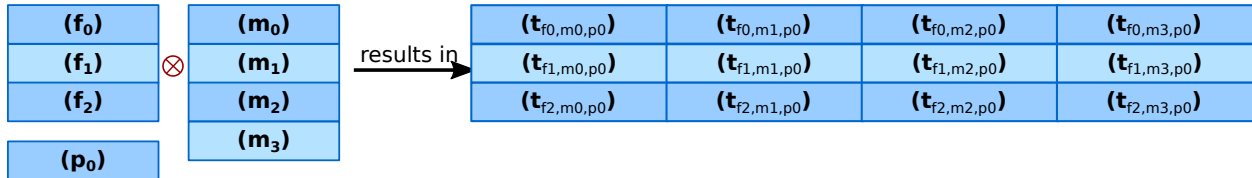


Advanced flows in a Node

Sometimes the default pairwise behaviour is not desirable. For example if you want to test all combinations of certain input samples. To achieve this we can change the `input_group` of `Inputs` to set them apart from the rest. By default all `Inputs` are assigned to the default input group. Now let us change that:

```
>>> node = network.create_node('Elastix', id_='elastix')
>>> node.inputs['moving_image'].input_group = 'moving'
```

This will result in `moving_image` to be put in a different input group. Now if we would supply `fixed_image` with 3 samples and `moving_image` with 4 samples, instead of an error we would get the following result:

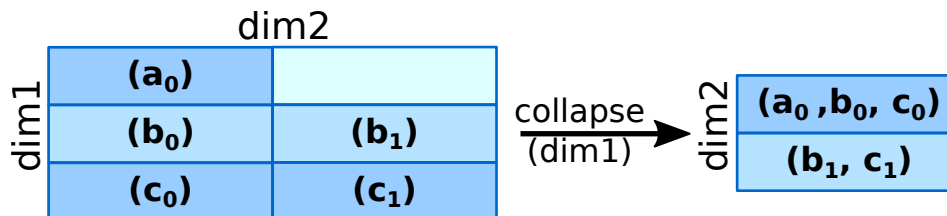


Warning: TODO: Expand this section with the merging dimensions

Data flows in a Link

As mentioned before the data flows from an `Output` to an `Input` through a `Link`. By default the `Link` passed the data as is, however there are two special directives that change the shape of the data:

1. Collapsing flow, this collapses certain dimensions from the sample array into the cardinality. As a user you have to specify the dimension or tuple of dimensions you want to collapse.

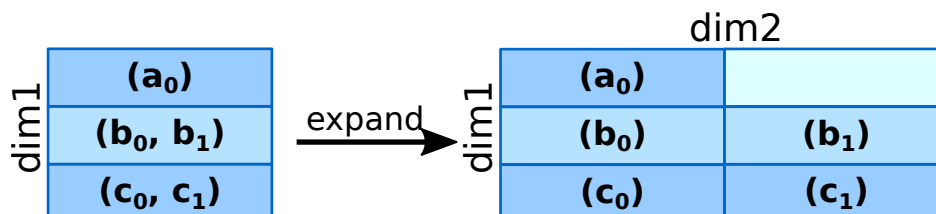


This is useful in situation where you want to use a tool that aggregates over a number of samples (e.g. take a mean or sum).

To achieve this you can set the `collapse` property of the `Link` as follows:

```
>>> link.collapse = 'dim1'
>>> link.collapse = ('dim1', 'dim2') # In case you want to collapse multiple_
↳ dimensions
```

2. Expanding flow, this turns the cardinality into a new dimension. The new dimension will be named after the `Output` from which the link originates. It will be in the form of `{nodeid}__{outputid}`

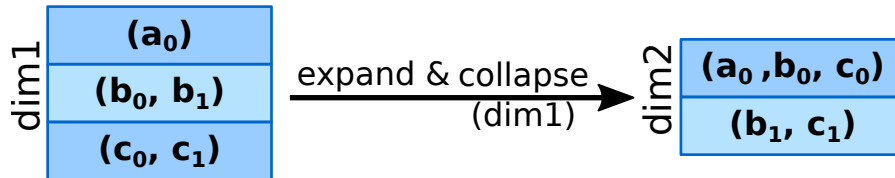


This flow directive is useful if you want to split a large sample in multiple smaller samples. This could be because processing the whole sample is not feasible because of resource constraints. An example would be splitting a 3D image into slices to process separately to avoid high memory use or to achieve parallelism.

To achieve this you can set the `expand` property of the `Link` to `True`:

```
>>> link.expand = True
```

Note: both collapsing and expanding can be used on the same link, it will executes similar to a expand-collapse sequence, but the newly created expand dimension is ignored in the collapse.



```
>>> link.collapse = 'dim1'
>>> link.expand = True
```

Data flows in an Input

If an `Inputs` has multiple `Links` attached to it, the data will be combined by concatenating the values for each corresponding sample in the cardinality.

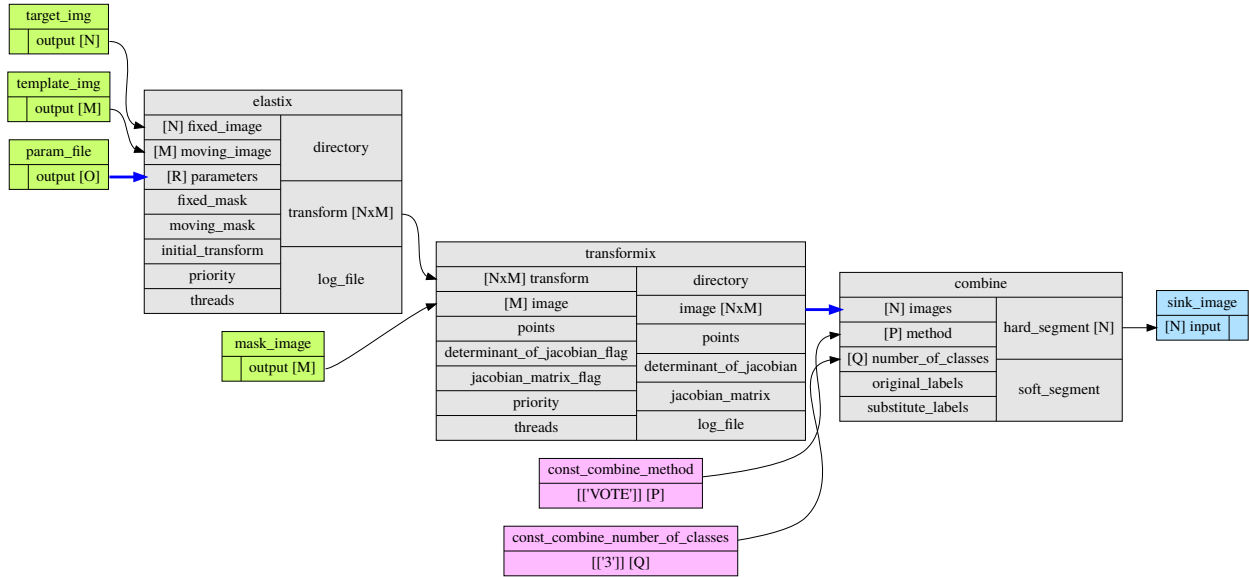
Broadcasting (matching data of different dimensions)

Sometimes you might want to combine data that does not have the same number of dimensions. As long as all dimensions of the lower dimensional datasets match a dimension in the higher dimensional dataset, this can be achieved using *broadcasting*. The term *broadcasting* is borrowed from `NumPy` and described as:

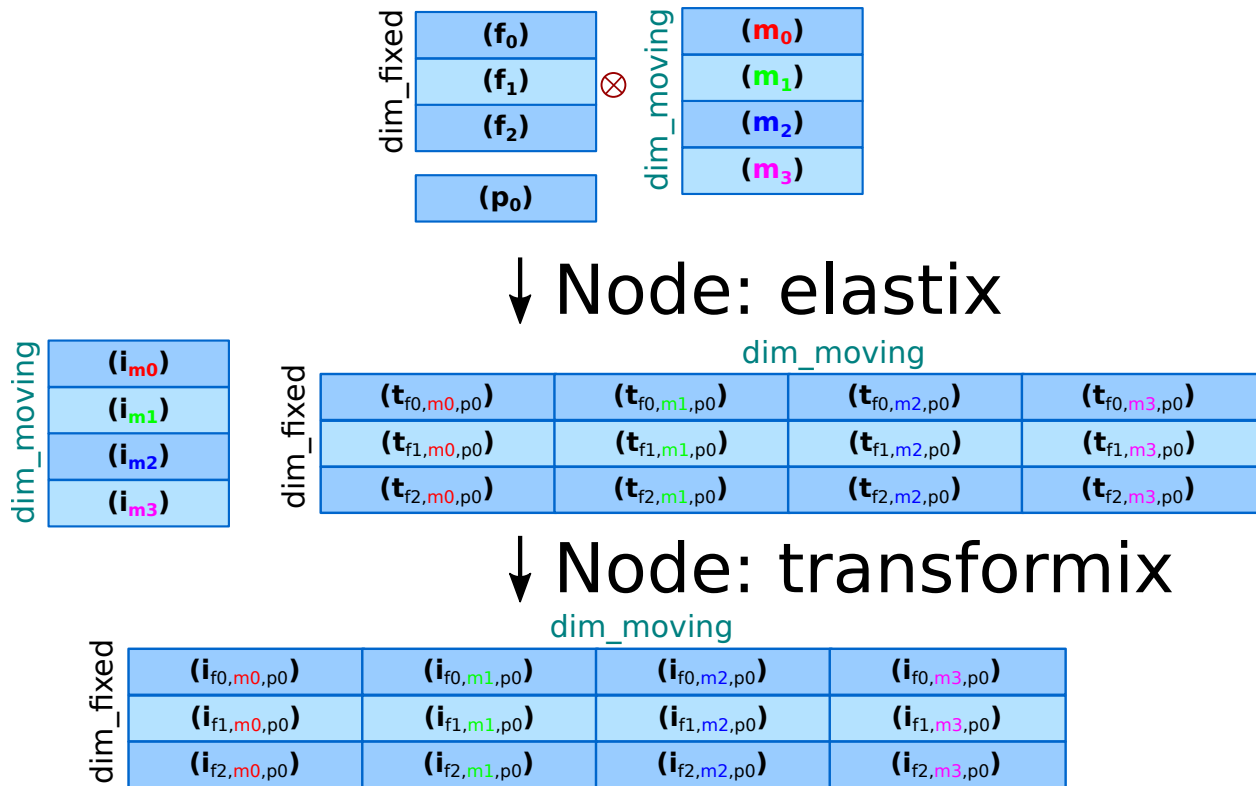
“The term broadcasting describes how numpy treats arrays with different shapes during arithmetic operations. Subject to certain constraints, the smaller array is “broadcast” across the larger array so that they have compatible shapes.”

—NumPy manual on broadcasting

In `fastr` it works similar, but to combined different `Inputs` in an `InputGroup`. To illustrate broadcasting it is best to use an example, the following network uses broadcasting in the `transformix` Node:



As you can see this visualization prints the dimensions for each Input and Output (e.g. the `elastix.fixed_image` Input has dimensions `[N]`). To explain what happens in more detail, we present an image illustrating the details for the samples in `elastix` and `transformix`:



In the figure the `moving_image` (and references to it) are identified with different colors, so they are easy to track across the different steps.

At the top the Inputs for the `elastix` Node are illustrated. Because the input groups a set differently, output samples are generated for all combinations of `fixed_image` and `moving_image` (see [Advanced flows in a Node](#) for details).

In the `transformix` Node, we want to combine a list of samples that is related to the `moving_image` (it has the same dimension name and sizes) with the resulting `transform` samples from the `elastix` Node. As you can see the sizes of the sample collections do not match ($[N]$ vs $[N \times M]$). This is where *broadcasting* comes into play, it allows the system to match these related sample collections. Because all the dimensions in $[N]$ are known in $[N \times M]$, it is possible to match them uniquely. This is done automatically and the result is a new $[N \times M]$ sample collection. To create a matching sample collections, the samples in the `transformix.image` Input are reused as indicated by the colors.

Warning: Note that this might fail when there are data-blocks with non-unique dimension names, as it will be not be clear which of the dimensions with identical names should be matched!

DataTypes

In Fastr all data is contained in object of a specific type. The types in Fastr are represented by classes that subclass `BaseDataType`. There are a few different other classes under `BaseDataType` that are each a base class for a family of types:

- `DataType` – The base class for all types that hold data
 - `ValueType` – The base class for types that contain simple data (e.g. Int, String) that can be represented as a str
 - `EnumType` – The base class for all types that are a choice from a `set` of options
 - `URLType` – The base class for all types that have their data stored in files (which are referenced by URL)
- `TypeGroup` – The base class for all types that actually represent a group of types

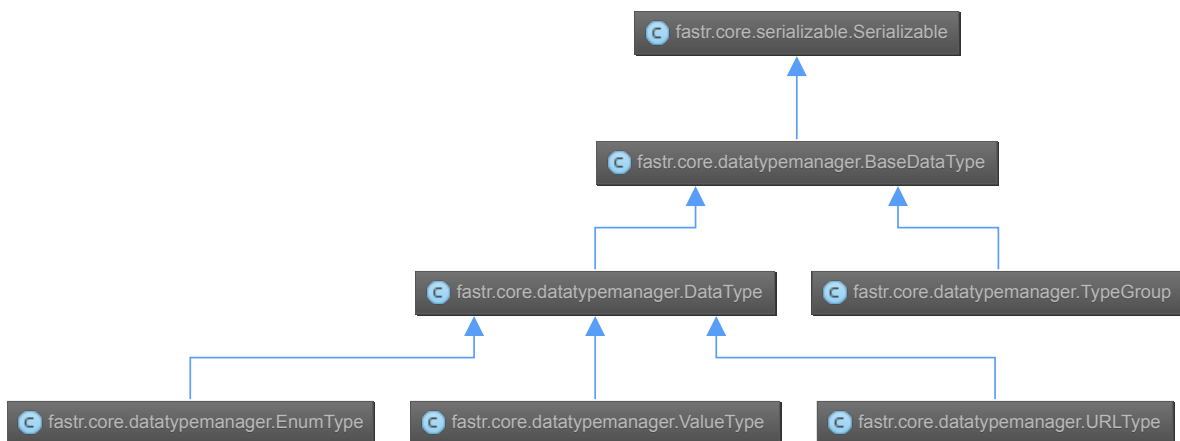


Fig. 1.2: The relation between the different `DataType` classes

The types are defined in xml files and created by the `DataTypeManager`. The `DataTypeManager` acts as a container containing all Fastr types. It is automatically instantiated as `fastr.typelist`. In fastr the created `DataType`s classes are also automatically place in the `fastr.datatypes` module once created.

Resolving Datatypes

`Outputs` in fastr can have a `TypeGroup` or a number of `DataType`s associated with them. The final `DataType`

used will depend on the linked *Inputs*. The *DataType* resolving works as a two-step procedure.

1. All possible *DataTypes* are determined and considered as *options*.
2. The best possible *DataType* from *options* is selected for non-automatic Outputs

The *options* are defined as the intersection of the set of possible values for the *Output* and each separate *Input* connected to the *Output*. Given the resulting *options* there are three scenarios:

- If there are no valid *DataTypes* (*options* is empty) the result will be None.
- If there is a single valid *DataType*, then this is automatically the result (even if it is not a preferred *DataType*).
- If there are multiple valid *DataTypes*, then the preferred *DataTypes* are used to resolve conflicts.

There are a number of places where the preferred *DataTypes* can be set, these are used in the order as given:

1. The *preferred* keyword argument to *match_types*
2. The preferred types specified in the *fastr.config*

Execution

Executing a Network is very simple:

```
>>> source_data = {'source_id1': ['val1', 'val2'],
                  'source_id2': {'id3': 'val3', 'id4': 'val4'}}
>>> sink_data = {'sink_id1': 'vfs://some_output_location/{sample_id}/file.txt'}
>>> network.execute(source_data, sink_data)
```

The *Network.execute* method takes a *dict* of source data and a *dict* sink data as arguments. The dictionaries should have a key for each *SourceNode* or *SinkNode*.

TODO: add .. figure:: images/execution_layers.*

The execution of a Network uses a layered model:

- *Network.execute* will analyze the Network and call all Nodes.
- *Node.execute* will create jobs and fill their payload
- *execute_job* will execute the job on the execute machine and resolve any deferred values (*val* : // urls).
- *Tool.execute* will find the correct target and call the interface and if required resolve *vfs* : // urls
- *Interface.execute* will actually run the required command(s)

The *ExecutionPlugin* will call the *executionscript.py* for each job, passing the job as a gzipped pickle file. The *executionscript.py* will resolve deferred values and then call *Tool.execute* which analyses the required target and executes the underlying *Interface*. The *Interface* actually executes the job and collect the results. The result is returned (via the *Tool*) to the *executionscript.py*. There we save the result, provenance and profiling in a new gzipped pickle file. The execution system will use a callback to load the data back into the Network.

The selection and settings of the *ExecutionPlugin* are defined in the *fastr config*.

Continuing a Network

Normally a random temporary directory is created for each run. To continue a previously stopped/crashed network, you should call the *Network.execute* method using the same temporary directory(tmp dir). You can set the temporary directory to a fixed value using the following code:

```
>>> tmpdir = '/tmp/example_network_rerun'
>>> network.execute(source_data, sink_data, tmpdir=tmpdir)
```

Warning: Be aware that at this moment, Fastr will rerun only the jobs where not all output files are present or if the job/tool parameters have been changed. It will not rerun if the input data of the node has changed or the actual tools have been adjusted. In these cases you should remove the output files of these nodes, to force a rerun.

IOPlugins

Sources and sink are used to get data in and out of a *Network* during execution. To make the data retrieval and storage easier, a plugin system was created that selects different plugins based on the URL scheme used. So for example, a url starting with `vfs://` will be handles by the `VirtualFileSystem` plugin. A list of all the *IOPlugins* known by the system and their use can be found at *IOPlugin Reference*.

Secrets

Fastr uses a secrets system for storing and retrieving login credentials. Currently the following keyrings are supported:

- Python keyring and keyrings.alt lib: - Mac OS X Keychain - Freedesktop Secret Service (requires secretstorage) - KWallet (requires dbus) - Windows Credential Vault - Gnome Keyring - Google Keyring (stores keyring on Google Docs) - Windows Crypto API (File-based keyring secured by Windows Crypto API) - Windows Registry Keyring (registry-based keyring secured by Windows Crypto API) - PyCrypto File Keyring - Plaintext File Keyring (not recommended)
- Netrc (not recommended)

When a password is retrieved trough the fastr SecretService it loops trough all of the available SecretProviders (currently keyring and netrc) until a match is found.

The Python keyring library automatically picks the best available keyring backend. If you wish to choose your own python keyring backend it is possible to do so by make a keyring configuration file according to the keyring library documentation. The python keyring library connects to one keyring. Currently it cannot loop trough all available keyrings until a match is found.

Debugging

This section is about debugging Fastr tools wrappers, Fastr Networks (when building a Network) and Fastr Network Runs.

Debugging a Fastr tool

When wrapping a Tool in Fastr sometimes it will not work as expected or not load properly. Fastr is shipped with a command that helps checking Tools. The *fastr verify* command can try to load a Tool in steps to make it more easy to understand where the loading went wrong.

The `fastr verify` command will use the following steps:

- Try to load the tool with and without compression
- Try to find the correct serializer and make sure the format is correct
- Try to validate the Tool content against the json_schema of a proper Tool

- Try to create a Tool object
- If available, execute the tool test

An example of the use of `fastr verify`:

```
$ fastr verify tool fastr/resources/tools/fastr/math/0.1/add.xml
[INFO]    verify:0020 >> Trying to read file with compression OFF
[INFO]    verify:0036 >> Read data from file successfully
[INFO]    verify:0040 >> Trying to load file using serializer "xml"
[INFO]    verify:0070 >> Validating data against Tool schema
[INFO]    verify:0080 >> Instantiating Tool object
[INFO]    verify:0088 >> Loaded tool <Tool: Add version: 1.0> successfully
[INFO]    verify:0090 >> Testing tool...
```

If your Tool is loading but not functioning as expected you might want to easily test your Tool without building an entire Network around it that can obscure errors. It is possible to run a tool from the Python prompt directly using `tool.execute`:

```
>>> tool.execute(left_hand=40, right_hand=2)
[INFO] localbinarytarget:0090 >> Changing ./bin
[INFO]    tool:0311 >> Target is <Plugin: LocalBinaryTarget>
[INFO]    tool:0318 >> Using payload: {'inputs': {'right_hand': (2,), 'left_hand': (40,)}, 'outputs': {}}
[INFO] localbinarytarget:0135 >> Adding extra PATH: ['/home/hachterberg/dev/fastr-develop/fastr/resources/tools/fastr/math/0.1/bin']
[INFO] fastrinterface:0393 >> Execution payload: {'inputs': {'right_hand': (2,), 'left_hand': (40,)}, 'outputs': {}}
[INFO] fastrinterface:0496 >> Adding (40,) to argument list based on <fastrinterface.InputParameterDescription object at 0x7fc950fa8850>
[INFO] fastrinterface:0496 >> Adding (2,) to argument list based on <fastrinterface.InputParameterDescription object at 0x7fc950fa87d0>
[INFO] localbinarytarget:0287 >> Options: ['/home/hachterberg/dev/fastr-develop/fastr/resources/tools/fastr/math/0.1/bin']
[INFO] localbinarytarget:0201 >> Calling command arguments: ['python', '/home/hachterberg/dev/fastr-develop/fastr/resources/tools/fastr/math/0.1/bin/addint.py', '--in1', '40', '--in2', '2']
[INFO] localbinarytarget:0205 >> Calling command: "python /home/hachterberg/dev/fastr-develop/fastr/resources/tools/fastr/math/0.1/bin/addint.py --in1 '40' --in2 '2'"
[INFO] fastrinterface:0400 >> Collecting results
[INFO] executionpluginmanager:0467 >> Callback processing thread ended!
[INFO] executionpluginmanager:0467 >> Callback processing thread ended!
[INFO] executionpluginmanager:0467 >> Callback processing thread ended!
[INFO] jsoncollector:0076 >> Setting data for result with [42]
<fastr.core.interface.InterfaceResult at 0x7fc9661ccfd0>
```

In this case an `AddInt` was ran from the python shell. As you can see it shows the payload it created based on the call, followed by the options for the directories that contain the binary. Then the command that is called is given both as a list and string (for easy copying to the prompt yourself). Finally the collected results is displayed.

Note: You can give input and outputs as keyword arguments for `execute`. If an input and output have the same name, you can disambiguate them by prefixing them with `in_` or `out_` (e.g. `in_image` and `out_image`)

Debugging an invalid Network

The simplest command to check if your Network is considered valid is to use the `Network.is_valid` method. It will simply check if the Network is valid:

```
>>> network.is_valid()
True
```

It will return a boolean that only indicates the validity of the Network, but it will print any errors it found to the console/log with the ERROR log level, for example when datatypes on a link do not match:

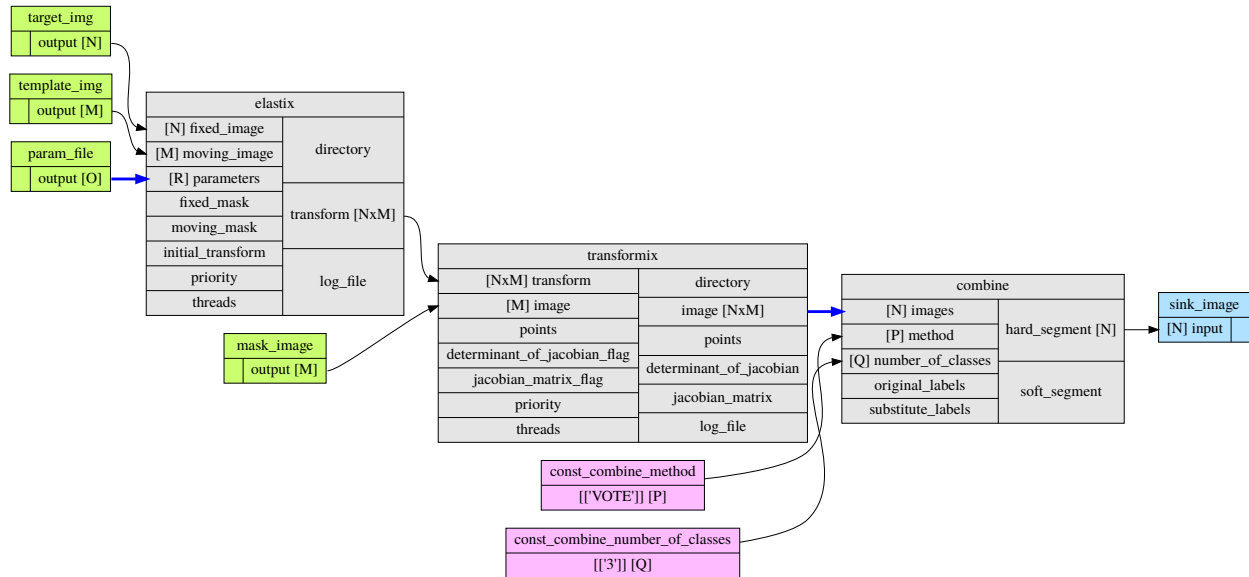
```
>>> invalid_network.is_valid()
[WARNING] datatypemanager:0388 >> No matching DataType available (args (<ValueType:
↳Float class [Loaded]>, <ValueType: Int class [Loaded]>))
[WARNING] link:0546 >> Cannot match datatypes <ValueType: Float class [Loaded]>
↳and <ValueType: Int class [Loaded]> or not preferred datatype is set! Abort linking
↳fastr:///networks/add_ints/0.0/nodelist/source/outputs/output to fastr:///networks/
↳add_ints/0.0/nodelist/add/inputs/left_hand!
[WARNING] datatypemanager:0388 >> No matching DataType available (args (<ValueType:
↳Float class [Loaded]>, <ValueType: Int class [Loaded]>))
[ERROR] network:0571 >> [add] Input left_hand is not valid: SubInput fastr:///
↳networks/add_ints/0.0/nodelist/add/inputs/left_hand/0 is not valid: SubInput source
↳(link_0) is not valid
[ERROR] network:0571 >> [add] Input left_hand is not valid: SubInput fastr:///
↳networks/add_ints/0.0/nodelist/add/inputs/left_hand/0 is not valid: [link_0] source
↳and target have non-matching datatypes: source Float and Int
[ERROR] network:0571 >> [link_0] source and target have non-matching datatypes:
↳source Float and Int
False
```

Because the messages might not always be enough to understand errors in the more complex Networks, we would advice you to create a plot of the network using the `network.draw_network` method:

```
>>> network.draw_network(network.id, draw_dimensions=True, expand_macro=True)
'add_ints.svg'
```

The value returned is the path of the output image generated (it will be placed in the current working directory. The `draw_dimensions=True` will make the drawing add indications about the sample dimensions in each Input and Output, whereas `expand_macro=True` causes the draw to expand MacroNodes and draw the content of them. If you have many nested MacroNodes, you can set `expand_macro` to an integer and that is the depth until which the MacroNodes will be draw in detail.

An example of a simple multi-atlas segmentation Network nicely shows the use of drawing the dimensions, the dimensions vary in certain Nodes due to the use of input_groups and a collapsing link (drawn in blue):



Debugging a Network run with errors

If a Network run did finish but there were errors detected, Fastr will report those at the end of the execution. We included an example of a Network that has failing samples in `fastr/examples/failing_network.py` which can be used to test debugging. An example of the output of a Network run with failures:

```
[INFO] networkrun:0604 >> #####
[INFO] networkrun:0605 >> #   network execution FINISHED   #
[INFO] networkrun:0606 >> #####
[INFO] networkrun:0618 >> ===== RESULTS =====
[INFO] networkrun:0627 >> sink_1: 2 success / 2 failed
[INFO] networkrun:0627 >> sink_2: 2 success / 2 failed
[INFO] networkrun:0627 >> sink_3: 1 success / 3 failed
[INFO] networkrun:0627 >> sink_4: 1 success / 3 failed
[INFO] networkrun:0627 >> sink_5: 1 success / 3 failed
[INFO] networkrun:0628 >> =====
[WARNING] networkrun:0651 >> There were failed samples in the run, to start debugging,
↪you can run:

    fastr trace $RUNDIR/__sink_data__.json --sinks

see the debug section in the manual at https://fastr.readthedocs.io/en/default/static/
↪user_manual.html#debugging for more information.
```

As you can see, there were failed samples in every sink. Also you already get the suggestion to use *fastr trace*. This command helps you inspect the staging directory of the Network run and pinpoint the errors.

The suggested command will print a similar summary as given by the network execution:

```
$ fastr trace $RUNDIR/__sink_data__.json --sinks
sink_1 -- 2 failed -- 2 succeeded
sink_2 -- 2 failed -- 2 succeeded
sink_3 -- 3 failed -- 1 succeeded
sink_4 -- 3 failed -- 1 succeeded
sink_5 -- 3 failed -- 1 succeeded
```

Since this is not given us new information we can add the `-v` flag for more output and limit the output to one sink, in this case `sink_5`:

```
$ fastr trace $RUNDIR/__sink_data__.json --sinks sink_5
sink_5 -- 3 failed -- 1 succeeded
  sample_1_1: Encountered error: [FastrOutputValidationError] Could not find result_
↳for output out_2 (/home/hachterberg/dev/fastr-develop/fastr/fastr/execution/job.
↳py:970)
  sample_1_2: Encountered error: [FastrOutputValidationError] Could not find result_
↳for output out_1 (/home/hachterberg/dev/fastr-develop/fastr/fastr/execution/job.
↳py:970)
  sample_1_3: Encountered error: [FastrOutputValidationError] Could not find result_
↳for output out_1 (/home/hachterberg/dev/fastr-develop/fastr/fastr/execution/job.
↳py:970)
  sample_1_3: Encountered error: [FastrOutputValidationError] Could not find result_
↳for output out_2 (/home/hachterberg/dev/fastr-develop/fastr/fastr/execution/job.
↳py:970)
```

Now we are given one error per sample, but this does not yet give us that much information. To get a very detailed report we have to specify one sink and one sample. This will make the `fastr trace` command print a complete error report for that sample:

```
$ fastr trace $RUNDIR/__sink_data__.json --sinks sink_5 --sample sample_1_1 -v
Tracing errors for sample sample_1_1 from sink sink_5
Located result pickle: /home/hachterberg/FastrTemp/fastr_failing_network_2017-09-
↳04T10-44-58_uMWeMV/step_1/sample_1_1/__fastr_result__.pickle.gz

===== JOB failing_network__step_1__sample_1_1 =====
Network: failing_network
Run: failing_network_2017-09-04T10-44-58
Node: step_1
Sample index: (1)
Sample id: sample_1_1
Status: JobState.execution_failed
Timestamp: 2017-09-04 08:45:19.238192
Job file: /home/hachterberg/FastrTemp/fastr_failing_network_2017-09-04T10-44-58_
↳uMWeMV/step_1/sample_1_1/__fastr_result__.pickle.gz

Command:
List representation: [u'python', u'/home/hachterberg/dev/fastr-develop/fastr/fastr/
↳resources/tools/fastr/util/0.1/bin/fail.py', u'--in_1', u'1', u'--in_2', u'1', u'--
↳fail_2']
String representation: 'python' '/home/hachterberg/dev/fastr-develop/fastr/fastr/
↳resources/tools/fastr/util/0.1/bin/fail.py' '--in_1' '1' '--in_2' '1' '--fail_2'

Output data:
{'out_1': [<Int: 2>]}

Status history:
2017-09-04 08:45:19.238212: JobState.created
2017-09-04 08:45:21.537417: JobState.running
2017-09-04 08:45:31.578864: JobState.execution_failed

----- ERRORS -----
- FastrOutputValidationError: Could not find result for output out_2 (/home/
↳hachterberg/dev/fastr-develop/fastr/fastr/execution/job.py:970)
- FastrValueError: [failing_network__step_1__sample_1_1] Output values are not_
↳valid! (/home/hachterberg/dev/fastr-develop/fastr/fastr/execution/job.py:747)
```

```

-----
----- STDOUT -----
Namespace(fail_1=False, fail_2=True, in_1=1, in_2=1)
in 1   : 1
in 2   : 1
fail_1: False
fail_2: True
RESULT_1=[2]

-----

----- STDERR -----
-----

```

As shown above, it finds the result files of the failed job(s) and prints the most important information. The first paragraph shows the information about the Job that was involved. The second paragraph shows the command used both as a list (which is clearer and internally used in Python) and as a string (which you can copy/paste to the shell to test the command). Then there is the output data as determined by Fastr. The next section shows the status history of the Job which can give an indication about wait and run times. Then there are the errors that Fastr encountered during the execution of the Job. In this case it could not find the output for the Tool. Finally the stdout and stderr of the subprocess are printed. In this case we can see that `RESULT_2=[...]` was not in the stdout, and so the result could not be located.

Note: Sometimes there are no Job results in a directory, this usually means the process got killed before the Job could finished. On cluster environments, this often means that the process was killed due to memory constraints.

Asking for help with debugging

If you would like help with debugging, you can contact us via the [fastr-users google group](#). To enable us to track the errors please include the following:

- The entire log of the fastr run (can be copied from console or from the end of `~/ .fastr/logs/info.log`).
- A dump of the network run, which can be created that by using the *fastr dump* command like:

```
$ fastr dump $RUNDIR fastr_run_dump.zip
```

This will create a zip file including all the job files, logs, etc but not the actual data files.

These should be enough information to trace most errors. In some cases we might need to ask for additional information (e.g. tool files, datatype files) or actions from your side.

Naming Convention

For the naming convention of the tools we tried to stay close to the Python [PEP 8](#) coding style. In short, we defined toolnames as classes so they should be UpperCamelCased. The inputs and outputs of a tool we considered as functions or method arguments, these should we named lower_case_with_underscores.

An overview of the mapping of Fastr to [PEP 8](#):

Fastr construct	Python PEP8 equivalent	Examples
Network.id	module	brain_tissue_segmentation
Tool.id	class	BrainExtractionTool, ThresholdImage
Node.id	variable name	brain_extraction, threshold_mask
Input/Output.id	method	image, number_of_classes, probability_image

Furthermore there are some small guidelines:

- No input or output in the input or output names. This is already specified when setting or getting the data.
- Add the type of the output that is named. i.e. enum, string, flag, image,
 - No File in the input/output name (Passing files around is what Fastr was developed for).
 - No type necessary where type is implied i.e. lower_threshold, number_of_levels, max_threads.
- Where possible/useful use the fullname instead of an abbreviation.

Provenance

For every data derived data object, Fastr records the **Provenance**. The *SinkNode* write provenance records next to every data object it writes out. The records contain information on what operations were performed to obtain the resulting data object.

W3C Prov

The provenance is recorded using the **W3C Prov Data Model (PROV-DM)**. Behind the scenes we are using the python **prov** implementation.

The PROV-DM defines 3 Starting Point Classes and and their relating properties. See [Fig. 1.3](#) for a graphic representation of the classes and the relations. *

Fig. 1.3: The three Starting Point classes and the properties that relate them. The diagrams in this document depict Entities as yellow ovals, Activities as blue rectangles, and Agents as orange pentagons. The responsibility properties are shown in pink.*⁰

Implementation

In the workflow document the provenance classes map to fastr concepts in the following way:

Agent Fastr, *Networks*, *Tools*, *Nodes*

Activity *Jobs*

Entities Data

⁰ This picture and caption is taken from <http://www.w3.org/TR/prov-o/> . “Copyright © 2011-2013 World Wide Web Consortium, (MIT, ERCIM, Keio, Beihang). <http://www.w3.org/Consortium/Legal/2015/doc-license>”

Usage

The provenance is stored in ProvDocument objects in pickles. The convenience command line tool `fastr prov` can be used to extract the provenance in the **PROV-N** notation and can be serialized to **PROV-JSON** and **PROV-XML**. The provenance document can also be vizualized using the `fastr prov` command line tool.

Command Line Tools

Fastr is shipped with a number of command line tools to perform common tasks and greatly simplify things such as debugging. The list of command line tools that is included in Fastr:

command	description
<i>cat</i>	Print information from a job file
<i>dump</i>	Dump the contents of a network run tempdir into a zip for remote assistance
<i>execute</i>	Execute a fastr job file
<i>extract_argparse</i>	Create a stub for a Tool based on a python script using argparse
<i>prov</i>	Get PROV information from the result pickle.
<i>run</i>	Run a Network from the commandline
<i>test</i>	Run the tests of a tool to verify the proper function
<i>trace</i>	Trace samples/sinks from a run
<i>verify</i>	Print information from a job file
<i>webapp</i>	Start the fastr webapp and open in a new browser tab

fastr cat

Extract selected information from the extra job info. The path is the selection of the data to retrieve. Every parts of the path (separated by a /) is seen as the index for the previous object. So for example to get the stdout of a job, you could use 'fastr cat __fastr_extra_job_info__.json process/stdout'.

```
usage: fastr cat [-h] __fastr_extra_job_info__.json path
```

Positional Arguments

__fastr_extra_job_info__.json result file to cat

path path of the data to print

fastr dump

Create a dump of a network run directory that contains the most important information for debugging. This includes a serialization of the network, all the job command and result files, the extra job information files and the provenance files. No data files will be included, but note that if jobs get sensitive information passed via the command line this will be included in the job files.

```
usage: fastr dump [-h] RUNDIR DUMP.zip
```

Positional Arguments

RUNDIR The run directory to dump

DUMP.zip The file to place the dump in

fastr execute

Execute a job from commandline.

```
usage: fastr execute [-h] [JOBFILE]
```

Positional Arguments

JOBFILE File of the job to execute (default ./__fastr_command__.pickle.gz)

fastr extract_argparse

Extract basic information from argparse.

```
usage: fastr extract_argparse [-h] SCRIPT.py TOOL.xml
```

Positional Arguments

SCRIPT.py Python script to inspect

TOOL.xml created Tool stub

fastr prov

Export the provenance information from JSON to other formats or plot the provenance data as a graph.

```
usage: fastr prov [-h] [-so SYNTAX_OUT_FILE] [-sf SYNTAX_FORMAT] [-i INDENT]
                  [-vo VISUALIZE_OUT_FILE]
                  [RESULTFILE]
```

Positional Arguments

RESULTFILE File of the job to execute (default ./__fastr_prov__.json)

Named Arguments

-so, --syntax-out-file Write the syntax to file.

-sf, --syntax-format Choices are: [json], provn or xml
Default: “json”

-i, --indent Indent size of the serialized documents.
Default: 2

-vo, --visualize-out-file Visualize the provenance. The most preferred format is svg. You can specify any format pydot supports. Specify the format by postfixing the filename with an extension.

fastr run

Execute a job or network from commandline.

```
usage: fastr run [-h] NETWORKFILE
```

Positional Arguments

NETWORKFILE File of the network to execute

fastr test

Run a tests for a fastr resource.

```
usage: fastr test [-h] {tool,tools,network,networks} ...
```

Sub-commands:

tool

Test a single tool

```
fastr test tool [-h] TOOL
```

Positional Arguments

TOOL Tool to test or directory with tool reference data

tools

Test all tools known to fastr

```
fastr test tools [-h]
```

network

Test a single network

```
fastr test network [-h] NETWORK
```

Positional Arguments

NETWORK The reference data to test the Network

networks

Test all network references inside subdirectories

```
fastr test networks [-h] [--result RESULT.json] REFERENCE
```

Positional Arguments

REFERENCE	path of the directory containing subdirectories with reference data
------------------	---

Named Arguments

--result	Write the results of the test to a JSON file
-----------------	--

fastr trace

Fastr trace helps you inspect the staging directory of the Network run and pinpoint the errors.

```
usage: fastr trace [-h] [--verbose] [--sinks [SINKS [SINKS ...]]]
                  [--samples [SAMPLES [SAMPLES ...]]]
                  [--sink_data __sink_data__.json]
```

Positional Arguments

__sink_data__.json	result file to cat
	Default: “/home/docs/checkouts/readthedocs.org/user_builds/fastr/checkouts/feature-networkrun/fastr/doc/__sink_data__.json”

Named Arguments

--verbose, -v	set verbose output for more details
	Default: False
--sinks	list results for specified sinks
--samples	list result for all samples

fastr verify

Verify fastr resources, at the moment only tool definitions are supported.

```
usage: fastr verify [-h] TYPE path
```

Positional Arguments

TYPE	Possible choices: tool Type of resource to verify (e.g. tool)
path	path of the resource to verify

fastr webapp

Starts the fastr web client.

```
usage: fastr webapp [-h] [-d] [-o]
```

Named Arguments

-d, --debug	Debug mode. Default: False
-o, --openpage	Open web page after start. Default: False

Resource File Formats

This chapter describes the various files fastr uses. The function and format of the files is described allowing the user to configure fastr and add DataTypes and Tools.

Config file

Fastr reads the config files from the following locations by default (in order):

- \$FASTRHOME/config.py
- ~/.fastr/config.py

Reading a new config file change or override settings, making the last config file read have the highest priority. All settings have a default value, making config files and all settings within optional.

Example config file

Here is a minimal config file:

```
# Enable debugging output
debug = False

# Define the path to the tool definitions
tools_path = ['/path/to/tools',
              '/path/to/other/tools'] + tools_path
types_path = ['/path/to/datatypes',
              '/path/to/other/datatypes'] + types_path
```

```
# Specify what your preferred output types are.
preferred_types += ["NiftiImageFileCompressed",
                   "NiftiImageFile"]

# Set the tmp mount
mounts['tmp'] = '/path/to/tmpdir'
```

Format

The config file is actually a python source file. The next syntax applies to setting configuration values:

```
# Simple values
float_value = 1.0
int_value = 1
str_value = "Some value"
other_str_value = 'name'.capitalize()

# List-like values
list_value = ['over', 'ride', 'values']
other_list_value.prepend('first')
other_list_value.append('list')

# Dict-like values
dict_value = {'this': 1, 'is': 2, 'fixed': 3}
other_dict_value['added'] = 'this key'
```

Note: Dictionaries and list always have a default, so you can always append or assign elements to them and do not have to create them in a config file. Best practice is to only edit them unless you really want to block out the earlier config files.

Most operations will be assigning values, but for list and dict values a special wrapper object is used that allows manipulations from the default. This limits the operations allowed.

List values in the `config.py` have the following supported operators/methods:

- `+`, `__add__` and `__radd__`
- `+=` or `__iadd__`
- `append`
- `prepend`
- `extend`

Mapping (dict-like) values in the `config.py` have the following supported operators/methods:

- `update`
- `[]` or `__getitem__`, `__setitem__` and `__delitem__`

Configuration fields

This is a table the known config fields on the system:

name	type	description	default
debug	bool	Flag to enable/disable debugging	False
examplesdir	str	Directory containing the fastr examples	\$systemdir/examples
execution_plugin	str	The default execution plugin to use	'ProcessPoolExecution'
execution-script	str	Execution script location	\$systemdir/execution/executionscript.py
filesyncurl	str	Redis url e.g. redis://localhost:6379	''
logdir	str	Directory where the fastr logs will be placed	\$userdir/logs
logging_config	dict	Python logger config	{}
loglevel	int	The log level to use (as int), INFO is 20, WARNING is 30, etc	20
logtype	str	Type of logging to use	'default'
mounts	dict	A dictionary containing all mount points in the VFS system	{ 'tmp': '\$TMPDIR', 'home': '~/', 'example_data': '\$systemdir/examples/data' }
networks_path	list	Directories to scan for networks	['\$userdir/networks', '\$resourcedir/networks']
pim_host	str	Host of the PIM server to report to	''
plugins_path	list	Directories to scan for plugins	['\$userdir/plugins', '\$resourcedir/plugins']
preferred_types	list	A list indicating the order of the preferred types to use. First item is most preferred.	[]
protected_modules	list	A list of modules in the environment modules that are protected against unloading	[]
resourcesdir	str	Directory containing the fastr system resources	\$systemdir/resources
schemadir	str	Directory containing the fastr data schemas	\$systemdir/schemas
source_job_limit	int	The number of source jobs allowed to run concurrently	0
systemdir	str	Fastr installation directory	'/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr-1.3.0-py2.7.egg/fastr'
tools_path	list	Directories to scan for tools	['\$userdir/tools', '\$resourcedir/tools']
types_path	list	Directories to scan for datatypes	['\$userdir/datatypes', '\$resourcedir/datatypes']
userdir	str	Fastr user configuration directory	~/.fastr
warn_develop	bool	Warning users on import if this is not a production version of fastr	True
web_hostname	str	The hostname to expose the web app for	'localhost'
web_port	str	The port to expose the web app on	'5000'
web_secretkey	str	The secret key to use for the flask web app	'VERYSECRETKEY!'

Tool description

Tools are the building blocks in the fastr network. To add new *Tools* to fastr, XML/json files containing a *Tool* definition can be added. These files have the following layout:

Attribute		Description
id		The id of this Tool (used internally in fastr)
name		The name of the Tool, for human readability
version		The version of the Tool wrapper (not the binary)
url		The url of the Tool wrapper
authors[]		List of authors of the Tools wrapper
	name	Name of the author
	email	Email address of the author
	url	URL of the website of the author
tags	tag[]	List of tags describing the Tool
command		Description of the underlying command
	version	Version of the tool that is wrapped
	url	Website where the tools that is wrapped can be obtained
	targets[]	Description of the target binaries/script of this Tool
		os OS targeted (windows, linux, macos or * (for any)
		arch Architecture targeted 32, 64 or * (for any)
		... Extra variables based on the target used, see <i>Targets</i>
	description	Description of the Tool
	license	License of the Tool, either full license or a clear name (e.g. LGPL, GPL v2)
	authors[]	List of authors of the Tool (not the wrapper!)
		name Name of the authors
		email Email address of the author
		url URL of the website of the author
interface		The interface definition see <i>Interfaces</i>
help		Help text explaining the use of the Tool
cite		Bibtext of the Citation(s) to reference when using this Tool for a publication

Resource Reference

In this chapter we describe the different plugins bundled with Fastr (e.g. IOPlugins, ExecutionPlugins). The reference is build automatically from code, so after installing a new plugin the documentation has to be rebuild for it to be included in the docs.

CollectorPlugin Reference

CollectorPlugins are used for finding and collecting the output data of outputs part of a FastrInterface

scheme	CollectorPlugin
JsonCollector	<i>JsonCollector</i>
PathCollector	<i>PathCollector</i>
StdoutCollector	<i>StdoutCollector</i>

JsonCollector

The JsonCollector plugin allows a program to print out the result in a pre-defined JSON format. It is then used as values for fastr.

The working is as follows:

1. The location of the output is taken
2. If the location is `None`, go to step 5
3. The substitutions are performed on the location field (see below)
4. The location is used as a [regular expression](#) and matched to the stdout line by line
5. The matched string (or entire stdout if location is `None`) is loaded as a json
6. The data is parsed by `set_result`

The structure of the JSON has to follow the a predefined format. For normal Nodes the format is in the form:

```
[value1, value2, value3]
```

where the multiple values represent the cardinality.

For a FlowNodes the format is the form:

```
{
  'sample_id1': [value1, value2, value3],
  'sample_id2': [value4, value5, value6]
}
```

This allows the tool to create multiple output samples in a single run.

PathCollector

The PathCollector plugin for the FastrInterface. This plugin uses the location fields to find data on the filesystem. To use this plugin the method of the output has to be set to `path`

The general working is as follows:

1. The location field is taken from the output
2. The substitutions are performed on the location field (see below)
3. The updated location field will be used as a [regular expression](#) filter
4. The filesystem is scanned for all matching files/directory

The special substitutions performed on the location use the Format Specification Mini-Language [Format Specification Mini-Language](#). The predefined fields that can be used are:

- `inputs`, an objet with the input values (use like `{inputs.image[0]}`) The input contains the following attributes that you can access:
 - `.directory` for the directory name (use like `input.image[0].directory`) The directory is the same as the result of `os.path.dirname`
 - `.filename` is the result of `os.path.basename` on the path
 - `.basename` for the basename name (use like `input.image[0].basename`) The basename is the same as the result of `os.path.basename` and the extension stripped. The extension is considered to be everything after the first dot in the filename.

- `.extension` for the extension name (use like `input.image[0].extension`)
- `output`, an object with the output values (use like `{output.result[0]}`) It contains the same attributes as the input
 - `special.cardinality`, the index of the current cardinality
 - `special.extension`, is the extension for the output `DataType`

Example use:

```
<output ... method="path" location="{output.directory[0]}/TransformParameters.  
↪{special.cardinality}.{special.extension}"/>
```

Given the output directory `./nodeid/sampleid/result`, the second sample in the output and filetype with a `txt` extension, this would be translated into:

```
<output ... method="path" location="./nodeid/sampleid/result/TransformParameters.1.  
↪txt>
```

StdoutCollector

The `StdoutCollector` can collect data from the `stdout` stream of a program. It filters the `stdout` line by line matching a predefined regular expression.

The general working is as follows:

1. The location field is taken from the output
2. The substitutions are performed on the location field (see below)
3. The updated location field will be used as a [regular expression](#) filter
4. The `stdout` is scanned line by line and the [regular expression](#) filter is applied

The special substitutions performed on the location use the Format Specification Mini-Language [Format Specification Mini-Language](#). The predefined fields that can be used are:

- `inputs`, an object with the input values (use like `{inputs.image[0]}`)
- `outputs`, an object with the output values (use like `{outputs.result[0]}`)
- `special` which has two subfields:
 - `special.cardinality`, the index of the current cardinality
 - `special.extension`, is the extension for the output `DataType`

Note: because the plugin scans line by line, it is impossible to catch multi-line output into a single value

ExecutionPlugin Reference

This class is the base for all Plugins to execute jobs somewhere. There are many methods already in place for taking care of stuff.

There are fall-backs for certain features, but if a system already implements those it is usually preferred to skip the fall-back and let the external system handle it. There are a few flags to enable/disable these features:

- `cls.SUPPORTS_CANCEL` indicates that the plugin can cancel queued jobs

- `cls.SUPPORTS_HOLD_RELEASE` indicates that the plugin can queue jobs in a hold state and can release them again (if not, the base plugin will create a hidden queue for held jobs). The plugin should respect the `Job.status == JobState.hold` when queueing jobs.
- `cls.SUPPORTS_DEPENDENCY` indicate that the plugin can manage job dependencies, if not the base plugin job dependency system will be used and jobs will only be submitted when all dependencies are met.
- `cls.CANCELS_DEPENDENCIES` indicates that if a job is cancelled it will automatically cancel all jobs depending on that job. If not the plugin traverse the dependency graph and kill each job manual.

Note: If a plugin supports dependencies it is assumed that when a job gets cancelled, the depending job also get cancelled automatically!

Most plugins should only need to redefine a few abstract methods:

- `__init__` the constructor
- `cleanup` a clean up function that frees resources, closes connections, etc
- `_queue_job` the method that queues the job for execution

Optionally an extra job finished callback could be added:

- `_job_finished` extra callback for when a job finishes

If `SUPPORTS_CANCEL` is set to `True`, the plugin should also implement:

- `_cancel_job` cancels a previously queued job

If `SUPPORTS_HOLD_RELEASE` is set to `True`, the plugin should also implement:

- `_hold_job` hold a job that is currently held
- `_release_job` releases a job that is currently held

If `SUPPORTED_DEPENDENCY` is set to `True`, the plugin should:

- Make sure to use the `Job.hold_jobs` as a list of its dependencies

Not all of the functions need to actually do anything for a plugin. There are examples of plugins that do not really need a `cleanup`, but for safety you need to implement it. Just using a `pass` for the method could be fine in such a case.

Warning: When overwriting other functions, extreme care must be taken not to break the plugins working, as there is a lot of bookkeeping that can go wrong.

scheme	ExecutionPlugin
BlockingExecution	<i>BlockingExecution</i>
DRMAAExecution	<i>DRMAAExecution</i>
LinearExecution	<i>LinearExecution</i>
ProcessPoolExecution	<i>ProcessPoolExecution</i>
RQExecution	<i>RQExecution</i>
StrongrExecution	<i>StrongrExecution</i>

BlockingExecution

The blocking execution plugin is a special plugin which is meant for debug purposes. It will not queue jobs but immediately execute them inline, effectively blocking fastr until the Job is finished. It is the simplest execution plugin

and can be used as a template for new plugins or for testing purposes.

DRMAAExecution

A DRMAA execution plugin to execute Jobs on a Grid Engine cluster. It uses a configuration option for selecting the queue to submit to. It uses the python `drmaa` package.

Note: To use this plugin, make sure the `drmaa` package is installed and that the execution is started on an SGE submit host with DRMAA libraries installed.

Note: This plugin is at the moment tailored to SGE, but it should be fairly easy to make different subclasses for different DRMAA supporting systems.

Configuration fields

name	type	description	default
<code>drmaa_engine</code>	str	The engine to use (options: <code>grid_engine</code> , <code>torque</code>)	<code>'grid_engine'</code>
<code>drmaa_queue</code>	str	The default queue to use for jobs send to the scheduler	<code>'week'</code>
<code>dr-maa_max_jobs</code>	int	The maximum jobs that can be send to the scheduler at the same time (0 for no limit)	0

LinearExecution

An execution engine that has a background thread that executes the jobs in order. The queue is a simple FIFO queue and there is one worker thread that operates in the background. This plugin is meant as a fallback when other plugins do not function properly. It does not multi-processing so it is safe to use in environments that do no support that.

ProcessPoolExecution

A local execution plugin that uses multiprocessing to create a pool of worker processes. This allows fastr to execute jobs in parallel with true concurrency. The number of workers can be specified in the fastr configuration, but the default amount is the `number of cores - 1` with a minimum of 1.

Warning: The `ProcessPoolExecution` does not check memory requirements of jobs and running many workers might lead to memory starvation and thus an unresponsive system.

Configuration fields

name	type	description	default
<code>process_pool_worker_number</code>	int	Number of workers to use in a process pool	3

RQExecution

A execution plugin based on Redis Queue. Fastr will submit jobs to the redis queue and workers will peel the jobs from the queue and process them.

This system requires a running redis database and the database url has to be set in the fastr configuration.

Note: This execution plugin required the `redis` and `rq` packages to be installed before it can be loaded properly.

Configuration fields

name	type	description	default
<code>rq_queue</code>	str	The redis queue to use	'default'
<code>rq_host</code>	str	The url of the redis serving the redis queue	'redis://localhost:6379/0'

StrongrExecution

A execution plugin based on Redis Queue. Fastr will submit jobs to the redis queue and workers will peel the jobs from the queue and process them.

This system requires a running redis database and the database url has to be set in the fastr configuration.

Note: This execution plugin required the `redis` and `rq` packages to be installed before it can be loaded properly.

FlowPlugin Reference

Plugin that can manage an advanced data flow. The plugins override the execution of node. The execution receives all data of a node in one go, so not split per sample combination, but all data on all inputs in one large payload. The flow plugin can then re-order the data and create resulting samples as it sees fits. This can be used for all kinds of specialized data flows, e.g. cross validation.

To create a new FlowPlugin there is only one method that needs to be implemented: `execute`.

<code>scheme</code>	<code>FlowPlugin</code>
<code>CrossValidation</code>	<i><code>CrossValidation</code></i>

CrossValidation

Advanced flow plugin that generated a cross-validation data flow. The node need an input with data and an input number of folds. Based on that the outputs test and train will be supplied with a number of data sets.

IOPlugin Reference

IOPlugins are used for data import and export for the sources and sinks. The main use of the *IOPlugins* is during execution (see *Execution*). The *IOPlugins* can be accessed via `fastr.ioplugins`, but generally there should be no need for direct interaction with these objects. The use of is mainly via the URL used to specify source and sink data.

scheme	IOPlugin
CommaSeperatedValueFile	<i>CommaSeperatedValueFile</i>
FileSystem	<i>FileSystem</i>
Null	<i>Null</i>
Reference	<i>Reference</i>
S3Filesystem	<i>S3Filesystem</i>
VirtualFileSystem	<i>VirtualFileSystem</i>
VirtualFileSystemRegularExpression	<i>VirtualFileSystemRegularExpression</i>
VirtualFileSystemValueList	<i>VirtualFileSystemValueList</i>
XNATStorage	<i>XNATStorage</i>

CommaSeperatedValueFile

The CommaSeperatedValueFile an expand-only type of IOPlugin. No URLs can actually be fetched, but it can expand a single URL into a larger amount of URLs.

The `csv://` URL is a `vfs://` URL with a number of query variables available. The URL mount and path should point to a valid CSV file. The query variable then specify what column(s) of the file should be used.

The following variable can be set in the query:

variable	usage
value	the column containing the value of interest, can be int for index or string for key
id	the column containing the sample id (optional)
header	indicates if the first row is considered the header, can be <code>true</code> or <code>false</code> (optional)
delimiter	the delimiter used in the csv file (optional)
quote	the quote character used in the csv file (optional)
reformat	a reformatting string so that <code>value = reformat.format(value)</code> (used before <code>relative_path</code>)
relative_path	indicates the entries are relative paths (for files), can be <code>true</code> or <code>false</code> (optional)

The header is by default `false` if the neither the `value` and `id` are set as a string. If either of these are a string, the header is required to define the column names and it automatically is assumed `true`

The delimiter and quota characters of the file should be detected automatically using the `Sniffer`, but can be forced by setting them in the URL.

Example of valid `csv` URLs:

```
# Use the first column in the file (no header row assumed)
csv://mount/some/dir/file.csv?value=0

# Use the images column in the file (first row is assumed header row)
csv://mount/some/dir/file.csv?value=images

# Use the segmentations column in the file (first row is assumed header row)
# and use the id column as the sample id
csv://mount/some/dir/file.csv?value=segmentations&id=id

# Use the first column as the id and the second column as the value
# and skip the first row (considered the header)
csv://mount/some/dir/file.csv?value=1&id=0&header=true

# Use the first column and force the delimiter to be a comma
csv://mount/some/dir/file.csv?value=0&delimiter=,
```

FileSystem

The FileSystem plugin is create to handle `file://` type or URLs. This is generally not a good practice, as this is not portable over between machines. However, for test purposes it might be useful.

The URL scheme is rather simple: `file://host/path` (see [wikipedia](#) for details)

We do not make use of the `host` part and at the moment only support localhost (just leave the host empty) leading to `file:///` URLs.

Warning: This plugin ignores the hostname in the URL and does only accept driver letters on Windows in the form `c:/`

Null

The Null plugin is create to handle `null://` type or URLs. These URLs are indicating the sink should not do anything. The data is not written to anywhere. Besides the scheme, the rest of the URL is ignored.

Reference

The Reference plugin is create to handle `ref://` type or URLs. These URLs are to make the sink just write a simple reference file to the data. The reference file contains the `DataType` and the value so the result can be reconstructed. It for files just leaves the data on disk by reference. This plugin is not useful for production, but is used for testing purposes.

S3Filesystem

Warning: As this IOPlugin is under development, it has not been thoroughly tested.

example url: `s3://bucket.server/path/to/resource`

VirtualFileSystem

The virtual file system class. This is an IOPlugin, but also heavily used internally in fastr for working with directories. The VirtualFileSystem uses the `vfs://` url scheme.

A typical virtual filesystem url is formatted as `vfs://mountpoint/relative/dir/from/mount.ext`

Where the mountpoint is defined in the [Config file](#). A list of the currently known mountpoints can be found in the `fastr.config` object

```
>>> fastr.config.mounts
{'example_data': '/home/username/fastr-feature-documentation/fastr/fastr/examples/data
→ ',
 'home': '/home/username/',
 'tmp': '/home/username/FastrTemp'}
```

This shows that a url with the mount `home` such as `vfs://home/tempdir/testfile.txt` would be translated into `/home/username/tempdir/testfile.txt`.

There are a few default mount points defined by Fastr (that can be changed via the config file).

mountpoint	default location
home	the users home directory (<code>expanduser('~')</code>)
tmp	the fastr temporary dir, defaults to <code>tempfile.gettempdir()</code>
example_data	the fastr example data directory, defaults <code>\$FASTRDIR/example/data</code>

VirtualFileSystemRegularExpression

The `VirtualFileSystemValueList` an expand-only type of `IOPlugin`. No URLs can actually be fetched, but it can expand a single URL into a larger amount of URLs.

A `vfsregex://` URL is a `vfs` URL that can contain regular expressions on every level of the path. The regular expressions follow the `re` module definitions.

An example of a valid URLs would be:

```
vfsregex://tmp/network_dir/.*/*/__fastr_result__.pickle.gz
vfsregex://tmp/network_dir/nodeX/(?P<id>.*)/__fastr_result__.pickle.gz
```

The first URL would result in all the `__fastr_result__.pickle.gz` in the working directory of a `Network`. The second URL would only result in the file for a specific node (`nodeX`), but by adding the named group `id` using `(?P<id>.*)` the sample `id` of the data is automatically set to that group (see [Regular Expression Syntax](#) under the special characters for more info on named groups in regular expression).

Concretely if we would have a directory `vfs://mount/somedir` containing:

```
image_1/Image.nii
image_2/image.nii
image_3/anotherimage.nii
image_5/inconsistentnamingftw.nii
```

we could match these files using `vfsregex://mount/somedir/(?P<id>image_\d+)/.*\.nii` which would result in the following source data after expanding the URL:

```
{'image_1': 'vfs://mount/somedir/image_1/Image.nii',
 'image_2': 'vfs://mount/somedir/image_2/image.nii',
 'image_3': 'vfs://mount/somedir/image_3/anotherimage.nii',
 'image_5': 'vfs://mount/somedir/image_5/inconsistentnamingftw.nii'}
```

Showing the power of this regular expression filtering. Also it shows how the ID group from the URL can be used to have sensible sample ids.

Warning: due to the nature of regexp on multiple levels, this method can be slow when having many matches on the lower level of the path (because the tree of potential matches grows) or when directories that are parts of the path are very large.

VirtualFileSystemValueList

The `VirtualFileSystemValueList` an expand-only type of `IOPlugin`. No URLs can actually be fetched, but it can expand a single URL into a larger amount of URLs. A `vfslist://` URL basically is a url that points to a file using `vfs`. This file then contains a number lines each containing another URL.

If the contents of a file `vfs://mount/some/path/contents` would be:


```
vfs://mount/some/path/file1.txt
vfs://mount/some/path/file2.txt
vfs://mount/some/path/file3.txt
vfs://mount/some/path/file4.txt
```

Then using the URL `vfslist://mount/some/path/contents` as source data would result in the four files being pulled.

Note: The URLs in a `vfslist` file do not have to use the `vfs` scheme, but can use any scheme known to the Fastr system.

XNATStorage

Warning: As this IOPlugin is under development, it has not been thoroughly tested.

The XNATStorage plugin is an IOPlugin that can download data from and upload data to an XNAT server. It uses its own `xnat://` URL scheme. This is a scheme specific for this plugin and though it looks somewhat like the XNAT rest interface, a different type or URL.

Data resources can be access directly by a data url:

```
xnat://xnat.example.com/data/archive/projects/sandbox/subjects/subject001/experiments/
↳experiment001/scans/T1/resources/DICOM
xnat://xnat.example.com/data/archive/projects/sandbox/subjects/subject001/experiments/
↳*_BRAIN/scans/T1/resources/DICOM
```

In the second URL you can see a wildcard being used. This is possible as long as it resolves to exactly one item.

The `id` query element will change the field from the default experiment to subject and the `label` query element sets the use of the label as the fastr id (instead of the XNAT id) to `True` (the default is `False`)

To disable `https` transport and use `http` instead the query string can be modified to add `insecure=true`. This will make the plugin send requests over `http`:

```
xnat://xnat.example.com/data/archive/projects/sandbox/subjects/subject001/experiments/
↳*_BRAIN/scans/T1/resources/DICOM?insecure=true
```

For sinks it is import to know where to save the data. Sometimes you want to save data in a new assessor/resource and it needs to be created. To allow the Fastr sink to create an object in XNAT, you have to supply the type as a query parameter:

```
xnat://xnat.bmia.nl/data/archive/projects/sandbox/subjects/S01/experiments/_BRAIN/
↳assessors/test_assessor/resources/IMAGE/files/image.nii.gz?resource_
↳type=xnat:resourceCatalog&assessor_type=xnat:qcAssessmentData
```

Valid options are: `subject_type`, `experiment_type`, `assessor_type`, `scan_type`, and `resource_type`.

If you want to do a search where multiple resources are returned, it is possible to use a search url:

```
xnat://xnat.example.com/search?projects=sandbox&subjects=subject[0-9][0-9][0-9]&
↳experiments=*_BRAIN&scans=T1&resources=DICOM
```

This will return all DICOMs for the T1 scans for experiments that end with `_BRAIN` that belong to a subject `XXX` where `XXX` is a 3 digit number. By default the ID for the samples will be the experiment XNAT ID (e.g. `XNAT_E00123`). The wildcards that can be used are the same UNIX shell-style wildcards as provided by the module `fnmatch`.

It is possible to change the id to a different fields id or label. Valid fields are project, subject, experiment, scan, and resource:

```
xnat://xnat.example.com/search?projects=sandbox&subjects=subject[0-9][0-9][0-9]&
↳experiments=*_BRAIN&scans=T1&resources=DICOM&id=subject&label=true
```

The following variables can be set in the search query:

variable	default	usage
projects	*	The project(s) to select, can contain wildcards (see <code>fnmatch</code>)
subjects	*	The subject(s) to select, can contain wildcards (see <code>fnmatch</code>)
experiments	*	The experiment(s) to select, can contain wildcards (see <code>fnmatch</code>)
scans	*	The scan(s) to select, can contain wildcards (see <code>fnmatch</code>)
resources	*	The resource(s) to select, can contain wildcards (see <code>fnmatch</code>)
id	experiment	What field to use as the id, can be: project, subject, experiment, scan, or resource
label	false	Indicate the XNAT label should be used as fastr id, options <code>true</code> or <code>false</code>
insecure	false	Change the url scheme to be used to http instead of https
verify	true	(Dis)able the verification of SSL certificates
regex	false	Change search to use regex <code>re.match()</code> instead of <code>fnmatch</code> for matching
overwrite	false	Tell XNAT to overwrite existing files if a file with the name is already present

For storing credentials the `.netrc` file can be used. This is a common way to store credentials on UNIX systems. It is required that the file is only accessible by the owner only or a `NetrcParseError` will be raised. A `netrc` file is really easy to create, as its entries look like:

```
machine xnat.example.com
  login username
  password secret123
```

See the `netrc` module or the [GNU inet utils website](#) for more information about the `.netrc` file.

Note: On windows the location of the `netrc` file is assumed to be `os.path.expanduser('~/_netrc')`. The leading underscore is because windows does not like filename starting with a dot.

Note: For scan the label will be the scan type (this is initially the same as the series description, but can be updated manually or the XNAT scan type cleanup).

Warning: labels in XNAT are not guaranteed to be unique, so be careful when using them as the sample ID.

For background on XNAT, see the [XNAT API DIRECTORY](#) for the REST API of XNAT.

Interface Reference

Abstract base class of all Interfaces. Defines the minimal requirements for all Interface implementations.

scheme	Interface
FastrInterface	<i>FastrInterface</i>
FlowInterface	<i>FlowInterface</i>
NipypeInterface	<i>NipypeInterface</i>

FastrInterface

The default Interface for fastr. For the command-line Tools as used by fastr. It build a commandline call based on the input/output specification.

The fields that can be set in the interface:

Attribute		Description
id		The id of this Tool (used internally in fastr)
inputs[]		List of Inputs that can are accepted by the Tool
	id	ID of the Input
	name	Longer name of the Input (more human readable)
	datatype	The ID of the DataType of the Input ¹
	enum[]	List of possible values for an EnumType (created on the fly by fastr) ¹
	prefix	Commandline prefix of the Input (e.g. -in, -i)
	cardinality	Cardinality of the Input
	repeat_prefix	Flag indicating if for every value of the Input the prefix is repeated
	required	Flag indicating if the input is required
	nospace	Flag indicating if there is no space between prefix and value (e.g. -in=val)
	format	For DataTypes that have multiple representations, indicate which one to use
	default	Default value for the Input
	description	Long description for an input
outputs[]		List of Outputs that are generated by the Tool (and accessible to fastr)
	id	ID of the Output
	name	Longer name of the Output (more human readable)
	datatype	The ID of the DataType of the Output ¹
	enum[]	List of possible values for an EnumType (created on the fly by fastr) ¹
	prefix	Commandline prefix of the Output (e.g. -out, -o)
	cardinality	Cardinality of the Output
	repeat_prefix	Flag indicating if for every value of the Output the prefix is repeated
	required	Flag indicating if the input is required
	nospace	Flag indicating if there is no space between prefix and value (e.g. -out=val)
	format	For DataTypes that have multiple representations, indicate which one to use
	description	Long description for an input
	action	Special action (defined per DataType) that needs to be performed before creating output value
	automatic	Indicate that output doesn't require commandline argument, but is created automatically by a T
	method	The collector plugin to use for the gathering automatic output, see the Collector plugins
	location	Definition where to an automatically, usage depends on the method ²

FlowInterface

The Interface use for AdvancedFlowNodes to create the advanced data flows that are not implemented in the fastr. This allows nodes to implement new data flows using the plugin system.

The definition of FlowInterfaces are very similar to the default FastrInterfaces.

¹ datatype and enum are conflicting entries, if both specified datatype has presedence

² More details on defining automatica output are given in [TODO]

Note: A flow interface should be using a specific FlowPlugin

NipypeInterface

Experimental interfaces to using nipype interfaces directly in fastr tools, only using a simple reference.

To create a tool using a nipype interface just create an interface with the correct type and set the nipype argument to the correct class. For example in an xml tool this would become:

```
<interface class="NipypeInterface">
  <nipype_class>nipype.interfaces.elastix.Registration</nipype_class>
</interface>
```

Note: To use these interfaces nipype should be installed on the system.

Warning: This interface plugin is basically functional, but highly experimental!

Target Reference

The abstract base class for all targets. Execution with a target should follow the following pattern:

```
>>> with Target() as target:
...     target.run_command(['sleep', '10'])
...     target.run_command(['sleep', '10'])
...     target.run_command(['sleep', '10'])
```

The Target context operator will set the correct paths/initialization. Within the context command can be ran and when leaving the context the target reverts the state before.

scheme	Target
DockerTarget	<i>DockerTarget</i>
LocalBinaryTarget	<i>LocalBinaryTarget</i>

DockerTarget

A tool target that is located in a Docker images. Can be run using docker-py. A docker target only need two variables: the binary to call within the docker container, and the docker container to use.

```
{
  "arch": "*",
  "os": "*",
  "binary": "bin/test.py",
  "docker_image": "fastr/test"
}
```

```
<target os="*" arch="*" binary="bin/test.py" docker_image="fastr/test">
```

LocalBinaryTarget

A tool target that is a local binary on the system. Can be found using `environmentmodules` or a path on the executing machine. A local binary target has a number of fields that can be supplied:

- `binary` (required): the name of the binary/script to call, can also be called `bin` for backwards compatibility.
- `modules`: list of modules to load, this can be `environmentmodules` or `lmod` modules. If modules are given, the `paths`, `environment_variables` and `initscripts` are ignored.
- `paths`: a list of paths to add following the structure `{"value": "/path/to/dir", "type": "bin"}`. The types can be `bin` if it should be added to `$PATH` or `lib` if it should be added to the library path (e.g. `$LD_LIBRARY_PATH` for linux).
- `environment_variables`: a dictionary of environment variables to set.
- `initscript`: a list of script to run before running the main tool
- `interpreter`: the interpreter to use to call the binary e.g. `python`

The `LocalBinaryTarget` will first check if there are modules given and the module subsystem is loaded. If that is the case it will simply unload all current modules and load the given modules. If not it will try to set up the environment itself by using the following steps:

1. Prepend the bin paths to `$PATH`
2. Prepend the lib paths to the correct environment variable
3. Setting the other environment variables given (`$PATH` and the system library path are ignored and cannot be set that way)
4. Call the initscripts one by one

The definition of the target in JSON is very straightforward:

```
{
  "binary": "bin/test.py",
  "interpreter": "python",
  "paths": [
    {
      "type": "bin",
      "value": "vfs://apps/test/bin"
    },
    {
      "type": "lib",
      "value": "./lib"
    }
  ],
  "environment_variables": {
    "othervar": 42,
    "short_var": 1,
    "testvar": "value1"
  },
  "initscripts": [
    "bin/init.sh"
  ],
  "modules": ["elastix/4.8"]
}
```

In XML the definition would be in the form of:

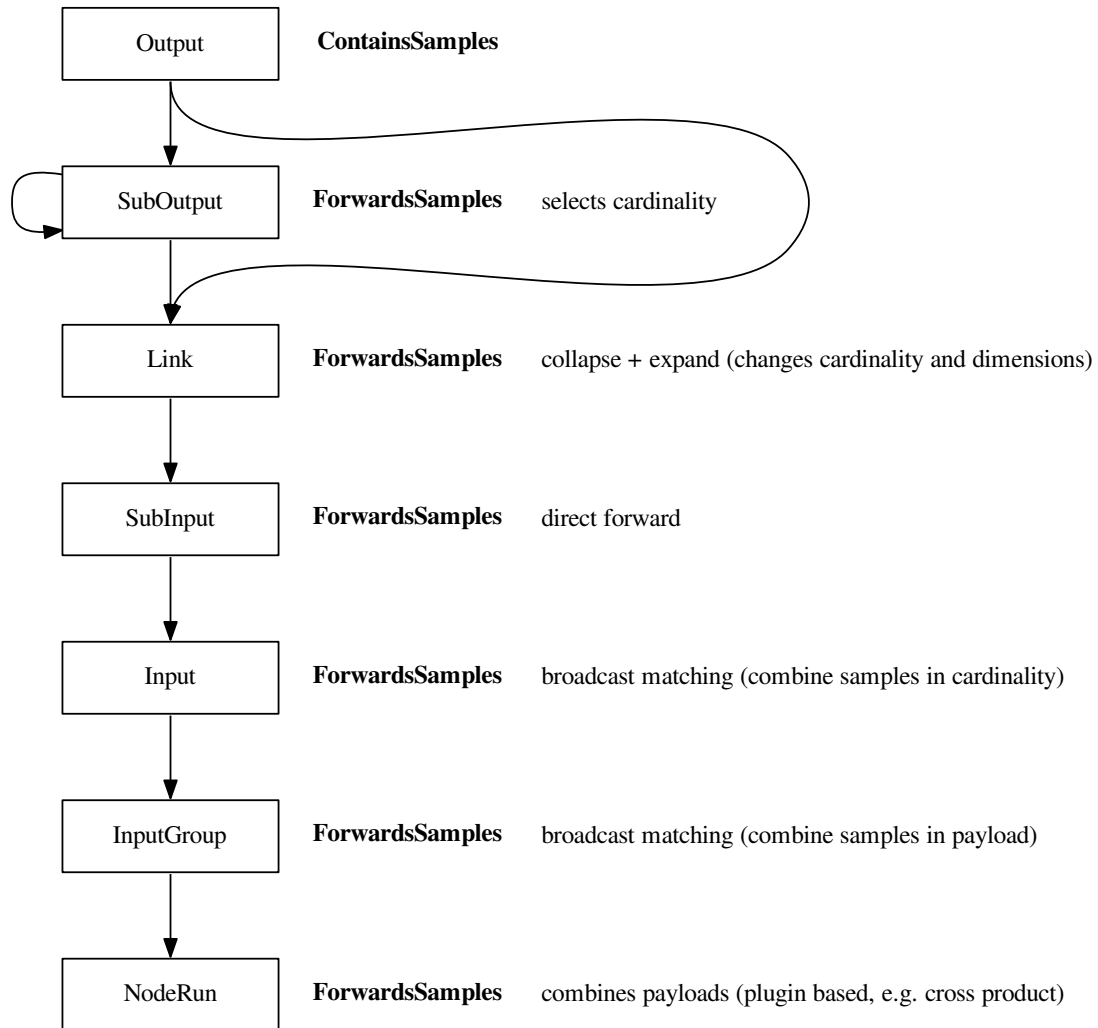
```
<target os="linux" arch="*" modules="elastix/4.8" bin="bin/test.py" interpreter=
↪ "python">
  <paths>
    <path type="bin" value="vfs://apps/test/bin" />
    <path type="lib" value="./lib" />
  </paths>
  <environment_variables short_var="1">
    <testvar>value1</testvar>
    <othervar>42</othervar>
  </environment_variables>
  <initscripts>
    <initscript>bin/init.sh</initscript>
  </initscripts>
</target>
```

Development and Design Documentation

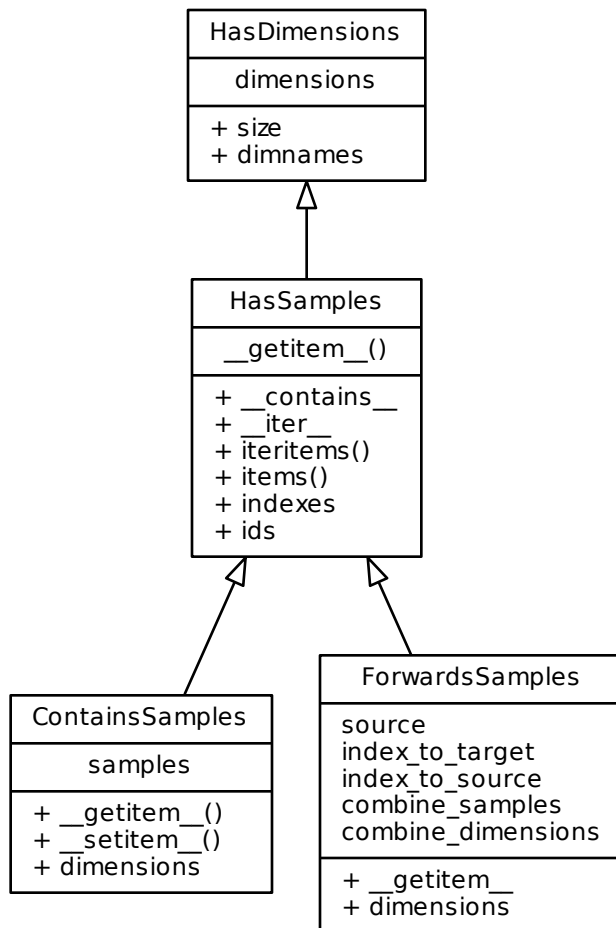
In this chapter we will discuss the design of Fastr in more detail. We give pointers for development and add the design documents as we currently envision Fastr. This is both for people who are interested in the Fastr develop and for current developers to have an archive of the design decision agreed upon.

Sample flow in Fastr

The current Sample flow is the following:



The idea is that we make a common interface for all classes that are related to the flow of Samples. For this we propose the following mixin classes that provide the interface and allow for better code sharing. The basic structure of the classes is given in the following diagram:



The abstract and mixin methods are as follows:

ABC	Inherits from	Abstract Methods	Mixin methods
HasDimensions		dimensions	size dimnames
HasSamples	HasDimensions	__getitem__	__contains__ __iter__ iteritems items indexes ids
ContainsSamples	HasSamples	samples	__getitem__ __setitem__ dimensions
ForwardsSamples	HasSamples	source index_to_target index_to_source combine_samples combine_dimensions	__getitem__ dimensions

Note: Though the flow is currently working like this, the mixins are not yet created.

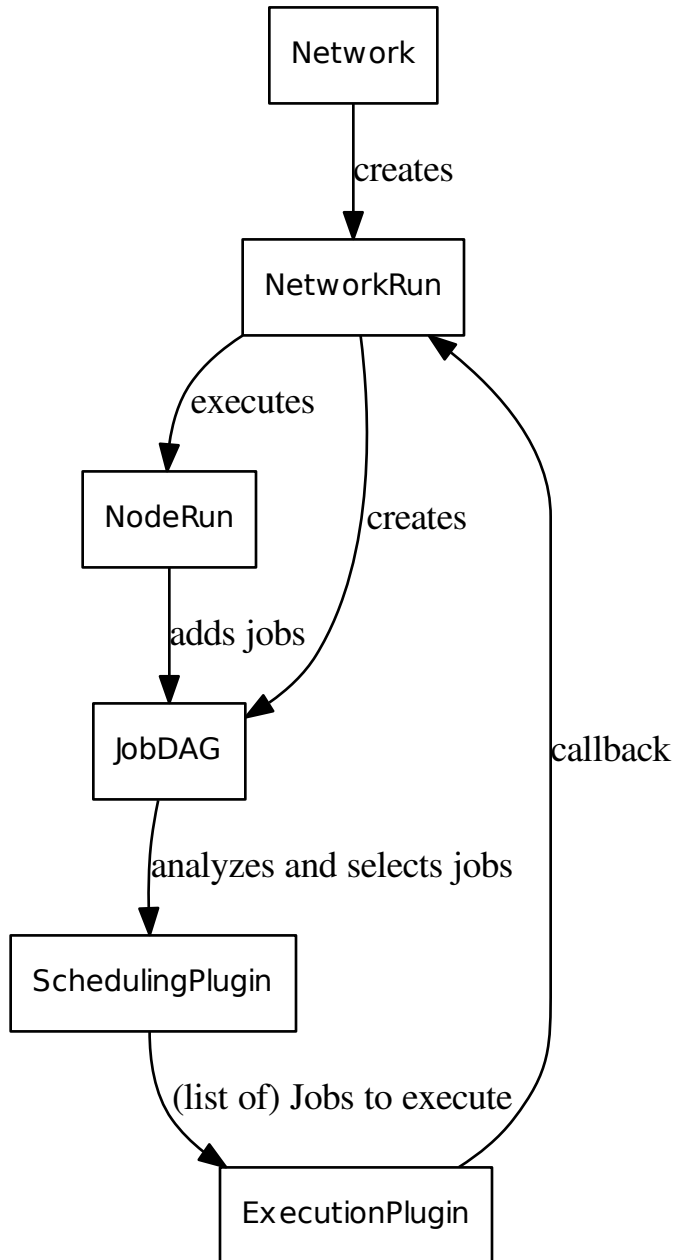
Network Execution

The network execution should contain a number of steps:

- `Network`
 - Creates a `NetworkRun` based on the current layout
- `NetworkRun`
 - Transform the `Network` (possibly joining `Nodes` of certain interface into a combined `NodeRun` etc)
 - Start generation of the Job Direct Acyclic Graph (DAG)
- `SchedulingPlugin`
 - Prioritize `Jobs` based on some predefined rules
 - Combine certain `Jobs` to improve efficiency (e.g. minimize i/o on a grid)
- `ExecutionPlugin`
 - Run a (list of) `Jobs`. If there is more than one jobs, run them sequentially on same execution host using a local temp for intermediate files.

- On finished callback: Updated DAG with newly ready jobs, or remove cancelled jobs

This could be visualized as the following loop:



The callback of the `ExecutionPlugin` to the `NetworkRun` would trigger the execution of the relevant `NodeRuns` and the addition of more `Jobs` to the `JobDAG`.

Note: The Job DAG should be thread-safe as it could be both read and extended at the same time.

Note: If a list of jobs is send to the `ExecutionPlugin` to be run as on Job on an external execution platform, the resources should be combined as follows: `memory=max`, `cores=max`, `runtime=sum`

Note: If there are execution hosts that have mutliple cores the `ExecutionPlugin` should manage this (for example by using pilot jobs). The `SchedulingPlugin` creates units that should be run sequentially on the resources noted and will not attempt parallelization

A `NetworkRun` would be contain similar information as the `Network` but not have functionality for editing/changing it. It would contain the functionality to execute the `Network` and track the status and samples. This would allow `Network.execute` to create multiple concurent runs that operate indepent of each other. Also editing a `Network` after the run started would have no effect on that run.

Note: This is a plan, not yet implemented

Note: For this to work, it would be important for a Jobs to have forward and backward dependency links.

SchedulingPlugins

The idea of the plugin is that it would give a priority on Jobs created by a `Network`. This could be done based on different strategies:

- Based on (sorted) sample id's, so that one sample is always prioritized over others. The idea is that samples are process as much as possible in order, finishing the first sample first. Only processing other samples if there is left-over capacity.
- Based on distance to a (particular) `Sink`. This is to generate specific results as quick as possible. It would not focus on specific samples, but give priority to whatever sample is closest to being finished.
- Based on the distance to from a `Souce`. Based on the sign of the weight it would either keep all samples on the same stage as much as possible, only progressing to a new `NodeRun` when all samples are done with the previous `NodeRun`, or it would push samples with accelerated rates.

Additionally it will group Jobs to be executed on a single host. This could reduce i/o and limited the number of jobs an external scheduler has to track.

Note: The interface for such a plugin has not yet been established.

Secrets

“Something that is kept or meant to be kept unknown or unseen by others.”

Using secrets

Fastr IOPlugins that need authentication data should use the Fastr SecretService for retrieving such data. The Secret-Service can be used as follows.

```
from fastr.utils.secrets import SecretService
from fastr.utils.secrets.exceptions import CouldNotRetrieveCredentials

secret_service = SecretService()

try:
    password = secret_service.find_password_for_user('testserver.lan:9000', 'john-doe')
except CouldNotRetrieveCredentials:
    # the password was not found
    pass
```

Implementing a SecretProvider

A SecretProvider is implemented as follows:

1. Create a file in fastr/utils/secrets/providers/<yourprovidername>.py
2. Use the template below to write your SecretProvider
3. Add the secret provider to fastr/utils/secrets/providers/__init__.py
4. Add the secret provider to fastr/utils/secrets/secretservice.py: import it and add it to the array in function `_init_providers`

```
from fastr.utils.secrets.secretprovider import SecretProvider
from fastr.utils.secrets.exceptions import CouldNotRetrieveCredentials, _
↳ CouldNotSetCredentials, CouldNotDeleteCredentials, NotImplemented

try:
    # this is where libraries can be imported
    # we don't want fastr to crash if a specific
    # library is unavailable
    # import my-library
except (ImportError, ValueError) as e:
    pass

class KeyringProvider(SecretProvider):
    def __init__(self):
        # if libraries are imported in the code above
        # we need to check if import was successful
        # if it was not, raise a RuntimeError
        # so that FASTR ignores this SecretProvider
        # if 'my-library' not in globals():
        #     raise RuntimeError("my-library module required")
        pass

    def get_password_for_user(self, machine, username):
        # This function should return the password as a string
        # or raise a CouldNotRetrieveCredentials error if the password
        # is not found.
        # In the event that this function is unsupported a
        # NotImplemented exception should be thrown
```

```

raise NotImplemented()

def set_password_for_user(self, machine, username, password):
    # This function should set the password for a specified
    # machine + user. If anything goes wrong while setting
    # the password a CouldNotSetCredentials error should be raised.
    # In the event that this function is unsupported a
    # NotImplemented exception should be thrown
    raise NotImplemented()

def del_password_for_user(self, machine, username):
    # This function should delete the password for a specified
    # machine + user. If anything goes wrong while setting
    # the password a CouldNotDeleteCredentials error should be raised.
    # In the event that this function is unsupported a
    # NotImplemented exception should be thrown
    raise NotImplemented()

```

Changelog

All notable changes to this project will be documented in this file.

The format is based on [Keep a Changelog](#) and this project adheres to [Semantic Versioning](#)

UNRELEASED

Added

- The default python logger can now be configured from the fastr config file under key `logging_config`
- Support for MacroNodes, a Network can be used as a Node inside of another Network. There is should be no limitation on the internal Network used, but currently the MacroNode ignores `input_groups` on its inputs.
- A sync helper was added to assist in slow file synchronisation over NFS
- Source and Sink can now handle S3 URL's
- `FastrInterface` can now forward errors from a subprocess if they are dumped to `stdout` or `stderr` in a json identified by `__FASTR_ERRORS__ = []`.
- A `specials.workdir` field in the `location` field of automatic outputs that gives the current working directory (e.g. job directory)
- Added support for Torque (using `pbs-drmaa` library) to `DRMAAExecution`
- Added option to set a limit for number of jobs submitted at same time be the `DRMAAExecution`
- Use of the `~/fastr/config.d` directory for adding additional config files. Any `.py` file in there will be parsed in alphabetical order.
- `XNATStorageIOPlugin` now has a retry scheme for uploads, if an uploaded file could not be found on the server, it is retried up to 3 times.
- Added `fastr dump` command to create a zip containing all important debugging information.

Changed

- FilePrefix type does not have an extension anymore (avoids ugly dot in middle of filename)
- Allow expanding of link where samples have a non-uniform cardinality. This will not result in a sparse array.
- The default for `required` for the automatic outputs is now `False`
- Removed `testtool` commandline subcommand in favour of the `test` subcommand which can test both Tools and Networks
- Moved `nodegroup` specification into the `Node` for speedup

Fixed

- Stop Jobs from failing when a non-required, non-requested output is invalid
- Bug in boolean value parsing in the Boolean datatype
- Bug in target that caused paths not to be expanded properly in some cases
- Made sure failed sources also create a sample so the failure becomes visible and traceable.
- Bug in XNAT IOPlugin that made download from XNAT seem to fail (while getting the correct data).

Removed

- `fastr.current_network` has been removed as it was deemed to “magical” and could change things out of the sight of the user.

1.2.2 - 2017-08-24

Fixed

- Fixed a bug breaking the XNAT IOPlugin due to an `xnatpy` version update.

1.2.1 - 2017-04-04

Added

- A `FastrInterface` can now specify a `negate` flag on an automatic output that also has a prefix, which will negate the flag. This is useful for flag the suppress the creation of an output (e.g. `no_mask`). An example is given in the Tool `fastr.util.AutoPrefixNegateTest`.

Changed

- The provenance and extra information of a Job now is not serialized in the Job, but exported to separate files next to the job file `__fastr_prov__.json` and `__fastr_extra_job_info__.json` which makes the information more accessible and reduces the memory footprint of the main process hugely as it will not read this information back anymore.
- Most execution plugin will not overwrite the `executionscript` stdout and stderr but rather append it. This is only relevant when continuing a run in the an existing temporary directory, but avoids loss of information.

Fixed

- Bug that stopped the `Link.append` function from returning the newly created link
- Bugs that caused some cardinality computations of the output to fail during execution
- Bug in the `job.tmpurl` that caused double slashes somewhere. Some tools chocked on this when it was used for parameters.

1.2.0 - 2017-03-15

Added

- Failed sample annotation: when a job fails, the result is annotated and forwarded until a `SinkNode`, where we can determine the status and possibly point of failure of the `Sample`.
- Commandline tool `fastr trace` that can inspect a workflow run and help trace errors and print debug information
- Supported for `Lmod` modules environment next to the old `environmentmodules`
- `BaseDataType` descendants are now (un)picklable (including `EnumTypes`)
- Option to use `{extension}` field in `sink_data`, which differs from `{ext}` in that it doesn't include a leading dot.
- Support for Docker targets. A Docker target will execute a command inside of a specified docker container, allowing Tools to use Docker for distribution
- Using the right and left shift operator (`<<` and `>>`) for creating links to Inputs using `input << output` or `output >> input`.
- In the `FastrInterfaces`, automatic outputs can have a prefix for a flag that should be set for the output to be actually generated.
- `Fastr` is now able to limit the amount of `SourceJobs` that are allowed to run concurrently.
- Ability to report progress to PIM (use the `pim_host` field in the config)

Changed

- Version can now also accept a format based on a date (e.g. `2017-02-17_bananas`) which will be parsed the same way as `2017.02.17_bananas`
- Work on the `ExecutionPlugin` and the corresponding API. Has better fall-backs and a mechanism to advertise plugin capabilities.
- The collector plugins have the `input` and `input_parts` fields merged, and the `output` and `output_parts` fields merged.

Fixed

- In some cases the log directory was not created properly, causing an handled exception
- A bug making the handling of Booleans incorrect for the `FastrInterface`, when a Boolean was given a flag would also appear when it was `False`
- Serialization of the namespace of a `Network` was not correct

- Check version of Fastr that creates and executes a Job against each other
- `load_gpickle` helper can handle data with Enums that use to cause an `AttributeError`
- Output validation of Jobs did not work correctly for automatic outputs

1.1.2 - 2016-12-22

Fixed

- The example network in `resources/networks/add_ints.json` was using an old serialization format making it non-functions. Replaced by a new network file.

1.1.1 - 2016-12-22

Fixed

- Network runs called from an interpreter (and not file) caused a crash because the network tried to report the file used. Better handling of these situations.

1.1.0 - 2016-12-08

Added

- Namespaces for resources (tools and networks)
- Network manager located at `fastr.networklist`
- `RQExecution` plugin. This plugin uses `python-rq` to manage a job queue.
- `LinearExecution` plugin. This plugin uses a background thread for execution.
- `BlockingExecution` plugin. This plugin executes jobs in a blocking fashion.
- Automatic generation of documentation for all plugins, the configuration fields and all commandline tools.

Changed

- Provenance is updated with a network dump and used tool definitions.
- New configuration system that uses python files
- New plugin system that integrates with the new configuration system and enables automatic importing of plugins
- The `fastr` command line tools now use an entrypoint which is located in `fastr.utils.cmd`. This code also dispatches the sub commands.

Removed

- `fastr.config` file. This is replaced by the `config.py` file. Go to the docs!

Fixed

- Adds explicit tool namespace and version to the provenance document.

Fastr User Reference

`fastr.toollist`

A ToolManager containing all versions of all Tools loaded into the FASTR environment. The ToolManager can be indexed using the Tool id string or a tool id string and a version. For example if you have two versions (4.5 and 4.8) of a tool called *Elastix*:

```
>>> fastr.toollist['elastix.Elastix']
Tool Elastix v4.8 (Elastix Registration)
Inputs
↳Outputs
-----
↳-----
fixed_image      (ITKImageFile)      | directory_
↳ (Directory)
moving_image     (ITKImageFile)      | transform_
↳ (ElastixTransformFile)
parameters       (ElastixParameterFile) | log_file _
↳ (ElastixLogFile)
fixed_mask       (ITKImageFile)      |
moving_mask      (ITKImageFile)      |
initial_transform (ElastixTransformFile) |
priority         (__Elastix_4.8_interface__priority__Enum__) |
threads          (Int)                |

>>> fastr.toollist['elastix.Elastix', '4.5']
Tool Elastix v4.5 (Elastix Registration)
Inputs
↳Outputs
-----
↳-----
fixed_image      (ITKImageFile)      | directory_
↳ (Directory)
```

moving_image	(ITKImageFile)		transform_
↪	(ElastixTransformFile)		
parameters	(ElastixParameterFile)		log_file
↪	(ElastixLogFile)		
fixed_mask	(ITKImageFile)		
moving_mask	(ITKImageFile)		
initial_transform	(ElastixTransformFile)		
priority	(__Elastix_4.5_interface__priority__Enum__)		
threads	(Int)		

`fastr.typelist`

A dictionary containing all types loaded into the FASTR environment. The keys are the typenames and the values are the classes.

`class fastr.Network(id_='unnamed_network', version=None, filename=None)`

The NetworkRun contains the entire Run state for a Network execution. It has a working copy of the network, but also includes all temporary data required for the execution. These objects are meant to be single use.

`add_link(link)`

Add a Link to the Network. Make sure the link is in the link list and the link parent is set to this Network

Parameters `link` (*Link*) – link to add

Raises

- *FastrTypeError* – if link is incorrectly typed
- *FastrNetworkMismatchError* – if the link already belongs to another Network

`add_node(node)`

Add a Node to the Network. Make sure the node is in the node list and the node parent is set to this Network

Parameters `node` (*Node*) – node to add

Raises *FastrTypeError* – if node is incorrectly typed

`create_link(source, target, id_=None, collapse=None, expand=None)`

Create a link between two Nodes and add it to the current Network.

Parameters

- **source** (*BaseOutput*) – the output that is the source of the link
- **target** (*BaseInput*) – the input that is the target of the link
- **id** (*str*) – the id of the link

Returns the created link

Type *Link*

`create_node(tool, id_=None, stepid=None, cores=None, memory=None, walltime=None, node-group=None)`

Create a Node in this Network. The Node will be automatically added to the Network.

Parameters

- **tool** (*Tool*) – The Tool to base the Node on
- **id** (*str*) – The id of the node to be created
- **stepid** (*str*) – The stepid to add the created node to

- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.

Returns the newly created node

Return type *Node*

create_sink (*datatype*, *id_=None*, *stepid=None*)

Create a SinkNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the sink node
- **id** (*str*) – The id of the sink node to be created
- **stepid** (*str*) – The stepid to add the created sink node to

Returns the newly created sink node

Return type *SinkNode*

create_source (*datatype*, *id_=None*, *stepid=None*, *nodegroup=None*, *sourcegroup=None*)

Create a SourceNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the source source_node
- **id** (*str*) – The id of the source source_node to be created
- **stepid** (*str*) – The stepid to add the created source source_node to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.
- **sourcegroup** (*str*) – *DEPRECATED!* The nodegroup this SourceNode will be added to

Returns the newly created source source_node

Return type *SourceNode*

draw_network (*name='network_layout'*, *img_format='svg'*, *draw_dimension=False*, *expand_macro=False*)

Output a dot file and try to convert it to an image file.

Parameters **img_format** (*str*) – extension of the image format to convert to

Returns path of the image created or None if failed

Return type *str* or *None*

class *fastr.Link* (*source*, *target*, *parent*, *id_=None*, *collapse=None*, *expand=None*)

Class for linking outputs (*BaseOutput*) to inputs (*BaseInput*)

Examples:

```
>>> import fastr
>>> network = fastr.Network()
>>> link1 = network.create_link( n1.ouputs['out1'], n2.inputs['in2'] )

link2 = Link()
link2.source = n1.ouputs['out1']
link2.target = n2.inputs['in2']
```

source

The source *BaseOutput* of the Link. Setting the source will automatically register the Link with the source BaseOutput. Updating source will also make sure the Link is unregistered with the previous source.

Raises *FastrTypeError* – if assigning a non *BaseOutput*

target

The target *BaseInput* of the Link. Setting the target will automatically register the Link with the target BaseInput. Updating target will also make sure the Link is unregistered with the previous target.

Raises *FastrTypeError* – if assigning a non *BaseInput*

FASTR Developer Module reference

fastr Package

fastr Package

FASTR is a top level package which includes all parts required to create networks and edit networks.

class `fastr.__init__.Network`

The class representing a Network, this is in fact a reference to `fastr.core.network.Network`.

class `fastr.__init__.NodeRun`

The class representing a NodeRun, this is in fact a reference to `fastr.core.node.NodeRun`.

class `fastr.__init__.Link`

The class representing a Link, this is in fact a reference to `fastr.core.link.Link`.

class `fastr.__init__.SourceNodeRun`

The class representing a data source, this is in fact a reference to `fastr.core.node.SourceNodeRun`.

class `fastr.__init__.SinkNodeRun`

The class representing a data sink, this is in fact a reference to `fastr.core.node.SinkNodeRun`.

class `fastr.__init__.ConstantNodeRun`

The class representing a constant data source, this is in fact a reference to `fastr.core.node.ConstantNodeRun`.

`fastr.__init__.toollist`

A `fastr.core.toolmanager.ToolManager` containing all Tools known to the FASTR environment. The toollist can be accessed in a similar way to a dict. Indexing with a tool id will return the newest version of the Tool. If a specific version of the tool is required a tuple can be used as the index:

```
>>> import fastr
>>> fastr.toollist['testtool']
<Tool: testtool version: 4.2>
>>> fastr.toollist['testtool', '2.0']
<Tool: testtool version: 2.0>
```

`fastr.__init__.typelist`

A `fastr.core.datatypemanager.DataTypeManager` containing all Types known to the FASTR environment. This is usable as a dict where the key is the datatype id and the value is the datatype itself.

class `fastr.__init__.Network` (*id*='unnamed_network', *version*=None, *filename*=None)

Bases: `fastr.core.serializable.Serializable`

The NetworkRun contains the entire Run state for a Network execution. It has a working copy of the network, but also includes all temporary data required for the execution. These objects are meant to be single use.

`NETWORK_DUMP_FILE_NAME` = '__fastr_network__.json'

`SINK_DUMP_FILE_NAME` = '__sink_data__.json'

`SOURCE_DUMP_FILE_NAME` = '__source_data__.pickle.gz'

`__dataschemafile__` = 'Network.schema.json'

`__eq__` (*other*)

Compare two Networks and see if they are equal.

Parameters *other* (`Network`) –

Returns flag indicating that the Networks are the same

Return type `bool`

`__getitem__` (*item*)

Get an item by its fullid. The fullid can point to a link, node, input, output or even subinput/suboutput.

Parameters *item* (`str`, `unicode`) – fullid of the item to retrieve

Returns the requested item

`__getstate__` ()

Retrieve the state of the Network

Returns the state of the object

Rtype `dict`

`__init__` (*id*='unnamed_network', *version*=None, *filename*=None)

Create a new, empty Network

Parameters *name* (`str`) – name of the Network

Returns newly created Network

Raises `OSError` – if the tmp mount in the config is not a writable directory

`__module__` = 'fastr.core.network'

`__ne__` (*other*)

Tests for non-equality, this is the negated version `__eq__`

`__repr__` ()

`__setstate__` (*state*)

Set the state of the Network by the given state. This completely overwrites the old state!

Parameters *state* (`dict`) – The state to populate the object with

Returns None

`add_link` (*link*)

Add a Link to the Network. Make sure the link is in the link list and the link parent is set to this Network

Parameters *link* (`Link`) – link to add

Raises

- ***FastrTypeError*** – if link is incorrectly typed
- ***FastrNetworkMismatchError*** – if the link already belongs to another Network

add_node (*node*)

Add a Node to the Network. Make sure the node is in the node list and the node parent is set to this Network

Parameters **node** (*Node*) – node to add

Raises ***FastrTypeError*** – if node is incorrectly typed

add_stepid (*stepid*, *node*)

Add a Node to a specific step id

Parameters

- **stepid** (*str*) – the stepid that the node will be added to
- **node** (*Node*) – the node to add to the stepid

check_id (*id_*)

Check if an id for an object is valid and unused in the Network. The method will always returns True if it does not raise an exception.

Parameters **id** (*str*) – the id to check

Returns True

Raises

- ***FastrValueError*** – if the id is not correctly formatted
- ***FastrValueError*** – if the id is already in use

create_constant (*datatype*, *data*, *id_=None*, *stepid=None*, *nodegroup=None*, *sourcegroup=None*)

Create a ConstantNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the constant node
- **data** (*datatype or list of datatype*) – The data to hold in the constant node
- **id** (*str*) – The id of the constant node to be created
- **stepid** (*str*) – The stepid to add the created constant node to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.

Returns the newly created constant node

Return type *ConstantNode*

create_link (*source*, *target*, *id_=None*, *collapse=None*, *expand=None*)

Create a link between two Nodes and add it to the current Network.

Parameters

- **source** (*BaseOutput*) – the output that is the source of the link
- **target** (*BaseInput*) – the input that is the target of the link
- **id** (*str*) – the id of the link

Returns the created link

Type *Link*

create_macro (*network*, *id=None*)

create_node (*tool*, *id=None*, *stepid=None*, *cores=None*, *memory=None*, *walltime=None*, *nodegroup=None*)

Create a Node in this Network. The Node will be automatically added to the Network.

Parameters

- **tool** (*Tool*) – The Tool to base the Node on
- **id** (*str*) – The id of the node to be created
- **stepid** (*str*) – The stepid to add the created node to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.

Returns the newly created node

Return type *Node*

create_reference (*source_data*, *output_directory*)

create_sink (*datatype*, *id=None*, *stepid=None*)

Create a SinkNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the sink node
- **id** (*str*) – The id of the sink node to be created
- **stepid** (*str*) – The stepid to add the created sink node to

Returns the newly created sink node

Return type *SinkNode*

create_source (*datatype*, *id=None*, *stepid=None*, *nodegroup=None*, *sourcegroup=None*)

Create a SourceNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the source source_node
- **id** (*str*) – The id of the source source_node to be created
- **stepid** (*str*) – The stepid to add the created source source_node to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.
- **sourcegroup** (*str*) – *DEPRECATED!* The nodegroup this SourceNode will be added to

Returns the newly created source source_node

Return type *SourceNode*

draw (*name=None*, *image_format=None*, *draw_dimensions=False*, *context=None*, *graph=None*, *expand_macro=False*)

draw_network (*name='network_layout'*, *img_format='svg'*, *draw_dimension=False*, *expand_macro=False*)

Output a dot file and try to convert it to an image file.

Parameters **img_format** (*str*) – extension of the image format to convert to

Returns path of the image created or None if failed

Return type `str` or `None`

execute (*sourcedata*, *sinkdata*, *blocking=True*, ***kwargs*)

fullid

The fullid of the Network, within the network scope

global_id

The global id of the Network, this is different for networks used in macronodes, as they still have parents.

id

The id of the Network. This is a read only property.

is_valid()

nodegroups

Give an overview of the nodegroups in the network

remove (*value*)

Remove an item from the Network.

Parameters **value** (*Node* or *Link*) – the item to remove

classmethod test (*reference_data_dir*, *network=None*, *source_data=None*, *force_remove_temp=False*)

Execute the network with the source data specified and test the results against the reference data. This effectively tests the network execution.

Parameters

- **reference_data_dir** (*str*) – The path or vfs url of reference data to compare with
- **source_data** (*dict*) – The source data to use

class `fastr.__init__.Link` (*source*, *target*, *parent*, *id_=None*, *collapse=None*, *expand=None*)

Bases: `fastr.core.dimension.HasDimensions`, `fastr.core.updateable.Updateable`, `fastr.core.serializable.Serializable`

Class for linking outputs (*BaseOutput*) to inputs (*BaseInput*)

Examples:

```
>>> import fastr
>>> network = fastr.Network()
>>> link1 = network.create_link( n1.outputs['out1'], n2.inputs['in2'] )

link2 = Link()
link2.source = n1.outputs['out1']
link2.target = n2.inputs['in2']
```

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'Link.schema.json'

__eq__ (*other*)

Test for equality between two Links

Parameters **other** (*Link*) – object to test against

Returns True for equality, False otherwise

Return type `bool`

`__getstate__()`

Retrieve the state of the Link

Returns the state of the object

Rtype dict

`__init__(source, target, parent, id_=None, collapse=None, expand=None)`

Create a new Link in a Network.

Parameters

- **source** (*BaseOutput*) – the source output
- **target** (*BaseInput*) – the target input
- **parent** (*Network* or None) – the parent network
- **id** (*str* or None) – the id of the link, if no **id** is given, the id will be in the form of “link_{:d}”
- **collapse** (*int*, *str*, or *tuple of int/str*) – the dimensions that the link has to collapse on
- **expand** (*bool*) – Does this link need to expand the cardinality into a new sample dimension

Returns newly created Link

Raises

- **FastrValueError** – if parent is not given
- **FastrValueError** – if the source output is not in the same network as the Link
- **FastrValueError** – if the target input is not in the same network as the Link

`__module__` = ‘fastr.core.link’

`__repr__()`

Get a string representation for the Link

Returns the string representation

Return type *str*

`__setstate__(state)`

Set the state of the Link by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

Raises **FastrValueError** – if the parent network is not set

cardinality (*index=None*)

Cardinality for a Link is given by source Output and the collapse/expand settings

Parameters **key** (*SampleIndex*) – key for a specific sample (can be only a sample index!)

Returns the cardinality

Return type *int*, *sympy.Symbol*

Raises **FastrIndexError** – if the index length does not match the number of dimension in the data

collapse

The converging dimensions of this link. Collapsing changes some dimensions of sample lists into cardinality, reshaping the data.

Collapse can be set to a tuple or an int/str, in which case it will be automatically wrapped in a tuple. The int will be seen as indices of the dimensions to collapse. The str will be seen as the name of the dimensions over which to collapse.

Raises *FastTypeError* – if assigning a collapse value of a wrong type

collapse_indexes

The converging dimensions of this link as integers. Dimension names are replaced with the corresponding int.

Collapsing changes some dimensions of sample lists into cardinality, reshaping the data

classmethod createobj (*state, network=None*)

Create object function for Link

Parameters

- **cls** – The class to create
- **state** – The state to use to create the Link
- **network** – the parent Network

Returns newly created Link

destroy ()

The destroy function of a link removes all default references to a link. This means the references in the network, input and output connected to this link. If there are no references in other places in the code, it will destroy the link (reference count dropping to zero).

This function is called when a source for an input is set to another value and the link becomes disconnected. This makes sure there are no dangling links.

dimensions

The dimensions of the data delivered by the link. This can be different from the source dimensions because the link can make data collapse or expand.

draw (*context, graph*)**expand**

Flag indicating that the link will expand the cardinality into a new sample dimension to be created.

fullid

The full defining ID for the Input

parent

The Network to which this Link belongs.

source

The source *BaseOutput* of the Link. Setting the source will automatically register the Link with the source BaseOutput. Updating source will also make sure the Link is unregistered with the previous source.

Raises *FastTypeError* – if assigning a non *BaseOutput*

status**target**

The target *BaseInput* of the Link. Setting the target will automatically register the Link with the target BaseInput. Updating target will also make sure the Link is unregistered with the previous target.

Raises *FastTypeError* – if assigning a non *BaseInput*

```
class fastr.__init__.Node(tool, id_=None, node_class=None, parent=None, cores=None, memory=None, walltime=None, nodegroup=None)
    Bases: fastr.core.dimension.HasDimensions, fastr.core.updateable.Updateable, fastr.core.serializable.Serializable
```

The class encapsulating a node in the network. The node is responsible for setting and checking inputs and outputs based on the description provided by a tool instance.

```
__abstractmethods__ = frozenset([])
```

```
__dataschemafile__ = 'Node.schema.json'
```

```
__eq__(other)
```

Compare two Node instances with each other. This function ignores the parent and update status, but tests rest of the dict for equality. equality

Parameters *other* (*Node*) – the other instances to compare to

Returns True if equal, False otherwise

```
__getstate__()
```

Retrieve the state of the Node

Returns the state of the object

Rtype dict

```
__init__(tool, id_=None, node_class=None, parent=None, cores=None, memory=None, walltime=None, nodegroup=None)
```

Instantiate a node.

Parameters

- **tool** (*Tool*) – The tool to base the node on
- **id** (*str*) – the id of the node
- **node_class** (*str*) – The class of the NodeRun to create (e.g. SourceNodeRun, NodeRun)
- **parent** (*Network*) – the parent network of the node
- **cores** (*int*) – number of cores required for executing this Node
- **memory** (*str*) – amount of memory required in the form d+[mMgG] where M is for megabyte and G for gigabyte
- **walltime** (*str*) – amount of time required in second or in the form HOURS:MINUTES:SECOND

Returns the newly created Node

```
__metaclass__
```

alias of ABCMeta

```
__module__ = 'fastr.core.node'
```

```
__repr__()
```

Get a string representation for the Node

Returns the string representation

Return type *str*

```
__setstate__(state)
```

Set the state of the Node by the given state.

Parameters `state` (*dict*) – The state to populate the object with

Returns None

`__str__()`

Get a string version for the Node

Returns the string version

Return type `str`

blocking

Indicate that the results of this Node cannot be determined without first executing the Node, causing a blockage in the creation of jobs. A blocking Nodes causes the Chunk borders.

classmethod `createobj` (*state, network=None*)

dimensions

dimnames

Names of the dimensions in the Node output. These will be reflected in the SampleIdList of this Node.

draw (*context, graph, color=None*)

draw_id (*context*)

draw_link_target (*context, port_name, input=True*)

find_source_index (*target_index, target, source*)

fullid

The full defining ID for the Node inside the network

get_sourced_nodes ()

A list of all Nodes connected as sources to this Node

Returns list of all nodes that are connected to an input of this node

global_id

The global defining ID for the Node from the main network (goes out of macro nodes to root network)

id

The id of the Node

input_groups

A list of input groups for this Node. An input group is InputGroup object filled according to the Node

listeners

All the listeners requesting output of this node, this means the listeners of all Outputs and SubOutputs

merge_dimensions

name

Name of the Tool the Node was based on. In case a Toolless Node was used the class name is given.

nodegroup

outputsize

The size of output of this SourceNode

parent

The parent network of this node.

required_cores

Number of cores required for the execution of this Node

required_memory

Amount of memory required for the execution of this Node. Follows the format d+[mMgG] so 500M or 4g would be valid ways to specify 500 megabytes or 4 gigabyte of memory.

required_time

Amount of time required for the execution of this Node. Follows the format of a number of second or H:M:S, with H the number of hours, M the number of minutes and S the number of seconds.

status**tool****update_input_groups()**

Update all input groups in this node

class `fastr.__init__.ConstantNode` (*datatype, data, id_=None, parent=None, nodegroup=None*)

Bases: `fastr.core.node.SourceNode`

Class encapsulating one output for which a value can be set. For example used to set a scalar value to the input of a node.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'ConstantNode.schema.json'

__getstate__()

Retrieve the state of the ConstantNode

Returns the state of the object

Rtype dict

__init__ (*datatype, data, id_=None, parent=None, nodegroup=None*)

Instantiation of the ConstantNode.

Parameters

- **datatype** – The datatype of the output.
- **data** – the prefilled data to use.
- **id** – The url pattern.

This class should never be instantiated directly (unless you know what you are doing). Instead create a constant using the network class like shown in the usage example below.

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> source = network.create_source(datatype=fastr.typelist['ITKImageFile'],
↳ id_='sourceN')
```

or alternatively create a constant node by assigning data to an InputDict:

```
>>> node_a.inputs['in'] = ['some', 'data']
```

which automatically creates and links a ConstantNode to the specified Input

__module__ = 'fastr.core.node'

__setstate__ (*state*)

Set the state of the ConstantNode by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

data

The data stored in this constant node

draw (*context, graph, color=None*)

set_data (*data=None, ids=None*)

Set the data of this constant node in the correct way. This is mainly for compatibility with the parent class `SourceNode`

Parameters

- **data** (*dict or list of urls*) – the data to use
- **ids** – if data is a list, a list of accompanying ids

class `fastr.__init__.SourceNode` (*datatype, id_=None, parent=None, nodegroup=None*)

Bases: `fastr.core.node.FlowNode`

Class providing a connection to data resources. This can be any kind of file, stream, database, etc from which data can be received.

__abstractmethods__ = `frozenset([])`

__dataschemafile__ = `'SourceNode.schema.json'`

__eq__ (*other*)

Compare two Node instances with each other. This function ignores the parent and update status, but tests rest of the dict for equality. equality

Parameters *other* (`Node`) – the other instances to compare to

Returns True if equal, False otherwise

__getstate__ ()

Retrieve the state of the `SourceNode`

Returns the state of the object

Rtype dict

__init__ (*datatype, id_=None, parent=None, nodegroup=None*)

Instantiation of the `SourceNode`.

Parameters

- **datatype** – The (id of) the datatype of the output.
- **id** – The url pattern.

This class should never be instantiated directly (unless you know what you are doing). Instead create a source using the network class like shown in the usage example below.

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> source = network.create_source(datatype=fastr.typelist['ITKImageFile'],
↳ id_='sourceN')
```

__module__ = `'fastr.core.node'`

__setstate__ (*state*)

Set the state of the `SourceNode` by the given state.

Parameters `state` (*dict*) – The state to populate the object with

Returns `None`

datatype

The datatype of the data this source supplies.

dimensions

The dimensions in the `SourceNode` output. These will be reflected in the `SampleIdLists`.

draw (*context, graph, color=None*)

nodegroup

output

Shorthand for `self.outputs['output']`

set_data (*data, ids=None*)

Set the data of this source node.

Parameters

- **data** (*dict, OrderedDict or list of urls*) – the data to use
- **ids** – if data is a list, a list of accompanying ids

sourcegroup

valid

This does nothing. It only overloads the `valid` method of `Node()`. The original is intended to check if the inputs are connected to some output. Since this class does not implement inputs, it is skipped.

class `fastr.__init__.SinkNode` (*datatype, id_=None, parent=None, nodegroup=None*)

Bases: `fastr.core.node.Node`

Class which handles where the output goes. This can be any kind of file, e.g. image files, textfiles, config files, etc.

__abstractmethods__ = `frozenset([])`

__dataschemafile__ = `'SinkNode.schema.json'`

__getstate__ ()

__init__ (*datatype, id_=None, parent=None, nodegroup=None*)

Instantiation of the `SourceNode`.

Parameters

- **datatype** – The datatype of the output.
- **id** – the id of the node to create

Returns newly created sink node

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> sink = network.create_sink(datatype=fastr.typelist['ITKImageFile'], id_=
↪ 'SinkN')
```

__module__ = `'fastr.core.node'`

__setstate__ (*state*)

datatype

The datatype of the data this sink can store.

draw (*context, graph, color=None*)

input

The default input of the sink Node

configmanager Module

This module defines the Fastr Config class for managing the configuration of Fastr. The config object is stored directly in the fastr top-level module.

class `fastr.configmanager.Config` (**configfiles*)

Bases: `object`

Class contain the fastr configuration

DEFAULT_FIELDS = {'resourcesdir': (<type 'str'>, '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature

__dict__ = dict_proxy({'plugins_path': <property object>, '__dict__': <attribute '__dict__' of 'Config' objects>, '__we

__init__ (**configfiles*)

__module__ = 'fastr.configmanager'

__repr__ ()

__weakref__

list of weak references to the object (if defined)

debug

examplesdir

execution_plugin

executionscript

filesynchelper_url

get_field (*item*)

logdir

logging_config

loglevel

logtype

mounts

networks_path

pim_host

plugins_path

preferred_types

process_pool_worker_number

protected_modules

read_config (*filename*)

Read a configuration and update the configuration object accordingly

Parameters **filename** – the configuration file to read

read_config_files = None

Trace of the config files read by this object

read_config_string (*value*)

register_fields (*fields_spec*)

Register extra fields to the configuration manager.

resourcesdir

schemadir

set_field (*item*, *value*)

source_job_limit

systemdir

tools_path

types_path

userdir

warn_develop

web_hostname

web_port

web_secret_key

web_url ()

Construct a fqdn from the web['hostname'] and web['port'] settings. :return: FQDN :rtype: str

x = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr-1

class fastr.configmanager.**EmptyDefault** (*data=None*)

Bases: `object`

Empty defaultdict.

__add__ (*right*)

__delitem__ (*key*)

__dict__ = `dict_proxy` ({'extend': <function extend>, '__delitem__': <function __delitem__>, '__module__': 'fastr.conf

__getitem__ (*item*)

__iadd__ (*right*)

__init__ (*data=None*)

__module__ = 'fastr.configmanager'

__radd__ (*other*)

__setitem__ (*key*, *value*)

__weakref__

list of weak references to the object (if defined)

append (*value*)

asdict ()

aslist ()

```

extend (other)
prepend (value)
update (other)

```

datatypes Module

The datatypes module holds all DataTypes generated by fastr and all the base classes for these datatypes.

```
class fastr.datatypes.AnalyzeImageFile (value=None, format_=None)
```

Bases: *fastr.datatypes.URLType*

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.datatypes'
```

```
classmethod content (invalue, outvalue=None)
```

```
description = 'Analyze Image file format'
```

```
extension = 'hdr'
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'AnalyzeImageFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-netw
```

```
class fastr.datatypes.AnyFile (value=None)
```

Bases: *fastr.datatypes.TypeGroup*

Special Datatype in fastr that is a TypeGroup with all known DataTypes as its members.

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.datatypes'
```

```
description = 'TypeGroup AnyFile\nAnyFile (AnyFile) is a group of consisting of all URLTypes known by fastr, curre
```

```
class fastr.datatypes.AnyType (value=None)
```

Bases: *fastr.datatypes.TypeGroup*

Special Datatype in fastr that is a TypeGroup with all known DataTypes as its members.

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.datatypes'
```

```
description = 'TypeGroup AnyType\nAnyType (AnyType) is a group of consisting of all DataTypes known by fastr, cu
```

```
class fastr.datatypes.BaseDataType (value=None, format_=None)
```

Bases: *fastr.core.baseplugin.BasePlugin*

The base class for all datatypes in the fastr type system.

```
__abstractmethods__ = frozenset(['__init__'])
```

```
__eq__ (other)
```

Test the equality of two DataType objects

Parameters *other* (*DataType*) – the object to compare against

Returns flag indicating equality

Return type *bool*

```
__getstate__ ()
```

`__init__ (value=None, format_=None)`

The BaseDataType constructor.

Parameters

- **value** – value to assign to the new BaseDataType object
- **format** – the format used for the ValueType

Returns new BaseDataType object

Raises *FastrNotImplementedError* – if *id*, *name*, *version* or *description* is None

`__module__ = 'fastr.datatypes'`

`__ne__ (other)`

Test if two objects are not equal. This is by default done by negating the `__eq__` operator

Parameters *other* (*DataType*) – the object to compare against

Returns flag indicating equality

Return type *bool*

`__reduce_ex__ (*args, **kwargs)`

`__repr__ ()`

Returns string representation of the BaseDataType

Returns string representation

Return type *str*

`__setstate__ (state)`

`__str__ ()`

Returns the string version of the BaseDataType

Returns string version

Return type *str*

`checksum ()`

Generate a checksum for the value of this DataType

Returns the checksum of the value

Return type *str*

`description = ''`

`extension = None`

`filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag`

`fullid = 'fastr://typelist/BaseDataType'`

`id = 'BaseDataType'`

`classmethod isinstance (value)`

Indicate whether value is an instance for this DataType.

Returns the flag indicating the value is of this DataType

Return type *bool*

`name = 'BaseDataType'`

`parent = DataTypeManager AnalyzeImageFile : <URLType: AnalyzeImageFile> AnyFile : <TypeGroup: AnyFile> Any`

parsed_value

The parsed value of object instantiation of this DataType.

raw_value

The raw value of object instantiation of this DataType. For datatypes that override value (like Deferred) this is the way to access the `_value` field.

classmethod test ()

Define the test for the BasePluginManager. Make sure we are not one of the base classes

valid

A boolean flag that indicates weather or not the value assigned to this DataType is valid. This property is generally overwritten by implementation of specific DataTypes.

value

The value of object instantiation of this DataType.

version = <Version: 1.0>

class `fastr.datatypes.Boolean (value=None, format_=None)`

Bases: `fastr.datatypes.ValueType`

Datatype representing a boolean

__abstractmethods__ = frozenset([])

__module__ = 'fastr.datatypes'

__str__ ()

description = 'A boolean value (True of False)'

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

module = <module 'Boolean' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib

value

The value of object instantiation of this DataType.

class `fastr.datatypes.DataType (value=None, format_=None)`

Bases: `fastr.datatypes.BaseDataType`

This class is the base class for all DataTypes that can hold a value.

__abstractmethods__ = frozenset(['__init__'])

__init__ (value=None, format_=None)

The DataType constructor.

Parameters

- **value** – value to assign to the new DataType object
- **format** – the format used for the ValueType

Returns new DataType object

__module__ = 'fastr.datatypes'

action (name)

This function can be overwritten by subclasses to implement certain action that should be performed. For example, the *Directory* DataType has an action *ensure*. This method makes sure the Directory exists. A Tool can indicate an action that should be called for an Output which will be called before execution.

Parameters **name** (*str*) – name of the action to execute

Returns None

```
class fastr.datatypes.Deferred(value=None, format_=None)
    Bases: fastr.datatypes.DataType

    __abstractmethods__ = frozenset({})

    __getstate__()

    __init__(value=None, format_=None)
        The Deferred constructor.

        Parameters
            • value – value to assign to the new DataType object
            • format – This is ignore but here for compatibility

        Returns new Deferred object

    __module__ = 'fastr.datatypes'

    __repr__()
        Returns string representation of the BaseDataType

        Returns string represenation

        Return type str

    __setstate__(state)

    checksum()
        Generate a checksum for the value of this DataType

        Returns the checksum of the value

        Return type str

    job

    classmethod lookup(value)
        Look up the deferred target and return that object

        Param value

        Returns The value the deferred points to

        Return type DataType

        Raises
            • FastrKeyError – if the deferred is not available (yet)
            • FastrValueError – if the value is not a valid deferred url

    parsed_value
        The value of object instantiation of this DataType.

    provenance

    target
        Target object for this deferred.

        Raises
            • FastrKeyError – if the deferred is not available (yet)
            • FastrValueError – if the value is not a valid deferred url

    value
        The value of object instantiation of this DataType.
```

```

class fastr.datatypes.Directory (value=None, format_=None)
    Bases: fastr.datatypes.URLType

    DataType representing a directory.

    __abstractmethods__ = frozenset([])

    __eq__ (other)
        Directories are equal by default as long as the validity matches.

        Parameters other (Directory) – other to compare against
        Returns equality flag

    __module__ = 'fastr.datatypes'

    action (name)
        This method makes sure the Directory exists. A Tool can indicate an action that should be called for an
        Output which will be called before execution.

        Parameters name (str) – name of the action to execute
        Returns None

    description = 'A directory on the disk'
    extension = None
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'Directory' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/l

class fastr.datatypes.EnumType (value=None, format_=None)
    Bases: fastr.datatypes.DataType

    The EnumType is the base for DataTypes that can have a value which is an option from a predefined set of
    possibilities (similar to an enum type in many programming languages).

    __abstractmethods__ = frozenset([])

    __init__ (value=None, format_=None)
        The EnumType constructor.

        Parameters
            • value – value to assign to the new EnumType object
            • format – the format used for the ValueType

        Returns new EnumType object

        Raises FastrDataTypeNotInstantiableError – if not subclassed

    __module__ = 'fastr.datatypes'
    __reduce_ex__ (*args, **kwargs)

    description = 'EnumType (EnumType) is a enumerate type with options:\n\nEnumType can take the value of any of
    options = frozenset([])
    version = <Version: 1.0>

class fastr.datatypes.FilePrefix (value=None, format_=None)
    Bases: fastr.datatypes.URLType

    __abstractmethods__ = frozenset([])
    __module__ = 'fastr.datatypes'

```

```
checksum()

description = 'Prefix for another file, including the path'

extension = None

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

module = <module 'FilePrefix' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/l

class fastr.datatypes.Float (value=None, format_=None)
    Bases: fastr.datatypes.ValueType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'A floating point value'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'Float' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/py
    value
        The value of object instantiation of this DataType.

class fastr.datatypes.ITKImageFile (value=None)
    Bases: fastr.datatypes.TypeGroup
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'Text file to store point coordinates'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'ITKImageFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkk

class fastr.datatypes.Int (value=None, format_=None)
    Bases: fastr.datatypes.ValueType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'an integer value'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'Int' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/pyth
    value
        The value of object instantiation of this DataType.

class fastr.datatypes.JsonFile (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    checksum()
    description = 'json file'
    extension = 'json'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```



```

    module = <module 'JsonFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/JsonFile.py'>
class fastr.datatypes.MetaImageFile (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset([])
    __eq__ (other)
    __module__ = 'fastr.datatypes'
    checksum ()
        Return the checksum of this MetaImageFile
        Returns checksum string
        Return type str
    classmethod content (invalue, outvalue=None)
    description = 'Meta Image file format'
    extension = 'mhd'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/MetaImageFile.py'
    module = <module 'MetaImageFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/MetaImageFile.py'>
class fastr.datatypes.NiftiImageFile (value=None)
    Bases: fastr.datatypes.TypeGroup
    __abstractmethods__ = frozenset([])
    __module__ = 'fastr.datatypes'
    description = 'NiftiTypeGroup'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/NiftiImageFile.py'
    module = <module 'NiftiImageFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/NiftiImageFile.py'>
class fastr.datatypes.NiftiImageFileCompressed (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset([])
    __module__ = 'fastr.datatypes'
    description = 'Compressed Nifti Image File format'
    extension = 'nii.gz'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/NiftiImageFileCompressed.py'
    module = <module 'NiftiImageFileCompressed' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/NiftiImageFileCompressed.py'>
class fastr.datatypes.NiftiImageFileUncompressed (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset([])
    __module__ = 'fastr.datatypes'
    description = 'Nifti Image File format'
    extension = 'nii'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/NiftiImageFileUncompressed.py'
    module = <module 'NiftiImageFileUncompressed' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/fastr/datatypes/NiftiImageFileUncompressed.py'>

```

```
class fastr.datatypes.Number (value=None)
    Bases: fastr.datatypes.TypeGroup
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'an numeric value'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'Number' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/

class fastr.datatypes.ProvNFile (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'Provenance file in the prov N format'
    extension = 'provn'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'ProvNFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/

class fastr.datatypes.String (value=None, format_=None)
    Bases: fastr.datatypes.ValueType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'A simple string value'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'String' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/p

class fastr.datatypes.TifImageFile (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'Tif Image File format'
    extension = 'tif'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'TifImageFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkru

class fastr.datatypes.TxtFile (value=None, format_=None)
    Bases: fastr.datatypes.URLType
    __abstractmethods__ = frozenset({})
    __module__ = 'fastr.datatypes'
    description = 'General text file'
    extension = 'txt'
    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
    module = <module 'TxtFile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/
```

class `fastr.datatypes.TypeGroup` (*value=None*)

Bases: `fastr.datatypes.BaseDataType`

The TypeGroup is a special DataType that does not hold a value of its own but is used to group a number of DataTypes. For example ITK has a list of supported file formats that all tools build on ITK support. A group can be used to conveniently specify this in multiple Tools that use the same set DataTypes.

__abstractmethods__ = frozenset(['_members'])

__init__ (*value=None*)

Dummy constructor. TypeGroups are not instantiable and cannot hold a value of its own.

Raises `FastrDataTypeNotInstantiableError` – if called

__module__ = 'fastr.datatypes'

static **__new__** (*value=None, format_=None*)

Instantiate a TypeGroup. This will for match the value to the best matching type and instantiate that. Not that the returned object will not be of type TypeGroup but one of the TypeGroup members.

classmethod **isinstance** (*value*)

members

A descriptor that can act like a property for a class.

class `fastr.datatypes.URLType` (*value=None, format_=None*)

Bases: `fastr.datatypes.DataType`

The URLType is the base for DataTypes that point to a resource somewhere else (typically a filesystem). The true value is actually the resource referenced by the value in this object.

__abstractmethods__ = frozenset([])

__eq__ (*other*)

Test the equality of two DataType objects

Parameters **other** (`URLType`) – the object to compare against

Returns flag indicating equality

Return type `bool`

__init__ (*value=None, format_=None*)

The URLType constructor

Parameters

- **value** – value to assign to the new URLType
- **format** – the format used for the ValueType

Returns new URLType object

__module__ = 'fastr.datatypes'

checksum ()

Return the checksum of this URL type

Returns checksum string

Return type `str`

classmethod **content** (*inval, outval=None*)

Give the contents of a URLType, this is generally useful for filetypes that consists of multiple files (e.g. AnalyzeImageFile, DICOM). The value will indicate the main file, and the contents function can determine all files that form a single data value.

Parameters

- **inval** – a value to figure out contents for this type
- **outval** – the place where the copy should point to

Returns a list of all files part of the value (e.g. header and data file)

Return type list

parsed_value

The parsed value of object instantiation of this DataType.

valid

A boolean flag that indicates weather or not the value assigned to this DataType is valid. This property is generally overwritten by implementation of specific DataTypes.

```
class fastr.datatypes.UnsignedInt (value=None, format_=None)
```

Bases: *fastr.datatypes.ValueType*

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.datatypes'
```

```
description = 'an unsigned integer value'
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'UnsignedInt' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkru
```

value

The value of object instantiation of this DataType.

```
class fastr.datatypes.ValueType (value=None, format_=None)
```

Bases: *fastr.datatypes.DataType*

The ValueType is the base for DataTypes that hold simple values (not an EnumType and not a file/URL). The values is generally represented by a string.

```
__abstractmethods__ = frozenset([])
```

```
__init__ (value=None, format_=None)
```

The ValueType constructor

Parameters

- **value** – value to assign to the new ValueType
- **format** – the format used for the ValueType

Returns new ValueType object

```
__module__ = 'fastr.datatypes'
```

```
fastr.datatypes.fastr_isinstance (obj, datatype)
```

Check if an object is of a specific datatype.

Parameters

- **obj** – Object to inspect
- **datatype** (*tuple*, *BaseDataType*) – The datatype(s) to check

Returns flag indicating object is of datatype

Return type *bool*

exceptions Module

This module contains all Fastr-related Exceptions

exception `fastr.exceptions.FastrAttributeError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`, `exceptions.AttributeError`

AttributeError in the fastr system

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrCannotChangeAttributeError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

Attempting to change an attribute of an object that can be set only once.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrCardinalityError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

The description of the cardinality is not valid.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrCollectorError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

Cannot collect the results from a Job because of an error

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrDataTypeFileNotReadable (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

Could not read the datatype file.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrDataTypeMismatchError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

When using a DataType as the key for the DataTypeManager, the DataTypeManager found another DataType with the same name already in the DataTypeManager. The means fastr has two version of the same DataType in the system, which should never happen!

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrDataTypeNotAvailableError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

The DataType requested is not found by the fastr system. Typically this means that no matching DataType is found in the DataTypeManager.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrDataTypeNotInstantiableError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

The base classes for DataTypes cannot be instantiated and should always be sub-classed.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrDataTypeValueError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

This value in fastr did not pass the validation specified for its `DataType`, typically means that the data is missing or corrupt.

```
__module__ = 'fastr.exceptions'
```

```
exception fastr.exceptions.FastrError (*args, **kwargs)
```

Bases: `exceptions.Exception`

This is the base class for all fastr related exceptions. Catching this class of exceptions should ensure a proper execution of fastr.

```
__init__ (*args, **kwargs)
```

Constructor for all exceptions. Saves the caller object fullid (if found) and the file, function and line number where the object was created.

```
__module__ = 'fastr.exceptions'
```

```
__str__ ()
```

String representation of the error

Returns error string

Return type `str`

```
__weakref__
```

list of weak references to the object (if defined)

```
excerpt ()
```

Return a excerpt of the Error as a tuple.

```
exception fastr.exceptions.FastrErrorInSubprocess (*args, **kwargs)
```

Bases: `fastr.exceptions.FastrExecutionError`

Encountered an error in the subprocess started by the execution script

```
__module__ = 'fastr.exceptions'
```

```
exception fastr.exceptions.FastrExecutableNotFoundError (executable=None, *args, **kwargs)
```

Bases: `fastr.exceptions.FastrExecutionError`

The executable could not be found!

```
__init__ (executable=None, *args, **kwargs)
```

```
__module__ = 'fastr.exceptions'
```

```
__str__ ()
```

String representation of the error

```
exception fastr.exceptions.FastrExecutionError (*args, **kwargs)
```

Bases: `fastr.exceptions.FastrError`

Base class for all fastr execution related errors

```
__module__ = 'fastr.exceptions'
```

```
exception fastr.exceptions.FastrIOError (*args, **kwargs)
```

Bases: `fastr.exceptions.FastrError`, `exceptions.IOError`

IOError in the fastr system

```
__module__ = 'fastr.exceptions'
```

```
__weakref__
```

list of weak references to the object (if defined)

exception `fastr.exceptions.FastrImportError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrError`, `exceptions.ImportError`

ImportError in the fastr system

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrIndexError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrError`, `exceptions.IndexError`

IndexError in the fastr system

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrIndexNonexistent(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrIndexError`

This is an IndexError for samples requested from a sparse data array. The sample is not there but is probably not there because of sparseness rather than being a missing sample (e.g. out of bounds).

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrKeyError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrError`, `exceptions.KeyError`

KeyError in the fastr system

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrLookupError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrError`

Could not find specified object in the fastr environment.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrMountUnknownError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrKeyError`

Trying to access an undefined mount

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrNetworkMismatchError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrError`

Two interacting objects belong to different fastr network.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrNetworkUnknownError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrKeyError`

Reference to a Tool that is not recognised by the fastr system. This typically means the specific id/version combination of the requested tool has not been loaded by the ToolManager.

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrNoValidTargetError(*args, **kwargs)`
 Bases: `fastr.exceptions.FastrKeyError`

Cannot find a valid target for the tool

`__module__` = 'fastr.exceptions'

exception `fastr.exceptions.FastrNodeAlreadyPreparedError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrStateError`

A attempt is made at preparing a NodeRun for the second time. This is not allowed as it would wipe the current execution data and cause data-loss.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrNodeNotPreparedError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrStateError`

When trying to access execution data of a NodeRun, the NodeRun must be prepare. The NodeRun has not been prepared by the execution, so the data is not available!

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrNodeNotValidError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrStateError`

A NodeRun is not in a valid state where it should be, typically an invalid NodeRun is passed to the executor causing trouble.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrNotExecutableError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrExecutionError`

The command invoked by subprocess is not executable on the system

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrNotImplementedError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`, `exceptions.NotImplementedError`

This function/method has not been implemented on purpose (e.g. should be overwritten in a sub-class)

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrOSError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`, `exceptions.OSError`

OSError in the fastr system

`__module__ = 'fastr.exceptions'`

`__weakref__`

list of weak references to the object (if defined)

exception `fastr.exceptions.FastrObjectUnknownError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrKeyError`

Reference to a Tool that is not recognised by the fastr system. This typically means the specific id/version combination of the requested tool has not been loaded by the ToolManager.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrOptionalModuleNotAvailableError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrNotImplementedError`

A optional modules for Fastr is needed for this function, but is not available on the current python installation.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrOutputValidationError (*args, **kwargs)`

Bases: `fastr.exceptions.FastrExecutionError`

An output of a Job does not pass validation


```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrParentMismatchError` (**args, **kwargs*)

Bases: `fastr.exceptions.FastrError`

Two interactive objects have different parent where they should be the same

```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrPluginCapabilityNotImplemented` (**args, **kwargs*)

Bases: `fastr.exceptions.FastrNotImplementedError`

A plugin did not implement a capability that it advertised.

```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrPluginNotAvailable` (**args, **kwargs*)

Bases: `fastr.exceptions.FastrKeyError`

Indicates that a requested Plugin was not found on the system.

```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrPluginNotLoaded` (**args, **kwargs*)

Bases: `fastr.exceptions.FastrStateError`

The plugin was not successfully loaded. This means the plugin class cannot be instantiated.

```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrResultFileNotFound` (**args, **kwargs*)

Bases: `fastr.exceptions.FastrExecutionError`

Could not found the result file of job that finished. This means the executionscript process was killed during interruption. Generally this means a scheduler killed it because of resource shortage.

```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrSerializationError` (*message, serializer, original_exception=None*)

Bases: `fastr.exceptions.FastrError`

The serialization encountered a serious problem

```
__init__(message, serializer, original_exception=None)
```

```
__module__ = 'fastr.exceptions'
```

```
__repr__()
```

Simple string representation of the exception

```
__str__()
```

Advanced string representation of the exception including the data about where in the schema things went wrong.

exception `fastr.exceptions.FastrSerializationIgnoreDefaultError` (*message, serializer, original_exception=None*)

Bases: `fastr.exceptions.FastrSerializationError`

The value and default are both None, so the value should not be serialized.

```
__module__ = 'fastr.exceptions'
```

exception `fastr.exceptions.FastrSerializationInvalidDataError` (*message*, *serializer*, *original_exception=None*)

Bases: `fastr.exceptions.FastrSerializationError`

Encountered data to serialize that is invalid given the serialization schema.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSerializationMethodError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrKeyError`

The desired serialization method does not exist.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSinkDataUnavailableError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrKeyError`

Could not find the Sink data for the desire sink.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSizeInvalidError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrError`

The given size cannot be valid.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSizeMismatchError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrError`

The size of two object in fastr is not matching where it should.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSizeUnknownError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrError`

The size of object is not (yet) known and only a theoretical estimate is available at the moment.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSourceDataUnavailableError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrKeyError`

Could not find the Source data for the desire source.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrStateError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrError`

An object is in an invalid/unexpected state.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrSubprocessNotFinished` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrExecutionError`

Encountered an error before the subprocess call by the execution script was properly finished.

`__module__` = `'fastr.exceptions'`

exception `fastr.exceptions.FastrToolNotAvailableError` (**args*, ***kwargs*)

Bases: `fastr.exceptions.FastrError`

The tool used is not available on the current platform (OS and architecture combination) and cannot be used.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrToolTargetNotFound(*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`

Could not determine the location of the tools target binary/script. The tool cannot be used.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrToolUnknownError(*args, **kwargs)`

Bases: `fastr.exceptions.FastrKeyError`

Reference to a Tool that is not recognised by the fastr system. This typically means the specific id/version combination of the requested tool has not been loaded by the ToolManager.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrTypeError(*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`, `exceptions.TypeError`

TypeError in the fastr system

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrUnknownURLSchemeError(*args, **kwargs)`

Bases: `fastr.exceptions.FastrKeyError`

Fastr encountered a data URL with a scheme that was not recognised by the IOPlugin manager.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrValueError(*args, **kwargs)`

Bases: `fastr.exceptions.FastrError`, `exceptions.ValueError`

ValueError in the fastr system

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrVersionInvalidError(*args, **kwargs)`

Bases: `fastr.exceptions.FastrValueError`

The string representation of the version is malformed.

`__module__ = 'fastr.exceptions'`

exception `fastr.exceptions.FastrVersionMismatchError(*args, **kwargs)`

Bases: `fastr.exceptions.FastrValueError`

There is a mismatch between different parts of the Fastr environment and integrity is compromised.

`__module__ = 'fastr.exceptions'`

plugins Module

The plugins module holds all plugins loaded by Fastr. It is empty on start and gets filled by the BasePluginManager

class `fastr.plugins.BlockingExecution(finished_callback=None, cancelled_callback=None, status_callback=None)`

Bases: `fastr.execution.executionpluginmanager.ExecutionPlugin`

The blocking execution plugin is a special plugin which is meant for debug purposes. It will not queue jobs but immediately execute them inline, effectively blocking fastr until the Job is finished. It is the simplest execution plugin and can be used as a template for new plugins or for testing purposes.

```
__abstractmethods__ = frozenset([])
```

```
__init__ (finished_callback=None, cancelled_callback=None, status_callback=None)
```

```
__module__ = 'fastr.plugins'
```

```
cleanup ()
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'blockingexecution' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-netw
```

```
class fastr.plugins.CommaSeperatedValueFile
```

```
Bases: fastr.core.ioplugin.IOPlugin
```

The CommaSeperatedValueFile an expand-only type of IOPlugin. No URLs can actually be fetched, but it can expand a single URL into a larger amount of URLs.

The `csv:// URL` is a `vfs:// URL` with a number of query variables available. The URL mount and path should point to a valid CSV file. The query variable then specify what column(s) of the file should be used.

The following variable can be set in the query:

variable	usage
value	the column containing the value of interest, can be int for index or string for key
id	the column containing the sample id (optional)
header	indicates if the first row is considered the header, can be <code>true</code> or <code>false</code> (optional)
delimiter	the delimiter used in the csv file (optional)
quote	the quote character used in the csv file (optional)
reformat	a reformatting string so that <code>value = reformat.format(value)</code> (used before <code>relative_path</code>)
relative_path	indicates the entries are relative paths (for files), can be <code>true</code> or <code>false</code> (optional)

The header is by default `false` if the neither the `value` and `id` are set as a string. If either of these are a string, the header is required to define the column names and it automatically is assumed `true`

The delimiter and quota characters of the file should be detected automatically using the `Sniffer`, but can be forced by setting them in the URL.

Example of valid `csv` URLs:

```
# Use the first column in the file (no header row assumed)
csv://mount/some/dir/file.csv?value=0

# Use the images column in the file (first row is assumed header row)
csv://mount/some/dir/file.csv?value=images

# Use the segmentations column in the file (first row is assumed header row)
# and use the id column as the sample id
csv://mount/some/dir/file.csv?value=segmentations&id=id

# Use the first column as the id and the second column as the value
# and skip the first row (considered the header)
csv://mount/some/dir/file.csv?value=1&id=0&header=true

# Use the first column and force the delimiter to be a comma
csv://mount/some/dir/file.csv?value=0&delimiter=,
```

```

__abstractmethods__ = frozenset([])

__init__()

__module__ = 'fastr.plugins'

expand_url(url)

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

module = <module 'commaseperatedvaluefile' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/featur

scheme = 'csv'

class fastr.plugins.CrossValidation
    Bases: flowinterface.FlowPlugin

    Advanced flow plugin that generated a cross-validation data flow. The node need an input with data and an input
    number of folds. Based on that the outputs test and train will be supplied with a number of data sets.

    __abstractmethods__ = frozenset([])

    __module__ = 'fastr.plugins'

    static execute(payload)

    filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

    module = <module 'crossvalidation' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-network

class fastr.plugins.DRMAAExecution(finished_callback=None, cancelled_callback=None, sta-
                                   tus_callback=None)
    Bases: fastr.execution.executionpluginmanager.ExecutionPlugin

    A DRMAA execution plugin to execute Jobs on a Grid Engine cluster. It uses a configuration option for selecting
    the queue to submit to. It uses the python drmaa package.

```

Note: To use this plugin, make sure the `drmaa` package is installed and that the execution is started on an SGE submit host with DRMAA libraries installed.

Note: This plugin is at the moment tailored to SGE, but it should be fairly easy to make different subclasses for different DRMAA supporting systems.

```

CANCELS_DEPENDENCIES = False

GE_NATIVE_SPEC = {'QUEUE': '-q {queue}', 'DEPENDS': '-hold_jid {hold_list}', 'HOLD': '-h', 'MEMORY': '-l h_vmem'}

NATIVE_SPEC = {'grid_engine': {'QUEUE': '-q {queue}', 'DEPENDS': '-hold_jid {hold_list}', 'HOLD': '-h', 'MEMORY': '-l h_vmem'}}

SUPPORTS_CANCEL = True

SUPPORTS_DEPENDENCY = True

SUPPORTS_HOLD_RELEASE = True

TORQUE_NATIVE_SPEC = {'QUEUE': '-q {queue}', 'DEPENDS': '-W depend=afterok:{hold_list}', 'HOLD': '-h', 'MEMORY': '-l h_vmem'}

__abstractmethods__ = frozenset([])

__init__(finished_callback=None, cancelled_callback=None, status_callback=None)

__module__ = 'fastr.plugins'

cleanup()

```

```
collect_jobs()
```

```
configuration_fields = {'drmaa_engine': (<type 'str'>, 'grid_engine', 'The engine to use (options: grid_engine, to
```

```
create_native_spec(queue, walltime, memory, ncores, outputLog, errorLog, hold_job, hold)
```

Create the native spec for the DRMAA scheduler. Needs to be implemented in the subclasses

Parameters

- **queue** (*str*) – the queue to submit to
- **walltime** (*str*) – walltime specified
- **memory** (*str*) – memory requested
- **ncores** (*int*) – number of cores requested
- **outputLog** (*str*) – the location of the stdout log
- **errorLog** (*str*) – the location of stderr log
- **hold_job** (*list*) – list of jobs to depend on
- **hold** (*bool*) – flag if job should be submitted in hold mode

Returns

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'drmaaexecution' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networ
```

```
send_job(command, arguments, queue=None, walltime=None, job_name=None, memory=None,
          ncores=None, joinLogFiles=False, outputLog=None, errorLog=None, hold_job=None,
          hold=False)
```

```
spec_fields
```

```
submit_jobs()
```

```
classmethod test()
```

```
class fastr.plugins.DockerTarget(binary, docker_image)
```

Bases: *fastr.core.target.Target*

A tool target that is located in a Docker images. Can be run using docker-py. A docker target only need two variables: the binary to call within the docker container, and the docker container to use.

```
{
  "arch": "*",
  "os": "*",
  "binary": "bin/test.py",
  "docker_image": "fastr/test"
}
```

```
<target os="*" arch="*" binary="bin/test.py" docker_image="fastr/test">
```

```
__abstractmethods__ = frozenset([])
```

```
__enter__()
```

```
__exit__(exc_type, exc_value, traceback)
```

```
__init__(binary, docker_image)
```

Define a new docker target.

Parameters **docker_image** (*str*) – Docker image to use

```
__module__ = 'fastr.plugins'
```

```
container
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'dockertarget' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun
```

```
monitor_docker(container, resources)
```

Monitor a docker container and profile the cpu, memory and io use. Register the resource use every `_MONITOR_INTERVAL` seconds.

Parameters

- **container** (*ContainerCollection*) – process to monitor
- **resources** (*ProcessUsageCollection*) – list to append measurements to

```
run_command(command)
```

```
class fastr.plugins.FastrInterface(id_, document)
```

Bases: *fastr.core.interface.Interface*

The default Interface for fastr. For the command-line Tools as used by fastr. It build a commandline call based on the input/output specification.

The fields that can be set in the interface:

Attribute		Description
id		The id of this Tool (used internally in fastr)
inputs[]		List of Inputs that can are accepted by the Tool
	id	ID of the Input
	name	Longer name of the Input (more human readable)
	datatype	The ID of the DataType of the Input ¹
	enum[]	List of possible values for an EnumType (created on the fly by fastr) ¹
	prefix	Commandline prefix of the Input (e.g. -in, -i)
	cardinality	Cardinality of the Input
	repeat_prefix	Flag indicating if for every value of the Input the prefix is repeated
	required	Flag indicating if the input is required
	nospace	Flag indicating if there is no space between prefix and value (e.g. -in=val)
	format	For DataTypes that have multiple representations, indicate which one to use
	default	Default value for the Input
	description	Long description for an input
outputs[]		List of Outputs that are generated by the Tool (and accessible to fastr)
	id	ID of the Output
	name	Longer name of the Output (more human readable)
	datatype	The ID of the DataType of the Output ¹
	enum[]	List of possible values for an EnumType (created on the fly by fastr) ¹
	prefix	Commandline prefix of the Output (e.g. -out, -o)
	cardinality	Cardinality of the Output
	repeat_prefix	Flag indicating if for every value of the Output the prefix is repeated
	required	Flag indicating if the input is required
	nospace	Flag indicating if there is no space between prefix and value (e.g. -out=val)
	format	For DataTypes that have multiple representations, indicate which one to use
	description	Long description for an input
	action	Special action (defined per DataType) that needs to be performed before creating output value
	automatic	Indicate that output doesn't require commandline argument, but is created automatically by a T
	method	The collector plugin to use for the gathering automatic output, see the <i>Collector plugins</i>

Table 3.1 – continued from previous page

Attribute	Description
<code>location</code>	Definition where to an automatically, usage depends on the method ²

`__abstractmethods__ = frozenset([])`

`__dataschemafile__ = 'FastrInterface.schema.json'`

`__eq__ (other)`

`__getstate__ ()`

Get the state of the FastrInterface object.

Returns state of interface

Return type `dict`

`__init__ (id_, document)`

`__module__ = 'fastr.plugins'`

`__setstate__ (state)`

Set the state of the Interface

`check_input_id (id_)`

Check if an id for an object is valid and unused in the Tool. The method will always returns True if it does not raise an exception.

Parameters `id (str)` – the id to check

Returns True

Raises

- `FastrValueError` – if the id is not correctly formatted
- `FastrValueError` – if the id is already in use

`check_output_id (id_)`

Check if an id for an object is valid and unused in the Tool. The method will always returns True if it does not raise an exception.

Parameters `id (str)` – the id to check

Returns True

Raises

- `FastrValueError` – if the id is not correctly formatted
- `FastrValueError` – if the id is already in use

`static collect_errors (result)`

Special error collection for fastr interfaces

`collect_results (result)`

Collect all results of the interface

`collector_plugin_type`

alias of `CollectorPlugin`

`collectors = CollectorPluginManager [37m[42m[1mLoaded[0m json : <CollectorPlugin: JsonCollector> [37m[42m[1m`

¹ `datatype` and `enum` are conflicting entries, if both specified `datatype` has presedence

² More details on defining automatica output are given in [TODO]

execute (*target, payload*)

Execute the interface using a specific target and payload (containing a set of values for the arguments)

Parameters

- **target** (*SampleId*) – the target to use
- **payload** (*dict*) – the values for the arguments

Returns result of the execution

Return type *InterfaceResult*

expanding

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

get_arguments (*values*)

Get the argument list for this interface

Returns return list of arguments

get_command (*target, payload*)

get_specials (*payload, output, cardinality_nr*)

Get special attributes. Returns tuples for specials, inputs and outputs that are used for formatting substitutions.

Parameters

- **output** – Output for which to get the specials
- **cardinality_nr** (*int*) – the cardinality number

inputs

module = <module 'fastrinterface' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkr

outputs

class fastr.plugins.**FileSystem**

Bases: *fastr.core.ioplugin.IOPlugin*

The FileSystem plugin is create to handle `file://` type or URLs. This is generally not a good practice, as this is not portable over between machines. However, for test purposes it might be useful.

The URL scheme is rather simple: `file://host/path` (see [wikipedia](#) for details)

We do not make use of the `host` part and at the moment only support localhost (just leave the host empty) leading to `file:///` URLs.

Warning: This plugin ignores the hostname in the URL and does only accept driver letters on Windows in the form `c:/`

__abstractmethods__ = frozenset([])

__init__ ()

__module__ = 'fastr.plugins'

fetch_url (*inurl, outpath*)

Fetch the files from the file.

Parameters

- **inurl** – url to the item in the data store, starts with `file://`

- **outpath** – path where to store the fetch data locally

fetch_value (*inurl*)

Fetch a value from an external file file.

Parameters *inurl* – url of the value to read

Returns the fetched value

filename = `‘/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag`

module = `<module ‘filesystem’ from ‘/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/l`

path_to_url (*path, mountpoint=None*)

Construct an url from a given mount point and a relative path to the mount point.

put_url (*inpath, outurl*)

Put the files to the external data store.

Parameters

- **inpath** – path of the local data
- **outurl** – url to where to store the data, starts with `file://`

put_value (*value, outurl*)

Put the value in the external data store.

Parameters

- **value** – value to store
- **outurl** – url to where to store the data, starts with `file://`

scheme = `‘file’`

url_to_path (*url*)

Get the path to a file from a url. Currently supports the `file://` scheme

Examples:

```
>>> 'file:///d:/data/project/file.ext'
'd:\data\project\file.ext'
```

Warning: `file://` will not function cross platform and is mainly for testing

class `fastr.plugins.FlowInterface` (*id_, document*)

Bases: `fastr.core.interface.Interface`

The Interface use for AdvancedFlowNodes to create the advanced data flows that are not implemented in the fastr. This allows nodes to implement new data flows using the plugin system.

The definition of FlowInterfaces are very similar to the default FastrInterfaces.

Note: A flow interface should be using a specific FlowPlugin

__abstractmethods__ = `frozenset([])`

__dataschemafile__ = `‘FastrInterface.schema.json’`

__eq__ (*other*)

`__getstate__()`

Get the state of the FastrInterface object.

Returns state of interface

Return type dict

`__init__(id_, document)`

`__module__ = 'fastr.plugins'`

`__setstate__(state)`

Set the state of the Interface

`execute(target, payload)`

`expanding`

`filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag`

`flow_plugin_type`

alias of FlowPlugin

`flow_plugins = FlowPluginManager [37m[42m[1mLoaded[0m CrossValidation : <FlowPlugin: CrossValidation>`

`inputs`

`module = <module 'flowinterface' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun`

`outputs`

class `fastr.plugins.LinearExecution` (`finished_callback=None`, `cancelled_callback=None`, `status_callback=None`)

Bases: `fastr.execution.executionpluginmanager.ExecutionPlugin`

An execution engine that has a background thread that executes the jobs in order. The queue is a simple FIFO queue and there is one worker thread that operates in the background. This plugin is meant as a fallback when other plugins do not function properly. It does not multi-processing so it is safe to use in environments that do not support that.

`__abstractmethods__ = frozenset([])`

`__init__(finished_callback=None, cancelled_callback=None, status_callback=None)`

`__module__ = 'fastr.plugins'`

`cleanup()`

`exec_worker()`

`filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag`

`module = <module 'linearexecution' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun`

class `fastr.plugins.LocalBinaryTarget` (`binary`, `paths=None`, `environment_variables=None`, `initscripts=None`, `modules=None`, `interpreter=None`, `**kwargs`)

Bases: `fastr.core.target.Target`

A tool target that is a local binary on the system. Can be found using environmentmodules or a path on the executing machine. A local binary target has a number of fields that can be supplied:

- `binary` (required): the name of the binary/script to call, can also be called `bin` for backwards compatibility.
- `modules`: list of modules to load, this can be environmentmodules or lmod modules. If modules are given, the `paths`, `environment_variables` and `initscripts` are ignored.

- paths**: a list of paths to add following the structure {"value": "/path/to/dir", "type": "bin"}. The types can be `bin` if it should be added to `$PATH` or `lib` if it should be added to the library path (e.g. `$LD_LIBRARY_PATH` for linux).
- environment_variables**: a dictionary of environment variables to set.
- initscript**: a list of script to run before running the main tool
- interpreter**: the interpreter to use to call the binary e.g. `python`

The `LocalBinaryTarget` will first check if there are modules given and the module subsystem is loaded. If that is the case it will simply unload all current modules and load the given modules. If not it will try to set up the environment itself by using the following steps:

1. Prepend the bin paths to `$PATH`
2. Prepend the lib paths to the correct environment variable
3. Setting the other environment variables given (`$PATH` and the system library path are ignored and cannot be set that way)
4. Call the initscripts one by one

The definition of the target in JSON is very straightforward:

```
{
  "binary": "bin/test.py",
  "interpreter": "python",
  "paths": [
    {
      "type": "bin",
      "value": "vfs://apps/test/bin"
    },
    {
      "type": "lib",
      "value": "./lib"
    }
  ],
  "environment_variables": {
    "othervar": 42,
    "short_var": 1,
    "testvar": "value1"
  },
  "initscripts": [
    "bin/init.sh"
  ],
  "modules": ["elastix/4.8"]
}
```

In XML the definition would be in the form of:

```
<target os="linux" arch="*" modules="elastix/4.8" bin="bin/test.py" interpreter=
↪"python">
  <paths>
    <path type="bin" value="vfs://apps/test/bin" />
    <path type="lib" value="./lib" />
  </paths>
  <environment_variables short_var="1">
    <testvar>value1</testvar>
    <othervar>42</othervar>
  </environment_variables>
</target>
```

```
<initscripts>
  <initscript>bin/init.sh</initscript>
</initscripts>
</target>
```

DYNAMIC_LIBRARY_PATH_DICT = {'windows': 'PATH', 'darwin': 'DYLD_LIBRARY_PATH', 'linux': 'LD_LIBRARY_PATH'}

__abstractmethods__ = frozenset([])

__enter__ ()

Set the environment in such a way that the target will be on the path.

__exit__ (exc_type, exc_value, traceback)

Cleanup the environment

__init__ (binary, paths=None, environment_variables=None, initscripts=None, modules=None, interpreter=None, **kwargs)

Define a new local binary target. Must be defined either using paths and optionally environment_variables and initscripts, or environment modules.

__module__ = 'fastr.plugins'

call_subprocess (command)

Call a subprocess with logging/timing/profiling

Parameters **command** (*list*) – the command to execute

Returns execution info

Return type *dict*

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages'

module = <module 'localbinarytarget' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packages/localbinarytarget.py'>

monitor_process (process, resources)

Monitor a process and profile the cpu, memory and io use. Register the resource use every _MONITOR_INTERVAL seconds.

Parameters

- **process** (*subprocess.Popen*) – process to monitor
- **resources** (*ProcessUsageCollection*) – list to append measurements to

run_command (command)

class fastr.plugins.**NipypeInterface** (id_, nipype_cls=None, document=None)

Bases: *fastr.core.interface.Interface*

Experimental interfaces to using nipype interfaces directly in fastr tools, only using a simple reference.

To create a tool using a nipype interface just create an interface with the correct type and set the nipype argument to the correct class. For example in an xml tool this would become:

```
<interface class="NipypeInterface">
  <nipype_class>nipype.interfaces.elastix.Registration</nipype_class>
</interface>
```

Note: To use these interfaces nipype should be installed on the system.

Warning: This interface plugin is basically functional, but highly experimental!

```
__abstractmethods__ = frozenset([])
```

```
__eq__ (other)
```

```
__getstate__ ()
```

```
__init__ (id_, nitype_cls=None, document=None)
```

```
__module__ = 'fastr.plugins'
```

```
__setstate__ (state)
```

```
execute (target, payload)
```

Execute the interface using a specific target and payload (containing a set of values for the arguments)

Parameters

- **target** (*SampleId*) – the target to use
- **payload** (*dict*) – the values for the arguments

Returns result of the execution

Return type *InterfaceResult*

expanding

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
get_type (trait)
```

inputs

```
module = <module 'nitypeinterface' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-network
```

outputs

```
classmethod test ()
```

class `fastr.plugins.Null`

Bases: *fastr.core.ioplugin.IOPlugin*

The Null plugin is create to handle `null://` type or URLs. These URLs are indicating the sink should not do anything. The data is not written to anywhere. Besides the scheme, the rest of the URL is ignored.

```
__abstractmethods__ = frozenset([])
```

```
__init__ ()
```

```
__module__ = 'fastr.plugins'
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'null' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/pyt
```

```
put_url (inpath, outurl)
```

Put the files to the external data store.

Parameters

- **inpath** – path of the local data
- **outurl** – url to where to store the data, starts with `file://`

```
put_value (value, outurl)
```

Put the value in the external data store.

Parameters

- **value** – value to store
- **outurl** – url to where to store the data, starts with `file://`

scheme = 'null'

```
class fastr.plugins.ProcessPoolExecution (finished_callback=None, cancelled_callback=None,
                                          status_callback=None, nr_of_workers=None)
```

Bases: `fastr.execution.executionpluginmanager.ExecutionPlugin`

A local execution plugin that uses multiprocessing to create a pool of worker processes. This allows fastr to execute jobs in parallel with true concurrency. The number of workers can be specified in the fastr configuration, but the default amount is the number of cores - 1 with a minimum of 1.

Warning: The ProcessPoolExecution does not check memory requirements of jobs and running many workers might lead to memory starvation and thus an unresponsive system.

```
__abstractmethods__ = frozenset([])
```

```
__init__ (finished_callback=None, cancelled_callback=None, status_callback=None,
          nr_of_workers=None)
```

```
__module__ = 'fastr.plugins'
```

```
cleanup ()
```

```
configuration_fields = {'process_pool_worker_number': (<type 'int'>, 3, 'Number of workers to use in a process p
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'processpoolexecution' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-ne
```

```
classmethod test ()
```

```
class fastr.plugins.RQExecution (finished_callback=None, cancelled_callback=None, sta-
                                tus_callback=None)
```

Bases: `fastr.execution.executionpluginmanager.ExecutionPlugin`

A execution plugin based on Redis Queue. Fastr will submit jobs to the redis queue and workers will peel the jobs from the queue and process them.

This system requires a running redis database and the database url has to be set in the fastr configuration.

Note: This execution plugin required the `redis` and `rq` packages to be installed before it can be loaded properly.

```
__abstractmethods__ = frozenset([])
```

```
__init__ (finished_callback=None, cancelled_callback=None, status_callback=None)
```

```
__module__ = 'fastr.plugins'
```

```
check_finished ()
```

```
cleanup ()
```

```
configuration_fields = {'rq_queue': (<type 'str'>, 'default', 'The redis queue to use'), 'rq_host': (<type 'str'>, 're
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'rqexecution' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun
```

```
classmethod run_job (job_id, job_command, job_stdout, job_stderr)
```

```
class fastr.plugins.Reference
```

```
Bases: fastr.core.ioplugin.IOPlugin
```

The Reference plugin is create to handle `ref://` type or URLs. These URLs are to make the sink just write a simple reference file to the data. The reference file contains the `DataType` and the value so the result can be reconstructed. It for files just leaves the data on disk by reference. This plugin is not useful for production, but is used for testing purposes.

```
__abstractmethods__ = frozenset([])
```

```
__init__()
```

```
__module__ = 'fastr.plugins'
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'reference' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/li
```

```
push_sink_data (value, outurl, datatype=None)
```

Write out the sink data from the inpath to the outurl.

Parameters

- **value** (*str*) – the path of the data to be pushed
- **outurl** (*str*) – the url to write the data to
- **datatype** (*DataType*) – the datatype of the data, used for determining the total contents of the transfer

Returns None

```
scheme = 'ref'
```

```
class fastr.plugins.S3Filesystem
```

```
Bases: fastr.core.ioplugin.IOPlugin
```

Warning: As this IOPlugin is under development, it has not been thoroughly tested.

example url: s3://bucket.server/path/to/resource

```
__abstractmethods__ = frozenset([])
```

```
__init__()
```

```
__module__ = 'fastr.plugins'
```

```
cleanup()
```

```
expand_url (url)
```

Expand an S3 URL. This allows a source to collect multiple samples from a single url.

Parameters **url** (*str*) – url to expand

Returns the resulting url(s), a tuple if multiple, otherwise a str

Return type *str* or tuple of *str*

```
fetch_url (inurl, outpath)
```

Get the file(s) or values from s3.

Parameters

- **inurl** – url to the item in the data store

- **outpath** – path where to store the fetch data locally

fetch_value (*inurl*)

Fetch a value from S3

Parameters *inurl* – url of the value to read

Returns the fetched value

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

module = <module 's3filesystem' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun

put_url (*inpath, outurl*)

Upload the files to the S3 storage

Parameters

- **inpath** – path to the local data
- **outurl** – url to where to store the data in the external data store.

put_value (*value, outurl*)

Put the value in S3

Parameters

- **value** – value to store
- **outurl** – url to where to store the data, starts with `file://`

scheme = ('s3', 's3list')

class `fastr.plugins.StrongrExecution` (*finished_callback=None, cancelled_callback=None, status_callback=None*)

Bases: `fastr.execution.executionpluginmanager.ExecutionPlugin`

A execution plugin based on Redis Queue. Fastr will submit jobs to the redis queue and workers will peel the jobs from the queue and process them.

This system requires a running redis database and the database url has to be set in the fastr configuration.

Note: This execution plugin required the `redis` and `rq` packages to be installed before it can be loaded properly.

__abstractmethods__ = frozenset([])

__init__ (*finished_callback=None, cancelled_callback=None, status_callback=None*)

__module__ = 'fastr.plugins'

check_finished ()

cleanup ()

configuration_fields = {}

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

module = <module 'strongrexecution' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-netwo

classmethod **test** ()

class `fastr.plugins.VirtualFileSystem`

Bases: `fastr.core.ioplugin.IOPlugin`

The virtual file system class. This is an IOPlugin, but also heavily used internally in fastr for working with directories. The VirtualFileSystem uses the `vfs://url` scheme.

A typical virtual filesystem url is formatted as `vfs://mountpoint/relative/dir/from/mount.ext`

Where the mountpoint is defined in the *Config file*. A list of the currently known mountpoints can be found in the `fastr.config` object

```
>>> fastr.config.mounts
{'example_data': '/home/username/fastr-feature-documentation/fastr/fastr/examples/
↪data',
 'home': '/home/username/',
 'tmp': '/home/username/FastrTemp'}
```

This shows that a url with the mount home such as `vfs://home/tempdir/testfile.txt` would be translated into `/home/username/tempdir/testfile.txt`.

There are a few default mount points defined by Fastr (that can be changed via the config file).

mountpoint	default location
home	the users home directory (<code>expanduser('~')</code>)
tmp	the fastr temporary dir, defaults to <code>tempfile.gettempdir()</code>
example_data	the fastr example data directory, defaults <code>\$FASTRDIR/example/data</code>

`__abstractmethods__ = frozenset([])`

`__init__()`

Instantiate the VFS plugin

Returns the VirtualFileSystem plugin

`__module__ = 'fastr.plugins'`

`abstract = False`

static `copy_file_dir(inpath, outpath)`

Helper function, copies a file or directory not caring what the inpath actually is

Parameters

- **inpath** – path of the things to be copied
- **outpath** – path of the destination

Returns the result of `shutil.copy2` or `shutil.copytree` (depending on inpath pointing to a file or directory)

expand_url(url)

Try to expand the url. For vfs will return the original url.

Parameters **url** – url to expand

Returns the expanded url (same as url)

fetch_url(inurl, outpath)

Fetch the files from the vfs.

Parameters

- **inurl** – url to the item in the data store, starts with `vfs://`
- **outpath** – path where to store the fetch data locally

fetch_value (*inurl*)

Fetch a value from an external vfs file.

Parameters *inurl* – url of the value to read

Returns the fetched value

path_to_url (*path*, *mountpoint=None*, *scheme=None*)

Construct an url from a given mount point and a relative path to the mount point.

Parameters *path* (*str*) – the path to find the url for

Mountpoint *str* mountpoint the url should be under

Returns url of the

put_url (*inpath*, *outurl*)

Put the files to the external data store.

Parameters

- **inpath** – path of the local data
- **outurl** – url to where to store the data, starts with `vfs://`

put_value (*value*, *outurl*)

Put the value in the external data store.

Parameters

- **value** – value to store
- **outurl** – url to where to store the data, starts with `vfs://`

scheme

setup ()

The plugin setup, does nothing but needs to be implemented

url_to_path (*url*, *scheme=None*)

Get the path to a file from a vfs url

Parameters *url* (*str*) – url to get the path for

Returns the matching path

Return type *str*

Raises

- **FastrMountUnknownError** – if the mount in url is unknown
- **FastrUnknownURLSchemeError** – if the url scheme is not correct

Example (the mountpoint tmp points to /tmp):

```
>>> fastr.vfs.url_to_path('vfs://tmp/file.ext')
'/tmp/file.ext'
```

class `fastr.plugins.VirtualFileSystemRegularExpression`

Bases: `fastr.core.ioplugin.IOPlugin`

The VirtualFileSystemValueList an expand-only type of IOPlugin. No URLs can actually be fetched, but it can expand a single URL into a larger amount of URLs.

A `vfsexpr://` URL is a vfs URL that can contain regular expressions on every level of the path. The regular expressions follow the `re` module definitions.

An example of a valid URLs would be:

```
vfsregex://tmp/network_dir/.*/*/__fastr_result__.pickle.gz
vfsregex://tmp/network_dir/nodeX/(?P<id>.*)/__fastr_result__.pickle.gz
```

The first URL would result in all the `__fastr_result__.pickle.gz` in the working directory of a Network. The second URL would only result in the file for a specific node (nodeX), but by adding the named group `id` using `(?P<id>.*)` the sample `id` of the data is automatically set to that group (see [Regular Expression Syntax](#) under the special characters for more info on named groups in regular expression).

Concretely if we would have a directory `vfs://mount/somedir` containing:

```
image_1/Image.nii
image_2/image.nii
image_3/anotherimage.nii
image_5/inconsistentnamingftw.nii
```

we could match these files using `vfsregex://mount/somedir/(?P<id>image_\d+)/.*\.nii` which would result in the following source data after expanding the URL:

```
{'image_1': 'vfs://mount/somedir/image_1/Image.nii',
 'image_2': 'vfs://mount/somedir/image_2/image.nii',
 'image_3': 'vfs://mount/somedir/image_3/anotherimage.nii',
 'image_5': 'vfs://mount/somedir/image_5/inconsistentnamingftw.nii'}
```

Showing the power of this regular expression filtering. Also it shows how the ID group from the URL can be used to have sensible sample ids.

Warning: due to the nature of regexp on multiple levels, this method can be slow when having many matches on the lower level of the path (because the tree of potential matches grows) or when directories that are parts of the path are very large.

```
__abstractmethods__ = frozenset([])
```

```
__init__()
```

```
__module__ = 'fastr.plugins'
```

```
expand_url(url)
```

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'virtualfilesystemregularexpression' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/en
```

```
scheme = 'vfsregex'
```

```
class fastr.plugins.VirtualFileSystemValueList
```

```
Bases: fastr.core.ioplugin.IOPlugin
```

The `VirtualFileSystemValueList` an expand-only type of `IOPlugin`. No URLs can actually be fetched, but it can expand a single URL into a larger amount of URLs. A `vfslist://` URL basically is a url that points to a file using `vfs`. This file then contains a number lines each containing another URL.

If the contents of a file `vfs://mount/some/path/contents` would be:

```
vfs://mount/some/path/file1.txt
vfs://mount/some/path/file2.txt
vfs://mount/some/path/file3.txt
vfs://mount/some/path/file4.txt
```

Then using the URL `vfslist://mount/some/path/contents` as source data would result in the four files being pulled.

Note: The URLs in a `vfslist` file do not have to use the `vfs` scheme, but can use any scheme known to the Fastr system.

```
__abstractmethods__ = frozenset([])

__init__()

__module__ = 'fastr.plugins'

expand_url(url)

filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag

module = <module 'virtualfilesystemvaluelist' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/featur

scheme = 'vfslist'

class fastr.plugins.XNATStorage
Bases: fastr.core.ioplugin.IOPlugin
```

Warning: As this IOPlugin is under development, it has not been thoroughly tested.

The XNATStorage plugin is an IOPlugin that can download data from and upload data to an XNAT server. It uses its own `xnat://` URL scheme. This is a scheme specific for this plugin and though it looks somewhat like the XNAT rest interface, a different type or URL.

Data resources can be access directly by a data url:

```
xnat://xnat.example.com/data/archive/projects/sandbox/subjects/subject001/
↪experiments/experiment001/scans/T1/resources/DICOM
xnat://xnat.example.com/data/archive/projects/sandbox/subjects/subject001/
↪experiments/*_BRAIN/scans/T1/resources/DICOM
```

In the second URL you can see a wildcard being used. This is possible as long as it resolves to exactly one item.

The `id` query element will change the field from the default experiment to subject and the `label` query element sets the use of the label as the fastr id (instead of the XNAT id) to `True` (the default is `False`)

To disable `https` transport and use `http` instead the query string can be modified to add `insecure=true`. This will make the plugin send requests over `http`:

```
xnat://xnat.example.com/data/archive/projects/sandbox/subjects/subject001/
↪experiments/*_BRAIN/scans/T1/resources/DICOM?insecure=true
```

For sinks it is import to know where to save the data. Sometimes you want to save data in a new assessor/resource and it needs to be created. To allow the Fastr sink to create an object in XNAT, you have to supply the type as a query parameter:

```
xnat://xnat.bmia.nl/data/archive/projects/sandbox/subjects/S01/experiments/_BRAIN/
↪assessors/test_assessor/resources/IMAGE/files/image.nii.gz?resource_
↪type=xnat:resourceCatalog&assessor_type=xnat:qcAssessmentData
```

Valid options are: `subject_type`, `experiment_type`, `assessor_type`, `scan_type`, and `resource_type`.

If you want to do a search where multiple resources are returned, it is possible to use a search url:

```
xnat://xnat.example.com/search?projects=sandbox&subjects=subject[0-9][0-9][0-9]&
↳experiments=*_BRAIN&scans=T1&resources=DICOM
```

This will return all DICOMs for the T1 scans for experiments that end with `_BRAIN` that belong to a subjectXXX where XXX is a 3 digit number. By default the ID for the samples will be the experiment XNAT ID (e.g. XNAT_E00123). The wildcards that can be used are the same UNIX shell-style wildcards as provided by the module `fnmatch`.

It is possible to change the id to a different fields id or label. Valid fields are project, subject, experiment, scan, and resource:

```
xnat://xnat.example.com/search?projects=sandbox&subjects=subject[0-9][0-9][0-9]&
↳experiments=*_BRAIN&scans=T1&resources=DICOM&id=subject&label=true
```

The following variables can be set in the search query:

variable	default	usage
projects	*	The project(s) to select, can contain wildcards (see <code>fnmatch</code>)
subjects	*	The subject(s) to select, can contain wildcards (see <code>fnmatch</code>)
experiments	*	The experiment(s) to select, can contain wildcards (see <code>fnmatch</code>)
scans	*	The scan(s) to select, can contain wildcards (see <code>fnmatch</code>)
resources	*	The resource(s) to select, can contain wildcards (see <code>fnmatch</code>)
id	experiment	What field to use as the id, can be: project, subject, experiment, scan, or resource
label	false	Indicate the XNAT label should be used as fastr id, options <code>true</code> or <code>false</code>
insecure	false	Change the url scheme to be used to http instead of https
verify	true	(Dis)able the verification of SSL certificates
regex	false	Change search to use regex <code>re.match()</code> instead of <code>fnmatch</code> for matching
overwrite	false	Tell XNAT to overwrite existing files if a file with the name is already present

For storing credentials the `.netrc` file can be used. This is a common way to store credentials on UNIX systems. It is required that the file is only accessible by the owner only or a `NetrcParseError` will be raised. A `netrc` file is really easy to create, as its entries look like:

```
machine xnat.example.com
  login username
  password secret123
```

See the `netrc` module or the [GNU inet utils website](#) for more information about the `.netrc` file.

Note: On windows the location of the `netrc` file is assumed to be `os.path.expanduser('~/_netrc')`. The leading underscore is because windows does not like filename starting with a dot.

Note: For scan the label will be the scan type (this is initially the same as the series description, but can be updated manually or the XNAT scan type cleanup).

Warning: labels in XNAT are not guaranteed to be unique, so be careful when using them as the sample ID.

For background on XNAT, see the [XNAT API DIRECTORY](#) for the REST API of XNAT.

```
__abstractmethods__ = frozenset([])
```

```
__init__ ()
```

```
__module__ = 'fastr.plugins'
```

```
cleanup ()
```

```
connect (server, path='', insecure=False, verify=True)
```

```
expand_url (url)
```

```
fetch_url (inurl, outpath)
```

Get the file(s) or values from XNAT.

Parameters

- **inurl** – url to the item in the data store
- **outpath** – path where to store the fetch data locally

```
filename = '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-packag
```

```
module = <module 'xnatstorage' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun
```

```
put_url (inpath, outurl)
```

Upload the files to the XNAT storage

Parameters

- **inpath** – path to the local data
- **outurl** – url to where to store the data in the external data store.

```
scheme = 'xnat'
```

```
server
```

```
static upload (resource, in_path, location, retries=3, overwrite=False)
```

```
xnat
```

```
fastr.plugins.json
```

alias of JsonCollector

```
fastr.plugins.path
```

alias of PathCollector

```
fastr.plugins.stdout
```

alias of StdoutCollector

version Module

This module keeps track of the version of the currently used Fastr framework. It can check its version from mercurial or a saved file

```
fastr.version.clear_version ()
```

Remove the cached version info

```
fastr.version.get_base_version ()
```

Get the version from the top-level version file

Returns the version

Rtype str

`fastr.version.get_hg_info()`

Read information about the current mercurial branch and revision

Returns tuple containing head revision and branch

`fastr.version.get_saved_version()`

Get cached version from file

Returns tuple with version, head revision and branch

`fastr.version.save_version(current_version, current_hg_head, current_hg_branch)`

Cache the version information (useful for when installing)

Parameters

- **current_version** (*str*) – version
- **current_hg_head** (*str*) – mercurial head revision
- **current_hg_branch** (*str*) – mercurial branch

Returns

Subpackages

core Package

core Package

This module contains all of the core components of fastr. It has the classes to create networks and work with them.

basemanager Module

This module contains the core class for all managers

class `fastr.core.basemanager.BaseManager` (*path=None, recursive=False*)

Bases: `_abcoll.MutableMapping`

Baseclass for a Manager, subclasses needs to override the following methods:

`BaseManager._item_extension`, `BaseManager._load_item()`

`_item_extension()`

Abstract property that sets the extension of the files to be loaded by the BaseManager. When scanning for items, only files with this extension will be loaded.

Returns desired extension

Return type `str`

Raises `FastNotImplementedError` – if property not reimplemented in subclass

`_load_item` (*filepath, namespace*)

Abstract method to load an item of the BaseManager. This function is not implemented and needs to be reimplemented by a subclass.

Parameters

- **filepath** (*str*) – path of the item to load
- **namespace** (*str*) – the namespace of the item to be loaded

Returns the loaded item

Raises *FastrNotImplementedError* – if called without being reimplemented by a subclass

__abstractmethods__ = frozenset(['_load_item', '_item_extension'])

__delitem__ (*key*)
Remove item from the BaseManager

Parameters *key* – key of the item to remove

Returns None

Raises *FastrKeyError* – if the key is not found in the BaseManager

__getitem__ (*key*)
Retrieve item from BaseManager

Parameters *key* – the key of the item to retrieve

Returns the value indicated by the key

Raises *FastrKeyError* – if the key is not found in the BaseManager

__init__ (*path=None, recursive=False*)
The BaseManager constructor

Parameters

- *path* (*str* or *None*) – path to scan for items, or None for no path
- *recursive* (*bool*) – Flag to indicate a recursive search is desired

Returns the newly created BaseManager

Return type *BaseManager*

__iter__ ()
Get an iterator from the BaseManager. The iterator will iterate over the keys of the BaseManager.

Returns the iterator

Return type dictionary-keyiterator

__keytransform__ (*key*)
Identity transform for the keys. This function can be reimplemented by a subclass to implement a different key transform.

Parameters *key* – key to transform

Returns the transformed key (in this case the same key as inputted)

__len__ ()
Return the number of items in the BaseManager

Returns number of items in the BaseManager

Return type *int*

__metaclass__
alias of ABCMeta

__module__ = 'fastr.core.basemanager'

__repr__ ()
Convert the BaseManager to a representation string.

Returns Representation string

Return type `str`

__setitem__ (*key, value*)
Set item in the BaseManager

Parameters

- **key** – the key of the item to store
- **value** – the value of the item to store

Returns `None`

data
The actual data dict underlying this Manager

match_filename (*filename*)
Check if the filename matches the pattern the manager expects.

Parameters **filename** – filename to match

Returns flag indicating that the filename matches

populate ()
Populate the manager with the data. This is a method that will be called when the Managers data is first accessed. This way we avoid doing expensive directory scans when the data is never requested.

reload ()
Reload entire contents of this manager.

baseplugin Module

The base class for all Plugins in the fastr system

class `fastr.core.baseplugin.BasePlugin`

Bases: `object`

Base class for Plugins in the fastr system.

__abstractmethods__ = `frozenset([])`

__dict__ = `dict_proxy({'status': <fastr.utils.classproperty.ClassPropertyDescriptor object>, '__module__': 'fastr.core.b`

__init__ ()
The BasePlugin constructor.

Returns the created plugin

Return type `BasePlugin`

Raises `FastrPluginNotLoaded` – if the plugin did not load correctly

__metaclass__
alias of `PluginMeta`

__module__ = `'fastr.core.baseplugin'`

__repr__ ()

__str__ ()
Create string representation of the plugin.

Returns string represenation

Return type `str`

```

__weakref__
    list of weak references to the object (if defined)

cleanup ()
    Perform any cleanup action needed when the plugin use ended. This can be closing files/streams etc.

configuration_fields = {}

fullid = 'fastr://plugins/BasePlugin'

id = 'BasePlugin'

instantiate = False

module = None

classmethod register_configuration ()
    Register and test the configuration fields of the plugin

classmethod set_code (source_code)
    Set the filename and source code of the plugin

    Parameters source_code (str) – the source code of the plugin

classmethod set_status (status, message, exception=None)
    Update the status of the plugin

    Parameters
        • status (str) – the new status
        • message (str) – message explaining the status change
        • exception (str) – stacktrace of the exception causing the failed load

source_code
    A descriptor that can act like a property for a class.

status = '\x1b[46mUnInitialized\x1b[0m'

status_message = 'Plugin object created'

classmethod test ()
    Test the plugin, default behaviour is just to instantiate the plugin

class fastr.core.baseplugin.Plugin
    Bases: fastr.core.baseplugin.BasePlugin

    __abstractmethods__ = frozenset([])

    __module__ = 'fastr.core.baseplugin'

class fastr.core.baseplugin.PluginMeta
    Bases: abc.ABCMeta

    Meta class for the BasePlugin.

    __module__ = 'fastr.core.baseplugin'

    __repr__ ()

class fastr.core.baseplugin.PluginState
    Bases: enum.Enum

    Plugin status Enum.

    __format__ (format_spec)

```

```
__module__ = 'fastr.core.baseplugin'
static __new__(value)
__reduce_ex__(proto)
__repr__()
__str__()
failed = '\x1b[37m\x1b[41m\x1b[1mFailed\x1b[0m'
loaded = '\x1b[37m\x1b[42m\x1b[1mLoaded\x1b[0m'
preload = '\x1b[102mPreLoad\x1b[0m'
uninitialized = '\x1b[46mUnInitialized\x1b[0m'
unloaded = '\x1b[46mUnLoaded\x1b[0m'
```

datatypemanager Module

This module manages datatypes. These datatypes are python classes generated from the XML/JSON datatype files.

class `fastr.core.datatypemanager.DataTypeManager`

Bases: `fastr.core.pluginmanager.BasePluginManager`

The DataTypeManager hold a mapping of all DataTypes in the fast system and can create new DataTypes from files/data structures.

__abstractmethods__ = `frozenset([])`

__init__ ()

The DataTypeManager constructor will create a new DataTypeManager and populate it with all DataTypes it can find in the paths set in `fastr.config.types_path`.

Returns the created DataTypeManager

__keytransform__ (*key*)

Key transformation for this mapping. The key transformation allows indexing by both the DataType name as well as the DataType it self.

Parameters **key** (`fastr.datatypes.BaseDataType` or `str`) – The name of the requested datatype or the datatype itself

Returns The requested datatype

__module__ = 'fastr.core.datatypemanager'

create_enumtype (*type_id*, *options*, *name=None*)

Create a python class based on an XML file. This function return a completely functional python class based on the contents of a DataType XML file.

Such a class will be of type EnumType.

Parameters

- **type_id** (`str`) – the id of the new class
- **options** (`iterable`) – an iterable of options, each option should be str

Returns the newly created subclass of EnumType

Raises `FastTypeError` – if the options is not an iterable of str

fullid

The fullid of the datatype manager

get_type (*name*)

Read a type given a typename. This will scan all directories in types_path and attempt to load the newest version of the DataType.

Parameters **name** (*str*) – Name of the datatype that should be imported in the system

Returns the datatype with the requested name, or None if datatype is not found

Note: If type is already in TypeManager it will not load anything and return the already loaded version.

guess_type (*value, exists=True, options=None, preferred=None*)

Guess the DataType based on a value str.

Parameters

- **value** (*str*) – the value to guess the type for
- **options** (*TypeGroup, DataType or tuple of DataTypes*) – The options that are allowed to be guessed from
- **exists** (*bool*) – Indicate the value exists (if file) and can be checked for validity, if false skip validity check
- **preferred** (*iterable*) – An iterable of preferred types in case multiple types match.

Returns The resulting DataType or None if no match was found

Raises *FastrTypeError* – if the options argument is of the wrong type

The function will first create a list of all candidate DataTypes. Subsequently, it will check for each candidate if the value would valid. If there are multiple matches, the config value for preferred types is consulted to break the ties. If non of the DataTypes are in the preferred types list, a somewhat random DataType will be picked as the most optimal result.

has_type (*name*)

Check if the datatype with requested name exists

Parameters **name** (*str*) – the name of the requested datatype

Returns flag indicating if the datatype exists

Return type *bool*

static isdatatype (*item*)

Check if item is a valid datatype for the fastr system.

Parameters **item** – item to check

Returns flag indicating if the item is a fastr datatype

Return type *bool*

match_types (**args, **kwargs*)

Find the match between a list of DataTypes/TypeGroups, see resolve-datatype for details

Parameters

- **args** – A list of DataType/TypeGroup objects to match
- **kwargs** – A ‘preferred’ keyword argument can be used to indicate a list of DataTypes to prefer in case of ties (first has precedence over later in list)

Returns The best DataType match, or None if no match is possible.

Raises *FastrTypeError* – if not all args are subclasses of BaseDataType

match_types_any (*args)

Find the match between a list of DataTypes/TypeGroups, see resolve-datatype for details

Parameters **args** – A list of DataType/TypeGroup objects to match

Returns A set with all DataTypes that match.

Return type *set*

Raises *FastrTypeError* – if not all args are subclasses of BaseDataType

plugin_class

The PluginClass of the items of the BasePluginManager

poll_datatype (filename)

Poll an xml file to see if there is a definition of a datatype in it.

Parameters **filename** (*str*) – path of the file to poll

Returns tuple with (id, version, basetype) if a datatype is found or (None, None, None) if no datatype is found

populate ()

Populate Manager. After scanning for DataTypes, create the AnyType and set the preferred types

preferred_types

dimension Module

class `fastr.core.dimension.Dimension` (name, size)

Bases: *object*

A class representing a dimension. It contains the name and size of the dimension.

__dict__ = `dict_proxy({'__ne__': <function __ne__>, '__module__': 'fastr.core.dimension', 'name': <property object>,`

`__eq__` (*other*)

Dimension is the same if the name and size are the same

__init__ (name, size)

The constructor for the dimension.

Parameters

- **name** (*str*) – Name of the dimension
- **size** (*int* or *sympy.Symbol*) – Size fo the dimension

__module__ = 'fastr.core.dimension'

__ne__ (*other*)

The not equal test is simply the inverse of the equal test

__repr__ ()

String representation of a Dimension

__weakref__

list of weak references to the object (if defined)

name

size

update_size (*value*)

class `fastr.core.dimension.ForwardsDimensions`

Bases: `fastr.core.dimension.HasDimensions`

Class of objects that have dimensions not because they contain data with dimensions but forward them (optionally with changes via `combine_dimensions`)

__abstractmethods__ = `frozenset(['source', 'combine_dimensions'])`

__module__ = `'fastr.core.dimension'`

combine_dimensions (*dimensions*)

Method to combine/manipulate the dimensions

Parameters **dimensions** – the input dimensions from the source

Returns dimensions manipulated for this object

Return type tuple of dimensions

dimensions

The dimensions of the object based on the forwarding

source

The source object from which the dimensions are forwarded

Returns the object from which the dimensions are forwarded

Return type `HasDimensions`

class `fastr.core.dimension.HasDimensions`

Bases: `object`

A Mixin class for any object that has a notion of dimensions and size. It uses the dimension property to expose the dimension name and size.

__abstractmethods__ = `frozenset(['dimensions'])`

__dict__ = `dict_proxy({'__module__': 'fastr.core.dimension', '__metaclass__': <class 'abc.ABCMeta'>, '_abc_negative'`

__metaclass__

alias of `ABCMeta`

__module__ = `'fastr.core.dimension'`

__weakref__

list of weak references to the object (if defined)

dimensions

The dimensions has to be implemented by any subclass. It has to provide a tuple of Dimensions.

Returns dimensions

Return type `tuple`

dimnames

A tuple containing the dimension names of this object. All items of the tuple are of type `str`.

ndims

The number of dimensions in this object

size

A tuple containing the size of this object. All items of the tuple are of type `int` or `sympy.Symbol`.

inputgroup Module

class `fastr.core.inputgroup.InputGroup(*args, **kwargs)`

Bases: `collections.OrderedDict`, `fastr.core.dimension.HasDimensions`

A class representing a group of inputs. Input groups allow the

`__abstractmethods__ = frozenset([])`

`__delitem__(*args, **kwargs)`

`od.__delitem__(y) <==> del od[y]`

Note: This is a wrapped version of `collections.__delitem__` which triggers an update of the object after being called

`__getitem__(key)`

`__init__(*args, **kwargs)`

Create a new InputGroup representation

Parameters

- **parent** (`NodeRun`) – the parent node
- **id** (`str`) – the id of the input group

Raises `FastTypeError` – if parent is not a `NodeRun`

Note: This is a wrapped version of `fastr.core.inputgroup.__init__` which triggers an update of the object after being called

`__metaclass__`

alias of `UpdateableMeta`

`__module__ = 'fastr.core.inputgroup'`

`__setitem__(*args, **kwargs)`

Assign an input to this input group.

Parameters

- **key** (`str`) – id of the input
- **value** (`Input`) – the input to assign

Raises `FastTypeError` – if value of valid type

Note: This is a wrapped version of `fastr.core.inputgroup.__setitem__` which triggers an update of the object after being called

`__updatefunc__()`

Update the InputGroup. Triggers when a change is made to the content of the InputGroup. Automatically recalculates the size, primary Input etc.

`__updatetriggers__ = ['__init__', '__setitem__', '__delitem__', 'clear', 'pop', 'popitem', 'setdefault', 'update']`

`clear()` → None. Remove all items from `od`.

Note: This is a wrapped version of `collections.clear` which triggers an update of the object after being called

dimensions

The dimensions of this InputGroup

empty

Bool indicating that this InputGroup is empty (has no data connected)

find_source_index (*target_size, target_dimnames, source_size, source_dimnames, target_index*)

fullid**iterinputvalues**

Iterate over the item in this InputGroup

Returns iterator yielding `SampleItems`

parent

The parent node of this InputGroup

pop (*k[, d]*) \rightarrow v, remove specified key and return the corresponding

value. If key is not found, d is returned if given, otherwise **KeyError** is raised.

Note: This is a wrapped version of `collections.pop` which triggers an update of the object after being called

popitem () \rightarrow (k, v), return and remove a (key, value) pair.

Pairs are returned in LIFO order if last is true or FIFO order if false.

Note: This is a wrapped version of `collections.popitem` which triggers an update of the object after being called

primary

The primary Input in this InputGroup. The primary Input is the Input that defines the size of this InputGroup. In case of ties it will be the first in the tool definition.

setdefault (*k[, d]*) \rightarrow od.get(k,d), also set od[k]=d if k not in od

Note: This is a wrapped version of `collections.setdefault` which triggers an update of the object after being called

classmethod solve_broadcast (*target_size, target_dimnames, source_size, source_dimnames, target_index, nodegroups=None*)

update (*[E]*, ***F*) \rightarrow None. Update D from mapping/iterable E and F.

If E present and has a .keys() method, does: for k in E: D[k] = E[k] If E present and lacks .keys() method, does: for (k, v) in E: D[k] = v In either case, this is followed by: for k, v in F.items(): D[k] = v

Note: This is a wrapped version of `_abcoll.update` which triggers an update of the object after being called

inputgroupcombiner Module

class `fastr.core.inputgroupcombiner.BaseInputGroupCombiner` (*parent*)

Bases: `fastr.core.dimension.HasDimensions`

An object that takes the different input groups and combines them in the correct way.

__abstractmethods__ = frozenset(['merge', 'unmerge', 'iter_input_groups'])

__init__ (*parent*)

__iter__ ()

__metaclass__
alias of ABCMeta

__module__ = 'fastr.core.inputgroupcombiner'

dimensions

fullid

The full id of the InputGroupCombiner

input_groups

iter_input_groups ()

Iterate over all the merged samples :return:

merge (*list_of_items*)

Given a list of items for each input group, it returns the combined list of items.

Parameters **list_of_items** (*list*) – items to combine

Returns combined list

merge_failed_annotations (*list_of_failed_annotations*)

merge_payloads (*sample_payloads*)

merge_sample_data (*list_of_sample_data*)

merge_sample_id (*list_of_sample_ids*)

merge_sample_index (*list_of_sample_indexes*)

merge_sample_jobs (*list_of_sample_jobs*)

unmerge (*item*)

Given a item it will recreate the separate items, basically this is the inverse operation of merge. However, this create an OrderedDict so that specific input groups can be easily retrieved. To get a round trip, the values of the OrderedDict should be taken:

```
>>> odict_of_items = combiner.unmerge(item)
>>> item = combiner.merge(odict_of_items.values())
```

Parameters **item** (*list*) – the item to unmerge

Returns items

Return type OrderedDict

update ()

class `fastr.core.inputgroupcombiner.DefaultInputGroupCombiner` (*parent*)

Bases: `fastr.core.inputgroupcombiner.BaseInputGroupCombiner`

The default input group combiner combines the input group in a cross product version, taking each combinations of samples between the input groups. So if there are two input groups with one with size N and the other with size M x P the result would be N x M x P samples, with all possible combinations of the samples in each input group.

__abstractmethods__ = frozenset([])

__module__ = 'fastr.core.inputgroupcombiner'

iter_input_groups ()

merge (*list_of_items*)

Given a list of items for each input group, it returns the combined list of items.

Parameters *list_of_items* (*list*) – items to combine

Returns combined list

unmerge (*item*)

Given a item it will recreate the separate items, basically this is the inverse operation of merge. However, this create an OrderedDict so that specific input groups can be easily retrieved. To get a round trip, the values of the OrderedDict should be taken:

```
>>> odict_of_items = combiner.unmerge(item)
>>> item = combiner.merge(odict_of_items.values())
```

Parameters *item* (*list*) – the item to unmerge

Returns items

Return type OrderedDict

class `fastr.core.inputgroupcombiner.MergingInputGroupCombiner` (*input_groups*,
merge_dimension)

Bases: `fastr.core.inputgroupcombiner.BaseInputGroupCombiner`

The merging input group combiner takes a similar approach as the default combiner but merges dimensions that are the same. If input group A has N(3) x M(2) samples and B has M(2) x P(4) it wil not result in N(3) x M(2) x M(2) x P(4), but merge the dimensions M leading to N(3) x M(2) x P(4) in resulting size.

__abstractmethods__ = frozenset([])

__init__ (*input_groups*, *merge_dimension*)

__module__ = 'fastr.core.inputgroupcombiner'

iter_input_groups ()

merge (*list_of_items*)

unmerge (*item*)

update ()

inputoutput Module

Classes for arranging the input and output for nodes.

Exported classes:

Input – An input for a node (holding datatype). Output – The output of a node (holding datatype and value). ConstantOutput – The output of a node (holding datatype and value).

Warning: Don't mess with the Link, Input and Output internals from other places. There will be a huge chances of breaking the network functionality!

class `fastr.core.inputoutput.AdvancedFlowOutput` (*node, description*)

Bases: `fastr.core.inputoutput.Output`

Output for nodes that have an advanced flow. This means that the output sample id and index is not the same as the input sample id and index. The AdvancedFlowOutput has one extra dimensions that is created by the Node.

`__abstractmethods__` = frozenset([])

`__module__` = 'fastr.core.inputoutput'

`dimensions`

class `fastr.core.inputoutput.BaseInput` (*node, description*)

Bases: `fastr.core.inputoutput.BaseInputOutput`

Base class for all inputs.

`__abstractmethods__` = frozenset(['itersubinputs', '_update', 'dimensions', 'fullid'])

`__init__` (*node, description*)

Instantiate a BaseInput

Parameters

- **node** – the parent node the input/output belongs to.
- **description** – the `ParameterDescription` describing the input/output.

Returns the created BaseInput

Raises

- **`FastrTypeError`** – if description is not of class `ParameterDescription`
- **`FastrDataTypeNotAvailableError`** – if the `DataType` requested cannot be found in the `fastr.typelist`

`__lshift__` (*other*)

`__module__` = 'fastr.core.inputoutput'

`__rrshift__` (*other*)

`create_link_from` (*value*)

`itersubinputs` ()

Iterator over the SubInputs

Returns iterator

example:

```
>>> for subinput in input_a.itersubinputs():
      print subinput
```

class `fastr.core.inputoutput.BaseInputOutput` (*node*, *description*)

Bases: `fastr.core.dimension.HasDimensions`, `fastr.core.updateable.Updateable`, `fastr.core.serializable.Serializable`

Base class for Input and Output classes. It mainly implements the properties to access the data from the underlying ParameterDescription.

__abstractmethods__ = frozenset(['_update', 'dimensions', 'fullid'])

__getstate__ ()

Retrieve the state of the BaseInputOutput

Returns the state of the object

Rtype dict

__init__ (*node*, *description*)

Instantiate a BaseInputOutput

Parameters

- **node** – the parent node the input/output belongs to.
- **description** – the ParameterDescription describing the input/output.

Returns created BaseInputOutput

Raises

- **FastrTypeError** – if description is not of class ParameterDescription
- **FastrDataTypeNotAvailableError** – if the DataType requested cannot be found in the `fastr.typelist`

__iter__ ()

This function is blocked to avoid support for iteration using a legacy `__getitem__` method.

Returns None

Raises **FastrNotImplementedError** – always

__module__ = 'fastr.core.inputoutput'

__repr__ ()

Get a string representation for the Input/Output

Returns the string representation

Return type str

__setstate__ (*state*)

Set the state of the BaseInputOutput by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

cardinality (*key=None*, *job_data=None*)

Determine the cardinality of this Input/Output. Optionally a key can be given to determine for a sample.

Parameters **key** – key for a specific sample

Returns the cardinality

Return type `int`, `sympy.Symbol`, or `None`

check_cardinality (*key=None*)

Check if the actual cardinality matches the cardinality specified in the `ParameterDescription`. Optionally you can use a key to test for a specific sample.

Parameters **key** – `sample_index` (tuple of `int`) or `SampleId` for desired sample

Returns flag indicating that the cardinality is correct

Return type `bool`

Raises *FastrCardinalityError* – if the Input/Output has an incorrect cardinality description.

datatype

The datatype of this Input/Output

description

The description object of this input/output

fullid

The fullid of the Input/Output, the fullid should be unique and makes the object retrievable by the network.

id

Id of the Input/Output

node

The NodeRun to which this Input/Output belongs

required

Flag indicating that the Input/Output is required

class `fastr.core.inputoutput.BaseOutput` (*node, description*)

Bases: *fastr.core.inputoutput.BaseInputOutput*

Base class for all outputs.

__abstractmethods__ = `frozenset(['_update', 'dimensions', 'fullid'])`

__init__ (*node, description*)

Instantiate a BaseOutput

Parameters

- **node** – the parent node the output belongs to.
- **description** – the `ParameterDescription` describing the output.

Returns created BaseOutput

Raises

- *FastrTypeError* – if description is not of class `ParameterDescription`
- *FastrDataTypeNotAvailableError* – if the `DataType` requested cannot be found in the `fastr.typelist`

__module__ = `'fastr.core.inputoutput'`

automatic

Flag indicating that the Output is generated automatically without being specified on the command line

class `fastr.core.inputoutput.Input` (*node, description*)

Bases: `fastr.core.inputoutput.BaseInput`

Class representing an input of a node. Such an input will be connected to the output of another node or the output of an constant node to provide the input value.

__abstractmethods__ = frozenset([])

__eq__ (*other*)

Compare two Input instances with each other. This function ignores the parent node and update status, but tests rest of the dict for equality.

Parameters *other* (*Input*) – the other instances to compare to

Returns True if equal, False otherwise

Return type `bool`

__getitem__ (*key*)

Retrieve an item from this Input.

Parameters *key* (`str`, `SampleId` or `tuple`) – the key of the requested item, can be a key `str`, sample index tuple or a `SampleId`

Returns the return value depends on the requested key. If the key was an `int` the corresponding `SubInput` will be returned. If the key was a `SampleId` or sample index tuple, the corresponding `SampleItem` will be returned.

Return type `SampleItem` or `SubInput`

Raises

- `FastrTypeError` – if key is not of a valid type
- `FastrKeyError` – if the key is not found

__getstate__ ()

Retrieve the state of the Input

Returns the state of the object

Rtype `dict`

__init__ (*node, description*)

Instantiate an input.

Parameters

- **node** (`NodeRun`) – the parent node of this input.
- **description** (`ParameterDescription`) – the `ParameterDescription` of the input.

Returns the created Input

__module__ = 'fastr.core.inputoutput'

__setitem__ (*key, value*)

Create a link between a `SubInput` of this Inputs and an `Output/Constant`

Parameters

- **key** (`int`, `str`) – the key of the `SubInput`
- **value** (`BaseOutput`, `list`, `tuple`, `dict`, `OrderedDict`) – the target to link, can be an output or a value to create a constant for

Raises `FastrTypeError` – if key is not of a valid type

`__setstate__(state)`

Set the state of the Input by the given state.

Parameters `state` (*dict*) – The state to populate the object with

Returns `None`

`__str__()`

Get a string version for the Input

Returns the string version

Return type `str`

`append(value)`

When you want to append a link to an Input, you can use the `append` property. This will automatically create a new `SubInput` to link to.

example:

```
>>> link = node2['input'].append(node1['output'])
```

will create a new `SubInput` in `node2['input']` and link to that.

`cardinality(key=None, job_data=None)`

Cardinality for an Input is the sum the cardinalities of the `SubInputs`, unless defined otherwise.

Parameters `key` (tuple of `int` or `SampleId`) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type `int`, `sympy.Symbol`, or `None`

`clear()`

`datatype`

The datatype of this Input

`dimensions`

The list names of the dimensions in this Input. This will be a list of `str`.

`fullid`

The full defining ID for the Input

`get_sourced_nodes()`

Get a list of all *Nodes* connected as sources to this Input

Returns list of all connected *Nodes*

Return type `list`

`get_sourced_outputs()`

Get a list of all *Outputs* connected as sources to this Input

Returns tuple of all connected *Outputs*

Return type `tuple`

`index(value)`

Find index of a `SubInput`

Parameters `value` (*SubInput*) – the *SubInput* to find the index of

Returns `key`

Return type `int`, `str`

input_group

The id of the InputGroup this Input belongs to.

insert (*index*)

Insert a new SubInput at index in the sources list

Parameters **key** (*int*) – positive integer for position in `_source` list to insert to

Returns newly inserted *SubInput*

Return type *SubInput*

itersubinputs ()

Iterate over the *SubInputs* in this Input.

Returns iterator yielding *SubInput*

example:

```
>>> for subinput in input_a.itersubinputs():
      print subinput
```

remove (*value*)

Remove a SubInput from the SubInputs list based on the connected Link.

Parameters **value** (*SubInput*, `<fastr.core.inputoutput.SubInput>`) – the *SubInput* or *SubLink* to removed from this Input

source

The mapping of *SubInputs* that are connected and have more than 0 elements.

class `fastr.core.inputoutput.MacroOutput` (*node*, *description*)

Bases: `fastr.core.inputoutput.Output`

`__abstractmethods__` = frozenset({})

`__module__` = 'fastr.core.inputoutput'

dimensions

class `fastr.core.inputoutput.Output` (*node*, *description*)

Bases: `fastr.core.inputoutput.BaseOutput`

Class representing an output of a node. It holds the output values of the tool ran. Output fields can be connected to inputs of other nodes.

`__abstractmethods__` = frozenset({})

`__eq__` (*other*)

Compare two Output instances with each other. This function ignores the parent node, listeners and update status, but tests rest of the dict for equality.

Parameters **other** (*Output*) – the other instances to compare to

Returns True if equal, False otherwise

Return type `bool`

`__getitem__` (*key*)

Retrieve an item from this Output. The returned value depends on what type of key used:

- Retrieving data using index tuple: [index_tuple]
- Retrieving data sample_id str: [SampleId]
- Retrieving a list of data using SampleId list: [sample_id1, ..., sample_idN]

- Retrieving a *SubOutput* using an int or slice: [n] or [n:m]

Parameters **key** (int, slice, *SampleId* or tuple) – the key of the requested item, can be a number, slice, sample index tuple or a *SampleId*

Returns the return value depends on the requested key. If the key was an int or slice the corresponding *SubOutput* will be returned (and created if needed). If the key was a *SampleId* or sample index tuple, the corresponding *SampleItem* will be returned. If the key was a list of *SampleId* a tuple of *SampleItem* will be returned.

Return type *SubInput* or *SampleItem* or list of *SampleItem*

Raises

- *FastrTypeError* – if key is not of a valid type
- *FastrKeyError* – if the parent Node has not been executed

`__getstate__()`

Retrieve the state of the Output

Returns the state of the object

Rtype dict

`__init__(node, description)`

Instantiate an Output

Parameters

- **node** – the parent node the output belongs to.
- **description** – the *ParameterDescription* describing the output.

Returns created Output

Raises

- *FastrTypeError* – if description is not of class *ParameterDescription*
- *FastrDataTypeNotAvailableError* – if the *DataType* requested cannot be found in the *fastr.typelist*

`__module__ = 'fastr.core.inputoutput'`

`__setstate__(state)`

Set the state of the Output by the given state.

Parameters **state** (dict) – The state to populate the object with

Returns None

`__str__()`

Get a string version for the Output

Returns the string version

Return type str

blocking

Flag indicating that this Output will cause blocking in the execution

cardinality()

Cardinality of this Output, may depend on the inputs of the parent Node.

Returns the cardinality

Return type `int`, `sympy.Symbol`, or `None`

Raises

- ***FastrCardinalityError*** – if cardinality references an invalid *Input*
- ***FastrTypeError*** – if the referenced cardinality values type cannot be case to int
- ***FastrValueError*** – if the referenced cardinality value cannot be case to int

static `create_output_cardinality` (*desc*)

Create a lambda function that returns an integer value of the cardinality.

param `str desc` The cardinality description string

return output cardinality description

rtype `tuple`

The description string can be one of the following forms:

- `N`: N number of values needed.
- `as:input_name`: the same number of values as attached to `input_name` are needed.
- `val:input_name`: the number of values needed is the value of `input_name`.
- `unknown`: the output cardinality cannot be estimated a priori

datatype

The datatype of this Output

dimensions

The list of the dimensions in this Output. This will be a tuple of `Dimension`.

fullid

The full defining ID for the Output

listeners

The list of *Links* connected to this Output.

preferred_types

The list of preferred `DataTypes` for this Output.

resulting_datatype

The `DataType` that will the results of this Output will have.

valid

Check if the output is valid, i.e. has a valid cardinality

class `fastr.core.inputoutput.SourceOutput` (*node*, *description*)

Bases: `fastr.core.inputoutput.Output`

Output for a `SourceNodeRun`, this type of Output determines the cardinality in a different way than a normal `NodeRun`.

__abstractmethods__ = `frozenset([])`

__getitem__ (*item*)

Retrieve an item from this Output. The returned value depends on what type of key used:

- Retrieving data using index tuple: `[index_tuple]`
- Retrieving data sample_id str: `[SampleId]`
- Retrieving a list of data using SampleId list: `[sample_id1, ..., sample_idN]`
- Retrieving a *SubOutput* using an int or slice: `[n]` or `[n:m]`

Parameters **key** (int, slice, `SampleId` or tuple) – the key of the requested item, can be a number, slice, sample index tuple or a `SampleId`

Returns the return value depends on the requested key. If the key was an int or slice the corresponding `SubOutput` will be returned (and created if needed). If the key was a `SampleId` or sample index tuple, the corresponding `SampleItem` will be returned. If the key was a list of `SampleId` a tuple of `SampleItem` will be returned.

Return type `SubInput` or `SampleItem` or list of `SampleItem`

Raises

- **`FastrTypeError`** – if key is not of a valid type
- **`FastrKeyError`** – if the parent `NodeRun` has not been executed

`__init__` (*node*, *description*)

Instantiate a `FlowOutput`

Parameters

- **node** – the parent node the output belongs to.
- **description** – the `ParameterDescription` describing the output.

Returns created `FlowOutput`

Raises

- **`FastrTypeError`** – if description is not of class `ParameterDescription`
- **`FastrDataTypesNotAvailableError`** – if the `DataType` requested cannot be found in the `fastr.typelist`

`__module__` = `'fastr.core.inputoutput'`

`cardinality` ()

Cardinality of this `SourceOutput`, may depend on the inputs of the parent `NodeRun`.

Parameters **key** (tuple of int or `SampleId`) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type int, `sympy.Symbol`, or `None`

`linearized`

A linearized version of the sample data, this is lazily cached linearized version of the underlying `SampleCollection`.

class `fastr.core.inputoutput.SubInput` (*input_*)

Bases: `fastr.core.inputoutput.BaseInput`

This class is used by `Input` to allow for multiple links to an `Input`. The `SubInput` class can hold only a single Link to a (Sub)Output, but behaves very similar to an `Input` otherwise.

`__abstractmethods__` = `frozenset([])`

`__eq__` (*other*)

Compare two `SubInput` instances with each other. This function ignores the parent, node, source and update status, but tests rest of the dict for equality.

Parameters **other** (`SubInput`) – the other instances to compare to

Returns True if equal, False otherwise

__getitem__ (*key*)

Retrieve an item from this SubInput.

Parameters **key** (*int*) – the index of the requested item

Returns the corresponding *SubInput*

Return type *SubInput*

Raises *FastrTypeError* – if key is not of a valid type

Note: As a SubInput has only one SubInput, only requesting int key 0 or -1 is allowed, and it will return self

__getstate__ ()

Retrieve the state of the SubInput

Returns the state of the object

Rtype dict

__init__ (*input_*)

Instantiate an SubInput.

Parameters **input** (*Input*) – the parent of this SubInput.

Returns the created SubInput

__module__ = 'fastr.core.inputoutput'

__setstate__ (*state*)

Set the state of the SubInput by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

__str__ ()

Get a string version for the SubInput

Returns the string version

Return type *str*

cardinality (*key=None, job_data=None*)

Get the cardinality for this SubInput. The cardinality for a SubInputs is defined by the incoming link.

Parameters **key** (*SampleIndex* or *SampleId*) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type *int*, *sympy.Symbol*, or *None*

description

dimensions

List of dimension for this SubInput

fullid

The full defining ID for the SubInput

get_sourced_nodes ()

Get a list of all *Nodes* connected as sources to this SubInput

Returns list of all connected *Nodes*

Return type list

get_sourced_outputs()

Get a list of all *Outputs* connected as sources to this SubInput

Returns list of all connected *Outputs*

Return type list

input_group

The id of the InputGroup this SubInputs parent belongs to.

iteritems()

Iterate over the *SampleItems* that are in the SubInput.

Returns iterator yielding *SampleItem* objects

itersubinputs()

Iterate over SubInputs (for a SubInput it will yield self and stop iterating after that)

Returns iterator yielding *SubInput*

example:

```
>>> for subinput in input_a.itersubinputs():
    print subinput
```

node

The Node to which this SubInputs parent belongs

remove(value)

Remove a SubInput from parent Input.

Parameters *value* (*SubInput*) – the *SubInput* to removed from this Input

source

A list with the source *Link*. The list is to be compatible with *Input*

source_output

The *Output* linked to this SubInput

class `fastr.core.inputoutput.SubOutput(output, index)`

Bases: `fastr.core.inputoutput.Output`

The SubOutput is an Output that represents a slice of another Output.

__abstractmethods__ = frozenset([])

__eq__(*other*)

Compare two SubOutput instances with each other. This function ignores the parent, node and update status, but tests rest of the dict for equality. equality

Parameters *other* (*SubOutput*) – the other instances to compare to

Returns True if equal, False otherwise

Return type `bool`

__getitem__(*key*)

Retrieve an item from this SubOutput. The returned value depends on what type of key used:

- Retrieving data using index tuple: [index_tuple]
- Retrieving data sample_id str: [SampleId]

- Retrieving a list of data using SampleId list: [sample_id1, ..., sample_idN]
- Retrieving a *SubOutput* using an int or slice: [n] or [n:m]

Parameters **key** (int, slice, SampleId or tuple) – the key of the requested item, can be a number, slice, sample index tuple or a SampleId

Returns the return value depends on the requested key. If the key was an int or slice the corresponding *SubOutput* will be returned (and created if needed). If the key was a SampleId or sample index tuple, the corresponding SampleItem will be returned. If the key was a list of SampleId a tuple of SampleItem will be returned.

Return type *SubInput* or SampleItem or list of SampleItem

Raises *FastrTypeError* – if key is not of a valid type

`__getstate__()`

Retrieve the state of the SubOutput

Returns the state of the object

Rtype dict

`__init__(output, index)`

Instantiate a SubOutput

Parameters

- **output** – the parent output the suboutput slices.
- **index** (*int* or *slice*) – the way to slice the parent output

Returns created SubOutput

Raises

- *FastrTypeError* – if the output argument is not an instance of *Output*
- *FastrTypeError* – if the index argument is not an int or slice

`__len__()`

Return the length of the Output.

Note: In a SubOutput this is always 1.

`__module__ = 'fastr.core.inputoutput'`

`__setstate__(state)`

Set the state of the SubOutput by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

`__str__()`

Get a string version for the SubOutput

Returns the string version

Return type *str*

`cardinality()`

Cardinality of this SubOutput depends on the parent Output and `self.index`

Parameters **key** (tuple of int or `SampleId`) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type `int`, `sympy.Symbol`, or `None`

Raises

- ***FastrCardinalityError*** – if cardinality references an invalid *Input*
- ***FastrTypeError*** – if the referenced cardinality values type cannot be case to int
- ***FastrValueError*** – if the referenced cardinality value cannot be case to int

datatype

The datatype of this SubOutput

fullid

The full defining ID for the SubOutput

indexrep

Simple representation of the index.

listeners

The list of *Links* connected to this Output.

node

The NodeRun to which this SubOutput belongs

preferred_types

The list of preferred `DataTypes` for this SubOutput.

resulting_datatype

The `DataType` that will the results of this SubOutput will have.

samples

The `SampleCollection` for this SubOutput

interface Module

A module that describes the interface of a Tool. It specifies how a set of input values will be translated to commands to be executed. This creates a generic interface to different ways of executing underlying software.

class `fastr.core.interface.InputSpec`

Bases: `fastr.core.interface.InputSpec`

`__dict__` = `dict_proxy`({'__dict__': <attribute '__dict__' of 'InputSpec' objects>, '__module__': 'fastr.core.interface',

`__module__` = 'fastr.core.interface'

`static __new__`(*id_*, *cardinality*, *datatype*, *required=False*, *description=''*, *default=None*, *hidden=False*)

`fastr.core.interface.InputSpecBase`

alias of *InputSpec*

class `fastr.core.interface.Interface`

Bases: `fastr.core.baseplugin.Plugin`, `fastr.core.serializable.Serializable`

Abstract base class of all Interfaces. Defines the minimal requirements for all Interface implementations.

`__abstractmethods__` = `frozenset`(['inputs', 'execute', '__setstate__', 'expanding', '__getstate__', 'outputs'])

__getstate__()

Retrieve the state of the Interface

Returns the state of the object

Rtype dict

__metaclass__

alias of ABCMeta

__module__ = 'fastr.core.interface'

__setstate__(state)

Set the state of the Interface

execute(target, payload)

Execute the interface given the a target and payload. The payload should have the form {'input': {'input_id_a': (value, value), 'input_id_b': (value, value)}, 'output': {'output_id_a': (value, value), 'output_id_b': (value, value)}}

Parameters

- **target** – the target to call
- **payload** – the payload to use

Returns the result of the execution

Return type (tuple of) *InterfaceResult*

expanding

Indicates whether or not this Interface will result in multiple samples per run. If the flow is unaffected, this will be zero, if it is nonzero it means that number of dimension will be added to the sample array.

inputs

OrderedDict of Inputs connected to the Interface. The format should be {input_id: InputSpec}.

outputs

OrderedDict of Output connected to the Interface. The format should be {output_id: OutputSpec}.

classmethod test()

Test the plugin, interfaces do not need to be tested on import

class fastr.core.interface.**InterfacePluginManager**

Bases: *fastr.core.pluginmanager.PluginSubManager*

Container holding all the CollectorPlugins

__abstractmethods__ = frozenset([])

__init__()

Create the Coll :param path: :param recursive: :return:

__module__ = 'fastr.core.interface'

class fastr.core.interface.**InterfaceResult**(result_data, log_data, payload, sample_index=None, sample_id=None, errors=None)

Bases: *object*

The class in which Interfaces should wrap their results to be picked up by fastr

__dict__ = dict_proxy({'__dict__': <attribute '__dict__' of 'InterfaceResult' objects>, '__module__': 'fastr.core.interfa

__init__(result_data, log_data, payload, sample_index=None, sample_id=None, errors=None)

__module__ = 'fastr.core.interface'

```
__weakref__
    list of weak references to the object (if defined)

class fastr.core.interface.OutputSpec
    Bases: fastr.core.interface.OutputSpec

    __dict__ = dict_proxy({'__dict__': <attribute '__dict__' of 'OutputSpec' objects>, '__module__': 'fastr.core.interface',
    __module__ = 'fastr.core.interface'

    static __new__(id_, cardinality, datatype, automatic=True, required=False, description='', hidden=False)

fastr.core.interface.OutputSpecBase
    alias of OutputSpec
```

ioplugin Module

This module contains the manager class for IOPlugins and the base class for all IOPlugins

```
class fastr.core.ioplugin.IOPlugin
    Bases: fastr.core.baseplugin.Plugin

    IOPlugins are used for data import and export for the sources and sinks. The main use of the IOPlugins is during execution (see Execution). The IOPlugins can be accessed via fastr.ioplugins, but generally there should be no need for direct interaction with these objects. The use of is mainly via the URL used to specify source and sink data.

    __abstractmethods__ = frozenset(['scheme'])

    __init__()
        Initialization for the IOPlugin

        Returns newly created IOPlugin

    __metaclass__
        alias of ABCMeta

    __module__ = 'fastr.core.ioplugin'

    cleanup()
        (abstract) Clean up the IOPlugin. This is to do things like closing files or connections. Will be called when the plugin is no longer required.

    expand_url(url)
        (abstract) Expand an URL. This allows a source to collect multiple samples from a single url. The URL will have a wildcard or point to something with info and multiple urls will be returned.

        Parameters url (str) – url to expand

        Returns the resulting url(s), a tuple if multiple, otherwise a str

        Return type str or tuple of str

    fetch_url(inurl, outfile)
        (abstract) Fetch a file from an external data source.

        Parameters

        • inurl – url to the item in the data store

        • outpath – path where to store the fetch data locally
```

fetch_value (*inurl*)

(abstract) Fetch a value from an external data source.

Parameters *inurl* – the url of the value to retrieve

Returns the fetched value

static isurl (*string*)

Test if given string is an url.

Parameters *string* (*str*) – string to test

Returns `True` if the string is an url, `False` otherwise

Return type `bool`

path_to_url (*path*, *mountpoint=None*)

(abstract) Construct an url from a given mount point and a relative path to the mount point.

Parameters

- **path** (*str*) – the path to determine the url for
- **mountpoint** (*str* or *None*) – the mount point to use, will be automatically detected if *None* is given

Returns url matching the path

Return type `str`

static print_result (*result*)

Print the result of the IOPlugin to stdout to be picked up by the tool

Parameters *result* – value to print as a result

Returns `None`

pull_source_data (*inurl*, *outdir*, *sample_id*, *datatype=None*)

Transfer the source data from inurl to be available in outdir.

Parameters

- **inurl** (*str*) – the input url to fetch data from
- **outdir** (*str*) – the directory to write the data to
- **datatype** (`DataType`) – the datatype of the data, used for determining the total contents of the transfer

Returns `None`

push_sink_data (*inpath*, *outurl*, *datatype=None*)

Write out the sink data from the inpath to the outurl.

Parameters

- **inpath** (*str*) – the path of the data to be pushed
- **outurl** (*str*) – the url to write the data to
- **datatype** (`DataType`) – the datatype of the data, used for determining the total contents of the transfer

Returns `None`

put_url (*inpath*, *outurl*)

(abstract) Put the files to the external data store.

Parameters

- **inpath** – path to the local data
- **outurl** – url to where to store the data in the external data store.

put_value (*value*, *outurl*)

(abstract) Put the files to the external data store.

Parameters

- **value** – the value to store
- **outurl** – url to where to store the data in the external data store.

scheme

(abstract) This abstract property is to be overwritten by a subclass to indicate the url scheme associated with the IOPlugin.

setup (**args*, ***kwargs*)

(abstract) Setup before data transfer. This can be any function that needs to be used to prepare the plugin for data transfer.

url_to_path (*url*)

(abstract) Get the path to a file from a url.

Parameters **url** (*str*) – the url to retrieve the path for**Returns** the corresponding path**Return type** *str***class** `fastr.core.ioplugin.IOPluginManager`Bases: `fastr.core.pluginmanager.PluginSubManager`

A mapping containing the IOPlugins known to this system

__abstractmethods__ = `frozenset([])`**__init__** ()

Create the IOPluginManager and populate it.

Returns newly created IOPluginManager**__iter__** ()**__keytransform__** (*key*)**__module__** = `'fastr.core.ioplugin'`**cleanup** ()

Cleanup all plugins, this closes files, connections and other things that could be left dangling otherwise.

static create_ioplugin_tool ()

Create the tools which handles sinks and sources. The command of this tool is the main of core.ioplugin.

expand_url (*url*)

Expand the url by filling the wildcards. This function checks the url scheme and uses the expand function of the correct IOPlugin.

Parameters **url** (*str*) – url to expand**Returns** list of urls**Return type** list of *str*

populate()

Populate the IOPlugins manager. After the default directory scan, add the vfs IOPlugin and create the Tools for the IOPlugins

pull_source_data (*url, outdir, sample_id, datatype=None*)

Retrieve data from an external source. This function checks the url scheme and selects the correct IOPlugin to retrieve the data.

Parameters

- **url** – url to pull
- **outdir** (*str*) – the directory to write the data to
- **datatype** (*DataType*) – the datatype of the data, used for determining the total contents of the transfer

Returns None

push_sink_data (*inpath, outurl, datatype=None*)

Send data to an external source. This function checks the url scheme and selects the correct IOPlugin to retrieve the data.

Parameters

- **inpath** (*str*) – the path of the data to be pushed
- **outurl** (*str*) – the url to write the data to
- **datatype** (*DataType*) – the datatype of the data, used for determining the total contents of the transfer

put_url (*inpath, outurl*)

Put the files to the external data store.

Parameters

- **inpath** – path to the local data
- **outurl** – url to where to store the data in the external data store.

static register_url_scheme (*scheme*)

Register a custom scheme to behave http like. This is needed to parse all things properly with urlparse.

Parameters **scheme** – the scheme to register

url_to_path (*url*)

Retrieve the path for a given url

Parameters **url** (*str*) – the url to parse

Returns the path corresponding to the input url

Return type *str*

fastr.core.ioplugin.main()

The main entry point for command line access to the IOPlugin

link Module

The link module contain the Link class. This class represents the links in a network. These links lead from an output (BaseOutput) to an input (BaseInput) and indicate the desired data flow. Links are smart objects, in the sense that when you set their start or end point, they register themselves with the Input and Output. They do all the book keeping, so as long as you only set the source and target of the Link, the link should be valid.

Warning: Don't mess with the Link, Input and Output internals from other places. There will be a huge chances of breaking the network functionality!

class `fastr.core.link.Link` (*source, target, parent, id_=None, collapse=None, expand=None*)
 Bases: `fastr.core.dimension.HasDimensions`, `fastr.core.updateable.Updateable`,
`fastr.core.serializable.Serializable`

Class for linking outputs (*BaseOutput*) to inputs (*BaseInput*)

Examples:

```
>>> import fastr
>>> network = fastr.Network()
>>> link1 = network.create_link( n1.outputs['out1'], n2.inputs['in2'] )

link2 = Link()
link2.source = n1.outputs['out1']
link2.target = n2.inputs['in2']
```

`__abstractmethods__` = frozenset({})

`__dataschemafile__` = 'Link.schema.json'

`__eq__` (*other*)

Test for equality between two Links

Parameters *other* (*Link*) – object to test against

Returns True for equality, False otherwise

Return type `bool`

`__getstate__` ()

Retrieve the state of the Link

Returns the state of the object

Rtype `dict`

`__init__` (*source, target, parent, id_=None, collapse=None, expand=None*)

Create a new Link in a Network.

Parameters

- **source** (*BaseOutput*) – the source output
- **target** (*BaseInput*) – the target input
- **parent** (*Network* or *None*) – the parent network
- **id** (*str* or *None*) – the id of the link, if no **id** is given, the id will be in the form of “link_{:d}”
- **collapse** (*int*, *str*, or *tuple of int/str*) – the dimensions that the link has to collapse on
- **expand** (*bool*) – Does this link need to expand the cardinality into a new sample dimension

Returns newly created Link

Raises

- **FastrValueError** – if parent is not given

- **FastrValueError** – if the source output is not in the same network as the Link
- **FastrValueError** – if the target input is not in the same network as the Link

__module__ = 'fastr.core.link'

__repr__ ()

Get a string representation for the Link

Returns the string representation

Return type `str`

__setstate__ (*state*)

Set the state of the Link by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

Raises **FastrValueError** – if the parent network is not set

cardinality (*index=None*)

Cardinality for a Link is given by source Output and the collapse/expand settings

Parameters **key** (*SampleIndex*) – key for a specific sample (can be only a sample index!)

Returns the cardinality

Return type `int`, `sympy.Symbol`

Raises **FastrIndexError** – if the index length does not match the number of dimension in the data

collapse

The converging dimensions of this link. Collapsing changes some dimensions of sample lists into cardinality, reshaping the data.

Collapse can be set to a tuple or an int/str, in which case it will be automatically wrapped in a tuple. The int will be seen as indices of the dimensions to collapse. The str will be seen as the name of the dimensions over which to collapse.

Raises **FastrTypeError** – if assigning a collapse value of a wrong type

collapse_indexes

The converging dimensions of this link as integers. Dimension names are replaced with the corresponding int.

Collapsing changes some dimensions of sample lists into cardinality, reshaping the data

classmethod createobj (*state, network=None*)

Create object function for Link

Parameters

- **cls** – The class to create
- **state** – The state to use to create the Link
- **network** – the parent Network

Returns newly created Link

destroy ()

The destroy function of a link removes all default references to a link. This means the references in the network, input and output connected to this link. If there is no references in other places in the code, it will destroy the link (reference count dropping to zero).

This function is called when a source for an input is set to another value and the links becomes disconnected. This makes sure there is no dangling links.

dimensions

The dimensions of the data delivered by the link. This can be different from the source dimensions because the link can make data collapse or expand.

draw (*context*, *graph*)**expand**

Flag indicating that the link will expand the cardinality into a new sample dimension to be created.

fullid

The full defining ID for the Input

parent

The Network to which this Link belongs.

source

The source *BaseOutput* of the Link. Setting the source will automatically register the Link with the source BaseOutput. Updating source will also make sure the Link is unregistered with the previous source.

Raises *FastrTypeError* – if assigning a non *BaseOutput*

status**target**

The target *BaseInput* of the Link. Setting the target will automatically register the Link with the target BaseInput. Updating target will also make sure the Link is unregistered with the previous target.

Raises *FastrTypeError* – if assigning a non *BaseInput*

network Module

Network module containing Network facilitators and analysers.

class `fastr.core.network.Network` (*id_*='unnamed_network', *version*=None, *filename*=None)

Bases: `fastr.core.serializable.Serializable`

The NetworkRun contains the entire Run state for a Network execution. It has a working copy of the network, but also includes all temporary data required for the execution. These objects are meant to be single use.

NETWORK_DUMP_FILE_NAME = '__fastr_network__.json'

SINK_DUMP_FILE_NAME = '__sink_data__.json'

SOURCE_DUMP_FILE_NAME = '__source_data__.pickle.gz'

__dataschemafile__ = 'Network.schema.json'

__eq__ (*other*)

Compare two Networks and see if they are equal.

Parameters *other* (*Network*) –

Returns flag indicating that the Networks are the same

Return type `bool`

__getitem__ (*item*)

Get an item by its fullid. The fullid can point to a link, node, input, output or even subinput/suboutput.

Parameters *item* (*str*, *unicode*) – fullid of the item to retrieve

Returns the requested item

__getstate__ ()

Retrieve the state of the Network

Returns the state of the object

Rtype dict

__init__ (*id_*='unnamed_network', *version*=None, *filename*=None)

Create a new, empty Network

Parameters **name** (*str*) – name of the Network

Returns newly created Network

Raises **OSError** – if the tmp mount in the config is not a writable directory

__module__ = 'fastr.core.network'

__ne__ (*other*)

Tests for non-equality, this is the negated version **__eq__**

__repr__ ()

__setstate__ (*state*)

Set the state of the Network by the given state. This completely overwrites the old state!

Parameters **state** (*dict*) – The state to populate the object with

Returns None

add_link (*link*)

Add a Link to the Network. Make sure the link is in the link list and the link parent is set to this Network

Parameters **link** (*Link*) – link to add

Raises

- **FastrTypeError** – if link is incorrectly typed
- **FastrNetworkMismatchError** – if the link already belongs to another Network

add_node (*node*)

Add a Node to the Network. Make sure the node is in the node list and the node parent is set to this Network

Parameters **node** (*Node*) – node to add

Raises **FastrTypeError** – if node is incorrectly typed

add_stepid (*stepid*, *node*)

Add a Node to a specific step id

Parameters

- **stepid** (*str*) – the stepid that the node will be added to
- **node** (*Node*) – the node to add to the stepid

check_id (*id_*)

Check if an id for an object is valid and unused in the Network. The method will always returns True if it does not raise an exception.

Parameters **id** (*str*) – the id to check

Returns True

Raises

- **FastrValueError** – if the id is not correctly formatted
- **FastrValueError** – if the id is already in use

create_constant (*datatype, data, id_=None, stepid=None, nodegroup=None, sourcegroup=None*)

Create a ConstantNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the constant node
- **data** (*datatype or list of datatype*) – The data to hold in the constant node
- **id** (*str*) – The id of the constant node to be created
- **stepid** (*str*) – The stepid to add the created constant node to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.

Returns the newly created constant node

Return type *ConstantNode*

create_link (*source, target, id_=None, collapse=None, expand=None*)

Create a link between two Nodes and add it to the current Network.

Parameters

- **source** (*BaseOutput*) – the output that is the source of the link
- **target** (*BaseInput*) – the input that is the target of the link
- **id** (*str*) – the id of the link

Returns the created link

Type *Link*

create_macro (*network, id_=None*)

create_node (*tool, id_=None, stepid=None, cores=None, memory=None, walltime=None, nodegroup=None*)

Create a Node in this Network. The Node will be automatically added to the Network.

Parameters

- **tool** (*Tool*) – The Tool to base the Node on
- **id** (*str*) – The id of the node to be created
- **stepid** (*str*) – The stepid to add the created node to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.

Returns the newly created node

Return type *Node*

create_reference (*source_data, output_directory*)

create_sink (*datatype, id_=None, stepid=None*)

Create a SinkNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the sink node

- **id** (*str*) – The id of the sink node to be created
- **stepid** (*str*) – The stepid to add the created sink node to

Returns the newly created sink node

Return type *SinkNode*

create_source (*datatype*, *id_=None*, *stepid=None*, *nodegroup=None*, *sourcegroup=None*)

Create a SourceNode in this Network. The Node will be automatically added to the Network.

Parameters

- **datatype** (*BaseDataType*) – The DataType of the source *source_node*
- **id** (*str*) – The id of the source *source_node* to be created
- **stepid** (*str*) – The stepid to add the created source *source_node* to
- **nodegroup** (*str*) – The group the node belongs to, this can be important for FlowNodes and such, as they will have matching dimension names.
- **sourcegroup** (*str*) – *DEPRECATED!* The nodegroup this SourceNode will be added to

Returns the newly created source *source_node*

Return type *SourceNode*

draw (*name=None*, *image_format=None*, *draw_dimensions=False*, *context=None*, *graph=None*, *expand_macro=False*)

draw_network (*name='network_layout'*, *img_format='svg'*, *draw_dimension=False*, *expand_macro=False*)

Output a dot file and try to convert it to an image file.

Parameters **img_format** (*str*) – extension of the image format to convert to

Returns path of the image created or None if failed

Return type *str* or *None*

execute (*sourcedata*, *sinkdata*, *blocking=True*, ***kwargs*)

fullid

The fullid of the Network, within the network scope

global_id

The global id of the Network, this is different for networks used in macronodes, as they still have parents.

id

The id of the Network. This is a read only property.

is_valid ()

namespace = None

The namespace this network lives in, this will be set by the NetworkManager on load

nodegroups

Give an overview of the nodegroups in the network

remove (*value*)

Remove an item from the Network.

Parameters **value** (*Node* or *Link*) – the item to remove

```
classmethod test (reference_data_dir, network=None, source_data=None,  
                 force_remove_temp=False)
```

Execute the network with the source data specified and test the results against the refence data. This effectively tests the network execution.

Parameters

- **reference_data_dir** (*str*) – The path or vfs url of reference data to compare with
- **source_data** (*dict*) – The source data to use

networkmanager Module

This module contains the tool manager class

```
class fastr.core.networkmanager.NetworkManager (path)
```

Bases: *fastr.core.objectmanager.ObjectManager*

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.core.networkmanager'
```

```
get_object_version (obj)
```

```
object_class
```

```
fastr.core.networkmanager.networklist = NetworkManager add_ints v0.0 : /home/docs/checkouts/readthedocs.org
```

The fastr networklist

node Module

A module to maintain a network node.

Exported classes:

Node – A class encapsulating a tool. ConstantNode – A node encapsulating an Output to set scalar values. SourceNode – A class providing a handle to a file.

```
class fastr.core.node.AdvancedFlowNode (tool, id_=None, parent=None, cores=None, memory=None, walltime=None, nodegroup=None)
```

Bases: *fastr.core.node.FlowNode*

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.core.node'
```

```
class fastr.core.node.ConstantNode (datatype, data, id_=None, parent=None, nodegroup=None)
```

Bases: *fastr.core.node.SourceNode*

Class encapsulating one output for which a value can be set. For example used to set a scalar value to the input of a node.

```
__abstractmethods__ = frozenset([])
```

```
__dataschemafile__ = 'ConstantNode.schema.json'
```

```
__getstate__ ()
```

Retrieve the state of the ConstantNode

Returns the state of the object

Rtype dict

`__init__ (datatype, data, id_=None, parent=None, nodegroup=None)`
 Instantiation of the ConstantNode.

Parameters

- **datatype** – The datatype of the output.
- **data** – the prefilled data to use.
- **id** – The url pattern.

This class should never be instantiated directly (unless you know what you are doing). Instead create a constant using the network class like shown in the usage example below.

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> source = network.create_source(datatype=fastr.typelist['ITKImageFile'],
↳ id_='sourceN')
```

or alternatively create a constant node by assigning data to an item in an InputDict:

```
>>> node_a.inputs['in'] = ['some', 'data']
```

which automatically creates and links a ConstantNode to the specified Input

`__module__ = 'fastr.core.node'`

`__setstate__ (state)`
 Set the state of the ConstantNode by the given state.

Parameters *state* (*dict*) – The state to populate the object with

Returns None

data
 The data stored in this constant node

draw (*context*, *graph*, *color=None*)

set_data (*data=None*, *ids=None*)
 Set the data of this constant node in the correct way. This is mainly for compatibility with the parent class SourceNode

Parameters

- **data** (*dict* or *list of urls*) – the data to use
- **ids** – if data is a list, a list of accompanying ids

class `fastr.core.node.FlowNode` (*tool*, *id_=None*, *parent=None*, *cores=None*, *memory=None*, *walltime=None*, *nodegroup=None*)

Bases: `fastr.core.node.Node`

A Flow Node is a special subclass of Nodes in which the amount of samples can vary per Output. This allows non-default data flows.

`__abstractmethods__ = frozenset([])`

`__init__ (tool, id_=None, parent=None, cores=None, memory=None, walltime=None, nodegroup=None)`
 Instantiate a flow node.

Parameters

- **tool** (*Tool*) – The tool to base the node on
- **id** (*str*) – the id of the node
- **parent** (*Network*) – the parent network of the node

Returns the newly created FlowNode

__module__ = 'fastr.core.node'

blocking

A FlowNode is (for the moment) always considered blocking.

Returns True

dimensions

Names of the dimensions in the Node output. These will be reflected in the SampleIdList of this Node.

outputsize

Size of the outputs in this Node

class `fastr.core.node.InputDict` (**args, **kws*)

Bases: `collections.OrderedDict`

The container containing the Inputs of Node. Implements helper functions for the easy linking syntax.

__module__ = 'fastr.core.node'

__setitem__ (*key, value, dict_setitem=<slot wrapper '__setitem__' of 'dict' objects>*)

Set an item in the input dictionary. The behaviour depends on the type of the value. For a *BaseInput*, the input will simply be added to the list of inputs. For a *BaseOutput*, a link between the output and input will be created.

Parameters

- **key** (*str*) – id of the input to assign/link
- **value** (*BaseInput* or *BaseOutput*) – either the input to add or the output to link
- **dict_setitem** – the setitem function to use for the underlying OrderedDict insert

class `fastr.core.node.MacroNode` (*network, id_=None, parent=None, cores=None, memory=None, walltime=None, nodegroup=None*)

Bases: `fastr.core.node.Node`

MacroNode encapsulates an entire network in a single node.

__abstractmethods__ = frozenset({})

__getstate__ ()

Retrieve the state of the MacroNode

Returns the state of the object

Rtype dict

__init__ (*network, id_=None, parent=None, cores=None, memory=None, walltime=None, nodegroup=None*)

Parameters **network** (*Network*) – network to create macronode for

__module__ = 'fastr.core.node'

__setstate__ (*state*)

draw (*context, graph, color=None*)

draw_link_target (*context, port_name, input=True*)

get_output_info (*output*)

This functions maps the output dimensions based on the input dimensions of the macro. This is cached for speed as this can become rather costly otherwise

Parameters *output* – output to get info for

Returns tuple of Dimensions

network

class `fastr.core.node.Node` (*tool*, *id_=None*, *node_class=None*, *parent=None*, *cores=None*, *memory=None*, *walltime=None*, *nodegroup=None*)

Bases: `fastr.core.dimension.HasDimensions`, `fastr.core.updateable.Updateable`, `fastr.core.serializable.Serializable`

The class encapsulating a node in the network. The node is responsible for setting and checking inputs and outputs based on the description provided by a tool instance.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'Node.schema.json'

__eq__ (*other*)

Compare two Node instances with each other. This function ignores the parent and update status, but tests rest of the dict for equality. equality

Parameters *other* (`Node`) – the other instances to compare to

Returns True if equal, False otherwise

__getstate__ ()

Retrieve the state of the Node

Returns the state of the object

Rtype dict

__init__ (*tool*, *id_=None*, *node_class=None*, *parent=None*, *cores=None*, *memory=None*, *walltime=None*, *nodegroup=None*)

Instantiate a node.

Parameters

- **tool** (`Tool`) – The tool to base the node on
- **id** (`str`) – the id of the node
- **node_class** (`str`) – The class of the NodeRun to create (e.g. `SourceNodeRun`, `NodeRun`)
- **parent** (`Network`) – the parent network of the node
- **cores** (`int`) – number of cores required for executing this Node
- **memory** (`str`) – amount of memory required in the form d+[mMgG] where M is for megabyte and G for gigabyte
- **walltime** (`str`) – amount of time required in second or in the form HOURS:MINUTES:SECOND

Returns the newly created Node

__metaclass__

alias of ABCMeta

__module__ = 'fastr.core.node'

`__repr__()`

Get a string representation for the Node

Returns the string representation

Return type `str`

`__setstate__(state)`

Set the state of the Node by the given state.

Parameters `state` (*dict*) – The state to populate the object with

Returns None

`__str__()`

Get a string version for the Node

Returns the string version

Return type `str`

blocking

Indicate that the results of this Node cannot be determined without first executing the Node, causing a blockage in the creation of jobs. A blocking Nodes causes the Chunk borders.

classmethod `createobj` (*state, network=None*)

dimensions

dimnames

Names of the dimensions in the Node output. These will be reflected in the SampleIdList of this Node.

draw (*context, graph, color=None*)

draw_id (*context*)

draw_link_target (*context, port_name, input=True*)

find_source_index (*target_index, target, source*)

fullid

The full defining ID for the Node inside the network

get_sourced_nodes ()

A list of all Nodes connected as sources to this Node

Returns list of all nodes that are connected to an input of this node

global_id

The global defining ID for the Node from the main network (goes out of macro nodes to root network)

id

The id of the Node

id_ = None

The Node id s a unique string identifying the Node

input_groups

A list of input groups for this Node. An input group is `InputGroup` object filled according to the Node

inputs = None

A list of inputs of this Node

listeners

All the listeners requesting output of this node, this means the listeners of all Outputs and SubOutputs

merge_dimensions

name

Name of the Tool the Node was based on. In case a Toolless Node was used the class name is given.

nodegroup

outputs = None

A list of outputs of this Node

outputsize

The size of output of this SourceNode

parent

The parent is the Network this Node is part of

required_cores

Number of cores required for the execution of this Node

required_memory

Amount of memory required for the execution of this Node. Follows the format d+[mMgG] so 500M or 4g would be valid ways to specify 500 megabytes or 4 gigabyte of memory.

required_time

Amount of time required for the execution of this Node. Follows the format of a number of second or H:M:S, with H the number of hours, M the number of minutes and S the number of seconds.

status

tool

update_input_groups()

Update all input groups in this node

class `fastr.core.node.OutputDict(*args, **kws)`

Bases: `collections.OrderedDict`

The container containing the Inputs of Node. Only checks if the inserted values are actually outputs.

__module__ = 'fastr.core.node'

__setitem__(key, value, dict_setitem=<slot wrapper '__setitem__' of 'dict' objects>)

Set an output.

Parameters

- **key** (*str*) – the of the item to set
- **value** (*BaseOutput*) – the output to set
- **dict_setitem** – the setitem function to use for the underlying OrderedDict insert

class `fastr.core.node.SinkNode(datatype, id_=None, parent=None, nodegroup=None)`

Bases: `fastr.core.node.Node`

Class which handles where the output goes. This can be any kind of file, e.g. image files, textfiles, config files, etc.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'SinkNode.schema.json'

__getstate__()

__init__(datatype, id_=None, parent=None, nodegroup=None)

Instantiation of the SourceNode.

Parameters

- **datatype** – The datatype of the output.
- **id** – the id of the node to create

Returns newly created sink node

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> sink = network.create_sink(datatype=fastr.typelist['ITKImageFile'], id_=
↳ 'SinkN')
```

__module__ = 'fastr.core.node'

__setstate__ (*state*)

datatype

The datatype of the data this sink can store.

draw (*context, graph, color=None*)

input

The default input of the sink Node

class `fastr.core.node.SourceNode` (*datatype, id_=None, parent=None, nodegroup=None*)

Bases: `fastr.core.node.FlowNode`

Class providing a connection to data resources. This can be any kind of file, stream, database, etc from which data can be received.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'SourceNode.schema.json'

__eq__ (*other*)

Compare two Node instances with each other. This function ignores the parent and update status, but tests rest of the dict for equality. equality

Parameters **other** (`Node`) – the other instances to compare to

Returns True if equal, False otherwise

__getstate__ ()

Retrieve the state of the SourceNode

Returns the state of the object

Rtype dict

__init__ (*datatype, id_=None, parent=None, nodegroup=None*)

Instantiation of the SourceNode.

Parameters

- **datatype** – The (id of) the datatype of the output.
- **id** – The url pattern.

This class should never be instantiated directly (unless you know what you are doing). Instead create a source using the network class like shown in the usage example below.

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> source = network.create_source(datatype=fastr.typelist['ITKImageFile'],
↳ id_='sourceN')
```

__module__ = 'fastr.core.node'

__setstate__ (*state*)

Set the state of the SourceNode by the given state.

Parameters *state* (*dict*) – The state to populate the object with

Returns None

datatype

The datatype of the data this source supplies.

dimensions

The dimensions in the SourceNode output. These will be reflected in the SampleIdLists.

draw (*context*, *graph*, *color=None*)

nodegroup

output

Shorthand for `self.outputs['output']`

set_data (*data*, *ids=None*)

Set the data of this source node.

Parameters

- **data** (*dict*, *OrderedDict* or *list of urls*) – the data to use
- **ids** – if data is a list, a list of accompanying ids

sourcegroup

valid

This does nothing. It only overloads the valid method of Node(). The original is intended to check if the inputs are connected to some output. Since this class does not implement inputs, it is skipped.

objectmanager Module

This module contains the object manager class

class `fastr.core.objectmanager.ObjectManager` (*path*)

Bases: `fastr.core.basemanager.BaseManager`

Class for managing all the objects loaded in the fastr system

__abstractmethods__ = frozenset(['object_class', 'get_object_version'])

__contains__ (*key*)

Check if an item is in the ObjectManager

Parameters *key* (*str* or *tuple*) – object id or tuple (Objectid, version)

Returns flag indicating the item is in the manager

__getitem__ (*key*)

Retrieve a Object from the ObjectManager. You can request by only an id, which results in the newest version of the Object being returned, or request using both an id and a version.

Parameters **key** (*str or tuple*) – object id or tuple (Objectid, version)

Returns the requested Object

Raises *FastrObjectUnknownError* – if a non-existing Object was requested

__init__ (*path*)

Create a ObjectManager and scan path to search for Objects

Parameters **path** (*str or iterable of str*) – the path(s) to scan for Objects

Returns newly created ObjectManager

__keytransform__ (*key*)

Key transform, used for allowing indexing both by id-only and by (id, version)

Parameters **key** – key to transform

Returns key in form (id, version)

__module__ = 'fastr.core.objectmanager'

get_object_version (*obj*)

Get the version of a given object

Parameters **object** – the object to use

Returns the version of the object

object_class

The class of the objects to populate the manager with

objectversions (*obj*)

Return a list of available versions for the object

Parameters **object** – The object to check the versions for. Can be either a *Object* or a *str*.

Returns List of version objects. Returns *None* when the given object is not known.

todict ()

Return a dictionary version of the Manager

Returns manager as a dict

pluginmanager Module

This module contains the Manager class for Plugins in the fastr system

class `fastr.core.pluginmanager.BasePluginManager` (*path=None, recursive=False*)

Bases: `fastr.core.basemanager.BaseManager`

Baseclass for PluginManagers, need to override the self._plugin_class

__abstractmethods__ = frozenset(['plugin_class'])

__getitem__ (*key*)

Retrieve item from BaseManager

Parameters **key** – the key of the item to retrieve

Returns the value indicated by the key

Raises *FastrKeyError* – if the key is not found in the BaseManager

__init__ (*path=None, recursive=False*)

Create a BasePluginManager and scan the give path for matching plugins

Parameters

- **path** (*str*) – path to scan
- **recursive** (*bool*) – flag to indicate a recursive search

Returns newly created plugin manager

Raises *FastTypeError* – if self._plugin_class is set to a class not subclassing BasePlugin

__module__ = 'fastr.core.pluginmanager'

load_plugin (*plugin_key*)

plugin_class

The class from which the plugins must be subclassed

populate ()

Populate the manager with the data. This is a method that will be called when the Managers data is first accessed. This way we avoid doing expensive directory scans when the data is never requested.

test_plugin (*plugin*)

class *fastr.core.pluginmanager.LazyModule* (*name, parent, plugin_manager*)

Bases: *module*

A module that allows content to be loaded lazily from plugins. It generally is (almost) empty and gets (partially) populated when an attribute cannot be found. This allows lazy loading and plugins depending on other plugins.

__getattr__ (*item*)

The getattr is called when getattribute does not return a value and is used as a fallback. In this case we try to find the value normally and will trigger the plugin manager if it cannot be found.

Parameters **item** (*str*) – attribute to retrieve

Returns the requested attribute

__init__ (*name, parent, plugin_manager*)

__module__ = 'fastr.core.pluginmanager'

__repr__ ()

__weakref__

list of weak references to the object (if defined)

class *fastr.core.pluginmanager.PluginManager* (*path=None*)

Bases: *fastr.core.pluginmanager.BasePluginManager*

__abstractmethods__ = frozenset([])

__init__ (*path=None*)

__module__ = 'fastr.core.pluginmanager'

__setitem__ (*key, value*)

Store an item in the BaseManager, will ignore the item if the key is already present in the BaseManager.

Parameters

- **name** – the key of the item to save
- **value** – the value of the item to save

Returns None

plugin_class

The plugin manager contains any Plugin subclass

```
class fastr.core.pluginmanager.PluginSubManager (parent, plugin_class)
```

Bases: *fastr.core.pluginmanager.BasePluginManager*

A PluginManager that is a selection of a parent plugin manger. It uses the PluginsView to only expose part of the parent PluginManager. This is used to create plugin managers for only certain types of plugins (e.g. IOPlugins) without loading them multiple times.

```
__abstractmethods__ = frozenset([])
```

```
__init__ (parent, plugin_class)
```

```
__module__ = 'fastr.core.pluginmanager'
```

data

plugin_class

PluginSubManagers only expose the plugins of a certain class

```
class fastr.core.pluginmanager.PluginsView (parent, plugin_class)
```

Bases: *_abcoll.MutableMapping*

A collection that acts like view of the plugins of another plugin manager. This is a proxy object that only gives access the plugins of a certain plugin class. It behaves like a mapping and is used as the data object for a PluginSubManager.

```
__abstractmethods__ = frozenset([])
```

```
__delitem__ (key)
```

```
__getitem__ (item)
```

```
__init__ (parent, plugin_class)
```

Constructor for the plugins view

Parameters

- **parent** (*BasePluginManager*) – the parent plugin manager
- **plugin_class** (*class*) – the class of the plugins to expose

```
__iter__ ()
```

```
__len__ ()
```

```
__module__ = 'fastr.core.pluginmanager'
```

```
__setitem__ (key, value)
```

```
filter_plugin (plugin)
```

```
class fastr.core.pluginmanager.plugin_option_type (filename, name, namespace, id)
```

Bases: *tuple*

```
__dict__ = dict_proxy({'__module__': 'fastr.core.pluginmanager', '_make': <classmethod object>, '_replace': <function
```

```
__getnewargs__ ()
```

Return self as a plain tuple. Used by copy and pickle.

```
__getstate__ ()
```

Exclude the OrderedDict from pickling

```
__module__ = 'fastr.core.pluginmanager'
```

```
static __new__ (_cls, filename, name, namespace, id)
```

Create new instance of plugin_option_type(filename, name, namespace, id)

```

__repr__()
    Return a nicely formatted representation string

__slots__ = ()

filename
    Alias for field number 0

id
    Alias for field number 3

name
    Alias for field number 1

namespace
    Alias for field number 2

```

provenance Module

```
class fastr.core.provenance.Provenance(host=None)
```

Bases: `object`

The Provenance object keeps track of everything that happens to a data object.

```
__dict__ = dict_proxy({'__module__': 'fastr.core.provenance', 'init_provenance': <function init_provenance>, 'collect_
```

```
__init__(host=None)
```

```
__module__ = 'fastr.core.provenance'
```

```
__weakref__
```

list of weak references to the object (if defined)

```
activity(identifier, start_time=None, end_time=None, other_attributes=None)
```

```
agent(identifier, other_attributes=None)
```

```
collect_input_argument_provenance(input_argument)
```

```
collect_provenance(job, advanced_flow=False)
```

Collect the provenance for this job

```
static data_uri(value, job)
```

```
entity(identifier, other_attributes=None)
```

```
static get_parent_provenance(value)
```

Find the provenance of the parent job

Parameters `value` (`str`) – url for the value for which to find the job

Returns the provenance of the job that created the value

Raises

- `FastrKeyError` – if the deferred is not available (yet)
- `FastrValueError` – if the value is not a valid deferred url

```
init_provenance(job)
```

Create initial provenance document

```
serialize(filename, format)
```

`samples` Module

This package holds the classes for working with samples.

```
class fastr.core.samples.ContainsSamples
    Bases: fastr.core.samples.HasSamples
    __abstractmethods__ = frozenset(['samples'])
    __getitem__ (item)
    __module__ = 'fastr.core.samples'
    __setitem__ (key, value)
    dimensions
    samples
```

```
class fastr.core.samples.HasSamples
    Bases: fastr.core.dimension.HasDimensions
    Base class for all classes that supply samples. This base class allows to only define __getitem__ and size and get all other basic functions mixed in so that the object behaves similar to a Mapping.
```

```
    __abstractmethods__ = frozenset(['dimensions', '__getitem__'])
    __contains__ (item)
    __getitem__ (item)
    __iter__ ()
    __metaclass__
        alias of ABCMeta
    __module__ = 'fastr.core.samples'
    ids ()
    indexes ()
    items ()
    iteritems ()
```

```
class fastr.core.samples.SampleBaseId
    Bases: tuple
```

This class represents a sample id. A sample id is a multi-dimensional id that has a simple, consistent string representation.

```
    __add__ (other)
        Add another SampleId, this allows to add parts to the SampleId in a convenient way.
    __dict__ = dict_proxy({'__module__': 'fastr.core.samples', '__new__': <staticmethod object>, '__str__': <function __s
    __module__ = 'fastr.core.samples'
    static __new__ (*args)
        Create a new SampleId
```

Parameters `args` (*iterator/iterable of element type or element type*)
– the strings to make sample id for

`__radd__ (other)`

Add another SampleId, this allows to add parts to the SampleId in a convenient way. This is the right-hand version of the operator.

`__repr__ ()`

Get a string representation for the SampleBaseId

Returns the string representation

Return type `str`

`__str__ ()`

Get a string version for the SampleId, joins the SampleId with `__` to create a single string version.

Returns the string version

Return type `str`

class `fastr.core.samples.SampleCollection (dimnames, parent)`

Bases: `_abcoll.MutableMapping`, `fastr.core.dimension.HasDimensions`

The SampleCollections is a class that contains the data including a form of ordering. Each sample is reachable both by its SampleId and a SampleIndex. The object is sparse, so not all SampleId have to be defined allowing for non-rectangular data shapes.

Note: This object is meant to replace both the SampleIdList and the ValueStorage.

`__abstractmethods__ = frozenset([])`

`__contains__ (item)`

Check if an item is in the SampleCollection. The item can be a SampleId or SampleIndex. If the item is a slicing SampleIndex, then check if it would return any data (True) or no data (False)

Parameters `item (SampleId, SampleIndex)` – the item to check for

Returns flag indicating item is in the collections

Return type `bool`

`__delitem__ (key)`

Remove an item from the SampleCollection

Parameters `key (SampleId, SampleIndex, tuple of both, or SampleItem)` – the key of the item to remove

`__getitem__ (item)`

Retrieve (a) SampleItem(s) from the SampleCollection using the SampleId or SampleIndex. If the item is a tuple, it should be valid tuple for constructing either a SampleId or SampleIndex.

Parameters `item (SampleId, SampleIndex, or tuple)` – the identifier of the item to retrieve

Returns the requested item

Return type `SampleItem`

Raises

- **FastrTypeError** – if the item parameter is of incorrect type
- **KeyError** – if the item is not found

`__init__ (dimnames, parent)`

Create a new SampleCollection

`__iter__()`
Iterate over the indices

`__len__()`
Get the number of samples in the SampleCollections.

`__module__ = 'fastr.core.samples'`

`__repr__()`

`__setitem__(key, value)`
Set an item to the SampleCollection. The key can be a SampleId, SampleIndex or a tuple containing a SampleId and SampleIndex. The value can be a SampleItem (with the SampleId and SampleIndex matching), a tuple with values (assuming no depending jobs), or a with a list of values and a set of depending jobs.

Parameters

- **key** (*SampleId, SampleIndex, tuple of both, or SampleItem*) – the key of the item to store
- **value** (*SampleItem, tuple of values, or tuple of tuple of values and set of depending jobs*) – the value of the SampleItem to store

Raises

- *FastrTypeError* – if the key or value types are incorrect
- *FastrValueError* – if the id or values are incorrectly formed

dimensions

fullid

The full defining ID for the SampleIdList

ndims

The number of dimensions in this SampleCollection

parent

The parent object holding the SampleCollection

class `fastr.core.samples.SampleId`
Bases: `fastr.core.samples.SampleBaseId`
SampleId is an identifier for data using human readable strings

`__module__ = 'fastr.core.samples'`

class `fastr.core.samples.SampleIndex`
Bases: `fastr.core.samples.SampleBaseId`
SampleId is an identifier for data using the location in the N-d data structure.

`__module__ = 'fastr.core.samples'`

`__repr__()`
Get a string representation for the SampleIndex

Returns the string representation

Return type `str`

`__str__()`
Get a string version for the SampleId, joins the SampleId with `__` to create a single string version.

Returns the string version

Return type `str`

expand (*size*)

Function expanding a slice SampleIndex into a list of non-slice SampleIndex objects

Parameters *size* – the size of the collection to slice

isslice

Flag indicating that the SampleIndex is a slice (as opposed to a simple single index).

class `fastr.core.samples.SampleItem`

Bases: `fastr.core.samples.SampleItemBase`

`__module__` = 'fastr.core.samples'

static `__new__` (*index, id_, data, jobs=None, failed_annotations=None*)

Create a SampleItem. Data should be an OrderedDict of tuples.

Parameters

- **index** (*tuple, slice*) – the sample index
- **id** (`SampleId`) – the sample id
- **data** (`SampleValue, Mapping`) – the data values
- **jobs** (*set*) – set of jobs on which this SampleItems data depends.
- **failed_annotations** (*set*) – set of tuples. The tuple is constructed like follows: (job_id, reason).

class `fastr.core.samples.SampleItemBase`

Bases: `tuple`

This class represents a sample item, a combination of a SampleIndex, SampleID, value and required jobs. The SampleItem based on a named tuple and has some extra methods to combine SampleItems easily.

`__add__` (*other*)

The addition operator combines two SampleItems into a single SampleItems. It merges the data and jobs and takes the index and id of the left-hand item.

Parameters *other* (`SampleItem`) – The other item to add to this one

Returns the combined SampleItem

Return type `SampleItem`

`__dict__` = `dict_proxy` ({'index': <property object>, '__module__': 'fastr.core.samples', 'dimensionality': <property object>})

`__getnewargs__` ()

Get new args gives the arguments to use to re-create this object, This is used for serialization.

`__module__` = 'fastr.core.samples'

static `__new__` (*index, id_, data, jobs=None, failed_annotations=None*)

Create a SampleItem. Data should be an OrderedDict of tuples.

Parameters

- **index** (*tuple, slice*) – the sample index
- **id** (`SampleId`) – the sample id
- **data** (`SampleValue, Mapping`) – the data values
- **jobs** (*set*) – set, tuple or list of jobs on which this SampleItems data depends.

- **failed_annotations** (*set*) – set of tuples. The tuple is constructed like follows: (job_id, reason).

__repr__ ()

Get a string representation for the SampleItem

Returns the string representation

Return type *str*

cardinality

The cardinality of this Sample

static combine (*args)

Combine a number of SampleItems into a new one.

Parameters **args* – the SampleItems to combine

Returns the combined SampleItem

Return type *SampleItem*

It is possible to both give multiple arguments, where each argument is a SampleItem, or a single argument which is an iterable yielding SampleItems.

```
# variables a, b, c, d are SampleItems to combine
# These are all valid ways of combining the SampleItems
comb1 = SampleItem.combine(a, b, c, d) # Using multiple arguments
l = [a, b, c, d]
comb2 = SampleItem.combine(l) # Using a list of arguments
comb3 = SampleItem.combine(l.__iter__()) # Using an iterator
```

data

The data SampleValue of the SampleItem

Returns The value of this SampleItem

Return type *SampleValue*

dimensionality

The dimensionality of this Sample

failed_annotations

id

The sample id of the SampleItem

Returns The id of this SampleItem

Return type *SampleId*

index

The index of the SampleItem

Returns The index of this SampleItem

Return type *SampleIndex*

jobs

The set of the jobs on which this SampleItem depends

Returns The jobs that generated the data for this SampleItem

Return type *set*

```
class fastr.core.samples.SamplePayload
```

Bases: *fastr.core.samples.SampleItemBase*

__add__ (*other*)

The addition operator combines two SampleItems into a single SampleItems. It merges the data and jobs and takes the index and id of the left-hand item.

Parameters *other* (*SampleItem*) – The other item to add to this one

Returns the combined SamplePayload

Return type *SamplePayload*

__module__ = 'fastr.core.samples'

static __new__ (*index, id, data, jobs=None, failed_annotations=None*)

Create a SampleItem. Data should be an OrderedDict of tuples.

Parameters

- **index** (*tuple, slice*) – the sample index
- **id** (*SampleId*) – the sample id
- **data** (*SampleValue, Mapping*) – the data values
- **jobs** (*set*) – set of jobs on which this SampleItems data depends.
- **failed_annotations** (*set*) – set of tuples. The tuple is constructed like follows: (job_id, reason).

```
class fastr.core.samples.SampleValue (*args, **kwargs)
```

Bases: *_abcoll.MutableMapping*

A collection containing the content of a sample

__abstractmethods__ = frozenset([])

__add__ (*other*)

__delitem__ (*key*)

__getitem__ (*item*)

__getstate__ ()

__init__ (**args, **kwargs*)

__iter__ ()

__len__ ()

__module__ = 'fastr.core.samples'

__radd__ (*other*)

__repr__ ()

__setitem__ (*key, value*)

__setstate__ (*state*)

cast (*datatype*)

is_mapping

is_sequence

iterelements ()

```
mapping_part ()
sequence_part ()
```

serializable Module

This package contains the base class and meta class for all serializable objects in the Fastr system.

```
class fastr.core.serializable.PassThroughSerializer
```

Bases: `object`

```
__dict__ = dict_proxy({'__module__': 'fastr.core.serializable', 'dumps': <staticmethod object>, '__dict__': <attribute
```

```
__module__ = 'fastr.core.serializable'
```

```
__weakref__
```

list of weak references to the object (if defined)

```
static dumps (data)
```

```
static loads (data)
```

```
class fastr.core.serializable.Serializable
```

Bases: `object`

Superclass for all classes that can be serialized.

```
SERIALIZERS = {'/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/feature-networkrun/lib/python2.7/site-p
```

```
__dict__ = dict_proxy({'load': <classmethod object>, '__module__': 'fastr.core.serializable', 'SERIALIZERS': {'/hom
```

```
__getstate__ ()
```

```
__module__ = 'fastr.core.serializable'
```

```
__weakref__
```

list of weak references to the object (if defined)

```
classmethod createobj (state, _=None)
```

Create object function for generic objects

Parameters

- **cls** – The class to create
- **state** – The state to use to create the Link
- **network** – the parent Network

Returns newly created Link

```
dump (file_handle, method='json', **kwargs)
```

Dump the object to a file like object.

Parameters

- **file_handle** – file descriptor to write the data to
- **method** (*str*) – method of final serialization to use (e.g. json, xml, pickle)
- **kwargs** – extra arguments passed to the final serializer

```
dumpf (path, method=None, **kwargs)
```

Dump the object to a file

Parameters

- **path** – path where to write the file
- **method** (*str*) – method of final serialization to use (e.g. json, xml, pickle)
- **kwargs** – extra arguments passed to the final serializer

Note: The `dumpf` function can determine the method based on the desired output filename. Also, if the filename ends with `.gz` it will continue search for another extension (so `.json.gz` could be found) and will then compress the result with `gzip`.

dumpfuncs = {'xml': <module 'fastr.utils.xmltodict' from '/home/docs/checkouts/readthedocs.org/user_builds/fastr/envs/

dumps (*method='json', **kwargs*)

Dump the object to a string

Parameters

- **method** (*str*) – method of final serialization to use (e.g. json, xml, pickle)
- **kwargs** – extra arguments passed to the final serializer

Returns serialization string

Return type *str*

classmethod get_serializer (*filename=None*)

classmethod load (*file_handle, method=None, network=None, **kwargs*)

Load the object from a file-like object

Parameters

- **cls** – class of the object
- **file_handle** – file descriptor to write the data to
- **method** (*str*) – method of final serialization to use (e.g. json, xml, pickle)
- **network** – network in which to place the loaded object
- **kwargs** – extra arguments passed to the final serializer

Returns newly created object

Warning: Unlike the `loadf` functions, this function does not automatically detect `gzip` compression. You read a `gzip` using the `gzip.open` method, but not simply opening a stream and hoping this function will function.

classmethod loadf (*path, method=None, network=None, **kwargs*)

Load the object from a file

Parameters

- **cls** – class of the object
- **path** – path where to write the file
- **method** (*str*) – method of final serialization to use (e.g. json, xml, pickle)
- **network** – network in which to place the loaded object
- **kwargs** – extra arguments passed to the final serializer

Returns newly created object

Note: The `loadf` function can determine the method of loading based on the filename. Also it can automatically determine whether a file is gzipped.

classmethod `loads` (*string*, *method=None*, *network=None*, ***kwargs*)

Load the object from a string

Parameters

- **cls** – class of the object
- **string** (*str*) – the string containing the serialized data
- **method** (*str*) – method of final serialization to use (e.g. json, xml, pickle)
- **network** – network in which to place the loaded object
- **kwargs** – extra arguments passed to the final serializer

Returns newly created object

target Module

The module containing the classes describing the targets.

class `fastr.core.target.ProcessUsageCollection`

Bases: `_abcoll.Sequence`

`__abstractmethods__` = `frozenset([])`

`__getitem__` (*item*)

`__init__` ()

`__len__` ()

`__module__` = `'fastr.core.target'`

`aggregate` (*number_of_points*)

`append` (*value*)

`usage_type`

alias of `SystemUsageInfo`

class `fastr.core.target.SystemUsageInfo` (*timestamp*, *cpu_percent*, *vmem*, *rmem*, *read_bytes*,
write_bytes)

Bases: `tuple`

`__dict__` = `dict_proxy({'__module__': 'fastr.core.target', '_make': <classmethod object>, 'timestamp': <property object>})`

`__getnewargs__` ()

Return self as a plain tuple. Used by copy and pickle.

`__getstate__` ()

Exclude the `OrderedDict` from pickling

`__module__` = `'fastr.core.target'`

static `__new__` (*_cls*, *timestamp*, *cpu_percent*, *vmem*, *rmem*, *read_bytes*, *write_bytes*)

Create new instance of `SystemUsageInfo(timestamp, cpu_percent, vmem, rmem, read_bytes, write_bytes)`

`__repr__` ()

Return a nicely formatted representation string

__slots__ = ()

cpu_percent
Alias for field number 1

read_bytes
Alias for field number 4

rmem
Alias for field number 3

timestamp
Alias for field number 0

vmem
Alias for field number 2

write_bytes
Alias for field number 5

class `fastr.core.target.Target`
Bases: `fastr.core.baseplugin.Plugin`

The abstract base class for all targets. Execution with a target should follow the following pattern:

```
>>> with Target() as target:
...     target.run_command(['sleep', '10'])
...     target.run_command(['sleep', '10'])
...     target.run_command(['sleep', '10'])
```

The Target context operator will set the correct paths/initialization. Within the context command can be ran and when leaving the context the target reverts the state before.

__abstractmethods__ = frozenset(['run_command'])

__enter__ ()
Set the environment in such a way that the target will be on the path.

__exit__ (*exc_type, exc_value, traceback*)
Cleanup the environment where needed

__metaclass__
alias of ABCMeta

__module__ = 'fastr.core.target'

run_command (*command*)

classmethod test ()
Test the plugin, interfaces do not need to be tested on import

class `fastr.core.target.TargetManager`
Bases: `fastr.core.pluginmanager.PluginSubManager`
Container holding all the ExecutionPlugins known to the Fastr system

__abstractmethods__ = frozenset([])

__init__ ()
Initialize a ExecutionPluginManager and load plugins.

Parameters

- **path** – path to search for plugins

- **recursive** – flag for searching recursively

Returns newly created ExecutionPluginManager

__module__ = 'fastr.core.target'

tool Module

A module to maintain a tool.

Exported classes:

- Tool – A class encapsulating a tool.
- ParameterDescription – The base class containing the shared description of a parameter (both input and output).
- InputParameterDescription – A class containing the description of an input parameter.
- OutputParameterDescription – A class containing the description of an output parameter.

class `fastr.core.tool.Tool` (*doc=None*)

Bases: `fastr.core.serializable.Serializable`

The class encapsulating a tool.

TOOL_REFERENCE_FILE_NAME = '__fastr_tool_ref__.json'

TOOL_RESULT_FILE_NAME = '__fastr_tool_result.pickle.gz'

__dataschemafile__ = 'Tool.schema.json'

__eq__ (*other*)

Compare two Tool instances with each other.

Parameters *other* (`Tool`) – the other instances to compare to

Returns True if equal, False otherwise

__getstate__ ()

Retrieve the state of the Tool

Returns the state of the object

Rtype dict

__init__ (*doc=None*)

Create a new Tool :param doc: path of toolfile or a dict containing the tool data :type doc: str or dict

__module__ = 'fastr.core.tool'

__repr__ ()

Get a string representation for the Tool. This will show the inputs and output defined in a table-like structure.

Returns the string representation

Return type str

__setstate__ (*state*)

Set the state of the Tool by the given state.

Parameters *state* (*dict*) – The state to populate the object with

__str__ ()

Get a string version for the Tool

Returns the string version

Return type `str`

authors = None

List of authors of the tool. These people wrapped the executable but are not responsible for executable itself.

cite = None

This holds the citation you should use when publishing something based on this Tool

command = None

Command is a dictionary contain information about the command which is called by this Tool: `command['interpreter']` holds the (possible) interpreter to use `command['targets']` holds a per os/arch dictionary of files that should be executed `command['url']` is the webpage of the command to be called `command['version']` is the version of the command used `command['description']` can help a description of the command `command['authors']` lists the original authors of the command

command_version

static compare_output_data (*current_output_data, reference_output_data, validation_result, output*)

create_reference (*input_data, output_directory, mount_name='__ref_tmp__', copy_input=True*)

description = None

Description of the tool and it's functionality

execute (*payload=None, **kwargs*)

Execute a Tool given the payload for a single run

Parameters **payload** – the data to execute the Tool with

Returns The result of the execution

Return type `InterFaceResult`

fullid

The full id of this tool

hash

help = None

Man page for the Tool. Here usage and examples can be described in detail

inputs

interface_class = None

Create the Interface based on the class specified in the tool file

name = None

Name of the tool, this should be a descriptive, human readable name.

namespace = None

The namespace this tools lives in, this will be set by the ToolManager on load

node_class = None

Class for of the Node to use

ns_id

The namespace and id of the Tool

outputs

path

The path of the directory in which the tool definition file was located.

references = None

A list of documents and in depth reading about the methods used in this tool

regex = None

Identifier for the tool

requirements = None

Requirements for this Tool

Warning: Not yet implemented

tags = None

List of tags for this tool

target

The OS and arch matched target definition.

test (*reference=None*)

Run the tests for this tool

test_spec

alias of TestSpecification

classmethod test_tool (*reference_data_dir, tool=None, input_data=None*)

Execute the tool with the input data specified and test the results against the reference data. This effectively tests the tool execution.

Parameters

- **reference_data_dir** (*str*) – The path or vfs url of reference data to compare with
- **source_data** (*dict*) – The source data to use

tests = None

Test for this tool. A test should be a collection of inputs, parameters and outputs to verify the proper functioning of the Tool.

The format of the tests is a list of namedtuples, that have 3 fields: - input: a dict of the input data - command: a list given the expected command-line arguments - output: a dict of the output data to validate

Warning: Not yet implemented

url = None

URL to website where this tool can be downloaded from

version = None

Version of the tool, not of the underlying software

toolmanager Module

This module contains the tool manager class

class `fastr.core.toolmanager.ToolManager` (*path*)

Bases: `fastr.core.objectmanager.ObjectManager`

`__abstractmethods__` = frozenset([])

`__module__` = 'fastr.core.toolmanager'

`get_object_version(obj)`

`object_class`

`populate()`

`toolversions(tool)`

Return a list of available versions for the tool

Parameters `tool` – The tool to check the versions for. Can be either a *Tool* or a *str*.

Returns List of version objects. Returns *None* when the given tool is not known.

`fastr.core.toolmanager.toollist = ToolManager fastr.Sink v1.0 : /home/docs/checkouts/readthedocs.org/user_builds`
The fastr toollist

updateable Module

This module contains both the Updateable class and UpdateableMeta meta-class for objects which support updates within the fastr system

class `fastr.core.updateable.Updateable`

Bases: `object`

Super class for all classes that can be updated and have a status. These objects can be valid/invalid state. These states are set by the function update. This allows for interactively checking the network.

`__abstractmethods__ = frozenset(['_update'])`

`__dict__ = dict_proxy({'_abc_cache': <_weakrefset.WeakSet object>, '__module__': 'fastr.core.updateable', '__update'`

`__getstate__()`

Retrieve the state of the object, make sure the status is not part of the description as it will not be valid after re-creating the object.

Returns the state of the object

Rtype dict

`__init__()`

Constructor, creates the status field

Returns newly created object

`__metaclass__`

alias of `UpdateableMeta`

`__module__ = 'fastr.core.updateable'`

`__setstate__(state)`

Set the state of the object by the given state. This adds a clean status field, making sure it is not unintended, outdated information from before serialization.

Parameters `state(dict)` – The state to populate the object with

`__updatefunc__(key=None, forward=True, backward=False)`

Default function for updating, it can be called without key to have a new update started with a new key.

Parameters

- **key** (*int*) – a key for this update, should be different than the last update key
- **forward** (*bool*) – flag indicating to update forward in the network
- **backward** (*bool*) – flag indicating to update backward in the network

__updateinprogress__ = <thread.lock object>

Lock to avoid multiple updates happening at the same time

__updatetriggers__ = []

Which methods need to be wrapped to trigger an update. Override this value to have the functions automatically wrapped. E.g. `__update_triggers__ = ['append', 'insert', '__setitem__']` to have these functions wrapped.

__updating__ = True

Flag to indicate that this object is allowed to update

__weakref__

list of weak references to the object (if defined)

messages

The messages of the last update

update (*key=None, forward=True, backward=False*)

Default function for updating, it can be called without key to have a new update started with a new key.

Parameters

- **key** (*int*) – a key for this update, should be different than the last update key
- **forward** (*bool*) – flag indicating to update forward in the network
- **backward** (*bool*) – flag indicating to update backward in the network

valid

Flag indicating that the object is valid

class `fastr.core.updateable.UpdateableMeta`

Bases: `abc.ABCMeta`

A metaclass for objects which are updateable and need some methods/properties to trigger an update.

__module__ = 'fastr.core.updateable'

static **__new__** (*mcs, name, parents, dct*)

classmethod **calcmro** (*mcs, bases*)

Calculate the Method Resolution Order of bases using the C3 algorithm.

Suppose you intended creating a class K with the given base classes. This function returns the MRO which K would have, *excluding* K itself (since it doesn't yet exist), as if you had actually created the class.

Another way of looking at this, if you pass a single class K, this will return the linearization of K (the MRO of K, *including* itself).

Parameters **bases** – the list of bases for which create the MRO

Returns the list representing the entire MRO, except the (non-existing) class itself

Note: Taken from <http://code.activestate.com/recipes/577748-calculate-the-mro-of-a-class/> Created by Steven D'Aprano and licensed under the MIT license

classmethod **find_member** (*mcs, name, parents, dct*)

Find a member of the class in the same way as Python would if it had a given dict and set of bases

Parameters

- **mcs** – metaclass at work
- **name** – name of the class to be created

- **parents** – list of the bases for the new class
- **dct** – the dict of the class being created

Returns the firstly resolved member or None if nothing found

static `updatetrigger` (*func*)

Function decorator to make a function trigger an update after being called. This is a way to easily have function trigger an update after setting a value without writing tons of wrapper functions. The function keeps the original docstring and appends a note to it.

version Module

Module containing the class that represent versions

class `fastr.core.version.Version`

Bases: `tuple`

Class representing a software version definition. Allows for sorting and extraction of parts.

`__dict__` = `dict_proxy({‘status’: <property object>, ‘__module__’: ‘fastr.core.version’, ‘__new__’: <staticmethod object>})`

`__module__` = ‘fastr.core.version’

static `__new__` (**version*)

Class containing a version

Can be constructed by:

```
Version( 'major.$minor.$extra[0].$extra[1]$separator$status$build$suffix' )
Version( major, minor, extra, status, build, suffix, seperator )
Version( (major, minor, extra, status, build, suffix, seperator) )
Version( [major, minor, extra, status, build, suffix, seperator] )
```

Parameters

- **major** (*int*) – interger giving major version
- **minor** (*int*) – is an integer (required)
- **extra** (*list of int*) – is a list of integers
- **status** (*str*) – can be “a”, “alpha”, “b”, “beta”, “rc”, or “r”
- **build** (*int*) – is an integer
- **suffix** (*str*) – can contain any combination of alpha-numeric character and “.”, “_”
- **seperator** (*str*) – is any of “.”, “-”, or “_”, which is located between \$extra and \$build

Note: The method based on strings is the recommended method. For strings the major and minor version are required, where for tuple and list constructors all seven elements are optional.

Examples:

```
>>> a = Version('0.1')
>>> print(tuple(a))
(0, 1, None, None, None, '', None)
>>> b = Version('2.5.3-rc2')
>>> print(tuple(b))
```

```
(2, 5, [3], 'rc', 2, '', '-')
>>> c = Version('1.2.3.4.5.6.7-beta8_with_suffix')
>>> print(tuple(c))
(1, 2, [3, 4, 5, 6, 7], 'beta', 8, '_with_suffix', '-')

```

__repr__()

Return a in-editor representation of the version

__str__()

Return a string representation of the version

build

the build number, this is following the status (e.g. for 3.2-beta4, this would be 4)

date_version_matcher = <_sre.SRE_Pattern object>

extra

extra version extension as a list

extra_string

extra version extension as a string

major

major version

minor

minor version

status

the status of the version (a, alpha, b, beta, rc or r)

suffix

the remainder of the version which was not formatted in a known way

version_matcher = <_sre.SRE_Pattern object at 0x2261f20>

vfs Module

This module contains the virtual file system code. This is both an internally used object as well as an IOPlugin.

Subpackages

test Package

test Package

testdatatypemanager Module

testdimension Module

testnetwork Module

testnode Module

testsamples Module

testtool Module

testversion Module

testvfs Module

data Package

data Package

Package containig data related modules

url Module

Module providing tools to parse and create valid urls and paths.

usage example:

When in fastr.config under the mounts section the data mount is set to /media/data, you will get the following. ..
code-block:: python

```
>>> import fastrdata.url import get_path_from_url
>>> get_path_from_url('vfs://data/temp/blaatl.png')
'/media/data/temp/blaatl.png'
```

`fastr.data.url.basename(url)`

Get basename of url

Parameters `url (str)` – the url

Returns the basename of the path in the url

`fastr.data.url.create_vfs_url(mountpoint, path)`

Construct an url from a given mount point and a relative path to the mount point.

Parameters

- **mountpoint (str)** – the name of the mountpoint
- **path (str)** – relative path from the mountpoint

Returns the created vfs url

`fastr.data.url.dirname(url)`

Get the dirname of the url

Parameters `url (str)` – the url

Returns the dirname of the path in the url

`fastr.data.url.dirurl(url)`

Get the a new url only having the dirname as the path

Parameters `url (str)` – the url

Returns the modified url with only dirname as path

`fastr.data.url.full_split(urlpath)`

Split the path in the url in a list of parts

Parameters `urlpath` – the url path

Returns a list of parts

`fastr.data.url.get_path_from_url(url)`

Get the path to a file from a url. Currently supports the file:// and vfs:// scheme's

Examples:

```
>>> url.get_path_from_url('vfs://neurodata/user/project/file.ext')
'Y:\neuro3\user\project\file.ext'

>>> 'file:///d:/data/project/file.ext'
'd:\data\project\file.ext'
```

Warning: file:// will not function cross platform and is mainly for testing

`fastr.data.url.get_url_scheme(url)`

Get the schem of the url

Parameters `url (str)` – url to extract scheme from

Returns the url scheme

Return type `str`

`fastr.data.url.isurl(string)`

Check if string is a valid url

Parameters `string (str)` – potential url

Returns flag indicating if string is a valid url

`fastr.data.url.join(url, *p)`

Join the path in the url with p

Parameters

- `url (str)` – the base url to join with
- `p` – additional parts of the path

Returns the url with the parts added to the path

`fastr.data.url.normurl(url)`

Normalized the path of the url

Parameters `url (str)` – the url

Returns the normalized url

`fastr.data.url.register_url_scheme(scheme)`

Register a custom scheme to behave http like. This is needed to parse all things properly.

`fastr.data.url.split(url)`

Split a url in a url with the dirname and the basename part of the path of the url

Parameters `url (str)` – the url

Returns a tuple with (dirname_url, basename)

examples Package

examples Package

`__generate_reference__` Module

```
fastr.examples.__generate_reference__.create_reference(example_path)
fastr.examples.__generate_reference__.generate_all_references()
```

`add_ints` Module

```
fastr.examples.add_ints.create_network()
fastr.examples.add_ints.main()
fastr.examples.add_ints.sink_data(network)
fastr.examples.add_ints.source_data(network)
```

`add_ints_s3` Module

```
fastr.examples.add_ints_s3.create_network()
fastr.examples.add_ints_s3.main()
fastr.examples.add_ints_s3.sink_data(network)
fastr.examples.add_ints_s3.source_data(network)
```

`auto_prefix` Module

```
fastr.examples.auto_prefix.create_network()
fastr.examples.auto_prefix.main()
```

`collapse` Module

```
fastr.examples.collapse.create_network()
fastr.examples.collapse.main()
fastr.examples.collapse.sink_data(network)
fastr.examples.collapse.source_data(network)
```

`collapse_expand` Module

```
fastr.examples.collapse_expand.create_network()
fastr.examples.collapse_expand.main()
fastr.examples.collapse_expand.sink_data(network)
fastr.examples.collapse_expand.source_data(network)
```

cross_validation Module

```
fastr.examples.cross_validation.create_network()  
fastr.examples.cross_validation.main()  
fastr.examples.cross_validation.sink_data(network)  
fastr.examples.cross_validation.source_data(network)
```

elastix_nipype Module

```
fastr.examples.elastix_nipype.create_network()  
fastr.examples.elastix_nipype.main()  
fastr.examples.elastix_nipype.sink_data(network)  
fastr.examples.elastix_nipype.source_data(network)
```

expand Module

```
fastr.examples.expand.create_network()  
fastr.examples.expand.main()  
fastr.examples.expand.sink_data(network)  
fastr.examples.expand.source_data(network)
```

failing_network Module

```
fastr.examples.failing_network.create_network()  
fastr.examples.failing_network.main()  
fastr.examples.failing_network.sink_data(network)  
fastr.examples.failing_network.source_data(network)
```

filecopy Module

```
fastr.examples.filecopy.create_network()  
fastr.examples.filecopy.main()  
fastr.examples.filecopy.sink_data(network)  
fastr.examples.filecopy.source_data(network)
```

input_groups Module

```
fastr.examples.input_groups.create_network()  
fastr.examples.input_groups.main()  
fastr.examples.input_groups.sink_data(network)
```

```
fastr.examples.input_groups.source_data (network)
```

macro_node Module

```
fastr.examples.macro_node.create_macro_network()  
fastr.examples.macro_node.create_network()  
fastr.examples.macro_node.create_super_macro_node()  
fastr.examples.macro_node.main()  
fastr.examples.macro_node.sink_data (network)  
fastr.examples.macro_node.source_data (network)
```

macro_node2 Module

```
fastr.examples.macro_node2.create_macro_network()  
fastr.examples.macro_node2.create_network()  
fastr.examples.macro_node2.main()  
fastr.examples.macro_node2.sink_data (network)  
fastr.examples.macro_node2.source_data (network)
```

shift_links Module

```
fastr.examples.shift_links.create_network()  
fastr.examples.shift_links.main()  
fastr.examples.shift_links.sink_data (network)  
fastr.examples.shift_links.source_data (network)
```

source_sink Module

```
fastr.examples.source_sink.create_network()  
fastr.examples.source_sink.main()  
fastr.examples.source_sink.sink_data (network)  
fastr.examples.source_sink.source_data (network)
```

Subpackages

test Package

test_examples Module

execution Package

execution Package

This package contains all modules related directly to the execution

environmentmodules Module

This module contains a class to interact with EnvironmentModules

class `fastr.execution.environmentmodules.EnvironmentModules` (*protected=None*)
Bases: `object`

This class can control the module environments in python. It can list, load and unload environmentmodules. These modules are then used if subprocess is

called from python.

__dict__ = `dict_proxy({'load': <function load>, '__module__': 'fastr.execution.environmentmodules', '__repr__': <fun`

__init__ (*protected=None*)

Create the environmentmodules control object

Parameters `protected` (*list*) – list of modules that should never be unloaded

Returns newly created EnvironmentModules

__module__ = 'fastr.execution.environmentmodules'

__repr__ ()

__weakref__

list of weak references to the object (if defined)

avail (*namestart=None*)

Print available modules in same way as commandline version

Parameters `namestart` – filter on modules that start with namestart

avail_modules

List of available modules

clear ()

Unload all modules (except the protected modules as they cannot be unloaded). This should result in a clean environment.

exception = `FastrImportError('Cannot find Environment Modules home directory (environment variables not setup p`

isloaded (*module*)

Check if a specific module is loaded

Parameters `module` – module to check

Returns flag indicating the module is loaded

load (*module*)

Load specified module

Parameters `module` – module to load

loaded_modules

List of currently loaded modules

reload (*module*)

Reload specified module

Parameters **module** – module to reload

swap (*module1*, *module2*)

Swap one module for another one

Parameters

- **module1** – module to unload
- **module2** – module to load

sync ()

Sync the object with the underlying enviroment. Re-checks the available and loaded modules

static tostring_modvalue (*value*)

Turn a representation of a module into a string representation

Parameters **value** – module representation (either str or tuple)

Returns string representation

static totuple_modvalue (*value*)

Turn a representation of a module into a tuple representation

Parameters **value** – module representation (either str or tuple)

Returns tuple representation (name, version, default)

unload (*module*)

Unload specified module

Parameters **module** – module to unload

class `fastr.execution.environmentmodules.ModuleSystem`

Bases: `enum.Enum`

`__format__` (*format_spec*)

`__module__` = `'fastr.execution.environmentmodules'`

static `__new__` (*value*)

`__reduce_ex__` (*proto*)

`__repr__` ()

`__str__` ()

envmod = `'enviromentmodules'`

lmod = `'Lmod'`

executionpluginmanager Module

This module holds the ExecutionPluginManager as well as the base-class for all ExecutionPlugins.

class `fastr.execution.executionpluginmanager.ExecutionPlugin` (*finished_callback=None*,
cancelled_callback=None,
status_callback=None)

Bases: `fastr.core.baseplugin.Plugin`

This class is the base for all Plugins to execute jobs somewhere. There are many methods already in place for taking care of stuff.

There are fall-backs for certain features, but if a system already implements those it is usually preferred to skip the fall-back and let the external system handle it. There are a few flags to enable/disable these features:

- `cls.SUPPORTS_CANCEL` indicates that the plugin can cancel queued jobs
- `cls.SUPPORTS_HOLD_RELEASE` indicates that the plugin can queue jobs in a hold state and can release them again (if not, the base plugin will create a hidden queue for held jobs). The plugin should respect the `Job.status == JobState.hold` when queueing jobs.
- `cls.SUPPORTS_DEPENDENCY` indicate that the plugin can manage job dependencies, if not the base plugin job dependency system will be used and jobs will only be submitted when all dependencies are met.
- `cls.CANCELS_DEPENDENCIES` indicates that if a job is cancelled it will automatically cancel all jobs depending on that job. If not the plugin traverses the dependency graph and kills each job manually.

Note: If a plugin supports dependencies it is assumed that when a job gets cancelled, the depending job also gets cancelled automatically!

Most plugins should only need to redefine a few abstract methods:

- `__init__` the constructor
- `cleanup` a clean up function that frees resources, closes connections, etc
- `_queue_job` the method that queues the job for execution

Optionally an extra job finished callback could be added:

- `_job_finished` extra callback for when a job finishes

If `SUPPORTS_CANCEL` is set to `True`, the plugin should also implement:

- `_cancel_job` cancels a previously queued job

If `SUPPORTS_HOLD_RELEASE` is set to `True`, the plugin should also implement:

- `_hold_job` holds a job that is currently held
- `_release_job` releases a job that is currently held

If `SUPPORTED_DEPENDENCY` is set to `True`, the plugin should:

- Make sure to use the `Job.hold_jobs` as a list of its dependencies

Not all of the functions need to actually do anything for a plugin. There are examples of plugins that do not really need a `cleanup`, but for safety you need to implement it. Just using a `pass` for the method could be fine in such a case.

Warning: When overwriting other functions, extreme care must be taken not to break the plugins working, as there is a lot of bookkeeping that can go wrong.

CANCELS_DEPENDENCIES = False

Indicates that when a job is cancelled the dependencies

SUPPORTS_CANCEL = False

Indicates if the plugin can cancel queued jobs

SUPPORTS_DEPENDENCY = False

Indicate if the plugin can manage job dependencies, if not the base plugin job dependency system will be used and jobs will only be submitted when all dependencies are met.

SUPPORTS_HOLD_RELEASE = False

Indicates if the plugin can queue jobs in a hold state and can release them again (if not, the base plugin will create a hidden queue for held

jobs)

__abstractmethods__ = frozenset(['cleanup', '_queue_job', '__init__'])

__del__()

Cleanup if the variable was deleted on purpose

__enter__()

__exit__(type_, value, tb)

__init__(finished_callback=None, cancelled_callback=None, status_callback=None)

Setup the ExecutionPlugin

Parameters

- **finished_callback** – the callback to call after a job finished
- **cancelled_callback** – the callback to call after a job cancelled

Returns newly created ExecutionPlugin

__module__ = 'fastr.execution.executionpluginmanager'

cancel_job(job)

Cancel a job previously queued

Parameters **job** – job to cancel

check_job_requirements(job_id)

Check if the requirements for a job are fulfilled.

Parameters **job_id** – job to check

Returns directive what should happen with the job

Return type *JobAction*

check_job_status(job_id)

Get the status of a specified job

Parameters **job_id** – the target job

Returns the status of the job (or None if job not found)

cleanup()

Method to call to clean up the ExecutionPlugin. This can be to clear temporary data, close connections, etc.

Parameters **force** – force cleanup (e.g. kill instead of join a process)

get_job(job_id)

get_status(job)

hold_job(job)

job_finished(job, errors=None, blocking=False)

The default callback that is called when a Job finishes. This will create a new thread that handles the actual callback.

Parameters

- **job** (*Job*) – the job that finished

- **errors** – optional list of errors encountered
- **blocking** (*bool*) – if blocking, do not create threads

Returns

process_callbacks ()

queue_job (*job*)

Add a job to the execution queue

Parameters *job* (*Job*) – job to add

register_job (*job*)

release_job (*job*)

Release a job that has been put on hold

Parameters *job* – job to release

show_jobs (*req_status=None*)

List the queued jobs, possible filtered by status

Parameters *req_status* – requested status to filter on

Returns list of jobs

class `fastr.execution.executionpluginmanager.ExecutionPluginManager`

Bases: `fastr.core.pluginmanager.PluginSubManager`

Container holding all the ExecutionPlugins known to the Fastr system

__abstractmethods__ = frozenset([])

__init__ ()

Initialize a ExecutionPluginManager and load plugins.

Parameters

- **path** – path to search for plugins
- **recursive** – flag for searching recursively

Returns newly created ExecutionPluginManager

__module__ = 'fastr.execution.executionpluginmanager'

class `fastr.execution.executionpluginmanager.JobAction`

Bases: `enum.Enum`

Job actions that can be performed. This is used for checking if held jobs should be queued, held longer or be cancelled.

__format__ (*format_spec*)

__module__ = 'fastr.execution.executionpluginmanager'

static __new__ (*value*)

__reduce_ex__ (*proto*)

__repr__ ()

__str__ ()

cancel = 'cancel'

hold = 'hold'

```
queue = 'queue'
```

executionscript Module

The executionscript is the script that wraps around a tool executable. It takes a job, builds the command, executes the command (while profiling it) and collects the results.

```
fastr.execution.executionscript.execute_job(job)
```

Execute a Job and save the result to disk

Parameters `job` – the job to execute

```
fastr.execution.executionscript.main(joblist=None)
```

This is the main code. Wrapped inside a function to avoid the variables being seen as globals and to shut up pylint. Also if the joblist argument is given it can run any given job, otherwise it takes the first command line argument.

flownoderun Module

```
class fastr.execution.flownoderun.FlowNodeRun(node, parent)
```

Bases: `fastr.execution.noderun.NodeRun`

A Flow NodeRun is a special subclass of Nodes in which the amount of samples can vary per Output. This allows non-default data flows.

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.execution.flownoderun'
```

blocking

A FlowNodeRun is (for the moment) always considered blocking.

Returns True

dimnames

Names of the dimensions in the NodeRun output. These will be reflected in the SampleIdList of this NodeRun.

outputsize

Size of the outputs in this NodeRun

```
set_result(job, failed_annotation)
```

Incorporate result of a job into the FlowNodeRun.

Parameters `job` (*Type*) – job of which the result to store

```
class fastr.execution.flownoderun.AdvancedFlowNodeRun(node, parent)
```

Bases: `fastr.execution.flownoderun.FlowNodeRun`

```
__abstractmethods__ = frozenset([])
```

```
__module__ = 'fastr.execution.flownoderun'
```

```
execute()
```

Execute the node and create the jobs that need to run

Returns list of jobs to run

Return type list of *Jobs*

```
set_result(job, failed_annotation)
```

inputoutputrun Module

Classes for arranging the input and output for nodes.

Exported classes:

Input – An input for a node (holding datatype). Output – The output of a node (holding datatype and value). ConstantOutput – The output of a node (holding datatype and value).

Warning: Don't mess with the Link, Input and Output internals from other places. There will be a huge chances of breaking the network functionality!

```
class fastr.execution.inputoutputrun.AdvancedFlowOutputRun (node_run, template)
    Bases: fastr.execution.inputoutputrun.OutputRun
```

```
    __abstractmethods__ = frozenset([])
```

```
    __module__ = 'fastr.execution.inputoutputrun'
```

```
class fastr.execution.inputoutputrun.BaseInputRun (node_run, template)
    Bases: fastr.core.samples.HasSamples, fastr.core.inputoutput.BaseInput
```

Base class for all inputs runs.

```
    __abstractmethods__ = frozenset(['itersubinputs', '_update', '__getitem__', 'fullid', 'dimensions'])
```

```
    __init__ (node_run, template)
```

Instantiate a BaseInput

Parameters

- **node** – the parent node the input/output belongs to.
- **description** – the ParameterDescription describing the input/output.

Returns the created BaseInput

Raises

- **FastrTypeError** – if description is not of class ParameterDescription
- **FastrDataTypeNotAvailableError** – if the DataType requested cannot be found in the fastr.typelist

```
    __module__ = 'fastr.execution.inputoutputrun'
```

```
    itersubinputs ()
```

Iterator over the SubInputs

Returns iterator

example:

```
>>> for subinput in input_a.itersubinputs():
      print subinput
```

```
class fastr.execution.inputoutputrun.InputRun (node_run, template)
```

```
    Bases: fastr.execution.inputoutputrun.BaseInputRun
```

Class representing an input of a node. Such an input will be connected to the output of another node or the output of an constant node to provide the input value.

```
    __abstractmethods__ = frozenset([])
```

`__getitem__ (key)`

Retrieve an item from this Input.

Parameters `key` (str, `SampleId` or tuple) – the key of the requested item, can be a key str, sample index tuple or a `SampleId`

Returns the return value depends on the requested key. If the key was an int the corresponding `SubInput` will be returned. If the key was a `SampleId` or sample index tuple, the corresponding `SampleItem` will be returned.

Return type `SampleItem` or `SubInput`

Raises

- `FastrTypeError` – if key is not of a valid type
- `FastrKeyError` – if the key is not found

`__getstate__ ()`

Retrieve the state of the Input

Returns the state of the object

Rtype dict

`__init__ (node_run, template)`

Instantiate an input.

Parameters `template` – the Input that the InputRun is based on

`__module__ = 'fastr.execution.inputoutputrun'`

`__setstate__ (state)`

Set the state of the Input by the given state.

Parameters `state` (dict) – The state to populate the object with

Returns None

`__str__ ()`

Get a string version for the Input

Returns the string version

Return type str

`cardinality (key=None, job_data=None)`

Cardinality for an Input is the sum the cardinalities of the SubInputs, unless defined otherwise.

Parameters `key` (tuple of int or `SampleId`) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type int, sympy.Symbol, or None

`datatype`

The datatype of this Input

`dimensions`

The size of the sample collections that can accessed via this Input.

`fullid`

The full defining ID for the Input

`get_sourced_nodes ()`

Get a list of all `Nodes` connected as sources to this Input

Returns list of all connected *Nodes*

Return type list

get_sourced_outputs ()

Get a list of all *Outputs* connected as sources to this Input

Returns tuple of all connected *Outputs*

Return type tuple

index (*value*)

Find index of a SubInput

Parameters **value** (*SubInput*) – the *SubInput* to find the index of

Returns key

Return type int, str

input_group

The id of the InputGroup this Input belongs to.

insert (*index*)

Insert a new SubInput at index in the sources list

Parameters **key** (*int*) – positive integer for position in _source list to insert to

Returns newly inserted *SubInput*

Return type *SubInput*

itersubinputs ()

Iterate over the *SubInputs* in this Input.

Returns iterator yielding *SubInput*

example:

```
>>> for subinput in input_a.itersubinputs():
    print subinput
```

remove (*value*)

Remove a SubInput from the SubInputs list.

Parameters **value** (*SubInput*) – the *SubInput* to removed from this Input

source

The mapping of *SubInputs* that are connected and have more than 0 elements.

class fastr.execution.inputoutputrun.**MacroOutputRun** (*node_run, template*)

Bases: *fastr.execution.inputoutputrun.OutputRun*

__abstractmethods__ = frozenset([])

__module__ = 'fastr.execution.inputoutputrun'

dimensions

class fastr.execution.inputoutputrun.**OutputRun** (*node_run, template*)

Bases: *fastr.core.inputoutput.BaseOutput*, *fastr.core.samples.ContainsSamples*

Class representing an output of a node. It holds the output values of the tool ran. Output fields can be connected to inputs of other nodes.

__abstractmethods__ = frozenset([])

`__getitem__(key)`

Retrieve an item from this Output. The returned value depends on what type of key used:

- Retrieving data using index tuple: [index_tuple]
- Retrieving data sample_id str: [SampleId]
- Retrieving a list of data using SampleId list: [sample_id1, ..., sample_idN]
- Retrieving a *SubOutput* using an int or slice: [n] or [n:m]

Parameters **key** (int, slice, SampleId or tuple) – the key of the requested item, can be a number, slice, sample index tuple or a SampleId

Returns the return value depends on the requested key. If the key was an int or slice the corresponding *SubOutput* will be returned (and created if needed). If the key was a SampleId or sample index tuple, the corresponding SampleItem will be returned. If the key was a list of SampleId a tuple of SampleItem will be returned.

Return type *SubInput* or SampleItem or list of SampleItem

Raises

- *FastrTypeError* – if key is not of a valid type
- *FastrKeyError* – if the parent Node has not been executed

`__getstate__()`

Retrieve the state of the Output

Returns the state of the object

Rtype dict

`__init__(node_run, template)`

Instantiate an Output

Parameters

- **node** – the parent node the output belongs to.
- **description** – the ParameterDescription describing the output.

Returns created Output

Raises

- *FastrTypeError* – if description is not of class ParameterDescription
- *FastrDataTypeNotAvailableError* – if the DataType requested cannot be found in the `fastr.typelist`

`__module__ = 'fastr.execution.inputoutputrun'`

`__setitem__(key, value)`

Store an item in the Output

Parameters

- **key** (tuple of int or SampleId) – key of the value to store
- **value** – the value to store

Returns None

Raises *FastrTypeError* – if key is not of correct type

__setstate__ (*state*)

Set the state of the Output by the given state.

Parameters *state* (*dict*) – The state to populate the object with

Returns None

__str__ ()

Get a string version for the Output

Returns the string version

Return type *str*

automatic

Flag indicating that the Output is generated automatically without being specified on the command line

blocking

Flag indicating that this Output will cause blocking in the execution

cardinality (*key=None, job_data=None*)

Cardinality of this Output, may depend on the inputs of the parent Node.

Parameters *key* (tuple of int or *SampleId*) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type *int*, *sympy.Symbol*, or *None*

Raises

- *FastrCardinalityError* – if cardinality references an invalid *Input*
- *FastrTypeError* – if the referenced cardinality values type cannot be case to int
- *FastrValueError* – if the referenced cardinality value cannot be case to int

static create_output_cardinality (*desc*)

Create a lambda function that returns an integer value of the cardinality.

param str desc The cardinality description string

return output cardinality description

rtype tuple

The description string can be one of the following forms:

- N: N number of values needed.
- as:input_name: the same number of values as attached to input_name are needed.
- val:input_name: the number of values needed is the value of input_name.
- unknown: the output cardinality cannot be estimated a priori

datatype

The datatype of this Output

fullid

The full defining ID for the Output

iterconvergingindices (*collapse_dims*)

Iterate over all data, but collapse certain dimension to create lists of data.

Parameters *collapse_dims* (*iterable of int*) – dimension to collapse

Returns iterator `SampleIndex` (possibly containing slices)

listeners

The list of *Links* connected to this Output.

preferred_types

The list of preferred `DataTypes` for this Output.

resulting_datatype

The `DataType` that will the results of this Output will have.

samples

The `SampleCollection` of the samples in this Output. None if the `NodeRun` has not yet been executed. Otherwise a `SampleCollection`.

valid

Check if the output is valid, i.e. has a valid cardinality

class `fastr.execution.inputoutputrun.SourceOutputRun` (*node_run, template*)

Bases: `fastr.execution.inputoutputrun.OutputRun`

Output for a `SourceNodeRun`, this type of Output determines the cardinality in a different way than a normal `NodeRun`.

__abstractmethods__ = `frozenset([])`

__getitem__ (*item*)

Retrieve an item from this Output. The returned value depends on what type of key used:

- Retrieving data using index tuple: [index_tuple]
- Retrieving data sample_id str: [SampleId]
- Retrieving a list of data using SampleId list: [sample_id1, ..., sample_idN]
- Retrieving a *SubOutput* using an int or slice: [n] or [n:m]

Parameters **key** (int, slice, `SampleId` or tuple) – the key of the requested item, can be a number, slice, sample index tuple or a `SampleId`

Returns the return value depends on the requested key. If the key was an int or slice the corresponding *SubOutput* will be returned (and created if needed). If the key was a `SampleId` or sample index tuple, the corresponding `SampleItem` will be returned. If the key was a list of `SampleId` a tuple of `SampleItem` will be returned.

Return type *SubInput* or `SampleItem` or list of `SampleItem`

Raises

- *FastrTypeError* – if key is not of a valid type
- *FastrKeyError* – if the parent `NodeRun` has not been executed

__init__ (*node_run, template*)

Instantiate a `FlowOutput`

Parameters

- **node** – the parent node the output belongs to.
- **description** – the `ParameterDescription` describing the output.

Returns created `FlowOutput`

Raises

- ***FastrTypeError*** – if description is not of class `ParameterDescription`
- ***FastrDataTypeNotAvailableError*** – if the `DataType` requested cannot be found in the `fastr.typelist`

__module__ = 'fastr.execution.inputoutputrun'

__setitem__ (*key*, *value*)
Store an item in the Output

Parameters

- **key** (tuple of int or `SampleId`) – key of the value to store
- **value** – the value to store

Returns `None`

Raises ***FastrTypeError*** – if key is not of correct type

cardinality (*key=None*, *job_data=None*)

Cardinality of this SourceOutput, may depend on the inputs of the parent NodeRun.

Parameters **key** (tuple of int or `SampleId`) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type `int`, `sympy.Symbol`, or `None`

dimensions

The dimensions of this SourceOutputRun

linearized

A linearized version of the sample data, this is lazily cached linearized version of the underlying `SampleCollection`.

ndims

The number of dimensions in this SourceOutput

size

The sample size of the SourceOutput

class `fastr.execution.inputoutputrun.SubInputRun` (*input_*)

Bases: `fastr.execution.inputoutputrun.BaseInputRun`

This class is used by `Input` to allow for multiple links to an `Input`. The `SubInput` class can hold only a single Link to a (Sub)Output, but behaves very similar to an `Input` otherwise.

__abstractmethods__ = `frozenset([])`

__getitem__ (*key*)
Retrieve an item from this SubInput.

Parameters **key** (`int`, `SampleId` or `SampleIndex`) – the key of the requested item, can be a number, sample index tuple or a `SampleId`

Returns the return value depends on the requested key. If the key was an `int` the corresponding `SubInput` will be returned. If the key was a `SampleId` or sample index tuple, the corresponding `SampleItem` will be returned.

Return type `SampleItem` or `SubInput`

Raises ***FastrTypeError*** – if key is not of a valid type

Note: As a SubInput has only one SubInput, only requesting int key 0 or -1 is allowed, and it will return self

__getstate__()

Retrieve the state of the SubInput

Returns the state of the object

Rtype dict

__init__() (*input_*)

Instantiate an SubInput.

Parameters *input* (*Input*) – the parent of this SubInput.

Returns the created SubInput

__module__ = 'fastr.execution.inputoutputrun'

__setstate__() (*state*)

Set the state of the SubInput by the given state.

Parameters *state* (*dict*) – The state to populate the object with

Returns None

__str__()

Get a string version for the SubInput

Returns the string version

Return type *str*

cardinality (*key=None, job_data=None*)

Get the cardinality for this SubInput. The cardinality for a SubInputs is defined by the incoming link.

Parameters *key* (*SampleIndex* or *SampleId*) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type *int*, *sympy.Symbol*, or *None*

description

dimensions

The sample size of the SubInput

fullid

The full defining ID for the SubInput

get_sourced_nodes()

Get a list of all *Nodes* connected as sources to this SubInput

Returns list of all connected *Nodes*

Return type list

get_sourced_outputs()

Get a list of all *Outputs* connected as sources to this SubInput

Returns list of all connected *Outputs*

Return type list

input_group

The id of the `InputGroup` this `SubInputs` parent belongs to.

iteritems()

Iterate over the `SampleItems` that are in the `SubInput`.

Returns iterator yielding `SampleItem` objects

itersubinputs()

Iterate over `SubInputs` (for a `SubInput` it will yield self and stop iterating after that)

Returns iterator yielding `SubInput`

example:

```
>>> for subinput in input_a.itersubinputs():
      print subinput
```

node

The `Node` to which this `SubInputs` parent belongs

source

A list with the source `Link`. The list is to be compatible with `Input`

source_output

The `Output` linked to this `SubInput`

class `fastr.execution.inputoutputrun.SubOutputRun(output, index)`

Bases: `fastr.execution.inputoutputrun.OutputRun`

The `SubOutput` is an `Output` that represents a slice of another `Output`.

__abstractmethods__ = `frozenset()`

__getitem__(key)

Retrieve an item from this `SubOutput`. The returned value depends on what type of key used:

- Retrieving data using index tuple: [index_tuple]
- Retrieving data sample_id str: [SampleId]
- Retrieving a list of data using SampleId list: [sample_id1, ..., sample_idN]
- Retrieving a `SubOutput` using an int or slice: [n] or [n:m]

Parameters **key** (int, slice, `SampleId` or tuple) – the key of the requested item, can be a number, slice, sample index tuple or a `SampleId`

Returns the return value depends on the requested key. If the key was an int or slice the corresponding `SubOutput` will be returned (and created if needed). If the key was a `SampleId` or sample index tuple, the corresponding `SampleItem` will be returned. If the key was a list of `SampleId` a tuple of `SampleItem` will be returned.

Return type `SubInput` or `SampleItem` or list of `SampleItem`

Raises `FastrTypeError` – if key is not of a valid type

__getstate__()

Retrieve the state of the `SubOutput`

Returns the state of the object

Rtype dict

__init__ (*output, index*)
 Instantiate a SubOutput

Parameters

- **output** – the parent output the suboutput slices.
- **index** (*int* or *slice*) – the way to slice the parent output

Returns created SubOutput

Raises

- **FastrTypeError** – if the output argument is not an instance of *Output*
- **FastrTypeError** – if the index argument is not an *int* or *slice*

__len__ ()
 Return the length of the Output.

Note: In a SubOutput this is always 1.

__module__ = 'fastr.execution.inputoutputrun'

__setitem__ (*key, value*)
 A function blocking the assignment operator. Values cannot be assigned to a SubOutput.

Raises **FastrNotImplementedError** – if called

__setstate__ (*state*)
 Set the state of the SubOutput by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

__str__ ()
 Get a string version for the SubOutput

Returns the string version

Return type *str*

cardinality (*key=None, job_data=None*)
 Cardinality of this SubOutput depends on the parent Output and *self.index*

Parameters **key** (tuple of *int* or *SampleId*) – key for a specific sample, can be sample index or id

Returns the cardinality

Return type *int*, *sympy.Symbol*, or *None*

Raises

- **FastrCardinalityError** – if cardinality references an invalid *Input*
- **FastrTypeError** – if the referenced cardinality values type cannot be case to *int*
- **FastrValueError** – if the referenced cardinality value cannot be case to *int*

datatype
 The datatype of this SubOutput

fullid
 The full defining ID for the SubOutput

indexrep

Simple representation of the index.

listeners

The list of [Links](#) connected to this Output.

node

The NodeRun to which this SubOutput belongs

preferred_types

The list of preferred DataTypes for this SubOutput.

resulting_datatype

The DataType that will the results of this SubOutput will have.

samples

The SampleCollection for this SubOutput

job Module

This module contains the Job class and some related classes.

```
class fastr.execution.job.InlineJob(*args, **kwargs)
```

Bases: [fastr.execution.job.Job](#)

```
    __init__(*args, **kwargs)
```

```
    __module__ = 'fastr.execution.job'
```

```
    get_result()
```

```
class fastr.execution.job.Job(node, sample_id, sample_index, input_arguments, output_arguments,
                              hold_jobs=None, status_callback=None, preferred_types=None)
```

Bases: [fastr.core.serializable.Serializable](#)

Class describing a job.

Arguments: tool_name - the name of the tool (str) tool_version - the version of the tool (Version) argument - the arguments used when calling the tool (list) tmpdir - temporary directory to use to store output data hold_jobs - list of jobs that need to finished before this job can run (list)

```
COMMAND_DUMP = '__fastr_command__.pickle.gz'
```

```
INFO_DUMP = '__fastr_extra_job_info__.json'
```

```
PROV_DUMP = '__fastr_prov__.json'
```

```
RESULT_DUMP = '__fastr_result__.pickle.gz'
```

```
STDERR_DUMP = '__fastr_stderr__.txt'
```

```
STDOUT_DUMP = '__fastr_stdout__.txt'
```

```
    __getstate__()
```

Get the state of the job

Returns job state

Return type dict

```
    __init__(node, sample_id, sample_index, input_arguments, output_arguments, hold_jobs=None, sta-
            tus_callback=None, preferred_types=None)
```

Create a job

Parameters

- **node** (*Node*) – the node the job is based on
- **sample_id** (*fastr.core.samples.SampleId*) – the id of the sample
- **sample_index** (*fastr.core.samples.SampleIndex*) – the index of the sample
- **input_arguments** (*list[dict]*) – the argument list
- **output_arguments** (*list[dict]*) – the argument list
- **hold_jobs** (*list[str]*) – the jobs on which this jobs depend
- **status_callback** (*callable*) – The callback to call when the status changed
- **preferred_types** – The list of preferred types to use

Returns

__module__ = 'fastr.execution.job'

__repr__ ()

String representation of the Job

__setstate__ (*state*)

Set the state of the job

Parameters *state* (*dict*) –

static calc_cardinality (*description*, *payload*)

commandfile

The path of the command pickle

commandurl

The url of the command pickle

create_payload ()

Create the payload for this object based on all the input/output arguments

Returns the payload

Return type *dict*

ensure_tmp_dir ()

execute ()

Execute this job

Returns The result of the execution

Return type *InterFaceResult*

extrainfofile

The path where the extra job info document is saved

extrainfourl

The url where the extra job info document is saved

classmethod fill_output_argument (*output_spec*, *cardinality*, *desired_type*, *requested*, *tmpurl*)

This is an abstract class method. The method should take the argument_dict generated from calling self.get_argument_dict() and turn it into a list of cmdline arguments that represent this Input/Output.

Parameters

- **cardinality** (*int*) – the cardinality for this output (can be non for automatic outputs)
- **desired_type** (*DataType*) – the desired datatype for this output

- **requested** (*bool*) – flag to indicate that the output is requested by Fastr

Returns the values for this output

Return type list

fullid

The full id of the job

get_deferred (*output_id, cardinality_nr, sample_id=None*)

Get a deferred pointing to a specific output value in the Job

Parameters

- **output_id** (*str*) – the output to select from
- **cardinality_nr** (*int*) – the index of the cardinality
- **sample_id** (*str*) – the sample id to select (optional)

Returns The deferred

get_output_datatype (*output_id*)

Get the datatype for a specific output

Parameters **output_id** (*str*) – the id of the output to get the datatype for

Returns the requested datatype

Return type *BaseDataType*

get_result ()

Get the result of the job if it is available. Load the output file if found and check if the job matches the current object. If so, load and return the result.

Returns Job after execution or None if not available

Return type Job | None

classmethod get_value (*value*)

Get a value

Parameters

- **value** – the url of the value
- **datatype** – datatype of the value

Returns the retrieved value

hash_inputs ()

Create hashes for all input values and store them in the info store

hash_results ()

Create hashes of all output values and store them in the info store

id

The id of this job

logfile

The path of the result pickle

logurl

The url of the result pickle

provfile

The path where the prov document is saved

provurl

The url where the prov document is saved

required_cores

Number of required cores

required_memory

Number of required memory

required_time

Number of required runtime

status

The status of the job

stderrfile

The path where the stderr text is saved

stderrurl

The url where the stderr text is saved

stdoutfile

The path where the stdout text is saved

stdouturl

The url where the stdout text is saved

tmpurl

The URL of the tmpdir to use

tool**classmethod translate_argument** (*value*)

Translate an argument from a URL to an actual path.

Parameters

- **value** – value to translate
- **datatype** – the datatype of the value

Returns the translated value

static translate_output_results (*value, datatype, preferred_type, mountpoint=None*)

Translate the results for on Output

Parameters

- **value** – the results value for the output
- **datatype** – the datatype of the output
- **preferred_type** – the preferred datatype of the output

Returns the update value for the result

translate_results (*result*)

Translate the results of an interface (using paths etc) to the proper form using URI's instead.

Parameters **result** (*dict*) – the result data of an interface

Returns the translated result

Return type *dict*

validate_results (*payload*)

Validate the results of the Job

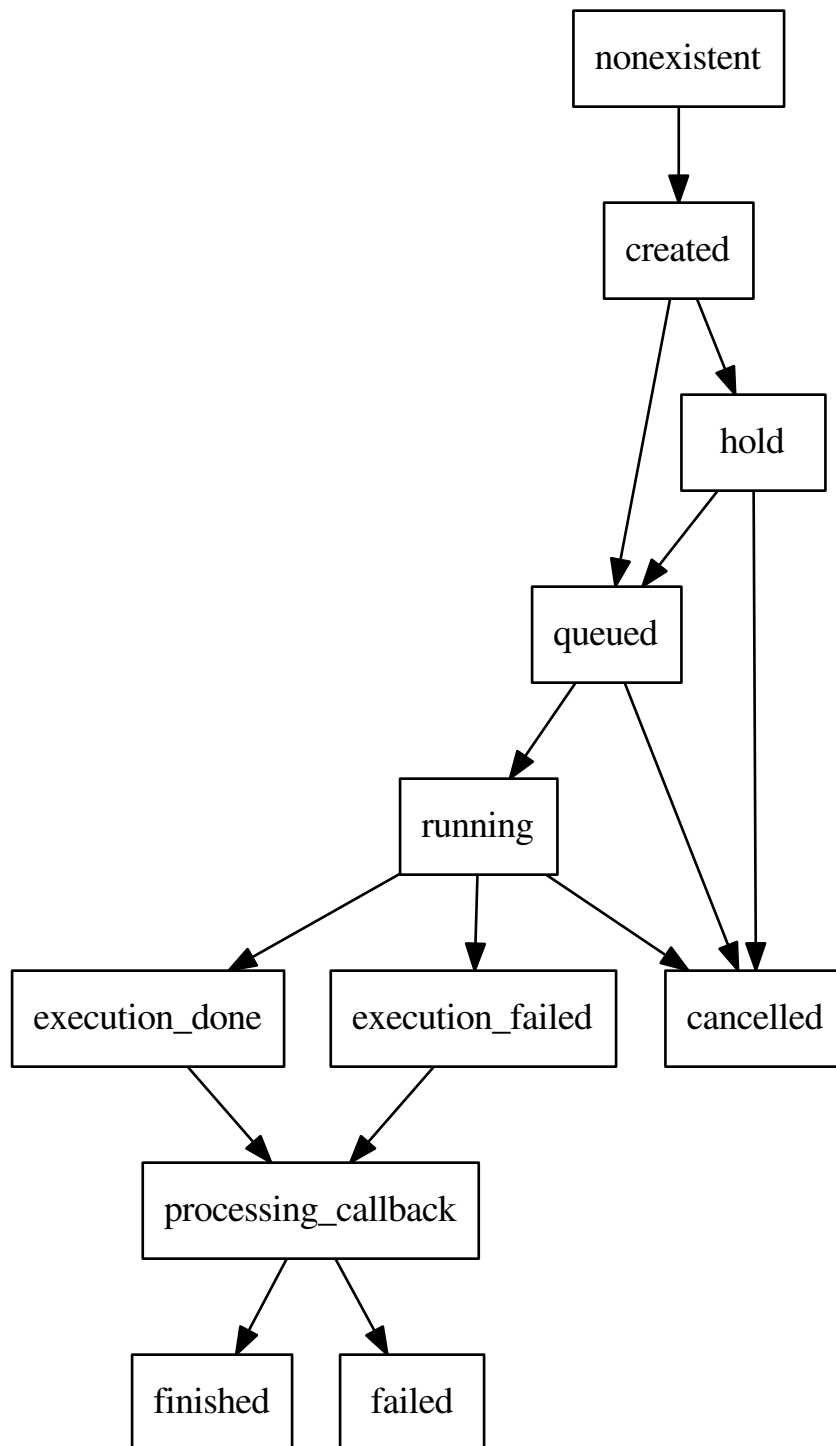
Returns flag indicating the results are complete and valid

write()

class `fastr.execution.job.JobState` (`_, stage, error`)

Bases: `enum.Enum`

The possible states a Job can be in. An overview of the states and the advised transitions are depicted in the following figure:



`__format__` (*format_spec*)

```
__init__ (_, stage, error)
__module__ = 'fastr.execution.job'
static __new__ (value)
__reduce_ex__ (proto)
__repr__ ()
__str__ ()
cancelled = ('cancelled', 'done', True)
created = ('created', 'idle', False)
done
execution_done = ('execution_done', 'in_progress', False)
execution_failed = ('execution_failed', 'in_progress', True)
failed = ('failed', 'done', True)
finished = ('finished', 'done', False)
hold = ('hold', 'idle', False)
idle
in_progress
nonexistent = ('nonexistent', 'idle', False)
processing_callback = ('processing_callback', 'in_progress', False)
queued = ('queued', 'idle', False)
running = ('running', 'in_progress', False)
class fastr.execution.job.SinkJob (node, sample_id, sample_index, input_arguments, out-
                                     put_arguments, hold_jobs=None, substitutions=None, sta-
                                     tus_callback=None, preferred_types=None)
    Bases: fastr.execution.job.Job
    Special SinkJob for the Sink
    __init__ (node, sample_id, sample_index, input_arguments, output_arguments, hold_jobs=None, sub-
              stitutions=None, status_callback=None, preferred_types=None)
    __module__ = 'fastr.execution.job'
    __repr__ ()
        String representation for the SinkJob
    create_payload ()
        Create the payload for this object based on all the input/output arguments
        Returns the payload
        Return type dict
    get_result ()
        Get the result of the job if it is available. Load the output file if found and check if the job matches the
        current object. If so, load and return the result.
        Returns Job after execution
```

hash_inputs ()

Create hashes for all input values and store them in the info store

id

The id of this job

substitute (*value*, *datatype=None*)

Substitute the special fields that can be used in a SinkJob.

Parameters

- **value** (*str*) – the value to substitute fields in
- **datatype** (*BaseDataType*) – the datatype for the value

Returns string with substitutions performed

Return type *str*

tmpurl

The URL of the tmpdir to use

validate_results (*payload*)

Validate the results of the SinkJob

Returns flag indicating the results are complete and valid

class `fastr.execution.job.SourceJob` (*node*, *sample_id*, *sample_index*, *input_arguments*, *output_arguments*, *hold_jobs=None*, *status_callback=None*, *preferred_types=None*)

Bases: `fastr.execution.job.Job`

Special SourceJob for the Source

__module__ = 'fastr.execution.job'

__repr__ ()

String representation for the SourceJob

get_output_datatype (*output_id*)

Get the datatype for a specific output

Parameters **output_id** (*str*) – the id of the output to get the datatype for

Returns the requested datatype

Return type *BaseDataType*

hash_inputs ()

Create hashes for all input values and store them in the info store

validate_results (*payload*)

Validate the results of the Job

Returns flag indicating the results are complete and valid

linkrun Module

The link module contain the Link class. This class represents the links in a network. These links lead from an output (BaseOutput) to an input (BaseInput) and indicate the desired data flow. Links are smart objects, in the sense that when you set their start or end point, they register themselves with the Input and Output. They do all the book keeping, so as long as you only set the source and target of the Link, the link should be valid.

Warning: Don't mess with the Link, Input and Output internals from other places. There will be a huge chances of breaking the network functionality!

class `fastr.execution.linkrun.LinkRun` (*link, parent=None*)

Bases: `fastr.core.updateable.Updateable`, `fastr.core.serializable.Serializable`

Class for linking outputs (*BaseOutput*) to inputs (*BaseInput*)

Examples:

```
>>> import fastr
>>> network = fastr.Network()
>>> link1 = network.create_link( n1.outputs['out1'], n2.inputs['in2'] )

link2 = Link()
link2.source = n1.outputs['out1']
link2.target = n2.inputs['in2']
```

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'Link.schema.json'

__eq__ (*other*)

Test for equality between two Links

Parameters *other* (`LinkRun`) – object to test against

Returns True for equality, False otherwise

Return type `bool`

__getitem__ (*index*)

Get a an item for this Link. The item will be retrieved from the connected output, but a diverging or converging flow can change the number of samples/cardinality.

Parameters *index* (`SampleIndex`) – index of the item to retrieve

Returns the requested item

Return type `SampleItem`

Raises `FastrIndexError` – if the index length does not match the number dimensions in the source data (after collapsing/expanding)

__getstate__ ()

Retrieve the state of the Link

Returns the state of the object

Rtype `dict`

__init__ (*link, parent=None*)

Create a new Link in a Network.

Parameters

- **link** (`Link`) – the base link
- **parent** (`Network` or `None`) – the parent network, if `None` is given the `fastr.current_network` is assumed to be the parent

Returns newly created `LinkRun`

Raises

- **FastrValueError** – if parent is not given and *fastr.current_network* is not set
- **FastrValueError** – if the source output is not in the same network as the Link
- **FastrValueError** – if the target input is not in the same network as the Link

__module__ = 'fastr.execution.linkrun'

__repr__ ()

Get a string representation for the Link

Returns the string representation

Return type `str`

__setstate__ (*state*)

Set the state of the Link by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

Raises **FastrValueError** – if the parent network and *fastr.current_network* are not set

cardinality (*index=None*)

Cardinality for a Link is given by source Output and the collapse/expand settings

Parameters **key** (*SampleIndex*) – key for a specific sample (can be only a sample index!)

Returns the cardinality

Return type `int`, `sympy.Symbol`

Raises **FastrIndexError** – if the index length does not match the number of dimension in the data

collapse

The converging dimensions of this link. Collapsing changes some dimensions of sample lists into cardinality, reshaping the data.

Collapse can be set to a tuple or an int/str, in which case it will be automatically wrapped in a tuple. The int will be seen as indices of the dimensions to collapse. The str will be seen as the name of the dimensions over which to collapse.

Raises **FastrTypeError** – if assigning a collapse value of a wrong type

collapse_indexes

The converging dimensions of this link as integers. Dimension names are replaces with the corresponding int.

Collapsing changes some dimensions of sample lists into cardinality, reshaping the data

classmethod createobj (*state, network=None*)

Create object function for Link

Parameters

- **cls** – The class to create
- **state** – The state to use to create the Link
- **network** – the parent Network

Returns newly created Link

destroy()

The destroy function of a link removes all default references to a link. This means the references in the network, input and output connected to this link. If there is no references in other places in the code, it will destroy the link (reference count dropping to zero).

This function is called when a source for an input is set to another value and the links becomes disconnected. This makes sure there is no dangling links.

dimensions

The dimensions of the data delivered by the link. This can be different from the source dimensions because the link can make data collapse or expand.

expand

Flag indicating that the link will expand the cardinality into a new sample dimension to be created.

fullid

The full defining ID for the Input

parent

The Network to which this Link belongs.

size

The size of the data delivered by the link. This can be different from the source size because the link can make data collapse or expand.

source

The source *BaseOutput* of the Link. Setting the source will automatically register the Link with the source BaseOutput. Updating source will also make sure the Link is unregistered with the previous source.

Raises *FastrTypeError* – if assigning a non *BaseOutput*

status**target**

The target *BaseInput* of the Link. Setting the target will automatically register the Link with the target BaseInput. Updating target will also make sure the Link is unregistered with the previous target.

Raises *FastrTypeError* – if assigning a non *BaseInput*

macronoderun Module

```
class fastr.execution.macronoderun.MacroNodeRun (node, parent)
```

Bases: *fastr.execution.noderun.NodeRun*

MacroNodeRun encapsulates an entire network in a single node.

```
__abstractmethods__ = frozenset([])
```

```
__getstate__ ()
```

Retrieve the state of the MacroNodeRun

Returns the state of the object

Rtype dict

```
__init__ (node, parent)
```

Parameters *network* (*Network*) – network to create macronode for

```
__module__ = 'fastr.execution.macronoderun'
```

```
__setstate__ (state)
```



```

execute ()
get_output_info (output)
network_run

```

networkanalyzer Module

Module that defines the NetworkAnalyzer and holds the reference implementation.

```

class fastr.execution.networkanalyzer.DefaultNetworkAnalyzer
    Bases: fastr.execution.networkanalyzer.NetworkAnalyzer

```

Default implementation of the NetworkAnalyzer.

```
__module__ = 'fastr.execution.networkanalyzer'
```

```
analyze_network (network, chunk)
```

Analyze a chunk of a Network. Simply process the Nodes in the chunk sequentially.

Parameters

- **network** – Network corresponding with the chunk
- **chunk** – The chunk of the network to analyze

```

class fastr.execution.networkanalyzer.NetworkAnalyzer
    Bases: object

```

Base class for NetworkAnalyzers

```
__dict__ = dict_proxy({'__dict__': <attribute '__dict__' of 'NetworkAnalyzer' objects>, '__weakref__': <attribute '__weakref__' of 'NetworkAnalyzer' objects>})
```

```
__module__ = 'fastr.execution.networkanalyzer'
```

```
__weakref__
```

list of weak references to the object (if defined)

```
analyze_network (network, chunk)
```

Analyze a chunk of a Network.

Parameters

- **network** – Network corresponding with the chunk
- **chunk** – The chunk of the network to analyze

networkchunker Module

This module contains the NetworkChunker class and its default implementation the DefaultNetworkChunker

```

class fastr.execution.networkchunker.DefaultNetworkChunker
    Bases: fastr.execution.networkchunker.NetworkChunker

```

The default implementation of the NetworkChunker. It tries to create as large as possible chunks so the execution blocks as little as possible.

```
__init__ ()
```

```
__module__ = 'fastr.execution.networkchunker'
```

chunk_network (*network*)

Create a list of Network chunks that can be pre-analyzed completely. Each chunk needs to be executed before the next can be analyzed and executed.

The returned chunks are (at the moment) in the format of a tuple (start, nodes) which are both tuples. The tuple contain the nodes where to start execution (should ready if previous chunks are done) and all nodes of the chunk respectively.

Parameters **network** – Network to split into chunks

Returns tuple containing chunks

class `fastr.execution.networkchunker.NetworkChunker`

Bases: `object`

The base class for NetworkChunkers. A Network chunker is a class that takes a Network and produces a list of chunks that can each be analyzed and executed in one go.

`__dict__` = `dict_proxy({ '__dict__': <attribute '__dict__' of 'NetworkChunker' objects>, '__module__': 'fastr.execution`

`__module__` = `'fastr.execution.networkchunker'`

`__weakref__`

list of weak references to the object (if defined)

chunk_network (*network*)

Create a list of Network chunks that can be pre-analyzed completely. Each chunk needs to be executed before the next can be analyzed and executed.

Parameters **network** – Network to split into chunks

Returns list containing chunks

networkrun Module

Network module containing Network facilitators and analysers.

class `fastr.execution.networkrun.NetworkRun` (*network*)

Bases: `fastr.core.serializable.Serializable`

The Network class represents a workflow. This includes all Nodes (including ConstantNodes, SourceNodes and Sinks) and Links.

`NETWORK_DUMP_FILE_NAME` = `'__fastr_network__.json'`

`SINK_DUMP_FILE_NAME` = `'__sink_data__.json'`

`SOURCE_DUMP_FILE_NAME` = `'__source_data__.pickle.gz'`

`__eq__` (*other*)

Compare two Networks and see if they are equal.

Parameters **other** (*Network*) –

Returns flag indicating that the Networks are the same

Return type `bool`

`__getitem__` (*item*)

Get an item by its fullid. The fullid can point to a link, node, input, output or even subinput/suboutput.

Parameters **item** (*str, unicode*) – fullid of the item to retrieve

Returns the requested item

__getstate__()
Retrieve the state of the Network

Returns the state of the object

Rtype dict

__init__(network)
Create a new, empty Network

Parameters **name** (*str*) – name of the Network

Returns newly created Network

Raises **OSError** – if the tmp mount in the fastr.config is not a writable directory

__module__ = 'fastr.execution.networkrun'

__ne__(other)
Tests for non-equality, this is the negated version **__eq__**

__repr__()

__setstate__(state)
Set the state of the Network by the given state. This completely overwrites the old state!

Parameters **state** (*dict*) – The state to populate the object with

Returns None

abort()

check_id(id_)
Check if an id for an object is valid and unused in the Network. The method will always returns True if it does not raise an exception.

Parameters **id** (*str*) – the id to check

Returns True

Raises

- **FastrValueError** – if the id is not correctly formatted
- **FastrValueError** – if the id is already in use

constantlist

execute(sourcedata, sinkdata, execution_plugin=None, tmpdir=None, cluster_queue=None)
Execute the Network with the given data. This will analyze the Network, create jobs and send them to the execution backend of the system.

Parameters

- **sourcedata** (*dict*) – dictionary containing all data for the sources
- **sinkdata** (*dict*) – dictionary containing directives for the sinks
- **execution_plugin** (*str*) – the execution plugin to use (None will use the config value)

Raises

- **FastrKeyError** – if a source has not corresponding key in sourcedata
- **FastrKeyError** – if a sink has not corresponding key in sinkdata

fullid

The fullid of the Network

generate_jobs ()

global_id

The global id of the Network, this is different for networks used in macronodes, as they still have parents.

id

The id of the Network. This is a read only property.

job_finished (*job*, *execution_interface*)

Call-back handler for when a job is finished. Will collect the results and handle blocking jobs. This function is automatically called when the execution plugin finished a job.

Parameters *job* (*Job*) – the job that finished

job_finished_callback

job_status_callback

long_id

network

nodegroups

Give an overview of the nodegroups in the network

set_data (*sourcedata*, *sinkdata*)

sinklist

sourcelist

noderun Module

A module to maintain a run of a network node.

class `fastr.execution.noderun.NodeRun` (*node*, *parent*)

Bases: `fastr.core.updateable.Updateable`, `fastr.core.serializable.Serializable`

The class encapsulating a node in the network. The node is responsible for setting and checking inputs and outputs based on the description provided by a tool instance.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'NodeRun.schema.json'

__eq__ (*other*)

Compare two Node instances with each other. This function ignores the parent and update status, but tests rest of the dict for equality. equality

Parameters *other* (*NodeRun*) – the other instances to compare to

Returns True if equal, False otherwise

__getstate__ ()

Retrieve the state of the NodeRun

Returns the state of the object

Rtype dict

__init__ (*node*, *parent*)

Instantiate a node.

Parameters

- **node** (`Tool`) – The node to base the noderun on
- **parent** (`Network`) – the parent network of the node

Returns the newly created NodeRun

__metaclass__

alias of ABCMeta

__module__ = 'fastr.execution.noderun'

__repr__ ()

Get a string representation for the NodeRun

Returns the string representation

Return type `str`

__setstate__ (*state*)

Set the state of the NodeRun by the given state.

Parameters **state** (*dict*) – The state to populate the object with

Returns None

__str__ ()

Get a string version for the NodeRun

Returns the string version

Return type `str`

blocking

Indicate that the results of this NodeRun cannot be determined without first executing the NodeRun, causing a blockage in the creation of jobs. A blocking Nodes causes the Chunk borders.

create_job (*sample_id*, *sample_index*, *job_data*, *job_dependencies*, ***kwargs*)

Create a job based on the sample id, job data and job dependencies.

Parameters

- **sample_id** (`SampleId`) – the id of the corresponding sample
- **sample_index** (`SampleIndex`) – the index of the corresponding sample
- **job_data** (*dict*) – dictionary containing all input data for the job
- **job_dependencies** – other jobs that need to finish before this job can run

Returns the created job

Return type `Job`

classmethod createobj (*state*, *network=None*)

dimnames

Names of the dimensions in the NodeRun output. These will be reflected in the SampleIdList of this NodeRun.

execute ()

Execute the node and create the jobs that need to run

Returns list of jobs to run

Return type list of `Jobs`

find_source_index (*target_index, target, source*)

fullid

The full defining ID for the NodeRun inside the network

get_sourced_nodes ()

A list of all Nodes connected as sources to this NodeRun

Returns list of all nodes that are connected to an input of this node

global_id

The global defining ID for the Node from the main network (goes out of macro nodes to root network)

id

The id of the NodeRun

input_groups

A list of input groups for this NodeRun. An input group is InputGroup object filled according to the NodeRun

listeners

All the listeners requesting output of this node, this means the listeners of all Outputs and SubOutputs

merge_dimensions

name

Name of the Tool the NodeRun was based on. In case a Toolless NodeRun was used the class name is given.

outputsize

Size of the outputs in this NodeRun

parent

The parent network of this node.

required_cores

Number of cores required for the execution of this NodeRun

required_memory

Amount of memory required for the execution of this NodeRun. Follows the format d+[mMgG] so 500M or 4g would be valid ways to specify 500 megabytes or 4 gigabyte of memory.

required_time

Amount of time required for the execution of this NodeRun. Follows the format of a number of second or H:M:S, with H the number of hours, M the number of minutes and S the number of seconds.

set_result (*job, failed_annotation*)

Incorporate result of a job into the NodeRun.

Parameters

- **job** (*Type*) – job of which the result to store
- **failed_annotation** – A set of annotations, None if no errors else containing a tuple describing the errors

status

tool

update_input_groups ()

Update all input groups in this node

sinknoderun Module

class `fastr.execution.sinknoderun.SinkNodeRun` (*node*, *parent*)

Bases: `fastr.execution.noderun.NodeRun`

Class which handles where the output goes. This can be any kind of file, e.g. image files, textfiles, config files, etc.

`__abstractmethods__` = `frozenset([])`

`__dataschemafile__` = 'SinkNodeRun.schema.json'

`__getstate__` ()

`__init__` (*node*, *parent*)

Instantiation of the SinkNodeRun.

Parameters

- **node** (`Node`) – The Node that this Run is based on.
- **parent** (`NetworkRun`) – The NetworkRun that this NodeRun belongs to

Returns newly created sink node run

`__module__` = 'fastr.execution.sinknoderun'

`__setstate__` (*state*)

create_job (*sample_id*, *sample_index*, *job_data*, *job_dependencies*, ***kwargs*)

Create a job for a sink based on the sample id, job data and job dependencies.

Parameters

- **sample_id** (`SampleId`) – the id of the corresponding sample
- **job_data** (*dict*) – dictionary containing all input data for the job
- **job_dependencies** – other jobs that need to finish before this job can run

Returns the created job

Return type `Job`

datatype

The datatype of the data this sink can store.

execute ()

Execute the sink node and create the jobs that need to run

Returns list of jobs to run

Return type list of `Jobs`

input

The default input of the sink NodeRun

set_data (*data*)

Set the targets of this sink node.

Parameters **data** (*dict* or *list of urls*) – the targets rules for where to write the data

The target rules can include a few fields that can be filled out:

field	description
sample_id	the sample id of the sample written in string form
cardinality	the cardinality of the sample written
ext	the extension of the datatype of the written data, including the .
extension	the extension of the datatype of the written data, excluding the .
network	the id of the network the sink is part of
node	the id of the node of the sink
timestamp	the iso formatted datetime the network execution started
uuid	the uuid of the network run (generated using uuid.uuid1)

An example of a valid target could be:

```
>>> target = 'vfs://output_mnt/some/path/image_{sample_id}_{cardinality}{ext}'
```

Note: The {ext} and {extension} are very similar but are both offered. In many cases having a name.{extension} will feel like the correct way to do it. However, if you have DataTypes with and without extension that can both exported by the same sink, this would cause either name.ext or name. to be generated. In this particular case name{ext} can help as it will create either name.ext or name.

set_result (*job*, *failed_annotation*)

Incorporate result of a sink job into the Network.

Parameters

- **job** (*Type*) – job of which the result to store
- **failed_annotation** (*set*) – A set of annotations, None if no errors else containing a tuple describing the errors

sourcenoderun Module

class `fastr.execution.sourcenoderun.SourceNodeRun` (*node*, *parent*)

Bases: `fastr.execution.flownoderun.FlowNodeRun`

Class providing a connection to data resources. This can be any kind of file, stream, database, etc from which data can be received.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'SourceNodeRun.schema.json'

__eq__ (*other*)

Compare two Node instances with each other. This function ignores the parent and update status, but tests rest of the dict for equality. equality

Parameters *other* (`NodeRun`) – the other instances to compare to

Returns True if equal, False otherwise

__getstate__ ()

Retrieve the state of the SourceNodeRun

Returns the state of the object

Rtype dict

__init__ (*node*, *parent*)

Instantiation of the SourceNodeRun.

Parameters

- **node** (*Node*) – The Node that this Run is based on.
- **parent** (*NetworkRun*) – The NetworkRun that this NodeRun belongs to

Returns newly created sink node run

__module__ = 'fastr.execution.sourcenoderun'

__setstate__ (*state*)

Set the state of the SourceNodeRun by the given state.

Parameters *state* (*dict*) – The state to populate the object with

Returns None

create_job (*sample_id*, *sample_index*, *job_data*, *job_dependencies*, ***kwargs*)

datatype

The datatype of the data this source supplies.

dimnames

Names of the dimensions in the SourceNodeRun output. These will be reflected in the SampleIdLists.

execute ()

Execute the source node and create the jobs that need to run

Returns list of jobs to run

Return type list of *Jobs*

output

Shorthand for `self.outputs['output']`

outputsize

The size of output of this SourceNodeRun

set_data (*data*, *ids=None*)

Set the data of this source node.

Parameters

- **data** (*dict*, *OrderedDict* or *list of urls*) – the data to use
- **ids** – if data is a list, a list of accompanying ids

sourcegroup

valid

This does nothing. It only overloads the valid method of NodeRun(). The original is intended to check if the inputs are connected to some output. Since this class does not implement inputs, it is skipped.

class `fastr.execution.sourcenoderun.ConstantNodeRun` (*node*, *parent*)

Bases: `fastr.execution.sourcenoderun.SourceNodeRun`

Class encapsulating one output for which a value can be set. For example used to set a scalar value to the input of a node.

__abstractmethods__ = frozenset([])

__dataschemafile__ = 'ConstantNodeRun.schema.json'

__getstate__ ()

Retrieve the state of the ConstantNodeRun

Returns the state of the object

Rtype dict**__init__** (*node, parent*)

Instantiation of the ConstantNodeRun.

Parameters

- **datatype** – The datatype of the output.
- **data** – the prefilled data to use.
- **id** – The url pattern.

This class should never be instantiated directly (unless you know what you are doing). Instead create a constant using the network class like shown in the usage example below.

usage example:

```
>>> import fastr
>>> network = fastr.Network()
>>> source = network.create_source(datatype=fastr.typelist['ITKImageFile'],
↳ id_='sourceN')
```

or alternatively create a constant node by assigning data to an item in an InputDict:

```
>>> node_a.inputs['in'] = ['some', 'data']
```

which automatically creates and links a ConstantNodeRun to the specified Input

__module__ = 'fastr.execution.sourcenoderun'**__setstate__** (*state*)

Set the state of the ConstantNodeRun by the given state.

Parameters *state* (*dict*) – The state to populate the object with**Returns** None**data**

The data stored in this constant node

execute ()

Execute the constant node and create the jobs that need to run

Returns list of jobs to run**Return type** list of *Jobs***set_data** (*data=None, ids=None*)

Set the data of this constant node in the correct way. This is mainly for compatibility with the parent class SourceNodeRun

Parameters

- **data** (*dict or list of urls*) – the data to use
- **ids** – if data is a list, a list of accompanying ids

resources Package**resources Package**

Subpackages

`datatypes` Package

`datatypes` Package

`AnalyzeImageFile` Module

`Boolean` Module

`Directory` Module

`FilePrefix` Module

`Float` Module

`ITKImageFile` Module

`Int` Module

`JsonFile` Module

`MetaImageFile` Module

`NiftiImageFile` Module

`NiftiImageFileCompressed` Module

`NiftiImageFileUncompressed` Module

`Number` Module

`ProvNFile` Module

`String` Module

`TifImageFile` Module

`TxtFile` Module

`UnsignedInt` Module

`tools` Package

`tools` Package

Subpackages

fastr Package

Subpackages

util Package

Subpackages

0.1 Package

Subpackages

bin Package

auto_prefix Module

auto_prefix_negate Module

delay Module

fail Module

passthroughauto Module

range Module

stdout Module

test Package

test Package

testdatatypes Module

utils Package

utils Package

A collections of utils for fastr (command line tools or non-core functionality)

checksum Module

This module contains a number of functions for checksumming files and objects

`fastr.utils.checksum.checksum(filepath, algorithm='md5', hasher=None)`

Generate the checksum of a file

Parameters

- **filepath** (*str*, *list*) – path of the file(s) to checksum
- **algorithm** (*str*) – the algorithm to use
- **hasher** (`_hashlib.HASH`) – a hasher to continue updating (rather than creating a new one)

Returns the checksum

Return type *str*

`fastr.utils.checksum.checksum_directory(directory, algorithm='md5', hasher=None)`

Generate the checksum of an entire directory

Parameters

- **directory** (*str*) – path of the file(s) to checksum
- **algorithm** (*str*) – the algorithm to use
- **hasher** (`_hashlib.HASH`) – a hasher to continue updating (rather than creating a new one)

Returns the checksum

Return type *str*

`fastr.utils.checksum.hashsum(objects, hasher=None)`

Generate the md5 checksum of (a) python object(s)

Parameters

- **objects** – the objects to hash
- **hasher** – the hasher to use as a base

Returns the hash generated

Return type *str*

`fastr.utils.checksum.md5_checksum(filepath)`

Generate the md5 checksum of a file

Parameters **filepath** (*str*, *list*) – path of the file(s) to checksum

Returns the checksum

Return type *str*

`fastr.utils.checksum.sha1_checksum(filepath)`

Generate the sha1 checksum of a file

Parameters **filepath** (*str*, *list*) – path of the file(s) to checksum

Returns the checksum

Return type *str*

classproperty Module

Module containing the code to create class properties.

class `fastr.utils.classproperty.ClassPropertyDescriptor` (*fget*)

Bases: `object`

A descriptor that can act like a property for a class.

`__dict__` = `dict_proxy`({'`__module__`': 'fastr.utils.classproperty', '`__dict__`': <attribute '`__dict__`' of '`ClassPropertyDescriptor`'>})

`__get__` (*obj, cls=None*)

`__init__` (*fget*)

`__module__` = 'fastr.utils.classproperty'

`__weakref__`

list of weak references to the object (if defined)

`fastr.utils.classproperty.classproperty` (*func*)

Decorator to create a “class property”

Parameters `func` – the function to wrap

Returns a class property

Return type `ClassPropertyDescriptor`

clear_pycs Module

A small tool to wipe all .pyc files from fastr

`fastr.utils.clear_pycs.dir_list` (*directory*)

Find all .pyc files

Parameters `directory` (*str*) – directory to search

Returns all .pyc files

Return type list

`fastr.utils.clear_pycs.main` ()

Main entry point

compare Module

Module to compare various fastr specific things such as a execution directory or a reference directory.

`fastr.utils.compare.compare_execution_dir` (*path1, path2*)

`fastr.utils.compare.compare_job_dirs` (*sample, node, node_dir1, node_dir2*)

`fastr.utils.compare.compare_job_output_data` (*output, job1, job2*)

`fastr.utils.compare.compare_set` (*set1, set2, path, sub_compare_func, f_args=None, f_kwargs=None*)

Compare two sets and dispatch each item to a sub comparison function

Parameters

- **set1** (*Iterable*) – first set of items

- **set2** (*Iterable*) – second set of items
- **path** (*str*) – identifier of the data location
- **sub_compare_func** – function to apply to items
- **f_args** – args to pass to sub_compare_func
- **f_kwargs** – kwargs to pass to sub_compare_func

Returns generator that iterates over the differences

Return type generator

```
fastr.utils.compare.compare_value_dict_item(key, data1, data2, path)
```

```
fastr.utils.compare.compare_value_list(data1, data2, path, key=None)
```

dicteq Module

Some helper function to compare dictionaries and find the parts of the dict that are different. This is mostly to help in debugging.

```
fastr.utils.dicteq.dicteq(self, other)
```

Compare two dicts for equality

Parameters

- **self** – the first object to compare
- **other** – the oth

Returns

```
fastr.utils.dicteq.diffdict(self, other, path=None, visited=None)
```

Find the differences in two dictionaries.

Parameters

- **self** – the first object to compare
- **other** (*dict*) – other dictionary
- **path** (*list*) – the path for nested dicts (too keep track of recursion)

Returns list of messages indicating the differences

Return type list

```
fastr.utils.dicteq.diffobj(self, other, path=None, visited=None)
```

Compare two objects by comparing their `__dict__` entries

Parameters

- **self** – the first object to compare
- **other** – other objects to compare
- **path** (*list*) – the path for nested dicts (too keep track of recursion)

Returns list of messages

Return type list

```
fastr.utils.dicteq.diffobj_str(self, other)
```

Compare two objects by comparing their `__dict__` entries, but returns the differences in a single string ready for logging.

Parameters

- **self** – the first object to compare
- **other** – other object to compare to

Returns the description of the differences

Return type `str`

filesynchelper Module

Some helper functions that aid with NFS file sync issues.

class `fastr.utils.filesynchelper.FileSyncHelper`

```
__init__()  
__module__ = 'fastr.utils.filesynchelper'  
has_file_promise(url)  
job_finished(jobfile)  
load(url)  
make_file_promise(url)  
store(url, data)  
wait_for_file(path, timeout=300)  
wait_for_job(jobfile)  
wait_for_pickle(url, timeout=300)  
wait_for_vfs_url(vfs_url, timeout=300)
```

`fastr.utils.filesynchelper.filesynchelper_enabled()`

gettools Module

`fastr.utils.gettools.main()`

iohelpers Module

```
fastr.utils.iohelpers.load_gpickle(path, retry_scheme=None)  
fastr.utils.iohelpers.load_json(path)  
fastr.utils.iohelpers.save_gpickle(path, data)  
fastr.utils.iohelpers.save_json(path, data, indent=2)
```


jsonschemaresolver Module

The JSON schema parser validates a json data structure and if possible casts data to the correct type and fills out default values. The result is a valid document that can be used to construct objects.

class `fastr.utils.jsonschemaresolver.FastrRefResolver` (*base_uri*, *referrer*, *store*=(), *cache_remote*=True, *handlers*=())

Bases: `jsonschema.validators.RefResolver`

Adapted version of the RefResolver for handling inter-file references more to our liking

__init__ (*base_uri*, *referrer*, *store*=(), *cache_remote*=True, *handlers*=())

Create a new FastrRefResolver

Parameters

- **base_uri** (*str*) – URI of the referring document
- **referrer** – the actual referring document
- **store** (*dict*) – a mapping from URIs to documents to cache
- **cache_remote** (*bool*) – whether remote refs should be cached after first resolution
- **handlers** (*dict*) – a mapping from URI schemes to functions that should be used to retrieve them

__module__ = 'fastr.utils.jsonschemaresolver'

classmethod from_schema (*schema*, **args*, ***kwargs*)

Instantiate a RefResolver based on a schema

static readfastrschema (*name*)

Open a json file based on a fastr:// url that points to a file in the fastr.schemadir

Parameters **name** (*str*) – the url of the file to open

Returns the resulting json schema data

static readfile (*filename*)

Open a json file based on a simple filename

Parameters **filename** (*str*) – the path of the file to read

Returns the resulting json schema data

`fastr.utils.jsonschemaresolver.any_of_draft4` (*validator*, *any_of*, *instance*, *schema*)

The oneOf directory needs to be done stepwise, because a validation even if it fails will try to change types / set defaults etc. Therefore we first create a copy of the data per subschema and test if they match. Then for all the schemas that are valid, we perform the validation on the actual data so that only the valid subschemas will effect the data.

Parameters

- **validator** – the json schema validator
- **any_of** (*dict*) – the current oneOf
- **instance** – the current object instance
- **schema** (*dict*) – the current json schema

`fastr.utils.jsonschemaresolver.extend` (*validator_cls*)

Extend the given jsonschema.Validator with the Seep layer.

`fastr.utils.jsonschemaparser.getblueprinter(uri, blueprint=None)`

Instantiate the given data using the blueprinter.

Parameters `blueprint` – a blueprint (JSON Schema with Seep properties)

`fastr.utils.jsonschemaparser.items_prevalidate(validator, items, instance, schema)`

The pre-validation function for items

Parameters

- **validator** – the json schema validator
- **items** (*dict*) – the current items
- **instance** – the current object instance
- **schema** (*dict*) – the current json schema

`fastr.utils.jsonschemaparser.not_draft4(validator, not_schema, instance, schema)`

The not needs to use a temporary copy of the instance, not to change the instance with the invalid schema

Parameters

- **validator** – the json schema validator
- **not_schema** (*dict*) – the current oneOf
- **instance** – the current object instance
- **schema** (*dict*) – the current json schema

`fastr.utils.jsonschemaparser.one_of_draft4(validator, one_of, instance, schema)`

The one_of directory needs to be done stepwise, because a validation even if it fails will try to change types / set defaults etc. Therefore we first create a copy of the data per subschema and test if they match. Once we found a proper match, we only validate that branch on the real data so that only the valid piece of schema will effect the data.

Parameters

- **validator** – the json schema validator
- **one_of** (*dict*) – the current one_of
- **instance** – the current object instance
- **schema** (*dict*) – the current json schema

`fastr.utils.jsonschemaparser.pattern_properties_prevalid(validator, pattern_properties, instance, schema)`

The pre-validation function for patternProperties

Parameters

- **validator** – the json schema validator
- **pattern_properties** (*dict*) – the current patternProperties
- **instance** (*dict*) – the current object instance
- **schema** (*dict*) – the current json schema

`fastr.utils.jsonschemaparser.properties_postvalidate(validator, properties, instance, schema)`

All arguments must be used because this function is called like this # pylint: disable=unused-argument The post-validation function for properties

Parameters

- **validator** – the json schema validator
- **properties** (*dict*) – the current properties
- **instance** – the current object instance
- **schema** (*dict*) – the current json schema

`fastr.utils.jsonschemaparser.properties_prevalidate` (*validator*, *properties*, *instance*, *schema*)

The pre-validation function for properties

Parameters

- **validator** – the json schema validator
- **properties** (*dict*) – the current properties
- **instance** – the current object instance
- **schema** (*dict*) – the current json schema

multiprocesswrapper Module

`fastr.utils.multiprocesswrapper.function_wrapper` (*filepath*, *fnc_name*, **args*, ***kwargs*)

pim_publisher Module

`class fastr.utils.pim_publisher.PimPublisher` (*uri=None*)

Bases: `object`

Class to publish to PIM

PIM_STATUS_MAPPING = {<JobState.execution_done: ('execution_done', 'in_progress', False)>: 'running', <JobState.n

__dict__ = dict_proxy({'__dict__': <attribute '__dict__' of 'PimPublisher' objects>, '__module__': 'fastr.utils.pim_pul

__init__ (*uri=None*)

__module__ = 'fastr.utils.pim_publisher'

__weakref__

list of weak references to the object (if defined)

pim_register_run (*network*)

pim_serialize_network (*network*, *scope=None*, *network_data=None*)

Serialize Network in the correct for to use with PIM.

Returns json data for PIM

pim_update_status (*network_run*, *job*)

procutils Module

`fastr.utils.procutils.which` (*name*)

Find executable by name on the PATH, returns the executable that will be found in case it is used for a Popen call

rest_generation Module

`fastr.utils.rest_generation.create_rest_table(data, headers)`

Create a ReST table from data. The data should be a list of columns and the headers should be a list of column names.

Parameters

- **data** (*list*) – List of lists/tuples representing the columns
- **headers** (*list*) – List of strings for the column names

Returns a string representing the table in ReST

Return type `str`

schematotable Module

A module to generate reStructuredText tables from json schema files

`class fastr.utils.schematotable.SchemaPrinter(schema, skipfirst=False)`

Bases: `object`

Object that create a table in reStructuredText from a json schema

`__dict__ = dict_proxy({'parse': <function parse>, '__module__': 'fastr.utils.schematotable', 'descend': <function descend>})`

`__init__(schema, skipfirst=False)`

Create the printer object

Parameters

- **schema** (*dict*) – the json schema to print
- **skipfirst** (*bool*) – flag to indicate that the first line should not be printed

`__module__ = 'fastr.utils.schematotable'`

`__str__()`

String representation of json schema (that is the printed table)

`__weakref__`

list of weak references to the object (if defined)

`descend(properties)`

Descend into a subschema

Parameters **properties** (*dict*) – the properties in the subschema

`parse(schema=None)`

Parse a schema

Parameters **schema** (*dict*) – the schema to parse

`printlines()`

Given a parsed schema (parsing happens when the object is constructed), print all the lines

Returns the printed table

Return type `str`

sysinfo Module

This module contains function to help gather system information use for the provenance of the Job execution.

```
fastr.utils.sysinfo.get_cpu_usage()
```

Get the current CPU usage

Returns CPU usage info

Return type dict

```
fastr.utils.sysinfo.get_drmaa_info()
```

Get information about the SGE cluster (if applicable)

Returns cluster info

Return type dict

```
fastr.utils.sysinfo.get_hostinfo()
```

Get all information about the current host machine

Returns host info

Return type dict

```
fastr.utils.sysinfo.get_memory_usage()
```

Get the current memory usage

Returns memory usage info

Return type dict

```
fastr.utils.sysinfo.get_mounts()
```

Get the current mounts known on the system

Returns mount info

Return type dict

```
fastr.utils.sysinfo.get_os()
```

Get information about the OS

Returns OS information

Return type dict

```
fastr.utils.sysinfo.get_processes()
```

Get a list of all currently running processes

Returns process information

Return type list

```
fastr.utils.sysinfo.get_python()
```

Get information about the currently used Python implementation

Returns python info

Return type dict

```
fastr.utils.sysinfo.get_sysinfo()
```

Get system information (cpu, memory, mounts and users)

Returns system information

Return type dict

`fastr.utils.sysinfo.get_users()`

Get current users on the system

Returns user info

Return type `dict`

`fastr.utils.sysinfo.namedtuple_to_dict(ntuple)`

Helper function to convert a named tuple into a dict

Parameters `ntuple` (*namedtuple*) – the namedtuple to convert

Returns named tuple as a dict

Return type `dict`

verify Module

`fastr.utils.verify.verify_resource_loading(filename)`

`fastr.utils.verify.verify_tool(filename)`

Verify that a file

xmltodict Module

This module contains tool for converting python dictionaries into XML object and vice-versa.

`fastr.utils.xmltodict.dump(data, filehandle)`

Write a dict to an XML file

Parameters

- **data** – data to write
- **filehandle** – file handle to write to

`fastr.utils.xmltodict.dumps(data)`

Write a dict to an XML string

Parameters **data** – data to write

Returns the XML data

Return type `str`

`fastr.utils.xmltodict.load(filehandle)`

Load an xml file and parse it to a dict

Parameters **filehandle** – file handle to load

Returns the parsed data

`fastr.utils.xmltodict.loads(data)`

Load an xml string and parse it to a dict

Parameters **data** (*str*) – the xml data to load

Returns the parsed data

Subpackages

cmd Package

cmd Package

```
fastr.utils.cmd.add_parser_doc_link(parser, filepath)
fastr.utils.cmd.find_commands()
fastr.utils.cmd.get_command_module(command)
fastr.utils.cmd.main()
fastr.utils.cmd.print_help(commands=None)
```

cat Module

```
fastr.utils.cmd.cat.fastr_cat(infile, path)
fastr.utils.cmd.cat.get_parser()
fastr.utils.cmd.cat.main()
    Print information from a job file
```

dump Module

```
fastr.utils.cmd.dump.create_zip(directory, output_file)
fastr.utils.cmd.dump.get_parser()
fastr.utils.cmd.dump.main()
    Dump the contents of a network run tempdir into a zip for remote assistance
```

execute Module

```
fastr.utils.cmd.execute.get_parser()
fastr.utils.cmd.execute.main()
    Execute a fastr job file
```

extract_argparse Module

```
fastr.utils.cmd.extract_argparse.cardinality_from_nargs(value)
fastr.utils.cmd.extract_argparse.datatype_from_type(type_, metavar)
fastr.utils.cmd.extract_argparse.extract_argparser(filepath)
fastr.utils.cmd.extract_argparse.find_argparser(entry, basename='/home/docs/checkouts/readthedocs.org/user_
networkrun/bin/sphinx-build')
fastr.utils.cmd.extract_argparse.get_parser()
fastr.utils.cmd.extract_argparse.main()
    Create a stub for a Tool based on a python script using argparse
```

prov Module

```
fastr.utils.cmd.prov.get_parser()  
fastr.utils.cmd.prov.get_prov_document(result)  
fastr.utils.cmd.prov.main()  
    Get PROV information from the result pickle.
```

run Module

```
fastr.utils.cmd.run.create_network_parser(network)  
fastr.utils.cmd.run.get_parser()  
fastr.utils.cmd.run.main()  
    Run a Network from the commandline
```

test Module

```
fastr.utils.cmd.test.check_network(args)  
fastr.utils.cmd.test.check_networks(args)  
fastr.utils.cmd.test.check_tool(args)  
fastr.utils.cmd.test.check_tools(args)  
fastr.utils.cmd.test.directory(path)  
    Make sure the path is a valid directory for argparse  
fastr.utils.cmd.test.get_parser()  
fastr.utils.cmd.test.main()  
    Run the tests of a tool to verify the proper function  
fastr.utils.cmd.test.tool(value)  
    Make sure the value is a correct tool for argparse or reference directory
```

trace Module

```
fastr.utils.cmd.trace.get_parser()  
fastr.utils.cmd.trace.main()  
    Trace samples/sinks from a run  
fastr.utils.cmd.trace.print_job_result(job_file)  
fastr.utils.cmd.trace.print_sample_sink(sink_data, dirname, sample_sink_tuples, verbose)  
fastr.utils.cmd.trace.print_samples(sink_data, sample_ids, verbose)  
fastr.utils.cmd.trace.print_sinks(sink_data, sink_ids, verbose)  
fastr.utils.cmd.trace.read_sink_data(infile)  
fastr.utils.cmd.trace.switch_sample_sink(sink_data)
```


verify Module

`fastr.utils.cmd.verify.get_parser()`

`fastr.utils.cmd.verify.main()`

Print information from a job file

webapp Module

`fastr.utils.cmd.webapp.get_parser()`

`fastr.utils.cmd.webapp.main()`

Start the fastr webapp and open in a new browser tab

`fastr.utils.cmd.webapp.open_url(url)`

secrets Package

secrets Package

secretprovider Module

secretservice Module

Subpackages

exceptions Package

exceptions Package

couldnotdeletecredentials Module

couldnotretrievecredentials Module

couldnotsetcredentials Module

notimplemented Module

providernotfound Module

providers Package

providers Package

keyringprovider Module

netrcprovider Module

web Package

web Package

api Module

```
class fastr.web.api.NetworkApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource
    __module__ = 'fastr.web.api'
    endpoint = 'api_network'
    get (id_)
        Get a Network json description from the server
    mediatypes (resource_cls)
    methods = ['GET']

class fastr.web.api.NetworkListApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource
    __module__ = 'fastr.web.api'
    endpoint = 'api_networks'
    get (*args, **kwargs)
        Get a list of the networks
    mediatypes (resource_cls)
    methods = ['GET']

class fastr.web.api.ObjectUrl (object_class, **kwargs)
    Bases: flask_restplus.fields.Raw
    __init__ (object_class, **kwargs)
    __module__ = 'fastr.web.api'
    __schema_type__ = 'string'
    __slotnames__ = []
    format (value)

class fastr.web.api.Run (id_, network, source_data, sink_data)
    Bases: object
    __dict__ = dict_proxy({'status': <function status>, '__module__': 'fastr.web.api', 'abort': <function abort>, '__dict__'
    __init__ (id_, network, source_data, sink_data)
    __module__ = 'fastr.web.api'
    __weakref__
        list of weak references to the object (if defined)
    abort ()
    run_network (network, source_data, sink_data, abort_lock)
    status ()
```

```

class fastr.web.api.RunApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource

    Run API documentation

    __module__ = 'fastr.web.api'

    delete (id_)
        Abort a Network run and stop all associated execution

    endpoint = 'api_run'

    get (*args, **kwargs)
        Get information about a Network run

    mediatypes (resource_cls)

    methods = ['DELETE', 'GET']

class fastr.web.api.RunListApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource

    __module__ = 'fastr.web.api'

    endpoint = 'api_runs'

    get (*args, **kwargs)
        Get a list of all Network runs on the server

    mediatypes (resource_cls)

    methods = ['GET', 'POST']

    post ()
        Create a new Network run and start execution

    request_parser = <flask_restplus.reqparse.RequestParser object>

class fastr.web.api.StatusApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource

    __module__ = 'fastr.web.api'

    endpoint = 'api_status'

    get (id_)
        Get the status of a Network Run on the server

    mediatypes (resource_cls)

    methods = ['GET']

class fastr.web.api.SubUrl (object_classss, subfield, **kwargs)
    Bases: flask_restplus.fields.Raw

    __init__ (object_classss, subfield, **kwargs)

    __module__ = 'fastr.web.api'

    __schema_type__ = 'string'

    format (value)

class fastr.web.api.ToolApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource

    __module__ = 'fastr.web.api'

```

```
    endpoint = 'api_version_tool'

    get (id_, version=None)
        Get a Tool json description from the server

    mediatypes (resource_cls)

    methods = ['GET']

class fastr.web.api.ToolListApi (api=None, *args, **kwargs)
    Bases: flask_restplus.resource.Resource

    __module__ = 'fastr.web.api'

    endpoint = 'api_tools'

    get (*args, **kwargs)
        Get a list of all Tools known to the server

    mediatypes (resource_cls)

    methods = ['GET']

fastr.web.api.network_lock_thread (lock, network)

fastr.web.api.network_runner (network, source_data, sink_data, chuck_status, job_status,
                               job_results, abort_lock)

fastr.web.api.update_job_result (job, job_status, job_results)

fastr.web.api.update_status (job, job_status)
```

run Module

```
fastr.web.run.main ()

fastr.web.run.runapp (debug=False)
```

views Module

```
fastr.web.views.doc ()

fastr.web.views.index ()

fastr.web.views.network (name=None)

fastr.web.views.networks ()

fastr.web.views.prov ()

fastr.web.views.shutdown ()

fastr.web.views.shutdown_server ()

fastr.web.views.tool (toolname=None, version=None)

fastr.web.views.websocket_client ()
```

CHAPTER 4

Indices and tables

- `genindex`
- `modindex`
- `search`

f

- `fastr.__init__`, 65
- `fastr.configmanager`, 77
- `fastr.core`, 116
 - `fastr.core.basemanager`, 116
 - `fastr.core.baseplugin`, 118
 - `fastr.core.datatypemanager`, 120
 - `fastr.core.dimension`, 122
 - `fastr.core.inputgroup`, 124
 - `fastr.core.inputgroupcombiner`, 126
 - `fastr.core.inputoutput`, 128
 - `fastr.core.interface`, 140
 - `fastr.core.ioplugin`, 142
 - `fastr.core.link`, 145
 - `fastr.core.network`, 148
 - `fastr.core.networkmanager`, 152
 - `fastr.core.node`, 152
 - `fastr.core.objectmanager`, 159
 - `fastr.core.pluginmanager`, 160
 - `fastr.core.provenance`, 163
 - `fastr.core.samples`, 164
 - `fastr.core.serializable`, 170
 - `fastr.core.target`, 172
 - `fastr.core.test`, 180
 - `fastr.core.tool`, 174
 - `fastr.core.toolmanager`, 176
 - `fastr.core.updateable`, 177
 - `fastr.core.version`, 179
 - `fastr.core.vfs`, 180
- `fastr.data`, 181
 - `fastr.data.url`, 181
- `fastr.datatypes`, 79
- `fastr.examples`, 183
 - `fastr.examples.__generate_reference__`, 183
 - `fastr.examples.add_ints`, 183
 - `fastr.examples.add_ints_s3`, 183
 - `fastr.examples.auto_prefix`, 183
 - `fastr.examples.collapse`, 183
 - `fastr.examples.collapse_expand`, 183
 - `fastr.examples.cross_validation`, 184
 - `fastr.examples.elastix_nipype`, 184
 - `fastr.examples.expand`, 184
 - `fastr.examples.failing_network`, 184
 - `fastr.examples.filecopy`, 184
 - `fastr.examples.input_groups`, 184
 - `fastr.examples.macro_node`, 185
 - `fastr.examples.macro_node2`, 185
 - `fastr.examples.shift_links`, 185
 - `fastr.examples.source_sink`, 185
- `fastr.exceptions`, 89
- `fastr.execution`, 186
 - `fastr.execution.environmentmodules`, 186
 - `fastr.execution.executionpluginmanager`, 187
 - `fastr.execution.executionscript`, 191
 - `fastr.execution.flownoderun`, 191
 - `fastr.execution.inputoutputrun`, 192
 - `fastr.execution.job`, 202
 - `fastr.execution.linkrun`, 209
 - `fastr.execution.macronoderun`, 212
 - `fastr.execution.networkanalyzer`, 213
 - `fastr.execution.networkchunker`, 213
 - `fastr.execution.networkrun`, 214
 - `fastr.execution.noderun`, 216
 - `fastr.execution.sinknoderun`, 219
 - `fastr.execution.sourcenoderun`, 220
- `fastr.plugins`, 95
- `fastr.resources`, 222
- `fastr.utils`, 224
 - `fastr.utils.checksum`, 224
 - `fastr.utils.classproperty`, 226
 - `fastr.utils.clear_pycs`, 226
 - `fastr.utils.cmd`, 235
 - `fastr.utils.cmd.cat`, 235
 - `fastr.utils.cmd.dump`, 235
 - `fastr.utils.cmd.execute`, 235
 - `fastr.utils.cmd.extract_argparse`, 235
 - `fastr.utils.cmd.prov`, 236

`fastr.utils.cmd.run`, [236](#)
`fastr.utils.cmd.test`, [236](#)
`fastr.utils.cmd.trace`, [236](#)
`fastr.utils.cmd.verify`, [237](#)
`fastr.utils.cmd.webapp`, [237](#)
`fastr.utils.compare`, [226](#)
`fastr.utils.dicteq`, [227](#)
`fastr.utils.filesynchelper`, [228](#)
`fastr.utils.gettools`, [228](#)
`fastr.utils.iohelpers`, [228](#)
`fastr.utils.jsonschemaresolver`, [229](#)
`fastr.utils.multiprocesswrapper`, [231](#)
`fastr.utils.pim_publisher`, [231](#)
`fastr.utils.procutils`, [231](#)
`fastr.utils.rest_generation`, [232](#)
`fastr.utils.schematatable`, [232](#)
`fastr.utils.sysinfo`, [233](#)
`fastr.utils.verify`, [234](#)
`fastr.utils.xmltodict`, [234](#)
`fastr.version`, [115](#)
`fastr.web`, [238](#)
`fastr.web.api`, [238](#)
`fastr.web.run`, [240](#)
`fastr.web.views`, [240](#)

Symbols

- `__abstractmethods__` (fastr.__init__.ConstantNode attribute), 74
- `__abstractmethods__` (fastr.__init__.Link attribute), 69
- `__abstractmethods__` (fastr.__init__.Node attribute), 72
- `__abstractmethods__` (fastr.__init__.SinkNode attribute), 76
- `__abstractmethods__` (fastr.__init__.SourceNode attribute), 75
- `__abstractmethods__` (fastr.core.basemanager.BaseManager attribute), 117
- `__abstractmethods__` (fastr.core.baseplugin.BasePlugin attribute), 118
- `__abstractmethods__` (fastr.core.baseplugin.Plugin attribute), 119
- `__abstractmethods__` (fastr.core.datatypemanager.DataTypeManager attribute), 120
- `__abstractmethods__` (fastr.core.dimension.ForwardsDimensions attribute), 123
- `__abstractmethods__` (fastr.core.dimension.HasDimensions attribute), 123
- `__abstractmethods__` (fastr.core.inputgroup.InputGroup attribute), 124
- `__abstractmethods__` (fastr.core.inputgroupcombiner.BaseInputGroupCombiner attribute), 126
- `__abstractmethods__` (fastr.core.inputgroupcombiner.DefaultInputGroupCombiner attribute), 127
- `__abstractmethods__` (fastr.core.inputgroupcombiner.MergingInputGroupCombiner attribute), 127
- `__abstractmethods__` (fastr.core.inputoutput.AdvancedFlowOutput attribute), 128
- `__abstractmethods__` (fastr.core.inputoutput.BaseInput attribute), 128
- `__abstractmethods__` (fastr.core.inputoutput.BaseInputOutput attribute), 129
- `__abstractmethods__` (fastr.core.inputoutput.BaseOutput attribute), 130
- `__abstractmethods__` (fastr.core.inputoutput.Input attribute), 131
- `__abstractmethods__` (fastr.core.inputoutput.MacroOutput attribute), 133
- `__abstractmethods__` (fastr.core.inputoutput.Output attribute), 133
- `__abstractmethods__` (fastr.core.inputoutput.SourceOutput attribute), 135
- `__abstractmethods__` (fastr.core.inputoutput.SubInput attribute), 136
- `__abstractmethods__` (fastr.core.inputoutput.SubOutput attribute), 138
- `__abstractmethods__` (fastr.core.interface.Interface attribute), 140
- `__abstractmethods__` (fastr.core.interface.InterfacePluginManager attribute), 141
- `__abstractmethods__` (fastr.core.ioplugin.IOPlugin attribute), 142
- `__abstractmethods__` (fastr.core.ioplugin.IOPluginManager attribute), 144
- `__abstractmethods__` (fastr.core.link.Link attribute), 146
- `__abstractmethods__` (fastr.core.networkmanager.NetworkManager attribute), 152
- `__abstractmethods__` (fastr.core.node.AdvancedFlowNode attribute), 152
- `__abstractmethods__` (fastr.core.node.ConstantNode attribute), 152
- `__abstractmethods__` (fastr.core.node.FlowNode attribute), 153
- `__abstractmethods__` (fastr.core.node.MacroNode attribute), 154
- `__abstractmethods__` (fastr.core.node.Node attribute), 155
- `__abstractmethods__` (fastr.core.node.SinkNode attribute), 157
- `__abstractmethods__` (fastr.core.node.SourceNode attribute), 158
- `__abstractmethods__` (fastr.core.objectmanager.ObjectManager attribute), 159
- `__abstractmethods__` (fastr.core.pluginmanager.BasePluginManager attribute), 160
- `__abstractmethods__` (fastr.core.pluginmanager.PluginManager attribute), 160

- attribute), 161
- __abstractmethods__ (fastr.core.pluginmanager.PluginSubManager attribute), 162
- __abstractmethods__ (fastr.core.pluginmanager.PluginsView attribute), 162
- __abstractmethods__ (fastr.core.samples.ContainsSamples attribute), 164
- __abstractmethods__ (fastr.core.samples.HasSamples attribute), 164
- __abstractmethods__ (fastr.core.samples.SampleCollection attribute), 165
- __abstractmethods__ (fastr.core.samples.SampleValue attribute), 169
- __abstractmethods__ (fastr.core.target.ProcessUsageCollection attribute), 172
- __abstractmethods__ (fastr.core.target.Target attribute), 173
- __abstractmethods__ (fastr.core.target.TargetManager attribute), 173
- __abstractmethods__ (fastr.core.toolmanager.ToolManager attribute), 176
- __abstractmethods__ (fastr.core.updateable.Updateable attribute), 177
- __abstractmethods__ (fastr.datatypes.AnalyzeImageFile attribute), 79
- __abstractmethods__ (fastr.datatypes.AnyFile attribute), 79
- __abstractmethods__ (fastr.datatypes.AnyType attribute), 79
- __abstractmethods__ (fastr.datatypes.BaseDataType attribute), 79
- __abstractmethods__ (fastr.datatypes.Boolean attribute), 81
- __abstractmethods__ (fastr.datatypes.DataType attribute), 81
- __abstractmethods__ (fastr.datatypes.Deferred attribute), 82
- __abstractmethods__ (fastr.datatypes.Directory attribute), 83
- __abstractmethods__ (fastr.datatypes.EnumType attribute), 83
- __abstractmethods__ (fastr.datatypes.FilePrefix attribute), 83
- __abstractmethods__ (fastr.datatypes.Float attribute), 84
- __abstractmethods__ (fastr.datatypes.ITKImageFile attribute), 84
- __abstractmethods__ (fastr.datatypes.Int attribute), 84
- __abstractmethods__ (fastr.datatypes.JsonFile attribute), 84
- __abstractmethods__ (fastr.datatypes.MetaImageFile attribute), 85
- __abstractmethods__ (fastr.datatypes.NiftiImageFile attribute), 85
- __abstractmethods__ (fastr.datatypes.NiftiImageFileCompressed attribute), 85
- __abstractmethods__ (fastr.datatypes.NiftiImageFileUncompressed attribute), 85
- __abstractmethods__ (fastr.datatypes.Number attribute), 86
- __abstractmethods__ (fastr.datatypes.ProvNFile attribute), 86
- __abstractmethods__ (fastr.datatypes.String attribute), 86
- __abstractmethods__ (fastr.datatypes.TifImageFile attribute), 86
- __abstractmethods__ (fastr.datatypes.TxtFile attribute), 86
- __abstractmethods__ (fastr.datatypes.TypeGroup attribute), 87
- __abstractmethods__ (fastr.datatypes.URLType attribute), 87
- __abstractmethods__ (fastr.datatypes.UnsignedInt attribute), 88
- __abstractmethods__ (fastr.datatypes.ValueType attribute), 88
- __abstractmethods__ (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 189
- __abstractmethods__ (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 190
- __abstractmethods__ (fastr.execution.flownoderun.AdvancedFlowNodeRun attribute), 191
- __abstractmethods__ (fastr.execution.flownoderun.FlowNodeRun attribute), 191
- __abstractmethods__ (fastr.execution.inputoutputrun.AdvancedFlowOutputRun attribute), 192
- __abstractmethods__ (fastr.execution.inputoutputrun.BaseInputRun attribute), 192
- __abstractmethods__ (fastr.execution.inputoutputrun.InputRun attribute), 192
- __abstractmethods__ (fastr.execution.inputoutputrun.MacroOutputRun attribute), 194
- __abstractmethods__ (fastr.execution.inputoutputrun.OutputRun attribute), 194
- __abstractmethods__ (fastr.execution.inputoutputrun.SourceOutputRun attribute), 197
- __abstractmethods__ (fastr.execution.inputoutputrun.SubInputRun attribute), 198
- __abstractmethods__ (fastr.execution.inputoutputrun.SubOutputRun attribute), 200
- __abstractmethods__ (fastr.execution.linkrun.LinkRun attribute), 210
- __abstractmethods__ (fastr.execution.macronoderun.MacroNodeRun attribute), 212
- __abstractmethods__ (fastr.execution.noderun.NodeRun attribute), 216
- __abstractmethods__ (fastr.execution.sinknoderun.SinkNodeRun attribute), 219
- __abstractmethods__ (fastr.execution.sourcenoderun.ConstantNodeRun attribute), 221

- `__abstractmethods__` (fastr.execution.sourcenoderun.SourceNodeRun attribute), 220
- `__abstractmethods__` (fastr.plugins.BlockingExecution attribute), 96
- `__abstractmethods__` (fastr.plugins.CommaSeperatedValueFiledataschemafile attribute), 96
- `__abstractmethods__` (fastr.plugins.CrossValidation attribute), 97
- `__abstractmethods__` (fastr.plugins.DRMAAExecution attribute), 97
- `__abstractmethods__` (fastr.plugins.DockerTarget attribute), 98
- `__abstractmethods__` (fastr.plugins.FastrInterface attribute), 100
- `__abstractmethods__` (fastr.plugins.FileSystem attribute), 101
- `__abstractmethods__` (fastr.plugins.FlowInterface attribute), 102
- `__abstractmethods__` (fastr.plugins.LinearExecution attribute), 103
- `__abstractmethods__` (fastr.plugins.LocalBinaryTarget attribute), 105
- `__abstractmethods__` (fastr.plugins.NipypeInterface attribute), 106
- `__abstractmethods__` (fastr.plugins.Null attribute), 106
- `__abstractmethods__` (fastr.plugins.ProcessPoolExecution attribute), 107
- `__abstractmethods__` (fastr.plugins.RQExecution attribute), 107
- `__abstractmethods__` (fastr.plugins.Reference attribute), 108
- `__abstractmethods__` (fastr.plugins.S3Filesystem attribute), 108
- `__abstractmethods__` (fastr.plugins.StrongrExecution attribute), 109
- `__abstractmethods__` (fastr.plugins.VirtualFileSystem attribute), 110
- `__abstractmethods__` (fastr.plugins.VirtualFileSystemRegularExpression attribute), 112
- `__abstractmethods__` (fastr.plugins.VirtualFileSystemValueList attribute), 113
- `__abstractmethods__` (fastr.plugins.XNATStorage attribute), 115
- `__add__` () (fastr.configmanager.EmptyDefault method), 78
- `__add__` () (fastr.core.samples.SampleBaseId method), 164
- `__add__` () (fastr.core.samples.SampleItemBase method), 167
- `__add__` () (fastr.core.samples.SamplePayload method), 169
- `__add__` () (fastr.core.samples.SampleValue method), 169
- `__contains__` () (fastr.core.objectmanager.ObjectManager method), 159
- `__contains__` () (fastr.core.samples.HasSamples method), 164
- `__contains__` () (fastr.core.samples.SampleCollection method), 165
- `__dataschemafile__` (fastr.__init__.ConstantNode attribute), 74
- `__dataschemafile__` (fastr.__init__.Link attribute), 69
- `__dataschemafile__` (fastr.__init__.Network attribute), 66
- `__dataschemafile__` (fastr.__init__.Node attribute), 72
- `__dataschemafile__` (fastr.__init__.SinkNode attribute), 76
- `__dataschemafile__` (fastr.__init__.SourceNode attribute), 75
- `__dataschemafile__` (fastr.core.link.Link attribute), 146
- `__dataschemafile__` (fastr.core.network.Network attribute), 148
- `__dataschemafile__` (fastr.core.node.ConstantNode attribute), 152
- `__dataschemafile__` (fastr.core.node.Node attribute), 155
- `__dataschemafile__` (fastr.core.node.SinkNode attribute), 157
- `__dataschemafile__` (fastr.core.node.SourceNode attribute), 158
- `__dataschemafile__` (fastr.core.tool.Tool attribute), 174
- `__dataschemafile__` (fastr.execution.linkrun.LinkRun attribute), 210
- `__dataschemafile__` (fastr.execution.noderun.NodeRun attribute), 216
- `__dataschemafile__` (fastr.execution.sinknoderun.SinkNodeRun attribute), 219
- `__dataschemafile__` (fastr.execution.sourcenoderun.ConstantNodeRun attribute), 221
- `__dataschemafile__` (fastr.execution.sourcenoderun.SourceNodeRun attribute), 220
- `__dataschemafile__` (fastr.plugins.FastrInterface attribute), 100
- `__dataschemafile__` (fastr.plugins.FlowInterface attribute), 102
- `__del__` () (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- `__delitem__` () (fastr.configmanager.EmptyDefault method), 78
- `__delitem__` () (fastr.core.basemanager.BaseManager method), 117
- `__delitem__` () (fastr.core.inputgroup.InputGroup method), 124
- `__delitem__` () (fastr.core.pluginmanager.PluginsView method), 162
- `__delitem__` () (fastr.core.samples.SampleCollection method), 165
- `__delitem__` () (fastr.core.samples.SampleValue method), 169
- `__dict__` (fastr.configmanager.Config attribute), 77
- `__dict__` (fastr.configmanager.EmptyDefault attribute),

- 78
- `__dict__` (fastr.core.baseplugin.BasePlugin attribute), 118
- `__dict__` (fastr.core.dimension.Dimension attribute), 122
- `__dict__` (fastr.core.dimension.HasDimensions attribute), 123
- `__dict__` (fastr.core.interface.InputSpec attribute), 140
- `__dict__` (fastr.core.interface.InterfaceResult attribute), 141
- `__dict__` (fastr.core.interface.OutputSpec attribute), 142
- `__dict__` (fastr.core.pluginmanager.plugin_option_type attribute), 162
- `__dict__` (fastr.core.provenance.Provenance attribute), 163
- `__dict__` (fastr.core.samples.SampleBaseId attribute), 164
- `__dict__` (fastr.core.samples.SampleItemBase attribute), 167
- `__dict__` (fastr.core.serializable.PassThroughSerializer attribute), 170
- `__dict__` (fastr.core.serializable.Serializable attribute), 170
- `__dict__` (fastr.core.target.SystemUsageInfo attribute), 172
- `__dict__` (fastr.core.updateable.Updateable attribute), 177
- `__dict__` (fastr.core.version.Version attribute), 179
- `__dict__` (fastr.execution.environmentmodules.EnvironmentModule attribute), 186
- `__dict__` (fastr.execution.networkanalyzer.NetworkAnalyzer attribute), 213
- `__dict__` (fastr.execution.networkchunker.NetworkChunker attribute), 214
- `__dict__` (fastr.utils.classproperty.ClassPropertyDescriptor attribute), 226
- `__dict__` (fastr.utils.pim_publisher.PimPublisher attribute), 231
- `__dict__` (fastr.utils.schematatable.SchemaPrinter attribute), 232
- `__dict__` (fastr.web.api.Run attribute), 238
- `__enter__` () (fastr.core.target.Target method), 173
- `__enter__` () (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- `__enter__` () (fastr.plugins.DockerTarget method), 98
- `__enter__` () (fastr.plugins.LocalBinaryTarget method), 105
- `__eq__` () (fastr.__init__.Link method), 69
- `__eq__` () (fastr.__init__.Network method), 66
- `__eq__` () (fastr.__init__.Node method), 72
- `__eq__` () (fastr.__init__.SourceNode method), 75
- `__eq__` () (fastr.core.dimension.Dimension method), 122
- `__eq__` () (fastr.core.inputoutput.Input method), 131
- `__eq__` () (fastr.core.inputoutput.Output method), 133
- `__eq__` () (fastr.core.inputoutput.SubInput method), 136
- `__eq__` () (fastr.core.inputoutput.SubOutput method), 138
- `__eq__` () (fastr.core.link.Link method), 146
- `__eq__` () (fastr.core.network.Network method), 148
- `__eq__` () (fastr.core.node.Node method), 155
- `__eq__` () (fastr.core.node.SourceNode method), 158
- `__eq__` () (fastr.core.tool.Tool method), 174
- `__eq__` () (fastr.datatypes.BaseDataType method), 79
- `__eq__` () (fastr.datatypes.Directory method), 83
- `__eq__` () (fastr.datatypes.MetaImageFile method), 85
- `__eq__` () (fastr.datatypes.URLType method), 87
- `__eq__` () (fastr.execution.linkrun.LinkRun method), 210
- `__eq__` () (fastr.execution.networkrun.NetworkRun method), 214
- `__eq__` () (fastr.execution.noderun.NodeRun method), 216
- `__eq__` () (fastr.execution.sourcenoderun.SourceNodeRun method), 220
- `__eq__` () (fastr.plugins.FastrInterface method), 100
- `__eq__` () (fastr.plugins.FlowInterface method), 102
- `__eq__` () (fastr.plugins.NipypeInterface method), 106
- `__exit__` () (fastr.core.target.Target method), 173
- `__exit__` () (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- `__exit__` () (fastr.plugins.DockerTarget method), 98
- `__exit__` () (fastr.plugins.LocalBinaryTarget method), 105
- `__format__` () (fastr.core.baseplugin.PluginState method), 119
- `__format__` () (fastr.execution.environmentmodules.ModuleSystem method), 187
- `__format__` () (fastr.execution.executionpluginmanager.JobAction method), 190
- `__format__` () (fastr.execution.job.JobState method), 207
- `__get__` () (fastr.utils.classproperty.ClassPropertyDescriptor method), 226
- `__getattr__` () (fastr.core.pluginmanager.LazyModule method), 161
- `__getitem__` () (fastr.__init__.Network method), 66
- `__getitem__` () (fastr.configmanager.EmptyDefault method), 78
- `__getitem__` () (fastr.core.basemanager.BaseManager method), 117
- `__getitem__` () (fastr.core.inputgroup.InputGroup method), 124
- `__getitem__` () (fastr.core.inputoutput.Input method), 131
- `__getitem__` () (fastr.core.inputoutput.Output method), 133
- `__getitem__` () (fastr.core.inputoutput.SourceOutput method), 135
- `__getitem__` () (fastr.core.inputoutput.SubInput method), 136
- `__getitem__` () (fastr.core.inputoutput.SubOutput method), 138
- `__getitem__` () (fastr.core.network.Network method), 148
- `__getitem__` () (fastr.core.objectmanager.ObjectManager method), 159
- `__getitem__` () (fastr.core.pluginmanager.BasePluginManager

- method), 160
- `__getitem__()` (fastr.core.pluginmanager.PluginsView method), 162
- `__getitem__()` (fastr.core.samples.ContainsSamples method), 164
- `__getitem__()` (fastr.core.samples.HasSamples method), 164
- `__getitem__()` (fastr.core.samples.SampleCollection method), 165
- `__getitem__()` (fastr.core.samples.SampleValue method), 169
- `__getitem__()` (fastr.core.target.ProcessUsageCollection method), 172
- `__getitem__()` (fastr.execution.inputoutputrun.InputRun method), 192
- `__getitem__()` (fastr.execution.inputoutputrun.OutputRun method), 194
- `__getitem__()` (fastr.execution.inputoutputrun.SourceOutputRun method), 197
- `__getitem__()` (fastr.execution.inputoutputrun.SubInputRun method), 198
- `__getitem__()` (fastr.execution.inputoutputrun.SubOutputRun method), 200
- `__getitem__()` (fastr.execution.linkrun.LinkRun method), 210
- `__getitem__()` (fastr.execution.networkrun.NetworkRun method), 214
- `__getnewargs__()` (fastr.core.pluginmanager.plugin_option_type method), 162
- `__getnewargs__()` (fastr.core.samples.SampleItemBase method), 167
- `__getnewargs__()` (fastr.core.target.SystemUsageInfo method), 172
- `__getstate__()` (fastr.__init__.ConstantNode method), 74
- `__getstate__()` (fastr.__init__.Link method), 69
- `__getstate__()` (fastr.__init__.Network method), 66
- `__getstate__()` (fastr.__init__.Node method), 72
- `__getstate__()` (fastr.__init__.SinkNode method), 76
- `__getstate__()` (fastr.__init__.SourceNode method), 75
- `__getstate__()` (fastr.core.inputoutput.BaseInputOutput method), 129
- `__getstate__()` (fastr.core.inputoutput.Input method), 131
- `__getstate__()` (fastr.core.inputoutput.Output method), 134
- `__getstate__()` (fastr.core.inputoutput.SubInput method), 137
- `__getstate__()` (fastr.core.inputoutput.SubOutput method), 139
- `__getstate__()` (fastr.core.interface.Interface method), 140
- `__getstate__()` (fastr.core.link.Link method), 146
- `__getstate__()` (fastr.core.network.Network method), 149
- `__getstate__()` (fastr.core.node.ConstantNode method), 152
- `__getstate__()` (fastr.core.node.MacroNode method), 154
- `__getstate__()` (fastr.core.node.Node method), 155
- `__getstate__()` (fastr.core.node.SinkNode method), 157
- `__getstate__()` (fastr.core.node.SourceNode method), 158
- `__getstate__()` (fastr.core.pluginmanager.plugin_option_type method), 162
- `__getstate__()` (fastr.core.samples.SampleValue method), 169
- `__getstate__()` (fastr.core.serializable.Serializable method), 170
- `__getstate__()` (fastr.core.target.SystemUsageInfo method), 172
- `__getstate__()` (fastr.core.tool.Tool method), 174
- `__getstate__()` (fastr.core.updateable.Updateable method), 177
- `__getstate__()` (fastr.datatypes.BaseDataType method), 79
- `__getstate__()` (fastr.datatypes.Deferred method), 82
- `__getstate__()` (fastr.execution.inputoutputrun.InputRun method), 193
- `__getstate__()` (fastr.execution.inputoutputrun.OutputRun method), 195
- `__getstate__()` (fastr.execution.inputoutputrun.SubInputRun method), 199
- `__getstate__()` (fastr.execution.inputoutputrun.SubOutputRun method), 200
- `__getstate__()` (fastr.execution.job.Job method), 202
- `__getstate__()` (fastr.execution.linkrun.LinkRun method), 210
- `__getstate__()` (fastr.execution.macronoderun.MacroNodeRun method), 212
- `__getstate__()` (fastr.execution.networkrun.NetworkRun method), 214
- `__getstate__()` (fastr.execution.noderun.NodeRun method), 216
- `__getstate__()` (fastr.execution.sinknoderun.SinkNodeRun method), 219
- `__getstate__()` (fastr.execution.sourcenoderun.ConstantNodeRun method), 221
- `__getstate__()` (fastr.execution.sourcenoderun.SourceNodeRun method), 220
- `__getstate__()` (fastr.plugins.FastrInterface method), 100
- `__getstate__()` (fastr.plugins.FlowInterface method), 102
- `__getstate__()` (fastr.plugins.NipypeInterface method), 106
- `__iadd__()` (fastr.configmanager.EmptyDefault method), 78
- `__init__()` (fastr.__init__.ConstantNode method), 74
- `__init__()` (fastr.__init__.Link method), 70
- `__init__()` (fastr.__init__.Network method), 66
- `__init__()` (fastr.__init__.Node method), 72
- `__init__()` (fastr.__init__.SinkNode method), 76
- `__init__()` (fastr.__init__.SourceNode method), 75
- `__init__()` (fastr.configmanager.Config method), 77
- `__init__()` (fastr.configmanager.EmptyDefault method),

- [78](#)
- `__init__()` (fastr.core.basemanager.BaseManager method), [117](#)
- `__init__()` (fastr.core.baseplugin.BasePlugin method), [118](#)
- `__init__()` (fastr.core.datatypemanager.DataTypeManager method), [120](#)
- `__init__()` (fastr.core.dimension.Dimension method), [122](#)
- `__init__()` (fastr.core.inputgroup.InputGroup method), [124](#)
- `__init__()` (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), [126](#)
- `__init__()` (fastr.core.inputgroupcombiner.MergingInputGroupCombiner method), [127](#)
- `__init__()` (fastr.core.inputoutput.BaseInput method), [128](#)
- `__init__()` (fastr.core.inputoutput.BaseInputOutput method), [129](#)
- `__init__()` (fastr.core.inputoutput.BaseOutput method), [130](#)
- `__init__()` (fastr.core.inputoutput.Input method), [131](#)
- `__init__()` (fastr.core.inputoutput.Output method), [134](#)
- `__init__()` (fastr.core.inputoutput.SourceOutput method), [136](#)
- `__init__()` (fastr.core.inputoutput.SubInput method), [137](#)
- `__init__()` (fastr.core.inputoutput.SubOutput method), [139](#)
- `__init__()` (fastr.core.interface.InterfacePluginManager method), [141](#)
- `__init__()` (fastr.core.interface.InterfaceResult method), [141](#)
- `__init__()` (fastr.core.ioplugin.IOPlugin method), [142](#)
- `__init__()` (fastr.core.ioplugin.IOPluginManager method), [144](#)
- `__init__()` (fastr.core.link.Link method), [146](#)
- `__init__()` (fastr.core.network.Network method), [149](#)
- `__init__()` (fastr.core.node.ConstantNode method), [152](#)
- `__init__()` (fastr.core.node.FlowNode method), [153](#)
- `__init__()` (fastr.core.node.MacroNode method), [154](#)
- `__init__()` (fastr.core.node.Node method), [155](#)
- `__init__()` (fastr.core.node.SinkNode method), [157](#)
- `__init__()` (fastr.core.node.SourceNode method), [158](#)
- `__init__()` (fastr.core.objectmanager.ObjectManager method), [160](#)
- `__init__()` (fastr.core.pluginmanager.BasePluginManager method), [160](#)
- `__init__()` (fastr.core.pluginmanager.LazyModule method), [161](#)
- `__init__()` (fastr.core.pluginmanager.PluginManager method), [161](#)
- `__init__()` (fastr.core.pluginmanager.PluginSubManager method), [162](#)
- `__init__()` (fastr.core.pluginmanager.PluginsView method), [162](#)
- `__init__()` (fastr.core.provenance.Provenance method), [163](#)
- `__init__()` (fastr.core.samples.SampleCollection method), [165](#)
- `__init__()` (fastr.core.samples.SampleValue method), [169](#)
- `__init__()` (fastr.core.target.ProcessUsageCollection method), [172](#)
- `__init__()` (fastr.core.target.TargetManager method), [173](#)
- `__init__()` (fastr.core.tool.Tool method), [174](#)
- `__init__()` (fastr.core.updateable.Updateable method), [177](#)
- `__init__()` (fastr.datatypes.BaseDataType method), [79](#)
- `__init__()` (fastr.datatypes.DataType method), [81](#)
- `__init__()` (fastr.datatypes.Deferred method), [82](#)
- `__init__()` (fastr.datatypes.EnumType method), [83](#)
- `__init__()` (fastr.datatypes.TypeGroup method), [87](#)
- `__init__()` (fastr.datatypes.URLType method), [87](#)
- `__init__()` (fastr.datatypes.ValueType method), [88](#)
- `__init__()` (fastr.exceptions.FastrError method), [90](#)
- `__init__()` (fastr.exceptions.FastrExecutableNotFoundError method), [90](#)
- `__init__()` (fastr.exceptions.FastrSerializationError method), [93](#)
- `__init__()` (fastr.execution.environmentmodules.EnvironmentModules method), [186](#)
- `__init__()` (fastr.execution.executionpluginmanager.ExecutionPlugin method), [189](#)
- `__init__()` (fastr.execution.executionpluginmanager.ExecutionPluginManager method), [190](#)
- `__init__()` (fastr.execution.inputoutputrun.BaseInputRun method), [192](#)
- `__init__()` (fastr.execution.inputoutputputrun.InputRun method), [193](#)
- `__init__()` (fastr.execution.inputoutputputrun.OutputRun method), [195](#)
- `__init__()` (fastr.execution.inputoutputputrun.SourceOutputRun method), [197](#)
- `__init__()` (fastr.execution.inputoutputputrun.SubInputRun method), [199](#)
- `__init__()` (fastr.execution.inputoutputputrun.SubOutputRun method), [200](#)
- `__init__()` (fastr.execution.job.InlineJob method), [202](#)
- `__init__()` (fastr.execution.job.Job method), [202](#)
- `__init__()` (fastr.execution.job.JobState method), [207](#)
- `__init__()` (fastr.execution.job.SinkJob method), [208](#)
- `__init__()` (fastr.execution.linkrun.LinkRun method), [210](#)
- `__init__()` (fastr.execution.macronoderun.MacroNodeRun method), [212](#)
- `__init__()` (fastr.execution.networkchunker.DefaultNetworkChunker method), [213](#)
- `__init__()` (fastr.execution.networkrun.NetworkRun method), [215](#)
- `__init__()` (fastr.execution.noderun.NodeRun method), [216](#)
- `__init__()` (fastr.execution.sinknoderun.SinkNodeRun method), [216](#)

- method), 219
- `__init__()` (fastr.execution.sourcenoderun.ConstantNodeRun method), 222
- `__init__()` (fastr.execution.sourcenoderun.SourceNodeRun method), 220
- `__init__()` (fastr.plugins.BlockingExecution method), 96
- `__init__()` (fastr.plugins.CommaSeperatedValueFile method), 97
- `__init__()` (fastr.plugins.DRMAAExecution method), 97
- `__init__()` (fastr.plugins.DockerTarget method), 98
- `__init__()` (fastr.plugins.FastrInterface method), 100
- `__init__()` (fastr.plugins.FileSystem method), 101
- `__init__()` (fastr.plugins.FlowInterface method), 103
- `__init__()` (fastr.plugins.LinearExecution method), 103
- `__init__()` (fastr.plugins.LocalBinaryTarget method), 105
- `__init__()` (fastr.plugins.NipypeInterface method), 106
- `__init__()` (fastr.plugins.Null method), 106
- `__init__()` (fastr.plugins.ProcessPoolExecution method), 107
- `__init__()` (fastr.plugins.RQExecution method), 107
- `__init__()` (fastr.plugins.Reference method), 108
- `__init__()` (fastr.plugins.S3Filesystem method), 108
- `__init__()` (fastr.plugins.StrongrExecution method), 109
- `__init__()` (fastr.plugins.VirtualFileSystem method), 110
- `__init__()` (fastr.plugins.VirtualFileSystemRegularExpression method), 112
- `__init__()` (fastr.plugins.VirtualFileSystemValueList method), 113
- `__init__()` (fastr.plugins.XNATStorage method), 115
- `__init__()` (fastr.utils.classproperty.ClassPropertyDescriptor method), 226
- `__init__()` (fastr.utils.filesynhelper.FileSyncHelper method), 228
- `__init__()` (fastr.utils.jsonschemaparser.FastrRefResolver method), 229
- `__init__()` (fastr.utils.pim_publisher.PimPublisher method), 231
- `__init__()` (fastr.utils.schematotable.SchemaPrinter method), 232
- `__init__()` (fastr.web.api.ObjectUrl method), 238
- `__init__()` (fastr.web.api.Run method), 238
- `__init__()` (fastr.web.api.SubUrl method), 239
- `__iter__()` (fastr.core.basemanager.BaseManager method), 117
- `__iter__()` (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
- `__iter__()` (fastr.core.inputoutput.BaseInputOutput method), 129
- `__iter__()` (fastr.core.ioplugin.IOPluginManager method), 144
- `__iter__()` (fastr.core.pluginmanager.PluginsView method), 162
- `__iter__()` (fastr.core.samples.HasSamples method), 164
- `__iter__()` (fastr.core.samples.SampleCollection method), 165
- `__iter__()` (fastr.core.samples.SampleValue method), 169
- `__keytransform__()` (fastr.core.basemanager.BaseManager method), 117
- `__keytransform__()` (fastr.core.datatypemanager.DataTypeManager method), 120
- `__keytransform__()` (fastr.core.ioplugin.IOPluginManager method), 144
- `__keytransform__()` (fastr.core.objectmanager.ObjectManager method), 160
- `__len__()` (fastr.core.basemanager.BaseManager method), 117
- `__len__()` (fastr.core.inputoutput.SubOutput method), 139
- `__len__()` (fastr.core.pluginmanager.PluginsView method), 162
- `__len__()` (fastr.core.samples.SampleCollection method), 166
- `__len__()` (fastr.core.samples.SampleValue method), 169
- `__len__()` (fastr.core.target.ProcessUsageCollection method), 172
- `__len__()` (fastr.execution.inputoutputrun.SubOutputRun method), 201
- `__lshift__()` (fastr.core.inputoutput.BaseInput method), 128
- `__metaclass__` (fastr.__init__.Node attribute), 72
- `__metaclass__` (fastr.core.basemanager.BaseManager attribute), 117
- `__metaclass__` (fastr.core.baseplugin.BasePlugin attribute), 118
- `__metaclass__` (fastr.core.dimension.HasDimensions attribute), 123
- `__metaclass__` (fastr.core.inputgroup.InputGroup attribute), 124
- `__metaclass__` (fastr.core.inputgroupcombiner.BaseInputGroupCombiner attribute), 126
- `__metaclass__` (fastr.core.interface.Interface attribute), 141
- `__metaclass__` (fastr.core.ioplugin.IOPlugin attribute), 142
- `__metaclass__` (fastr.core.node.Node attribute), 155
- `__metaclass__` (fastr.core.samples.HasSamples attribute), 164
- `__metaclass__` (fastr.core.target.Target attribute), 173
- `__metaclass__` (fastr.core.updateable.Updateable attribute), 177
- `__metaclass__` (fastr.execution.noderun.NodeRun attribute), 217
- `__module__` (fastr.__init__.ConstantNode attribute), 74
- `__module__` (fastr.__init__.Link attribute), 70
- `__module__` (fastr.__init__.Network attribute), 66
- `__module__` (fastr.__init__.Node attribute), 72
- `__module__` (fastr.__init__.SinkNode attribute), 76
- `__module__` (fastr.__init__.SourceNode attribute), 75

- `__module__` (fastr.configmanager.Config attribute), 77
- `__module__` (fastr.configmanager.EmptyDefault attribute), 78
- `__module__` (fastr.core.basemanager.BaseManager attribute), 117
- `__module__` (fastr.core.baseplugin.BasePlugin attribute), 118
- `__module__` (fastr.core.baseplugin.Plugin attribute), 119
- `__module__` (fastr.core.baseplugin.PluginMeta attribute), 119
- `__module__` (fastr.core.baseplugin.PluginState attribute), 119
- `__module__` (fastr.core.datatypemanager.DataTypeManager attribute), 120
- `__module__` (fastr.core.dimension.Dimension attribute), 122
- `__module__` (fastr.core.dimension.ForwardsDimensions attribute), 123
- `__module__` (fastr.core.dimension.HasDimensions attribute), 123
- `__module__` (fastr.core.inputgroup.InputGroup attribute), 124
- `__module__` (fastr.core.inputgroupcombiner.BaseInputGroupCombiner attribute), 126
- `__module__` (fastr.core.inputgroupcombiner.DefaultInputGroupCombiner attribute), 127
- `__module__` (fastr.core.inputgroupcombiner.MergingInputGroupCombiner attribute), 127
- `__module__` (fastr.core.inputoutput.AdvancedFlowOutput attribute), 128
- `__module__` (fastr.core.inputoutput.BaseInput attribute), 128
- `__module__` (fastr.core.inputoutput.BaseInputOutput attribute), 129
- `__module__` (fastr.core.inputoutput.BaseOutput attribute), 130
- `__module__` (fastr.core.inputoutput.Input attribute), 131
- `__module__` (fastr.core.inputoutput.MacroOutput attribute), 133
- `__module__` (fastr.core.inputoutput.Output attribute), 134
- `__module__` (fastr.core.inputoutput.SourceOutput attribute), 136
- `__module__` (fastr.core.inputoutput.SubInput attribute), 137
- `__module__` (fastr.core.inputoutput.SubOutput attribute), 139
- `__module__` (fastr.core.interface.InputSpec attribute), 140
- `__module__` (fastr.core.interface.Interface attribute), 141
- `__module__` (fastr.core.interface.InterfacePluginManager attribute), 141
- `__module__` (fastr.core.interface.InterfaceResult attribute), 141
- `__module__` (fastr.core.interface.OutputSpec attribute), 142
- `__module__` (fastr.core.ioplugin.IOPlugin attribute), 142
- `__module__` (fastr.core.ioplugin.IOPluginManager attribute), 144
- `__module__` (fastr.core.link.Link attribute), 147
- `__module__` (fastr.core.network.Network attribute), 149
- `__module__` (fastr.core.networkmanager.NetworkManager attribute), 152
- `__module__` (fastr.core.node.AdvancedFlowNode attribute), 152
- `__module__` (fastr.core.node.ConstantNode attribute), 153
- `__module__` (fastr.core.node.FlowNode attribute), 154
- `__module__` (fastr.core.node.InputDict attribute), 154
- `__module__` (fastr.core.node.MacroNode attribute), 154
- `__module__` (fastr.core.node.Node attribute), 155
- `__module__` (fastr.core.node.OutputDict attribute), 157
- `__module__` (fastr.core.node.SinkNode attribute), 158
- `__module__` (fastr.core.node.SourceNode attribute), 159
- `__module__` (fastr.core.objectmanager.ObjectManager attribute), 160
- `__module__` (fastr.core.pluginmanager.BasePluginManager attribute), 161
- `__module__` (fastr.core.pluginmanager.LazyModule attribute), 161
- `__module__` (fastr.core.pluginmanager.PluginManager attribute), 161
- `__module__` (fastr.core.pluginmanager.PluginSubManager attribute), 162
- `__module__` (fastr.core.pluginmanager.PluginsView attribute), 162
- `__module__` (fastr.core.pluginmanager.plugin_option_type attribute), 162
- `__module__` (fastr.core.provenance.Provenance attribute), 163
- `__module__` (fastr.core.samples.ContainsSamples attribute), 164
- `__module__` (fastr.core.samples.HasSamples attribute), 164
- `__module__` (fastr.core.samples.SampleBaseId attribute), 164
- `__module__` (fastr.core.samples.SampleCollection attribute), 166
- `__module__` (fastr.core.samples.SampleId attribute), 166
- `__module__` (fastr.core.samples.SampleIndex attribute), 166
- `__module__` (fastr.core.samples.SampleItem attribute), 167
- `__module__` (fastr.core.samples.SampleItemBase attribute), 167
- `__module__` (fastr.core.samples.SamplePayload attribute), 169
- `__module__` (fastr.core.samples.SampleValue attribute), 169

<code>__module__</code> (fastr.core.serializable.PassThroughSerializer attribute), 170	<code>__module__</code> (fastr.exceptions.FastrCardinalityError attribute), 89
<code>__module__</code> (fastr.core.serializable.Serializable attribute), 170	<code>__module__</code> (fastr.exceptions.FastrCollectorError attribute), 89
<code>__module__</code> (fastr.core.target.ProcessUsageCollection attribute), 172	<code>__module__</code> (fastr.exceptions.FastrDataTypeFileNotReadable attribute), 89
<code>__module__</code> (fastr.core.target.SystemUsageInfo attribute), 172	<code>__module__</code> (fastr.exceptions.FastrDataTypeMismatchError attribute), 89
<code>__module__</code> (fastr.core.target.Target attribute), 173	<code>__module__</code> (fastr.exceptions.FastrDataTypeNotAvailableError attribute), 89
<code>__module__</code> (fastr.core.target.TargetManager attribute), 174	<code>__module__</code> (fastr.exceptions.FastrDataTypeNotInstantiableError attribute), 89
<code>__module__</code> (fastr.core.tool.Tool attribute), 174	<code>__module__</code> (fastr.exceptions.FastrDataTypeValueError attribute), 90
<code>__module__</code> (fastr.core.toolmanager.ToolManager attribute), 176	<code>__module__</code> (fastr.exceptions.FastrError attribute), 90
<code>__module__</code> (fastr.core.updateable.Updateable attribute), 177	<code>__module__</code> (fastr.exceptions.FastrErrorInSubprocess attribute), 90
<code>__module__</code> (fastr.core.updateable.UpdateableMeta attribute), 178	<code>__module__</code> (fastr.exceptions.FastrExecutableNotFoundError attribute), 90
<code>__module__</code> (fastr.core.version.Version attribute), 179	<code>__module__</code> (fastr.exceptions.FastrExecutionError attribute), 90
<code>__module__</code> (fastr.datatypes.AnalyzeImageFile attribute), 79	<code>__module__</code> (fastr.exceptions.FastrIOError attribute), 90
<code>__module__</code> (fastr.datatypes.AnyFile attribute), 79	<code>__module__</code> (fastr.exceptions.FastrImportError attribute), 91
<code>__module__</code> (fastr.datatypes.AnyType attribute), 79	<code>__module__</code> (fastr.exceptions.FastrIndexError attribute), 91
<code>__module__</code> (fastr.datatypes.BaseDataType attribute), 80	<code>__module__</code> (fastr.exceptions.FastrIndexNonexistent attribute), 91
<code>__module__</code> (fastr.datatypes.Boolean attribute), 81	<code>__module__</code> (fastr.exceptions.FastrKeyError attribute), 91
<code>__module__</code> (fastr.datatypes.DataType attribute), 81	<code>__module__</code> (fastr.exceptions.FastrLookupError attribute), 91
<code>__module__</code> (fastr.datatypes.Deferred attribute), 82	<code>__module__</code> (fastr.exceptions.FastrMountUnknownError attribute), 91
<code>__module__</code> (fastr.datatypes.Directory attribute), 83	<code>__module__</code> (fastr.exceptions.FastrNetworkMismatchError attribute), 91
<code>__module__</code> (fastr.datatypes.EnumType attribute), 83	<code>__module__</code> (fastr.exceptions.FastrNetworkUnknownError attribute), 91
<code>__module__</code> (fastr.datatypes.FilePrefix attribute), 83	<code>__module__</code> (fastr.exceptions.FastrNoValidTargetError attribute), 91
<code>__module__</code> (fastr.datatypes.Float attribute), 84	<code>__module__</code> (fastr.exceptions.FastrNodeAlreadyPreparedError attribute), 92
<code>__module__</code> (fastr.datatypes.ITKImageFile attribute), 84	<code>__module__</code> (fastr.exceptions.FastrNodeNotPreparedError attribute), 92
<code>__module__</code> (fastr.datatypes.Int attribute), 84	<code>__module__</code> (fastr.exceptions.FastrNodeNotValidError attribute), 92
<code>__module__</code> (fastr.datatypes.JsonFile attribute), 84	<code>__module__</code> (fastr.exceptions.FastrNotExecutableError attribute), 92
<code>__module__</code> (fastr.datatypes.MetaImageFile attribute), 85	<code>__module__</code> (fastr.exceptions.FastrNotImplementedError attribute), 92
<code>__module__</code> (fastr.datatypes.NiftiImageFile attribute), 85	<code>__module__</code> (fastr.exceptions.FastrOSError attribute), 92
<code>__module__</code> (fastr.datatypes.NiftiImageFileCompressed attribute), 85	<code>__module__</code> (fastr.exceptions.FastrObjectUnknownError attribute), 92
<code>__module__</code> (fastr.datatypes.NiftiImageFileUncompressed attribute), 85	<code>__module__</code> (fastr.exceptions.FastrOptionalModuleNotAvailableError attribute), 92
<code>__module__</code> (fastr.datatypes.Number attribute), 86	
<code>__module__</code> (fastr.datatypes.ProvNFile attribute), 86	
<code>__module__</code> (fastr.datatypes.String attribute), 86	
<code>__module__</code> (fastr.datatypes.TifImageFile attribute), 86	
<code>__module__</code> (fastr.datatypes.TxtFile attribute), 86	
<code>__module__</code> (fastr.datatypes.TypeGroup attribute), 87	
<code>__module__</code> (fastr.datatypes.URLType attribute), 87	
<code>__module__</code> (fastr.datatypes.UnsignedInt attribute), 88	
<code>__module__</code> (fastr.datatypes.ValueType attribute), 88	
<code>__module__</code> (fastr.exceptions.FastrAttributeError attribute), 89	
<code>__module__</code> (fastr.exceptions.FastrCannotChangeAttributeError attribute), 89	

__module__ (fastr.exceptions.FastrOutputValidationError attribute), 92	__module__ (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 189
__module__ (fastr.exceptions.FastrParentMismatchError attribute), 93	__module__ (fastr.execution.executionpluginmanager.ExecutionPluginManager attribute), 190
__module__ (fastr.exceptions.FastrPluginCapabilityNotImplementedError attribute), 93	__module__ (fastr.execution.executionpluginmanager.JobAction attribute), 190
__module__ (fastr.exceptions.FastrPluginNotAvailable attribute), 93	__module__ (fastr.execution.flownoderun.AdvancedFlowNodeRun attribute), 191
__module__ (fastr.exceptions.FastrPluginNotLoaded attribute), 93	__module__ (fastr.execution.flownoderun.FlowNodeRun attribute), 191
__module__ (fastr.exceptions.FastrResultFileNotFound attribute), 93	__module__ (fastr.execution.inputoutputrun.AdvancedFlowOutputRun attribute), 192
__module__ (fastr.exceptions.FastrSerializationError attribute), 93	__module__ (fastr.execution.inputoutputrun.BaseInputRun attribute), 192
__module__ (fastr.exceptions.FastrSerializationIgnoreDefaultOnError attribute), 93	__module__ (fastr.execution.inputoutputrun.InputRun attribute), 193
__module__ (fastr.exceptions.FastrSerializationInvalidDataError attribute), 94	__module__ (fastr.execution.inputoutputrun.MacroOutputRun attribute), 194
__module__ (fastr.exceptions.FastrSerializationMethodError attribute), 94	__module__ (fastr.execution.inputoutputrun.OutputRun attribute), 195
__module__ (fastr.exceptions.FastrSinkDataUnavailableError attribute), 94	__module__ (fastr.execution.inputoutputrun.SourceOutputRun attribute), 198
__module__ (fastr.exceptions.FastrSizeInvalidError attribute), 94	__module__ (fastr.execution.inputoutputrun.SubInputRun attribute), 199
__module__ (fastr.exceptions.FastrSizeMismatchError attribute), 94	__module__ (fastr.execution.inputoutputrun.SubOutputRun attribute), 201
__module__ (fastr.exceptions.FastrSizeUnknownError attribute), 94	__module__ (fastr.execution.job.InlineJob attribute), 202
__module__ (fastr.exceptions.FastrSourceDataUnavailableError attribute), 94	__module__ (fastr.execution.job.Job attribute), 203
__module__ (fastr.exceptions.FastrStateError attribute), 94	__module__ (fastr.execution.job.JobState attribute), 208
__module__ (fastr.exceptions.FastrSubprocessNotFinished attribute), 94	__module__ (fastr.execution.job.SinkJob attribute), 208
__module__ (fastr.exceptions.FastrToolNotAvailableError attribute), 95	__module__ (fastr.execution.job.SourceJob attribute), 209
__module__ (fastr.exceptions.FastrToolTargetNotFound attribute), 95	__module__ (fastr.execution.linkrun.LinkRun attribute), 211
__module__ (fastr.exceptions.FastrToolUnknownError attribute), 95	__module__ (fastr.execution.macronoderun.MacroNodeRun attribute), 212
__module__ (fastr.exceptions.FastrTypeError attribute), 95	__module__ (fastr.execution.networkanalyzer.DefaultNetworkAnalyzer attribute), 213
__module__ (fastr.exceptions.FastrUnknownURLSchemeError attribute), 95	__module__ (fastr.execution.networkanalyzer.NetworkAnalyzer attribute), 213
__module__ (fastr.exceptions.FastrValueError attribute), 95	__module__ (fastr.execution.networkanalyzer.DefaultNetworkChunker attribute), 213
__module__ (fastr.exceptions.FastrVersionInvalidError attribute), 95	__module__ (fastr.execution.networkanalyzer.NetworkChunker attribute), 214
__module__ (fastr.exceptions.FastrVersionMismatchError attribute), 95	__module__ (fastr.execution.networkchunker.DefaultNetworkChunker attribute), 213
__module__ (fastr.execution.environmentmodules.EnvironmentModules attribute), 186	__module__ (fastr.execution.networkchunker.NetworkChunker attribute), 214
__module__ (fastr.execution.environmentmodules.ModuleSystem attribute), 187	__module__ (fastr.execution.networkchunker.NetworkChunker attribute), 214
	__module__ (fastr.execution.networkrun.NetworkRun attribute), 215
	__module__ (fastr.execution.noderun.NodeRun attribute), 217
	__module__ (fastr.execution.sinknoderun.SinkNodeRun attribute), 219
	__module__ (fastr.execution.sourcenoderun.ConstantNodeRun attribute), 222
	__module__ (fastr.execution.sourcenoderun.SourceNodeRun attribute), 222

- attribute), 221
- __module__ (fastr.plugins.BlockingExecution attribute), 96
- __module__ (fastr.plugins.CommaSeperatedValueFile attribute), 97
- __module__ (fastr.plugins.CrossValidation attribute), 97
- __module__ (fastr.plugins.DRMAAExecution attribute), 97
- __module__ (fastr.plugins.DockerTarget attribute), 98
- __module__ (fastr.plugins.FastrInterface attribute), 100
- __module__ (fastr.plugins.FileSystem attribute), 101
- __module__ (fastr.plugins.FlowInterface attribute), 103
- __module__ (fastr.plugins.LinearExecution attribute), 103
- __module__ (fastr.plugins.LocalBinaryTarget attribute), 105
- __module__ (fastr.plugins.NipypeInterface attribute), 106
- __module__ (fastr.plugins.Null attribute), 106
- __module__ (fastr.plugins.ProcessPoolExecution attribute), 107
- __module__ (fastr.plugins.RQExecution attribute), 107
- __module__ (fastr.plugins.Reference attribute), 108
- __module__ (fastr.plugins.S3Filesystem attribute), 108
- __module__ (fastr.plugins.StrongrExecution attribute), 109
- __module__ (fastr.plugins.VirtualFileSystem attribute), 110
- __module__ (fastr.plugins.VirtualFileSystemRegularExpression attribute), 112
- __module__ (fastr.plugins.VirtualFileSystemValueList attribute), 113
- __module__ (fastr.plugins.XNATStorage attribute), 115
- __module__ (fastr.utils.classproperty.ClassPropertyDescriptor attribute), 226
- __module__ (fastr.utils.filesynchelper.FileSyncHelper attribute), 228
- __module__ (fastr.utils.jsonscemaparser.FastrRefResolver attribute), 229
- __module__ (fastr.utils.pim_publisher.PimPublisher attribute), 231
- __module__ (fastr.utils.schematotable.SchemaPrinter attribute), 232
- __module__ (fastr.web.api.NetworkApi attribute), 238
- __module__ (fastr.web.api.NetworkListApi attribute), 238
- __module__ (fastr.web.api.ObjectUrl attribute), 238
- __module__ (fastr.web.api.Run attribute), 238
- __module__ (fastr.web.api.RunApi attribute), 239
- __module__ (fastr.web.api.RunListApi attribute), 239
- __module__ (fastr.web.api.StatusApi attribute), 239
- __module__ (fastr.web.api.SubUrl attribute), 239
- __module__ (fastr.web.api.ToolApi attribute), 239
- __module__ (fastr.web.api.ToolListApi attribute), 240
- __ne__() (fastr.__init__.Network method), 66
- __ne__() (fastr.core.dimension.Dimension method), 122
- __ne__() (fastr.core.network.Network method), 149
- __ne__() (fastr.datatypes.BaseDataType method), 80
- __ne__() (fastr.execution.networkrun.NetworkRun method), 215
- __new__() (fastr.core.baseplugin.PluginState static method), 120
- __new__() (fastr.core.interface.InputSpec static method), 140
- __new__() (fastr.core.interface.OutputSpec static method), 142
- __new__() (fastr.core.pluginmanager.plugin_option_type static method), 162
- __new__() (fastr.core.samples.SampleBaseId static method), 164
- __new__() (fastr.core.samples.SampleItem static method), 167
- __new__() (fastr.core.samples.SampleItemBase static method), 167
- __new__() (fastr.core.samples.SamplePayload static method), 169
- __new__() (fastr.core.target.SystemUsageInfo static method), 172
- __new__() (fastr.core.updateable.UpdateableMeta static method), 178
- __new__() (fastr.core.version.Version static method), 179
- __new__() (fastr.datatypes.TypeGroup static method), 87
- __new__() (fastr.execution.environmentmodules.ModuleSystem static method), 187
- __new__() (fastr.execution.executionpluginmanager.JobAction static method), 190
- __new__() (fastr.execution.job.JobState static method), 208
- __radd__() (fastr.configmanager.EmptyDefault method), 78
- __radd__() (fastr.core.samples.SampleBaseId method), 164
- __radd__() (fastr.core.samples.SampleValue method), 169
- __reduce_ex__() (fastr.core.baseplugin.PluginState method), 120
- __reduce_ex__() (fastr.datatypes.BaseDataType method), 80
- __reduce_ex__() (fastr.datatypes.EnumType method), 83
- __reduce_ex__() (fastr.execution.environmentmodules.ModuleSystem method), 187
- __reduce_ex__() (fastr.execution.executionpluginmanager.JobAction method), 190
- __reduce_ex__() (fastr.execution.job.JobState method), 208
- __repr__() (fastr.__init__.Link method), 70
- __repr__() (fastr.__init__.Network method), 66
- __repr__() (fastr.__init__.Node method), 72
- __repr__() (fastr.configmanager.Config method), 77

[__repr__\(\)](#) (fastr.core.basemanager.BaseManager method), 117
[__repr__\(\)](#) (fastr.core.baseplugin.BasePlugin method), 118
[__repr__\(\)](#) (fastr.core.baseplugin.PluginMeta method), 119
[__repr__\(\)](#) (fastr.core.baseplugin.PluginState method), 120
[__repr__\(\)](#) (fastr.core.dimension.Dimension method), 122
[__repr__\(\)](#) (fastr.core.inputoutput.BaseInputOutput method), 129
[__repr__\(\)](#) (fastr.core.link.Link method), 147
[__repr__\(\)](#) (fastr.core.network.Network method), 149
[__repr__\(\)](#) (fastr.core.node.Node method), 155
[__repr__\(\)](#) (fastr.core.pluginmanager.LazyModule method), 161
[__repr__\(\)](#) (fastr.core.pluginmanager.plugin_option_type method), 162
[__repr__\(\)](#) (fastr.core.samples.SampleBaseId method), 165
[__repr__\(\)](#) (fastr.core.samples.SampleCollection method), 166
[__repr__\(\)](#) (fastr.core.samples.SampleIndex method), 166
[__repr__\(\)](#) (fastr.core.samples.SampleItemBase method), 168
[__repr__\(\)](#) (fastr.core.samples.SampleValue method), 169
[__repr__\(\)](#) (fastr.core.target.SystemUsageInfo method), 172
[__repr__\(\)](#) (fastr.core.tool.Tool method), 174
[__repr__\(\)](#) (fastr.core.version.Version method), 180
[__repr__\(\)](#) (fastr.datatypes.BaseDataType method), 80
[__repr__\(\)](#) (fastr.datatypes.Deferred method), 82
[__repr__\(\)](#) (fastr.exceptions.FastrSerializationError method), 93
[__repr__\(\)](#) (fastr.execution.environmentmodules.EnvironmentModules method), 186
[__repr__\(\)](#) (fastr.execution.environmentmodules.ModuleSystem method), 187
[__repr__\(\)](#) (fastr.execution.executionpluginmanager.JobAction method), 190
[__repr__\(\)](#) (fastr.execution.job.Job method), 203
[__repr__\(\)](#) (fastr.execution.job.JobState method), 208
[__repr__\(\)](#) (fastr.execution.job.SinkJob method), 208
[__repr__\(\)](#) (fastr.execution.job.SourceJob method), 209
[__repr__\(\)](#) (fastr.execution.linkrun.LinkRun method), 211
[__repr__\(\)](#) (fastr.execution.networkrun.NetworkRun method), 215
[__repr__\(\)](#) (fastr.execution.noderun.NodeRun method), 217
[__rrshift__\(\)](#) (fastr.core.inputoutput.BaseInput method), 128
[__schema_type__](#) (fastr.web.api.ObjectUrl attribute), 238
[__schema_type__](#) (fastr.web.api.SubUrl attribute), 239
[__setitem__\(\)](#) (fastr.configmanager.EmptyDefault method), 78
[__setitem__\(\)](#) (fastr.core.basemanager.BaseManager method), 118
[__setitem__\(\)](#) (fastr.core.inputgroup.InputGroup method), 124
[__setitem__\(\)](#) (fastr.core.inputoutput.Input method), 131
[__setitem__\(\)](#) (fastr.core.node.InputDict method), 154
[__setitem__\(\)](#) (fastr.core.node.OutputDict method), 157
[__setitem__\(\)](#) (fastr.core.pluginmanager.PluginManager method), 161
[__setitem__\(\)](#) (fastr.core.pluginmanager.PluginsView method), 162
[__setitem__\(\)](#) (fastr.core.samples.ContainsSamples method), 164
[__setitem__\(\)](#) (fastr.core.samples.SampleCollection method), 166
[__setitem__\(\)](#) (fastr.core.samples.SampleValue method), 169
[__setitem__\(\)](#) (fastr.execution.inputoutputrun.OutputRun method), 195
[__setitem__\(\)](#) (fastr.execution.inputoutputrun.SourceOutputRun method), 198
[__setitem__\(\)](#) (fastr.execution.inputoutputrun.SubOutputRun method), 201
[__setstate__\(\)](#) (fastr.__init__.ConstantNode method), 74
[__setstate__\(\)](#) (fastr.__init__.Link method), 70
[__setstate__\(\)](#) (fastr.__init__.Network method), 66
[__setstate__\(\)](#) (fastr.__init__.Node method), 72
[__setstate__\(\)](#) (fastr.__init__.SinkNode method), 76
[__setstate__\(\)](#) (fastr.__init__.SourceNode method), 75
[__setstate__\(\)](#) (fastr.core.inputoutput.BaseInputOutput method), 129
[__setstate__\(\)](#) (fastr.core.inputoutput.Input method), 131
[__setstate__\(\)](#) (fastr.core.inputoutput.Output method), 134
[__setstate__\(\)](#) (fastr.core.inputoutput.SubInput method), 137
[__setstate__\(\)](#) (fastr.core.inputoutput.SubOutput method), 139
[__setstate__\(\)](#) (fastr.core.interface.Interface method), 141
[__setstate__\(\)](#) (fastr.core.link.Link method), 147
[__setstate__\(\)](#) (fastr.core.network.Network method), 149
[__setstate__\(\)](#) (fastr.core.node.ConstantNode method), 153
[__setstate__\(\)](#) (fastr.core.node.MacroNode method), 154
[__setstate__\(\)](#) (fastr.core.node.Node method), 156
[__setstate__\(\)](#) (fastr.core.node.SinkNode method), 158
[__setstate__\(\)](#) (fastr.core.node.SourceNode method), 159
[__setstate__\(\)](#) (fastr.core.samples.SampleValue method), 169
[__setstate__\(\)](#) (fastr.core.tool.Tool method), 174
[__setstate__\(\)](#) (fastr.core.updateable.Updateable method),

- 177
- `__setstate__()` (fastr.datatypes.BaseDataType method), 80
 - `__setstate__()` (fastr.datatypes.Deferred method), 82
 - `__setstate__()` (fastr.execution.inputoutputrun.InputRun method), 193
 - `__setstate__()` (fastr.execution.inputoutputrun.OutputRun method), 195
 - `__setstate__()` (fastr.execution.inputoutputrun.SubInputRun method), 199
 - `__setstate__()` (fastr.execution.inputoutputrun.SubOutputRun method), 201
 - `__setstate__()` (fastr.execution.job.Job method), 203
 - `__setstate__()` (fastr.execution.linkrun.LinkRun method), 211
 - `__setstate__()` (fastr.execution.macronoderun.MacroNodeRun method), 212
 - `__setstate__()` (fastr.execution.networkrun.NetworkRun method), 215
 - `__setstate__()` (fastr.execution.noderun.NodeRun method), 217
 - `__setstate__()` (fastr.execution.sinknoderun.SinkNodeRun method), 219
 - `__setstate__()` (fastr.execution.sourcenoderun.ConstantNodeRun method), 222
 - `__setstate__()` (fastr.execution.sourcenoderun.SourceNodeRun method), 221
 - `__setstate__()` (fastr.plugins.FastrInterface method), 100
 - `__setstate__()` (fastr.plugins.FlowInterface method), 103
 - `__setstate__()` (fastr.plugins.NipypeInterface method), 106
 - `__slotnames__` (fastr.web.api.ObjectUrl attribute), 238
 - `__slots__` (fastr.core.pluginmanager.plugin_option_type attribute), 163
 - `__slots__` (fastr.core.target.SystemUsageInfo attribute), 172
 - `__str__()` (fastr.__init__.Node method), 73
 - `__str__()` (fastr.core.baseplugin.BasePlugin method), 118
 - `__str__()` (fastr.core.baseplugin.PluginState method), 120
 - `__str__()` (fastr.core.inputoutput.Input method), 132
 - `__str__()` (fastr.core.inputoutput.Output method), 134
 - `__str__()` (fastr.core.inputoutput.SubInput method), 137
 - `__str__()` (fastr.core.inputoutput.SubOutput method), 139
 - `__str__()` (fastr.core.node.Node method), 156
 - `__str__()` (fastr.core.samples.SampleBaseId method), 165
 - `__str__()` (fastr.core.samples.SampleIndex method), 166
 - `__str__()` (fastr.core.tool.Tool method), 174
 - `__str__()` (fastr.core.version.Version method), 180
 - `__str__()` (fastr.datatypes.BaseDataType method), 80
 - `__str__()` (fastr.datatypes.Boolean method), 81
 - `__str__()` (fastr.exceptions.FastrError method), 90
 - `__str__()` (fastr.exceptions.FastrExecutableNotFoundError method), 90
 - `__str__()` (fastr.exceptions.FastrSerializationError method), 93
 - `__str__()` (fastr.execution.environmentmodules.ModuleSystem method), 187
 - `__str__()` (fastr.execution.executionpluginmanager.JobAction method), 190
 - `__str__()` (fastr.execution.inputoutputrun.InputRun method), 193
 - `__str__()` (fastr.execution.inputoutputrun.OutputRun method), 196
 - `__str__()` (fastr.execution.inputoutputrun.SubInputRun method), 199
 - `__str__()` (fastr.execution.inputoutputrun.SubOutputRun method), 201
 - `__str__()` (fastr.execution.job.JobState method), 208
 - `__str__()` (fastr.execution.noderun.NodeRun method), 217
 - `__str__()` (fastr.utils.schematotable.SchemaPrinter method), 232
 - `__updatefunc__()` (fastr.core.inputgroup.InputGroup method), 124
 - `__updatefunc__()` (fastr.core.updateable.Updateable method), 177
 - `__updateinprogress__` (fastr.core.updateable.Updateable attribute), 177
 - `__updatetriggers__` (fastr.core.inputgroup.InputGroup attribute), 124
 - `__updatetriggers__` (fastr.core.updateable.Updateable attribute), 178
 - `__updating__` (fastr.core.updateable.Updateable attribute), 178
 - `__weakref__` (fastr.configmanager.Config attribute), 77
 - `__weakref__` (fastr.configmanager.EmptyDefault attribute), 78
 - `__weakref__` (fastr.core.baseplugin.BasePlugin attribute), 118
 - `__weakref__` (fastr.core.dimension.Dimension attribute), 122
 - `__weakref__` (fastr.core.dimension.HasDimensions attribute), 123
 - `__weakref__` (fastr.core.interface.InterfaceResult attribute), 141
 - `__weakref__` (fastr.core.pluginmanager.LazyModule attribute), 161
 - `__weakref__` (fastr.core.provenance.Provenance attribute), 163
 - `__weakref__` (fastr.core.serializable.PassThroughSerializer attribute), 170
 - `__weakref__` (fastr.core.serializable.Serializable attribute), 170
 - `__weakref__` (fastr.core.updateable.Updateable attribute), 178
 - `__weakref__` (fastr.exceptions.FastrError attribute), 90
 - `__weakref__` (fastr.exceptions.FastrIOError attribute), 90
 - `__weakref__` (fastr.exceptions.FastrOSError attribute), 92
 - `__weakref__` (fastr.execution.environmentmodules.EnvironmentModules

attribute), 186
 __weakref__ (fastr.execution.networkanalyzer.NetworkAnalyzer attribute), 213
 __weakref__ (fastr.execution.networkchunker.NetworkChunker attribute), 214
 __weakref__ (fastr.utils.classproperty.ClassPropertyDescriptor attribute), 226
 __weakref__ (fastr.utils.pim_publisher.PimPublisher attribute), 231
 __weakref__ (fastr.utils.schematatable.SchemaPrinter attribute), 232
 __weakref__ (fastr.web.api.Run attribute), 238
 _item_extension() (fastr.core.basemanager.BaseManager method), 116
 _load_item() (fastr.core.basemanager.BaseManager method), 116

A

abort() (fastr.execution.networkrun.NetworkRun method), 215
 abort() (fastr.web.api.Run method), 238
 abstract (fastr.plugins.VirtualFileSystem attribute), 110
 action() (fastr.datatypes.DataType method), 81
 action() (fastr.datatypes.Directory method), 83
 activity() (fastr.core.provenance.Provenance method), 163
 add_link() (fastr.__init__.Network method), 66
 add_link() (fastr.core.network.Network method), 149
 add_link() (fastr.Network method), 62
 add_node() (fastr.__init__.Network method), 67
 add_node() (fastr.core.network.Network method), 149
 add_node() (fastr.Network method), 62
 add_parser_doc_link() (in module fastr.utils.cmd), 235
 add_stepid() (fastr.__init__.Network method), 67
 add_stepid() (fastr.core.network.Network method), 149
 AdvancedFlowNode (class in fastr.core.node), 152
 AdvancedFlowNodeRun (class in fastr.execution.flownoderun), 191
 AdvancedFlowOutput (class in fastr.core.inputoutput), 128
 AdvancedFlowOutputRun (class in fastr.execution.inputoutputrun), 192
 agent() (fastr.core.provenance.Provenance method), 163
 aggregate() (fastr.core.target.ProcessUsageCollection method), 172
 analyze_network() (fastr.execution.networkanalyzer.DefaultNetworkAnalyzer method), 213
 analyze_network() (fastr.execution.networkanalyzer.NetworkAnalyzer method), 213
 AnalyzeImageFile (class in fastr.datatypes), 79
 any_of_draft4() (in module fastr.utils.jsonschemaresolver), 229
 AnyFile (class in fastr.datatypes), 79
 AnyType (class in fastr.datatypes), 79

append() (fastr.configmanager.EmptyDefault method), 78
 append() (fastr.core.inputoutput.Input method), 132
 append() (fastr.core.target.ProcessUsageCollection method), 172
 asdict() (fastr.configmanager.EmptyDefault method), 78
 aslist() (fastr.configmanager.EmptyDefault method), 78
 authors (fastr.core.tool.Tool attribute), 175
 automatic (fastr.core.inputoutput.BaseOutput attribute), 130
 automatic (fastr.execution.inputoutputrun.OutputRun attribute), 196
 avail() (fastr.execution.environmentmodules.EnvironmentModules method), 186
 avail_modules (fastr.execution.environmentmodules.EnvironmentModules attribute), 186

B

BaseDataType (class in fastr.datatypes), 79
 BaseInput (class in fastr.core.inputoutput), 128
 BaseInputGroupCombiner (class in fastr.core.inputgroupcombiner), 126
 BaseInputOutput (class in fastr.core.inputoutput), 129
 BaseInputRun (class in fastr.execution.inputoutputrun), 192
 BaseManager (class in fastr.core.basemanager), 116
 basename() (in module fastr.data.url), 181
 BaseOutput (class in fastr.core.inputoutput), 130
 BasePlugin (class in fastr.core.baseplugin), 118
 BasePluginManager (class in fastr.core.pluginmanager), 160
 blocking (fastr.__init__.Node attribute), 73
 blocking (fastr.core.inputoutput.Output attribute), 134
 blocking (fastr.core.node.FlowNode attribute), 154
 blocking (fastr.core.node.Node attribute), 156
 blocking (fastr.execution.flownoderun.FlowNodeRun attribute), 191
 blocking (fastr.execution.inputoutputrun.OutputRun attribute), 196
 blocking (fastr.execution.noderun.NodeRun attribute), 217
 BlockingExecution (class in fastr.plugins), 95
 Boolean (class in fastr.datatypes), 81
 build (fastr.core.version.Version attribute), 180

C

cancel_network_analyze() (fastr.execution.job.Job static method), 203
 cancel() (fastr.core.updateable.UpdateableMeta class method), 178
 call_subprocess() (fastr.plugins.LocalBinaryTarget method), 105
 cancel (fastr.execution.executionpluginmanager.JobAction attribute), 190

- cancel_job() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- cancelled (fastr.execution.job.JobState attribute), 208
- CANCELS_DEPENDENCIES (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 188
- CANCELS_DEPENDENCIES (fastr.plugins.DRMAAExecution attribute), 97
- cardinality (fastr.core.samples.SampleItemBase attribute), 168
- cardinality() (fastr.__init__.Link method), 70
- cardinality() (fastr.core.inputoutput.BaseInputOutput method), 129
- cardinality() (fastr.core.inputoutput.Input method), 132
- cardinality() (fastr.core.inputoutput.Output method), 134
- cardinality() (fastr.core.inputoutput.SourceOutput method), 136
- cardinality() (fastr.core.inputoutput.SubInput method), 137
- cardinality() (fastr.core.inputoutput.SubOutput method), 139
- cardinality() (fastr.core.link.Link method), 147
- cardinality() (fastr.execution.inputoutputrun.InputRun method), 193
- cardinality() (fastr.execution.inputoutputrun.OutputRun method), 196
- cardinality() (fastr.execution.inputoutputrun.SourceOutputRun method), 198
- cardinality() (fastr.execution.inputoutputrun.SubInputRun method), 199
- cardinality() (fastr.execution.inputoutputrun.SubOutputRun method), 201
- cardinality() (fastr.execution.linkrun.LinkRun method), 211
- cardinality_from_nargs() (in module fastr.utils.cmd.extract_argparse), 235
- cast() (fastr.core.samples.SampleValue method), 169
- check_cardinality() (fastr.core.inputoutput.BaseInputOutput method), 130
- check_finished() (fastr.plugins.RQExecution method), 107
- check_finished() (fastr.plugins.StrongrExecution method), 109
- check_id() (fastr.__init__.Network method), 67
- check_id() (fastr.core.network.Network method), 149
- check_id() (fastr.execution.networkrun.NetworkRun method), 215
- check_input_id() (fastr.plugins.FastrInterface method), 100
- check_job_requirements() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- check_job_status() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- check_network() (in module fastr.utils.cmd.test), 236
- check_networks() (in module fastr.utils.cmd.test), 236
- check_output_id() (fastr.plugins.FastrInterface method), 100
- check_tool() (in module fastr.utils.cmd.test), 236
- check_tools() (in module fastr.utils.cmd.test), 236
- checksum() (fastr.datatypes.BaseDataType method), 80
- checksum() (fastr.datatypes.Deferred method), 82
- checksum() (fastr.datatypes.FilePrefix method), 83
- checksum() (fastr.datatypes.JsonFile method), 84
- checksum() (fastr.datatypes.MetaImageFile method), 85
- checksum() (fastr.datatypes.URLType method), 87
- checksum() (in module fastr.utils.checksum), 224
- checksum_directory() (in module fastr.utils.checksum), 225
- chunk_network() (fastr.execution.networkchunker.DefaultNetworkChunker method), 213
- chunk_network() (fastr.execution.networkchunker.NetworkChunker method), 214
- cite (fastr.core.tool.Tool attribute), 175
- classproperty() (in module fastr.utils.classproperty), 226
- ClassPropertyDescriptor (class in fastr.utils.classproperty), 226
- cleanup() (fastr.core.baseplugin.BasePlugin method), 119
- cleanup() (fastr.core.ioplugin.IOPlugin method), 142
- cleanup() (fastr.core.ioplugin.IOPluginManager method), 144
- cleanup() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- cleanup() (fastr.plugins.BlockingExecution method), 96
- cleanup() (fastr.plugins.DRMAAExecution method), 97
- cleanup() (fastr.plugins.LinearExecution method), 103
- cleanup() (fastr.plugins.ProcessPoolExecution method), 107
- cleanup() (fastr.plugins.RQExecution method), 107
- cleanup() (fastr.plugins.S3Filesystem method), 108
- cleanup() (fastr.plugins.StrongrExecution method), 109
- cleanup() (fastr.plugins.XNATStorage method), 115
- clear() (fastr.core.inputgroup.InputGroup method), 124
- clear() (fastr.core.inputoutput.Input method), 132
- clear() (fastr.execution.environmentmodules.EnvironmentModules method), 186
- clear_version() (in module fastr.version), 115
- collapse (fastr.__init__.Link attribute), 70
- collapse (fastr.core.link.Link attribute), 147
- collapse (fastr.execution.linkrun.LinkRun attribute), 211
- collapse_indexes (fastr.__init__.Link attribute), 71
- collapse_indexes (fastr.core.link.Link attribute), 147
- collapse_indexes (fastr.execution.linkrun.LinkRun attribute), 211
- collect_errors() (fastr.plugins.FastrInterface static method), 100
- collect_provenance() (fastr.plugins.FastrInterface static method), 100

(fastr.core.provenance.Provenance method), 163

collect_jobs() (fastr.plugins.DRMAAExecution method), 97

collect_provenance() (fastr.core.provenance.Provenance method), 163

collect_results() (fastr.plugins.FastrInterface method), 100

collector_plugin_type (fastr.plugins.FastrInterface attribute), 100

collectors (fastr.plugins.FastrInterface attribute), 100

combine() (fastr.core.samples.SampleItemBase static method), 168

combine_dimensions() (fastr.core.dimension.ForwardsDimensions method), 123

command (fastr.core.tool.Tool attribute), 175

COMMAND_DUMP (fastr.execution.job.Job attribute), 202

command_version (fastr.core.tool.Tool attribute), 175

commandfile (fastr.execution.job.Job attribute), 203

commandurl (fastr.execution.job.Job attribute), 203

CommaSeperatedValueFile (class in fastr.plugins), 96

compare_execution_dir() (in module fastr.utils.compare), 226

compare_job_dirs() (in module fastr.utils.compare), 226

compare_job_output_data() (in module fastr.utils.compare), 226

compare_output_data() (fastr.core.tool.Tool static method), 175

compare_set() (in module fastr.utils.compare), 226

compare_value_dict_item() (in module fastr.utils.compare), 227

compare_value_list() (in module fastr.utils.compare), 227

Config (class in fastr.configmanager), 77

configuration_fields (fastr.core.baseplugin.BasePlugin attribute), 119

configuration_fields (fastr.plugins.DRMAAExecution attribute), 98

configuration_fields (fastr.plugins.ProcessPoolExecution attribute), 107

configuration_fields (fastr.plugins.RQExecution attribute), 107

configuration_fields (fastr.plugins.StrongrExecution attribute), 109

connect() (fastr.plugins.XNATStorage method), 115

constantlist (fastr.execution.networkrun.NetworkRun attribute), 215

ConstantNode (class in fastr.__init__), 74

ConstantNode (class in fastr.core.node), 152

ConstantNodeRun (class in fastr.__init__), 65

ConstantNodeRun (class in fastr.execution.sourcenoderun), 221

container (fastr.plugins.DockerTarget attribute), 99

ContainsSamples (class in fastr.core.samples), 164

content() (fastr.datatypes.AnalyzeImageFile class method), 79

content() (fastr.datatypes.MetaImageFile class method), 85

content() (fastr.datatypes.URLType class method), 87

copy_file_dir() (fastr.plugins.VirtualFileSystem static method), 110

cpu_percent (fastr.core.target.SystemUsageInfo attribute), 173

create_constant() (fastr.__init__.Network method), 67

create_constant() (fastr.core.network.Network method), 150

create_enumtype() (fastr.core.datatypemanager.DataTypeManager method), 144

create_ioplugintool() (fastr.core.ioplugintool.IOPuginManager static method), 144

create_job() (fastr.execution.noderun.NodeRun method), 217

create_job() (fastr.execution.sinknoderun.SinkNodeRun method), 219

create_job() (fastr.execution.sourcenoderun.SourceNodeRun method), 221

create_link() (fastr.__init__.Network method), 67

create_link() (fastr.core.network.Network method), 150

create_link() (fastr.Network method), 62

create_link_from() (fastr.core.inputoutput.BaseInput method), 128

create_macro() (fastr.__init__.Network method), 68

create_macro() (fastr.core.network.Network method), 150

create_macro_network() (in module fastr.examples.macro_node), 185

create_macro_network() (in module fastr.examples.macro_node2), 185

create_native_spec() (fastr.plugins.DRMAAExecution method), 98

create_network() (in module fastr.examples.add_ints), 183

create_network() (in module fastr.examples.add_ints_s3), 183

create_network() (in module fastr.examples.auto_prefix), 183

create_network() (in module fastr.examples.collapse), 183

create_network() (in module fastr.examples.collapse_expand), 183

create_network() (in module fastr.examples.cross_validation), 184

create_network() (in module fastr.examples.elastix_nipype), 184

create_network() (in module fastr.examples.expand), 184

create_network() (in module fastr.examples.failing_network), 184

create_network() (in module fastr.examples.filecopy), 184

- `create_network()` (in module `fastr.examples.input_groups`), 184
 - `create_network()` (in module `fastr.examples.macro_node`), 185
 - `create_network()` (in module `fastr.examples.macro_node2`), 185
 - `create_network()` (in module `fastr.examples.shift_links`), 185
 - `create_network()` (in module `fastr.examples.source_sink`), 185
 - `create_network_parser()` (in module `fastr.utils.cmd.run`), 236
 - `create_node()` (`fastr.__init__.Network` method), 68
 - `create_node()` (`fastr.core.network.Network` method), 150
 - `create_node()` (`fastr.Network` method), 62
 - `create_output_cardinality()` (`fastr.core.inputoutput.Output` static method), 135
 - `create_output_cardinality()` (`fastr.execution.inputoutputrun.OutputRun` static method), 196
 - `create_payload()` (`fastr.execution.job.Job` method), 203
 - `create_payload()` (`fastr.execution.job.SinkJob` method), 208
 - `create_reference()` (`fastr.__init__.Network` method), 68
 - `create_reference()` (`fastr.core.network.Network` method), 150
 - `create_reference()` (`fastr.core.tool.Tool` method), 175
 - `create_reference()` (in module `fastr.examples.__generate_reference__`), 183
 - `create_rest_table()` (in module `fastr.utils.rest_generation`), 232
 - `create_sink()` (`fastr.__init__.Network` method), 68
 - `create_sink()` (`fastr.core.network.Network` method), 150
 - `create_sink()` (`fastr.Network` method), 63
 - `create_source()` (`fastr.__init__.Network` method), 68
 - `create_source()` (`fastr.core.network.Network` method), 151
 - `create_source()` (`fastr.Network` method), 63
 - `create_super_macro_node()` (in module `fastr.examples.macro_node`), 185
 - `create_vfs_url()` (in module `fastr.data.url`), 181
 - `create_zip()` (in module `fastr.utils.cmd.dump`), 235
 - `created` (`fastr.execution.job.JobState` attribute), 208
 - `createobj()` (`fastr.__init__.Link` class method), 71
 - `createobj()` (`fastr.__init__.Node` class method), 73
 - `createobj()` (`fastr.core.link.Link` class method), 147
 - `createobj()` (`fastr.core.node.Node` class method), 156
 - `createobj()` (`fastr.core.serializable.Serializable` class method), 170
 - `createobj()` (`fastr.execution.linkrun.LinkRun` class method), 211
 - `createobj()` (`fastr.execution.noderun.NodeRun` class method), 217
 - `CrossValidation` (class in `fastr.plugins`), 97
- ## D
- `data` (`fastr.__init__.ConstantNode` attribute), 75
 - `data` (`fastr.core.basemanager.BaseManager` attribute), 118
 - `data` (`fastr.core.node.ConstantNode` attribute), 153
 - `data` (`fastr.core.pluginmanager.PluginSubManager` attribute), 162
 - `data` (`fastr.core.samples.SampleItemBase` attribute), 168
 - `data` (`fastr.execution.sourcenoderun.ConstantNodeRun` attribute), 222
 - `data_uri()` (`fastr.core.provenance.Provenance` static method), 163
 - `DataType` (class in `fastr.datatypes`), 81
 - `datatype` (`fastr.__init__.SinkNode` attribute), 76
 - `datatype` (`fastr.__init__.SourceNode` attribute), 76
 - `datatype` (`fastr.core.inputoutput.BaseInputOutput` attribute), 130
 - `datatype` (`fastr.core.inputoutput.Input` attribute), 132
 - `datatype` (`fastr.core.inputoutput.Output` attribute), 135
 - `datatype` (`fastr.core.inputoutput.SubOutput` attribute), 140
 - `datatype` (`fastr.core.node.SinkNode` attribute), 158
 - `datatype` (`fastr.core.node.SourceNode` attribute), 159
 - `datatype` (`fastr.execution.inputoutputrun.InputRun` attribute), 193
 - `datatype` (`fastr.execution.inputoutputrun.OutputRun` attribute), 196
 - `datatype` (`fastr.execution.inputoutputrun.SubOutputRun` attribute), 201
 - `datatype` (`fastr.execution.sinknoderun.SinkNodeRun` attribute), 219
 - `datatype` (`fastr.execution.sourcenoderun.SourceNodeRun` attribute), 221
 - `datatype_from_type()` (in module `fastr.utils.cmd.extract_argparse`), 235
 - `DataTypeManager` (class in `fastr.core.datatypemanager`), 120
 - `date_version_matcher` (`fastr.core.version.Version` attribute), 180
 - `debug` (`fastr.configmanager.Config` attribute), 77
 - `DEFAULT_FIELDS` (`fastr.configmanager.Config` attribute), 77
 - `DefaultInputGroupCombiner` (class in `fastr.core.inputgroupcombiner`), 127
 - `DefaultNetworkAnalyzer` (class in `fastr.execution.networkanalyzer`), 213
 - `DefaultNetworkChunker` (class in `fastr.execution.networkchunker`), 213
 - `Deferred` (class in `fastr.datatypes`), 81
 - `delete()` (`fastr.web.api.RunApi` method), 239
 - `descend()` (`fastr.utils.schematatable.SchemaPrinter` method), 232
 - `description` (`fastr.core.inputoutput.BaseInputOutput` attribute), 130

- description (fastr.core.inputoutput.SubInput attribute), 137
- description (fastr.core.tool.Tool attribute), 175
- description (fastr.datatypes.AnalyzeImageFile attribute), 79
- description (fastr.datatypes.AnyFile attribute), 79
- description (fastr.datatypes.AnyType attribute), 79
- description (fastr.datatypes.BaseDataType attribute), 80
- description (fastr.datatypes.Boolean attribute), 81
- description (fastr.datatypes.Directory attribute), 83
- description (fastr.datatypes.EnumType attribute), 83
- description (fastr.datatypes.FilePrefix attribute), 84
- description (fastr.datatypes.Float attribute), 84
- description (fastr.datatypes.Int attribute), 84
- description (fastr.datatypes.ITKImageFile attribute), 84
- description (fastr.datatypes.JsonFile attribute), 84
- description (fastr.datatypes.MetaImageFile attribute), 85
- description (fastr.datatypes.NiftiImageFile attribute), 85
- description (fastr.datatypes.NiftiImageFileCompressed attribute), 85
- description (fastr.datatypes.NiftiImageFileUncompressed attribute), 85
- description (fastr.datatypes.Number attribute), 86
- description (fastr.datatypes.ProvNFile attribute), 86
- description (fastr.datatypes.String attribute), 86
- description (fastr.datatypes.TifImageFile attribute), 86
- description (fastr.datatypes.TxtFile attribute), 86
- description (fastr.datatypes.UnsignedInt attribute), 88
- description (fastr.execution.inputoutputrun.SubInputRun attribute), 199
- destroy() (fastr.__init__.Link method), 71
- destroy() (fastr.core.link.Link method), 147
- destroy() (fastr.execution.linkrun.LinkRun method), 211
- dicteq() (in module fastr.utils.dicteq), 227
- diffdict() (in module fastr.utils.dicteq), 227
- diffobj() (in module fastr.utils.dicteq), 227
- diffobj_str() (in module fastr.utils.dicteq), 227
- Dimension (class in fastr.core.dimension), 122
- dimensionality (fastr.core.samples.SampleItemBase attribute), 168
- dimensions (fastr.__init__.Link attribute), 71
- dimensions (fastr.__init__.Node attribute), 73
- dimensions (fastr.__init__.SourceNode attribute), 76
- dimensions (fastr.core.dimension.ForwardsDimensions attribute), 123
- dimensions (fastr.core.dimension.HasDimensions attribute), 123
- dimensions (fastr.core.inputgroup.InputGroup attribute), 125
- dimensions (fastr.core.inputgroupcombiner.BaseInputGroupCombiner attribute), 126
- dimensions (fastr.core.inputoutput.AdvancedFlowOutput attribute), 128
- dimensions (fastr.core.inputoutput.Input attribute), 132
- dimensions (fastr.core.inputoutput.MacroOutput attribute), 133
- dimensions (fastr.core.inputoutput.Output attribute), 135
- dimensions (fastr.core.inputoutput.SubInput attribute), 137
- dimensions (fastr.core.link.Link attribute), 148
- dimensions (fastr.core.node.FlowNode attribute), 154
- dimensions (fastr.core.node.Node attribute), 156
- dimensions (fastr.core.node.SourceNode attribute), 159
- dimensions (fastr.core.samples.ContainsSamples attribute), 164
- dimensions (fastr.core.samples.SampleCollection attribute), 166
- dimensions (fastr.execution.inputoutputrun.InputRun attribute), 193
- dimensions (fastr.execution.inputoutputrun.MacroOutputRun attribute), 194
- dimensions (fastr.execution.inputoutputrun.SourceOutputRun attribute), 198
- dimensions (fastr.execution.inputoutputrun.SubInputRun attribute), 199
- dimensions (fastr.execution.linkrun.LinkRun attribute), 212
- dimnames (fastr.__init__.Node attribute), 73
- dimnames (fastr.core.dimension.HasDimensions attribute), 123
- dimnames (fastr.core.node.Node attribute), 156
- dimnames (fastr.execution.flownoderun.FlowNodeRun attribute), 191
- dimnames (fastr.execution.noderun.NodeRun attribute), 217
- dimnames (fastr.execution.sourcenoderun.SourceNodeRun attribute), 221
- dir_list() (in module fastr.utils.clear_pycs), 226
- Directory (class in fastr.datatypes), 82
- directory() (in module fastr.utils.cmd.test), 236
- dirname() (in module fastr.data.url), 181
- dirurl() (in module fastr.data.url), 181
- doc() (in module fastr.web.views), 240
- DockerTarget (class in fastr.plugins), 98
- done (fastr.execution.job.JobState attribute), 208
- draw() (fastr.__init__.ConstantNode method), 75
- draw() (fastr.__init__.Link method), 71
- draw() (fastr.__init__.Network method), 68
- draw() (fastr.__init__.Node method), 73
- draw() (fastr.__init__.SinkNode method), 77
- draw() (fastr.__init__.SourceNode method), 76
- draw() (fastr.core.link.Link method), 148
- draw() (fastr.core.network.Network method), 151
- draw() (fastr.core.node.ConstantNode method), 153
- draw() (fastr.core.node.MacroNode method), 154
- draw() (fastr.core.node.Node method), 156
- draw() (fastr.core.node.SinkNode method), 158
- draw() (fastr.core.node.SourceNode method), 159

- [draw_id\(\) \(fastr.__init__.Node method\), 73](#)
[draw_id\(\) \(fastr.core.node.Node method\), 156](#)
[draw_link_target\(\) \(fastr.__init__.Node method\), 73](#)
[draw_link_target\(\) \(fastr.core.node.MacroNode method\), 154](#)
[draw_link_target\(\) \(fastr.core.node.Node method\), 156](#)
[draw_network\(\) \(fastr.__init__.Network method\), 68](#)
[draw_network\(\) \(fastr.core.network.Network method\), 151](#)
[draw_network\(\) \(fastr.Network method\), 63](#)
[DRMAAExecution \(class in fastr.plugins\), 97](#)
[dump\(\) \(fastr.core.serializable.Serializable method\), 170](#)
[dump\(\) \(in module fastr.utils.xmltodict\), 234](#)
[dumpf\(\) \(fastr.core.serializable.Serializable method\), 170](#)
[dumpfuncs \(fastr.core.serializable.Serializable attribute\), 171](#)
[dumps\(\) \(fastr.core.serializable.PassThroughSerializer static method\), 170](#)
[dumps\(\) \(fastr.core.serializable.Serializable method\), 171](#)
[dumps\(\) \(in module fastr.utils.xmltodict\), 234](#)
[DYNAMIC_LIBRARY_PATH_DICT \(fastr.plugins.LocalBinaryTarget attribute\), 105](#)
- ## E
- [empty \(fastr.core.inputgroup.InputGroup attribute\), 125](#)
[EmptyDefault \(class in fastr.configmanager\), 78](#)
[endpoint \(fastr.web.api.NetworkApi attribute\), 238](#)
[endpoint \(fastr.web.api.NetworkListApi attribute\), 238](#)
[endpoint \(fastr.web.api.RunApi attribute\), 239](#)
[endpoint \(fastr.web.api.RunListApi attribute\), 239](#)
[endpoint \(fastr.web.api.StatusApi attribute\), 239](#)
[endpoint \(fastr.web.api.ToolApi attribute\), 239](#)
[endpoint \(fastr.web.api.ToolListApi attribute\), 240](#)
[ensure_tmp_dir\(\) \(fastr.execution.job.Job method\), 203](#)
[entity\(\) \(fastr.core.provenance.Provenance method\), 163](#)
[EnumType \(class in fastr.datatypes\), 83](#)
[EnvironmentModules \(class in fastr.execution.environmentmodules\), 186](#)
[envmod \(fastr.execution.environmentmodules.ModuleSystem attribute\), 187](#)
[examplesdir \(fastr.configmanager.Config attribute\), 77](#)
[exception \(fastr.execution.environmentmodules.EnvironmentModules attribute\), 186](#)
[excerpt\(\) \(fastr.exceptions.FastrError method\), 90](#)
[exec_worker\(\) \(fastr.plugins.LinearExecution method\), 103](#)
[execute\(\) \(fastr.__init__.Network method\), 69](#)
[execute\(\) \(fastr.core.interface.Interface method\), 141](#)
[execute\(\) \(fastr.core.network.Network method\), 151](#)
[execute\(\) \(fastr.core.tool.Tool method\), 175](#)
[execute\(\) \(fastr.execution.flownoderun.AdvancedFlowNodeRun method\), 191](#)
[execute\(\) \(fastr.execution.job.Job method\), 203](#)
[execute\(\) \(fastr.execution.macronoderun.MacroNodeRun method\), 212](#)
[execute\(\) \(fastr.execution.networkrun.NetworkRun method\), 215](#)
[execute\(\) \(fastr.execution.noderun.NodeRun method\), 217](#)
[execute\(\) \(fastr.execution.sinknoderun.SinkNodeRun method\), 219](#)
[execute\(\) \(fastr.execution.sourcenoderun.ConstantNodeRun method\), 222](#)
[execute\(\) \(fastr.execution.sourcenoderun.SourceNodeRun method\), 221](#)
[execute\(\) \(fastr.plugins.CrossValidation static method\), 97](#)
[execute\(\) \(fastr.plugins.FastrInterface method\), 100](#)
[execute\(\) \(fastr.plugins.FlowInterface method\), 103](#)
[execute\(\) \(fastr.plugins.NipypeInterface method\), 106](#)
[execute_job\(\) \(in module fastr.execution.executionscript\), 191](#)
[execution_done \(fastr.execution.job.JobState attribute\), 208](#)
[execution_failed \(fastr.execution.job.JobState attribute\), 208](#)
[execution_plugin \(fastr.configmanager.Config attribute\), 77](#)
[ExecutionPlugin \(class in fastr.execution.executionpluginmanager\), 187](#)
[ExecutionPluginManager \(class in fastr.execution.executionpluginmanager\), 190](#)
[executionscript \(fastr.configmanager.Config attribute\), 77](#)
[expand \(fastr.__init__.Link attribute\), 71](#)
[expand \(fastr.core.link.Link attribute\), 148](#)
[expand \(fastr.execution.linkrun.LinkRun attribute\), 212](#)
[expand\(\) \(fastr.core.samples.SampleIndex method\), 167](#)
[expand_url\(\) \(fastr.core.ioplugin.IOPlugin method\), 142](#)
[expand_url\(\) \(fastr.core.ioplugin.IOPluginManager method\), 144](#)
[expand_url\(\) \(fastr.plugins.CommaSeperatedValueFile method\), 97](#)
[expand_url\(\) \(fastr.plugins.S3Filesystem method\), 108](#)
[expand_url\(\) \(fastr.plugins.VirtualFilesystem method\), 110](#)
[expand_url\(\) \(fastr.plugins.VirtualFilesystemRegularExpression method\), 112](#)
[expand_url\(\) \(fastr.plugins.VirtualFilesystemValueList method\), 113](#)
[expand_url\(\) \(fastr.plugins.XNATStorage method\), 115](#)
[expanding \(fastr.core.interface.Interface attribute\), 141](#)
[expanding \(fastr.plugins.FastrInterface attribute\), 101](#)
[expanding \(fastr.plugins.FlowInterface attribute\), 103](#)
[expanding \(fastr.plugins.NipypeInterface attribute\), 106](#)
[extend\(\) \(fastr.configmanager.EmptyDefault method\), 78](#)

`extend()` (in module `fastr.utils.jsonschemaparser`), 229
`extension` (`fastr.datatypes.AnalyzeImageFile` attribute), 79
`extension` (`fastr.datatypes.BaseDataType` attribute), 80
`extension` (`fastr.datatypes.Directory` attribute), 83
`extension` (`fastr.datatypes.FilePrefix` attribute), 84
`extension` (`fastr.datatypes.JsonFile` attribute), 84
`extension` (`fastr.datatypes.MetaImageFile` attribute), 85
`extension` (`fastr.datatypes.NiftiImageFileCompressed` attribute), 85
`extension` (`fastr.datatypes.NiftiImageFileUncompressed` attribute), 85
`extension` (`fastr.datatypes.ProvNFile` attribute), 86
`extension` (`fastr.datatypes.TifImageFile` attribute), 86
`extension` (`fastr.datatypes.TxtFile` attribute), 86
`extra` (`fastr.core.version.Version` attribute), 180
`extra_string` (`fastr.core.version.Version` attribute), 180
`extract_argparser()` (in module `fastr.utils.cmd.extract_argparse`), 235
`extrainfofile` (`fastr.execution.job.Job` attribute), 203
`extrainfourl` (`fastr.execution.job.Job` attribute), 203

F

`failed` (`fastr.core.baseplugin.PluginState` attribute), 120
`failed` (`fastr.execution.job.JobState` attribute), 208
`failed_annotations` (`fastr.core.samples.SampleItemBase` attribute), 168
`fastr.__init__` (module), 65
`fastr.configmanager` (module), 77
`fastr.core` (module), 116
`fastr.core.basemanager` (module), 116
`fastr.core.baseplugin` (module), 118
`fastr.core.datatypemanager` (module), 120
`fastr.core.dimension` (module), 122
`fastr.core.inputgroup` (module), 124
`fastr.core.inputgroupcombiner` (module), 126
`fastr.core.inputoutput` (module), 128
`fastr.core.interface` (module), 140
`fastr.core.ioplugin` (module), 142
`fastr.core.link` (module), 145
`fastr.core.network` (module), 148
`fastr.core.networkmanager` (module), 152
`fastr.core.node` (module), 152
`fastr.core.objectmanager` (module), 159
`fastr.core.pluginmanager` (module), 160
`fastr.core.provenance` (module), 163
`fastr.core.samples` (module), 164
`fastr.core.serializable` (module), 170
`fastr.core.target` (module), 172
`fastr.core.test` (module), 180
`fastr.core.tool` (module), 174
`fastr.core.toolmanager` (module), 176
`fastr.core.updateable` (module), 177
`fastr.core.version` (module), 179

`fastr.core.vfs` (module), 180
`fastr.data` (module), 181
`fastr.data.url` (module), 181
`fastr.datatypes` (module), 79
`fastr.examples` (module), 183
`fastr.examples.__generate_reference__` (module), 183
`fastr.examples.add_ints` (module), 183
`fastr.examples.add_ints_s3` (module), 183
`fastr.examples.auto_prefix` (module), 183
`fastr.examples.collapse` (module), 183
`fastr.examples.collapse_expand` (module), 183
`fastr.examples.cross_validation` (module), 184
`fastr.examples.elastix_nipype` (module), 184
`fastr.examples.expand` (module), 184
`fastr.examples.failing_network` (module), 184
`fastr.examples.filecopy` (module), 184
`fastr.examples.input_groups` (module), 184
`fastr.examples.macro_node` (module), 185
`fastr.examples.macro_node2` (module), 185
`fastr.examples.shift_links` (module), 185
`fastr.examples.source_sink` (module), 185
`fastr.exceptions` (module), 89
`fastr.execution` (module), 186
`fastr.execution.environmentmodules` (module), 186
`fastr.execution.executionpluginmanager` (module), 187
`fastr.execution.executionscript` (module), 191
`fastr.execution.flownoderun` (module), 191
`fastr.execution.inputoutputrun` (module), 192
`fastr.execution.job` (module), 202
`fastr.execution.linkrun` (module), 209
`fastr.execution.macronoderun` (module), 212
`fastr.execution.networkanalyzer` (module), 213
`fastr.execution.networkchunker` (module), 213
`fastr.execution.networkrun` (module), 214
`fastr.execution.noderun` (module), 216
`fastr.execution.sinknoderun` (module), 219
`fastr.execution.sourcenoderun` (module), 220
`fastr.plugins` (module), 95
`fastr.resources` (module), 222
`fastr.utils` (module), 224
`fastr.utils.checksum` (module), 224
`fastr.utils.classproperty` (module), 226
`fastr.utils.clear_pycs` (module), 226
`fastr.utils.cmd` (module), 235
`fastr.utils.cmd.cat` (module), 235
`fastr.utils.cmd.dump` (module), 235
`fastr.utils.cmd.execute` (module), 235
`fastr.utils.cmd.extract_argparse` (module), 235
`fastr.utils.cmd.prov` (module), 236
`fastr.utils.cmd.run` (module), 236
`fastr.utils.cmd.test` (module), 236
`fastr.utils.cmd.trace` (module), 236
`fastr.utils.cmd.verify` (module), 237
`fastr.utils.cmd.webapp` (module), 237

- fastr.utils.compare (module), 226
- fastr.utils.dicteq (module), 227
- fastr.utils.filesynchelper (module), 228
- fastr.utils.gettools (module), 228
- fastr.utils.iohelpers (module), 228
- fastr.utils.jsonschemaparser (module), 229
- fastr.utils.multiprocesswrapper (module), 231
- fastr.utils.pim_publisher (module), 231
- fastr.utils.procutils (module), 231
- fastr.utils.rest_generation (module), 232
- fastr.utils.schematatable (module), 232
- fastr.utils.sysinfo (module), 233
- fastr.utils.verify (module), 234
- fastr.utils.xmltodict (module), 234
- fastr.version (module), 115
- fastr.web (module), 238
- fastr.web.api (module), 238
- fastr.web.run (module), 240
- fastr.web.views (module), 240
- fastr_cat() (in module fastr.utils.cmd.cat), 235
- fastr_isinstance() (in module fastr.datatypes), 88
- FastrAttributeError, 89
- FastrCannotChangeAttributeError, 89
- FastrCardinalityError, 89
- FastrCollectorError, 89
- FastrDataTypeFileNotReadable, 89
- FastrDataTypeMismatchError, 89
- FastrDataTypeNotAvailableError, 89
- FastrDataTypeNotInstantiableError, 89
- FastrDataTypeValueError, 89
- FastrError, 90
- FastrErrorInSubprocess, 90
- FastrExecutableNotFound, 90
- FastrExecutionError, 90
- FastrImportError, 90
- FastrIndexError, 91
- FastrIndexNonexistent, 91
- FastrInterface (class in fastr.plugins), 99
- FastrIOError, 90
- FastrKeyError, 91
- FastrLookupError, 91
- FastrMountUnknownError, 91
- FastrNetworkMismatchError, 91
- FastrNetworkUnknownError, 91
- FastrNodeAlreadyPreparedError, 91
- FastrNodeNotPreparedError, 92
- FastrNodeNotValidError, 92
- FastrNotExecutableError, 92
- FastrNotImplementedError, 92
- FastrNoValidTargetError, 91
- FastrObjectUnknownError, 92
- FastrOptionalModuleNotAvailableError, 92
- FastrOSError, 92
- FastrOutputValidationError, 92
- FastrParentMismatchError, 93
- FastrPluginCapabilityNotImplemented, 93
- FastrPluginNotAvailable, 93
- FastrPluginNotLoaded, 93
- FastrRefResolver (class in fastr.utils.jsonschemaparser), 229
- FastrResultFileNotFound, 93
- FastrSerializationError, 93
- FastrSerializationIgnoreDefaultError, 93
- FastrSerializationInvalidDataError, 93
- FastrSerializationMethodError, 94
- FastrSinkDataUnavailableError, 94
- FastrSizeInvalidError, 94
- FastrSizeMismatchError, 94
- FastrSizeUnknownError, 94
- FastrSourceDataUnavailableError, 94
- FastrStateError, 94
- FastrSubprocessNotFinished, 94
- FastrToolNotAvailableError, 94
- FastrToolTargetNotFound, 95
- FastrToolUnknownError, 95
- FastrTypeError, 95
- FastrUnknownURLSchemeError, 95
- FastrValueError, 95
- FastrVersionInvalidError, 95
- FastrVersionMismatchError, 95
- fetch_url() (fastr.core.ioplugin.IOPlugin method), 142
- fetch_url() (fastr.plugins.FileSystem method), 101
- fetch_url() (fastr.plugins.S3Filesystem method), 108
- fetch_url() (fastr.plugins.VirtualFilesystem method), 110
- fetch_url() (fastr.plugins.XNATStorage method), 115
- fetch_value() (fastr.core.ioplugin.IOPlugin method), 142
- fetch_value() (fastr.plugins.FileSystem method), 102
- fetch_value() (fastr.plugins.S3Filesystem method), 109
- fetch_value() (fastr.plugins.VirtualFilesystem method), 110
- filename (fastr.core.pluginmanager.plugin_option_type attribute), 163
- filename (fastr.datatypes.AnalyzeImageFile attribute), 79
- filename (fastr.datatypes.BaseDataType attribute), 80
- filename (fastr.datatypes.Boolean attribute), 81
- filename (fastr.datatypes.Directory attribute), 83
- filename (fastr.datatypes.FilePrefix attribute), 84
- filename (fastr.datatypes.Float attribute), 84
- filename (fastr.datatypes.Int attribute), 84
- filename (fastr.datatypes.ITKImageFile attribute), 84
- filename (fastr.datatypes.JsonFile attribute), 84
- filename (fastr.datatypes.MetaImageFile attribute), 85
- filename (fastr.datatypes.NiftiImageFile attribute), 85
- filename (fastr.datatypes.NiftiImageFileCompressed attribute), 85
- filename (fastr.datatypes.NiftiImageFileUncompressed attribute), 85
- filename (fastr.datatypes.Number attribute), 86

- filename (fastr.datatypes.ProvNFile attribute), 86
 - filename (fastr.datatypes.String attribute), 86
 - filename (fastr.datatypes.TifImageFile attribute), 86
 - filename (fastr.datatypes.TxtFile attribute), 86
 - filename (fastr.datatypes.UnsignedInt attribute), 88
 - filename (fastr.plugins.BlockingExecution attribute), 96
 - filename (fastr.plugins.CommaSeperatedValueFile attribute), 97
 - filename (fastr.plugins.CrossValidation attribute), 97
 - filename (fastr.plugins.DockerTarget attribute), 99
 - filename (fastr.plugins.DRMAAExecution attribute), 98
 - filename (fastr.plugins.FastrInterface attribute), 101
 - filename (fastr.plugins.FileSystem attribute), 102
 - filename (fastr.plugins.FlowInterface attribute), 103
 - filename (fastr.plugins.LinearExecution attribute), 103
 - filename (fastr.plugins.LocalBinaryTarget attribute), 105
 - filename (fastr.plugins.NipypeInterface attribute), 106
 - filename (fastr.plugins.Null attribute), 106
 - filename (fastr.plugins.ProcessPoolExecution attribute), 107
 - filename (fastr.plugins.Reference attribute), 108
 - filename (fastr.plugins.RQExecution attribute), 107
 - filename (fastr.plugins.S3Filesystem attribute), 109
 - filename (fastr.plugins.StrongrExecution attribute), 109
 - filename (fastr.plugins.VirtualFileSystemRegularExpression attribute), 112
 - filename (fastr.plugins.VirtualFileSystemValueList attribute), 113
 - filename (fastr.plugins.XNATStorage attribute), 115
 - FilePrefix (class in fastr.datatypes), 83
 - FileSyncHelper (class in fastr.utils.filesynchelper), 228
 - filesynchelper_enabled() (in module fastr.utils.filesynchelper), 228
 - filesynchelper_url (fastr.configmanager.Config attribute), 77
 - FileSystem (class in fastr.plugins), 101
 - fill_output_argument() (fastr.execution.job.Job class method), 203
 - filter_plugin() (fastr.core.pluginmanager.PluginsView method), 162
 - find_argparser() (in module fastr.utils.cmd.extract_argparse), 235
 - find_commands() (in module fastr.utils.cmd), 235
 - find_member() (fastr.core.updateable.UpdateableMeta class method), 178
 - find_source_index() (fastr.__init__.Node method), 73
 - find_source_index() (fastr.core.inputgroup.InputGroup method), 125
 - find_source_index() (fastr.core.node.Node method), 156
 - find_source_index() (fastr.execution.noderun.NodeRun method), 217
 - finished (fastr.execution.job.JobState attribute), 208
 - Float (class in fastr.datatypes), 84
 - flow_plugin_type (fastr.plugins.FlowInterface attribute), 103
 - flow_plugins (fastr.plugins.FlowInterface attribute), 103
 - FlowInterface (class in fastr.plugins), 102
 - FlowNode (class in fastr.core.node), 153
 - FlowNodeRun (class in fastr.execution.flownoderun), 191
 - format() (fastr.web.api.ObjectUrl method), 238
 - format() (fastr.web.api.SubUrl method), 239
 - ForwardsDimensions (class in fastr.core.dimension), 123
 - from_schema() (fastr.utils.jsonschemasparser.FastrRefResolver class method), 229
 - full_split() (in module fastr.data.url), 181
 - fullid (fastr.__init__.Link attribute), 71
 - fullid (fastr.__init__.Network attribute), 69
 - fullid (fastr.__init__.Node attribute), 73
 - fullid (fastr.core.baseplugin.BasePlugin attribute), 119
 - fullid (fastr.core.datatypemanager.DataTypeManager attribute), 120
 - fullid (fastr.core.inputgroup.InputGroup attribute), 125
 - fullid (fastr.core.inputgroupcombiner.BaseInputGroupCombiner attribute), 126
 - fullid (fastr.core.inputoutput.BaseInputOutput attribute), 130
 - fullid (fastr.core.inputoutput.Input attribute), 132
 - fullid (fastr.core.inputoutput.Output attribute), 135
 - fullid (fastr.core.inputoutput.SubInput attribute), 137
 - fullid (fastr.core.inputoutput.SubOutput attribute), 140
 - fullid (fastr.core.link.Link attribute), 148
 - fullid (fastr.core.network.Network attribute), 151
 - fullid (fastr.core.node.Node attribute), 156
 - fullid (fastr.core.samples.SampleCollection attribute), 166
 - fullid (fastr.core.tool.Tool attribute), 175
 - fullid (fastr.datatypes.BaseDataType attribute), 80
 - fullid (fastr.execution.inputoutputrun.InputRun attribute), 193
 - fullid (fastr.execution.inputoutputrun.OutputRun attribute), 196
 - fullid (fastr.execution.inputoutputrun.SubInputRun attribute), 199
 - fullid (fastr.execution.inputoutputrun.SubOutputRun attribute), 201
 - fullid (fastr.execution.job.Job attribute), 204
 - fullid (fastr.execution.linkrun.LinkRun attribute), 212
 - fullid (fastr.execution.networkrun.NetworkRun attribute), 215
 - fullid (fastr.execution.noderun.NodeRun attribute), 218
 - function_wrapper() (in module fastr.utils.multiprocesswrapper), 231
- ## G
- GE_NATIVE_SPEC (fastr.plugins.DRMAAExecution attribute), 97

- generate_all_references() (in module fastr.examples.__generate_reference__), 183
- generate_jobs() (fastr.execution.networkrun.NetworkRun method), 216
- get() (fastr.web.api.NetworkApi method), 238
- get() (fastr.web.api.NetworkListApi method), 238
- get() (fastr.web.api.RunApi method), 239
- get() (fastr.web.api.RunListApi method), 239
- get() (fastr.web.api.StatusApi method), 239
- get() (fastr.web.api.ToolApi method), 240
- get() (fastr.web.api.ToolListApi method), 240
- get_arguments() (fastr.plugins.FastrInterface method), 101
- get_base_version() (in module fastr.version), 115
- get_command() (fastr.plugins.FastrInterface method), 101
- get_command_module() (in module fastr.utils.cmd), 235
- get_cpu_usage() (in module fastr.utils.sysinfo), 233
- get_deferred() (fastr.execution.job.Job method), 204
- get_drmaa_info() (in module fastr.utils.sysinfo), 233
- get_field() (fastr.configmanager.Config method), 77
- get_hg_info() (in module fastr.version), 116
- get_hostinfo() (in module fastr.utils.sysinfo), 233
- get_job() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- get_memory_usage() (in module fastr.utils.sysinfo), 233
- get_mounts() (in module fastr.utils.sysinfo), 233
- get_object_version() (fastr.core.networkmanager.NetworkManager method), 152
- get_object_version() (fastr.core.objectmanager.ObjectManager method), 160
- get_object_version() (fastr.core.toolmanager.ToolManager method), 176
- get_os() (in module fastr.utils.sysinfo), 233
- get_output_datatype() (fastr.execution.job.Job method), 204
- get_output_datatype() (fastr.execution.job.SourceJob method), 209
- get_output_info() (fastr.core.node.MacroNode method), 154
- get_output_info() (fastr.execution.macronoderun.MacroNodeRun method), 213
- get_parent_provenance() (fastr.core.provenance.Provenance static method), 163
- get_parser() (in module fastr.utils.cmd.cat), 235
- get_parser() (in module fastr.utils.cmd.dump), 235
- get_parser() (in module fastr.utils.cmd.execute), 235
- get_parser() (in module fastr.utils.cmd.extract_argparse), 235
- get_parser() (in module fastr.utils.cmd.prov), 236
- get_parser() (in module fastr.utils.cmd.run), 236
- get_parser() (in module fastr.utils.cmd.test), 236
- get_parser() (in module fastr.utils.cmd.trace), 236
- get_parser() (in module fastr.utils.cmd.verify), 237
- get_parser() (in module fastr.utils.cmd.webapp), 237
- get_path_from_url() (in module fastr.data.url), 182
- get_processes() (in module fastr.utils.sysinfo), 233
- get_prov_document() (in module fastr.utils.cmd.prov), 236
- get_python() (in module fastr.utils.sysinfo), 233
- get_result() (fastr.execution.job.InlineJob method), 202
- get_result() (fastr.execution.job.Job method), 204
- get_result() (fastr.execution.job.SinkJob method), 208
- get_saved_version() (in module fastr.version), 116
- get_serializer() (fastr.core.serializable.Serializable class method), 171
- get_sourced_nodes() (fastr.__init__.Node method), 73
- get_sourced_nodes() (fastr.core.inputoutput.Input method), 132
- get_sourced_nodes() (fastr.core.inputoutput.SubInput method), 137
- get_sourced_nodes() (fastr.core.node.Node method), 156
- get_sourced_nodes() (fastr.execution.inputoutputrun.InputRun method), 193
- get_sourced_nodes() (fastr.execution.inputoutputrun.SubInputRun method), 199
- get_sourced_nodes() (fastr.execution.noderun.NodeRun method), 218
- get_sourced_outputs() (fastr.core.inputoutput.Input method), 132
- get_sourced_outputs() (fastr.core.inputoutput.SubInput method), 138
- get_sourced_outputs() (fastr.execution.inputoutputrun.InputRun method), 194
- get_sourced_outputs() (fastr.execution.inputoutputrun.SubInputRun method), 199
- get_specials() (fastr.plugins.FastrInterface method), 101
- get_status() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189
- get_sysinfo() (in module fastr.utils.sysinfo), 233
- get_type() (fastr.core.datatypepmanager.DataTypeManager method), 121
- get_type() (fastr.plugins.NipypeInterface method), 106
- get_url_scheme() (in module fastr.data.url), 182
- get_users() (in module fastr.utils.sysinfo), 233
- get_value() (fastr.execution.job.Job class method), 204
- getblueprinter() (in module fastr.utils.jsonschemaresolver), 229
- global_id (fastr.__init__.Network attribute), 69
- global_id (fastr.__init__.Node attribute), 73
- global_id (fastr.core.network.Network attribute), 151
- global_id (fastr.core.node.Node attribute), 156
- global_id (fastr.execution.networkrun.NetworkRun attribute), 216
- global_id (fastr.execution.noderun.NodeRun attribute), 218

`guess_type()` (fastr.core.datatypemanager.DataTypeManager method), 121

H

`has_file_promise()` (fastr.utils.filesynchelper.FileSyncHelper method), 228

`has_type()` (fastr.core.datatypemanager.DataTypeManager method), 121

`HasDimensions` (class in fastr.core.dimension), 123

`hash` (fastr.core.tool.Tool attribute), 175

`hash_inputs()` (fastr.execution.job.Job method), 204

`hash_inputs()` (fastr.execution.job.SinkJob method), 208

`hash_inputs()` (fastr.execution.job.SourceJob method), 209

`hash_results()` (fastr.execution.job.Job method), 204

`hashsum()` (in module fastr.utils.checksum), 225

`HasSamples` (class in fastr.core.samples), 164

`help` (fastr.core.tool.Tool attribute), 175

`hold` (fastr.execution.executionpluginmanager.JobAction attribute), 190

`hold` (fastr.execution.job.JobState attribute), 208

`hold_job()` (fastr.execution.executionpluginmanager.ExecutionPlugin method), 189

I

`id` (fastr.__init__.Network attribute), 69

`id` (fastr.__init__.Node attribute), 73

`id` (fastr.core.baseplugin.BasePlugin attribute), 119

`id` (fastr.core.inputoutput.BaseInputOutput attribute), 130

`id` (fastr.core.network.Network attribute), 151

`id` (fastr.core.node.Node attribute), 156

`id` (fastr.core.pluginmanager.plugin_option_type attribute), 163

`id` (fastr.core.samples.SampleItemBase attribute), 168

`id` (fastr.datatypes.BaseDataType attribute), 80

`id` (fastr.execution.job.Job attribute), 204

`id` (fastr.execution.job.SinkJob attribute), 209

`id` (fastr.execution.networkrun.NetworkRun attribute), 216

`id` (fastr.execution.noderun.NodeRun attribute), 218

`id_` (fastr.core.node.Node attribute), 156

`idle` (fastr.execution.job.JobState attribute), 208

`ids()` (fastr.core.samples.HasSamples method), 164

`in_progress` (fastr.execution.job.JobState attribute), 208

`index` (fastr.core.samples.SampleItemBase attribute), 168

`index()` (fastr.core.inputoutput.Input method), 132

`index()` (fastr.execution.inputoutputrun.InputRun method), 194

`index()` (in module fastr.web.views), 240

`indexes()` (fastr.core.samples.HasSamples method), 164

`indexrep` (fastr.core.inputoutput.SubOutput attribute), 140

`indexrep` (fastr.execution.inputoutputrun.SubOutputRun attribute), 201

`INFO_DUMP` (fastr.execution.job.Job attribute), 202

`init_provenance()` (fastr.core.provenance.Provenance method), 163

`InlineJob` (class in fastr.execution.job), 202

`Input` (class in fastr.core.inputoutput), 130

`input` (fastr.__init__.SinkNode attribute), 77

`input` (fastr.core.node.SinkNode attribute), 158

`input` (fastr.execution.sinknoderun.SinkNodeRun attribute), 219

`input_group` (fastr.core.inputoutput.Input attribute), 133

`input_group` (fastr.core.inputoutput.SubInput attribute), 138

`input_group` (fastr.execution.inputoutputrun.InputRun attribute), 194

`input_group` (fastr.execution.inputoutputrun.SubInputRun attribute), 199

`input_groups` (fastr.__init__.Node attribute), 73

`input_groups` (fastr.core.inputgroupcombiner.BaseInputGroupCombiner attribute), 126

`input_groups` (fastr.core.node.Node attribute), 156

`input_groups` (fastr.execution.noderun.NodeRun attribute), 218

`InputDict` (class in fastr.core.node), 154

`InputGroup` (class in fastr.core.inputgroup), 124

`InputRun` (class in fastr.execution.inputoutputrun), 192

`inputs` (fastr.core.interface.Interface attribute), 141

`inputs` (fastr.core.node.Node attribute), 156

`inputs` (fastr.core.tool.Tool attribute), 175

`inputs` (fastr.plugins.FastrInterface attribute), 101

`inputs` (fastr.plugins.FlowInterface attribute), 103

`inputs` (fastr.plugins.NipypeInterface attribute), 106

`InputSpec` (class in fastr.core.interface), 140

`InputSpecBase` (in module fastr.core.interface), 140

`insert()` (fastr.core.inputoutput.Input method), 133

`insert()` (fastr.execution.inputoutputrun.InputRun method), 194

`instantiate` (fastr.core.baseplugin.BasePlugin attribute), 119

`Int` (class in fastr.datatypes), 84

`Interface` (class in fastr.core.interface), 140

`interface_class` (fastr.core.tool.Tool attribute), 175

`InterfacePluginManager` (class in fastr.core.interface), 141

`InterfaceResult` (class in fastr.core.interface), 141

`IOPlugin` (class in fastr.core.ioplugin), 142

`IOPluginManager` (class in fastr.core.ioplugin), 144

`is_mapping` (fastr.core.samples.SampleValue attribute), 169

`is_sequence` (fastr.core.samples.SampleValue attribute), 169

`is_valid()` (fastr.__init__.Network method), 69

`is_valid()` (fastr.core.network.Network method), 151

`isdatatype()` (fastr.core.datatypemanager.DataTypeManager static method), 121

- [isinstance\(\) \(fastr.datatypes.BaseDataType class method\), 80](#)
[isinstance\(\) \(fastr.datatypes.TypeGroup class method\), 87](#)
[isloaded\(\) \(fastr.execution.environmentmodules.EnvironmentModules class method\), 186](#)
[isslice \(fastr.core.samples.SampleIndex attribute\), 167](#)
[isurl\(\) \(fastr.core.ioplugin.IOPlugin static method\), 143](#)
[isurl\(\) \(in module fastr.data.url\), 182](#)
[items\(\) \(fastr.core.samples.HasSamples method\), 164](#)
[items_prevalidate\(\) \(in module fastr.utils.jsonschemaresolver\), 230](#)
[iter_input_groups\(\) \(fastr.core.inputgroupcombiner.BaseInputGroupCombiner method\), 126](#)
[iter_input_groups\(\) \(fastr.core.inputgroupcombiner.DefaultInputGroupCombiner method\), 127](#)
[iter_input_groups\(\) \(fastr.core.inputgroupcombiner.MergingInputGroupCombiner method\), 127](#)
[iterconvergingindices\(\) \(fastr.execution.inputoutputrun.OutputRun method\), 196](#)
[iterelements\(\) \(fastr.core.samples.SampleValue method\), 169](#)
[iterinputvalues \(fastr.core.inputgroup.InputGroup attribute\), 125](#)
[iteritems\(\) \(fastr.core.inputoutput.SubInput method\), 138](#)
[iteritems\(\) \(fastr.core.samples.HasSamples method\), 164](#)
[iteritems\(\) \(fastr.execution.inputoutputrun.SubInputRun method\), 200](#)
[itersubinputs\(\) \(fastr.core.inputoutput.BaseInput method\), 128](#)
[itersubinputs\(\) \(fastr.core.inputoutput.Input method\), 133](#)
[itersubinputs\(\) \(fastr.core.inputoutput.SubInput method\), 138](#)
[itersubinputs\(\) \(fastr.execution.inputoutputrun.BaseInputRun method\), 192](#)
[itersubinputs\(\) \(fastr.execution.inputoutputrun.InputRun method\), 194](#)
[itersubinputs\(\) \(fastr.execution.inputoutputrun.SubInputRun method\), 200](#)
[ITKImageFile \(class in fastr.datatypes\), 84](#)
- ## J
- [Job \(class in fastr.execution.job\), 202](#)
[job \(fastr.datatypes.Deferred attribute\), 82](#)
[job_finished\(\) \(fastr.execution.executionpluginmanager.ExecutionPluginManager method\), 189](#)
[job_finished\(\) \(fastr.execution.networkrun.NetworkRun method\), 216](#)
[job_finished\(\) \(fastr.utils.filesynchelper.FileSyncHelper method\), 228](#)
[job_finished_callback \(fastr.execution.networkrun.NetworkRun attribute\), 216](#)
[job_status_callback \(fastr.execution.networkrun.NetworkRun attribute\), 216](#)
[JobAction \(class in fastr.execution.executionpluginmanager\), 190](#)
[jobs \(fastr.core.samples.SampleItemBase attribute\), 168](#)
[JobState \(class in fastr.execution.job\), 206](#)
[join\(\) \(in module fastr.data.url\), 182](#)
[json \(in module fastr.plugins\), 115](#)
[JsonFile \(class in fastr.datatypes\), 84](#)
- ## L
- [LazyModule \(class in fastr.core.pluginmanager\), 161](#)
[LinearExecution \(class in fastr.plugins\), 103](#)
[linearized \(fastr.execution.inputoutput.SourceOutput attribute\), 136](#)
[linearized \(fastr.execution.inputoutputrun.SourceOutputRun attribute\), 198](#)
[Link \(class in fastr.__init__\), 65, 69](#)
[Link \(class in fastr.core.link\), 146](#)
[LinkRun \(class in fastr.execution.linkrun\), 210](#)
[listeners \(fastr.__init__.Node attribute\), 73](#)
[listeners \(fastr.core.inputoutput.Output attribute\), 135](#)
[listeners \(fastr.core.inputoutput.SubOutput attribute\), 140](#)
[listeners \(fastr.core.node.Node attribute\), 156](#)
[listeners \(fastr.execution.inputoutputrun.OutputRun attribute\), 197](#)
[listeners \(fastr.execution.inputoutputrun.SubOutputRun attribute\), 202](#)
[listeners \(fastr.execution.noderun.NodeRun attribute\), 218](#)
[lmod \(fastr.execution.environmentmodules.ModuleSystem attribute\), 187](#)
[load\(\) \(fastr.core.serializable.Serializable class method\), 171](#)
[load\(\) \(fastr.execution.environmentmodules.EnvironmentModules method\), 186](#)
[load\(\) \(fastr.utils.filesynchelper.FileSyncHelper method\), 228](#)
[load\(\) \(in module fastr.utils.xmltodict\), 234](#)
[load_gpickle\(\) \(in module fastr.utils.iohelpers\), 228](#)
[load_json\(\) \(in module fastr.utils.iohelpers\), 228](#)
[load_plugin\(\) \(fastr.core.pluginmanager.BasePluginManager method\), 161](#)
[loaded \(fastr.core.baseplugin.PluginState attribute\), 120](#)
[loaded \(fastr.execution.environmentmodules.EnvironmentModules attribute\), 186](#)
[loadf\(\) \(fastr.core.serializable.Serializable class method\), 171](#)
[loads\(\) \(fastr.core.serializable.PassThroughSerializer static method\), 170](#)
[loads\(\) \(fastr.core.serializable.Serializable class method\), 172](#)
[loads\(\) \(in module fastr.utils.xmltodict\), 234](#)
[LocalBinaryTarget \(class in fastr.plugins\), 103](#)
[logdir \(fastr.configmanager.Config attribute\), 77](#)

logfile (fastr.execution.job.Job attribute), 204
 logging_config (fastr.configmanager.Config attribute), 77
 loglevel (fastr.configmanager.Config attribute), 77
 logtype (fastr.configmanager.Config attribute), 77
 logurl (fastr.execution.job.Job attribute), 204
 long_id (fastr.execution.networkrun.NetworkRun attribute), 216
 lookup() (fastr.datatypes.Deferred class method), 82

M

MacroNode (class in fastr.core.node), 154
 MacroNodeRun (class in fastr.execution.macronoderun), 212
 MacroOutput (class in fastr.core.inputoutput), 133
 MacroOutputRun (class in fastr.execution.inputoutputrun), 194
 main() (in module fastr.core.ioplugin), 145
 main() (in module fastr.examples.add_ints), 183
 main() (in module fastr.examples.add_ints_s3), 183
 main() (in module fastr.examples.auto_prefix), 183
 main() (in module fastr.examples.collapse), 183
 main() (in module fastr.examples.collapse_expand), 183
 main() (in module fastr.examples.cross_validation), 184
 main() (in module fastr.examples.elastix_nipype), 184
 main() (in module fastr.examples.expand), 184
 main() (in module fastr.examples.failing_network), 184
 main() (in module fastr.examples.filecopy), 184
 main() (in module fastr.examples.input_groups), 184
 main() (in module fastr.examples.macro_node), 185
 main() (in module fastr.examples.macro_node2), 185
 main() (in module fastr.examples.shift_links), 185
 main() (in module fastr.examples.source_sink), 185
 main() (in module fastr.execution.executionscript), 191
 main() (in module fastr.utils.clear_pycs), 226
 main() (in module fastr.utils.cmd), 235
 main() (in module fastr.utils.cmd.cat), 235
 main() (in module fastr.utils.cmd.dump), 235
 main() (in module fastr.utils.cmd.execute), 235
 main() (in module fastr.utils.cmd.extract_argparse), 235
 main() (in module fastr.utils.cmd.prov), 236
 main() (in module fastr.utils.cmd.run), 236
 main() (in module fastr.utils.cmd.test), 236
 main() (in module fastr.utils.cmd.trace), 236
 main() (in module fastr.utils.cmd.verify), 237
 main() (in module fastr.utils.cmd.webapp), 237
 main() (in module fastr.utils.gettools), 228
 main() (in module fastr.web.run), 240
 major (fastr.core.version.Version attribute), 180
 make_file_promise() (fastr.utils.filesynchelper.FileSyncHelper method), 228
 mapping_part() (fastr.core.samples.SampleValue method), 169
 match_filename() (fastr.core.basemanager.BaseManager method), 118

match_types() (fastr.core.datatypemanager.DataTypeManager method), 121
 match_types_any() (fastr.core.datatypemanager.DataTypeManager method), 122
 md5_checksum() (in module fastr.utils.checksum), 225
 mediatypes() (fastr.web.api.NetworkApi method), 238
 mediatypes() (fastr.web.api.NetworkListApi method), 238
 mediatypes() (fastr.web.api.RunApi method), 239
 mediatypes() (fastr.web.api.RunListApi method), 239
 mediatypes() (fastr.web.api.StatusApi method), 239
 mediatypes() (fastr.web.api.ToolApi method), 240
 mediatypes() (fastr.web.api.ToolListApi method), 240
 members (fastr.datatypes.TypeGroup attribute), 87
 merge() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 merge() (fastr.core.inputgroupcombiner.DefaultInputGroupCombiner method), 127
 merge() (fastr.core.inputgroupcombiner.MergingInputGroupCombiner method), 127
 merge_dimensions (fastr.__init__.Node attribute), 73
 merge_dimensions (fastr.core.node.Node attribute), 156
 merge_dimensions (fastr.execution.noderun.NodeRun attribute), 218
 merge_failed_annotations() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 merge_payloads() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 merge_sample_data() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 merge_sample_id() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 merge_sample_index() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 merge_sample_jobs() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner method), 126
 MergingInputGroupCombiner (class in fastr.core.inputgroupcombiner), 127
 messages (fastr.core.updateable.Updateable attribute), 178
 MetaImageFile (class in fastr.datatypes), 85
 methods (fastr.web.api.NetworkApi attribute), 238
 methods (fastr.web.api.NetworkListApi attribute), 238
 methods (fastr.web.api.RunApi attribute), 239
 methods (fastr.web.api.RunListApi attribute), 239
 methods (fastr.web.api.StatusApi attribute), 239
 methods (fastr.web.api.ToolApi attribute), 240
 methods (fastr.web.api.ToolListApi attribute), 240
 minor (fastr.core.version.Version attribute), 180
 module (fastr.core.baseplugin.BasePlugin attribute), 119
 module (fastr.datatypes.AnalyzeImageFile attribute), 79
 module (fastr.datatypes.Boolean attribute), 81
 module (fastr.datatypes.Directory attribute), 83

- module (fastr.datatypes.FilePrefix attribute), 84
 - module (fastr.datatypes.Float attribute), 84
 - module (fastr.datatypes.Int attribute), 84
 - module (fastr.datatypes.ITKImageFile attribute), 84
 - module (fastr.datatypes.JsonFile attribute), 84
 - module (fastr.datatypes.MetaImageFile attribute), 85
 - module (fastr.datatypes.NiftiImageFile attribute), 85
 - module (fastr.datatypes.NiftiImageFileCompressed attribute), 85
 - module (fastr.datatypes.NiftiImageFileUncompressed attribute), 85
 - module (fastr.datatypes.Number attribute), 86
 - module (fastr.datatypes.ProvNFile attribute), 86
 - module (fastr.datatypes.String attribute), 86
 - module (fastr.datatypes.TifImageFile attribute), 86
 - module (fastr.datatypes.TxtFile attribute), 86
 - module (fastr.datatypes.UnsignedInt attribute), 88
 - module (fastr.plugins.BlockingExecution attribute), 96
 - module (fastr.plugins.CommaSeperatedValueFile attribute), 97
 - module (fastr.plugins.CrossValidation attribute), 97
 - module (fastr.plugins.DockerTarget attribute), 99
 - module (fastr.plugins.DRMAAExecution attribute), 98
 - module (fastr.plugins.FastrInterface attribute), 101
 - module (fastr.plugins.FileSystem attribute), 102
 - module (fastr.plugins.FlowInterface attribute), 103
 - module (fastr.plugins.LinearExecution attribute), 103
 - module (fastr.plugins.LocalBinaryTarget attribute), 105
 - module (fastr.plugins.NipypeInterface attribute), 106
 - module (fastr.plugins.Null attribute), 106
 - module (fastr.plugins.ProcessPoolExecution attribute), 107
 - module (fastr.plugins.Reference attribute), 108
 - module (fastr.plugins.RQExecution attribute), 107
 - module (fastr.plugins.S3Filesystem attribute), 109
 - module (fastr.plugins.StrongrExecution attribute), 109
 - module (fastr.plugins.VirtualFileSystemRegularExpression attribute), 112
 - module (fastr.plugins.VirtualFileSystemValueList attribute), 113
 - module (fastr.plugins.XNATStorage attribute), 115
 - ModuleSystem (class in fastr.execution.environmentmodules), 187
 - monitor_docker() (fastr.plugins.DockerTarget method), 99
 - monitor_process() (fastr.plugins.LocalBinaryTarget method), 105
 - mounts (fastr.configmanager.Config attribute), 77
- N**
- name (fastr.__init__.Node attribute), 73
 - name (fastr.core.dimension.Dimension attribute), 122
 - name (fastr.core.node.Node attribute), 157
 - name (fastr.core.pluginmanager.plugin_option_type attribute), 163
 - name (fastr.core.tool.Tool attribute), 175
 - name (fastr.datatypes.BaseDataType attribute), 80
 - name (fastr.execution.noderun.NodeRun attribute), 218
 - namedtuple_to_dict() (in module fastr.utils.sysinfo), 234
 - namespace (fastr.core.network.Network attribute), 151
 - namespace (fastr.core.pluginmanager.plugin_option_type attribute), 163
 - namespace (fastr.core.tool.Tool attribute), 175
 - NATIVE_SPEC (fastr.plugins.DRMAAExecution attribute), 97
 - ndims (fastr.core.dimension.HasDimensions attribute), 123
 - ndims (fastr.core.samples.SampleCollection attribute), 166
 - ndims (fastr.execution.inputoutputrun.SourceOutputRun attribute), 198
 - Network (class in fastr), 62
 - Network (class in fastr.__init__), 65, 66
 - Network (class in fastr.core.network), 148
 - network (fastr.core.node.MacroNode attribute), 155
 - network (fastr.execution.networkrun.NetworkRun attribute), 216
 - network() (in module fastr.web.views), 240
 - NETWORK_DUMP_FILE_NAME (fastr.__init__.Network attribute), 66
 - NETWORK_DUMP_FILE_NAME (fastr.core.network.Network attribute), 148
 - NETWORK_DUMP_FILE_NAME (fastr.execution.networkrun.NetworkRun attribute), 214
 - network_lock_thread() (in module fastr.web.api), 240
 - network_run (fastr.execution.macronoderun.MacroNodeRun attribute), 213
 - network_runner() (in module fastr.web.api), 240
 - NetworkAnalyzer (class in fastr.execution.networkanalyzer), 213
 - NetworkApi (class in fastr.web.api), 238
 - NetworkChunker (class in fastr.execution.networkchunker), 214
 - networklist (in module fastr.core.networkmanager), 152
 - NetworkListApi (class in fastr.web.api), 238
 - NetworkManager (class in fastr.core.networkmanager), 152
 - NetworkRun (class in fastr.execution.networkrun), 214
 - networks() (in module fastr.web.views), 240
 - networks_path (fastr.configmanager.Config attribute), 77
 - NiftiImageFile (class in fastr.datatypes), 85
 - NiftiImageFileCompressed (class in fastr.datatypes), 85
 - NiftiImageFileUncompressed (class in fastr.datatypes), 85
 - NipypeInterface (class in fastr.plugins), 105
 - Node (class in fastr.__init__), 71

Node (class in fastr.core.node), 155
node (fastr.core.inputoutput.BaseInputOutput attribute), 130
node (fastr.core.inputoutput.SubInput attribute), 138
node (fastr.core.inputoutput.SubOutput attribute), 140
node (fastr.execution.inputoutputrun.SubInputRun attribute), 200
node (fastr.execution.inputoutputrun.SubOutputRun attribute), 202
node_class (fastr.core.tool.Tool attribute), 175
nodegroup (fastr.__init__.Node attribute), 73
nodegroup (fastr.__init__.SourceNode attribute), 76
nodegroup (fastr.core.node.Node attribute), 157
nodegroup (fastr.core.node.SourceNode attribute), 159
nodegroups (fastr.__init__.Network attribute), 69
nodegroups (fastr.core.network.Network attribute), 151
nodegroups (fastr.execution.networkrun.NetworkRun attribute), 216
NodeRun (class in fastr.__init__), 65
NodeRun (class in fastr.execution.noderun), 216
nonexistent (fastr.execution.job.JobState attribute), 208
normurl() (in module fastr.data.url), 182
not_draft4() (in module fastr.utils.jsonschemaresolver), 230
ns_id (fastr.core.tool.Tool attribute), 175
Null (class in fastr.plugins), 106
Number (class in fastr.datatypes), 85

O

object_class (fastr.core.networkmanager.NetworkManager attribute), 152
object_class (fastr.core.objectmanager.ObjectManager attribute), 160
object_class (fastr.core.toolmanager.ToolManager attribute), 177
ObjectManager (class in fastr.core.objectmanager), 159
ObjectUrl (class in fastr.web.api), 238
objectversions() (fastr.core.objectmanager.ObjectManager method), 160
one_of_draft4() (in module fastr.utils.jsonschemaresolver), 230
open_url() (in module fastr.utils.cmd.webapp), 237
options (fastr.datatypes.EnumType attribute), 83
Output (class in fastr.core.inputoutput), 133
output (fastr.__init__.SourceNode attribute), 76
output (fastr.core.node.SourceNode attribute), 159
output (fastr.execution.sourcenoderun.SourceNodeRun attribute), 221
OutputDict (class in fastr.core.node), 157
OutputRun (class in fastr.execution.inputoutputrun), 194
outputs (fastr.core.interface.Interface attribute), 141
outputs (fastr.core.node.Node attribute), 157
outputs (fastr.core.tool.Tool attribute), 175
outputs (fastr.plugins.FastrInterface attribute), 101
outputs (fastr.plugins.FlowInterface attribute), 103

outputs (fastr.plugins.NitypeInterface attribute), 106
outputsize (fastr.__init__.Node attribute), 73
outputsize (fastr.core.node.FlowNode attribute), 154
outputsize (fastr.core.node.Node attribute), 157
outputsize (fastr.execution.flownoderun.FlowNodeRun attribute), 191
outputsize (fastr.execution.noderun.NodeRun attribute), 218
outputsize (fastr.execution.sourcenoderun.SourceNodeRun attribute), 221
OutputSpec (class in fastr.core.interface), 142
OutputSpecBase (in module fastr.core.interface), 142

P

parent (fastr.__init__.Link attribute), 71
parent (fastr.__init__.Node attribute), 73
parent (fastr.core.inputgroup.InputGroup attribute), 125
parent (fastr.core.link.Link attribute), 148
parent (fastr.core.node.Node attribute), 157
parent (fastr.core.samples.SampleCollection attribute), 166
parent (fastr.datatypes.BaseDataType attribute), 80
parent (fastr.execution.linkrun.LinkRun attribute), 212
parent (fastr.execution.noderun.NodeRun attribute), 218
parse() (fastr.utils.schematatable.SchemaPrinter method), 232
parsed_value (fastr.datatypes.BaseDataType attribute), 80
parsed_value (fastr.datatypes.Deferred attribute), 82
parsed_value (fastr.datatypes.URLType attribute), 88
PassThroughSerializer (class in fastr.core.serializable), 170
path (fastr.core.tool.Tool attribute), 175
path (in module fastr.plugins), 115
path_to_url() (fastr.core.ioplugin.IOPlugin method), 143
path_to_url() (fastr.plugins.FileSystem method), 102
path_to_url() (fastr.plugins.VirtualFileSystem method), 111
pattern_properties_prevalid() (in module fastr.utils.jsonschemaresolver), 230
pim_host (fastr.configmanager.Config attribute), 77
pim_register_run() (fastr.utils.pim_publisher.PimPublisher method), 231
pim_serialize_network() (fastr.utils.pim_publisher.PimPublisher method), 231
PIM_STATUS_MAPPING (fastr.utils.pim_publisher.PimPublisher attribute), 231
pim_update_status() (fastr.utils.pim_publisher.PimPublisher method), 231
PimPublisher (class in fastr.utils.pim_publisher), 231
Plugin (class in fastr.core.baseplugin), 119
plugin_class (fastr.core.datatypemanager.DataTypeManager attribute), 122

[plugin_class \(fastr.core.pluginmanager.BasePluginManager attribute\), 161](#)
[plugin_class \(fastr.core.pluginmanager.PluginManager attribute\), 161](#)
[plugin_class \(fastr.core.pluginmanager.PluginSubManager attribute\), 162](#)
[plugin_option_type \(class in fastr.core.pluginmanager\), 162](#)
[PluginManager \(class in fastr.core.pluginmanager\), 161](#)
[PluginMeta \(class in fastr.core.baseplugin\), 119](#)
[plugins_path \(fastr.configmanager.Config attribute\), 77](#)
[PluginState \(class in fastr.core.baseplugin\), 119](#)
[PluginSubManager \(class in fastr.core.pluginmanager\), 161](#)
[PluginsView \(class in fastr.core.pluginmanager\), 162](#)
[poll_datatype\(\) \(fastr.core.datatypemanager.DataTypeManager method\), 122](#)
[pop\(\) \(fastr.core.inputgroup.InputGroup method\), 125](#)
[popitem\(\) \(fastr.core.inputgroup.InputGroup method\), 125](#)
[populate\(\) \(fastr.core.basemanager.BaseManager method\), 118](#)
[populate\(\) \(fastr.core.datatypemanager.DataTypeManager method\), 122](#)
[populate\(\) \(fastr.core.ioplugin.IOPluginManager method\), 144](#)
[populate\(\) \(fastr.core.pluginmanager.BasePluginManager method\), 161](#)
[populate\(\) \(fastr.core.toolmanager.ToolManager method\), 177](#)
[post\(\) \(fastr.web.api.RunListApi method\), 239](#)
[preferred_types \(fastr.configmanager.Config attribute\), 77](#)
[preferred_types \(fastr.core.datatypemanager.DataTypeManager attribute\), 122](#)
[preferred_types \(fastr.core.inputoutput.Output attribute\), 135](#)
[preferred_types \(fastr.core.inputoutput.SubOutput attribute\), 140](#)
[preferred_types \(fastr.execution.inputoutputrun.OutputRun attribute\), 197](#)
[preferred_types \(fastr.execution.inputoutputrun.SubOutputRun attribute\), 202](#)
[preload \(fastr.core.baseplugin.PluginState attribute\), 120](#)
[prepend\(\) \(fastr.configmanager.EmptyDefault method\), 79](#)
[primary \(fastr.core.inputgroup.InputGroup attribute\), 125](#)
[print_help\(\) \(in module fastr.utils.cmd\), 235](#)
[print_job_result\(\) \(in module fastr.utils.cmd.trace\), 236](#)
[print_result\(\) \(fastr.core.ioplugin.IOPlugin static method\), 143](#)
[print_sample_sink\(\) \(in module fastr.utils.cmd.trace\), 236](#)
[print_samples\(\) \(in module fastr.utils.cmd.trace\), 236](#)
[print_sinks\(\) \(in module fastr.utils.cmd.trace\), 236](#)
[printlines\(\) \(fastr.utils.schematatable.SchemaPrinter method\), 232](#)
[process_callbacks\(\) \(fastr.execution.executionpluginmanager.ExecutionPluginManager method\), 190](#)
[process_pool_worker_number \(fastr.configmanager.Config attribute\), 77](#)
[processing_callback \(fastr.execution.job.JobState attribute\), 208](#)
[ProcessPoolExecution \(class in fastr.plugins\), 107](#)
[ProcessUsageCollection \(class in fastr.core.target\), 172](#)
[properties_postvalidate\(\) \(in module fastr.utils.jsonschemaresolver\), 230](#)
[properties_prevalidate\(\) \(in module fastr.utils.jsonschemaresolver\), 231](#)
[protected_modules \(fastr.configmanager.Config attribute\), 77](#)
[promov\(\) \(in module fastr.web.views\), 240](#)
[PROV_DUMP \(fastr.execution.job.Job attribute\), 202](#)
[Provenance \(class in fastr.core.provenance\), 163](#)
[provenance \(fastr.datatypes.Deferred attribute\), 82](#)
[provfile \(fastr.execution.job.Job attribute\), 204](#)
[ProvNFile \(class in fastr.datatypes\), 86](#)
[provurl \(fastr.execution.job.Job attribute\), 204](#)
[pull_source_data\(\) \(fastr.core.ioplugin.IOPlugin method\), 143](#)
[pull_source_data\(\) \(fastr.core.ioplugin.IOPluginManager method\), 145](#)
[push_sink_data\(\) \(fastr.core.ioplugin.IOPlugin method\), 143](#)
[push_sink_data\(\) \(fastr.core.ioplugin.IOPluginManager method\), 145](#)
[push_sink_data\(\) \(fastr.plugins.Reference method\), 108](#)
[put_url\(\) \(fastr.core.ioplugin.IOPlugin method\), 143](#)
[put_url\(\) \(fastr.core.ioplugin.IOPluginManager method\), 145](#)
[put_url\(\) \(fastr.plugins.FileSystem method\), 102](#)
[put_url\(\) \(fastr.plugins.Null method\), 106](#)
[put_url\(\) \(fastr.plugins.S3Filesystem method\), 109](#)
[put_url\(\) \(fastr.plugins.VirtualFileSystem method\), 111](#)
[put_url\(\) \(fastr.plugins.XNATStorage method\), 115](#)
[put_value\(\) \(fastr.core.ioplugin.IOPlugin method\), 144](#)
[put_value\(\) \(fastr.plugins.FileSystem method\), 102](#)
[put_value\(\) \(fastr.plugins.Null method\), 106](#)
[put_value\(\) \(fastr.plugins.S3Filesystem method\), 109](#)
[put_value\(\) \(fastr.plugins.VirtualFileSystem method\), 111](#)
[Python Enhancement Proposals](#)
[PEP 8, 27](#)
[PEP 8#class-names, 28](#)
[PEP 8#global-variable-names, 28](#)
[PEP 8#method-names-and-instance-variables, 28](#)
[PEP 8#package-and-module-names, 28](#)
[PEP 8#prescriptive-naming-conventions, 28](#)

Q

queue (fastr.execution.executionpluginmanager.JobAction attribute), 190

queue_job() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 190

queued (fastr.execution.job.JobState attribute), 208

R

raw_value (fastr.datatypes.BaseDataType attribute), 81

read_bytes (fastr.core.target.SystemUsageInfo attribute), 173

read_config() (fastr.configmanager.Config method), 77

read_config_files (fastr.configmanager.Config attribute), 78

read_config_string() (fastr.configmanager.Config method), 78

read_sink_data() (in module fastr.utils.cmd.trace), 236

readfastrschema() (fastr.utils.jsonschemaparser.FastrRefResolver static method), 229

readfile() (fastr.utils.jsonschemaparser.FastrRefResolver static method), 229

Reference (class in fastr.plugins), 108

references (fastr.core.tool.Tool attribute), 176

regex (fastr.core.tool.Tool attribute), 176

register_configuration() (fastr.core.baseplugin.BasePlugin class method), 119

register_fields() (fastr.configmanager.Config method), 78

register_job() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 190

register_url_scheme() (fastr.core.ioplugin.IOPluginManager static method), 145

register_url_scheme() (in module fastr.data.url), 182

release_job() (fastr.execution.executionpluginmanager.ExecutionPlugin method), 190

reload() (fastr.core.basemanager.BaseManager method), 118

reload() (fastr.execution.environmentmodules.EnvironmentModules method), 186

remove() (fastr.__init__.Network method), 69

remove() (fastr.core.inputoutput.Input method), 133

remove() (fastr.core.inputoutput.SubInput method), 138

remove() (fastr.core.network.Network method), 151

remove() (fastr.execution.inputoutputrun.InputRun method), 194

request_parser (fastr.web.api.RunListApi attribute), 239

required (fastr.core.inputoutput.BaseInputOutput attribute), 130

required_cores (fastr.__init__.Node attribute), 73

required_cores (fastr.core.node.Node attribute), 157

required_cores (fastr.execution.job.Job attribute), 205

required_cores (fastr.execution.noderun.NodeRun attribute), 218

required_memory (fastr.__init__.Node attribute), 73

required_memory (fastr.core.node.Node attribute), 157

required_memory (fastr.execution.job.Job attribute), 205

required_memory (fastr.execution.noderun.NodeRun attribute), 218

required_time (fastr.__init__.Node attribute), 74

required_time (fastr.core.node.Node attribute), 157

required_time (fastr.execution.job.Job attribute), 205

required_time (fastr.execution.noderun.NodeRun attribute), 218

requirements (fastr.core.tool.Tool attribute), 176

resourcesdir (fastr.configmanager.Config attribute), 78

RESULT_DUMP (fastr.execution.job.Job attribute), 202

resulting_datatype (fastr.core.inputoutput.Output attribute), 135

resulting_datatype (fastr.core.inputoutput.SubOutput attribute), 140

resulting_datatype (fastr.execution.inputoutputrun.OutputRun attribute), 197

resulting_datatype (fastr.execution.inputoutputrun.SubOutputRun attribute), 202

rmem (fastr.core.target.SystemUsageInfo attribute), 173

RQExecution (class in fastr.plugins), 107

Run (class in fastr.web.api), 238

run_command() (fastr.core.target.Target method), 173

run_command() (fastr.plugins.DockerTarget method), 99

run_command() (fastr.plugins.LocalBinaryTarget method), 105

run_job() (fastr.plugins.RQExecution class method), 107

run_network() (fastr.web.api.Run method), 238

RunApi (class in fastr.web.api), 238

runapp() (in module fastr.web.run), 240

RunListApi (class in fastr.web.api), 239

running (fastr.execution.job.JobState attribute), 208

S

S3Filesystem (class in fastr.plugins), 108

SampleBaseId (class in fastr.core.samples), 164

SamplesCollection (class in fastr.core.samples), 165

SampleId (class in fastr.core.samples), 166

SampleIndex (class in fastr.core.samples), 166

SampleItem (class in fastr.core.samples), 167

SampleItemBase (class in fastr.core.samples), 167

SamplePayload (class in fastr.core.samples), 168

samples (fastr.core.inputoutput.SubOutput attribute), 140

samples (fastr.core.samples.ContainsSamples attribute), 164

samples (fastr.execution.inputoutputrun.OutputRun attribute), 197

samples (fastr.execution.inputoutputrun.SubOutputRun attribute), 202

SampleValue (class in fastr.core.samples), 169

save_gpickle() (in module fastr.utils.iohelpers), 228

save_json() (in module fastr.utils.iohelpers), 228

save_version() (in module fastr.version), 116

schemadir (fastr.configmanager.Config attribute), 78

SchemaPrinter (class in fastr.utils.schematatable), 232
 scheme (fastr.core.ioplugin.IOPlugin attribute), 144
 scheme (fastr.plugins.CommaSeperatedValueFile attribute), 97
 scheme (fastr.plugins.FileSystem attribute), 102
 scheme (fastr.plugins.Null attribute), 107
 scheme (fastr.plugins.Reference attribute), 108
 scheme (fastr.plugins.S3Filesystem attribute), 109
 scheme (fastr.plugins.VirtualFileSystem attribute), 111
 scheme (fastr.plugins.VirtualFileSystemRegularExpression attribute), 112
 scheme (fastr.plugins.VirtualFileSystemValueList attribute), 113
 scheme (fastr.plugins.XNATStorage attribute), 115
 send_job() (fastr.plugins.DRMAAExecution method), 98
 sequence_part() (fastr.core.samples.SampleValue method), 170
 Serializable (class in fastr.core.serializable), 170
 serialize() (fastr.core.provenance.Provenance method), 163
 SERIALIZERS (fastr.core.serializable.Serializable attribute), 170
 server (fastr.plugins.XNATStorage attribute), 115
 set_code() (fastr.core.baseplugin.BasePlugin class method), 119
 set_data() (fastr.__init__.ConstantNode method), 75
 set_data() (fastr.__init__.SourceNode method), 76
 set_data() (fastr.core.node.ConstantNode method), 153
 set_data() (fastr.core.node.SourceNode method), 159
 set_data() (fastr.execution.networkrun.NetworkRun method), 216
 set_data() (fastr.execution.sinknoderun.SinkNodeRun method), 219
 set_data() (fastr.execution.sourcenoderun.ConstantNodeRun method), 222
 set_data() (fastr.execution.sourcenoderun.SourceNodeRun method), 221
 set_field() (fastr.configmanager.Config method), 78
 set_result() (fastr.execution.flownoderun.AdvancedFlowNodeRun method), 191
 set_result() (fastr.execution.flownoderun.FlowNodeRun method), 191
 set_result() (fastr.execution.noderun.NodeRun method), 218
 set_result() (fastr.execution.sinknoderun.SinkNodeRun method), 220
 set_status() (fastr.core.baseplugin.BasePlugin class method), 119
 setdefault() (fastr.core.inputgroup.InputGroup method), 125
 setup() (fastr.core.ioplugin.IOPlugin method), 144
 setup() (fastr.plugins.VirtualFileSystem method), 111
 sha1_checksum() (in module fastr.utils.checksum), 225
 show_jobs() (fastr.execution.executionpluginmanager.ExecutionPluginManager method), 190
 shutdown() (in module fastr.web.views), 240
 shutdown_server() (in module fastr.web.views), 240
 sink_data() (in module fastr.examples.add_ints), 183
 sink_data() (in module fastr.examples.add_ints_s3), 183
 sink_data() (in module fastr.examples.collapse), 183
 sink_data() (in module fastr.examples.collapse_expand), 183
 sink_data() (in module fastr.examples.cross_validation), 184
 sink_data() (in module fastr.examples.elastix_nipype), 184
 sink_data() (in module fastr.examples.expand), 184
 sink_data() (in module fastr.examples.failing_network), 184
 sink_data() (in module fastr.examples.filecopy), 184
 sink_data() (in module fastr.examples.input_groups), 184
 sink_data() (in module fastr.examples.macro_node), 185
 sink_data() (in module fastr.examples.macro_node2), 185
 sink_data() (in module fastr.examples.shift_links), 185
 sink_data() (in module fastr.examples.source_sink), 185
 SINK_DUMP_FILE_NAME (fastr.__init__.Network attribute), 66
 SINK_DUMP_FILE_NAME (fastr.core.network.Network attribute), 148
 SINK_DUMP_FILE_NAME (fastr.execution.networkrun.NetworkRun attribute), 214
 SinkJob (class in fastr.execution.job), 208
 sinklist (fastr.execution.networkrun.NetworkRun attribute), 216
 SinkNode (class in fastr.__init__), 76
 SinkNode (class in fastr.core.node), 157
 SinkNodeRun (class in fastr.__init__), 65
 SinkNodeRun (class in fastr.execution.sinknoderun), 219
 size (fastr.core.dimension.Dimension attribute), 122
 size (fastr.core.dimension.HasDimensions attribute), 123
 size (fastr.execution.inputoutputrun.SourceOutputRun attribute), 198
 size (fastr.execution.linkrun.LinkRun attribute), 212
 solve_broadcast() (fastr.core.inputgroup.InputGroup class method), 125
 source (fastr.__init__.Link attribute), 71
 source (fastr.core.dimension.ForwardsDimensions attribute), 123
 source (fastr.core.inputoutput.Input attribute), 133
 source (fastr.core.inputoutput.SubInput attribute), 138
 source (fastr.core.link.Link attribute), 148
 source (fastr.execution.inputoutputrun.InputRun attribute), 194
 source (fastr.execution.inputoutputrun.SubInputRun attribute), 200
 source (fastr.execution.linkrun.LinkRun attribute), 212
 source (fastr.execution.linkrun.LinkRun attribute), 63

- ul style="list-style-type: none; padding-left: 0;">
- source_code (fastr.core.baseplugin.BasePlugin attribute), 119
- source_data() (in module fastr.examples.add_ints), 183
- source_data() (in module fastr.examples.add_ints_s3), 183
- source_data() (in module fastr.examples.collapse), 183
- source_data() (in module fastr.examples.collapse_expand), 183
- source_data() (in module fastr.examples.cross_validation), 184
- source_data() (in module fastr.examples.elastix_nipype), 184
- source_data() (in module fastr.examples.expand), 184
- source_data() (in module fastr.examples.failing_network), 184
- source_data() (in module fastr.examples.filecopy), 184
- source_data() (in module fastr.examples.input_groups), 184
- source_data() (in module fastr.examples.macro_node), 185
- source_data() (in module fastr.examples.macro_node2), 185
- source_data() (in module fastr.examples.shift_links), 185
- source_data() (in module fastr.examples.source_sink), 185
- SOURCE_DUMP_FILE_NAME (fastr.__init__.Network attribute), 66
- SOURCE_DUMP_FILE_NAME (fastr.core.network.Network attribute), 148
- SOURCE_DUMP_FILE_NAME (fastr.execution.networkrun.NetworkRun attribute), 214
- source_job_limit (fastr.configmanager.Config attribute), 78
- source_output (fastr.core.inputoutput.SubInput attribute), 138
- source_output (fastr.execution.inputoutputrun.SubInputRun attribute), 200
- sourcegroup (fastr.__init__.SourceNode attribute), 76
- sourcegroup (fastr.core.node.SourceNode attribute), 159
- sourcegroup (fastr.execution.sourcenoderun.SourceNodeRun attribute), 221
- SourceJob (class in fastr.execution.job), 209
- sourcelist (fastr.execution.networkrun.NetworkRun attribute), 216
- SourceNode (class in fastr.__init__), 75
- SourceNode (class in fastr.core.node), 158
- SourceNodeRun (class in fastr.__init__), 65
- SourceNodeRun (class in fastr.execution.sourcenoderun), 220
- SourceOutput (class in fastr.core.inputoutput), 135
- SourceOutputRun (class in fastr.execution.inputoutputrun), 197
- spec_fields (fastr.plugins.DRMAAExecution attribute), 98
- split() (in module fastr.data.url), 182
- status (fastr.__init__.Link attribute), 71
- status (fastr.__init__.Node attribute), 74
- status (fastr.core.baseplugin.BasePlugin attribute), 119
- status (fastr.core.link.Link attribute), 148
- status (fastr.core.node.Node attribute), 157
- status (fastr.core.version.Version attribute), 180
- status (fastr.execution.job.Job attribute), 205
- status (fastr.execution.linkrun.LinkRun attribute), 212
- status (fastr.execution.noderun.NodeRun attribute), 218
- status() (fastr.web.api.Run method), 238
- status_message (fastr.core.baseplugin.BasePlugin attribute), 119
- StatusApi (class in fastr.web.api), 239
- STDERR_DUMP (fastr.execution.job.Job attribute), 202
- stderrfile (fastr.execution.job.Job attribute), 205
- stderrurl (fastr.execution.job.Job attribute), 205
- stdout (in module fastr.plugins), 115
- STDOUT_DUMP (fastr.execution.job.Job attribute), 202
- stdoutfile (fastr.execution.job.Job attribute), 205
- stdouturl (fastr.execution.job.Job attribute), 205
- store() (fastr.utils.filesynchelper.FileSyncHelper method), 228
- String (class in fastr.datatypes), 86
- StrongrExecution (class in fastr.plugins), 109
- SubInput (class in fastr.core.inputoutput), 136
- SubInputRun (class in fastr.execution.inputoutputrun), 198
- submit_jobs() (fastr.plugins.DRMAAExecution method), 98
- SubOutput (class in fastr.core.inputoutput), 138
- SubOutputRun (class in fastr.execution.inputoutputrun), 200
- substitute() (fastr.execution.job.SinkJob method), 209
- SubUrl (class in fastr.web.api), 239
- suffix (fastr.core.version.Version attribute), 180
- SUPPORTS_CANCEL (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 188
- SUPPORTS_CANCEL (fastr.plugins.DRMAAExecution attribute), 97
- SUPPORTS_DEPENDENCY (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 188
- SUPPORTS_DEPENDENCY (fastr.plugins.DRMAAExecution attribute), 97
- SUPPORTS_HOLD_RELEASE (fastr.execution.executionpluginmanager.ExecutionPlugin attribute), 188
- SUPPORTS_HOLD_RELEASE (fastr.plugins.DRMAAExecution attribute), 97
- swap() (fastr.execution.environmentmodules.EnvironmentModules

method), 187
 switch_sample_sink() (in module fastr.utils.cmd.trace), 236
 sync() (fastr.execution.environmentmodules.EnvironmentModules class method), 187
 systemdir (fastr.configmanager.Config attribute), 78
 SystemUsageInfo (class in fastr.core.target), 172

T

tags (fastr.core.tool.Tool attribute), 176
 Target (class in fastr.core.target), 173
 target (fastr.__init__.Link attribute), 71
 target (fastr.core.link.Link attribute), 148
 target (fastr.core.tool.Tool attribute), 176
 target (fastr.datatypes.Deferred attribute), 82
 target (fastr.execution.linkrun.LinkRun attribute), 212
 target (fastr.Link attribute), 64
 TargetManager (class in fastr.core.target), 173
 test() (fastr.__init__.Network class method), 69
 test() (fastr.core.baseplugin.BasePlugin class method), 119
 test() (fastr.core.interface.Interface class method), 141
 test() (fastr.core.network.Network class method), 151
 test() (fastr.core.target.Target class method), 173
 test() (fastr.core.tool.Tool method), 176
 test() (fastr.datatypes.BaseDataType class method), 81
 test() (fastr.plugins.DRMAAExecution class method), 98
 test() (fastr.plugins.NipypeInterface class method), 106
 test() (fastr.plugins.ProcessPoolExecution class method), 107
 test() (fastr.plugins.StrongrExecution class method), 109
 test_plugin() (fastr.core.pluginmanager.BasePluginManager class method), 161
 test_spec (fastr.core.tool.Tool attribute), 176
 test_tool() (fastr.core.tool.Tool class method), 176
 tests (fastr.core.tool.Tool attribute), 176
 TifImageFile (class in fastr.datatypes), 86
 timestamp (fastr.core.target.SystemUsageInfo attribute), 173
 tmpurl (fastr.execution.job.Job attribute), 205
 tmpurl (fastr.execution.job.SinkJob attribute), 209
 todict() (fastr.core.objectmanager.ObjectManager class method), 160
 Tool (class in fastr.core.tool), 174
 tool (fastr.__init__.Node attribute), 74
 tool (fastr.core.node.Node attribute), 157
 tool (fastr.execution.job.Job attribute), 205
 tool (fastr.execution.noderun.NodeRun attribute), 218
 tool() (in module fastr.utils.cmd.test), 236
 tool() (in module fastr.web.views), 240
 TOOL_REFERENCE_FILE_NAME (fastr.core.tool.Tool attribute), 174
 TOOL_RESULT_FILE_NAME (fastr.core.tool.Tool attribute), 174

ToolApi (class in fastr.web.api), 239
 toollist (fastr attribute), 61
 toollist (in module fastr.__init__), 65
 ToolList (in module fastr.core.toolmanager), 177
 ToolListApi (class in fastr.web.api), 240
 ToolManager (class in fastr.core.toolmanager), 176
 tools_path (fastr.configmanager.Config attribute), 78
 toolversions() (fastr.core.toolmanager.ToolManager class method), 177
 TORQUE_NATIVE_SPEC (fastr.plugins.DRMAAExecution attribute), 97
 tostring_modvalue() (fastr.execution.environmentmodules.EnvironmentModules class static method), 187
 totuple_modvalue() (fastr.execution.environmentmodules.EnvironmentModules class static method), 187
 translate_argument() (fastr.execution.job.Job class method), 205
 translate_output_results() (fastr.execution.job.Job class static method), 205
 translate_results() (fastr.execution.job.Job class method), 205
 TxtFile (class in fastr.datatypes), 86
 TypeGroup (class in fastr.datatypes), 86
 typelist (fastr attribute), 62
 typelist (in module fastr.__init__), 65
 types_path (fastr.configmanager.Config attribute), 78

U

uninitialized (fastr.core.baseplugin.PluginState attribute), 120
 unload() (fastr.execution.environmentmodules.EnvironmentModules class method), 187
 unloaded (fastr.core.baseplugin.PluginState attribute), 120
 unmerge() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner class method), 126
 unmerge() (fastr.core.inputgroupcombiner.DefaultInputGroupCombiner class method), 127
 unmerge() (fastr.core.inputgroupcombiner.MergingInputGroupCombiner class method), 127
 UnsignedInt (class in fastr.datatypes), 88
 update() (fastr.configmanager.EmptyDefault method), 79
 update() (fastr.core.inputgroup.InputGroup class method), 125
 update() (fastr.core.inputgroupcombiner.BaseInputGroupCombiner class method), 127
 update() (fastr.core.inputgroupcombiner.MergingInputGroupCombiner class method), 127
 update() (fastr.core.updateable.Updateable class method), 178
 update_input_groups() (fastr.__init__.Node class method), 74
 update_input_groups() (fastr.core.node.Node class method), 157
 update_input_groups() (fastr.execution.noderun.NodeRun class method), 218
 update_job_result() (in module fastr.web.api), 240

`update_size()` (fastr.core.dimension.Dimension method), 123
`update_status()` (in module fastr.web.api), 240
`Updateable` (class in fastr.core.updateable), 177
`UpdateableMeta` (class in fastr.core.updateable), 178
`updatetrigger()` (fastr.core.updateable.UpdateableMeta static method), 179
`upload()` (fastr.plugins.XNATStorage static method), 115
`url` (fastr.core.tool.Tool attribute), 176
`url_to_path()` (fastr.core.ioplugin.IOPlugin method), 144
`url_to_path()` (fastr.core.ioplugin.IOPluginManager method), 145
`url_to_path()` (fastr.plugins.FileSystem method), 102
`url_to_path()` (fastr.plugins.VirtualFileSystem method), 111
`URLType` (class in fastr.datatypes), 87
`usage_type` (fastr.core.target.ProcessUsageCollection attribute), 172
`userdir` (fastr.configmanager.Config attribute), 78

V

`valid` (fastr.__init__.SourceNode attribute), 76
`valid` (fastr.core.inputoutput.Output attribute), 135
`valid` (fastr.core.node.SourceNode attribute), 159
`valid` (fastr.core.updateable.Updateable attribute), 178
`valid` (fastr.datatypes.BaseDataType attribute), 81
`valid` (fastr.datatypes.URLType attribute), 88
`valid` (fastr.execution.inputoutputrun.OutputRun attribute), 197
`valid` (fastr.execution.sourcenoderun.SourceNodeRun attribute), 221
`validate_results()` (fastr.execution.job.Job method), 205
`validate_results()` (fastr.execution.job.SinkJob method), 209
`validate_results()` (fastr.execution.job.SourceJob method), 209
`value` (fastr.datatypes.BaseDataType attribute), 81
`value` (fastr.datatypes.Boolean attribute), 81
`value` (fastr.datatypes.Deferred attribute), 82
`value` (fastr.datatypes.Float attribute), 84
`value` (fastr.datatypes.Int attribute), 84
`value` (fastr.datatypes.UnsignedInt attribute), 88
`ValueType` (class in fastr.datatypes), 88
`verify_resource_loading()` (in module fastr.utils.verify), 234
`verify_tool()` (in module fastr.utils.verify), 234
`Version` (class in fastr.core.version), 179
`version` (fastr.core.tool.Tool attribute), 176
`version` (fastr.datatypes.BaseDataType attribute), 81
`version` (fastr.datatypes.EnumType attribute), 83
`version_matcher` (fastr.core.version.Version attribute), 180
`VirtualFileSystem` (class in fastr.plugins), 109

`VirtualFileSystemRegularExpression` (class in fastr.plugins), 111
`VirtualFileSystemValueList` (class in fastr.plugins), 112
`vmem` (fastr.core.target.SystemUsageInfo attribute), 173

W

`wait_for_file()` (fastr.utils.filesynchelper.FileSyncHelper method), 228
`wait_for_job()` (fastr.utils.filesynchelper.FileSyncHelper method), 228
`wait_for_pickle()` (fastr.utils.filesynchelper.FileSyncHelper method), 228
`wait_for_vfs_url()` (fastr.utils.filesynchelper.FileSyncHelper method), 228
`warn_develop` (fastr.configmanager.Config attribute), 78
`web_hostname` (fastr.configmanager.Config attribute), 78
`web_port` (fastr.configmanager.Config attribute), 78
`web_secret_key` (fastr.configmanager.Config attribute), 78
`web_url()` (fastr.configmanager.Config method), 78
`websocket_client()` (in module fastr.web.views), 240
`which()` (in module fastr.utils.procutils), 231
`write()` (fastr.execution.job.Job method), 206
`write_bytes` (fastr.core.target.SystemUsageInfo attribute), 173

X

`x` (fastr.configmanager.Config attribute), 78
`xnat` (fastr.plugins.XNATStorage attribute), 115
`XNATStorage` (class in fastr.plugins), 113