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# AABBTree Documentation

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## Contents

1	Installation	1
2	Example	2
3	API	2
4	Contributing	5
5	License and Copyright Notice	5

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Repository Documentation PyPI

AABBTree is a pure Python implementation of a static d-dimensional axis aligned bounding box (AABB) tree. It is inspired by [Introductory Guide to AABB Tree Collision Detection](#) from *Azure From The Trenches*.

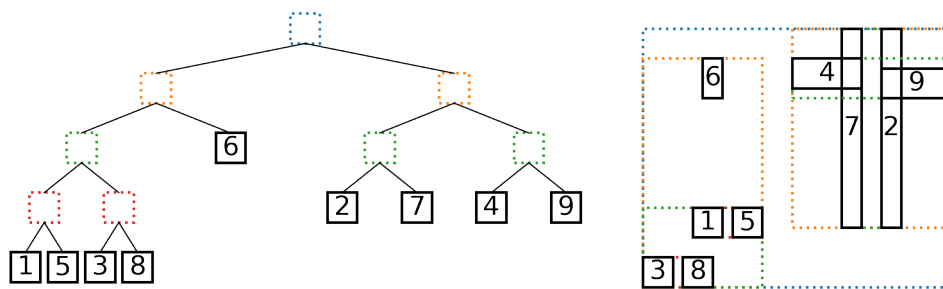


Fig. 1: Left: An AABB tree, leaves numbered by insertion order. Right: The AABBs and their bounding boxes.

## 1 Installation

AABBTree is available through PyPI and can be installed by running:

```
pip install aabbtree
```

To test that the package installed properly, run:

```
python -c "import aabbtree"
```

Alternatively, the package can be installed from source by downloading the latest release from the [AABBTree repository](#) on GitHub. Extract the source and, from the top-level directory, run:

```
pip install -e .
```

The `--user` flag may be needed, depending on permissions.

## 2 Example

The following example shows how to build an AABB tree and test for overlap:

```
>>> from aabbtree import AABB
>>> from aabbtree import AABBTree
>>> tree = AABBTree()
>>> aabb1 = AABB([(0, 0), (0, 0)])
>>> aabb2 = AABB([(-1, 1), (-1, 1)])
>>> aabb3 = AABB([(4, 5), (2, 3)])
>>> tree.add(aabb1, 'box 1')
>>> tree.does_overlap(aabb2)
True
>>> tree.overlap_values(aabb2)
['box 1']
>>> tree.does_overlap(aabb3)
False
>>> tree.add(aabb3)
>>> print(tree)
AABB: [(0, 5), (0, 3)]
Value: None
Left:
  AABB: [(0, 0), (0, 0)]
  Value: box 1
  Left: None
  Right: None
Right:
  AABB: [(4, 5), (2, 3)]
  Value: None
  Left: None
  Right: None
```

## 3 API

**class** aabbtree.**AABB** (*limits=None*)

Bases: object

Axis-aligned bounding box (AABB)

The AABB is a d-dimensional box.

**Parameters** `limits` (*iterable, optional*) – The limits of the box. These should be specified in the following manner:

```
limits = [(xmin, xmax),
          (ymin, ymax),
          (zmin, zmax),
          ...]
```

The default value is None.

**classmethod** `merge` (*aabb1, aabb2*)

Merge AABB

Find the AABB of the union of AABBs.

**Parameters**

- **aabb1** (*AABB*) – An AABB
- **aabb2** (*AABB*) – An AABB

**Returns** An AABB that contains both of the inputs

**Return type** AABB

**overlap\_volume** (*aabb*)

Determine volume of overlap between AABBs

Let  $(l_i^{(1)}, u_i^{(1)})$  be the  $i$ -th dimension lower and upper bounds for AABB 1, and let  $(l_i^{(2)}, u_i^{(2)})$  be the lower and upper bounds for AABB 2. The volume of overlap is:

$$V = \prod_{i=1}^n \max\left(0, \min\left(u_i^{(1)}, u_i^{(2)}\right) - \max\left(l_i^{(1)}, l_i^{(2)}\right)\right)$$

**Parameters** **aabb** (*AABB*) – The AABB to calculate for overlap volume

**Returns** Volume of overlap

**Return type** float

**overlaps** (*aabb*)

Determine if two AABBs overlap

**Parameters** **aabb** (*AABB*) – The AABB to check for overlap

**Returns** Flag set to true if the two AABBs overlap

**Return type** bool

**perimeter**

perimeter of AABB

The perimeter  $p_n$  of an AABB with side lengths  $l_1 \dots l_n$  is:

$$\begin{aligned} p_1 &= 0 \\ p_2 &= 2(l_1 + l_2) \\ p_3 &= 2(l_1l_2 + l_2l_3 + l_1l_3) \\ p_n &= 2 \sum_{i=1}^n \prod_{j=1, j \neq i}^n l_j \end{aligned}$$

**Type** float

## volume

volume of AABB

The volume  $V_n$  of an AABB with side lengths  $l_1 \dots l_n$  is:

$$V_1 = l_1$$

$$V_2 = l_1 l_2$$

$$V_3 = l_1 l_2 l_3$$

$$V_n = \prod_{i=1}^n l_i$$

**Type** float

**class** aabbtree.**AABBTree** (*aabb=AABB(None), value=None, left=None, right=None*)

Bases: object

Static AABB Tree

An AABB tree where the bounds of each AABB do not change.

### Parameters

- **aabb** (*AABB*) – An AABB
- **value** – The value associated with the AABB
- **left** (*AABBTree, optional*) – The left branch of the tree
- **right** (*AABBTree, optional*) – The right branch of the tree

**add** (*aabb, value=None, method='volume'*)

Add node to tree

This function inserts a node into the AABB tree. The function chooses one of three options for adding the node to the tree:

- Add it to the left side
- Add it to the right side
- Become a leaf node

The cost of each option is calculated based on the *method* keyword, and the option with the lowest cost is chosen.

### Parameters

- **aabb** (*AABB*) – The AABB to add.
- **value** – The value associated with the AABB. Defaults to None.
- **method** (*str*) – The method for deciding how to build the tree. Should be one of the following:
  - volume

**volume** *Costs based on total bounding volume and overlap volume*

Let  $p$  denote the parent,  $l$  denote the left child,  $r$  denote the right child,  $x$  denote the AABB to add, and  $V$  be the volume of an AABB. The three options to add  $x$  to the left branch, add it to the right branch, or create a new parent. The cost associated with each of these

options is:

$$\begin{aligned}C(\text{add left}) &= V(p \cup x) - V(p) + V(l \cup x) - V(l) + V((l \cup x) \cap r) \\C(\text{add right}) &= V(p \cup x) - V(p) + V(r \cup x) - V(r) + V((r \cup x) \cap l) \\C(\text{create parent}) &= V(p \cup x) + V(p \cap x)\end{aligned}$$

In the add-left cost, the term  $V(b \cup x) - V(b)$  is the increase in parent bounding volume. The cost  $V(l \cup x) - V(l)$  is the increase in left child bounding volume. The last term,  $V((l \cup x) \cap r)$  is the overlapping volume between children if  $x$  were added to the left child. The cost to create a new parent is the bounding volume of the parent and  $x$  plus their overlap volume.

This cost function includes the increases in bounding volumes and the amount of overlap—two values a balanced AABB tree should minimize. The cost function suits the author's current needs, though other applications may seek different tree properties. Please visit the [AABBTree repository](#) if interested in implementing another cost function.

**does\_overlap** (*aabb*)

Check for overlap

This function checks if the limits overlap any leaf nodes in the tree. It returns true if there is an overlap.

**Parameters** **aabb** (*AABB*) – The AABB to check.

**Returns** True if overlaps with a leaf node of tree.

**Return type** bool

**overlap\_values** (*aabb*)

Get values of overlapping AABBs

This function gets the value field of each overlapping AABB.

**Parameters** **aabb** (*AABB*) – The AABB to check.

**Returns** Value fields of each node that overlaps.

**Return type** list

**depth**

Depth of the tree

**Type** int

**is\_leaf**

returns True if is leaf node

**Type** bool

## 4 Contributing

Contributions to the project are welcome. Please visit the [AABBTree repository](#) to clone the source files, create a pull request, and submit issues.

## 5 License and Copyright Notice

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