
dask-geomodeling

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Dask-geomodeling is a collection of classes that are to be stacked together to create configurations for on-the-fly operations on geographical maps. By generating [Dask](#) compute graphs, these operation may be parallelized and (intermediate) results may be cached.

Multiple Block instances together make a view. Each Block has the `get_data` method that fetches the data in one go, as well as a `get_compute_graph` method that creates a graph to compute the data later.

Blocks are used for the on-the-fly modification of raster- and vectordata, respectively through the baseclasses `RasterBlock()` and `GeometryBlock()`. Derived classes support operations such as grouping basic math, shifting time, smoothing, reclassification, geometry operations, zonal statistics, and property field operations.

CHAPTER 1

About

This package was developed by Nelen & Schuurmans and is used commercially under the name Geoblocks. Please consult the [Lizard](#) website for more information about this product.

2.1 Installation

2.1.1 Requirements

- python \geq 3.5
- GDAL 2.* (with BigTIFF support)
- numpy
- scipy
- dask[delayed]
- pandas
- geopandas
- ipyleaflet, matplotlib, pillow (for the ipyleaflet plugin)

2.1.2 Anaconda (all platforms)

1. Install anaconda / miniconda
2. Start the *Anaconda Prompt* via the start menu
3. `conda config --add channels conda-forge`
4. `conda update conda`
5. `conda install python=3.6 gdal=2.4.1 scipy=1.3.1 dask-geomodeling ipyleaflet matplotlib pillow`

Note: The version pins of python, gdal and scipy are related to issues specific to Windows. On other platforms you may leave them out, although we do not recommend using Python 3.8 yet. If you need other python or GDAL versions

on windows: while *dask-geomodeling* itself is compatible with all current versions, you may may have a hard time getting it to work via Anaconda and it will probably be easier using the pip route listed below.

2.1.3 Windows (pip)

The following recipe is still a work in progress:

1. Install Python 3.* (stable)
2. Install GDAL 2.* (MSVC 2015)
3. Add the GDAL installation path to your PATH variable
4. Start the command prompt
5. `pip install gdal==2.* dask-geomodeling ipyleaflet matplotlib pillow`
6. (optionally) `pip install ipyleaflet matplotlib pillow`

Note: You might need to setup your C++ compiler according to [this](#)

2.1.4 On the ipyleaflet plugin

dask-geomodeling comes with a ipyleaflet plugin for [Jupyter](#) so that you can show your generated views on a mapviewer. If you want to use it, install some additional dependencies:

```
$ conda [or pip] install jupyter ipyleaflet matplotlib pillow
```

And start your notebook server with the plugin:

```
$ jupyter notebook --NotebookApp.nbserver_extensions={"dask_geomodeling.ipyleaflet_
↪plugin":True}"
```

Alternatively, you can add this extension to your [Jupyter configuration](#)

2.1.5 Advanced: local setup with system Python (Ubuntu)

These instructions make use of the system-wide Python 3 interpreter:

```
$ sudo apt install python3-pip python3-gdal
```

Install dask-geomodeling:

```
$ pip install --user dask-geomodeling[test,cityhash]
```

Run the tests:

```
$ pytest
```

2.1.6 Advanced: local setup for development (Ubuntu)

These instructions assume that `git`, `python3`, `pip`, and `virtualenv` are installed on your host machine.

Clone the `dask-geomodeling` repository:

```
$ git clone https://github.com/nens/dask-geomodeling
```

Make sure you have the GDAL libraries installed. On Ubuntu:

```
$ sudo apt install libgdal-dev
```

Take note of the GDAL version:

```
$ apt show libgdal-dev
```

Create and activate a `virtualenv`:

```
$ cd dask-geomodeling
$ virtualenv --python=python3 .venv
$ source .venv/bin/activate
```

Install `PyGDAL` with the correct version (example assumes GDAL 2.2.3):

```
(.venv) $ pip install pygdal==2.2.3.*
```

Install `dask-geomodeling`:

```
(.venv) $ pip install -e .[test,cityhash]
```

Run the tests:

```
(.venv) $ pytest
```

2.2 Quickstart

2.2.1 Constructing a view

A `dask-geomodeling` view can be constructed by creating a `Block` instance:

```
from dask_geomodeling.raster import RasterFileSource
source = RasterFileSource('/path/to/geotiff')
```

The view can now be used to obtain data from the specified file. More complex views can be created by nesting block instances:

```
from dask_geomodeling.raster import Smooth
smoothed = Smooth(source, 5)
smoothed_plus_two = smoothed + 2
```

2.2.2 Obtaining data from a view

To obtain data from a view directly, use the `get_data` method:

```
request = {
    "mode": "vals",
    "bbox": (138000, 480000, 139000, 481000),
    "projection": "epsg:28992",
    "width": 256,
    "height": 256
}
data = add.get_data(**request)
```

Which field to include in the request and what data to expect depends on the type of the block used. In this example, we used a RasterBlock. The request and response specifications are listed in the documentation of the specific block type.

2.2.3 Showing data on the map

If you are using Jupyter and our ipyleaflet plugin, you can inspect your dask-geomodeling View on an interactive map widget.

```
from ipyleaflet import Map, basemaps, basemap_to_tiles
from dask_geomodeling.ipyleaflet_plugin import GeomodelingLayer

# create the geomodeling layer and the background layer
# the 'styles' parameter refers to a matplotlib colormap;
# the 'vmin' and 'vmax' parameters determine the range of the colormap
geomodeling_layer = GeomodelingLayer(
    add, styles="viridis", vmin=0, vmax=10, opacity=0.5
)
osm_layer = basemap_to_tiles(basemaps.OpenStreetMap.Mapnik)

# center the map on the middle of the View's extent
extent = add.extent
Map(
    center=((extent[1] + extent[3]) / 2, (extent[0] + extent[2]) / 2),
    zoom=14,
    layers=[osm_layer, geomodeling_layer]
)
```

Please consult the [ipyleaflet docs](#) for examples in how to add different basemaps, other layers, or add controls.

2.2.4 Delayed evaluation

Dask-geomodeling revolves around *lazy data evaluation*. Each Block first evaluates what needs to be done for certain request, storing that in a *compute graph*. This graph can then be evaluated to obtain the data. The data is evaluated with dask, and the specification of the compute graph also comes from dask. For more information about how a graph works, consult the [dask documentation](#):

We use the previous example to demonstrate how this works:

```
import dask
request = {
    "mode": "vals",
    "bbox": (138000, 480000, 139000, 481000),
    "projection": "epsg:28992",
    "width": 256,
```

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```

    "height": 256
}
graph, name = add.get_compute_graph(**request)
data = dask.get(graph, [name])

```

Here, we first generate a compute graph using `dask-geomodeling`, then evaluate the graph using `dask`. The power of this two-step procedure is twofold:

1. Dask supports threaded, multiprocessing, and distributed schedulers. Consult the [dask documentation](#) to try these out.
2. The `name` is a unique identifier of this computation: this can easily be used in caching methods.

2.3 Views

A View is a combination of one or more Blocks. For instance:

```

from dask_geomodeling.raster import RasterFileSource, Group
source_1 = RasterFileSource("path/to/some/tiff")
source_2 = RasterFileSource("path/to/another/tiff")
view = Group(source_1, source_1)

```

2.3.1 View serialization

A View consists of several Block instances that reference each other. To serialize this we use Dask's `graph` format. This graph format replaces the nested structure by a flat dictionary with internal references

Warning: A serialized view looks much alike a compute graph. Don't get confused!

An example using the above view definition:

```

serialized_view = view.serialize()

```

```

{
  "version": 2,
  "graph": {
    "RasterFileSource_300b56b278d49bea13eff68f8cf52f90": [
      "dask_geomodeling.raster.sources.RasterFileSource",
      "file:///path/to/some/tiff"
    ],
    "RasterFileSource_9dc43c9bd98e2f9069e2b0c879d76cb1": [
      "dask_geomodeling.raster.sources.RasterFileSource",
      "file:///path/to/another/tiff"
    ],
    "Group_0d0a99fe65bffe87dd045627c27bcbbb": [
      "dask_geomodeling.raster.combine.Group",
      "RasterFileSource_300b56b278d49bea13eff68f8cf52f90",
      "RasterFileSource_9dc43c9bd98e2f9069e2b0c879d76cb1"
    ]
  }
},

```

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```
"name": "Group_0d0a99fe65bffe87dd045627c27bcbbb"
}
```

The above “view graph” contains all three operations that we defined together with their arguments. The names are automatically generated and contain a hash which is useful to uniquely determine the block. Also, we see the “name”, that points to the endpoint block.

To deserialize the view:

```
from dask_geomodeling.core import Block
view = Block.deserialize(serialized_view)
```

The methods `Block.to_json` and `Block.from_json`, or `Block.get_graph` and `dask_geomodeling.construct` serve the same purpose, but they in/output different object types.

2.4 Blocks

2.4.1 The Block class

To write a new `Block` subclass, we need to write the following:

1. the `__init__` that validates the arguments when constructing the block
2. the `get_sources_and_requests` that processes the request
3. the `process` that processes the data
4. a number of attributes such as `extent` and `period`

About the 2-step data processing

The `get_sources_and_requests` method of any block is called recursively from `get_compute_graph` and feeds the request from the block to its sources. It does so by returning a list of (source, request) tuples. During the data evaluation each of these 2-tuples will be converted to a single data object which is supplied to the `process` function.

First, an example in words. We construct a `View add = RasterFileSource('path/to/geotiff') + 2.4` and ask it the following:

- give me a 256x256 raster at location (138000, 480000)

We do that by calling `get_data`, which calls `get_compute_graph`, which calls `get_sources_and_requests` on each block instance recursively.

First `add.get_sources_and_requests` would respond with the following:

- I will need a 256x256 raster at location (138000, 480000) from `RasterFileSource('/path/to/geotiff')`
- I will need 2.4

Then, on recursion, the `RasterFileSource.get_sources_and_requests` would respond:

- I will give you the 256x256 raster at location (138000, 480000)

These small subtasks get summarized in a compute graph, which is returned by `get_compute_graph`. Then `get_data` feeds that compute graph to `dask`.

`Dask` will evaluate this graph by calling the `process` methods on each block:

1. A raster is loaded using `RasterFileSource.process`
2. This, together with the number 2.4, is given to `Add.process`
3. The resulting raster is presented to the user.

Implementation example

As an example, we use a simplified Dilate block, which adds a buffer of 1 pixel around all pixels of given value:

```
class Dilate(RasterBlock):
    def __init__(self, source, value):
        assert isinstance(source, RasterBlock):
        value = float(value)
        super().__init__(source, value)

    @property
    def source(self):
        return self.args[0]

    @property
    def value(self):
        return self.args[1]

    def get_sources_and_requests(self, **request):
        new_request = expand_request_pixels(request, radius=1)
        return [(self.store, new_request), (self.value, None)]

    @staticmethod
    def process(data, values=None):
        # handle empty data cases
        if data is None or values is None or 'values' not in data:
            return data
        # perform the dilation
        original = data['values']
        dilated = original.copy()
        dilated[ndimage.binary_dilation(original == value)] = value
        dilated = dilated[:, 1:-1, 1:-1]
        return {'values': dilated, 'no_data_value': data['no_data_value']}

    @property
    def extent(self):
        return self.source.extent

    @property
    def period(self):
        return self.source.period
```

In this example, we see all the essentials of a Block implementation.

- The `__init__` checks the types of the provided arguments and calls the `super().__init__` that further initializes the block.
- The `get_sources_and_requests` expands the request with 1 pixel, so that dilation will have no edge effects. It returns two (source, request) tuples.
- The `process` (static)method takes the amount arguments equal to the length of the list that `get_sources_and_requests` produces. It does the actual work and returns a data response.
- Some attributes like `extent` and `period` need manual specification, as they might change through the block.

- The class derives from `RasterBlock`, which sets the type of block, and through that its request/response schema and its required attributes.

2.4.2 Block types specification

A block type sets three things:

1. the response schema: e.g. “`RasterBlock.process` returns a dictionary with a numpy array and a no data value”
2. the request schema: e.g. “`RasterBlock.get_sources_and_requests` expects a dictionary with the fields ‘mode’, ‘bbox’, ‘projection’, ‘height’, ‘width’”
3. the attributes to be implemented on each block

This is not enforced at the code level, it is up to the developer to stick to this specification. The specification is written down in the type baseclass `RasterBlock()` or `GeometryBlock()`.

2.4.3 API specification

Module containing the core graphs.

class `dask_geomodeling.core.graphs.Block(*args)`

A class that generates dask-like compute graphs for given requests.

Arguments (`args`) are always stored in `self.args`. If a request is passed into the `Block` using the `get_data` or (the lazy version) `get_compute_graph` method, the `Block` figures out what `args` are actually necessary to evaluate the request, and what requests need to be sent to those `args`. This happens in the method `get_sources_and_requests`.

After the requests have been evaluated, the data comes back and is passed into the `process` method.

classmethod `deserialize(val, validate=False)`

Deserialize this block from a dict containing version, graph and name

static `from_import_path(path)`

Deserialize the `Block` by importing it from given path.

classmethod `from_json(val, **kwargs)`

Construct a graph from a json stream.

get_compute_graph (`cached_compute_graph=None, **request`)

Lazy version of `get_data`, returns a compute graph dict, that can be evaluated with `compute` (or `dask`'s `get` function).

The dictionary has keys in the form `name_token` and values in the form `tuple(process, *args)`, where `args` are the precise arguments that need to be passed to `process`, with the exception that `args` may reference to other keys in the dictionary.

get_data (`**request`)

Directly evaluate the request and return the data.

get_graph (`serialize=False`)

Generate a graph that defines this `Block` and its dependencies in a dictionary.

The dictionary has keys in the form `name_token` and values in the form `tuple(Block class, *args)`, where `args` are the precise arguments that were used to construct the `Block`, with the exception that `args` may also reference other keys in the dictionary.

If `serialize == True`, the `Block` classes will be replaced by their corresponding import paths.

classmethod `get_import_path()`

Serialize the Block by returning its import path.

get_sources_and_requests (***request*)

Adapt the request and/or select the sources to be computed. The request is allowed to differ per source.

This function should return an iterable of (source, request). For sources that are no Block instance, the request is ignored.

Exceptions raised here will be raised before actual computation starts. (at `.get_compute_graph(request)`).

static process (*data*)

Overridden to modify data from sources in unlimited ways.

Default implementation passes single-source unaltered data.

serialize ()

Serialize this block into a dict containing version, graph and name

to_json (***kwargs*)

Dump the graph to a json stream.

token

Generates a unique and deterministic representation of this object

`dask_geomodeling.core.graphs.construct` (*graph, name, validate=True*)

Construct a Block with dependent Blocks from a graph and endpoint name.

`dask_geomodeling.core.graphs.compute` (*graph, name, *args, **kwargs*)

Compute a graph ({name: [func, arg1, arg2, ...]}) using `dask.get_sync`

2.5 Raster Blocks

RasterBlocks are the main component of raster operations. Most raster operations take one or more RasterBlocks as input and produce a single RasterBlock as output.

Raster-type blocks contain rasters with data in three dimensions. Besides the x- and y-axes they also have a temporal axis.

Internally, dask-geomodeling stores the raster data as [NumPy](#) arrays.

2.5.1 API Specification

Module containing the RasterBlock base classes.

class `dask_geomodeling.raster.base.RasterBlock` (**args*)

The base block for temporal rasters.

All RasterBlocks must be derived from this base class and must implement the following attributes:

- `period`: a tuple of datetimes
- `timedelta`: a `datetime.timedelta` (or `None` if nonequidistant)
- `extent`: a tuple (`x1, y1, x2, y2`)
- `dtype`: a numpy dtype object
- `fillvalue`: a number
- `geometry`: OGR Geometry

- `projection`: WKT string
- `geo_transform`: a tuple of 6 numbers

These attributes are `None` if the raster is empty.

A raster data request contains the following fields:

- `mode`: values ('vals'), time ('time') or metadata ('meta')
- `bbox`: bounding box (x1, y1, x2, y2)
- `projection`: wkt spatial reference
- `width`: data width
- `height`: data height
- `start`: start date as naive UTC datetime
- `stop`: stop date as naive UTC datetime

The data response is `None` or a dictionary with the following fields:

- (if mode was "vals") "values": a three dimensional numpy ndarray of shape (bands, height, width)
- (if mode was "vals") "no_data_value": a number that represents 'no data'. If the ndarray is a boolean, there is no 'no data' value.
- (if mode was "time") "time": a list of naive UTC datetimes corresponding to the time axis
- (if mode was "meta") "meta": a list of metadata values corresponding to the time axis

`dask_geomodeling.raster.combine`

Module containing raster blocks that combine rasters.

class `dask_geomodeling.raster.combine.Group`(*args)

Combine multiple rasters into a single one.

Operation to combine multiple rasters into one along all three axes (x, y and temporal). To only fill 'no data' values of input rasters that have the same temporal resolution `dask_geomodeling.raster.elemwise.FillNoData` is preferred.

Values at equal timesteps in the contributing rasters are considered starting with the leftmost input raster. Therefore, values from rasters that are more 'to the right' are shown in the result. 'no data' values are transparent and will show data of rasters more 'to the left'.

Parameters *args (*list of RasterBlocks*) – list of rasters to be combined.

Returns `RasterBlock` that combines all input rasters

`dask_geomodeling.raster.elemwise`

Module containing elementwise raster blocks.

class `dask_geomodeling.raster.elemwise.Add`(a, b)

Add two rasters together or add a constant value to a raster.

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Addition term a
- **b** (`RasterBlock`, *number*) – Addition term b

Returns `RasterBlock` containing the result of the addition.

class `dask_geomodeling.raster.elemwise.Subtract` (*a, b*)
Subtract two rasters or subtract a constant value from a raster

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Term to be subtracted from
- **b** (`RasterBlock`, *number*) – Term to be subtracted

Returns `RasterBlock` containing the result of the function subtract.

class `dask_geomodeling.raster.elemwise.Multiply` (*a, b*)
Multiply two rasters or multiply a raster by a constant value.

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Multiplication factor a
- **b** (`RasterBlock`, *number*) – Multiplication factor b

Returns `RasterBlock` containing the result of the multiplication.

class `dask_geomodeling.raster.elemwise.Divide` (*a, b*)
Divide two rasters or divide a raster by a constant value.

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Numerator
- **b** (`RasterBlock`, *number*) – Denominator

Returns `RasterBlock` containing the result of the division.

class `dask_geomodeling.raster.elemwise.Power` (*a, b*)
Exponential function with either a raster and a number or two rasters.

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Base
- **b** (`RasterBlock`, *number*) – Exponent

Returns `RasterBlock` containing the result of the exponential function.

class `dask_geomodeling.raster.elemwise.FillNoData` (**args*)
Combines multiple rasters filling 'no data' values.

Values at equal timesteps in the contributing rasters are considered starting with the leftmost input raster. Therefore, values from rasters that are more 'to the right' are shown in the result. 'no data' values are transparent and will show data of rasters more 'to the left'.

The temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters **args* (*list of RasterBlocks*) – Rasters to be combined.

Returns RasterBlock that combines values from the inputs.

class `dask_geomodeling.raster.elemwise.Equal` (*a, b*)

Compares the values of two rasters and returns True for equal elements.

This operation can be used to compare two rasters or to compare a raster with a static value. Note that ‘no data’ is not equal to ‘no data’: False is returned if any of the two terms is ‘no data’.

Either one or both of the inputs should be a RasterBlock. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (*RasterBlock, number*) – Comparison term a
- **b** (*RasterBlock, number*) – Comparison term b

Returns RasterBlock containing boolean values

class `dask_geomodeling.raster.elemwise.NotEqual` (*a, b*)

Compares the values of two rasters and returns False for equal elements.

This operation can be used to compare two rasters or to compare a raster with a static value. Note that ‘no data’ is not equal to ‘no data’: True is returned if any of the two terms is ‘no data’.

Either one or both of the inputs should be a RasterBlock. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (*RasterBlock, number*) – Comparison term a
- **b** (*RasterBlock, number*) – Comparison term b

Returns RasterBlock containing boolean values

class `dask_geomodeling.raster.elemwise.Greater` (*a, b*)

Compares the values of two rasters and returns True if an element in the first term is greater.

This operation can be used to compare two rasters or to compare a raster with a static value. Note that False is returned if any of the two terms is ‘no data’.

Either one or both of the inputs should be a RasterBlock. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (*RasterBlock, number*) – Comparison term a
- **b** (*RasterBlock, number*) – Comparison term b

Returns RasterBlock containing boolean values

class `dask_geomodeling.raster.elemwise.GreaterEqual` (*a, b*)

” Compares the values of two rasters and returns True if an element in the first term is greater or equal.

This operation can be used to compare two rasters or to compare a raster with a static value. Note that False is returned if any of the two terms is ‘no data’.

Either one or both of the inputs should be a RasterBlock. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Comparison term a
- **b** (`RasterBlock`, *number*) – Comparison term b

Returns `RasterBlock` containing boolean values

class `dask_geomodeling.raster.elemwise.Less` (*a*, *b*)

Compares the values of two rasters and returns True if an element in the first term is less.

This operation can be used to compare two rasters or to compare a raster with a static value. Note that False is returned if any of the two terms is 'no data'.

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Comparison term a
- **b** (`RasterBlock`, *number*) – Comparison term b

Returns `RasterBlock` containing boolean values

class `dask_geomodeling.raster.elemwise.LessEqual` (*a*, *b*)

Compares the values of two rasters and returns True if an element in the first term is less or equal.

This operation can be used to compare two rasters or to compare a raster with a static value. Note that False is returned if any of the two terms is 'no data'.

Either one or both of the inputs should be a `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *number*) – Comparison term a
- **b** (`RasterBlock`, *number*) – Comparison term b

Returns `RasterBlock` containing boolean values

class `dask_geomodeling.raster.elemwise.Invert` (*x*)

Logically invert a raster (swap True and False).

Takes a single input raster containing boolean values and outputs a boolean raster with the same spatial and temporal properties.

Parameters **x** (`RasterBlock`) – Boolean raster with values to invert

Returns `RasterBlock` with boolean values opposite to the input raster.

class `dask_geomodeling.raster.elemwise.And` (*a*, *b*)

Returns True where both inputs are True.

Either one or both of the inputs should be a boolean `RasterBlock`. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (`RasterBlock`, *boolean*) – Logical term a
- **b** (`RasterBlock`, *boolean*) – Logical term b

Returns `RasterBlock` containing boolean values

class `dask_geomodeling.raster.elemwise.Or` (*a*, *b*)

Returns True where any of inputs is True.

Either one or both of the inputs should be a boolean RasterBlock. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (*RasterBlock*, *boolean*) – Logical term a
- **b** (*RasterBlock*, *boolean*) – Logical term b

Returns RasterBlock containing boolean values

class `dask_geomodeling.raster.elemwise.Xor(a, b)`
Exclusive or: returns True where exactly one of the inputs is True.

Where both inputs are True, False is returned.

Either one or both of the inputs should be a boolean RasterBlock. In case of two raster inputs the temporal properties of the rasters should be equal, however spatial properties can be different.

Parameters

- **a** (*RasterBlock*, *boolean*) – Logical term a
- **b** (*RasterBlock*, *boolean*) – Logical term b

Returns RasterBlock containing boolean values

class `dask_geomodeling.raster.elemwise.IsData(store)`
Returns True where raster has data.

Takes a single input raster and outputs a boolean raster with the same spatial and temporal properties.

Parameters **store** (*RasterBlock*) – Input raster

Returns RasterBlock with boolean values.

class `dask_geomodeling.raster.elemwise.IsNoData(store)`
Returns True where raster has no data.

Takes a single input raster and outputs a boolean raster with the same spatial and temporal properties.

Parameters **store** (*RasterBlock*) – Input raster

Returns RasterBlock with boolean values.

`dask_geomodeling.raster.misc`

Module containing miscellaneous raster blocks.

class `dask_geomodeling.raster.misc.Clip(store, source)`
Clip one raster to the extent of another raster.

Takes two raster inputs, one raster ('store') whose values are returned in the output and one raster ('source') that is used as the extent. Cells of the 'store' raster are replaced with 'no data' if there is no data in the 'source' raster.

If the 'source' raster is a boolean raster, False will result in 'no data'.

Parameters

- **store** (*RasterBlock*) – Raster whose values are clipped
- **source** (*RasterBlock*) – Raster that is used as the clipping mask

Returns RasterBlock with clipped values.

class `dask_geomodeling.raster.misc.Classify` (*store, bins, right=False*)

Classify raster data into binned categories

Takes a RasterBlock and classifies its values based on bins. The bins are supplied as a list of increasing bin edges.

For each raster cell this operation returns the index of the bin to which the raster cell belongs. The lowest possible output cell value is 0, which means that the input value was lower than the lowest bin edge. The highest possible output value is equal to the number of supplied bin edges.

Parameters

- **store** (`RasterBlock`) – The raster whose cell values are to be classified
- **bins** (`list`) – An increasing list of bin edges
- **right** (`boolean`) – Whether the intervals include the right or the left bin edge, defaults to False.

Returns RasterBlock with classified values

class `dask_geomodeling.raster.misc.Reclassify` (*store, data, select=False*)

Reclassify a raster of integer values.

This operation can be used to reclassify a classified raster into desired values. Reclassification is done by supplying a list of [from, to] pairs.

Parameters

- **store** (`RasterBlock`) – The raster whose cell values are to be reclassified
- **bins** (`list`) – A list of [from, to] pairs defining the reclassification. The from values can be of bool or int datatype; the to values can be of int or float datatype
- **select** (`boolean`) – Whether to set all non-reclassified cells to ‘no data’, defaults to False.

Returns RasterBlock with reclassified values

class `dask_geomodeling.raster.misc.Mask` (*store, value*)

Replace values in a raster with a single constant value. ‘no data’ values are preserved.

Parameters

- **store** (`RasterBlock`) – The raster whose values are to be converted.
- **value** (`number`) – The constant value to be given to ‘data’ values.

Returns RasterBlock containing a single value

class `dask_geomodeling.raster.misc.MaskBelow` (*store, value*)

Converts raster cells below the supplied value to ‘no data’.

Raster cells with values greater than or equal to the supplied value are returned unchanged.

Parameters

- **store** (`RasterBlock`) – The raster whose values are to be masked.
- **value** (`number`) – The constant value below which values are masked.

Returns RasterBlock with cells below the input value converted to ‘no data’.

class `dask_geomodeling.raster.misc.Step` (*store, left=0, right=1, value=0, at=None*)

Apply a step function to a raster.

This operation classifies the elements of a raster into three categories: less than, equal to, and greater than a value.

The step function is defined as follows, with x being the value of a raster cell:

- 'left' if $x < value$
- 'at' if $x == value$
- 'right' if $x > value$

Parameters

- **store** (*RasterBlock*) – The input raster
- **left** (*number*) – Value given to cells lower than the input value, defaults to 0
- **right** (*number*) – Value given to cells higher than the input value, defaults to 1
- **value** (*number*) – The constant value which raster cells are compared to, defaults to 0
- **at** (*number*) – Value given to cells equal to the input value, defaults to the average of left and right

Returns RasterBlock containing three values; left, right and at.

class `dask_geomodeling.raster.misc.Rasterize` (*source*, *column_name=None*, *dtype=None*, *limit=None*)

Converts geometry source to raster

This operation is used to transform GeometryBlocks into RasterBlocks. Here geometries (from for example a shapefile) are converted to a raster, using the values from one of the columns.

Note that to rasterize floating point values, it is necessary to pass `dtype="float"`.

Parameters

- **source** (*GeometryBlock*) – The geometry source to be rasterized
- **column_name** (*string*) – The name of the column whose values will be returned in the raster. If `column_name` is not provided, a boolean raster will be generated indicating where there are geometries.
- **dtype** (*string*) – A numpy datatype specification to return the array. Defaults to 'int32' if `column_name` is provided, or to 'bool' otherwise.

Returns RasterBlock with values from 'column_name' or a boolean raster.

See also:

<https://docs.scipy.org/doc/numpy/reference/arrays.dtypes.html>

The global geometry-limit setting can be adapted as follows:

```
>>> from dask import config
>>> config.set({"geomodeling.geometry-limit": 100000})
```

class `dask_geomodeling.raster.misc.RasterizeWKT` (*wkt*, *projection*)

Converts a single geometry to a raster mask

Parameters

- **wkt** (*string*) – the WKT representation of a geometry
- **projection** (*string*) – the projection of the geometry

Returns RasterBlock with True for cells that are inside the geometry.

dask_geomodeling.raster.sources

Module containing raster sources.

class dask_geomodeling.raster.sources.**MemorySource** (*data*, *no_data_value*, *projection*, *pixel_size*, *pixel_origin*, *time_first=0*, *time_delta=None*, *metadata=None*)

A raster source that interfaces data from memory.

Nodata values are supported, but when upsampling the data, these are assumed to be 0 biasing data edges towards 0.

Parameters

- **data** (*number or ndarray*) – the pixel values this value will be transformed in a 3D array (t, y, x)
- **no_data_value** (*number*) – the pixel value that designates ‘no data’
- **projection** (*str*) – the projection of the given pixel values
- **pixel_size** (*float or length-2 iterable of floats*) – the size of one pixel (in units given by projection) if x and y pixel sizes differ, provide them in (x, y) order
- **pixel_origin** (*length-2 iterable of floats*) – the location (x, y) of pixel with index (0, 0)
- **time_first** (*integer or naive datetime*) – the timestamp of the first frame in data (in milliseconds since 1-1-1970)
- **time_delta** (*integer or timedelta or NoneType*) – the difference between two consecutive frames (in ms)
- **metadata** (*list or NoneType*) – a list of metadata corresponding to the input frames

class dask_geomodeling.raster.sources.**RasterFileSource** (*url*, *time_first=0*, *time_delta=300000*)

A raster source that interfaces data from a file path.

Parameters

- **url** (*str*) – the path to the file. File paths have to be contained inside the current root setting. Relative paths are interpreted relative to this setting (but internally stored as absolute paths).
- **time_first** (*integer or datetime*) – the timestamp of the first frame in data (in milliseconds since 1-1-1970), defaults to 1-1-1970
- **time_delta** (*integer or timedelta*) – the difference between two consecutive frames (in ms), defaults to 5 minutes

The global root path can be adapted as follows:

```
>>> from dask import config
>>> config.set({"geomodeling.root": "/my/data/path"})
```

Note that this object keeps a file handle open. If you need to close the file handle, call `block.close_dataset` (or dereference the whole object).

dask_geomodeling.raster.spatial

Module containing raster blocks for spatial operations.

class `dask_geomodeling.raster.spatial.Dilate` (*store, values*)
Perform spatial dilation on specific cell values.

Cells with values in the supplied list are spatially dilated by one cell in each direction, including diagonals.

Dilation is performed in the order of the values parameter.

Parameters

- **store** (`RasterBlock`) – Raster to perform dilation on.
- **values** (*list*) – Only cells with these values are dilated.

Returns `RasterBlock` where cells in values list are dilated.

See also:

https://en.wikipedia.org/wiki/Dilation_%28morphology%29

class `dask_geomodeling.raster.spatial.Smooth` (*store, size, fill=0*)
Smooth the values from a raster spatially using Gaussian smoothing.

Parameters

- **store** (`RasterBlock`) – Raster to be smoothed
- **size** (*number*) – The extent of the smoothing in meters. The ‘sigma’ value for the Gaussian kernel equals `size / 3`.
- **fill** (*number*) – ‘no data’ are replaced by this value during smoothing, defaults to 0.

Returns `RasterBlock` with spatially smoothed values.

See also:

https://en.wikipedia.org/wiki/Gaussian_blur

class `dask_geomodeling.raster.spatial.MovingMax` (*store, size*)
Apply a spatial maximum filter to the data using a circular footprint.

This can be used for visualization of sparse data.

Parameters

- **store** (`RasterBlock`) – Raster to which the filter is applied
- **size** (*integer*) – Diameter of the circular footprint. This should always be an odd number larger than 1.

Returns `RasterBlock` with maximum values inside the footprint of each input cell.

class `dask_geomodeling.raster.spatial.HillShade` (*store, altitude=45, azimuth=315, fill=0*)

Calculate a hillshade from the raster values.

Parameters

- **store** (`RasterBlock`) – Raster to which the hillshade algorithm is applied.
- **size** (*number*) – Size of the effect in projected units.
- **altitude** (*number*) – Light source altitude in degrees, defaults to 45.
- **azimuth** (*number*) – Light source azimuth in degrees, defaults to 315.

- **fill** (*number*) – Fill value to be used for ‘no data’ values.

Returns Hillshaded raster

See also:

<https://pro.arcgis.com/en/pro-app/tool-reference/3d-analyst/how-hillshade-works.htm>

`dask_geomodeling.raster.temporal`

Module containing raster blocks for temporal operations.

class `dask_geomodeling.raster.temporal.Snap` (*store, index*)

Snap the time structure of a raster to that of another raster.

This operations allows to take the cell values from one raster (‘store’) and the temporal properties of another raster (‘index’).

If the store is not a temporal raster, its cell values are copied to each timestep of the index raster. If the store is also a temporal raster, this operation looks at each ‘index’ timestamp and takes the closest ‘store’ timestamp as cell values.

Parameters

- **store** (`RasterBlock`) – Return cell values from this raster
- **index** (`RasterBlock`) – Snap values to the timestamps from this raster

Returns `RasterBlock` with temporal properties of the index.

class `dask_geomodeling.raster.temporal.Shift` (*store, time*)

Shift a temporal raster by some timedelta.

A positive timedelta shifts into the future and a negative timedelta shifts into the past.

Parameters

- **store** (`RasterBlock`) – The store whose timestamps are to be shifted
- **time** (*integer*) – The timedelta to shift the store, in milliseconds.

Returns `RasterBlock` with its timestamps shifted.

class `dask_geomodeling.raster.temporal.TemporalAggregate` (*source, frequency, statistic='sum', closed=None, label=None, time-zone='UTC'*)

Resample a raster in time.

This operation performs temporal aggregation of rasters, for example a hourly average of data that has a 5 minute resolution.. The timedelta of the resulting raster is determined by the ‘frequency’ parameter.

Parameters

- **source** (`RasterBlock`) – The input raster whose timesteps are aggregated
- **frequency** (*string or None*) – The frequency to resample to, as pandas offset string (see the references below). If this value is None, this block will return the temporal statistic over the complete time range, with output timestamp at the end of the source raster period. Defaults to None.
- **statistic** (*string*) – The type of statistic to perform. Can be one of {"sum", "count", "min", "max", "mean", "median", "p<percentile>"}. Defaults to "sum".

- **closed** (*string or None*) – Determines what side of the interval is closed. Can be "left" or "right". The default depends on the frequency.
- **label** (*string or None*) – Determines what side of the interval is closed. Can be "left" or "right". The default depends on the frequency.
- **timezone** (*string*) – Timezone to perform the resampling in, defaults to "UTC".

Returns RasterBlock with temporally aggregated data.

See also:

<https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.Series.resample.html> https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html#dateoffset-objects

class `dask_geomodeling.raster.temporal.Cumulative` (*source*, *statistic='sum'*, *frequency=None*, *timezone='UTC'*)

Compute the cumulative of a raster over time.

Contrary to `dask_geomodeling.raster.temporal.TemporalAggregate`, in this operation the `timedelta` of the resulting raster equals the `timedelta` of the input raster. Cell values are accumulated over the supplied period. At the end of each period the accumulation is reset.

Parameters

- **source** (`RasterBlock`) – The input raster whose timesteps are accumulated.
- **statistic** (*string*) – The type of accumulation to perform. Can be "sum" or "count". Defaults to "sum".
- **frequency** (*string or None*) – The period over which accumulation is performed. Supply a pandas offset string (see the references below). If this value is None, the accumulation will continue indefinitely. Defaults to None.
- **timezone** (*string*) – Timezone in which the accumulation is performed, defaults to "UTC".

Returns RasterBlock with temporally accumulated data.

See also:

https://pandas.pydata.org/pandas-docs/stable/user_guide/timeseries.html#dateoffset-objects

2.6 Geometry and Series Blocks

Geometry-type blocks contain sets of geometries, optionally with 'start' and 'end' fields and other properties. Internally, geometry data is stored in `GeoPandas` `GeoDataframes`.

2.6.1 API Specification

Module containing the base geometry block classes.

class `dask_geomodeling.geometry.base.GeometryBlock` (**args*)
The base block for geometries

All geometry blocks must be derived from this base class and must implement the following attribute:

- **columns**: a set of column names to expect in the dataframe

A geometry request contains the following fields:

- **mode**: one of {"intersects", "centroid", "extent"}

- **geometry**: limit returned objects to objects that intersect with this shapely geometry object
- **projection**: projection to return the geometries in as WKT string
- **limit**: the maximum number of geometries
- **min_size**: geometries with a bbox that is smaller than this on all sides are left out
- **start**: start date as UTC datetime
- **stop**: stop date as UTC datetime
- **filters**: dict of Django ORM-like filters on properties (e.g. `id=598`)

The data response is a dictionary with the following fields:

- (if mode was "intersects" or "centroid") **"features"**: a GeoDataFrame of features with properties
- (if mode was "extent") **"extent"**: a tuple of 4 numbers (`min_x`, `min_y`, `max_x`, `max_y`) that represents the extent of the geometries that would be returned by an "intersects" request.
- (for all modes) **"projection"**: the EPSG or WKT representation of the projection.

To be able to perform operations on properties, there is a helper type called `SeriesBlock`. This is the block equivalent of a `pandas.Series`. You can get a `SeriesBlock` from a `GeometryBlock`, perform operations on it, and set it back into a `GeometryBlock`.

to_file (*args, **kwargs)

Utility function to export data from this block to a file on disk.

You need to specify the target file path as well as the extent geometry you want to save. Feature properties can be saved by providing a field mapping to the `fields` argument.

To stay within memory constraints or to parallelize an operation, the `tile_size` argument can be provided.

Parameters

- **url** (*str*) – The target file path. The extension determines the format. For supported formats, consult `GeometryFileSink.supported_extensions`.
- **fields** (*dict*) – a mapping that relates column names to output file field names, `{<output file field name>: <column name>, ...}`.
- **tile_size** (*int*) – Optionally use this for large exports to stay within memory constraints. The export is split in tiles of given size (units are determined by the projection). Finally the tiles are merged.
- **geometry** (*shapely Geometry*) – Limit exported objects to objects whose centroid intersects with this geometry.
- **projection** (*str*) – The projection as a WKT string or EPSG code. Sets the projection of the geometry argument, the target projection of the data, and the tiling projection.
- **start** (*datetime*) – start date as UTC datetime
- **stop** (*datetime*) – stop date as UTC datetime
- ****request** – see `GeometryBlock` request specification

Relevant settings can be adapted as follows:

```
>>> from dask import config
>>> config.set({"geomodeling.root": '/my/output/data/path'})
>>> config.set({"geomodeling.geometry-limit": 10000})
>>> config.set({"temporary_directory": '/my/alternative/tmp/dir'})
```

class `dask_geomodeling.geometry.base.SeriesBlock` (*args)

A block that represents one column from a GeometryBlock.

Use this helper class to modify (or to use logic on) a specific feature property.

Use `:class:dask_geomodeling.geometry.base.GetSeriesBlock` to retrieve a SeriesBlock from a GeometryBlock and `:class:dask_geomodeling.geometry.base.SetSeriesBlock` to add a SeriesBlock to a GeometryBlock.

class `dask_geomodeling.geometry.base.GetSeriesBlock` (source, name)

Obtain a single feature property column from a GeometryBlock.

Provide a GeometryBlock with one or more columns. One of these columns can be read from this source into a SeriesBlock. This SeriesBlock can be used to run for example classifications.

Parameters

- **source** (`GeometryBlock`) – GeometryBlock with the column you want to load into the SeriesBlock.
- **name** (`str`) – Name of the column to load into the SeriesBlock.

Returns SeriesBlock containing the single property column

class `dask_geomodeling.geometry.base.SetSeriesBlock` (source, column, value, *args)

Add one or multiple property columns (SeriesBlocks) to a GeometryBlock.

Provide the GeometryBlock that you want to add more properties to. Then provide the SeriesBlock(s) which you want to add to the GeometryBlock. The values of the SeriesBlock will be added to the features in the GeometryBlock automatically (if they are derived from the same geometries in previous operations, the features will have matching indexes so that each property is matched to the correct feature).

The value which is set can also be a single value, in which case each feature will get the same value as a property.

Parameters

- **source** (`GeometryBlock`) – The base GeometryBlock to which the SeriesBlock is added as a new column.
- **column** (`str`) – The name of the new column (if it exists, it will be overwritten)
- **value** (`SeriesBlock, number, str, bool`) – The SeriesBlock or constant value that has to be inserted in the destination column.
- ***args** – It is possible to repeat the "column" and "value" arguments multiple times to insert more than one column.

Example

Add two columns to an existing view like this: `SetSeriesBlock(view, "column_1", series_1, "column_2", series_2)`.

Returns The source GeometryBlock with additional property columns

`dask_geomodeling.geometry.aggregate`

Module containing raster blocks that aggregate rasters.

```
class dask_geomodeling.geometry.aggregate.AggregateRaster (source, raster,
                                                         statistic='sum',
                                                         projection=None,
                                                         pixel_size=None,
                                                         max_pixels=None,
                                                         column_name='agg',
                                                         auto_pixel_size=False,
                                                         *args)
```

Compute statistics of a raster for each geometry in a geometry source.

A statistic is computed in a specific projection and with a specified cell size. If `projection` or `pixel_size` are not given, these default to the native projection of the provided raster source.

Should the combination of the requested `pixel_size` and the extent of the source geometry cause the required raster size to exceed `max_pixels`, the `pixel_size` can be adjusted automatically if `auto_pixel_size` is set to `True`, else (the default) a `RuntimeError` is raised.

Please note that for any field operation on the result of this block a `GetSeriesBlock` should be used to retrieve data from the added column. The name of the added column is determined by the `column_name` parameter.

Parameters

- **source** (`GeometryBlock`) – The geometry source for which the statistics are determined.
- **raster** (`RasterBlock`) – The raster source that is sampled.
- **statistic** (`str`) – The type of statistical analysis that should be performed. The options are: {"sum", "count", "min", "max", "mean", "median", "p<percentile>"}. Percentiles are provided for example as follows: "p50". Default "sum".
- **projection** (`str`, *optional*) – Projection to perform the aggregation in, for example "EPSG:28992". Defaults to the native projection of the supplied raster.
- **pixel_size** (`float`, *optional*) – The raster cell size used in the aggregation. Defaults to the cell size of the supplied raster.
- **max_pixels** (`int`, *optional*) – The maximum number of pixels (cells) in the aggregation. Defaults to the `geomodeling.raster-limit` setting.
- **column_name** (`str`, *optional*) – The name of the column where the result should be placed. Defaults to "agg".
- **auto_pixel_size** (`boolean`) – Determines whether the pixel size is adjusted automatically when "max_pixels" is exceeded. Default False.

Returns `GeometryBlock` with aggregation results in an added column

The global raster-limit setting can be adapted as follows:

```
>>> from dask import config
>>> config.set({"geomodeling.raster-limit": 10 ** 9})
```

```
class dask_geomodeling.geometry.aggregate.AggregateRasterAboveThreshold (source,  
                                                                    raster,  
                                                                    statis-  
                                                                    tic='sum',  
                                                                    pro-  
                                                                    jec-  
                                                                    tion=None,  
                                                                    pixel_size=None,  
                                                                    max_pixels=None,  
                                                                    col-  
                                                                    umn_name='agg',  
                                                                    auto_pixel_size=False,  
                                                                    thresh-  
                                                                    old_name=None)
```

Compute statistics of a per-feature masked raster for each geometry in a geometry source.

Per feature, a threshold can be supplied to mask the raster with. Only values that exceed the threshold of a specific feature are included for the statistical value of that feature.

See :class:dask_geomodeling.geometry.aggregate.AggregateRaster for further information.

Parameters

- ***args** – See :class:dask_geomodeling.geometry.aggregate.AggregateRaster
- **threshold_name** (*str*) – The column that holds the thresholds.

Returns GeometryBlock with aggregation results in an added column

dask_geomodeling.geometry.constructive

Module containing geometry block constructive operations

```
class dask_geomodeling.geometry.constructive.Buffer (source, distance, projection, res-  
                                                                    olution=16)
```

Buffer ('expand') geometries with a given value.

A GeometryBlock and a buffer distance are provided. Each feature in the GeometryBlock is buffered with the distance provided, resulting in updated geometries.

Parameters

- **source** (*GeometryBlock*) – The source GeometryBlock whose geometry will be updated.
- **distance** (*float*) – The distance used to buffer all features. The distance is measured in the unit of the given projection (e.g. m, °).
- **projection** (*str*) – The projection used in the operation provided in the format: "EPSG:28992".
- **resolution** (*integer, optional*) – The resolution of the buffer provided as the number of points used to represent a quarter of a circle. The default value is 16.

Returns GeometryBlock with buffered geometries.

```
class dask_geomodeling.geometry.constructive.Simplify (source, tolerance=None, pre-  
                                                                    serve_topology=True)
```

Simplify geometries, mainly to make them computationally more efficient.

Provide a GeometryBlock and a tolerance value to simplify the geometries. As a result all features in the GeometryBlock are simplified.

Parameters

- **source** (*GeometryBlock*) – Source of the geometries to be simplified.
- **tolerance** (*float*) – The tolerance used in the simplification. If no tolerance is given the "min_size" request parameter is used.
- **preserve_topology** (*boolean, optional*) – Determines whether the topology should be preserved in the operation. Defaults to `True`.

Returns GeometryBlock which was provided as input with a simplified geometry.

dask_geomodeling.geometry.field_operations

Module containing geometry block operations that act on non-geometry fields

class dask_geomodeling.geometry.field_operations.**Classify**(*source, bins, labels, right=True*)

Classify a value column into different bins

For example: every value below 3 becomes "A", every value between 3 and 5 becomes "B", and every value above 5 becomes "C".

The provided SeriesBlock will be classified according to the given classification parameters. These parameters consist of two lists, one with the edges of the classification bins (i.e. [3, 5]) and one with the desired class output (i.e. ["A", "B", "C"]). The input data is then compared to the classification bins. In this example a value 1 is below 3 so it gets class "A". A value 4 is between 3 and 5 so it gets label "B".

How values outside of the bins are classified depends on the length of the labels list. If the length of the labels equals the length of the binedges plus 1 (the above example), then values outside of the bins are classified to the first and last elements of the labels list. If the length of the labels equals the length of the bins minus 1, then values outside of the bins are classified to 'no data'.

Parameters

- **source** (*SeriesBlock*) – The (numeric) data which should be classified.
- **bins** (*list*) – The edges of the classification intervals (i.e. [3, 5]).
- **labels** (*list*) – The classification returned if a value falls in a specific bin (i.e. ["A", "B", "C"]). The length of this list is either one larger or one less than the length of the bins argument.
- **right** (*boolean, optional*) – Determines what side of the intervals are closed. Defaults to `True` (the right side of the bin is closed so a value assigned to the bin on the left if it is exactly on a bin edge).

Returns A SeriesBlock with classified values instead of the original numbers.

class dask_geomodeling.geometry.field_operations.**ClassifyFromColumns**(*source, value_column, bin_columns, labels, right=True*)

Classify a continuous-valued geometry property based on bins located in other columns.

See :class:dask_geomodeling.geometry.field_operations.Classify for further information.

Parameters

- **source** (*GeometryBlock*) – The *GeometryBlock* which contains the column which should be classified as well as columns with the bin edges.
- **value_column** (*str*) – The column with (float) data which should be classified.
- **bin_columns** (*list*) – A list of columns that contain the bins for the classification. The order of the columns should be from low to high values.
- **labels** (*list*) – The classification returned if a value falls in a specific bin (i.e. ["A", "B", "C"]). The length of this list is either one larger or one less than the length of the *bins* argument.
- **right** (*boolean, optional*) – Determines what side of the intervals are closed. Defaults to True (the right side of the bin is closed so a value assigned to the bin on the left if it is exactly on a bin edge).

Returns A *SeriesBlock* with classified values instead of the original floats.

class `dask_geomodeling.geometry.field_operations.Add` (*source, other*)
Element-wise addition of *SeriesBlock* or number to another *SeriesBlock*.

Parameters

- **source** (*SeriesBlock*) – First addition term
- **other** (*SeriesBlock or number*) – Second addition term

Returns *SeriesBlock*

class `dask_geomodeling.geometry.field_operations.Subtract` (*source, other*)
Element-wise subtraction of *SeriesBlock* or number with another *SeriesBlock*.

Note that if you want to subtract a *SeriesBlock* from a constant value (like `4 - series`, you have to do `Add(Multiply(series, -1), 4)`.

Parameters

- **source** (*SeriesBlock*) – First subtraction term
- **other** (*SeriesBlock or number*) – Second subtraction term

Returns *SeriesBlock*

class `dask_geomodeling.geometry.field_operations.Multiply` (*source, other*)
Element-wise multiplication of *SeriesBlock* or number with another *SeriesBlock*.

Parameters

- **source** (*SeriesBlock*) – First multiplication factor
- **other** (*SeriesBlock or number*) – Second multiplication factor

Returns *SeriesBlock*

class `dask_geomodeling.geometry.field_operations.Divide` (*source, other*)
Element-wise division of *SeriesBlock* or number with another *SeriesBlock*.

Note that if you want to divide a constant value by a *SeriesBlock* (like `3 / series`, you have to do `Multiply(3, Power(series, -1))`.

Parameters

- **source** (*SeriesBlock*) – Numerator
- **other** (*SeriesBlock or number*) – Denominator

Returns *SeriesBlock*

class `dask_geomodeling.geometry.field_operations.FloorDivide` (*source, other*)
 Element-wise integer division of SeriesBlock or number with another SeriesBlock.

The outcome of the division is converted to the closest integer below (i.e. 3.4 becomes 3, 3.9 becomes 3 and -3.4 becomes -4)

Parameters

- **source** (`SeriesBlock`) – Numerator
- **other** (`SeriesBlock` or *number*) – Denominator

Returns `SeriesBlock`

class `dask_geomodeling.geometry.field_operations.Power` (*source, other*)
 Element-wise raise a SeriesBlock to the power of a number or another SeriesBlock.

For example, the inputs `[2, 4]` and `2` will give output `[4, 16]`.

Parameters

- **source** (`SeriesBlock`) – Base
- **other** (`SeriesBlock` or *number*) – Exponent

Returns `SeriesBlock`

class `dask_geomodeling.geometry.field_operations.Modulo` (*source, other*)
 Element-wise modulo (remainder after division) of SeriesBlock or number with another SeriesBlock.

Example: if the input is `[31, 5.3, -4]` and the modulus is `3`, the outcome would be `[1, 2.3, 2]`. The outcome is always positive and less than the modulus.

Parameters

- **source** (`SeriesBlock`) – Number
- **other** (`SeriesBlock` or *number*) – Modulus

Returns `SeriesBlock`

class `dask_geomodeling.geometry.field_operations.Equal` (*source, other*)
 Determine whether a SeriesBlock and a second SeriesBlock or a constant value are equal.

Note that 'no data' does not equal 'no data'.

Parameters

- **source** (`SeriesBlock`) – First comparison term
- **other** (`SeriesBlock` or *number*) – Second comparison term

Returns `SeriesBlock` with boolean values

class `dask_geomodeling.geometry.field_operations.NotEqual` (*source, other*)
 Determine whether a SeriesBlock and a second SeriesBlock or a constant value are not equal.

Note that 'no data' does not equal 'no data'.

Parameters

- **source** (`SeriesBlock`) – First comparison term
- **other** (`SeriesBlock` or *number*) – Second comparison term

Returns `SeriesBlock` with boolean values

class `dask_geomodeling.geometry.field_operations.Greater` (*source, other*)
Determine for each value in a SeriesBlock whether it is greater than a comparison value from a SeriesBlock or constant.

Parameters

- **source** (`SeriesBlock`) – First comparison term
- **other** (`SeriesBlock` or *number*) – Second comparison term

Returns SeriesBlock with boolean values

class `dask_geomodeling.geometry.field_operations.GreaterEqual` (*source, other*)
Determine for each value in a SeriesBlock whether it is greater than or equal to a comparison value from a SeriesBlock or constant.

Parameters

- **source** (`SeriesBlock`) – First comparison term
- **other** (`SeriesBlock` or *number*) – Second comparison term

Returns SeriesBlock with boolean values

class `dask_geomodeling.geometry.field_operations.Less` (*source, other*)
Determine for each value in a SeriesBlock whether it is less than a comparison value from a SeriesBlock or constant.

Parameters

- **source** (`SeriesBlock`) – First comparison term
- **other** (`SeriesBlock` or *number*) – Second comparison term

Returns SeriesBlock with boolean values

class `dask_geomodeling.geometry.field_operations.LessEqual` (*source, other*)
Determine for each value in a SeriesBlock whether it is less than or equal to a comparison value from a SeriesBlock or constant.

Parameters

- **source** (`SeriesBlock`) – First comparison term
- **other** (`SeriesBlock` or *number*) – Second comparison term

Returns SeriesBlock with boolean values

class `dask_geomodeling.geometry.field_operations.And` (*source, other*)
Perform an elementwise logical AND between two SeriesBlocks.
If a feature has a True value in both SeriesBlocks, True is returned, else False is returned.

Parameters

- **source** (`SeriesBlock`) – First boolean term
- **other** (`SeriesBlock`) – Second boolean term

Returns SeriesBlock with boolean values

class `dask_geomodeling.geometry.field_operations.Or` (*source, other*)
Perform an elementwise logical OR between two SeriesBlocks.
If a feature has a True value in any of the input SeriesBlocks, True is returned, else False is returned.

Parameters

- **source** (*SeriesBlock*) – First boolean term
- **other** (*SeriesBlock*) – Second boolean term

Returns *SeriesBlock* with boolean values

class `dask_geomodeling.geometry.field_operations.Xor` (*source, other*)

Perform an elementwise logical exclusive OR between two *SeriesBlocks*.

If a feature has a True value in precisely one of the input *SeriesBlocks*, True is returned, else False is returned.

Parameters

- **source** (*SeriesBlock*) – First boolean term
- **other** (*SeriesBlock*) – Second boolean term

Returns *SeriesBlock* with boolean values

class `dask_geomodeling.geometry.field_operations.Invert` (*source, *args*)

Invert a boolean *SeriesBlock* (swap True and False)

Parameters **source** (*SeriesBlock*) – *SeriesBlock* with boolean values.

Returns *SeriesBlock* with boolean values

class `dask_geomodeling.geometry.field_operations.Where` (*source, cond, other*)

Replace values in a *SeriesBlock* where values in another *SeriesBlock* are False.

Provide a source *SeriesBlock*, a conditional *SeriesBlock* (True/False) and a replacement value which can either be a *SeriesBlock* or a constant value. All entries in the source that correspond to a True value in the conditional are left unchanged. The values in the source that correspond to a False value in the conditional are replaced with the value from 'other'.

Parameters

- **source** (*SeriesBlock*) – Source *SeriesBlock* that is going to be updated
- **cond** (*SeriesBlock*) – Conditional (boolean) *SeriesBlock* that determines whether features in the source *SeriesBlock* will be updated.
- **other** (*SeriesBlock or constant*) – The value that should be used as a replacement for the source *SeriesBlock* where the conditional *SeriesBlock* is False.

Returns *SeriesBlock* with updated values where condition is False.

class `dask_geomodeling.geometry.field_operations.Mask` (*source, cond, other*)

Replace values in a *SeriesBlock* where values in another *SeriesBlock* are True.

Provide a source *SeriesBlock*, a conditional *SeriesBlock* (True/False) and a replacement value which can either be a *SeriesBlock* or a constant value. All entries in the source that correspond to a True value in the conditional are left unchanged. The values in the source that correspond to a True value in the conditional are replaced with the value from 'other'.

Parameters

- **source** (*SeriesBlock*) – Source *SeriesBlock* that is going to be updated
- **cond** (*SeriesBlock*) – Conditional (boolean) *SeriesBlock* that determines whether features in the source *SeriesBlock* will be updated.
- **other** (*SeriesBlock or constant*) – The value that should be used as a replacement for the source *SeriesBlock* where the conditional *SeriesBlock* is True.

Returns *SeriesBlock* with updated values where condition is True.

class `dask_geomodeling.geometry.field_operations.Round` (*source*, *decimals=0*)
Round each value in a SeriesBlock to the given number of decimals

Parameters

- **source** (*SeriesBlock*) – SeriesBlock with float data that is rounded to the provided number of decimals.
- **decimals** (*int*, *optional*) – number of decimal places to round to (default: 0). If decimals is negative, it specifies the number of positions to the left of the decimal point.

Returns SeriesBlock with rounded values.

`dask_geomodeling.geometry.geom_operations`

Module containing operations that return series from geometry fields

class `dask_geomodeling.geometry.geom_operations.Area` (*source*, *projection*)
Calculate the area of features in a GeometryBlock.

Provide a GeometryBlock and a projection. Returns the area of each individual geometry in the input block, in that projection.

Parameters

- **source** (*GeometryBlock*) – Source GeometryBlock which contains the features.
- **projection** (*str*) – Projection in which to compute the area (i.e. "epsg:28992").

Returns SeriesBlock with only the computed area

`dask_geomodeling.geometry.merge`

Module containing merge operation that act on geometry blocks

class `dask_geomodeling.geometry.merge.MergeGeometryBlocks` (*left*, *right*, *how='inner'*,
suffixes=(", '_right'))

Merge two GeometryBlocks into one by index

Provide two GeometryBlocks with the same original source to make sure they can be matched on index. The additional SeriesBlocks that have been added to the GeometryBlock will be combined to one GeometryBlock that contains all the information.

Parameters

- **left** (*GeometryBlock*) – The left GeometryBlock to be combined.
- **right** (*GeometryBlock*) – The right GeometryBlock to be combined.
- **how** (*str*, *optional*) – The parameter that describes how the merge should be performed. There are four options: 1. "left": The resulting GeometryBlock will have all the features that are present in the left GeometryBlock, no matter the features in the right GeometryBlock.
- 2. "right": The resulting GeometryBlock will have all the features that are present in the right GeometryBlock, no matter the features in the left GeometryBlock.
- 3. "inner" (default): The outcome will contain all the features that are present in both input GeometryBlocks. Features that are absent in one of the GeometryBlocks will be absent in the result.

4. `outer`: The result will contain all the features which are present in one of the input GeometryBlocks.

- **suffixes** (*tuple, optional*) – Text to be added to the column names to distinguish whether they originate from the left or right GeometryBlock. Default: ("`_left`", "`_right`").

Returns GeometryBlock that contains a combination of features and columns of the two input GeometryBlocks.

`dask_geomodeling.geometry.parallelize`

Module containing blocks that parallelize non-geometry fields

class `dask_geomodeling.geometry.parallelize.GeometryTiler` (*source, size, projection*)

Parallelize operations on a GeometryBlock by tiling the request.

Parameters

- **source** (*GeometryBlock*) – The source GeometryBlock
- **size** (*float*) – The maximum size of a tile in units of the projection
- **projection** (*str*) – The projection as EPSG or WKT string in which to compute tiles (e.g. "`EPSG:28992`")

Returns GeometryBlock that only supports "`centroid`" and "`extent`" request modes.

`dask_geomodeling.geometry.set_operations`

Module containing geometry block set operations

class `dask_geomodeling.geometry.set_operations.Difference` (*source, other*)

Calculate the geometric difference of two GeometryBlocks.

All geometries in the source GeometryBlock will be adapted by geometries with the same index from the second GeometryBlock. The difference operation removes any overlap between the geometries from the first geometry.

Parameters

- **source** (*GeometryBlock*) – First geometry source.
- **other** (*GeometryBlock*) – Second geometry source.

Returns A GeometryBlock with altered geometries. Properties are preserved.

class `dask_geomodeling.geometry.set_operations.Intersection` (*source, other=None*)

Calculate the intersection of a GeometryBlock with the request geometry.

Normally, geometries returned by a GeometryBlock may be partially outside of the requested geometry. This block ensures that the geometries are strictly inside the requested geometry by taking the intersection of each geometry with the request geometry.

Parameters **source** (*GeometryBlock*) – Input geometry source.

Returns A GeometryBlock with altered geometries. Properties are preserved.

dask_geomodeling.geometry.sources

Module containing geometry sources.

```
class dask_geomodeling.geometry.sources.GeometryFileSource (url, layer=None,  
                                                         id_field='id')
```

A geometry source that opens a geometry file from disk.

The input of this blocks is by default limited by the global geomodeling.geometry-limit setting.

Parameters

- **url** (*str*) – Path (URL) to the file. If relative, it is taken relative to the geomodeling.root setting.
- **layer** (*str*, *optional*) – The layer name in the source to select. If None, (default) the first layer is used.
- **id_field** (*str*, *optional*) – The field name to use as feature index. Default "id".

Relevant settings can be adapted as follows:

```
>>> from dask import config  
>>> config.set({"geomodeling.root": '/my/data/path'})  
>>> config.set({"geomodeling.geometry-limit": 100000})
```

```
class dask_geomodeling.geometry.sources.GeometryWKTSource (wkt, projection)
```

Converts a single geometry to a geometry source

Parameters

- **wkt** (*string*) – the WKT representation of a geometry
- **projection** (*string*) – the projection of the geometry

Returns GeometryBlock

dask_geomodeling.geometry.sinks

```
class dask_geomodeling.geometry.sinks.GeometryFileSink (source, url, extension='shp',  
                                                         fields=None)
```

Write geometry data to files in a specified directory

Use GeometryFileSink.merge_files to merge tiles into one large file.

Parameters

- **source** (*GeometryBlock*) – The block the data is coming from
- **url** (*str*) – The target directory to put the files in. If relative, it is taken relative to the geomodeling.root setting.
- **extension** (*str*) – The file extension (defines the format), one of {"shp", "gpkg", "geojson", "gml"}. On some platforms, these options might be limited. For an accurate list, see GeometryFileSink.supported_extensions.
- **fields** (*dict*) – A mapping that relates column names to output file field names field names like {<output file field name>: <column name>}.

Relevant settings can be adapted as follows:


```
>>> from dask import config
>>> config.set({"geomodeling.root": '/my/output/data/path'})
```

static merge_files (*path, target, remove_source=False*)

Merge files (the output of this Block) into one single file.

Optionally removes the source files.

`dask_geomodeling.geometry.sinks.to_file` (*source, url, fields=None, tile_size=None, dry_run=False, **request*)

Utility function to export data from a GeometryBlock to a file on disk.

You need to specify the target file path as well as the extent geometry you want to save. Feature properties can be saved by providing a field mapping to the `fields` argument.

To stay within memory constraints or to parallelize an operation, the `tile_size` argument can be provided.

Parameters

- **source** (*GeometryBlock*) – the block the data is coming from
- **url** (*str*) – The target file path. The extension determines the format. For supported formats, consult `GeometryFileSink.supported_extensions`.
- **fields** (*dict*) – a mapping that relates column names to output file field names, {<output file field name>: <column name>, ...}.
- **tile_size** (*int*) – Optionally use this for large exports to stay within memory constraints. The export is split in tiles of given size (units are determined by the projection). Finally the tiles are merged.
- **dry_run** (*bool*) – Do nothing, only validate the arguments.
- **geometry** (*shapely Geometry*) – Limit exported objects to objects whose centroid intersects with this geometry.
- **projection** (*str*) – The projection as a WKT string or EPSG code. Sets the projection of the geometry argument, the target projection of the data, and the tiling projection.
- **mode** (*str*) – one of {"intersects", "centroid"}, default "centroid"
- **start** (*datetime*) – start date as UTC datetime
- **stop** (*datetime*) – stop date as UTC datetime
- ****request** – see `GeometryBlock` request specification

Relevant settings can be adapted as follows:

```
>>> from dask import config
>>> config.set({"geomodeling.root": '/my/output/data/path'})
>>> config.set({"temporary_directory": '/my/alternative/tmp/dir'})
```

`dask_geomodeling.geometry.text`

Module containing text column operations that act on geometry blocks

class `dask_geomodeling.geometry.text.ParseTextColumn` (*source, source_column, key_mapping*)

Parses a text column into (possibly multiple) value columns.

Key, value pairs need to be separated by an equal (=) sign.

Parameters

- **source** (*GeometryBlock*) – Data source
- **source_column** (*str*) – Existing column in source.
- **key_mapping** (*dict*) – Mapping containing pairs {key_name: column_name}:

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Indices and tables

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