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# **schedula Documentation**

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2020-04-08 17:50:00

<https://github.com/vincilit2000/schedula>

<https://pypi.org/project/schedula/>

<https://schedula.readthedocs.io/>

<https://github.com/vincilit2000/schedula/wiki/>

<https://github.com/vincilit2000/schedula/releases/>

flow-based programming, dataflow, parallel, async, scheduling, dispatch, functional programming, dataflow programming

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EUPL 1.1+



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## About schedula

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**schedula** is a dynamic flow-based programming environment for python, that handles automatically the control flow of the program. The control flow generally is represented by a Directed Acyclic Graph (DAG), where nodes are the operations/functions to be executed and edges are the dependencies between them.

The algorithm of **schedula** dates back to 2014, when a colleague asked for a method to automatically populate the missing data of a database. The imputation method chosen to complete the database was a system of interdependent physical formulas - i.e., the inputs of a formula are the outputs of other formulas. The current library has been developed in 2015 to support the design of the CO<sub>2</sub>MPAS *tool* - a CO<sub>2</sub> vehicle *simulator*. During the developing phase, the physical formulas (more than 700) were known on the contrary of the software inputs and outputs.

### 1.1 Why schedula?

The design of flow-based programs begins with the definition of the control flow graph, and implicitly of its inputs and outputs. If the program accepts multiple combinations of inputs and outputs, you have to design and code all control flow graphs. With normal schedulers, it can be very demanding.

While with **schedula**, giving whatever set of inputs, it automatically calculates any of the desired computable outputs, choosing the most appropriate DAG from the dataflow execution model.

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**Note:** The DAG is determined at runtime and it is extracted using the shortest path from the provided inputs. The path is calculated based on a weighted directed graph (dataflow execution model) with a modified Dijkstra algorithm.

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**schedula** makes the code easy to debug, to optimize, and to present it to a non-IT audience through its interactive graphs and charts. It provides the option to run a model asynchronously or in parallel managing automatically the Global Interpreter Lock (GIL), and to convert a model into a web API service.

## 1.2 Dataflow Execution Model

The *Dispatcher* is the main model of **schedula** and it represents the dataflow execution model of your code. It is defined by a weighted directed graph. The nodes are the operations to be executed. The arcs between the nodes represent their dependencies. The weights are used to determine the control flow of your model (i.e. operations' invocation order).

Conceptually, when the model is executed, input-data flows as tokens along the arcs. When the execution/*dispatch()* begins, a special node (*START*) places the data onto key input arcs, triggering the computation of the control flow. The latter is represented by a Directed Acyclic Graph (DAG) and it is defined as the shortest path from the provided inputs. It is computed using the weighted directed graph and a modified Dijkstra algorithm. A node is executed when its inputs and domain are satisfied. After the node execution, new data are placed on some or all of its output arcs. In presence of cycles in the graph, to avoid undesired infinite loops, the nodes are computed only once. In case of an execution failure of a node, the algorithm searches automatically for an alternative path to compute the desired outputs. The nodes are differentiated according to their scope. **schedula** defines three node's types:

- **data node**: stores the data into the solution. By default, it is executable when it receives one input arch.
- **function node**: invokes the user defined function and place the results onto its output arcs. It is executable when all inputs are satisfied and it has at least one data output to be computed.
- **sub-dispatcher node**: packages particular dataflow execution model as sub component of the parent dispatcher. Practically, it creates a bridge between two dispatchers (parent and child) linking some data nodes. It allows to simplify your model, reusing some functionality defined in other models.

The key advantage is that, by this method, the scheduling is not affected by the operations' execution times. Therefore, it is deterministic and reproducible. Moreover, since it is based on flow-based programming, it inherits the ability to execute more than one operation at the same time, making the program executable in parallel. The following video shows an example of a runtime dispatch.



To install it use (with root privileges):

```
$ pip install schedula
```

or download the last git version and use (with root privileges):

```
$ python setup.py install
```

## 2.1 Install extras

Some additional functionality is enabled installing the following extras:

- `io`: enables to read/write functions (see `:`).
- `plot`: enables the plot of the Dispatcher model and workflow (see `plot()`).
- `web`: enables to build a dispatcher Flask app (see `web()`).
- `sphinx`: enables the sphinx extension directives (i.e., `autosummary` and `dispatcher`).
- `parallel`: enables the parallel execution of Dispatcher model.

To install **schedula** and all extras, do:

```
$ pip install schedula[all]
```

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**Note:** `plot` extra requires **Graphviz**. Make sure that the directory containing the `dot` executable is on your systems' path. If you have not you can install it from its [download page](#).

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Let's assume that we want develop a tool to automatically manage the symmetric cryptography. The base idea is to open a file, read its content, encrypt or decrypt the data and then write them out to a new file. This tutorial shows how to:

1. *define* and *execute* a dataflow execution model,
2. *extract* a sub-model, and
3. *deploy* a web API service.

**Note:** You can find more examples, on how to use the `schedula` library, into the folder `examples`.

## 3.1 Model definition

First of all we start defining an empty `Dispatcher` named `symmetric_cryptography` that defines the dataflow execution model:

```
>>> import schedula as sh
>>> dsp = sh.Dispatcher(name='symmetric_cryptography')
```

There are two main ways to get a key, we can either generate a new one or use one that has previously been generated. Hence, we can define three functions to simply generate, save, and load the key. To automatically populate the model inheriting the arguments names, we can use the decorator `add_function()` as follow:

```
>>> import os.path as osp
>>> from cryptography.fernet import Fernet
>>> @sh.add_function(dsp, outputs=['key'], weight=2)
... def generate_key():
...     return Fernet.generate_key().decode()
>>> @sh.add_function(dsp)
... def write_key(key_fpath, key):
```

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```
...     with open(key_fpath, 'w') as f:
...         f.write(key)
>>> @sh.add_function(dsp, outputs=['key'], input_domain=osp.isfile)
... def read_key(key_fpath):
...     with open(key_fpath) as f:
...         return f.read()
```

**Note:** Since Python does not come with anything that can encrypt/decrypt files, in this tutorial, we use a third party module named `cryptography`. To install it execute `pip install cryptography`.

To encrypt/decrypt a message, you will need a key as previously defined and your data *encrypted* or *decrypted*. Therefore, we can define two functions and add them, as before, to the model:

```
>>> @sh.add_function(dsp, outputs=['encrypted'])
... def encrypt_message(key, decrypted):
...     return Fernet(key.encode()).encrypt(decrypted.encode()).decode()
>>> @sh.add_function(dsp, outputs=['decrypted'])
... def decrypt_message(key, encrypted):
...     return Fernet(key.encode()).decrypt(encrypted.encode()).decode()
```

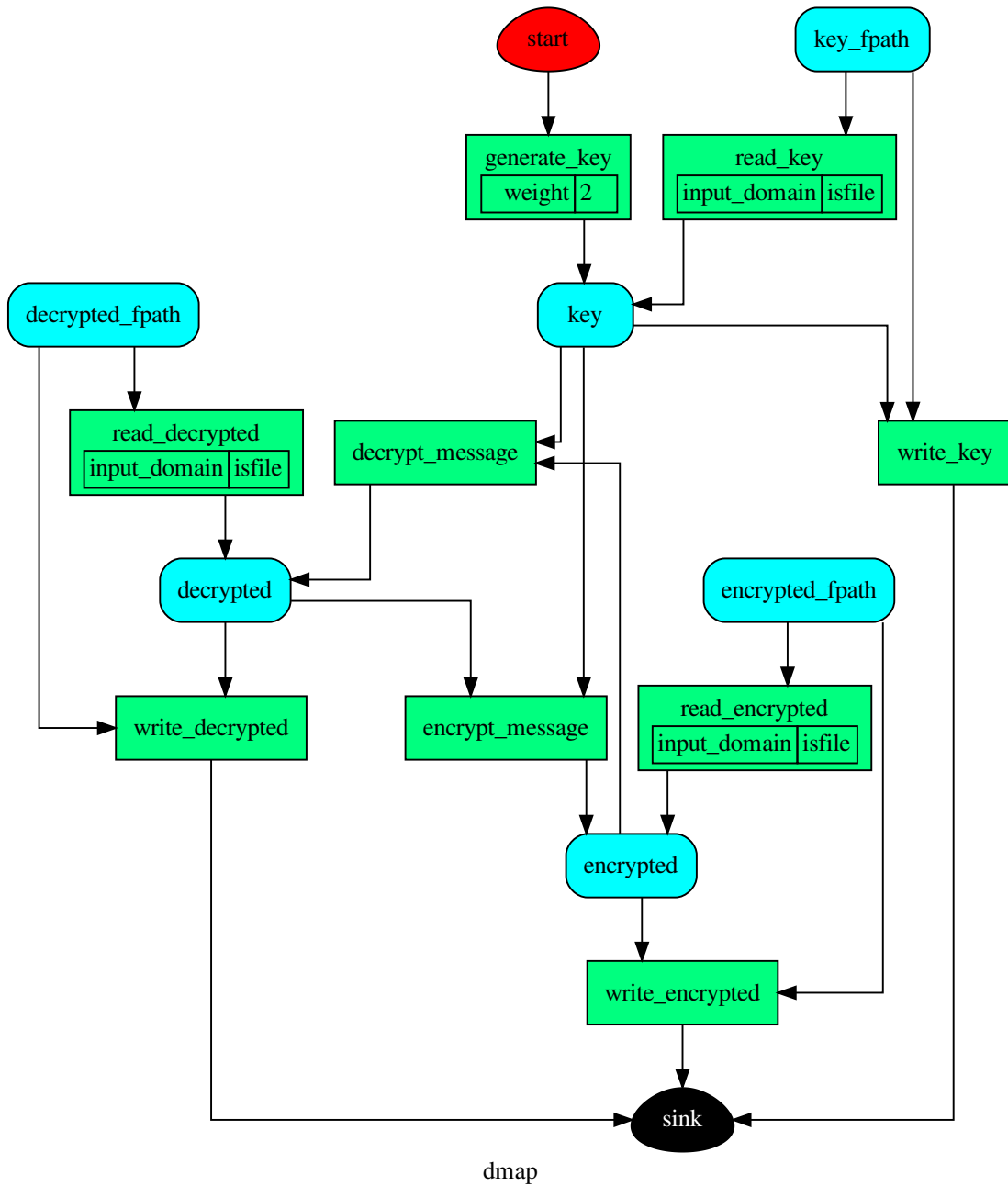
Finally, to read and write the encrypted or decrypted message, according to the functional programming philosophy, we can reuse the previously defined functions `read_key` and `write_key` changing the model mapping (i.e., *function\_id*, *inputs*, and *outputs*). To add to the model, we can simply use the `add_function` method as follow:

```
>>> dsp.add_function(
...     function_id='read_decrypted',
...     function=read_key,
...     inputs=['decrypted_fpath'],
...     outputs=['decrypted']
... )
'read_decrypted'
>>> dsp.add_function(
...     'read_encrypted', read_key, ['encrypted_fpath'], ['encrypted'],
...     input_domain=osp.isfile
... )
'read_encrypted'
>>> dsp.add_function(
...     'write_decrypted', write_key, ['decrypted_fpath', 'decrypted'],
...     input_domain=osp.isfile
... )
'write_decrypted'
>>> dsp.add_function(
...     'write_encrypted', write_key, ['encrypted_fpath', 'encrypted']
... )
'write_encrypted'
```

**Note:** For more details on how to create a *Dispatcher* see: `add_data()`, `add_func()`, `add_function()`, `add_dispatcher()`, `SubDispatch`, `SubDispatchFunction`, `SubDispatchPipe`, and `DispatchPipe`.

To inspect and visualize the dataflow execution model, you can simply plot the graph as follow:

```
>>> dsp.plot()
```

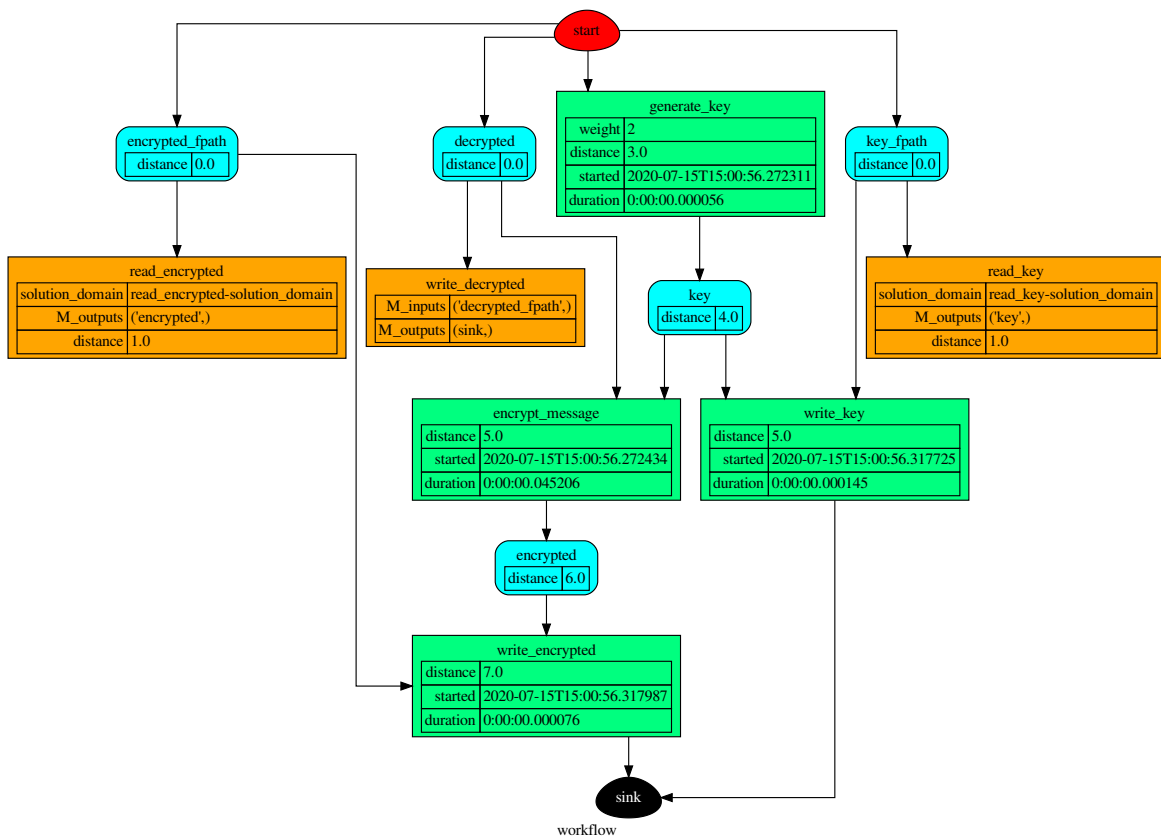


**Tip:** You can explore the diagram by clicking on it.

## 3.2 Dispatching

To see the dataflow execution model in action and its workflow to generate a key, to encrypt a message, and to write the encrypt data, you can simply invoke `dispatch()` or `__call__()` methods of the `dsp`:

```
>>> import tempfile
>>> tempdir = tempfile.mkdtemp()
>>> message = "secret message"
>>> sol = dsp(inputs=dict(
...     decrypted=message,
...     encrypted_fpath=osp.join(tempdir, 'data.secret'),
...     key_fpath=osp.join(tempdir, 'key.key')
... ))
>>> sol.plot(index=True) # doctest: +SKIP
```



**Note:** As you can see from the workflow graph (orange nodes), when some function's inputs does not respect its domain, the Dispatcher automatically finds an alternative path to estimate all computable outputs. The same logic applies when there is a function failure.

Now to decrypt the data and verify the message without saving the decrypted message, you just need to execute again the `dsp` changing the `inputs` and setting the desired `outputs`. In this way, the dispatcher automatically selects and executes only a sub-part of the dataflow execution model.

```
>>> dsp(  
...     inputs=sh.selector(('encrypted_fpath', 'key_fpath'), sol),  
...     outputs=['decrypted']  
... )['decrypted'] == message  
True
```

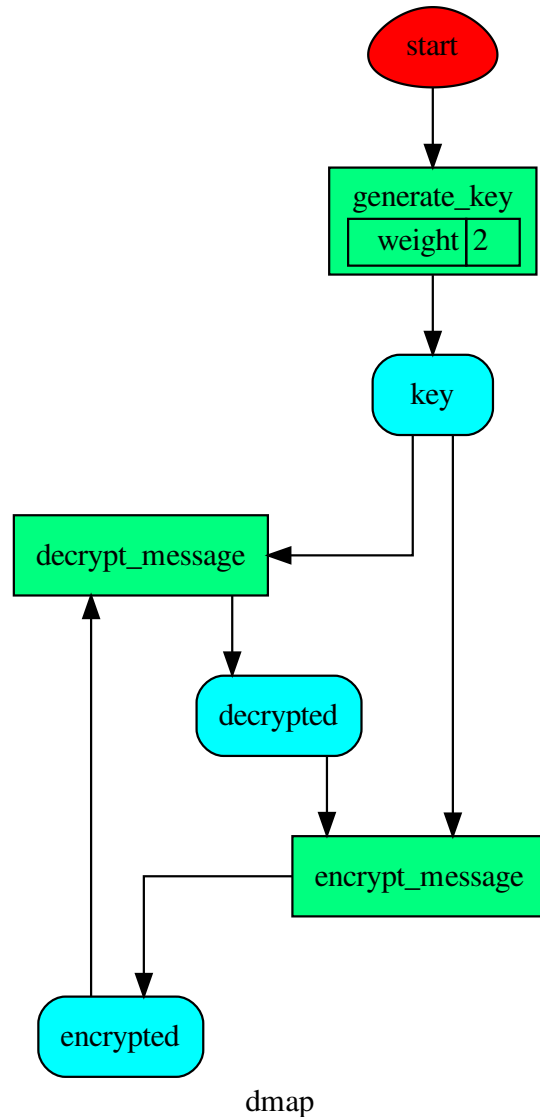
If you want to visualize the latest workflow of the dispatcher, you can use the `plot()` method with the keyword `workflow=True`:

```
>>> dsp.plot(workflow=True, index=True) # doctest: +SKIP
```

### 3.3 Sub-model extraction

A good security practice, when design a light web API service, is to avoid the unregulated access to the system's reading and writing features. Since our current dataflow execution model exposes these functionality, we need to extract sub-model without read/write of key and message functions:

```
>>> api = dsp.get_sub_dsp(  
...     'decrypt_message', 'encrypt_message', 'key', 'encrypted',  
...     'decrypted', 'generate_key', sh.START  
... ))
```




---

**Note:** For more details how to extract a sub-model see: [shrink\\_dsp\(\)](#), [get\\_sub\\_dsp\(\)](#), [get\\_sub\\_dsp\\_from\\_workflow\(\)](#), [SubDispatch](#), [SubDispatchFunction](#), [DispatchPipe](#), and [SubDispatchPipe](#).

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### 3.4 API server

Now that the `api` model is secure, we can deploy our web API service. **schedula** allows to convert automatically a `Dispatcher` to a web API service using the `web()` method. By default, it exposes the `dispatch()` method of the `Dispatcher` and maps all its functions and sub-dispatchers. Each of these APIs are commonly called endpoints.



You can launch the server with the code below:

```
>>> server = api.web().site(host='127.0.0.1', port=5000).run()
>>> url = server.url; url
'http://127.0.0.1:5000'
```

**Note:** When `server` object is garbage collected, the server shutdowns automatically. To force the server shutdown, use its method `server.shutdown()`.

Once the server is running, you can try out the encryption functionality making a JSON POST request, specifying the `args` and `kwargs` of the `dispatch()` method, as follow:

```
>>> import requests
>>> res = requests.post(
...     'http://127.0.0.1:5000', json={'args': [{'decrypted': 'message'}]})
... ).json()
```

**Note:** By default, the server returns a JSON response containing the function results (i.e., 'return') or, in case of server code failure, it returns the 'error' message.

To validate the encrypted message, you can directly invoke the decryption function as follow:

```
>>> res = requests.post(
...     '%s/symmetric_cryptography/decrypt_message?data=input,return' % url,
...     json={'kwargs': sh.selector(('key', 'encrypted'), res['return'])})
... ).json(); sorted(res)
['input', 'return']
>>> res['return'] == 'message'
True
```

**Note:** The available endpoints are formatted like:

- `/` or `{dsp_name}`: calls the `dispatch()` method,
- `{dsp_name}/{function_id}`: invokes the relative function.

There is an optional query param `data=input,return`, to include the inputs into the server JSON response and exclude the possible error message.



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## Asynchronous and Parallel dispatching

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When there are heavy calculations which takes a significant amount of time, you want to run your model asynchronously or in parallel. Generally, this is difficult to achieve, because it requires an higher level of abstraction and a deeper knowledge of python programming and the Global Interpreter Lock (GIL). Schedula will simplify again your life. It has four default executors to dispatch asynchronously or in parallel:

- `async`: execute all functions asynchronously in the same process,
- `parallel`: execute all functions in parallel excluding `SubDispatch` functions,
- `parallel-pool`: execute all functions in parallel using a process pool excluding `SubDispatch` functions,
- `parallel-dispatch`: execute all functions in parallel including `SubDispatch`.

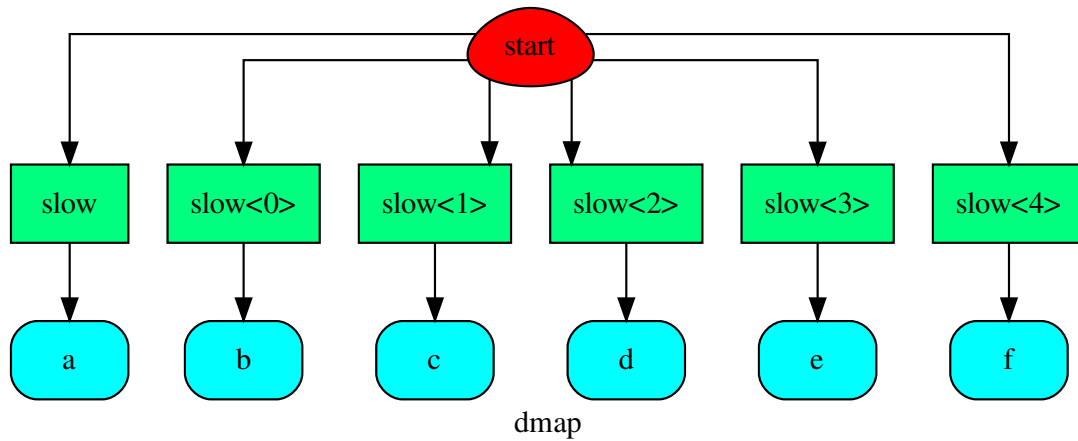
---

**Note:** Running functions asynchronously or in parallel has a cost. Schedula will spend time creating / deleting new threads / processes.

---

The code below shows an example of a time consuming code, that with the concurrent execution it requires at least 6 seconds to run. Note that the `slow` function return the process id.

```
>>> import schedula as sh
>>> dsp = sh.Dispatcher()
>>> def slow():
...     import os, time
...     time.sleep(1)
...     return os.getpid()
>>> for o in 'abcdef':
...     dsp.add_function(function=slow, outputs=[o])
'...'
```



while using the `async` executor, it lasts a bit more then 1 second:

```

>>> import time
>>> start = time.time()
>>> sol = dsp(executor='async').result() # Asynchronous execution.
>>> (time.time() - start) < 2 # Faster then concurrent execution.
True
    
```

all functions have been executed asynchronously, but on the same process:

```

>>> import os
>>> pid = os.getpid() # Current process id.
>>> {sol[k] for k in 'abcdef'} == {pid} # Single process id.
True
    
```

if we use the `parallel` executor all functions are executed on different processes:

```

>>> sol = dsp(executor='parallel').result() # Parallel execution.
>>> pids = {sol[k] for k in 'abcdef'} # Process ids returned by ``slow``.
>>> len(pids) == 6 # Each function returns a different process id.
True
>>> pid not in pids # The current process id is not in the returned pids.
True
>>> sorted(sh.shutdown_executors())
['async', 'parallel']
    
```

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## Contributing to `schedula`

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If you want to contribute to `schedula` and make it better, your help is very welcome. The contribution should be sent by a *pull request*. Next sections will explain how to implement and submit a new functionality:

- clone the repository
- implement a new functionality
- open a pull request

### 5.1 Clone the repository

The first step to contribute to `schedula` is to clone the repository:

- Create a personal *fork* of the `schedula` repository on Github.
- *Clone* the fork on your local machine. Your remote repo on Github is called `origin`.
- *Add* the original repository as a remote called `upstream`, to maintain updated your fork.
- If you created your fork a while ago be sure to *pull* `upstream` changes into your local repository.
- Create a new branch to work on! Branch from `dev`.

### 5.2 How to implement a new functionality

Test cases are very important. This library uses a data-driven testing approach. To implement a new function I recommend the *test-driven development cycle*. Hence, when you think that the code is ready, add new test in `test` folder.

When all test cases are ok (`python setup.py test`), open a pull request.

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**Note:** A pull request without new test case will not be taken into consideration.

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## 5.3 How to open a pull request

Well done! Your contribution is ready to be submitted:

- Squash your commits into a single commit with git's `interactive rebase`. Create a new branch if necessary. Always write your commit messages in the present tense. Your commit message should describe what the commit, when applied, does to the code – not what you did to the code.
- Push your branch to your fork on Github (i.e., `git push origin dev`).
- From your fork open a *pull request* in the correct branch. Target the project's dev branch!
- Once the *pull request* is approved and merged you can pull the changes from `upstream` to your local repo and delete your extra branch(es).

## CHAPTER 6

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Donate

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If you want to [support](#) the **schedula** development please donate.





The core of the library is composed from the following modules:

It contains a comprehensive list of all modules and classes within schedula.

Docstrings should provide sufficient understanding for any individual function.

Modules:

<i>dispatcher</i>	It provides Dispatcher class.
<i>utils</i>	It contains utility classes and functions.
<i>ext</i>	It provides sphinx extensions.

## 7.1 dispatcher

It provides Dispatcher class.

### Classes

<i>Dispatcher</i>	It provides a data structure to process a complex system of functions.
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### 7.1.1 Dispatcher

**class Dispatcher** (*dmap=None, name="", default\_values=None, raises=False, description="", executor=None*)

It provides a data structure to process a complex system of functions.

The scope of this data structure is to compute the shortest workflow between input and output data nodes.

A workflow is a sequence of function calls.

**Example:**

As an example, here is a system of equations:

$$b - a = c$$

$$\log(c) = d_{from-log}$$

$$d = (d_{from-log} + d_{initial-guess})/2$$

that will be solved assuming that  $a = 0$ ,  $b = 1$ , and  $d_{initial-guess} = 4$ .

**Steps**

Create an empty dispatcher:

```
>>> dsp = Dispatcher(name='Dispatcher')
```

Add data nodes to the dispatcher map:

```
>>> dsp.add_data(data_id='a')
'a'
>>> dsp.add_data(data_id='c')
'c'
```

Add a data node with a default value to the dispatcher map:

```
>>> dsp.add_data(data_id='b', default_value=1)
'b'
```

Add a function node:

```
>>> def diff_function(a, b):
...     return b - a
...
>>> dsp.add_function('diff_function', function=diff_function,
...                  inputs=['a', 'b'], outputs=['c'])
'diff_function'
```

Add a function node with domain:

```
>>> from math import log
...
>>> def log_domain(x):
...     return x > 0
...
>>> dsp.add_function('log', function=log, inputs=['c'], outputs=['d'],
...                  input_domain=log_domain)
'log'
```

Add a data node with function estimation and callback function.

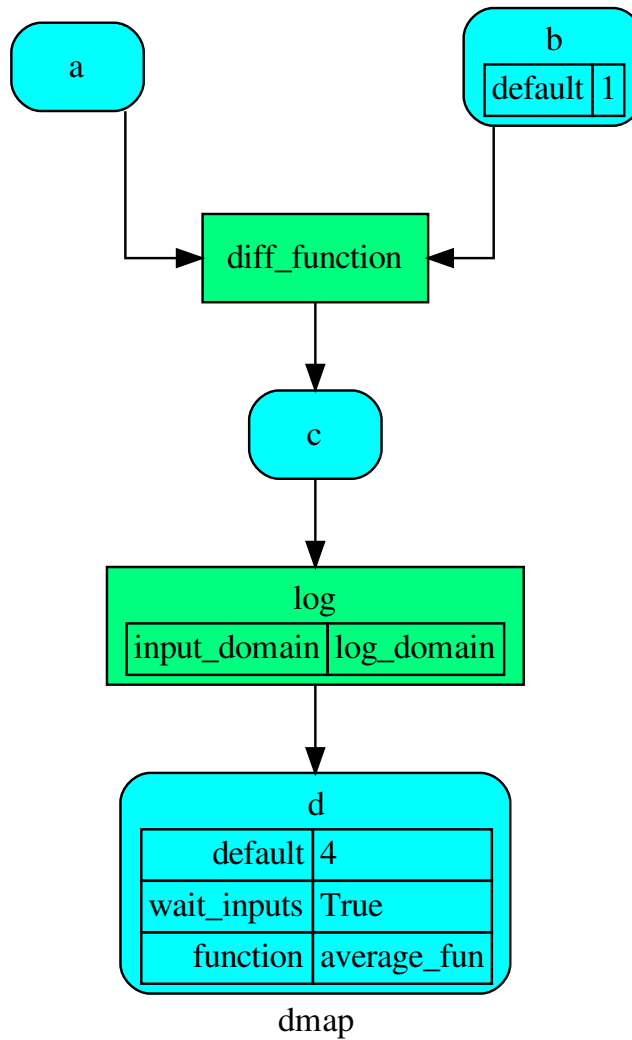
- function estimation: estimate one unique output from multiple estimations.
- callback function: is invoked after computing the output.

```
>>> def average_fun(kwargs):
...     '''
...     Returns the average of node estimations.
...     '''
```

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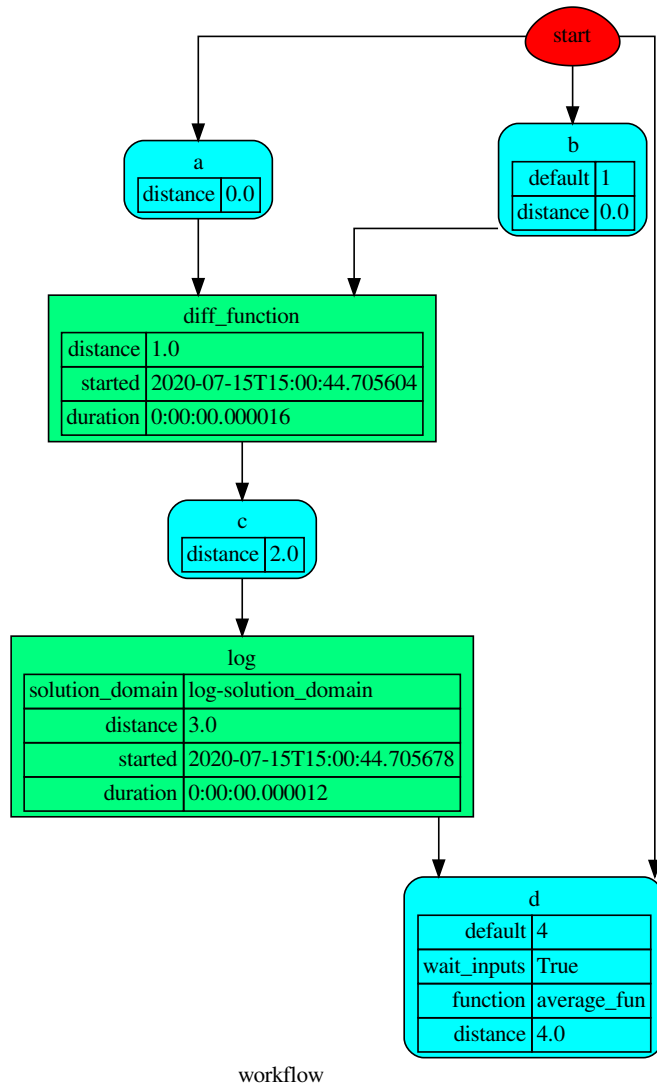
```
...     :param kwargs:
...         Node estimations.
...     :type kwargs: dict
...
...     :return:
...         The average of node estimations.
...     :rtype: float
...     '''
...
...     x = kwargs.values()
...     return sum(x) / len(x)
...
>>> def callback_fun(x):
...     print('(log(1) + 4) / 2 = %.1f' % x)
...
>>> dsp.add_data(data_id='d', default_value=4, wait_inputs=True,
...               function=average_fun, callback=callback_fun)
...
'd'
```



Dispatch the function calls to achieve the desired output data node *d*:

```

>>> outputs = dsp.dispatch(inputs={'a': 0}, outputs=['d'])
(log(1) + 4) / 2 = 2.0
>>> outputs
Solution([('a', 0), ('b', 1), ('c', 1), ('d', 2.0)])
  
```



## Methods

<code>__init__</code>	Initializes the dispatcher.
<code>add_data</code>	Add a single data node to the dispatcher.
<code>add_dispatcher</code>	Add a single sub-dispatcher node to dispatcher.
<code>add_from_lists</code>	Add multiple function and data nodes to dispatcher.
<code>add_func</code>	Add a single function node to dispatcher.
<code>add_function</code>	Add a single function node to dispatcher.
<code>blue</code>	Constructs a BlueDispatcher out of the current object.
<code>copy</code>	Returns a deepcopy of the Dispatcher.
<code>copy_structure</code>	Returns a copy of the Dispatcher structure.

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Table 3 – continued from previous page

<code>dispatch</code>	Evaluates the minimum workflow and data outputs of the dispatcher model from given inputs.
<code>extend</code>	Extends Dispatcher calling each deferred operation of given Blueprints.
<code>get_node</code>	Returns a sub node of a dispatcher.
<code>get_sub_dsp</code>	Returns the sub-dispatcher induced by given node and edge bunches.
<code>get_sub_dsp_from_workflow</code>	Returns the sub-dispatcher induced by the workflow from sources.
<code>plot</code>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<code>set_default_value</code>	Set the default value of a data node in the dispatcher.
<code>shrink_dsp</code>	Returns a reduced dispatcher.
<code>web</code>	Creates a dispatcher Flask app.

### `__init__`

Dispatcher.`__init__`(*dmap=None*, *name=""*, *default\_values=None*, *raises=False*, *description=""*, *executor=None*)  
 Initializes the dispatcher.

#### Parameters

- **dmap** (*schedula.utils.graph.DiGraph*, *optional*) – A directed graph that stores data & functions parameters.
- **name** (*str*, *optional*) – The dispatcher’s name.
- **default\_values** (*dict[str, dict]*, *optional*) – Data node default values. These will be used as input if it is not specified as inputs in the ArciDispatch algorithm.
- **raises** (*bool|callable|str*, *optional*) – If True the dispatcher interrupt the dispatch when an error occur, otherwise if raises != “ it logs a warning. If a callable is given it will be executed passing the exception to decide to raise or not the exception.
- **description** (*str*, *optional*) – The dispatcher’s description.
- **executor** (*str*, *optional*) – A pool executor id to dispatch asynchronously or in parallel.

There are four default Pool executors to dispatch asynchronously or in parallel:

- *async*: execute all functions asynchronously in the same process,
- *parallel*: execute all functions in parallel excluding *SubDispatch* functions,
- *parallel-pool*: execute all functions in parallel using a process pool excluding *SubDispatch* functions,
- *parallel-dispatch*: execute all functions in parallel including *SubDispatch*.

## add\_data

`Dispatcher.add_data` (*data\_id=None, default\_value=empty, initial\_dist=0.0, wait\_inputs=False, wildcard=None, function=None, callback=None, description=None, filters=None, await\_result=None, \*\*kwargs*)

Add a single data node to the dispatcher.

### Parameters

- **data\_id** (*str, optional*) – Data node id. If None will be assigned automatically ('unknown<%d>') not in dmap.
- **default\_value** (*T, optional*) – Data node default value. This will be used as input if it is not specified as inputs in the ArciDispatch algorithm.
- **initial\_dist** (*float, int, optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.
- **wait\_inputs** (*bool, optional*) – If True ArciDispatch algorithm stops on the node until it gets all input estimations.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
- **function** (*callable, optional*) – Data node estimation function. This can be any function that takes only one dictionary (key=function node id, value=estimation of data node) as input and return one value that is the estimation of the data node.
- **callback** (*callable, optional*) – Callback function to be called after node estimation. This can be any function that takes only one argument that is the data node estimation output. It does not return anything.
- **description** (*str, optional*) – Data node's description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits data results before assigning them to the solution. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Data node id.

**Return type** `str`

**See also:**

`add_func()`, `add_function()`, `add_dispatcher()`, `add_from_lists()`

**Example:**

Add a data to be estimated or a possible input data node:

```
>>> dsp.add_data(data_id='a')
'a'
```

Add a data with a default value (i.e., input data node):

```
>>> dsp.add_data(data_id='b', default_value=1)
'b'
```

Create a data node with function estimation and a default value.

- function estimation: estimate one unique output from multiple estimations.
- default value: is a default estimation.

```
>>> def min_fun(kwargs):
...     '''
...     Returns the minimum value of node estimations.
...
...     :param kwargs:
...         Node estimations.
...     :type kwargs: dict
...
...     :return:
...         The minimum value of node estimations.
...     :rtype: float
...     '''
...
...     return min(kwargs.values())
>>> dsp.add_data(data_id='c', default_value=2, wait_inputs=True,
...               function=min_fun)
'c'
```

Create a data with an unknown id and return the generated id:

```
>>> dsp.add_data()
'unknown'
```

## add\_dispatcher

`Dispatcher.add_dispatcher(dsp, inputs, outputs, dsp_id=None, input_domain=None, weight=None, inp_weight=None, description=None, include_defaults=False, await_domain=None, **kwargs)`

Add a single sub-dispatcher node to dispatcher.

### Parameters

- **dsp** (*Dispatcher* | *dict[str, list]*) – Child dispatcher that is added as sub-dispatcher node to the parent dispatcher.
- **inputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Inputs mapping. Data node ids from parent dispatcher to child sub-dispatcher.
- **outputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Outputs mapping. Data node ids from child sub-dispatcher to parent dispatcher.
- **dsp\_id** (*str, optional*) – Sub-dispatcher node id. If None will be assigned as `<dsp.name>`.



- **input\_domain** (*dict* → *bool*, *optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the a dictionary with the inputs of the sub-dispatcher node and returns True if input values satisfy the domain, otherwise False.

---

**Note:** This function is invoked every time that a data node reach the sub-dispatcher node.

---

- **weight** (*float*, *int*, *optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, int | float]*, *optional*) – Edge weights from data nodes to the sub-dispatcher node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str*, *optional*) – Sub-dispatcher node’s description.
- **include\_defaults** (*bool*, *optional*) – If True the default values of the sub-dispatcher are added to the current dispatcher.
- **await\_domain** (*bool|int|float*, *optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments*, *optional*) – Set additional node attributes using key=value.

**Returns** Sub-dispatcher node id.

**Return type** *str*

**See also:**

*add\_data()*, *add\_func()*, *add\_function()*, *add\_from\_lists()*

---

**Example:**

Create a sub-dispatcher:

```
>>> sub_dsp = Dispatcher()
>>> sub_dsp.add_function('max', max, ['a', 'b'], ['c'])
'max'
```

Add the sub-dispatcher to the parent dispatcher:

```
>>> dsp.add_dispatcher(dsp_id='Sub-Dispatcher', dsp=sub_dsp,
...                   inputs={'A': 'a', 'B': 'b'},
...                   outputs={'c': 'C'})
'Sub-Dispatcher'
```

Add a sub-dispatcher node with domain:

```
>>> def my_domain(kwargs):
...     return kwargs['C'] > 3
...
>>> dsp.add_dispatcher(dsp_id='Sub-Dispatcher with domain',
```

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```

...         dsp=sub_dsp, inputs={'C': 'a', 'D': 'b'},
...         outputs=({'c', 'b'): ('E', 'E1')},
...         input_domain=my_domain)
'Sub-Dispatcher with domain'

```

## add\_from\_lists

Dispatcher.**add\_from\_lists** (*data\_list=None, fun\_list=None, dsp\_list=None*)

Add multiple function and data nodes to dispatcher.

### Parameters

- **data\_list** (*list[dict], optional*) – It is a list of data node kwargs to be loaded.
- **fun\_list** (*list[dict], optional*) – It is a list of function node kwargs to be loaded.
- **dsp\_list** (*list[dict], optional*) – It is a list of sub-dispatcher node kwargs to be loaded.

### Returns

- Data node ids.
- Function node ids.
- Sub-dispatcher node ids.

**Return type** (*list[str], list[str], list[str]*)

### See also:

*add\_data(), add\_func(), add\_function(), add\_dispatcher()*

### Example:

Define a data list:

```

>>> data_list = [
...     {'data_id': 'a'},
...     {'data_id': 'b'},
...     {'data_id': 'c'},
... ]

```

Define a functions list:

```

>>> def func(a, b):
...     return a + b
...
>>> fun_list = [
...     {'function': func, 'inputs': ['a', 'b'], 'outputs': ['c']}
... ]

```

Define a sub-dispatchers list:

```
>>> sub_dsp = Dispatcher(name='Sub-dispatcher')
>>> sub_dsp.add_function(function=func, inputs=['e', 'f'],
...                       outputs=['g'])
'func'
>>>
>>> dsp_list = [
...     {'dsp_id': 'Sub', 'dsp': sub_dsp,
...      'inputs': {'a': 'e', 'b': 'f'}, 'outputs': {'g': 'c'}},
... ]
```

Add function and data nodes to dispatcher:

```
>>> dsp.add_from_lists(data_list, fun_list, dsp_list)
(['a', 'b', 'c'], ['func'], ['Sub'])
```

## add\_func

`Dispatcher.add_func` (*function*, *outputs=None*, *weight=None*, *inputs\_defaults=False*, *inputs\_kwargs=False*, *filters=None*, *input\_domain=None*, *await\_domain=None*, *await\_result=None*, *inp\_weight=None*, *out\_weight=None*, *description=None*, *inputs=None*, *function\_id=None*, *\*\*kwargs*)

Add a single function node to dispatcher.

### Parameters

- **inputs\_kwargs** (*bool*) – Do you want to include kwargs as inputs?
- **inputs\_defaults** (*bool*) – Do you want to set default values?
- **function\_id** (*str*, *optional*) – Function node id. If None will be assigned as <fun.\_\_name\_\_>.
- **function** (*callable*, *optional*) – Data node estimation function.
- **inputs** (*list*, *optional*) – Ordered arguments (i.e., data node ids) needed by the function. If None it will take parameters names from function signature.
- **outputs** (*list*, *optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable*, *optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn't pass on the node.
- **weight** (*float*, *int*, *optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int]*, *optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int]*, *optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.

- **description** (*str, optional*) – Function node’s description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_domain** (*bool/int/float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool/int/float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Function node id.

**Return type** `str`

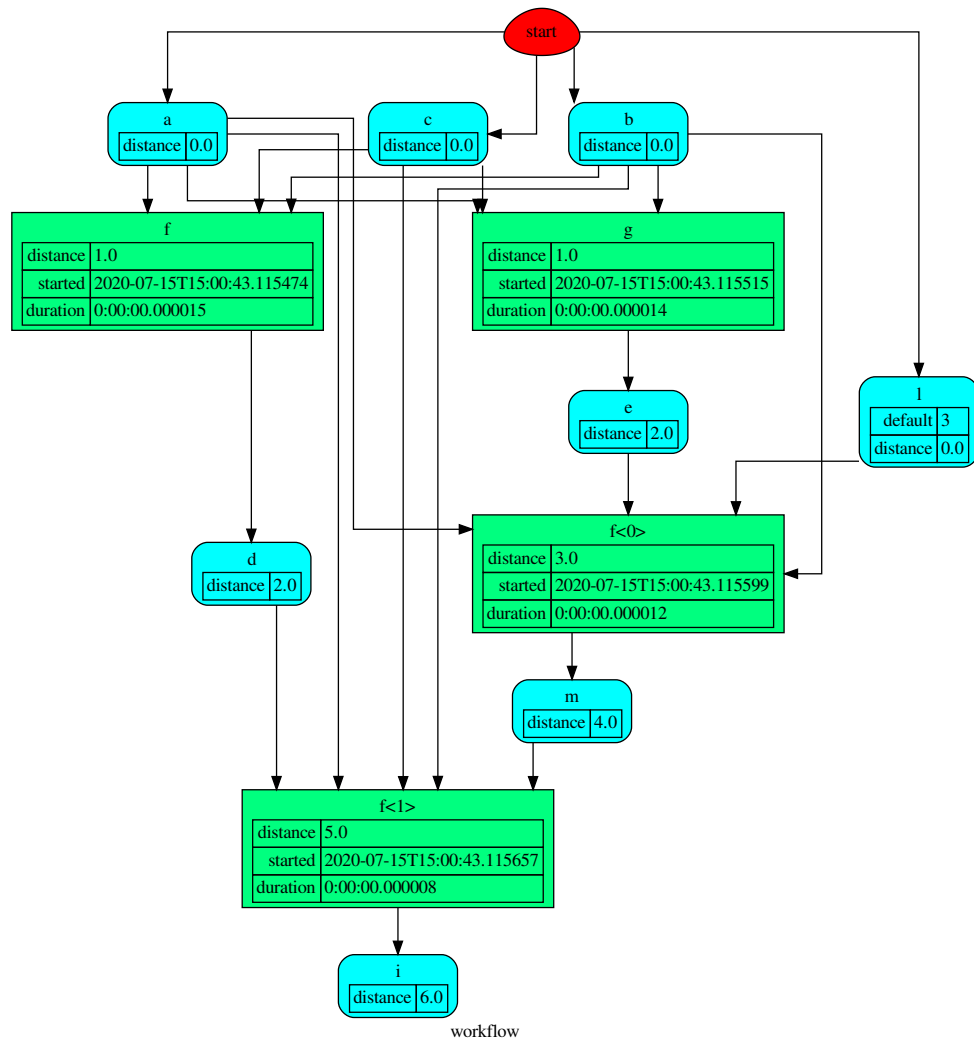
**See also:**

`add_func()`, `add_function()`, `add_dispatcher()`, `add_from_lists()`

---

**Example:**

```
>>> import schedula as sh
>>> dsp = sh.Dispatcher(name='Dispatcher')
>>> def f(a, b, c, d=3, m=5):
...     return (a + b) - c + d - m
>>> dsp.add_func(f, outputs=['d'])
'f'
>>> dsp.add_func(f, ['m'], inputs_defaults=True, inputs='beal')
'f<0>'
>>> dsp.add_func(f, ['i'], inputs_kwargs=True)
'f<1>'
>>> def g(a, b, c, *args, d=0):
...     return (a + b) * c + d
>>> dsp.add_func(g, ['e'], inputs_defaults=True)
'g'
>>> sol = dsp({'a': 1, 'b': 3, 'c': 0}); sol
Solution([('a', 1), ('b', 3), ('c', 0), ('l', 3), ('d', 2),
         ('e', 0), ('m', 0), ('i', 6)])
```



## add\_function

`Dispatcher.add_function` (*function\_id=None, function=None, inputs=None, outputs=None, input\_domain=None, weight=None, inp\_weight=None, out\_weight=None, description=None, filters=None, await\_domain=None, await\_result=None, \*\*kwargs*)

Add a single function node to dispatcher.

### Parameters

- **function\_id** (*str, optional*) – Function node id. If None will be assigned as `<fun.__name__>`.
- **function** (*callable, optional*) – Data node estimation function.
- **inputs** (*list, optional*) – Ordered arguments (i.e., data node ids) needed by the function.

- **outputs** (*list, optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn't pass on the node.
- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int], optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Function node's description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_domain** (*bool|int|float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Function node id.

**Return type** `str`

**See also:**

`add_data()`, `add_func()`, `add_dispatcher()`, `add_from_lists()`

---

**Example:**

Add a function node:

```
>>> def my_function(a, b):
...     c = a + b
...     d = a - b
...     return c, d
...
>>> dsp.add_function(function=my_function, inputs=['a', 'b'],
...                   outputs=['c', 'd'])
'my_function'
```

Add a function node with domain:

```
>>> from math import log
>>> def my_log(a, b):
...     return log(b - a)
...
>>> def my_domain(a, b):
...     return a < b
...
>>> dsp.add_function(function=my_log, inputs=['a', 'b'],
...                   outputs=['e'], input_domain=my_domain)
'my_log'
```

## blue

Dispatcher.**blue** (*memo=None*)

Constructs a BlueDispatcher out of the current object.

**Parameters** **memo** (*dict* [*T*, *schedula.utils.blue.Blueprint*]) – A dictionary to cache Blueprints.

**Returns** A BlueDispatcher of the current object.

**Return type** *schedula.utils.blue.BlueDispatcher*

## copy

Dispatcher.**copy** ()

Returns a deepcopy of the Dispatcher.

**Returns** A copy of the Dispatcher.

**Return type** *Dispatcher*

Example:

```
>>> dsp = Dispatcher()
>>> dsp is dsp.copy()
False
```

## copy\_structure

Dispatcher.**copy\_structure** (\*\**kwargs*)

Returns a copy of the Dispatcher structure.

**Parameters** **kwargs** (*dict*) – Additional parameters to initialize the new class.

**Returns** A copy of the Dispatcher structure.

**Return type** *Dispatcher*

## dispatch

Dispatcher.**dispatch** (*inputs=None*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *wildcard=False*, *no\_call=False*, *shrink=False*, *rm\_unused\_nds=False*, *select\_output\_kw=None*, *\_wait\_in=None*, *stopper=None*, *executor=False*, *sol\_name=()*)

Evaluates the minimum workflow and data outputs of the dispatcher model from given inputs.

### Parameters

- **inputs** (*dict[str, T], list[str], iterable, optional*) – Input data values.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
- **no\_call** (*bool, optional*) – If True data node estimation function is not used and the input values are not used.
- **shrink** (*bool, optional*) – If True the dispatcher is shrink before the dispatch.

**See also:**

*shrink\_dsp()*

- **rm\_unused\_nds** (*bool, optional*) – If True unused function and sub-dispatcher nodes are removed from workflow.
- **select\_output\_kw** (*dict, optional*) – Kwargs of selector function to select specific outputs.
- **\_wait\_in** (*dict, optional*) – Override wait inputs.
- **stopper** (*multiprocess.Event, optional*) – A semaphore to abort the dispatching.
- **executor** (*str, optional*) – A pool executor id to dispatch asynchronously or in parallel.
- **sol\_name** (*tuple[str], optional*) – Solution name.

**Returns** Dictionary of estimated data node outputs.

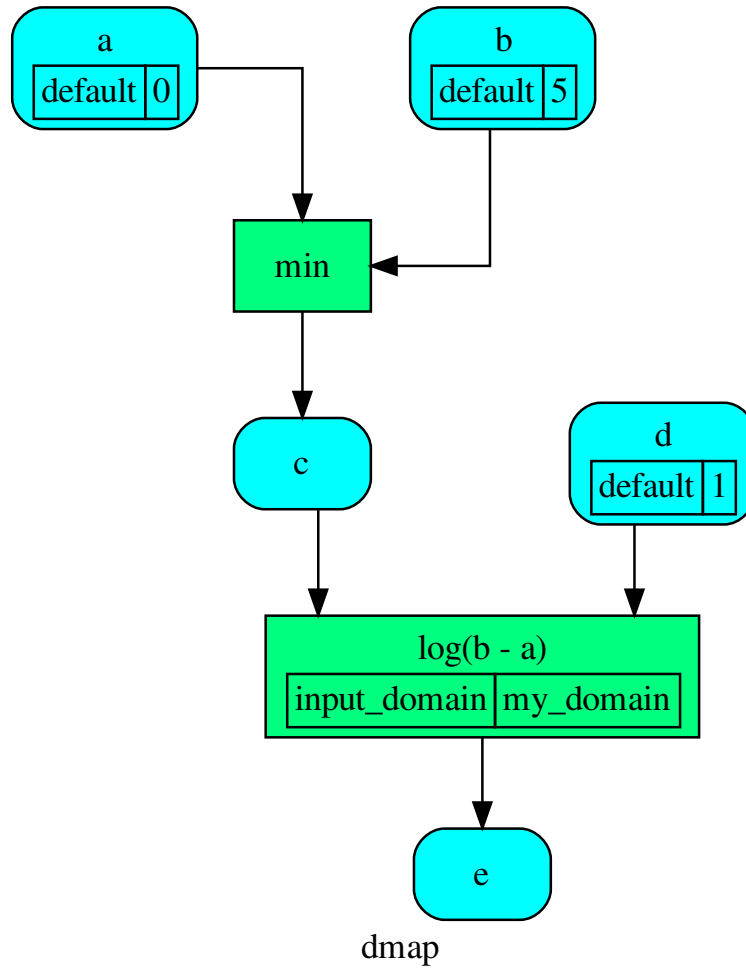
**Return type** *schedula.utils.sol.Solution*

---

### Example:

A dispatcher with a function  $\log(b - a)$  and two data  $a$  and  $b$  with default values:

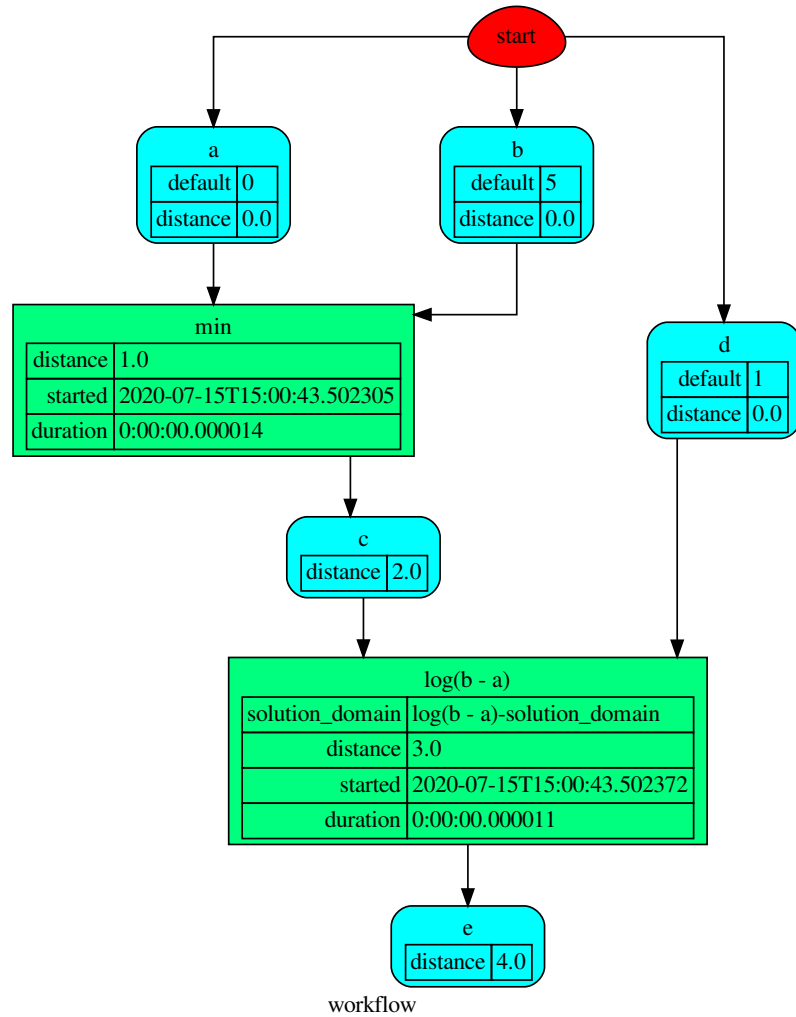




Dispatch without inputs. The default values are used as inputs:

```

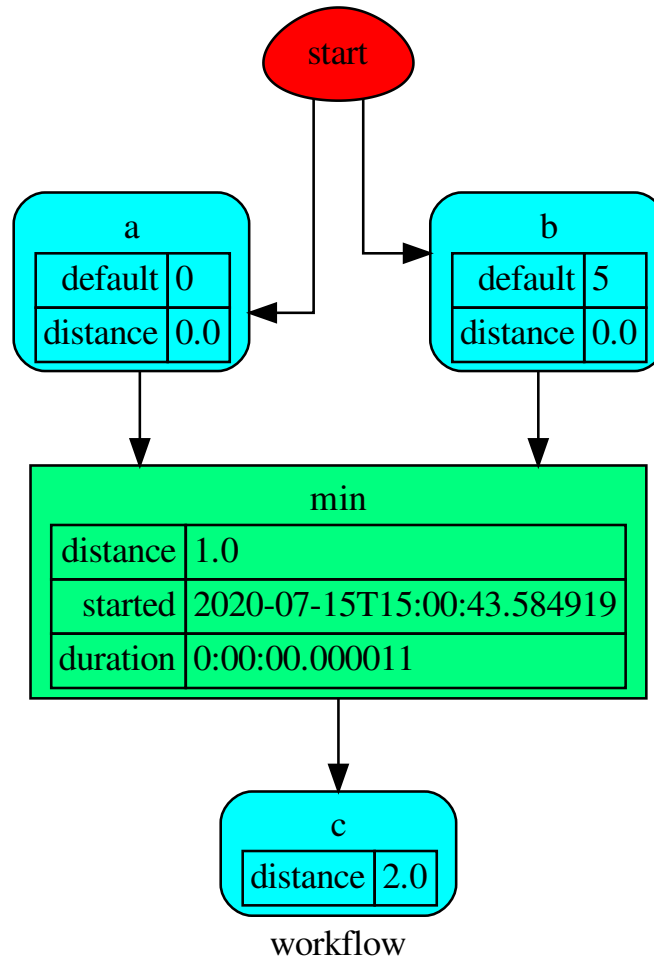
>>> outputs = dsp.dispatch()
>>> outputs
Solution([('a', 0), ('b', 5), ('d', 1), ('c', 0), ('e', 0.0)])
  
```



Dispatch until data node *c* is estimated:

```

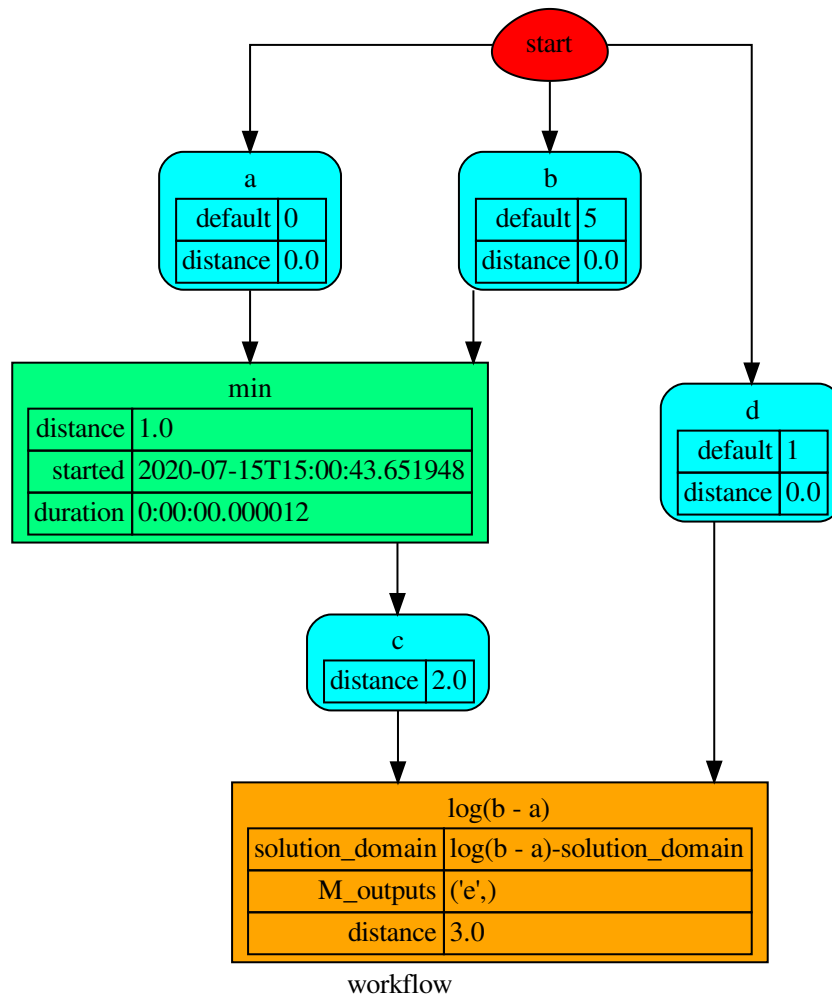
>>> outputs = dsp.dispatch(outputs=['c'])
>>> outputs
Solution([('a', 0), ('b', 5), ('c', 0)])
  
```



Dispatch with one inputs. The default value of *a* is not used as inputs:

```

>>> outputs = dsp.dispatch(inputs={'a': 3})
>>> outputs
Solution([('a', 3), ('b', 5), ('d', 1), ('c', 3)])
  
```



## extend

`Dispatcher.extend(*blues, memo=None)`

Extends Dispatcher calling each deferred operation of given Blueprints.

### Parameters

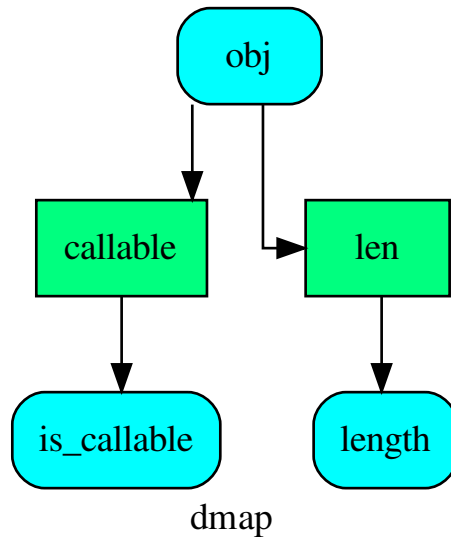
- **blues** (*Blueprint | schedula.dispatcher.Dispatcher*) – Blueprints or Dispatchers to extend deferred operations.
- **memo** (*dict[T, schedula.utils.blue.Blueprint | Dispatcher]*) – A dictionary to cache Blueprints and Dispatchers.

**Returns** Self.

**Return type** *Dispatcher*

**Example:**

```
>>> import schedula as sh
>>> dsp = sh.Dispatcher()
>>> dsp.add_func(callable, ['is_callable'])
'callable'
>>> blue = sh.BlueDispatcher().add_func(len, ['length'])
>>> dsp = sh.Dispatcher().extend(dsp, blue)
```



**get\_node**

`Dispatcher.get_node(*node_ids, node_attr=None)`

Returns a sub node of a dispatcher.

**Parameters**

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.
- **node\_attr** (*str, None, optional*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When 'auto', returns the "default" attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the 'function' attribute.

When 'description', returns the "description" of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

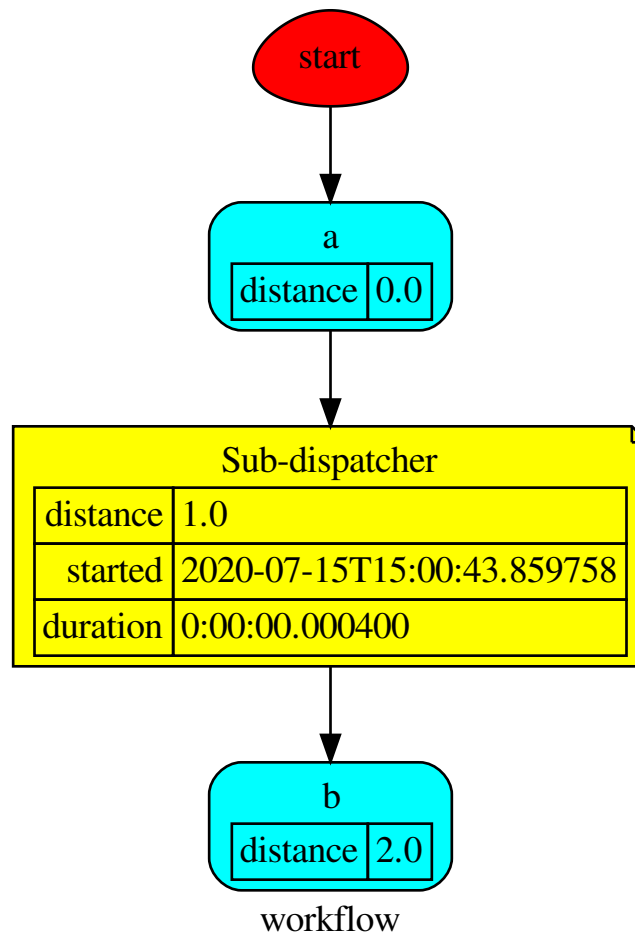
When 'value\_type', returns the data node value's type.

When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

**Example:**

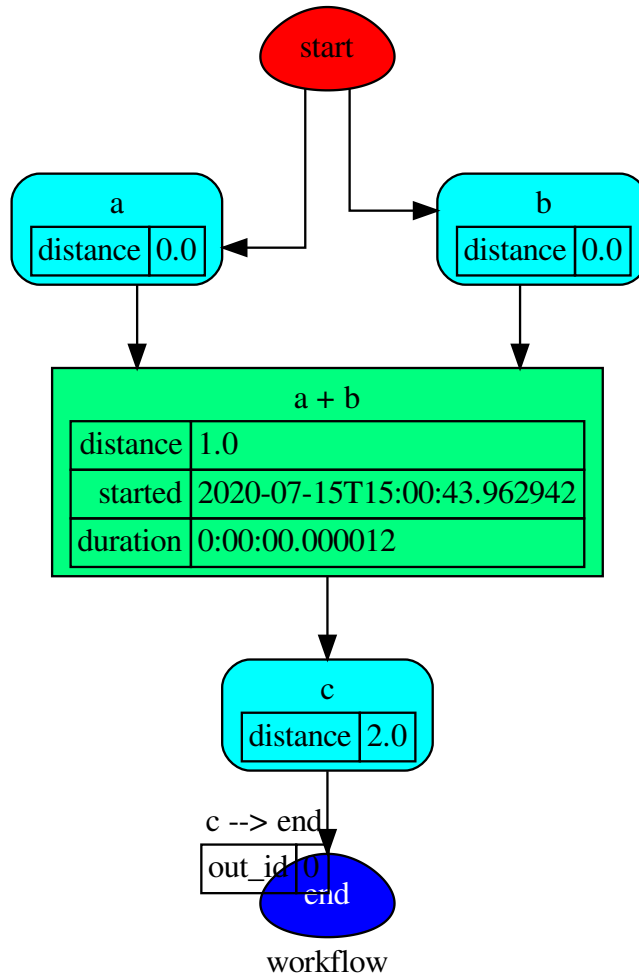


Get the sub node output:

```

>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_type('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
    
```

```
>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
```



### get\_sub\_dsp

Dispatcher.**get\_sub\_dsp**(nodes\_bunch, edges\_bunch=None)

Returns the sub-dispatcher induced by given node and edge bunches.

The induced sub-dispatcher contains the available nodes in nodes\_bunch and edges between those nodes, excluding those that are in edges\_bunch.

The available nodes are non isolated nodes and function nodes that have all inputs and at least one output.

#### Parameters

- **nodes\_bunch** (*list[str], iterable*) – A container of node ids which will be iterated through once.

- **edges\_bunch**(*list[(str, str)], iterable, optional*) – A container of edge ids that will be removed.

**Returns** A dispatcher.

**Return type** *Dispatcher*

**See also:**

*get\_sub\_dsp\_from\_workflow()*

---

**Note:** The sub-dispatcher edge or node attributes just point to the original dispatcher. So changes to the node or edge structure will not be reflected in the original dispatcher map while changes to the attributes will.

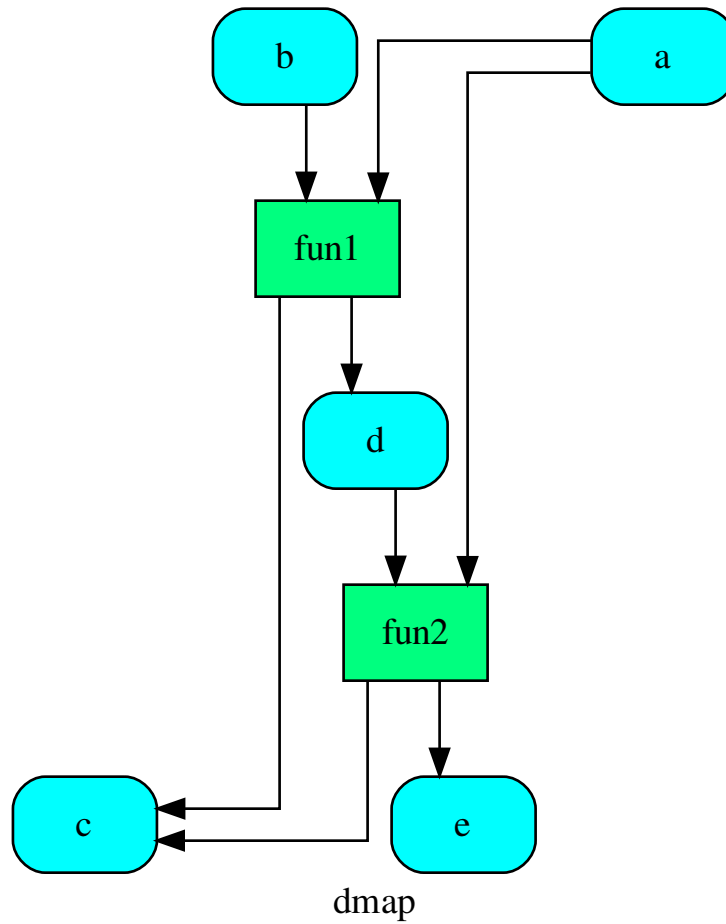
---

---

**Example:**

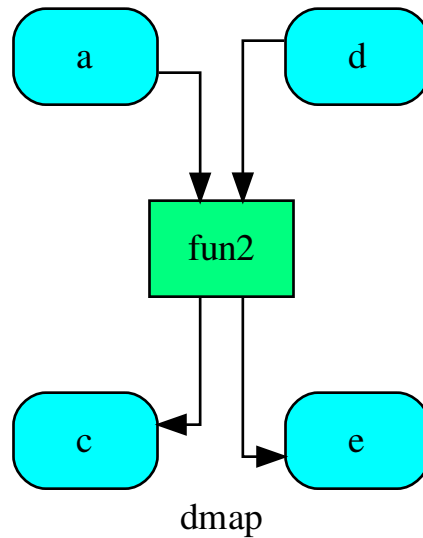
A dispatcher with a two functions *fun1* and *fun2*:





Get the sub-dispatcher induced by given nodes bunch:

```
>>> sub_dsp = dsp.get_sub_dsp(['a', 'c', 'd', 'e', 'fun2'])
```



### `get_sub_dsp_from_workflow`

`Dispatcher.get_sub_dsp_from_workflow` (*sources*, *graph=None*, *reverse=False*,  
*add\_missing=False*, *check\_inputs=True*,  
*blockers=None*, *wildcard=False*, *\_update\_links=True*)

Returns the sub-dispatcher induced by the workflow from sources.

The induced sub-dispatcher of the dsp contains the reachable nodes and edges evaluated with breadth-first-search on the workflow graph from source nodes.

#### Parameters

- **sources** (*list[str]*, *iterable*) – Source nodes for the breadth-first-search. A container of nodes which will be iterated through once.
- **graph** (*schedula.utils.graph.DiGraph*, *optional*) – A directed graph where evaluate the breadth-first-search.
- **reverse** (*bool*, *optional*) – If True the workflow graph is assumed as reversed.
- **add\_missing** (*bool*, *optional*) – If True, missing function' inputs are added to the sub-dispatcher.
- **check\_inputs** (*bool*, *optional*) – If True the missing function' inputs are not checked.
- **blockers** (*set[str]*, *iterable*, *optional*) – Nodes to not be added to the queue.
- **wildcard** (*bool*, *optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for

the connected functions, but not as output.

- `_update_links` (*bool*, *optional*) – If True, it updates remote links of the extracted dispatcher.

**Returns** A sub-dispatcher.

**Return type** *Dispatcher*

**See also:**

`get_sub_dsp()`

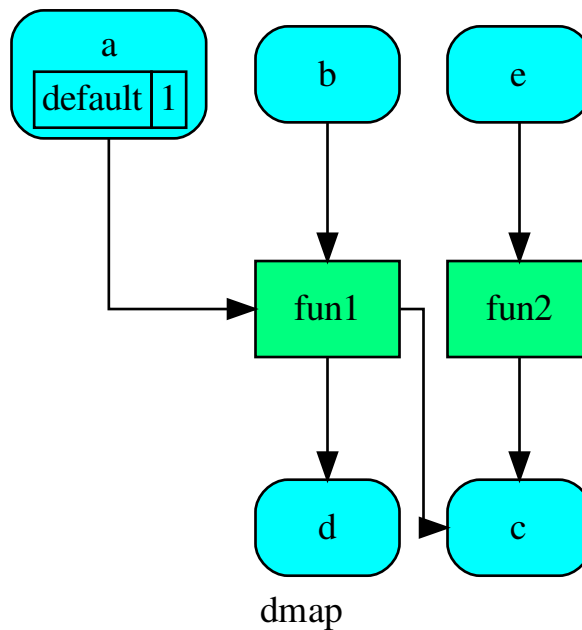
---

**Note:** The sub-dispatcher edge or node attributes just point to the original dispatcher. So changes to the node or edge structure will not be reflected in the original dispatcher map while changes to the attributes will.

---

**Example:**

A dispatcher with a function *fun* and a node *a* with a default value:

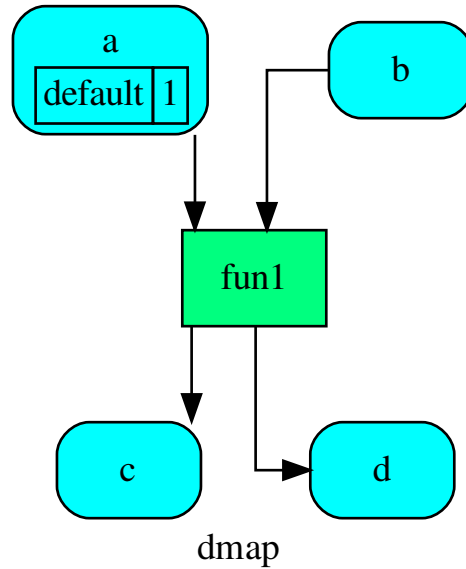


Dispatch with no calls in order to have a workflow:

```
>>> o = dsp.dispatch(inputs=['a', 'b'], no_call=True)
```

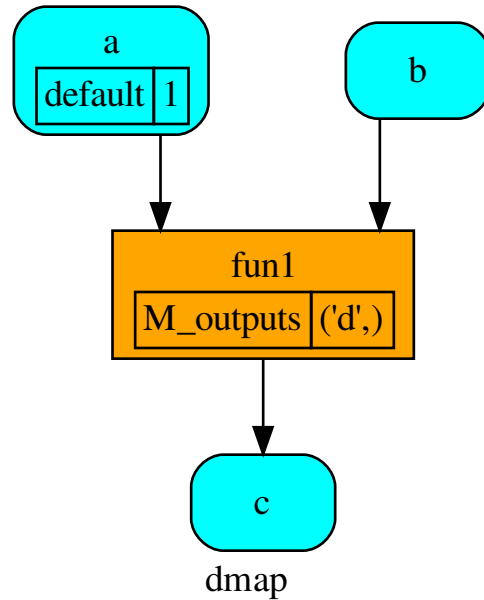
Get sub-dispatcher from workflow inputs *a* and *b*:

```
>>> sub_dsp = dsp.get_sub_dsp_from_workflow(['a', 'b'])
```



Get sub-dispatcher from a workflow output *c*:

```
>>> sub_dsp = dsp.get_sub_dsp_from_workflow(['c'], reverse=True)
```



## plot

Dispatcher.**plot** (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.

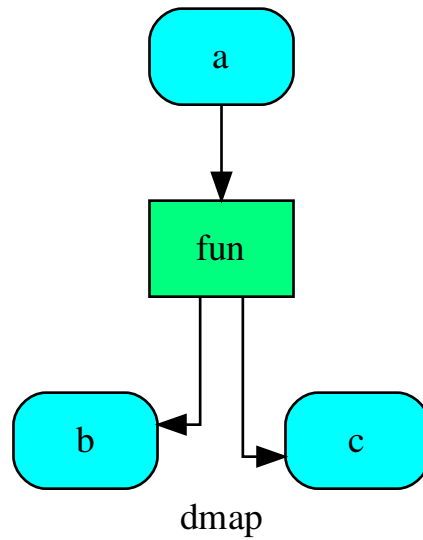
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict, optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool, optional*) – Add the site index as first page?
- **max\_lines** (*int, optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int, optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



### set\_default\_value

`Dispatcher.set_default_value (data_id, value=empty, initial_dist=0.0)`  
 Set the default value of a data node in the dispatcher.

#### Parameters

- **data\_id** (*str*) – Data node id.
- **value** (*T*, *optional*) – Data node default value.

---

**Note:** If *EMPTY* the previous default value is removed.

---

- **initial\_dist** (*float*, *int*, *optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.

#### Example:

A dispatcher with a data node named *a*:

```

>>> dsp = Dispatcher(name='Dispatcher')
...
>>> dsp.add_data(data_id='a')
'a'
  
```

Add a default value to *a* node:

```
>>> dsp.set_default_value('a', value='value of the data')
>>> list(sorted(dsp.default_values['a'].items()))
[('initial_dist', 0.0), ('value', 'value of the data')]
```

Remove the default value of *a* node:

```
>>> dsp.set_default_value('a', value=EMPTY)
>>> dsp.default_values
{}
```

## shrink\_dsp

Dispatcher.**shrink\_dsp** (*inputs=None, outputs=None, cutoff=None, inputs\_dist=None, wildcard=True*)

Returns a reduced dispatcher.

### Parameters

- **inputs** (*list[str], iterable, optional*) – Input data nodes.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.

**Returns** A sub-dispatcher.

**Return type** *Dispatcher*

**See also:**

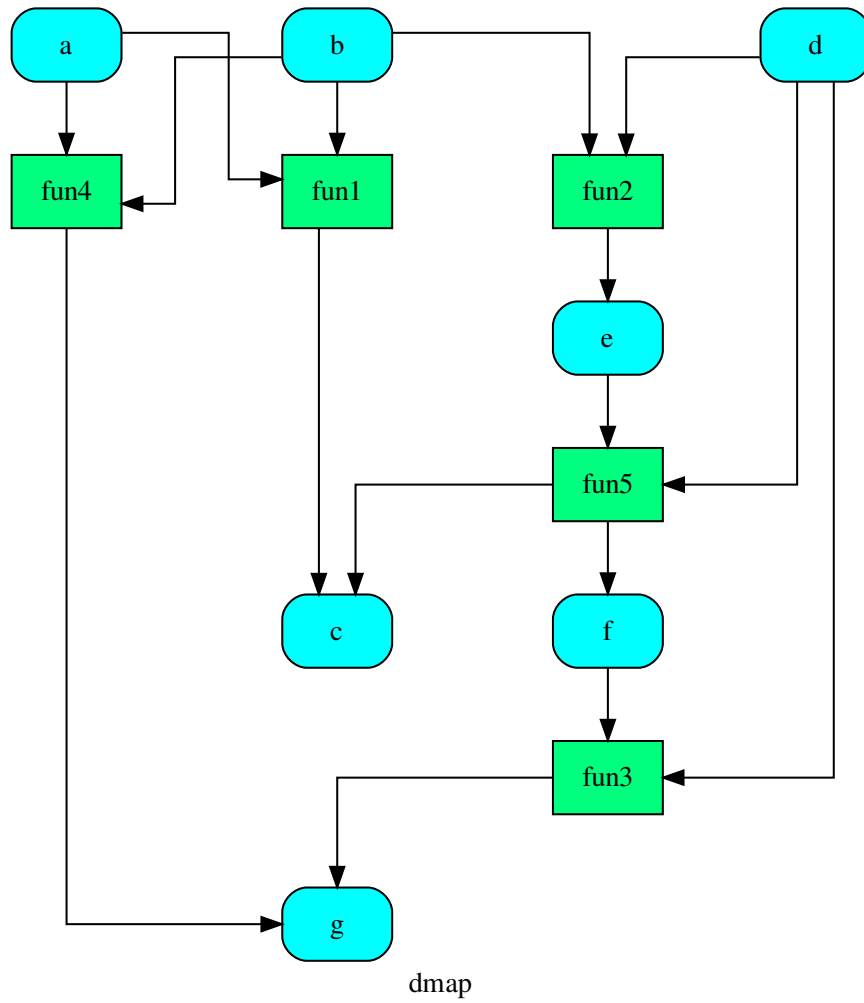
*dispatch()*

---

**Example:**

A dispatcher like this:

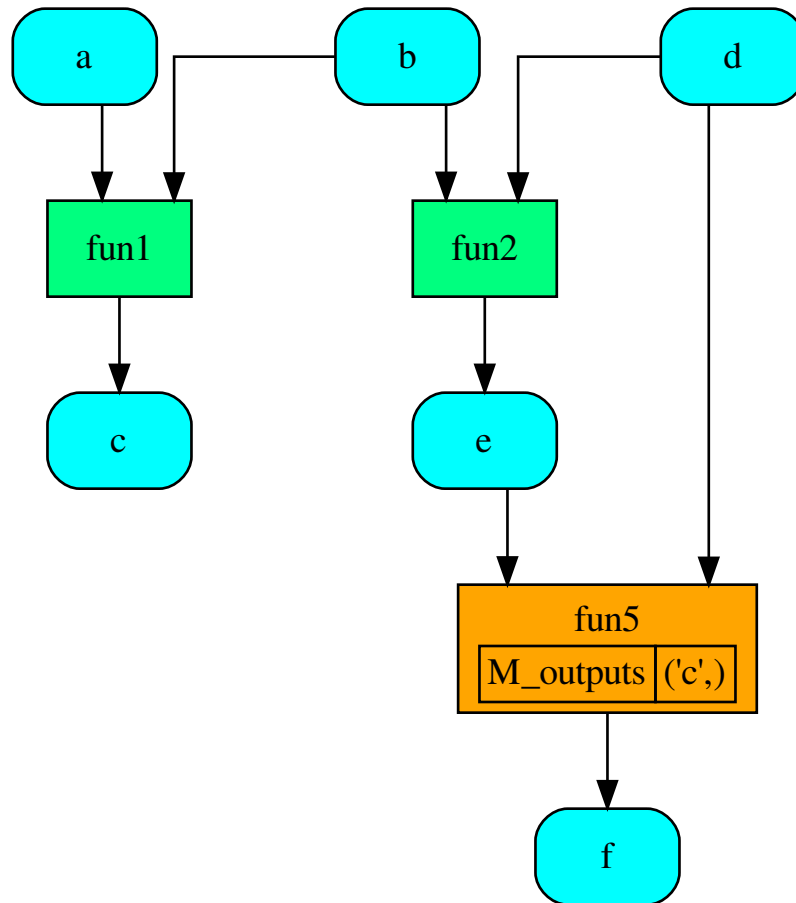




Get the sub-dispatcher induced by dispatching with no calls from inputs *a*, *b*, and *c* to outputs *c*, *e*, and *f*:

```

>>> shrink_dsp = dsp.shrink_dsp(inputs=['a', 'b', 'd'],
...                               outputs=['c', 'f'])
  
```



dmap

## web

Dispatcher.**web** (*depth=-1, node\_data=None, node\_function=None, directory=None, sites=None, run=True*)  
 Creates a dispatcher Flask app.

### Parameters

- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **directory** (*str, optional*) – Where is the generated Flask app root located?

- `sites` (*set* [*Site*], *optional*) – A set of *Site* to maintain alive the back-end server.
- `run` (*bool*, *optional*) – Run the backend server?

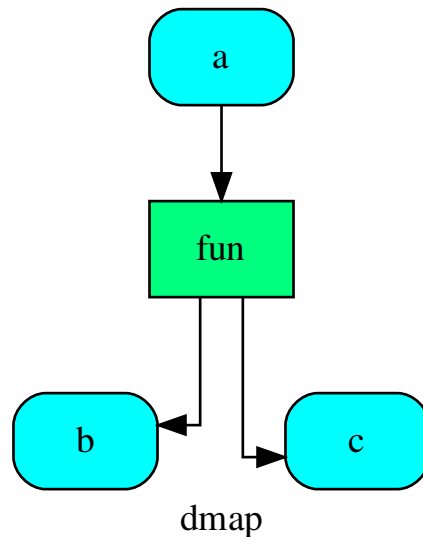
**Returns** A `WebMap`.

**Return type** `WebMap`

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```
>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
>>> requests.post(url, json={'args': (0,)}).json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
```

---

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

---

`__init__` (*dmap=None, name="", default\_values=None, raises=False, description="", executor=None*)  
 Initializes the dispatcher.

**Parameters**

- **dmap** (*schedula.utils.graph.DiGraph, optional*) – A directed graph that stores data & functions parameters.
- **name** (*str, optional*) – The dispatcher’s name.
- **default\_values** (*dict[str, dict], optional*) – Data node default values. These will be used as input if it is not specified as inputs in the ArciDispatch algorithm.
- **raises** (*bool|callable|str, optional*) – If True the dispatcher interrupt the dispatch when an error occur, otherwise if raises != “ it logs a warning. If a callable is given it will be executed passing the exception to decide to raise or not the exception.
- **description** (*str, optional*) – The dispatcher’s description.
- **executor** (*str, optional*) – A pool executor id to dispatch asynchronously or in parallel.

There are four default Pool executors to dispatch asynchronously or in parallel:

- *async*: execute all functions asynchronously in the same process,
- *parallel*: execute all functions in parallel excluding *SubDispatch* functions,
- *parallel-pool*: execute all functions in parallel using a process pool excluding *SubDispatch* functions,
- *parallel-dispatch*: execute all functions in parallel including *SubDispatch*.

**Attributes**

<i>data_nodes</i>	Returns all data nodes of the dispatcher.
<i>function_nodes</i>	Returns all function nodes of the dispatcher.
<i>sub_dsp_nodes</i>	Returns all sub-dispatcher nodes of the dispatcher.

**data\_nodes**

`Dispatcher.data_nodes`

Returns all data nodes of the dispatcher.

**Returns** All data nodes of the dispatcher.

**Return type** dict[str, dict]

**function\_nodes**

`Dispatcher.function_nodes`

Returns all function nodes of the dispatcher.

**Returns** All data function of the dispatcher.

**Return type** dict[str, dict]

## sub\_dsp\_nodes

Dispatcher.**sub\_dsp\_nodes**

Returns all sub-dispatcher nodes of the dispatcher.

**Returns** All sub-dispatcher nodes of the dispatcher.

**Return type** dict[str, dict]

**dmap = None**

The directed graph that stores data & functions parameters.

**name = None**

The dispatcher's name.

**nodes = None**

The function and data nodes of the dispatcher.

**default\_values = None**

Data node default values. These will be used as input if it is not specified as inputs in the ArciDispatch algorithm.

**raises = None**

If True the dispatcher interrupt the dispatch when an error occur.

**executor = None**

Pool executor to dispatch asynchronously.

**solution = None**

Last dispatch solution.

**counter = None**

Counter to set the node index.

**copy\_structure** (*\*\*kwargs*)

Returns a copy of the Dispatcher structure.

**Parameters** **kwargs** (*dict*) – Additional parameters to initialize the new class.

**Returns** A copy of the Dispatcher structure.

**Return type** *Dispatcher*

**add\_data** (*data\_id=None, default\_value=empty, initial\_dist=0.0, wait\_inputs=False, wildcard=None, function=None, callback=None, description=None, filters=None, await\_result=None, \*\*kwargs*)

Add a single data node to the dispatcher.

**Parameters**

- **data\_id** (*str, optional*) – Data node id. If None will be assigned automatically ('unknown<%d>') not in dmap.
- **default\_value** (*T, optional*) – Data node default value. This will be used as input if it is not specified as inputs in the ArciDispatch algorithm.
- **initial\_dist** (*float, int, optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.

- **wait\_inputs** (*bool, optional*) – If True ArciDispatch algorithm stops on the node until it gets all input estimations.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
- **function** (*callable, optional*) – Data node estimation function. This can be any function that takes only one dictionary (key=function node id, value=estimation of data node) as input and return one value that is the estimation of the data node.
- **callback** (*callable, optional*) – Callback function to be called after node estimation. This can be any function that takes only one argument that is the data node estimation output. It does not return anything.
- **description** (*str, optional*) – Data node’s description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits data results before assigning them to the solution. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Data node id.

**Return type** `str`

**See also:**

`add_func()`, `add_function()`, `add_dispatcher()`, `add_from_lists()`

**Example:**

Add a data to be estimated or a possible input data node:

```
>>> dsp.add_data(data_id='a')
'a'
```

Add a data with a default value (i.e., input data node):

```
>>> dsp.add_data(data_id='b', default_value=1)
'b'
```

Create a data node with function estimation and a default value.

- function estimation: estimate one unique output from multiple estimations.
- default value: is a default estimation.

```
>>> def min_fun(kwargs):
...     '''
...     Returns the minimum value of node estimations.
...
...     :param kwargs:
...         '''
```

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```

...     Node estimations.
...     :type kwargs: dict
...
...     :return:
...         The minimum value of node estimations.
...     :rtype: float
...     '''
...
...     return min(kwargs.values())
...
>>> dsp.add_data(data_id='c', default_value=2, wait_inputs=True,
...               function=min_fun)
'c'

```

Create a data with an unknown id and return the generated id:

```

>>> dsp.add_data()
'unknown'

```

**add\_function** (*function\_id=None, function=None, inputs=None, outputs=None, input\_domain=None, weight=None, inp\_weight=None, out\_weight=None, description=None, filters=None, await\_domain=None, await\_result=None, \*\*kwargs*)  
 Add a single function node to dispatcher.

**Parameters**

- **function\_id** (*str, optional*) – Function node id. If None will be assigned as <fun.\_\_name\_\_>.
- **function** (*callable, optional*) – Data node estimation function.
- **inputs** (*list, optional*) – Ordered arguments (i.e., data node ids) needed by the function.
- **outputs** (*list, optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn't pass on the node.
- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int], optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Function node's description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.

- **await\_domain** (*bool/int/float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool/int/float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Function node id.

**Return type** `str`

**See also:**

`add_data()`, `add_func()`, `add_dispatcher()`, `add_from_lists()`

**Example:**

Add a function node:

```
>>> def my_function(a, b):
...     c = a + b
...     d = a - b
...     return c, d
...
>>> dsp.add_function(function=my_function, inputs=['a', 'b'],
...                  outputs=['c', 'd'])
'my_function'
```

Add a function node with domain:

```
>>> from math import log
>>> def my_log(a, b):
...     return log(b - a)
...
>>> def my_domain(a, b):
...     return a < b
...
>>> dsp.add_function(function=my_log, inputs=['a', 'b'],
...                  outputs=['e'], input_domain=my_domain)
'my_log'
```

**add\_func** (*function, outputs=None, weight=None, inputs\_defaults=False, inputs\_kwargs=False, filters=None, input\_domain=None, await\_domain=None, await\_result=None, inp\_weight=None, out\_weight=None, description=None, inputs=None, function\_id=None, \*\*kwargs*)

Add a single function node to dispatcher.

**Parameters**

- **inputs\_kwargs** (*bool*) – Do you want to include kwargs as inputs?
- **inputs\_defaults** (*bool*) – Do you want to set default values?
- **function\_id** (*str, optional*) – Function node id. If None will be assigned as `<fun.__name__>`.



- **function** (*callable, optional*) – Data node estimation function.
- **inputs** (*list, optional*) – Ordered arguments (i.e., data node ids) needed by the function. If None it will take parameters names from function signature.
- **outputs** (*list, optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn't pass on the node.
- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int], optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Function node's description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_domain** (*bool|int|float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Function node id.

**Return type** *str*

**See also:**

*add\_func()*, *add\_function()*, *add\_dispatcher()*, *add\_from\_lists()*

**Example:**

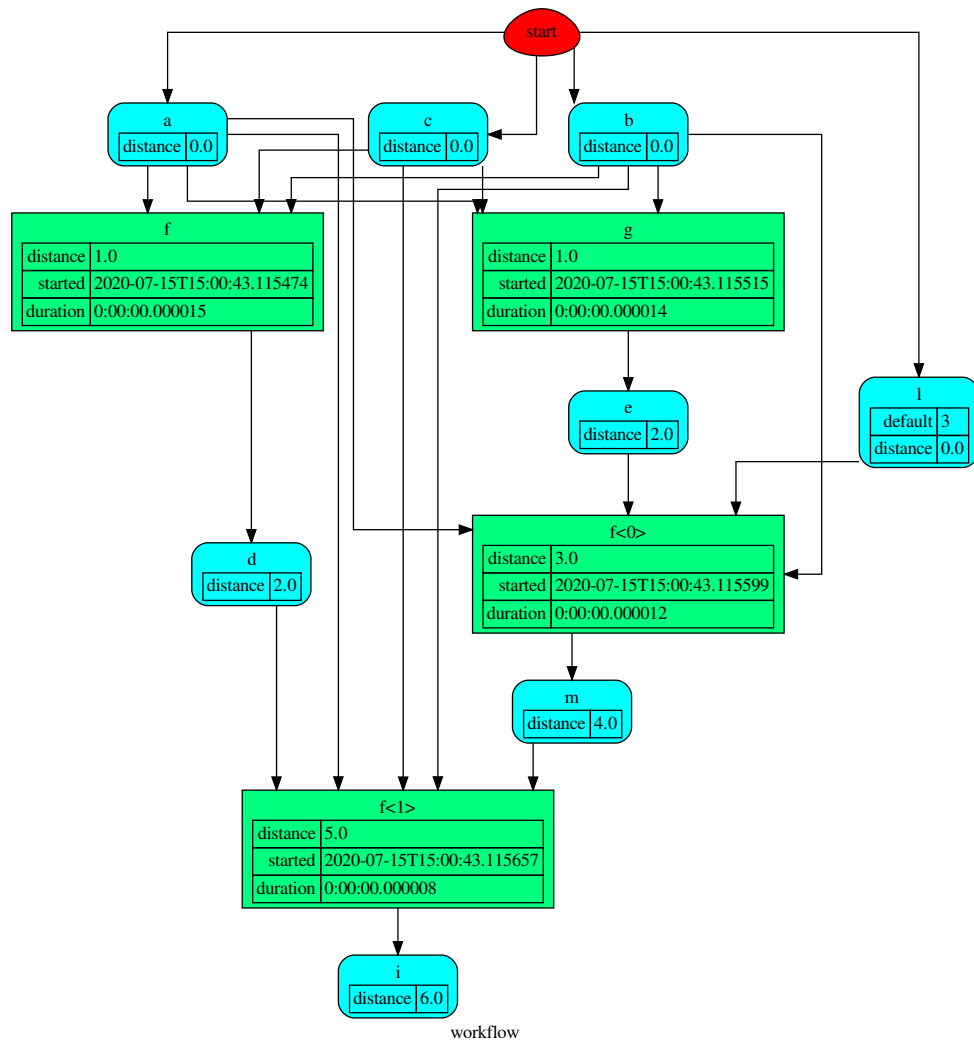
```
>>> import schedula as sh
>>> dsp = sh.Dispatcher(name='Dispatcher')
>>> def f(a, b, c, d=3, m=5):
...     return (a + b) - c + d - m
>>> dsp.add_func(f, outputs=['d'])
'f'
```

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```

>>> dsp.add_func(f, ['m'], inputs_defaults=True, inputs='beal')
'f<0>'
>>> dsp.add_func(f, ['i'], inputs_kwargs=True)
'f<1>'
>>> def g(a, b, c, *args, d=0):
...     return (a + b) * c + d
>>> dsp.add_func(g, ['e'], inputs_defaults=True)
'g'
>>> sol = dsp({'a': 1, 'b': 3, 'c': 0}); sol
Solution([('a', 1), ('b', 3), ('c', 0), ('l', 3), ('d', 2),
         ('e', 0), ('m', 0), ('i', 6)])
    
```



**add\_dispatcher** (*dsp*, *inputs*, *outputs*, *dsp\_id=None*, *input\_domain=None*, *weight=None*, *inp\_weight=None*, *description=None*, *include\_defaults=False*, *await\_domain=None*, *\*\*kwargs*)  
 Add a single sub-dispatcher node to dispatcher.

**Parameters**

- **dsp** (*Dispatcher* | *dict[str, list]*) – Child dispatcher that is added as sub-dispatcher node to the parent dispatcher.
- **inputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Inputs mapping. Data node ids from parent dispatcher to child sub-dispatcher.
- **outputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Outputs mapping. Data node ids from child sub-dispatcher to parent dispatcher.
- **dsp\_id** (*str, optional*) – Sub-dispatcher node id. If None will be assigned as `<dsp.name>`.
- **input\_domain** (*(dict) -> bool, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the a dictionary with the inputs of the sub-dispatcher node and returns True if input values satisfy the domain, otherwise False.

---

**Note:** This function is invoked every time that a data node reach the sub-dispatcher node.

---

- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, int | float], optional*) – Edge weights from data nodes to the sub-dispatcher node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Sub-dispatcher node’s description.
- **include\_defaults** (*bool, optional*) – If True the default values of the sub-dispatcher are added to the current dispatcher.
- **await\_domain** (*bool|int|float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Sub-dispatcher node id.

**Return type** `str`

**See also:**

`add_data()`, `add_func()`, `add_function()`, `add_from_lists()`

**Example:**

Create a sub-dispatcher:

```
>>> sub_dsp = Dispatcher()
>>> sub_dsp.add_function('max', max, ['a', 'b'], ['c'])
'max'
```

Add the sub-dispatcher to the parent dispatcher:

```
>>> dsp.add_dispatcher(dsp_id='Sub-Dispatcher', dsp=sub_dsp,
...                     inputs={'A': 'a', 'B': 'b'},
...                     outputs={'c': 'C'})
'Sub-Dispatcher'
```

Add a sub-dispatcher node with domain:

```
>>> def my_domain(kwargs):
...     return kwargs['C'] > 3
...
>>> dsp.add_dispatcher(dsp_id='Sub-Dispatcher with domain',
...                     dsp=sub_dsp, inputs={'C': 'a', 'D': 'b'},
...                     outputs=({'c', 'b'): ('E', 'E1')},
...                     input_domain=my_domain)
'Sub-Dispatcher with domain'
```

**add\_from\_lists** (*data\_list=None, fun\_list=None, dsp\_list=None*)

Add multiple function and data nodes to dispatcher.

#### Parameters

- **data\_list** (*list[dict], optional*) – It is a list of data node kwargs to be loaded.
- **fun\_list** (*list[dict], optional*) – It is a list of function node kwargs to be loaded.
- **dsp\_list** (*list[dict], optional*) – It is a list of sub-dispatcher node kwargs to be loaded.

#### Returns

- Data node ids.
- Function node ids.
- Sub-dispatcher node ids.

**Return type** (*list[str], list[str], list[str]*)

**See also:**

*add\_data(), add\_func(), add\_function(), add\_dispatcher()*

---

#### Example:

Define a data list:

```
>>> data_list = [
...     {'data_id': 'a'},
...     {'data_id': 'b'},
...     {'data_id': 'c'},
... ]
```

Define a functions list:

```
>>> def func(a, b):
...     return a + b
... 
```

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```
>>> fun_list = [
...     {'function': func, 'inputs': ['a', 'b'], 'outputs': ['c']}
... ]
```

Define a sub-dispatchers list:

```
>>> sub_dsp = Dispatcher(name='Sub-dispatcher')
>>> sub_dsp.add_function(function=func, inputs=['e', 'f'],
...                      outputs=['g'])
'func'
>>>
>>> dsp_list = [
...     {'dsp_id': 'Sub', 'dsp': sub_dsp,
...      'inputs': {'a': 'e', 'b': 'f'}, 'outputs': {'g': 'c'}},
... ]
```

Add function and data nodes to dispatcher:

```
>>> dsp.add_from_lists(data_list, fun_list, dsp_list)
(['a', 'b', 'c'], ['func'], ['Sub'])
```

**set\_default\_value** (*data\_id*, *value=empty*, *initial\_dist=0.0*)

Set the default value of a data node in the dispatcher.

#### Parameters

- **data\_id** (*str*) – Data node id.
- **value** (*T*, *optional*) – Data node default value.

---

**Note:** If *EMPTY* the previous default value is removed.

---

- **initial\_dist** (*float*, *int*, *optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.

#### Example:

A dispatcher with a data node named *a*:

```
>>> dsp = Dispatcher(name='Dispatcher')
...
>>> dsp.add_data(data_id='a')
'a'
```

Add a default value to *a* node:

```
>>> dsp.set_default_value('a', value='value of the data')
>>> list(sorted(dsp.default_values['a'].items()))
[('initial_dist', 0.0), ('value', 'value of the data')]
```

Remove the default value of *a* node:

```
>>> dsp.set_default_value('a', value=EMPTY)
>>> dsp.default_values
{}
```

**get\_sub\_dsp** (*nodes\_bunch*, *edges\_bunch=None*)

Returns the sub-dispatcher induced by given node and edge bunches.

The induced sub-dispatcher contains the available nodes in *nodes\_bunch* and edges between those nodes, excluding those that are in *edges\_bunch*.

The available nodes are non isolated nodes and function nodes that have all inputs and at least one output.

**Parameters**

- **nodes\_bunch** (*list[str]*, *iterable*) – A container of node ids which will be iterated through once.
- **edges\_bunch** (*list[(str, str)]*, *iterable*, *optional*) – A container of edge ids that will be removed.

**Returns** A dispatcher.

**Return type** *Dispatcher*

**See also:**

*get\_sub\_dsp\_from\_workflow()*

---

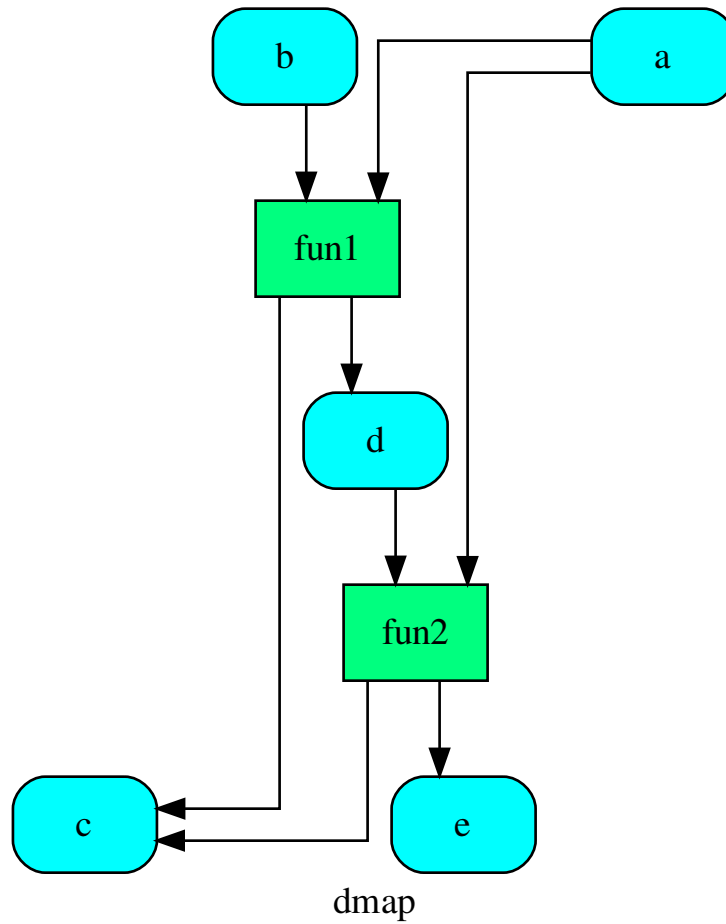
**Note:** The sub-dispatcher edge or node attributes just point to the original dispatcher. So changes to the node or edge structure will not be reflected in the original dispatcher map while changes to the attributes will.

---

---

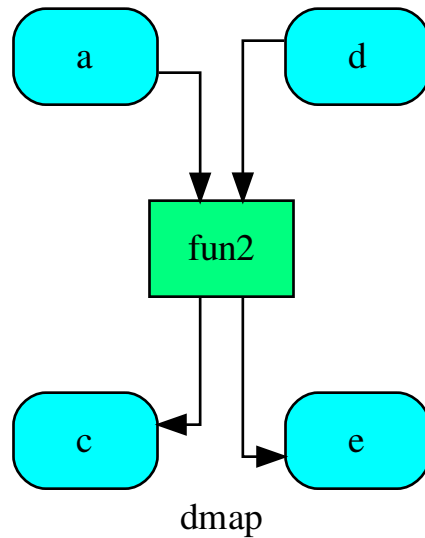
**Example:**

A dispatcher with a two functions *fun1* and *fun2*:



Get the sub-dispatcher induced by given nodes bunch:

```
>>> sub_dsp = dsp.get_sub_dsp(['a', 'c', 'd', 'e', 'fun2'])
```



`get_sub_dsp_from_workflow`(*sources*, *graph=None*, *reverse=False*, *add\_missing=False*, *check\_inputs=True*, *blockers=None*, *wildcard=False*, *\_update\_links=True*)

Returns the sub-dispatcher induced by the workflow from sources.

The induced sub-dispatcher of the dsp contains the reachable nodes and edges evaluated with breadth-first-search on the workflow graph from source nodes.

#### Parameters

- **sources** (*list[str]*, *iterable*) – Source nodes for the breadth-first-search. A container of nodes which will be iterated through once.
- **graph** (*schedula.utils.graph.DiGraph*, *optional*) – A directed graph where evaluate the breadth-first-search.
- **reverse** (*bool*, *optional*) – If True the workflow graph is assumed as reversed.
- **add\_missing** (*bool*, *optional*) – If True, missing function' inputs are added to the sub-dispatcher.
- **check\_inputs** (*bool*, *optional*) – If True the missing function' inputs are not checked.
- **blockers** (*set[str]*, *iterable*, *optional*) – Nodes to not be added to the queue.
- **wildcard** (*bool*, *optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
- **\_update\_links** (*bool*, *optional*) – If True, it updates remote links of the extracted dispatcher.



**Returns** A sub-dispatcher.

**Return type** *Dispatcher*

**See also:**

`get_sub_dsp()`

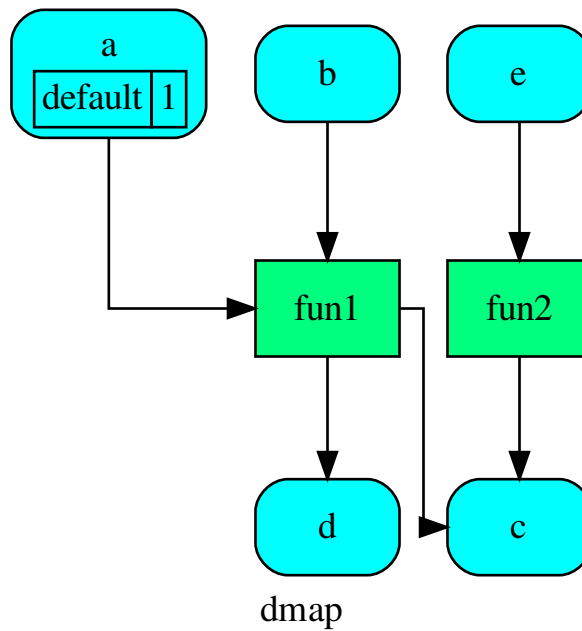
---

**Note:** The sub-dispatcher edge or node attributes just point to the original dispatcher. So changes to the node or edge structure will not be reflected in the original dispatcher map while changes to the attributes will.

---

**Example:**

A dispatcher with a function *fun* and a node *a* with a default value:

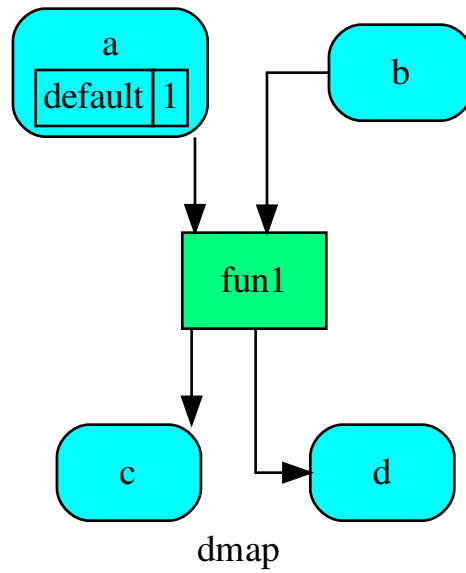


Dispatch with no calls in order to have a workflow:

```
>>> o = dsp.dispatch(inputs=['a', 'b'], no_call=True)
```

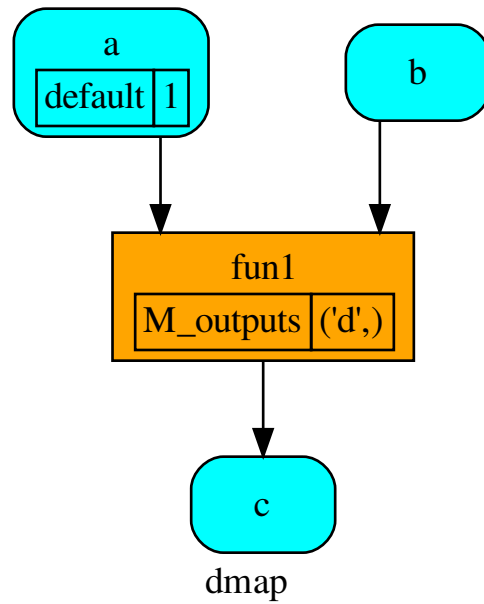
Get sub-dispatcher from workflow inputs *a* and *b*:

```
>>> sub_dsp = dsp.get_sub_dsp_from_workflow(['a', 'b'])
```



Get sub-dispatcher from a workflow output *c*:

```
>>> sub_dsp = dsp.get_sub_dsp_from_workflow(['c'], reverse=True)
```



**data\_nodes**

Returns all data nodes of the dispatcher.

**Returns** All data nodes of the dispatcher.

**Return type** dict[str, dict]

**function\_nodes**

Returns all function nodes of the dispatcher.

**Returns** All data function of the dispatcher.

**Return type** dict[str, dict]

**sub\_dsp\_nodes**

Returns all sub-dispatcher nodes of the dispatcher.

**Returns** All sub-dispatcher nodes of the dispatcher.

**Return type** dict[str, dict]

**copy ()**

Returns a deepcopy of the Dispatcher.

**Returns** A copy of the Dispatcher.

**Return type** Dispatcher

Example:

```

>>> dsp = Dispatcher()
>>> dsp is dsp.copy()
False
  
```

**blue** (*memo=None*)

Constructs a BlueDispatcher out of the current object.

**Parameters** **memo** (*dict* [*T*, *schedula.utils.blue.Blueprint*]) – A dictionary to cache Blueprints.

**Returns** A BlueDispatcher of the current object.

**Return type** *schedula.utils.blue.BlueDispatcher*

**extend** (*\*blues*, *memo=None*)

Extends Dispatcher calling each deferred operation of given Blueprints.

**Parameters**

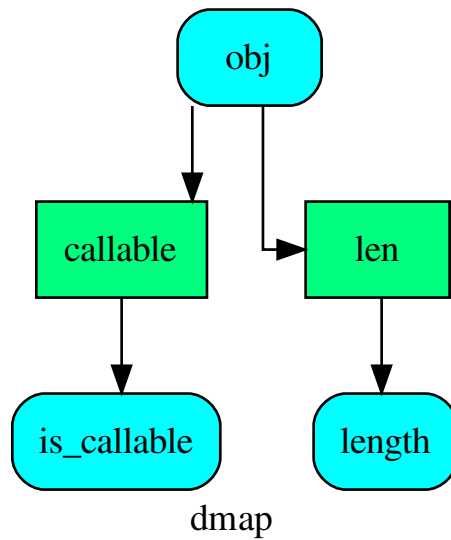
- **blues** (*Blueprint* | *schedula.dispatcher.Dispatcher*) – Blueprints or Dispatchers to extend deferred operations.
- **memo** (*dict* [*T*, *schedula.utils.blue.Blueprint* | *Dispatcher*]) – A dictionary to cache Blueprints and Dispatchers.

**Returns** Self.

**Return type** *Dispatcher*

**Example:**

```
>>> import schedula as sh
>>> dsp = sh.Dispatcher()
>>> dsp.add_func(callable, ['is_callable'])
'callable'
>>> blue = sh.BlueDispatcher().add_func(len, ['length'])
>>> dsp = sh.Dispatcher().extend(dsp, blue)
```



**dispatch** (*inputs=None, outputs=None, cutoff=None, inputs\_dist=None, wildcard=False, no\_call=False, shrink=False, rm\_unused\_nds=False, select\_output\_kw=None, \_wait\_in=None, stopper=None, executor=False, sol\_name=()*)

Evaluates the minimum workflow and data outputs of the dispatcher model from given inputs.

#### Parameters

- **inputs** (*dict[str, T], list[str], iterable, optional*) – Input data values.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
- **no\_call** (*bool, optional*) – If True data node estimation function is not used and the input values are not used.
- **shrink** (*bool, optional*) – If True the dispatcher is shrink before the dispatch.

See also:

*shrink\_dsp()*

- **rm\_unused\_nds** (*bool, optional*) – If True unused function and sub-dispatcher nodes are removed from workflow.
- **select\_output\_kw** (*dict, optional*) – Kwargs of selector function to select specific outputs.
- **\_wait\_in** (*dict, optional*) – Override wait inputs.
- **stopper** (*multiprocess.Event, optional*) – A semaphore to abort the dispatching.
- **executor** (*str, optional*) – A pool executor id to dispatch asynchronously or in parallel.
- **sol\_name** (*tuple[str], optional*) – Solution name.

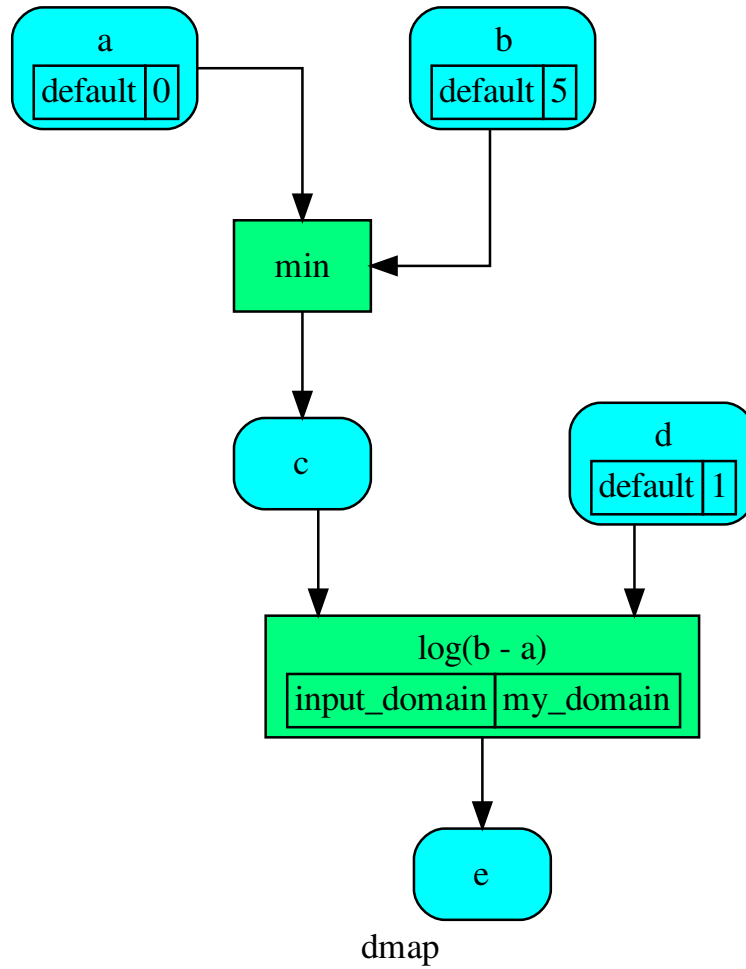
**Returns** Dictionary of estimated data node outputs.

**Return type** *schedula.utils.sol.Solution*

---

#### Example:

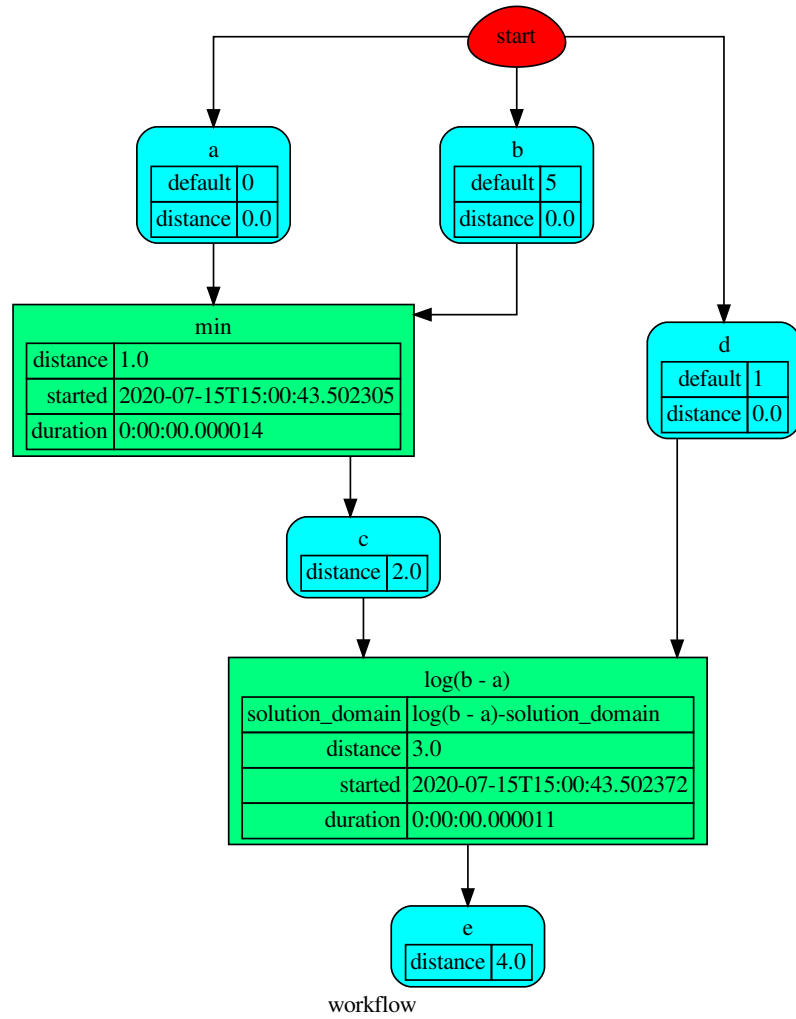
A dispatcher with a function  $\log(b - a)$  and two data  $a$  and  $b$  with default values:



Dispatch without inputs. The default values are used as inputs:

```

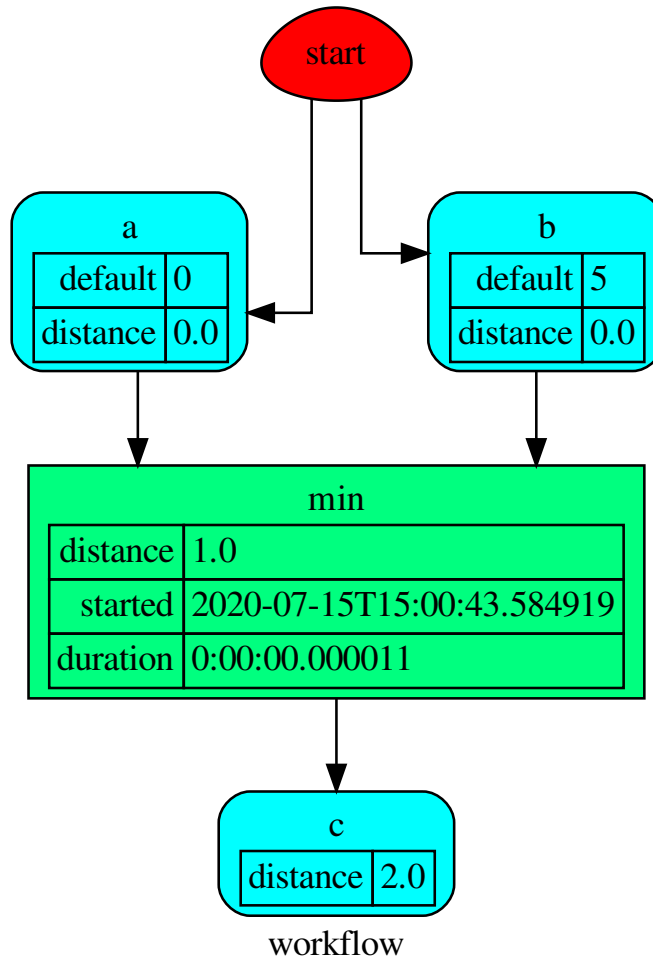
>>> outputs = dsp.dispatch()
>>> outputs
Solution([('a', 0), ('b', 5), ('d', 1), ('c', 0), ('e', 0.0)])
  
```



Dispatch until data node *c* is estimated:

```

>>> outputs = dsp.dispatch(outputs=['c'])
>>> outputs
Solution([('a', 0), ('b', 5), ('c', 0)])
  
```

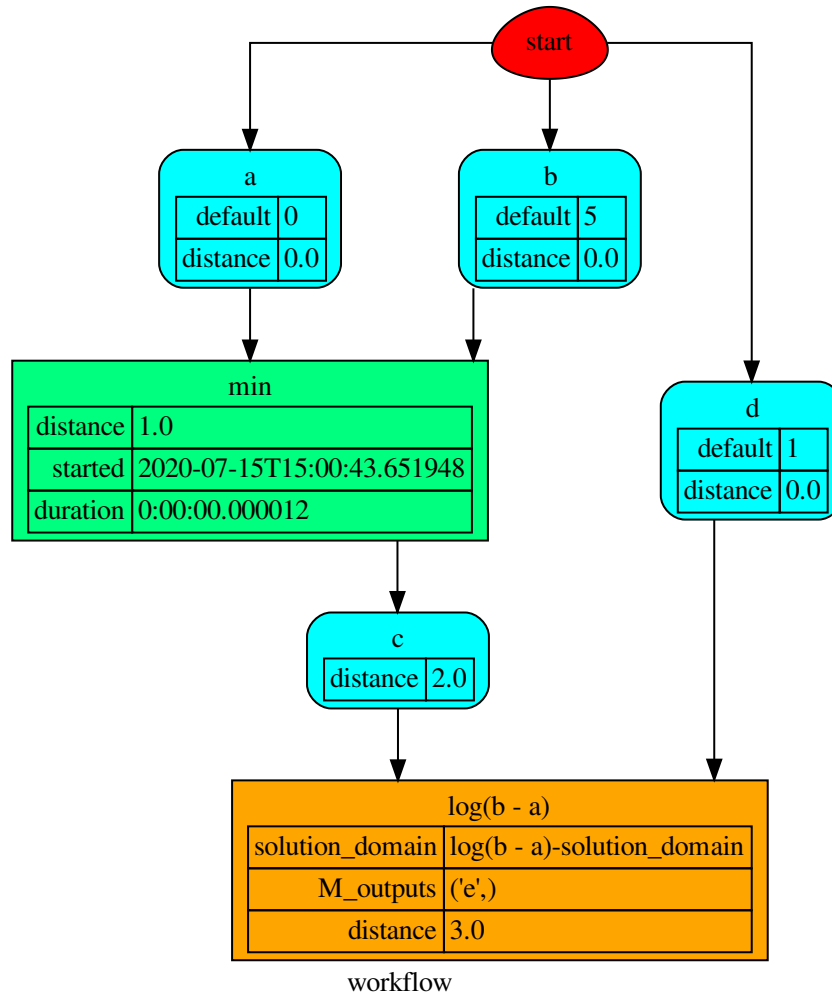


Dispatch with one inputs. The default value of *a* is not used as inputs:

```

>>> outputs = dsp.dispatch(inputs={'a': 3})
>>> outputs
Solution([('a', 3), ('b', 5), ('d', 1), ('c', 3)])
  
```





**shrink\_dsp** (*inputs=None, outputs=None, cutoff=None, inputs\_dist=None, wildcard=True*)  
Returns a reduced dispatcher.

**Parameters**

- **inputs** (*list[str], iterable, optional*) – Input data nodes.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.

**Returns** A sub-dispatcher.

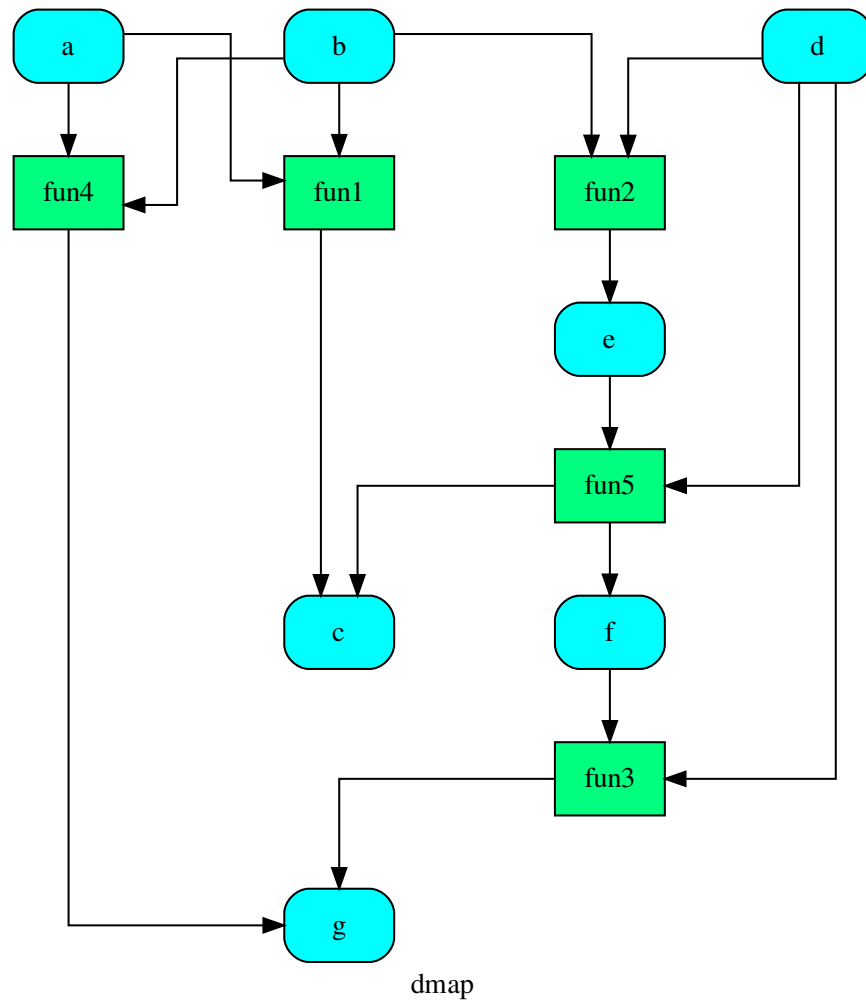
**Return type** *Dispatcher*

See also:

`dispatch()`

Example:

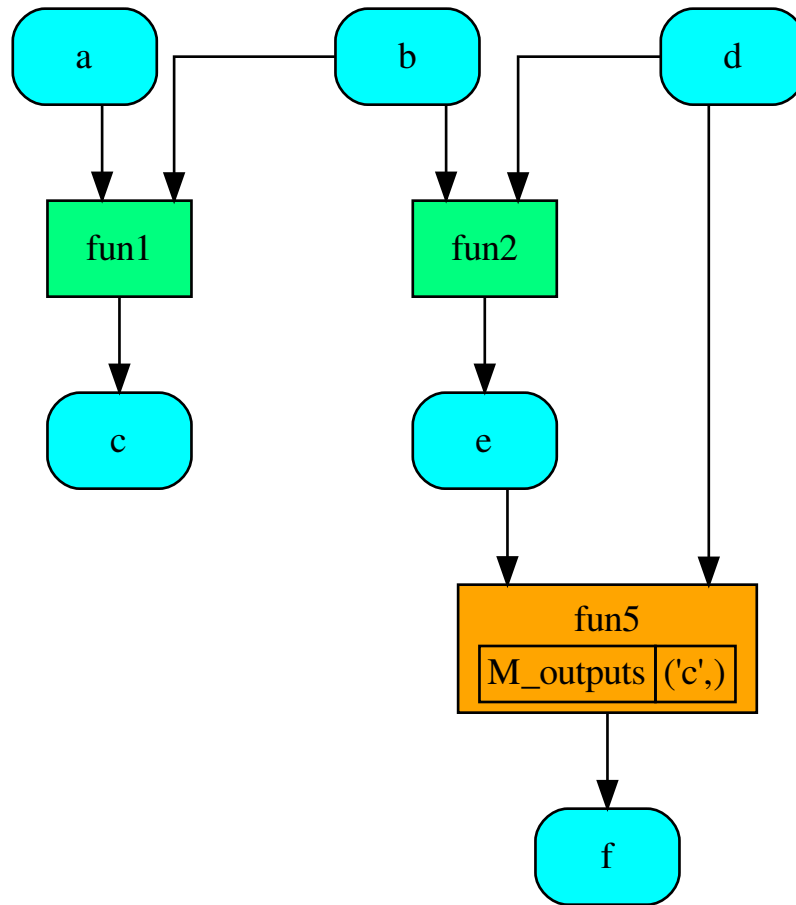
A dispatcher like this:



Get the sub-dispatcher induced by dispatching with no calls from inputs *a*, *b*, and *c* to outputs *c*, *e*, and *f*:

```

>>> shrink_dsp = dsp.shrink_dsp(inputs=['a', 'b', 'd'],
...                               outputs=['c', 'f'])
  
```



dmap

## 7.2 utils

It contains utility classes and functions.

The `utils` module contains classes and functions of general utility used in multiple places throughout *schedula*. Some of these are graph-specific algorithms while others are more python tricks.

The `utils` module is composed of submodules to make organization clearer. The submodules are fairly different from each other, but the main uniting theme is that all of these submodules are not specific to a particularly *schedula* application.

---

**Note:** The `utils` module is composed of submodules that can be accessed separately. However, they are all also included in the base module. Thus, as an example, `schedula.utils.gen.Token` and `schedula.utils.Token` are different names for the same class (`Token`). The `schedula.utils.Token` usage is preferred as this allows the internal organization

to be changed if it is deemed necessary.

---

Sub-Modules:

<i>alg</i>	It contains basic algorithms, numerical tricks, and data processing tasks.
<i>asy</i>	It contains functions to dispatch asynchronously and in parallel.
<i>base</i>	It provides a base class for dispatcher objects.
<i>blue</i>	It provides a Blueprint class to construct a Dispatcher and SubDispatch objects.
<i>cst</i>	It provides constants data node ids and values.
<i>des</i>	It provides tools to find data, function, and sub-dispatcher node description.
<i>drw</i>	It provides functions to plot dispatcher map and workflow.
<i>dsp</i>	It provides tools to create models with the <i>Dispatcher</i> .
<i>exc</i>	Defines the dispatcher exception.
<i>gen</i>	It contains classes and functions of general utility.
<i>graph</i>	It contains the <i>DiGraph</i> class.
<i>imp</i>	Fixes ImportError for MicroPython.
<i>io</i>	It provides functions to read and save a dispatcher from/to files.
<i>sol</i>	It provides a solution class for dispatch result.
<i>web</i>	It provides functions to build a flask app from a dispatcher.

### 7.2.1 alg

It contains basic algorithms, numerical tricks, and data processing tasks.

#### Functions

<i>add_edge_fun</i>	Returns a function that adds an edge to the <i>graph</i> checking only the out node.
<i>add_func_edges</i>	Adds function node edges.
<i>get_full_pipe</i>	Returns the full pipe of a dispatch run.
<i>get_sub_node</i>	Returns a sub node of a dispatcher.
<i>get_unused_node_id</i>	Finds an unused node id in <i>graph</i> .
<i>remove_edge_fun</i>	Returns a function that removes an edge from the <i>graph</i> .

#### add\_edge\_fun

##### add\_edge\_fun(*graph*)

Returns a function that adds an edge to the *graph* checking only the out node.

**Parameters** **graph** (*schedula.utils.graph.DiGraph*) – A directed graph.

**Returns** A function that adds an edge to the *graph*.

**Return type** callable

## add\_func\_edges

**add\_func\_edges** (*dsp, fun\_id, nodes\_bunch, edge\_weights=None, input=True, data\_nodes=None*)

Adds function node edges.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **fun\_id** (*str*) – Function node id.
- **nodes\_bunch** (*iterable*) – A container of nodes which will be iterated through once.
- **edge\_weights** (*dict, optional*) – Edge weights.
- **input** (*bool, optional*) – If True the nodes\_bunch are input nodes, otherwise are output nodes.
- **data\_nodes** (*list*) – Data nodes to be deleted if something fail.

**Returns** List of new data nodes.

**Return type** list

## get\_full\_pipe

**get\_full\_pipe** (*sol, base=()*)

Returns the full pipe of a dispatch run.

### Parameters

- **sol** (*schedula.utils.Solution*) – A Solution object.
- **base** (*tuple[str]*) – Base node id.

**Returns** Full pipe of a dispatch run.

**Return type** *DspPipe*

## get\_sub\_node

**get\_sub\_node** (*dsp, path, node\_attr='auto', solution=None, \_level=0, \_dsp\_name=None*)

Returns a sub node of a dispatcher.

### Parameters

- **dsp** (*schedula.Dispatcher | SubDispatch*) – A dispatcher object or a sub dispatch function.
- **path** (*tuple, str*) – A sequence of node ids or a single node id. Each id identifies a sub-level node.
- **node\_attr** (*str | None*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When 'auto', returns the "default" attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the 'function' attribute.

- **solution** (*schedula.utils.Solution*) – Parent Solution.
- **\_level** (*int*) – Path level.
- **\_dsp\_name** (*str*) – dsp name to show when the function raise a value error.

**Returns** A sub node of a dispatcher and its path.

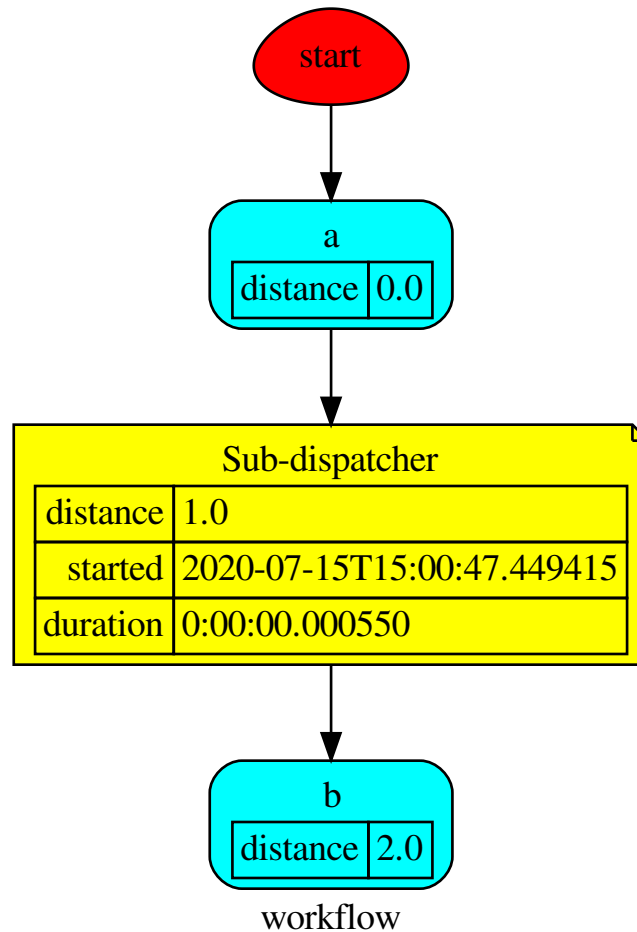
**Return type** dict | object, tuple[str]

**Example:**

```
>>> from schedula import Dispatcher
>>> s_dsp = Dispatcher(name='Sub-dispatcher')
>>> def fun(a, b):
...     return a + b
...
>>> s_dsp.add_function('a + b', fun, ['a', 'b'], ['c'])
'a + b'
>>> dispatch = SubDispatch(s_dsp, ['c'], output_type='dict')
>>> dsp = Dispatcher(name='Dispatcher')
>>> dsp.add_function('Sub-dispatcher', dispatch, ['a'], ['b'])
'Sub-dispatcher'
```

```
>>> o = dsp.dispatch(inputs={'a': {'a': 3, 'b': 1}})
...

```



Get the sub node 'c' output or type:

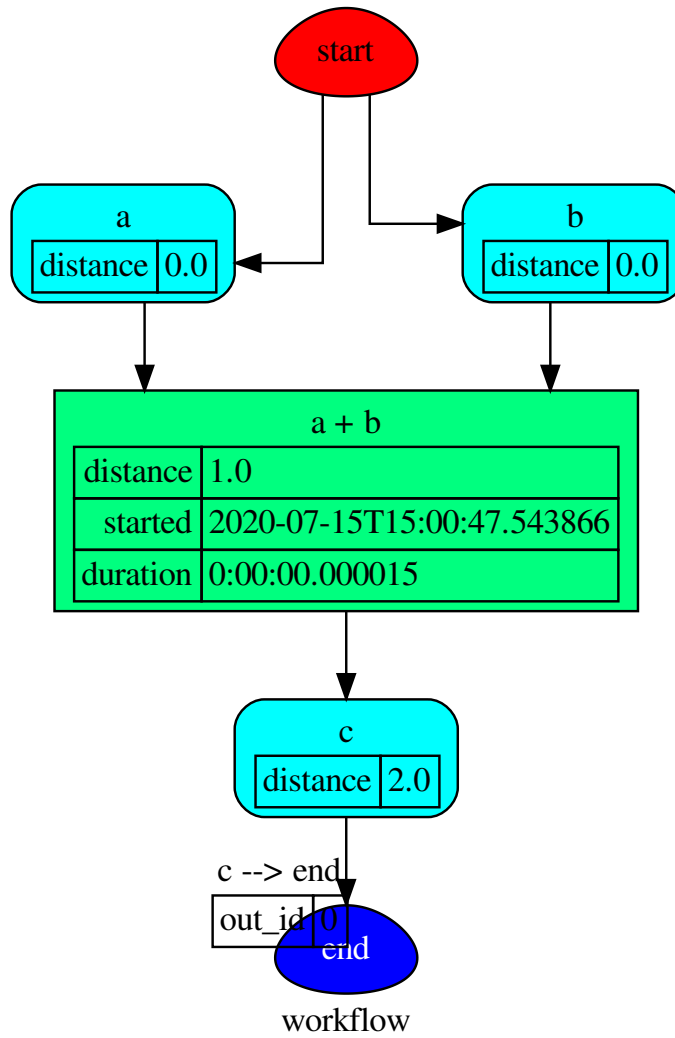
```

>>> get_sub_node(dsp, ('Sub-dispatcher', 'c'))
(4, ('Sub-dispatcher', 'c'))
>>> get_sub_node(dsp, ('Sub-dispatcher', 'c'), node_attr='type')
('data', ('Sub-dispatcher', 'c'))
    
```

Get the sub-dispatcher output:

```

>>> sol, p = get_sub_node(dsp, ('Sub-dispatcher',), node_attr='output')
>>> sol, p
(Solution([(('a', 3), ('b', 1), ('c', 4))], ('Sub-dispatcher',))
    
```



## get\_unused\_node\_id

**get\_unused\_node\_id** (*graph*, *initial\_guess*='unknown', *\_format*='{}<%d>')

Finds an unused node id in *graph*.

### Parameters

- **graph** (`schedula.utils.graph.DiGraph`) – A directed graph.
- **initial\_guess** (*str*, *optional*) – Initial node id guess.
- **\_format** (*str*, *optional*) – Format to generate the new node id if the given is already used.

**Returns** An unused node id.

**Return type** `str`



## remove\_edge\_fun

### remove\_edge\_fun(*graph*)

Returns a function that removes an edge from the *graph*.

..note:: The out node is removed if this is isolate.

**Parameters** **graph** (`schedula.utils.graph.DiGraph`) – A directed graph.

**Returns** A function that remove an edge from the *graph*.

**Return type** callable

## Classes

---

*DspPipe*

---

## DspPipe

**class** DspPipe

### Methods

clear	
copy	
fromkeys	Create a new ordered dictionary with keys from iterable and values set to value.
get	Return the value for key if key is in the dictionary, else default.
items	
keys	
move_to_end	Move an existing element to the end (or beginning if last is false).
pop	value.
popitem	Remove and return a (key, value) pair from the dictionary.
setdefault	Insert key with a value of default if key is not in the dictionary.
update	If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]
values	

### clear

DspPipe.**clear**() → None. Remove all items from od.

### copy

`DspPipe.copy()` → a shallow copy of `od`

### fromkeys

`DspPipe.fromkeys()`  
Create a new ordered dictionary with keys from iterable and values set to value.

### get

`DspPipe.get()`  
Return the value for key if key is in the dictionary, else default.

### items

`DspPipe.items()` → a set-like object providing a view on `D`'s items

### keys

`DspPipe.keys()` → a set-like object providing a view on `D`'s keys

### move\_to\_end

`DspPipe.move_to_end()`  
Move an existing element to the end (or beginning if `last` is false).  
Raise `KeyError` if the element does not exist.

### pop

`DspPipe.pop(k[, d])` → `v`, remove specified key and return the corresponding value. If key is not found, `d` is returned if given, otherwise `KeyError` is raised.

### popitem

`DspPipe.popitem()`  
Remove and return a (key, value) pair from the dictionary.  
Pairs are returned in LIFO order if `last` is true or FIFO order if false.

### setdefault

`DspPipe.setdefault()`  
Insert key with a value of default if key is not in the dictionary.  
Return the value for key if key is in the dictionary, else default.

## update

DspPipe.**update** (*[E]*, *\*\*F*) → None. Update D from dict/iterable E and F.

If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]

## values

DspPipe.**values** () → an object providing a view on D's values

**\_\_init\_\_** ()

Initialize self. See help(type(self)) for accurate signature.

## 7.2.2 asy

It contains functions to dispatch asynchronously and in parallel.

Sub-Modules:

<i>executors</i>	It defines the executors classes.
<i>factory</i>	It defines the <i>ExecutorFactory</i> class.

## executors

It defines the executors classes.

## Classes

<i>Executor</i>	Base Executor
<i>PoolExecutor</i>	General PoolExecutor to dispatch asynchronously and in parallel.
<i>ProcessExecutor</i>	Multi Process Executor
<i>ProcessPoolExecutor</i>	Process Pool Executor
<i>ThreadExecutor</i>	Multi Thread Executor

## Executor

**class Executor**

Base Executor

## Methods

<b>__init__</b>	Initialize self.
shutdown	
submit	

## `__init__`

`Executor.__init__()`  
 Initialize self. See `help(type(self))` for accurate signature.

## `shutdown`

`Executor.shutdown(wait=True)`

## `submit`

`Executor.submit(func, *args, **kwargs)`

`__init__()`  
 Initialize self. See `help(type(self))` for accurate signature.

## PoolExecutor

**class PoolExecutor** (*thread\_executor, process\_executor=None, parallel=None*)  
 General PoolExecutor to dispatch asynchronously and in parallel.

### Methods

---

<code>__init__</code>	<b>param thread_executor</b>
<code>add_future</code>	
<code>get_futures</code>	
<code>process</code>	
<code>process_funcs</code>	
<code>shutdown</code>	
<code>thread</code>	
<code>wait</code>	

## `__init__`

`PoolExecutor.__init__(thread_executor, process_executor=None, parallel=None)`

### Parameters

- **thread\_executor** (`ThreadExecutor`) – Thread pool executor to dispatch asynchronously.
- **process\_executor** (`ProcessExecutor` | `ProcessPoolExecutor`) – Process pool executor to execute in parallel the functions calls.
- **parallel** (`bool`) – Run `_process_funcs` in parallel.

### add\_future

`PoolExecutor.add_future(sol_id, fut)`

### get\_futures

`PoolExecutor.get_futures(sol_id=empty)`

### process

`PoolExecutor.process(sol_id, fn, *args, **kwargs)`

### process\_funcs

`PoolExecutor.process_funcs(exe_id, funcs, *args, **kw)`

### shutdown

`PoolExecutor.shutdown(wait=True)`

### thread

`PoolExecutor.thread(sol_id, *args, **kwargs)`

### wait

`PoolExecutor.wait(timeout=None)`

`__init__(thread_executor, process_executor=None, parallel=None)`

#### Parameters

- **thread\_executor** (`ThreadExecutor`) – Thread pool executor to dispatch asynchronously.
- **process\_executor** (`ProcessExecutor` | `ProcessPoolExecutor`) – Process pool executor to execute in parallel the functions calls.
- **parallel** (`bool`) – Run `_process_funcs` in parallel.

## ProcessExecutor

`class ProcessExecutor(mp_context=None)`

Multi Process Executor

### Methods

<code>__init__</code>	Initialize self.
<code>shutdown</code>	
<code>submit</code>	

### `__init__`

`ProcessExecutor.__init__(mp_context=None)`  
 Initialize self. See `help(type(self))` for accurate signature.

### `shutdown`

`ProcessExecutor.shutdown(wait=True)`

### `submit`

`ProcessExecutor.submit(func, *args, **kwargs)`  
`__init__(mp_context=None)`  
 Initialize self. See `help(type(self))` for accurate signature.

## ProcessPoolExecutor

**class ProcessPoolExecutor** (*max\_workers=None, mp\_context=None, initializer=None, initargs=()*)  
 Process Pool Executor

### Methods

<code>__init__</code>	Initialize self.
<code>shutdown</code>	
<code>submit</code>	

### `__init__`

`ProcessPoolExecutor.__init__(max_workers=None, mp_context=None, initializer=None, initargs=())`  
 Initialize self. See `help(type(self))` for accurate signature.

### `shutdown`

`ProcessPoolExecutor.shutdown(wait=True)`

### `submit`

`ProcessPoolExecutor.submit(func, *args, **kwargs)`  
`__init__(max_workers=None, mp_context=None, initializer=None, initargs=())`  
 Initialize self. See `help(type(self))` for accurate signature.

## ThreadExecutor

**class ThreadExecutor**

Multi Thread Executor

### Methods

<code>__init__</code>	Initialize self.
<code>shutdown</code>	
<code>submit</code>	

### `__init__`

`ThreadExecutor.__init__()`  
Initialize self. See `help(type(self))` for accurate signature.

### `shutdown`

`ThreadExecutor.shutdown(wait=True)`

### `submit`

`ThreadExecutor.submit(func, *args, **kwargs)`

`__init__()`  
Initialize self. See `help(type(self))` for accurate signature.

## factory

It defines the *ExecutorFactory* class.

## Classes

---

*ExecutorFactory*

---

## ExecutorFactory

**class ExecutorFactory** (\*args, \*\*kwargs)

### Methods

<code>__init__</code>	Initialize self.
<code>clear</code>	
<code>copy</code>	
<code>executor_id</code>	

Continued on next page

Table 17 – continued from previous page

fromkeys	Create a new dictionary with keys from iterable and values set to value.
get	Return the value for key if key is in the dictionary, else default.
get_executor	
items	
keys	
pop	If key is not found, d is returned if given, otherwise KeyError is raised
pop_active	
popitem	2-tuple; but raise KeyError if D is empty.
set_active	
set_executor	
setdefault	Insert key with a value of default if key is not in the dictionary.
shutdown_executor	
update	If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]
values	

### `__init__`

`ExecutorFactory.__init__(*args, **kwargs)`  
 Initialize self. See `help(type(self))` for accurate signature.

### `clear`

`ExecutorFactory.clear()` → None. Remove all items from D.

### `copy`

`ExecutorFactory.copy()` → a shallow copy of D

### `executor_id`

**static** `ExecutorFactory.executor_id(name, sol)`

### `fromkeys`

`ExecutorFactory.fromkeys()`  
 Create a new dictionary with keys from iterable and values set to value.



## get

`ExecutorFactory.get()`  
 Return the value for key if key is in the dictionary, else default.

## get\_executor

`ExecutorFactory.get_executor(exe_id)`

## items

`ExecutorFactory.items()` → a set-like object providing a view on D's items

## keys

`ExecutorFactory.keys()` → a set-like object providing a view on D's keys

## pop

`ExecutorFactory.pop(k[, d])` → v, remove specified key and return the corresponding value.  
 If key is not found, d is returned if given, otherwise `KeyError` is raised

## pop\_active

`ExecutorFactory.pop_active(sol_id)`

## popitem

`ExecutorFactory.popitem()` → (k, v), remove and return some (key, value) pair as a 2-tuple; but raise `KeyError` if D is empty.

## set\_active

`ExecutorFactory.set_active(sol_id, value=True)`

## set\_executor

`ExecutorFactory.set_executor(name, value)`

## setdefault

`ExecutorFactory.setdefault()`  
 Insert key with a value of default if key is not in the dictionary.  
 Return the value for key if key is in the dictionary, else default.

### shutdown\_executor

ExecutorFactory.**shutdown\_executor** (*name=empty, sol\_id=empty, wait=True*)

### update

ExecutorFactory.**update** (*[E], \*\*F*) → None. Update D from dict/iterable E and F.

If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]

### values

ExecutorFactory.**values** () → an object providing a view on D's values

**\_\_init\_\_** (\*args, \*\*kwargs)

Initialize self. See help(type(self)) for accurate signature.

## Functions

<i>async_process</i>	Execute <i>func(*args)</i> in an asynchronous parallel process.
<i>async_thread</i>	Execute <i>sol.evaluate_node</i> in an asynchronous thread.
<i>await_result</i>	Return the result of a <i>Future</i> object.
<i>register_executor</i>	Register a new executor type.
<i>shutdown_executor</i>	Clean-up the resources associated with the Executor.
<i>shutdown_executors</i>	Clean-up the resources of all initialized executors.

### async\_process

**async\_process** (*funcs, \*args, executor=False, sol=None, callback=None, \*\*kw*)

Execute *func(\*args)* in an asynchronous parallel process.

#### Parameters

- **funcs** (*list[callable]*) – Functions to be executed.
- **args** (*tuple*) – Arguments to be passed to first function call.
- **executor** (*str | bool*) – Pool executor to run the function.
- **sol** (*schedula.utils.sol.Solution*) – Parent solution.
- **callback** (*callable*) – Callback function to be called after all function execution.
- **kw** (*dict*) – Keywords to be passed to first function call.

**Returns** Functions result.

**Return type** object

## async\_thread

**async\_thread** (*sol, args, node\_attr, node\_id, \*a, \*\*kw*)

Execute *sol.\_evaluate\_node* in an asynchronous thread.

### Parameters

- **sol** (*schedula.utils.sol.Solution*) – Solution to be updated.
- **args** (*tuple*) – Arguments to be passed to node calls.
- **node\_attr** (*dict*) – Dictionary of node attributes.
- **node\_id** (*str*) – Data or function node id.
- **a** (*tuple*) – Extra args to invoke *sol.\_evaluate\_node*.
- **kw** (*dict*) – Extra kwargs to invoke *sol.\_evaluate\_node*.

**Returns** Function result.

**Return type** `concurrent.futures.Future` | `AsyncList`

## await\_result

**await\_result** (*obj, timeout=None*)

Return the result of a *Future* object.

### Parameters

- **obj** (*concurrent.futures.Future* | *object*) – Value object.
- **timeout** (*int*) – The number of seconds to wait for the result if the future isn't done. If None, then there is no limit on the wait time.

**Returns** Result.

**Return type** `object`

Example:

```
>>> from concurrent.futures import Future
>>> fut = Future()
>>> fut.set_result(3)
>>> await_result(fut), await_result(4)
(3, 4)
```

## register\_executor

**register\_executor** (*name, init*)

Register a new executor type.

### Parameters

- **name** (*str*) – Executor name.
- **init** (*callable*) – Function to initialize the executor.

## shutdown\_executor

**shutdown\_executor** (*name=empty, sol\_id=empty, wait=True*)

Clean-up the resources associated with the Executor.

### Parameters

- **name** (*str*) – Executor name.
- **sol\_id** (*int*) – Solution id.
- **wait** (*bool*) – If True then shutdown will not return until all running futures have finished executing and the resources used by the executor have been reclaimed.

**Returns** Shutdown pool executor.

**Return type** dict[concurrent.futures.Future,ThreadProcess]

## shutdown\_executors

**shutdown\_executors** (*wait=True*)

Clean-up the resources of all initialized executors.

**Parameters** **wait** (*bool*) – If True then shutdown will not return until all running futures have finished executing and the resources used by the executors have been reclaimed.

**Returns** Shutdown pool executor.

**Return type** dict[str,dict]

## Classes

---

<i>AsyncList</i>	List of asynchronous results.
------------------	-------------------------------

---

## AsyncList

**class AsyncList** (\*, *future=None, n=1*)

List of asynchronous results.

### Methods

<u><code>__init__</code></u>	Initialize self.
<code>append</code>	Append object to the end of the list.
<code>clear</code>	Remove all items from list.
<code>copy</code>	Return a shallow copy of the list.
<code>count</code>	Return number of occurrences of value.
<code>extend</code>	Extend list by appending elements from the iterable.
<code>index</code>	Return first index of value.
<code>insert</code>	Insert object before index.
<code>pop</code>	Remove and return item at index (default last).
<code>remove</code>	Remove first occurrence of value.
<code>reverse</code>	Reverse <i>IN PLACE</i> .
<code>sort</code>	Stable sort <i>IN PLACE</i> .

### `__init__`

AsyncList.**\_\_init\_\_** (\*, *future=None, n=1*)

Initialize self. See help(type(self)) for accurate signature.

## append

`AsyncList.append()`  
 Append object to the end of the list.

## clear

`AsyncList.clear()`  
 Remove all items from list.

## copy

`AsyncList.copy()`  
 Return a shallow copy of the list.

## count

`AsyncList.count()`  
 Return number of occurrences of value.

## extend

`AsyncList.extend()`  
 Extend list by appending elements from the iterable.

## index

`AsyncList.index()`  
 Return first index of value.  
 Raises `ValueError` if the value is not present.

## insert

`AsyncList.insert()`  
 Insert object before index.

## pop

`AsyncList.pop()`  
 Remove and return item at index (default last).  
 Raises `IndexError` if list is empty or index is out of range.

### remove

`AsyncList.remove()`  
 Remove first occurrence of value.  
 Raises `ValueError` if the value is not present.

### reverse

`AsyncList.reverse()`  
 Reverse *IN PLACE*.

### sort

`AsyncList.sort()`  
 Stable sort *IN PLACE*.  
`__init__(*, future=None, n=1)`  
 Initialize self. See `help(type(self))` for accurate signature.

## 7.2.3 base

It provides a base class for dispatcher objects.

### Classes

<i>Base</i>	Base class for dispatcher objects.
-------------	------------------------------------

### Base

**class Base**  
 Base class for dispatcher objects.

### Methods

<i>get_node</i>	Returns a sub node of a dispatcher.
<i>plot</i>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<i>web</i>	Creates a dispatcher Flask app.

### get\_node

`Base.get_node(*node_ids, node_attr=None)`  
 Returns a sub node of a dispatcher.

#### Parameters

- `node_ids (str)` – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.

- `node_attr(str, None, optional)` – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When ‘auto’, returns the “default” attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the ‘function’ attribute.

When ‘description’, returns the “description” of the searched node, searching also in function or sub-dispatcher input/output description.

When ‘output’, returns the data node output.

When ‘default\_value’, returns the data node default value.

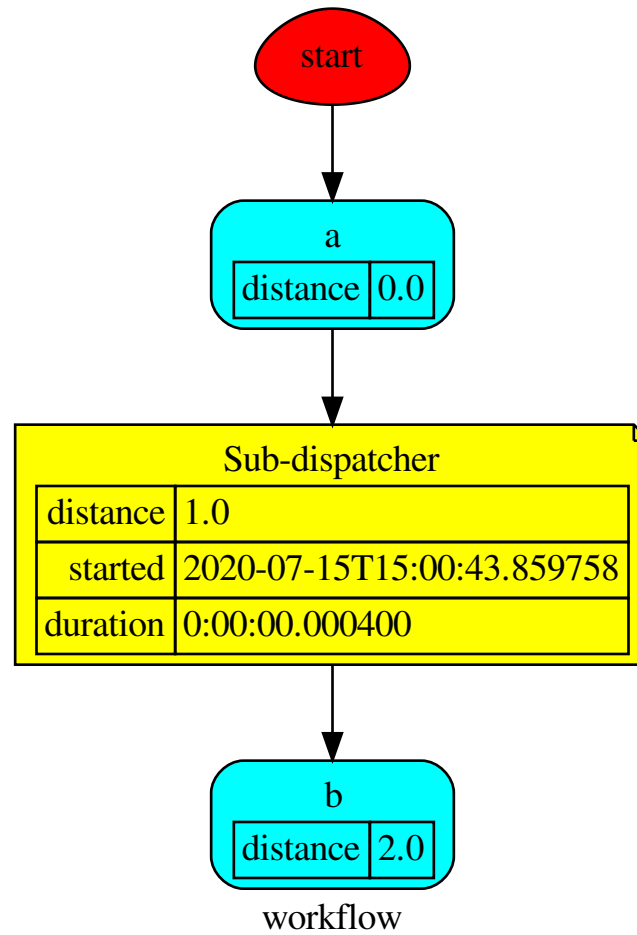
When ‘value\_type’, returns the data node value’s type.

When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

**Example:**

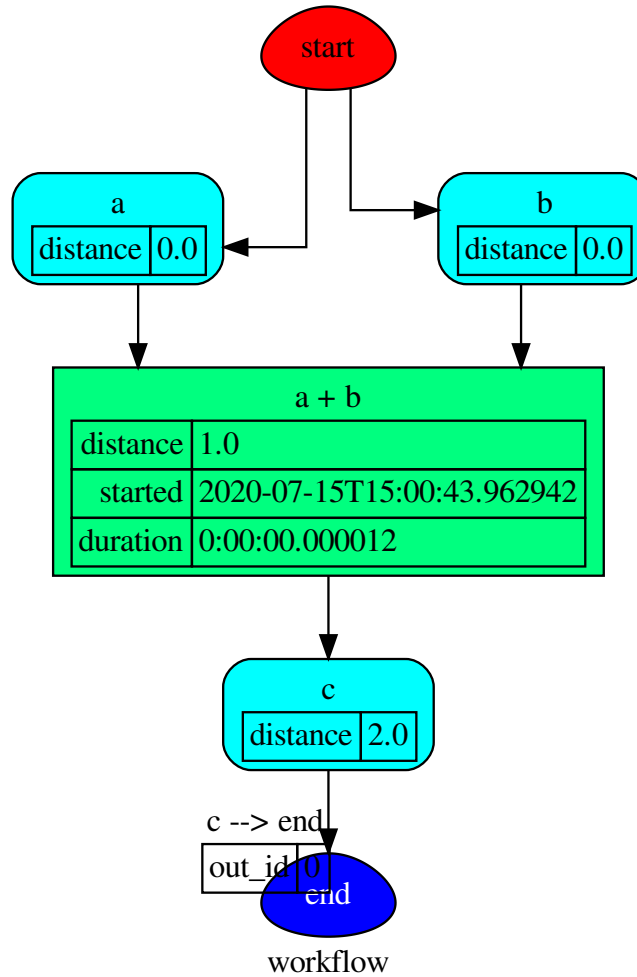


Get the sub node output:

```
>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
```

```
>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
```





## plot

Base.**plot** (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.

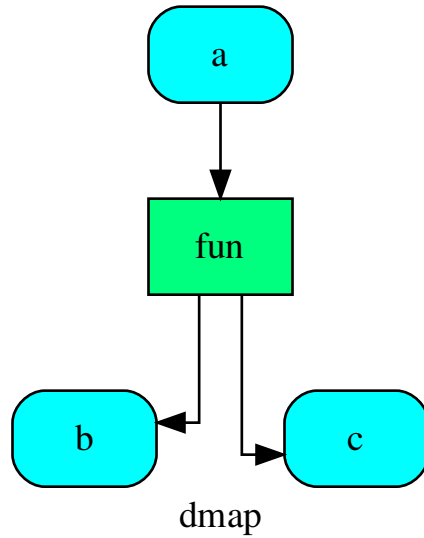
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict, optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool, optional*) – Add the site index as first page?
- **max\_lines** (*int, optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int, optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



## web

Base `.web` (*depth=-1*, *node\_data=None*, *node\_function=None*, *directory=None*, *sites=None*, *run=True*)  
 Creates a dispatcher Flask app.

### Parameters

- **depth** (*int*, *optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str]*, *optional*) – Data node attributes to view.
- **node\_function** (*tuple[str]*, *optional*) – Function node attributes to view.
- **directory** (*str*, *optional*) – Where is the generated Flask app root located?
- **sites** (*set[Site]*, *optional*) – A set of *Site* to maintain alive the backend server.
- **run** (*bool*, *optional*) – Run the backend server?

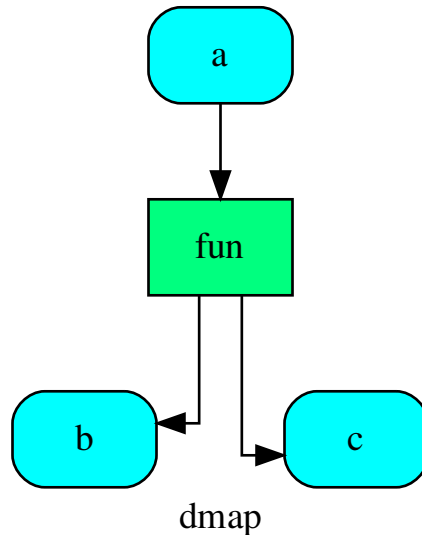
**Returns** A WebMap.

**Return type** *WebMap*

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```
>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
>>> requests.post(url, json={'args': (0,)}).json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
```

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

`__init__()`

Initialize self. See `help(type(self))` for accurate signature.

**web** (*depth=-1, node\_data=None, node\_function=None, directory=None, sites=None, run=True*)  
Creates a dispatcher Flask app.

#### Parameters

- **depth** (*int*, *optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str]*, *optional*) – Data node attributes to view.
- **node\_function** (*tuple[str]*, *optional*) – Function node attributes to view.
- **directory** (*str*, *optional*) – Where is the generated Flask app root located?
- **sites** (*set[Site]*, *optional*) – A set of *Site* to maintain alive the back-end server.
- **run** (*bool*, *optional*) – Run the backend server?

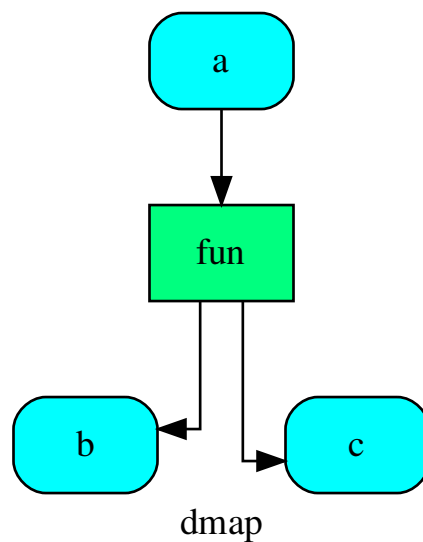
**Returns** A WebMap.

**Return type** *WebMap*

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```

>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
>>> requests.post(url, json={'args': (0,)}).json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True

```

---

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

---

**plot** (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)  
 Plots the Dispatcher with a graph in the DOT language with Graphviz.

#### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all edges.

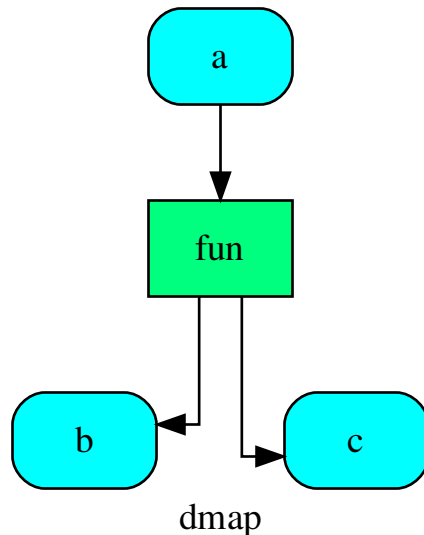
- **body** (*dict, optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool, optional*) – Add the site index as first page?
- **max\_lines** (*int, optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int, optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



**get\_node** (\**node\_ids, node\_attr=None*)  
Returns a sub node of a dispatcher.

### Parameters

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.
- **node\_attr** (*str, None, optional*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When 'auto', returns the "default" attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the 'function' attribute.

When 'description', returns the "description" of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

When 'value\_type', returns the data node value's type.

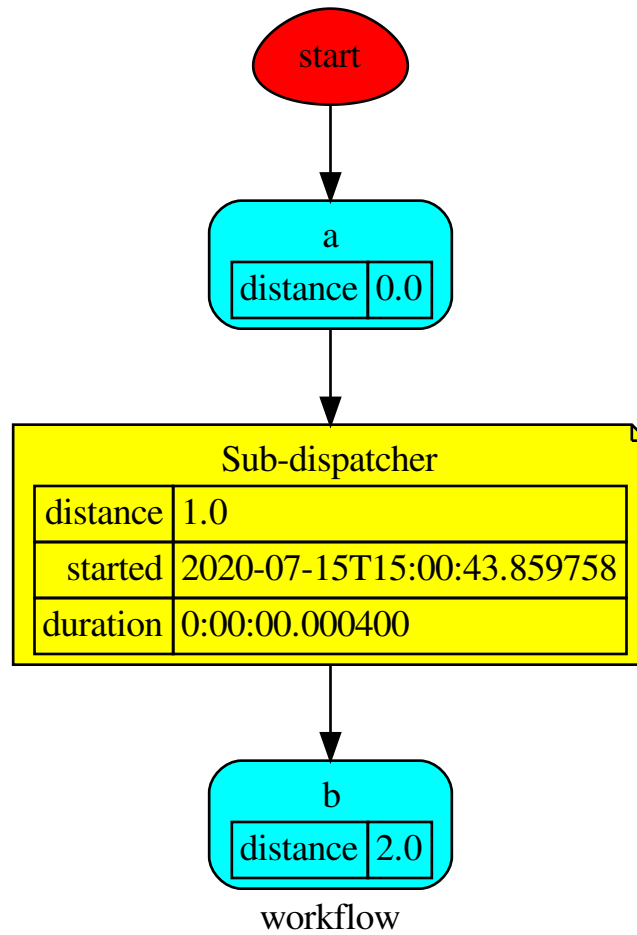
When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (*str*, ..))

**Example:**





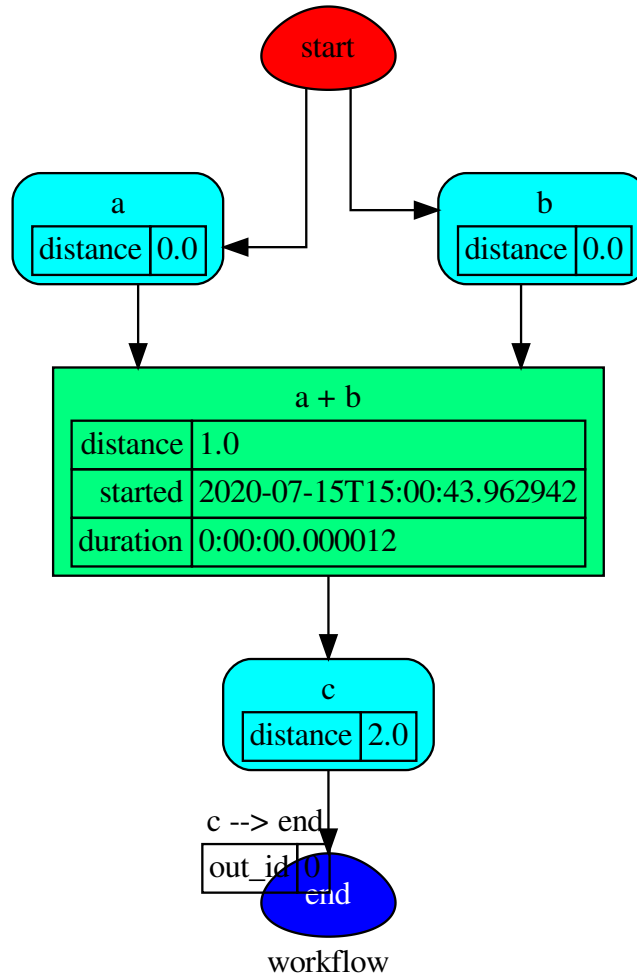
Get the sub node output:

```

>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
  
```

```

>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
  
```



## 7.2.4 blue

It provides a Blueprint class to construct a Dispatcher and SubDispatch objects.

### Classes

<i>BlueDispatcher</i>	Blueprint object is a blueprint of how to construct or extend a Dispatcher.
<i>Blueprint</i>	Base Blueprint class.

## BlueDispatcher

**class BlueDispatcher** (*dmap=None, name="", default\_values=None, raises=False, description="", executor=None*)

Blueprint object is a blueprint of how to construct or extend a Dispatcher.

### Example:

Create a BlueDispatcher:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher(name='Dispatcher')
```

Add data/function/dispatcher nodes to the dispatcher map as usual:

```
>>> blue.add_data(data_id='a', default_value=3)
<schedula.utils.blue.BlueDispatcher object at ...>
>>> @sh.add_function(blue, True, True, outputs=['c'])
... def diff_function(a, b=2):
...     return b - a
...
>>> blue.add_function(function=max, inputs=['c', 'd'], outputs=['e'])
<schedula.utils.blue.BlueDispatcher object at ...>
>>> from math import log
>>> sub_blue = sh.BlueDispatcher(name='Sub-Dispatcher')
>>> sub_blue.add_data(data_id='a', default_value=2).add_function(
...     function=log, inputs=['a'], outputs=['b']
... )
<schedula.utils.blue.BlueDispatcher object at ...>
>>> blue.add_dispatcher(sub_blue, ('a',), {'b': 'f'})
<schedula.utils.blue.BlueDispatcher object at ...>
```

You can set the default values as usual:

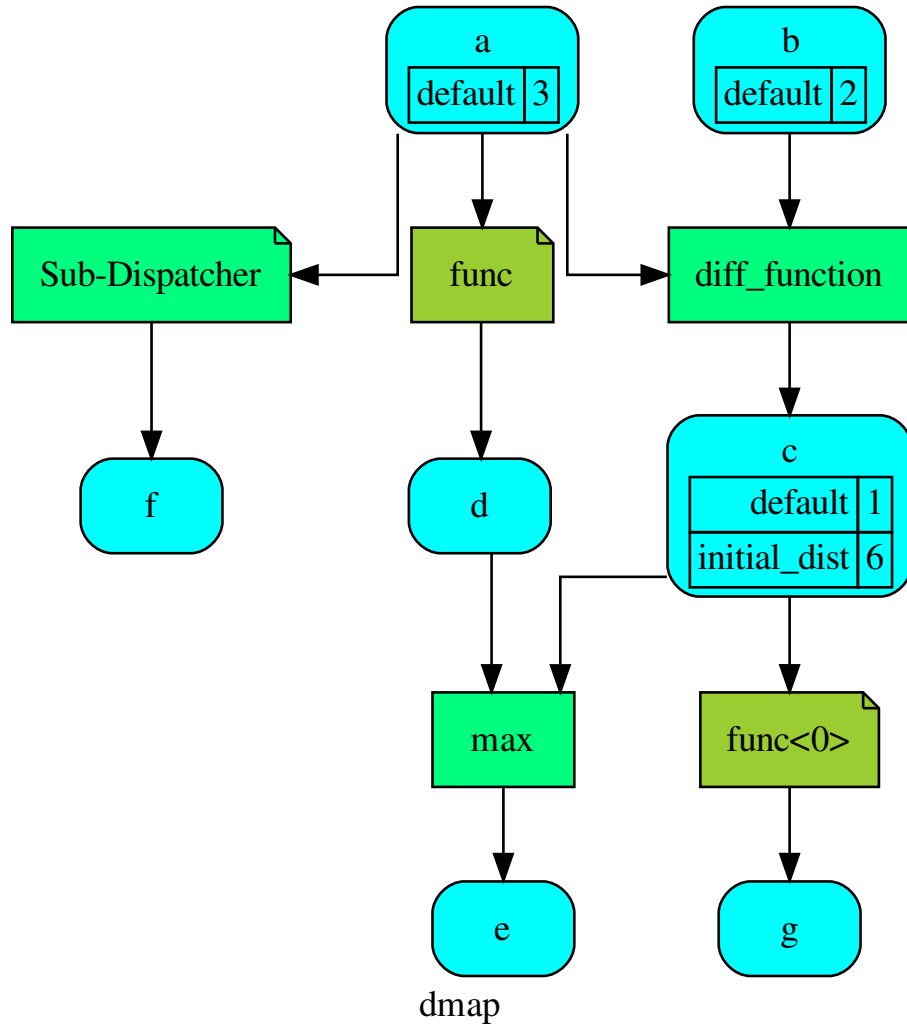
```
>>> blue.set_default_value(data_id='c', value=1, initial_dist=6)
<schedula.utils.blue.BlueDispatcher object at ...>
```

You can also create a *Blueprint* out of *SubDispatchFunction* and add it to the *Dispatcher* as follow:

```
>>> func = sh.SubDispatchFunction(sub_blue, 'func', ['a'], ['b'])
>>> blue.add_from_lists(fun_list=[
...     dict(function=func, inputs=['a'], outputs=['d']),
...     dict(function=func, inputs=['c'], outputs=['g']),
... ])
<schedula.utils.blue.BlueDispatcher object at ...>
```

Finally you can create the dispatcher object using the method *new*:

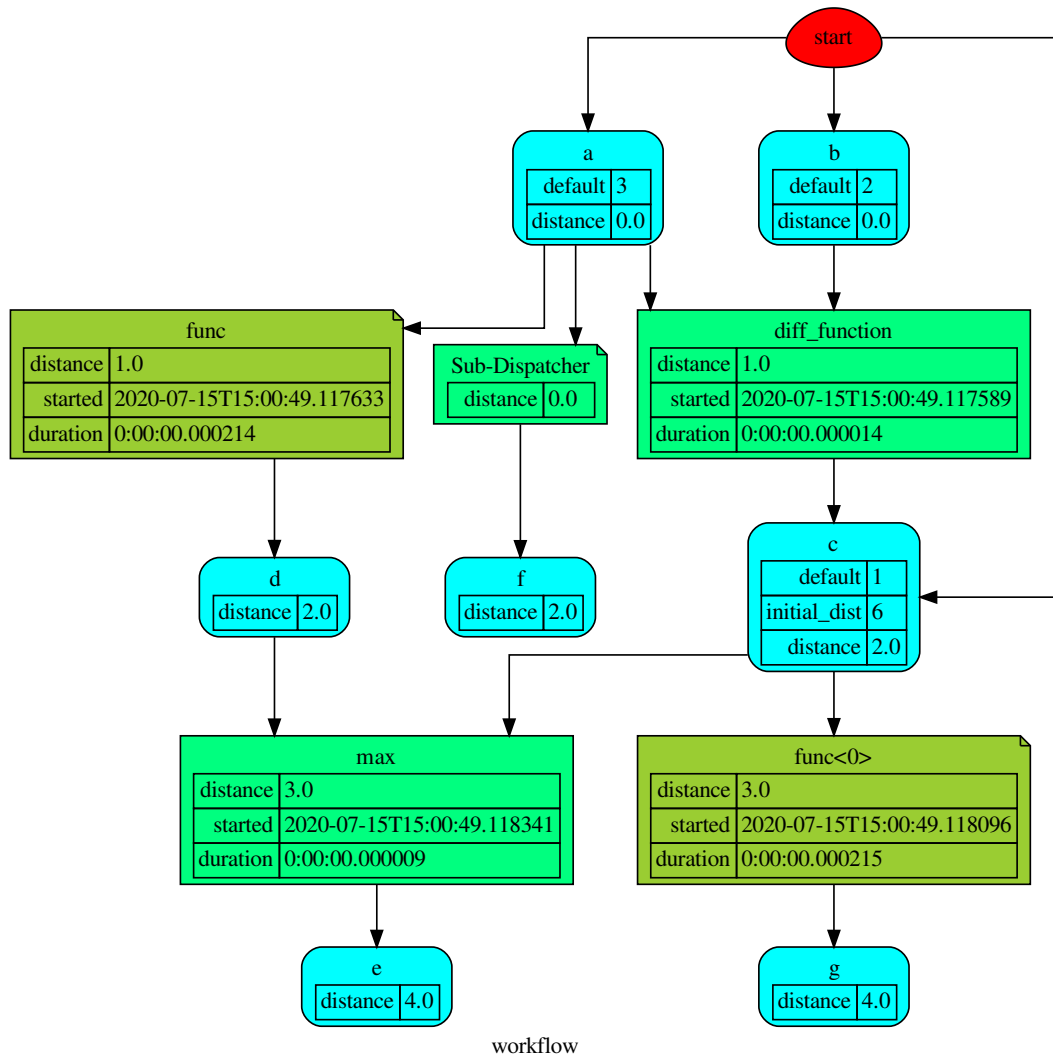
```
>>> dsp = blue.register(memo={}); dsp
<schedula.dispatcher.Dispatcher object at ...>
```



Or dispatch, calling the Blueprint object:

```

>>> sol = blue({'a': 1}); sol
Solution([('a', 1), ('b', 2), ('c', 1), ('d', 0.0),
         ('f', 0.0), ('e', 1), ('g', 0.0)])
  
```



## Methods

<code>__init__</code>	Initialize self.
<code>add_data</code>	Add a single data node to the dispatcher.
<code>add_dispatcher</code>	Add a single sub-dispatcher node to dispatcher.
<code>add_from_lists</code>	Add multiple function and data nodes to dispatcher.
<code>add_func</code>	Add a single function node to dispatcher.
<code>add_function</code>	Add a single function node to dispatcher.
<code>extend</code>	Extends deferred operations calling each operation of given Blueprints.
<code>register</code>	Creates a <code>Blueprint.cls</code> and calls each deferred operation.
<code>set_default_value</code>	Set the default value of a data node in the dispatcher.

## `__init__`

`BlueDispatcher.__init__(dmap=None, name="", default_values=None, raises=False, description="", executor=None)`  
 Initialize self. See `help(type(self))` for accurate signature.

## `add_data`

`BlueDispatcher.add_data(data_id=None, default_value=empty, initial_dist=0.0, wait_inputs=False, wildcard=None, function=None, callback=None, description=None, filters=None, await_result=None, **kwargs)`

Add a single data node to the dispatcher.

### Parameters

- **data\_id** (*str*, *optional*) – Data node id. If `None` will be assigned automatically ('unknown<%d>') not in `dmap`.
- **default\_value** (*T*, *optional*) – Data node default value. This will be used as input if it is not specified as inputs in the `ArciDispatch` algorithm.
- **initial\_dist** (*float*, *int*, *optional*) – Initial distance in the `ArciDispatch` algorithm when the data node default value is used.
- **wait\_inputs** (*bool*, *optional*) – If `True` `ArciDispatch` algorithm stops on the node until it gets all input estimations.
- **wildcard** (*bool*, *optional*) – If `True`, when the data node is used as input and target in the `ArciDispatch` algorithm, the input value will be used as input for the connected functions, but not as output.
- **function** (*callable*, *optional*) – Data node estimation function. This can be any function that takes only one dictionary (key=function node id, value=estimation of data node) as input and return one value that is the estimation of the data node.
- **callback** (*callable*, *optional*) – Callback function to be called after node estimation. This can be any function that takes only one argument that is the data node estimation output. It does not return anything.
- **description** (*str*, *optional*) – Data node's description.
- **filters** (*list[function]*, *optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_result** (*bool|int|float*, *optional*) – If `True` the Dispatcher waits data results before assigning them to the solution. If a number is defined this is used as *timeout* for `Future.result` method [default: `False`]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments*, *optional*) – Set additional node attributes using `key=value`.

**Returns** `Self`.

**Return type** `BlueDispatcher`

## add\_dispatcher

`BlueDispatcher.add_dispatcher(dsp, inputs, outputs, dsp_id=None, input_domain=None, weight=None, inp_weight=None, description=None, include_defaults=False, await_domain=None, **kwargs)`

Add a single sub-dispatcher node to dispatcher.

### Parameters

- **dsp** (*Dispatcher* | *dict[str, list]*) – Child dispatcher that is added as sub-dispatcher node to the parent dispatcher.
- **inputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Inputs mapping. Data node ids from parent dispatcher to child sub-dispatcher.
- **outputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Outputs mapping. Data node ids from child sub-dispatcher to parent dispatcher.
- **dsp\_id** (*str, optional*) – Sub-dispatcher node id. If None will be assigned as `<dsp.name>`.
- **input\_domain** (*(dict) -> bool, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the a dictionary with the inputs of the sub-dispatcher node and returns True if input values satisfy the domain, otherwise False.

---

**Note:** This function is invoked every time that a data node reach the sub-dispatcher node.

---

- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, int | float], optional*) – Edge weights from data nodes to the sub-dispatcher node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Sub-dispatcher node’s description.
- **include\_defaults** (*bool, optional*) – If True the default values of the sub-dispatcher are added to the current dispatcher.
- **await\_domain** (*bool|int|float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Self.

**Return type** *BlueDispatcher*

## add\_from\_lists

`BlueDispatcher.add_from_lists` (*data\_list=None, fun\_list=None, dsp\_list=None*)

Add multiple function and data nodes to dispatcher.

### Parameters

- **data\_list** (*list[dict], optional*) – It is a list of data node kwargs to be loaded.
- **fun\_list** (*list[dict], optional*) – It is a list of function node kwargs to be loaded.
- **dsp\_list** (*list[dict], optional*) – It is a list of sub-dispatcher node kwargs to be loaded.

**Returns** Self.

**Return type** *BlueDispatcher*

## add\_func

`BlueDispatcher.add_func` (*function, outputs=None, weight=None, inputs\_kwargs=False, inputs\_defaults=False, filters=None, input\_domain=None, await\_domain=None, await\_result=None, inp\_weight=None, out\_weight=None, description=None, inputs=None, function\_id=None, \*\*kwargs*)

Add a single function node to dispatcher.

### Parameters

- **inputs\_kwargs** (*bool*) – Do you want to include kwargs as inputs?
- **inputs\_defaults** (*bool*) – Do you want to set default values?
- **function\_id** (*str, optional*) – Function node id. If None will be assigned as `<fun.__name__>`.
- **function** (*callable, optional*) – Data node estimation function.
- **inputs** (*list, optional*) – Ordered arguments (i.e., data node ids) needed by the function. If None it will take parameters names from function signature.
- **outputs** (*list, optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn't pass on the node.
- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int], optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with



the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.

- **description** (*str*, *optional*) – Function node’s description.
- **filters** (*list[function]*, *optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_domain** (*bool|int|float*, *optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool|int|float*, *optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments*, *optional*) – Set additional node attributes using key=value.

**Returns** Self.

**Return type** *BlueDispatcher*

## add\_function

```
BlueDispatcher.add_function(function_id=None, function=None, inputs=None,
                           outputs=None, input_domain=None, weight=None,
                           inp_weight=None, out_weight=None, description=None,
                           filters=None, await_domain=None, await_result=None,
                           **kwargs)
```

Add a single function node to dispatcher.

### Parameters

- **function\_id** (*str*, *optional*) – Function node id. If None will be assigned as <fun.\_\_name\_\_>.
- **function** (*callable*, *optional*) – Data node estimation function.
- **inputs** (*list*, *optional*) – Ordered arguments (i.e., data node ids) needed by the function.
- **outputs** (*list*, *optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable*, *optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn’t pass on the node.
- **weight** (*float*, *int*, *optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int]*, *optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.

- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Function node’s description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_domain** (*bool|int|float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

## extend

`BlueDispatcher.extend(*blues, memo=None)`

Extends deferred operations calling each operation of given Blueprints.

### Parameters

- **blues** (*Blueprint | schedula.dispatcher.Dispatcher*) – Blueprints or Dispatchers to extend deferred operations.
- **memo** (*dict[T, Blueprint]*) – A dictionary to cache Blueprints.

**Returns** Self.

**Return type** *Blueprint*

---

Example:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher()
>>> blue.extend(
...     BlueDispatcher().add_func(len, ['length']),
...     BlueDispatcher().add_func(callable, ['is_callable'])
... )
<schedula.utils.blue.BlueDispatcher object at ...>
```

## register

`BlueDispatcher.register(obj=None, memo=None)`

Creates a *Blueprint.cls* and calls each deferred operation.

### Parameters

- **obj** (*object*) – The initialized object with which to call all deferred operations.

- **memo** (*dict* [*Blueprint*, *T*]) – A dictionary to cache registered Blueprints.

**Returns** The initialized object.

**Return type** *Blueprint.cls* | *Blueprint*

Example:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher().add_func(len, ['length'])
>>> blue.register()
<schedula.dispatcher.Dispatcher object at ...>
```

## set\_default\_value

*BlueDispatcher*.**set\_default\_value** (*data\_id*, *value=empty*, *initial\_dist=0.0*)

Set the default value of a data node in the dispatcher.

### Parameters

- **data\_id** (*str*) – Data node id.
- **value** (*T*, *optional*) – Data node default value.

---

**Note:** If *EMPTY* the previous default value is removed.

---

- **initial\_dist** (*float*, *int*, *optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.

**Returns** *Self*.

**Return type** *BlueDispatcher*

**\_\_init\_\_** (*dmap=None*, *name=""*, *default\_values=None*, *raises=False*, *description=""*, *executor=None*)

Initialize self. See help(type(self)) for accurate signature.

**add\_data** (*data\_id=None*, *default\_value=empty*, *initial\_dist=0.0*, *wait\_inputs=False*, *wildcard=None*, *function=None*, *callback=None*, *description=None*, *filters=None*, *await\_result=None*, *\*\*kwargs*)

Add a single data node to the dispatcher.

### Parameters

- **data\_id** (*str*, *optional*) – Data node id. If *None* will be assigned automatically ('unknown<%d>') not in *dmap*.
- **default\_value** (*T*, *optional*) – Data node default value. This will be used as input if it is not specified as inputs in the ArciDispatch algorithm.
- **initial\_dist** (*float*, *int*, *optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.
- **wait\_inputs** (*bool*, *optional*) – If *True* ArciDispatch algorithm stops on the node until it gets all input estimations.
- **wildcard** (*bool*, *optional*) – If *True*, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.

- **function** (*callable, optional*) – Data node estimation function. This can be any function that takes only one dictionary (key=function node id, value=estimation of data node) as input and return one value that is the estimation of the data node.
- **callback** (*callable, optional*) – Callback function to be called after node estimation. This can be any function that takes only one argument that is the data node estimation output. It does not return anything.
- **description** (*str, optional*) – Data node’s description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits data results before assigning them to the solution. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Self.

**Return type** *BlueDispatcher*

**add\_function** (*function\_id=None, function=None, inputs=None, outputs=None, input\_domain=None, weight=None, inp\_weight=None, out\_weight=None, description=None, filters=None, await\_domain=None, await\_result=None, \*\*kwargs*)  
Add a single function node to dispatcher.

**Parameters**

- **function\_id** (*str, optional*) – Function node id. If None will be assigned as <fun.\_\_name\_\_>.
- **function** (*callable, optional*) – Data node estimation function.
- **inputs** (*list, optional*) – Ordered arguments (i.e., data node ids) needed by the function.
- **outputs** (*list, optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn’t pass on the node.
- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int], optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Function node’s description.

- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.
- **await\_domain** (*bool|int|float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool|int|float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**add\_func** (*function, outputs=None, weight=None, inputs\_kwargs=False, inputs\_defaults=False, filters=None, input\_domain=None, await\_domain=None, await\_result=None, inp\_weight=None, out\_weight=None, description=None, inputs=None, function\_id=None, \*\*kwargs*)

Add a single function node to dispatcher.

#### Parameters

- **inputs\_kwargs** (*bool*) – Do you want to include kwargs as inputs?
- **inputs\_defaults** (*bool*) – Do you want to set default values?
- **function\_id** (*str, optional*) – Function node id. If None will be assigned as <fun.\_\_name\_\_>.
- **function** (*callable, optional*) – Data node estimation function.
- **inputs** (*list, optional*) – Ordered arguments (i.e., data node ids) needed by the function. If None it will take parameters names from function signature.
- **outputs** (*list, optional*) – Ordered results (i.e., data node ids) returned by the function.
- **input\_domain** (*callable, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the same inputs of the function and returns True if input values satisfy the domain, otherwise False. In this case the dispatch algorithm doesn't pass on the node.
- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, float | int], optional*) – Edge weights from data nodes to the function node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **out\_weight** (*dict[str, float | int], optional*) – Edge weights from the function node to data nodes. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Function node's description.
- **filters** (*list[function], optional*) – A list of functions that are invoked after the invocation of the main function.

- **await\_domain** (*bool/int/float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.
- **await\_result** (*bool/int/float, optional*) – If True the Dispatcher waits output results before assigning them to the workflow. If a number is defined this is used as *timeout* for *Future.result* method [default: False]. Note this is used when asynchronous or parallel execution is enable.
- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Self.

**Return type** *BlueDispatcher*

**add\_dispatcher** (*dsp, inputs, outputs, dsp\_id=None, input\_domain=None, weight=None, inp\_weight=None, description=None, include\_defaults=False, await\_domain=None, \*\*kwargs*)

Add a single sub-dispatcher node to dispatcher.

**Parameters**

- **dsp** (*Dispatcher | dict[str, list]*) – Child dispatcher that is added as sub-dispatcher node to the parent dispatcher.
- **inputs** (*dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]])*) – Inputs mapping. Data node ids from parent dispatcher to child sub-dispatcher.
- **outputs** (*(dict[str, str | list[str]] | tuple[str] | (str, .., dict[str, str | list[str]))*) – Outputs mapping. Data node ids from child sub-dispatcher to parent dispatcher.
- **dsp\_id** (*str, optional*) – Sub-dispatcher node id. If None will be assigned as <dsp.name>.
- **input\_domain** (*(dict) -> bool, optional*) – A function that checks if input values satisfy the function domain. This can be any function that takes the a dictionary with the inputs of the sub-dispatcher node and returns True if input values satisfy the domain, otherwise False.

---

**Note:** This function is invoked every time that a data node reach the sub-dispatcher node.

---

- **weight** (*float, int, optional*) – Node weight. It is a weight coefficient that is used by the dispatch algorithm to estimate the minimum workflow.
- **inp\_weight** (*dict[str, int | float], optional*) – Edge weights from data nodes to the sub-dispatcher node. It is a dictionary (key=data node id) with the weight coefficients used by the dispatch algorithm to estimate the minimum workflow.
- **description** (*str, optional*) – Sub-dispatcher node’s description.
- **include\_defaults** (*bool, optional*) – If True the default values of the sub-dispatcher are added to the current dispatcher.
- **await\_domain** (*bool/int/float, optional*) – If True the Dispatcher waits all input results before executing the *input\_domain* function. If a number is

defined this is used as *timeout* for *Future.result* method [default: True]. Note this is used when asynchronous or parallel execution is enable.

- **kwargs** (*keyword arguments, optional*) – Set additional node attributes using key=value.

**Returns** Self.

**Return type** *BlueDispatcher*

**add\_from\_lists** (*data\_list=None, fun\_list=None, dsp\_list=None*)

Add multiple function and data nodes to dispatcher.

**Parameters**

- **data\_list** (*list[dict], optional*) – It is a list of data node kwargs to be loaded.
- **fun\_list** (*list[dict], optional*) – It is a list of function node kwargs to be loaded.
- **dsp\_list** (*list[dict], optional*) – It is a list of sub-dispatcher node kwargs to be loaded.

**Returns** Self.

**Return type** *BlueDispatcher*

**set\_default\_value** (*data\_id, value=empty, initial\_dist=0.0*)

Set the default value of a data node in the dispatcher.

**Parameters**

- **data\_id** (*str*) – Data node id.
- **value** (*T, optional*) – Data node default value.

---

**Note:** If *EMPTY* the previous default value is removed.

---

- **initial\_dist** (*float, int, optional*) – Initial distance in the ArciDispatch algorithm when the data node default value is used.

**Returns** Self.

**Return type** *BlueDispatcher*

## Blueprint

**class Blueprint** (*\*args, \*\*kwargs*)

Base Blueprint class.

### Methods

<code>__init__</code>	Initialize self.
<code>extend</code>	Extends deferred operations calling each operation of given Blueprints.
<code>register</code>	Creates a <i>Blueprint.cls</i> and calls each deferred operation.

## `__init__`

`Blueprint.__init__(*args, **kwargs)`  
 Initialize self. See `help(type(self))` for accurate signature.

## `extend`

`Blueprint.extend(*blues, memo=None)`  
 Extends deferred operations calling each operation of given Blueprints.

### Parameters

- **blues** (*Blueprint | schedula.dispatcher.Dispatcher*) – Blueprints or Dispatchers to extend deferred operations.
- **memo** (*dict[T, Blueprint]*) – A dictionary to cache Blueprints.

**Returns** Self.

**Return type** *Blueprint*

---

Example:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher()
>>> blue.extend(
...     BlueDispatcher().add_func(len, ['length']),
...     BlueDispatcher().add_func(callable, ['is_callable'])
... )
<schedula.utils.blue.BlueDispatcher object at ...>
```

## `register`

`Blueprint.register(obj=None, memo=None)`  
 Creates a `Blueprint.cls` and calls each deferred operation.

### Parameters

- **obj** (*object*) – The initialized object with which to call all deferred operations.
- **memo** (*dict[Blueprint, T]*) – A dictionary to cache registered Blueprints.

**Returns** The initialized object.

**Return type** *Blueprint.cls | Blueprint*

---

Example:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher().add_func(len, ['length'])
>>> blue.register()
<schedula.dispatcher.Dispatcher object at ...>
```

`__init__(*args, **kwargs)`  
 Initialize self. See `help(type(self))` for accurate signature.



**cls**

alias of `schedula.dispatcher.Dispatcher`

**register** (*obj=None, memo=None*)

Creates a `Blueprint.cls` and calls each deferred operation.

**Parameters**

- **obj** (*object*) – The initialized object with which to call all deferred operations.
- **memo** (*dict [Blueprint, T]*) – A dictionary to cache registered Blueprints.

**Returns** The initialized object.

**Return type** `Blueprint.cls | Blueprint`

Example:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher().add_func(len, ['length'])
>>> blue.register()
<schedula.dispatcher.Dispatcher object at ...>
```

**extend** (*\*blues, memo=None*)

Extends deferred operations calling each operation of given Blueprints.

**Parameters**

- **blues** (*Blueprint | schedula.dispatcher.Dispatcher*) – Blueprints or Dispatchers to extend deferred operations.
- **memo** (*dict [T, Blueprint]*) – A dictionary to cache Blueprints.

**Returns** Self.

**Return type** `Blueprint`

Example:

```
>>> import schedula as sh
>>> blue = sh.BlueDispatcher()
>>> blue.extend(
...     BlueDispatcher().add_func(len, ['length']),
...     BlueDispatcher().add_func(callable, ['is_callable'])
... )
<schedula.utils.blue.BlueDispatcher object at ...>
```

## 7.2.5 cst

It provides constants data node ids and values.

**EMPTY = empty**

It is used set and unset empty values.

**See also:**

`set_default_value()`

**START = start**

Starting node that identifies initial inputs of the workflow.

**See also:**

*dispatch()*

**NONE = none**

Fake value used to set a default value to call functions without arguments.

**See also:**

*add\_function()*

**SINK = sink**

Sink node of the dispatcher that collects all unused outputs.

**See also:**

*add\_data(), add\_func(), add\_function(), add\_dispatcher()*

**END = end**

Ending node of SubDispatcherFunction.

**See also:**

*SubDispatchFunction*

**SELF = self**

Self node of the dispatcher, it is a node that contains the dispatcher.

**PLOT = plot**

Plot node, it is a node that plot the dispatcher solution. .. note:: you can pass the *kwargs* of *\_DspPlot* ..  
seealso:: *add\_data(), add\_func(), add\_function(), add\_dispatcher()*

## 7.2.6 des

It provides tools to find data, function, and sub-dispatcher node description.

### Functions

---

*get\_attr\_doc*

---

*get\_link*

---

*get\_summary*

---

*search\_node\_description*

---

#### **get\_attr\_doc**

**get\_attr\_doc** (*doc, attr\_name, get\_param=True, what='description'*)

#### **get\_link**

**get\_link** (*\*items*)

## get\_summary

**get\_summary** (*doc*)

## search\_node\_description

**search\_node\_description** (*node\_id, node\_attr, dsp, what='description'*)

## 7.2.7 drw

It provides functions to plot dispatcher map and workflow.

Sub-Modules:

<i>nodes</i>	It provides docutils nodes to plot dispatcher map and workflow.
--------------	---

## nodes

It provides docutils nodes to plot dispatcher map and workflow.

## Functions

<i>autoplot_callback</i>
<i>autoplot_function</i>
<i>basic_app</i>
<i>before_request</i>
<i>cached_view</i>
<i>jinjja2_format</i>
<i>render_output</i>
<i>run_server</i>
<i>site_view</i>
<i>uncpath</i>
<i>update_filenames</i>
<i>valid_filename</i>

## autoplot\_callback

**autoplot\_callback** (*res*)

## autoplot\_function

**autoplot\_function** (*kwargs*)

## basic\_app

**basic\_app** (*root\_path, cleanup=None, shutdown=None, mute=True, \*\*kwargs*)

### **before\_request**

**before\_request** (*mute*)

### **cached\_view**

**cached\_view** (*node, directory, context, rendered*)

### **jinja2\_format**

**jinja2\_format** (*source, context=None, \*\*kw*)

### **render\_output**

**render\_output** (*out, pformat*)

### **run\_server**

**run\_server** (*app, options*)

### **site\_view**

**site\_view** (*app, node, context, generated\_files, rendered, extra=None*)

### **uncpath**

**uncpath** (*p*)

### **update\_filenames**

**update\_filenames** (*node, filenames*)

### **valid\_filename**

**valid\_filename** (*item, filenames, ext=None*)

### **Classes**

---

*FolderNode*

---

*Site*

---

*SiteFolder*

---

*SiteIndex*

---

*SiteMap*

---

*SiteNode*

---

## FolderNode

**class FolderNode** (*folder, node\_id, attr, \*\*options*)

### Methods

<code>__init__</code>	Initialize self.
<code>dot</code>	
<code>href</code>	
<code>items</code>	
<code>parent_ref</code>	
<code>render_funcs</code>	
<code>render_size</code>	
<code>style</code>	
<code>yield_attr</code>	

### `__init__`

FolderNode.**\_\_init\_\_** (*folder, node\_id, attr, \*\*options*)  
 Initialize self. See help(type(self)) for accurate signature.

### `dot`

FolderNode.**dot** (*context=None*)

### `href`

FolderNode.**href** (*context, link\_id*)

### `items`

FolderNode.**items** ()

### `parent_ref`

FolderNode.**parent\_ref** (*context, node\_id, attr=None*)

### `render_funcs`

FolderNode.**render\_funcs** ()

### `render_size`

FolderNode.**render\_size** (*out*)

## style

FolderNode.**style**()

## yield\_attr

FolderNode.**yield\_attr**(*name*)

**\_\_init\_\_**(*folder, node\_id, attr, \*\*options*)

Initialize self. See help(type(self)) for accurate signature.

## Attributes

---

*counter*

---

edge\_data

---

max\_lines

---

max\_width

---

node\_data

---

node\_function

---

node\_map

---

node\_styles

---

re\_node

---

title

---

type

---

## counter

FolderNode.**counter** = <method-wrapper '\_\_next\_\_' of itertools.count object>

## edge\_data

FolderNode.**edge\_data** = ('?', '+wildcard', 'inp\_id', 'out\_id', 'weight')

## max\_lines

FolderNode.**max\_lines** = 5

## max\_width

FolderNode.**max\_width** = 200

## node\_data

FolderNode.**node\_data** = ('-', '.tooltip', '!default\_values', 'wait\_inputs', 'await\_resu...

### node\_function

```
FolderNode.node_function = ('-', '.tooltip', 'await_domain', 'await_result', '+input_d
```

### node\_map

```
FolderNode.node_map = {'': ('dot', 'table'), '!': ('dot', 'table'), '*': ('link',),
```

### node\_styles

```
FolderNode.node_styles = {'error': {empty: {'fillcolor': 'gray', 'label': 'empty',
```

### re\_node

```
FolderNode.re_node = regex.Regex('^([\.*+!]?)([\\w ]+)(?>\\|([\\w ]+)?$', flags=regex.
```

### title

```
FolderNode.title
```

### type

```
FolderNode.type
```

```
counter = <method-wrapper '__next__' of itertools.count object>
```

## Site

```
class Site (sitemap, host='localhost', port=0, delay=0.1, until=30, run_options=None, **kwargs)
```

### Methods

<code>__init__</code>	Initialize self.
<code>app</code>	
<code>get_port</code>	
<code>run</code>	
<code>shutdown_site</code>	
<code>wait_server</code>	

### `__init__`

```
Site.__init__(sitemap, host='localhost', port=0, delay=0.1, until=30, run_options=None,
              **kwargs)
```

Initialize self. See help(type(self)) for accurate signature.

## app

`Site.app()`

## get\_port

`Site.get_port (host=None, port=None, **kw)`

## run

`Site.run (**options)`

## shutdown\_site

`static Site.shutdown_site (url)`

## wait\_server

`Site.wait_server (elapsed=0)`

`__init__ (sitemap, host='localhost', port=0, delay=0.1, until=30, run_options=None, **kwargs)`  
Initialize self. See help(type(self)) for accurate signature.

## Attributes

---

`is_running`

---

`url`

---

## is\_running

`Site.is_running`

## url

`Site.url`

## SiteFolder

`class SiteFolder (item, dsp, graph, obj, name="", workflow=False, digraph=None, parent=None, **options)`

## Methods

---

`__init__`

Initialize self.

---

Continued on next page



Table 34 – continued from previous page

---

dot
view

---

### **`__init__`**

SiteFolder.**`__init__`**(*item, dsp, graph, obj, name="*, *workflow=False, digraph=None, parent=None, \*\*options*)  
 Initialize self. See help(type(self)) for accurate signature.

### **dot**

SiteFolder.**dot** (*context=None*)

### **view**

SiteFolder.**view** (*filepath, context=None*)

**`__init__`** (*item, dsp, graph, obj, name="*, *workflow=False, digraph=None, parent=None, \*\*options*)  
 Initialize self. See help(type(self)) for accurate signature.

### **Attributes**

---

<i>counter</i>
digraph
ext
filename
inputs
label_name
name
outputs
title
view_id

---

### **counter**

SiteFolder.**counter** = <method-wrapper '`__next__`' of `itertools.count` object>

### **digraph**

SiteFolder.**digraph** = {'body': {'splines': 'ortho', 'style': 'filled'}, 'edge\_attr':

### **ext**

SiteFolder.**ext** = 'html'

### filename

SiteFolder.**filename**

### inputs

SiteFolder.**inputs**

### label\_name

SiteFolder.**label\_name**

### name

SiteFolder.**name**

### outputs

SiteFolder.**outputs**

### title

SiteFolder.**title**

### view\_id

SiteFolder.**view\_id**

**counter** = <method-wrapper '\_\_next\_\_' of itertools.count object>

## SiteIndex

**class SiteIndex** (*sitemap*, *node\_id='index'*)

### Methods

---

<code>__init__</code>	Initialize self.
<code>legend</code>	
<code>render</code>	
<code>view</code>	

---

### `__init__`

SiteIndex.**\_\_init\_\_** (*sitemap*, *node\_id='index'*)  
Initialize self. See help(type(self)) for accurate signature.

## legend

`static SiteIndex.legend()`

## render

`SiteIndex.render(context, *args, **kwargs)`

## view

`SiteIndex.view(filepath, *args, **kwargs)`

`__init__(sitemap, node_id='index')`

Initialize self. See help(type(self)) for accurate signature.

## Attributes

---

counter

---

ext

---

filename

---

name

---

title

---

view\_id

---

### counter

`SiteIndex.counter = <method-wrapper '__next__' of itertools.count object>`

### ext

`SiteIndex.ext = 'html'`

### filename

`SiteIndex.filename`

### name

`SiteIndex.name`

### title

`SiteIndex.title`

## view\_id

SiteIndex.view\_id

## SiteMap

class SiteMap

### Methods

<code>__init__</code>	Initialize self.
<code>add_items</code>	
<code>app</code>	
<code>clear</code>	
<code>copy</code>	
<code>fromkeys</code>	Create a new ordered dictionary with keys from iterable and values set to value.
<code>get</code>	Return the value for key if key is in the dictionary, else default.
<code>get_dsp_from</code>	
<code>get_sol_from</code>	
<code>items</code>	
<code>keys</code>	
<code>move_to_end</code>	Move an existing element to the end (or beginning if last is false).
<code>pop</code>	value.
<code>popitem</code>	Remove and return a (key, value) pair from the dictionary.
<code>render</code>	
<code>rules</code>	
<code>setdefault</code>	Insert key with a value of default if key is not in the dictionary.
<code>site</code>	
<code>update</code>	If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]
<code>values</code>	

### `__init__`

SiteMap.`__init__`()  
 Initialize self. See help(type(self)) for accurate signature.

### `add_items`

SiteMap.`add_items` (*item*, *workflow=False*, *depth=-1*, *folder=None*, *\*\*options*)

### app

SiteMap.**app** (*root\_path=None, depth=-1, index=True, mute=True, \*\*kw*)

### clear

SiteMap.**clear** () → None. Remove all items from od.

### copy

SiteMap.**copy** () → a shallow copy of od

### fromkeys

SiteMap.**fromkeys** ()  
 Create a new ordered dictionary with keys from iterable and values set to value.

### get

SiteMap.**get** ()  
 Return the value for key if key is in the dictionary, else default.

### get\_dsp\_from

**static** SiteMap.**get\_dsp\_from** (*item*)

### get\_sol\_from

**static** SiteMap.**get\_sol\_from** (*item*)

### items

SiteMap.**items** () → a set-like object providing a view on D's items

### keys

SiteMap.**keys** () → a set-like object providing a view on D's keys

### move\_to\_end

SiteMap.**move\_to\_end** ()  
 Move an existing element to the end (or beginning if last is false).  
 Raise KeyError if the element does not exist.

## pop

`SiteMap.pop(k[, d])` → *v*, remove specified key and return the corresponding value. If key is not found, *d* is returned if given, otherwise `KeyError` is raised.

## popitem

`SiteMap.popitem()`  
 Remove and return a (key, value) pair from the dictionary.  
 Pairs are returned in LIFO order if `last` is true or FIFO order if false.

## render

`SiteMap.render(depth=-1, directory='static', view=False, index=True)`

## rules

`SiteMap.rules(depth=-1, index=True)`

## setdefault

`SiteMap.setdefault()`  
 Insert key with a value of default if key is not in the dictionary.  
 Return the value for key if key is in the dictionary, else default.

## site

`SiteMap.site(root_path=None, depth=-1, index=True, view=False, **kw)`

## update

`SiteMap.update([E], **F)` → None. Update D from dict/iterable E and F.  
 If E is present and has a `.keys()` method, then does: for *k* in E: `D[k] = E[k]` If E is present and lacks a `.keys()` method, then does: for *k*, *v* in E: `D[k] = v` In either case, this is followed by: for *k* in F: `D[k] = F[k]`

## values

`SiteMap.values()` → an object providing a view on D's values

`__init__()`  
 Initialize self. See `help(type(self))` for accurate signature.

## Attributes

---

```
include_folders_as_filenames
nodes
options
```

---

### include\_folders\_as\_filenames

```
SiteMap.include_folders_as_filenames = True
```

### nodes

```
SiteMap.nodes
```

### options

```
SiteMap.options = {'digraph', 'edge_data', 'max_lines', 'max_width', 'node_data', 'nod
```

## SiteNode

```
class SiteNode (folder, node_id, item, obj, dsp_node_id)
```

### Methods

---

<code>__init__</code>	Initialize self.
<code>render</code>	
<code>view</code>	

---

#### `__init__`

```
SiteNode.__init__(folder, node_id, item, obj, dsp_node_id)
Initialize self. See help(type(self)) for accurate signature.
```

#### `render`

```
SiteNode.render(*args, **kwargs)
```

#### `view`

```
SiteNode.view(filepath, *args, **kwargs)
```

```
__init__(folder, node_id, item, obj, dsp_node_id)
Initialize self. See help(type(self)) for accurate signature.
```

### Attributes

---

*counter*

---

*ext*

---

*filename*

---

*name*

---

*title*

---

*view\_id*

---

**counter**

SiteNode.**counter** = <method-wrapper '\_\_next\_\_' of itertools.count object>

**ext**

SiteNode.**ext** = 'html'

**filename**

SiteNode.**filename**

**name**

SiteNode.**name**

**title**

SiteNode.**title**

**view\_id**

SiteNode.**view\_id**

**counter** = <method-wrapper '\_\_next\_\_' of itertools.count object>

## 7.2.8 dsp

It provides tools to create models with the *Dispatcher*.

### Functions

<i>add_function</i>	Decorator to add a function to a dispatcher.
<i>are_in_nested_dicts</i>	Nested keys are inside of nested-dictionaries.
<i>bypass</i>	Returns the same arguments.
<i>combine_dicts</i>	Combines multiple dicts in one.
<i>combine_nested_dicts</i>	Merge nested-dictionaries.

Continued on next page



Table 42 – continued from previous page

<code>get_nested_dicts</code>	Get/Initialize the value of nested-dictionaries.
<code>kk_dict</code>	Merges and defines dictionaries with values identical to keys.
<code>map_dict</code>	Returns a dict with new key values.
<code>map_list</code>	Returns a new dict.
<code>parent_func</code>	Return the parent function of a wrapped function (wrapped with <code>functools.partial</code> and <code>add_args</code> ).
<code>replicate_value</code>	Replicates <i>n</i> times the input value.
<code>selector</code>	Selects the chosen dictionary keys from the given dictionary.
<code>stack_nested_keys</code>	Stacks the keys of nested-dictionaries into tuples and yields a list of k-v pairs.
<code>stlp</code>	Converts a string in a tuple.
<code>summation</code>	Sums inputs values.

## add\_function

**add\_function** (*dsp*, *inputs\_kwargs=False*, *inputs\_defaults=False*, *\*\*kw*)

Decorator to add a function to a dispatcher.

### Parameters

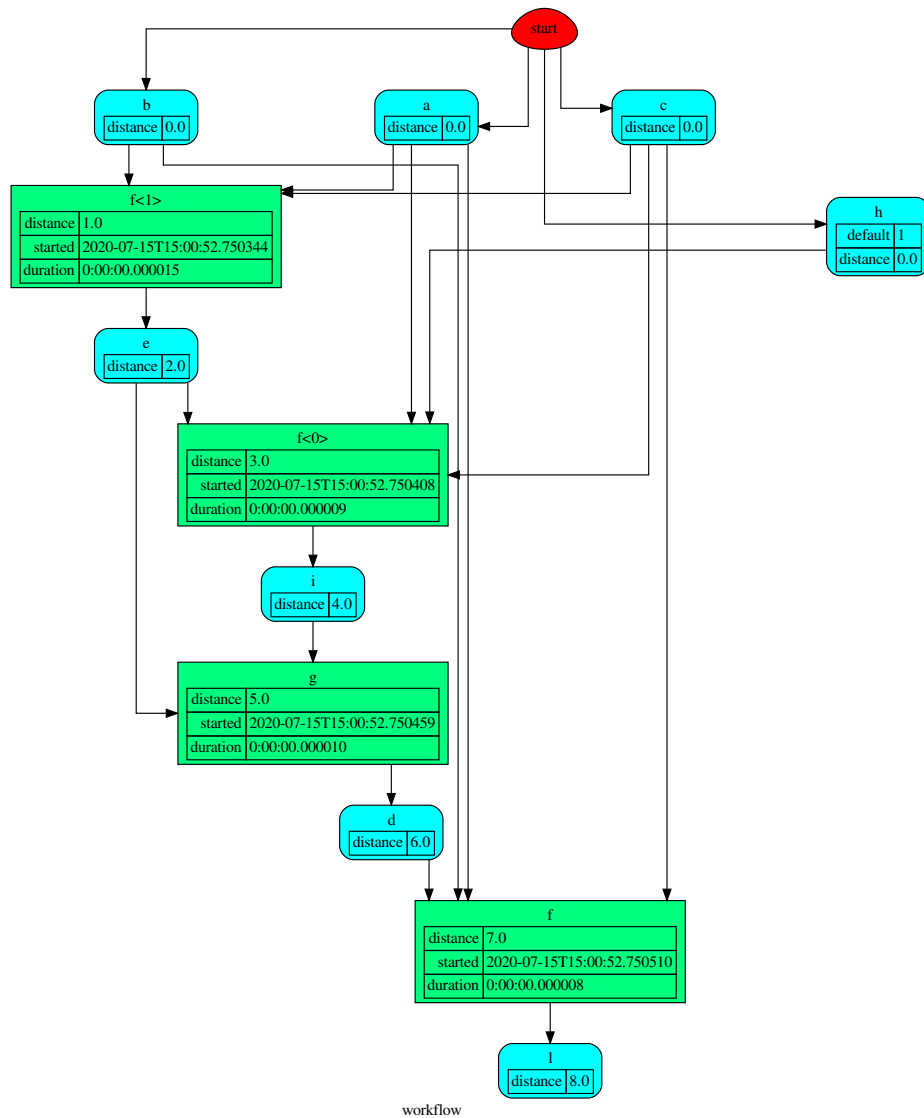
- **dsp** (*schedula.Dispatcher*) – A dispatcher.
- **inputs\_kwargs** (*bool*) – Do you want to include kwargs as inputs?
- **inputs\_defaults** (*bool*) – Do you want to set default values?
- **kw** (*dict*) – See `:func:~'schedula.dispatcher.Dispatcher.add_function'`.

**Returns** Decorator.

**Return type** callable

### Example:

```
>>> import schedula as sh
>>> dsp = sh.Dispatcher(name='Dispatcher')
>>> @sh.add_function(dsp, outputs=['e'])
... @sh.add_function(dsp, False, True, outputs=['i'], inputs='ecah')
... @sh.add_function(dsp, True, outputs=['l'])
... def f(a, b, c, d=1):
...     return (a + b) - c + d
>>> @sh.add_function(dsp, True, outputs=['d'])
... def g(e, i, *args, d=0):
...     return e + i + d
>>> sol = dsp({'a': 1, 'b': 2, 'c': 3}); sol
Solution([(('a', 1), ('b', 2), ('c', 3), ('h', 1), ('e', 1), ('i', 4),
          ('d', 5), ('l', 5))])
```



## are\_in\_nested\_dicts

**are\_in\_nested\_dicts** (*nested\_dict*, \**keys*)

Nested keys are inside of nested-dictionaries.

### Parameters

- **nested\_dict** (*dict*) – Nested dictionary.
- **keys** (*object*) – Nested keys.

**Returns** True if nested keys are inside of nested-dictionaries, otherwise False.

**Return type** bool

## bypass

**bypass** (\*inputs, copy=False)

Returns the same arguments.

### Parameters

- **inputs** (*T*) – Inputs values.
- **copy** (*bool*, *optional*) – If True, it returns a deepcopy of input values.

**Returns** Same input values.

**Return type** (*T*, ..), *T*

Example:

```
>>> bypass('a', 'b', 'c')
('a', 'b', 'c')
>>> bypass('a')
'a'
```

## combine\_dicts

**combine\_dicts** (\*dicts, copy=False, base=None)

Combines multiple dicts in one.

### Parameters

- **dicts** (*dict*) – A sequence of dicts.
- **copy** (*bool*, *optional*) – If True, it returns a deepcopy of input values.
- **base** (*dict*, *optional*) – Base dict where combine multiple dicts in one.

**Returns** A unique dict.

**Return type** *dict*

Example:

```
>>> sorted(combine_dicts({'a': 3, 'c': 3}, {'a': 1, 'b': 2}).items())
[('a', 1), ('b', 2), ('c', 3)]
```

## combine\_nested\_dicts

**combine\_nested\_dicts** (\*nested\_dicts, depth=-1, base=None)

Merge nested-dictionaries.

### Parameters

- **nested\_dicts** (*dict*) – Nested dictionaries.
- **depth** (*int*, *optional*) – Maximum keys depth.
- **base** (*dict*, *optional*) – Base dict where combine multiple dicts in one.

**Returns** Combined nested-dictionary.

**Return type** *dict*

## get\_nested\_dicts

**get\_nested\_dicts** (*nested\_dict*, \**keys*, *default=None*, *init\_nesting=<class 'dict'>*)

Get/Initialize the value of nested-dictionaries.

### Parameters

- **nested\_dict** (*dict*) – Nested dictionary.
- **keys** (*object*) – Nested keys.
- **default** (*callable*, *optional*) – Function used to initialize a new value.
- **init\_nesting** (*callable*, *optional*) – Function used to initialize a new intermediate nesting dict.

**Returns** Value of nested-dictionary.

**Return type** generator

## kk\_dict

**kk\_dict** (\**kk*, \*\**adict*)

Merges and defines dictionaries with values identical to keys.

### Parameters

- **kk** (*object | dict*, *optional*) – A sequence of keys and/or dictionaries.
- **adict** (*dict*, *optional*) – A dictionary.

**Returns** Merged dictionary.

**Return type** dict

Example:

```
>>> sorted(kk_dict('a', 'b', 'c').items())
[('a', 'a'), ('b', 'b'), ('c', 'c')]

>>> sorted(kk_dict('a', 'b', **{'a-c': 'c'}).items())
[('a', 'a'), ('a-c', 'c'), ('b', 'b')]

>>> sorted(kk_dict('a', {'b': 'c'}, 'c').items())
[('a', 'a'), ('b', 'c'), ('c', 'c')]

>>> sorted(kk_dict('a', 'b', **{'b': 'c'}).items())
Traceback (most recent call last):
...
ValueError: keyword argument repeated (b)
>>> sorted(kk_dict({'a': 0, 'b': 1}, **{'b': 2, 'a': 3}).items())
Traceback (most recent call last):
...
ValueError: keyword argument repeated (a, b)
```

## map\_dict

**map\_dict** (*key\_map*, \**dicts*, *copy=False*, *base=None*)

Returns a dict with new key values.

### Parameters

- **key\_map** (*dict*) – A dictionary that maps the dict keys ({old key: new key})

- **dicts** (*dict*) – A sequence of dicts.
- **copy** (*bool*, *optional*) – If True, it returns a deepcopy of input values.
- **base** (*dict*, *optional*) – Base dict where combine multiple dicts in one.

**Returns** A unique dict with new key values.

**Return type** `dict`

Example:

```
>>> d = map_dict({'a': 'c', 'b': 'd'}, {'a': 1, 'b': 1}, {'b': 2})
>>> sorted(d.items())
[('c', 1), ('d', 2)]
```

## map\_list

**map\_list** (*key\_map*, *\*inputs*, *copy=False*, *base=None*)

Returns a new dict.

**Parameters**

- **key\_map** (*list[str | dict | list]*) – A list that maps the dict keys ({old key: new key})
- **inputs** (*iterable | dict | int | float | list | tuple*) – A sequence of data.
- **copy** (*bool*, *optional*) – If True, it returns a deepcopy of input values.
- **base** (*dict*, *optional*) – Base dict where combine multiple dicts in one.

**Returns** A unique dict with new values.

**Return type** `dict`

Example:

```
>>> key_map = [
...     'a',
...     {'a': 'c'},
...     [
...         'a',
...         {'a': 'd'}
...     ]
... ]
>>> inputs = (
...     2,
...     {'a': 3, 'b': 2},
...     [
...         1,
...         {'a': 4}
...     ]
... )
>>> d = map_list(key_map, *inputs)
>>> sorted(d.items())
[('a', 1), ('b', 2), ('c', 3), ('d', 4)]
```

## parent\_func

**parent\_func** (*func*, *input\_id=None*)

Return the parent function of a wrapped function (wrapped with `functools.partial` and `add_args`).

**Parameters**

- **func** (*callable*) – Wrapped function.
- **input\_id** (*int*) – Index of the first input of the wrapped function.

**Returns** Parent function.

**Return type** callable

## replicate\_value

**replicate\_value** (*value*, *n=2*, *copy=True*)

Replicates *n* times the input value.

**Parameters**

- **n** (*int*) – Number of replications.
- **value** (*T*) – Value to be replicated.
- **copy** (*bool*) – If True the list contains deep-copies of the value.

**Returns** A list with the value replicated *n* times.

**Return type** list

Example:

```
>>> import schedula as sh
>>> fun = sh.partial(replicate_value, n=5)
>>> fun({'a': 3})
({'a': 3}, {'a': 3}, {'a': 3}, {'a': 3}, {'a': 3})
```

## selector

**selector** (*keys*, *dictionary*, *copy=False*, *output\_type='dict'*, *allow\_miss=False*)

Selects the chosen dictionary keys from the given dictionary.

**Parameters**

- **keys** (*list*, *tuple*, *set*) – Keys to select.
- **dictionary** (*dict*) – A dictionary.
- **copy** (*bool*) – If True the output contains deep-copies of the values.
- **output\_type** – Type of function output:
  - 'list': a list with all values listed in *keys*.
  - 'dict': a dictionary with any outputs listed in *keys*.
  - 'values': if output length == 1 return a single value otherwise a tuple with all values listed in *keys*.

**type output\_type** str, optional

- **allow\_miss** (*bool*) – If True it does not raise when some key is missing in the dictionary.

**Returns** A dictionary with chosen dictionary keys if present in the sequence of dictionaries. These are combined with `combine_dicts()`.

**Return type** dict

Example:

```
>>> import schedula as sh
>>> fun = sh.partial(selector, ['a', 'b'])
>>> sorted(fun({'a': 1, 'b': 2, 'c': 3}).items())
[('a', 1), ('b', 2)]
```

## stack\_nested\_keys

**stack\_nested\_keys** (*nested\_dict*, *key=()*, *depth=-1*)

Stacks the keys of nested-dictionaries into tuples and yields a list of k-v pairs.

**Parameters**

- **nested\_dict** (*dict*) – Nested dictionary.
- **key** (*tuple*, *optional*) – Initial keys.
- **depth** (*int*, *optional*) – Maximum keys depth.

**Returns** List of k-v pairs.

**Return type** generator

## stlp

**stlp** (*s*)

Converts a string in a tuple.

## summation

**summation** (*\*inputs*)

Sums inputs values.

**Parameters** **inputs** (*int*, *float*) – Inputs values.

**Returns** Sum of the input values.

**Return type** int, float

Example:

```
>>> summation(1, 3.0, 4, 2)
10.0
```

## Classes

<i>DispatchPipe</i>	It converts a <i>Dispatcher</i> into a function.
<i>NoSub</i>	Class for avoiding to add a sub solution to the workflow.
<i>SubDispatch</i>	It dispatches a given <i>Dispatcher</i> like a function.
<i>SubDispatchFunction</i>	It converts a <i>Dispatcher</i> into a function.
<i>SubDispatchPipe</i>	It converts a <i>Dispatcher</i> into a function.

Continued on next page

Table 43 – continued from previous page

<code>add_args</code>	
<code>inf</code>	Class to model infinite numbers for workflow distance.

## DispatchPipe

**class DispatchPipe** (*dsp*, *function\_id=None*, *inputs=None*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *no\_domain=True*, *wildcard=True*)

It converts a *Dispatcher* into a function.

This function takes a sequence of arguments as input of the dispatch.

**Returns** A function that executes the pipe of the given *dsp*, updating its workflow.

**Return type** callable

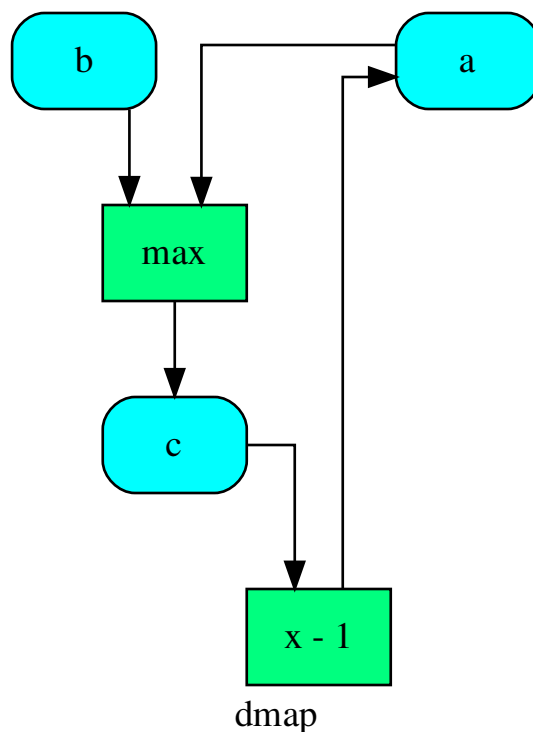
**Note:** This wrapper is not thread safe, because it overwrite the solution.

**See also:**

`dispatch()`, `shrink_dsp()`

**Example:**

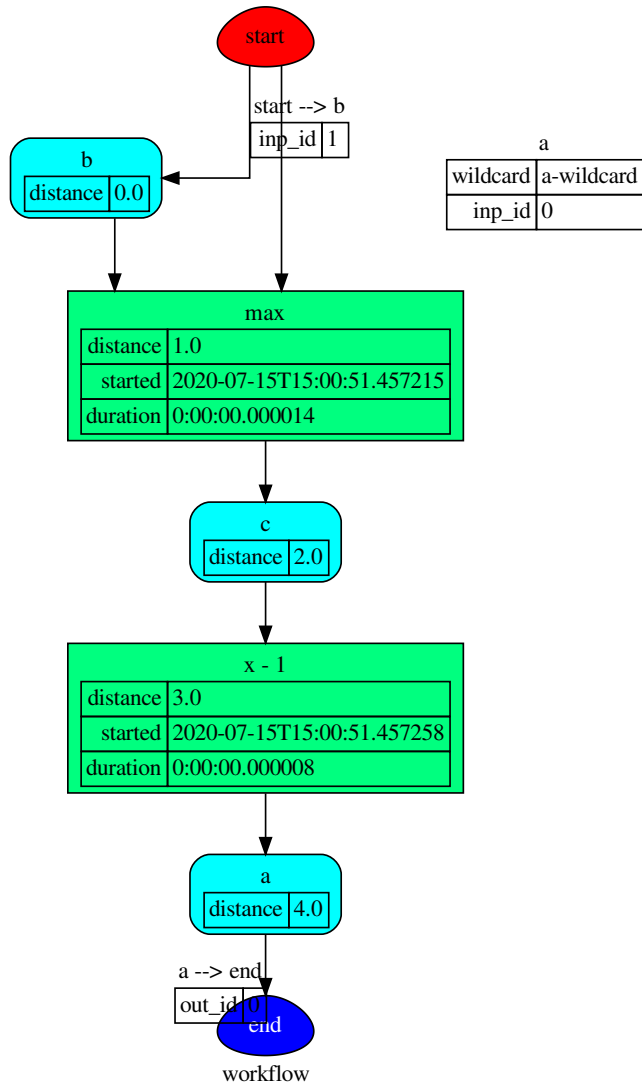
A dispatcher with two functions *max* and *min* and an unresolved cycle (i.e.,  $a \rightarrow \text{max} \rightarrow c \rightarrow \text{min} \rightarrow a$ ):



Extract a static function node, i.e. the inputs *a* and *b* and the output *a* are fixed:

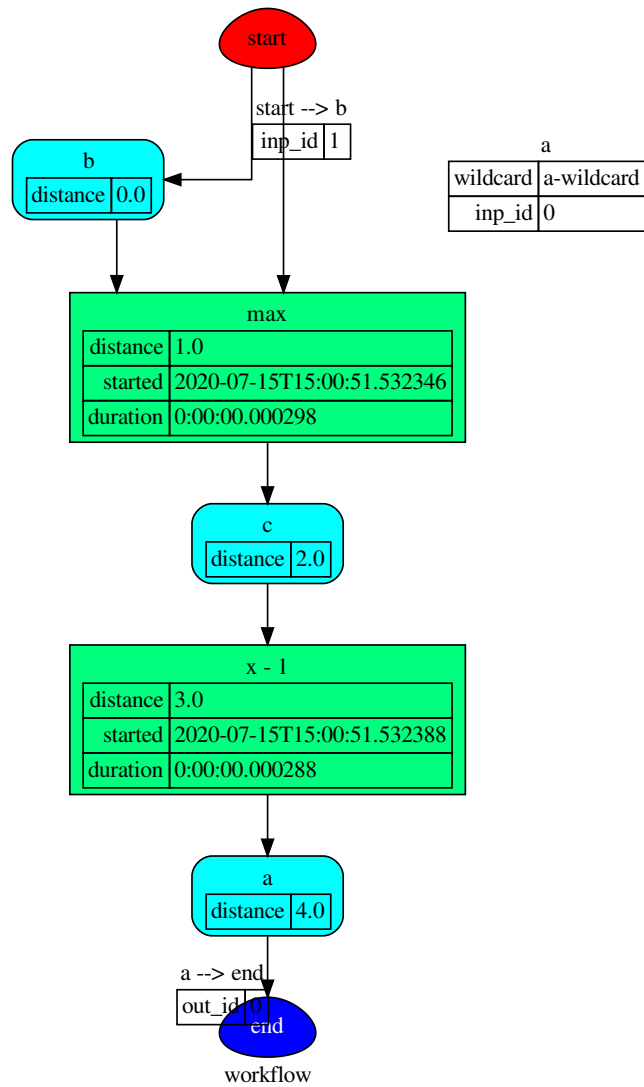


```
>>> fun = DispatchPipe(dsp, 'myF', ['a', 'b'], ['a'])
>>> fun.__name__
'myF'
>>> fun(2, 1)
1
```



The created function raises a ValueError if un-valid inputs are provided:

```
>>> fun(1, 0)
0
```



## Methods

<code>__init__</code>	Initializes the Sub-dispatch Function.
<code>blue</code>	Constructs a Blueprint out of the current object.
<code>copy</code>	
<code>get_node</code>	Returns a sub node of a dispatcher.
<code>plot</code>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<code>web</code>	Creates a dispatcher Flask app.

## `__init__`

`DispatchPipe.__init__(dsp, function_id=None, inputs=None, outputs=None, cutoff=None, inputs_dist=None, no_domain=True, wildcard=True)`

Initializes the Sub-dispatch Function.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **function\_id** (*str*) – Function name.
- **inputs** (*list[str], iterable*) – Input data nodes.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.

## `blue`

`DispatchPipe.blue(memo=None)`

Constructs a Blueprint out of the current object.

**Parameters** **memo** (*dict[T, schedula.utils.blue.Blueprint]*) – A dictionary to cache Blueprints.

**Returns** A Blueprint of the current object.

**Return type** *schedula.utils.blue.Blueprint*

## `copy`

`DispatchPipe.copy()`

## `get_node`

`DispatchPipe.get_node(*node_ids, node_attr=None)`

Returns a sub node of a dispatcher.

### Parameters

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.
- **node\_attr** (*str, None, optional*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When ‘auto’, returns the “default” attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the ‘function’ attribute.

When 'description', returns the "description" of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

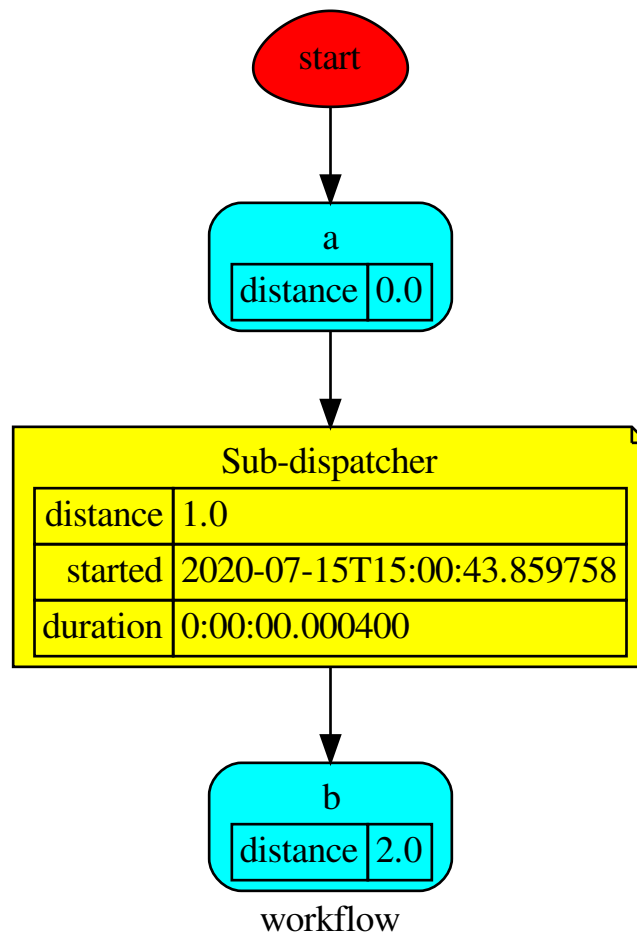
When 'value\_type', returns the data node value's type.

When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

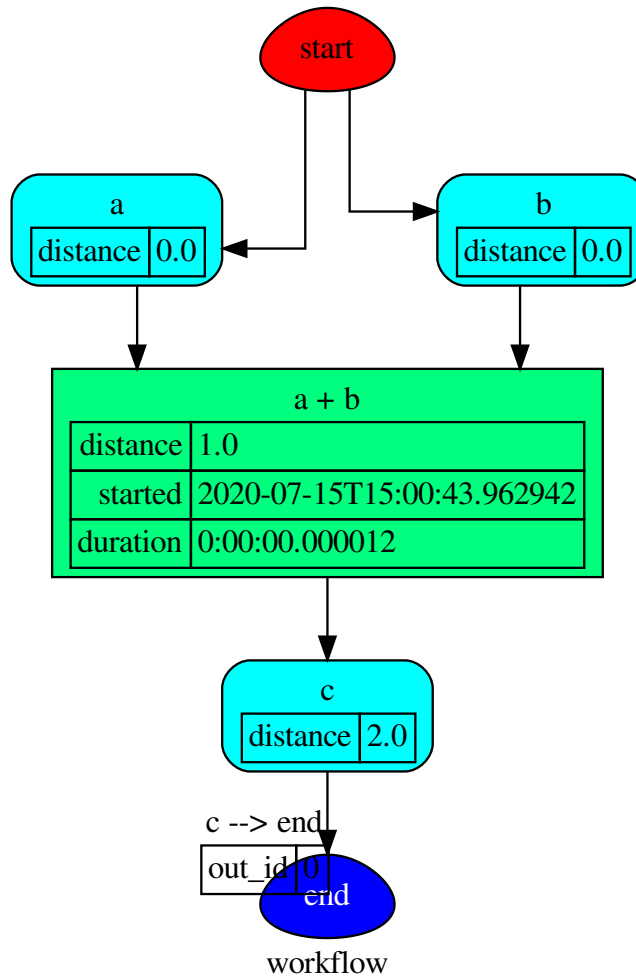
**Example:**



Get the sub node output:

```
>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
```

```
>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
```



## plot

DispatchPipe.**plot** (*workflow=None, \*args, \*\*kwargs*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.

- **view** (*bool*, *optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str]*, *optional*) – Edge attributes to view.
- **node\_data** (*tuple[str]*, *optional*) – Data node attributes to view.
- **node\_function** (*tuple[str]*, *optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int*, *optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str*, *optional*) – (Sub)directory for source saving and rendering.
- **format** (*str*, *optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str*, *optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str*, *optional*) – Encoding for saving the source.
- **graph\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict*, *optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site]*, *optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool*, *optional*) – Add the site index as first page?
- **max\_lines** (*int*, *optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int*, *optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** `schedula.utils.drw.SiteMap`

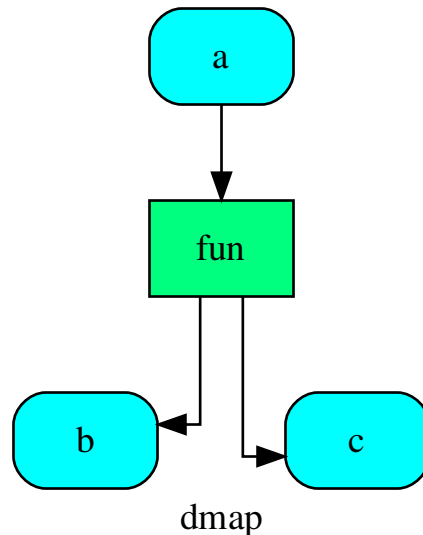
Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
```

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```
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



## web

`DispatchPipe.web` (*depth=-1, node\_data=None, node\_function=None, directory=None, sites=None, run=True*)  
 Creates a dispatcher Flask app.

### Parameters

- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **directory** (*str, optional*) – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the backend server.
- **run** (*bool, optional*) – Run the backend server?

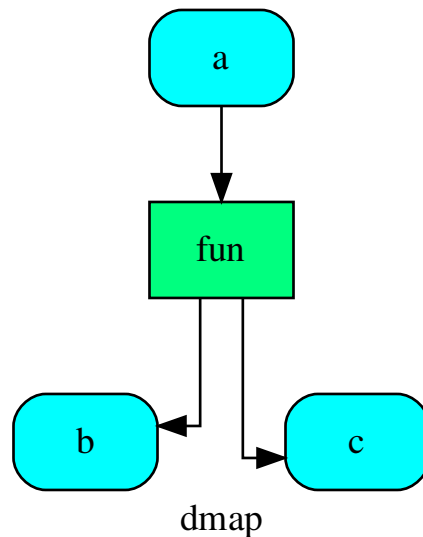
**Returns** A `WebMap`.

**Return type** `WebMap`

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```
>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
>>> requests.post(url, json={'args': (0,)}).json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
```

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

`__init__` (*dsp*, *function\_id=None*, *inputs=None*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *no\_domain=True*, *wildcard=True*)  
 Initializes the Sub-dispatch Function.

**Parameters**



- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **function\_id** (*str*) – Function name.
- **inputs** (*list[str], iterable*) – Input data nodes.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.

## Attributes

---

`var_keyword`

---

### `var_keyword`

`DispatchPipe.var_keyword = None`

**plot** (*workflow=None, \*args, \*\*kwargs*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

#### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.

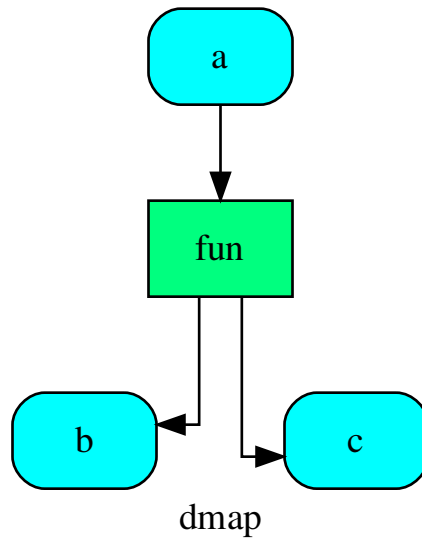
- **node\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict*, *optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set*[*Site*], *optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool*, *optional*) – Add the site index as first page?
- **max\_lines** (*int*, *optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int*, *optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



## NoSub

### class NoSub

Class for avoiding to add a sub solution to the workflow.

`__init__()`

Initialize self. See `help(type(self))` for accurate signature.

## SubDispatch

**class SubDispatch**(*dsp*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *wildcard=False*, *no\_call=False*, *shrink=False*, *rm\_unused\_nds=False*, *output\_type='all'*)

It dispatches a given *Dispatcher* like a function.

This function takes a sequence of dictionaries as input that will be combined before the dispatching.

**Returns** A function that executes the dispatch of the given *Dispatcher*.

**Return type** callable

**See also:**

`dispatch()`, `combine_dicts()`

Example:

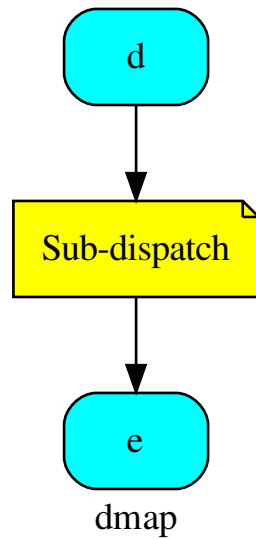
```

>>> from schedula import Dispatcher
>>> sub_dsp = Dispatcher(name='Sub-dispatcher')
...
>>> def fun(a):
...     return a + 1, a - 1
...
    
```

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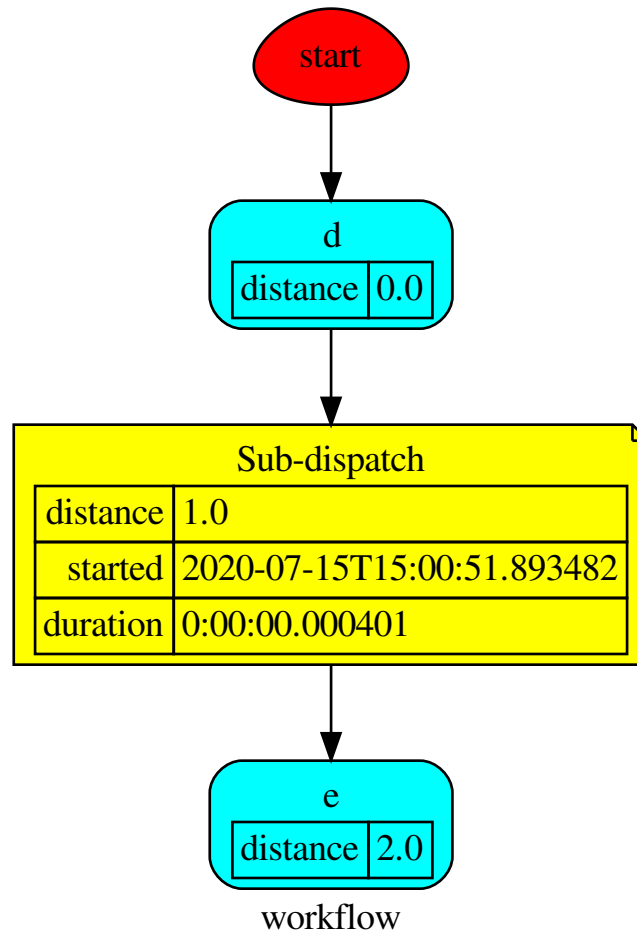
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```
>>> sub_dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dispatch = SubDispatch(sub_dsp, ['a', 'b', 'c'], output_type='dict')
>>> dsp = Dispatcher(name='Dispatcher')
>>> dsp.add_function('Sub-dispatch', dispatch, ['d'], ['e'])
'Sub-dispatch'
```



The Dispatcher output is:

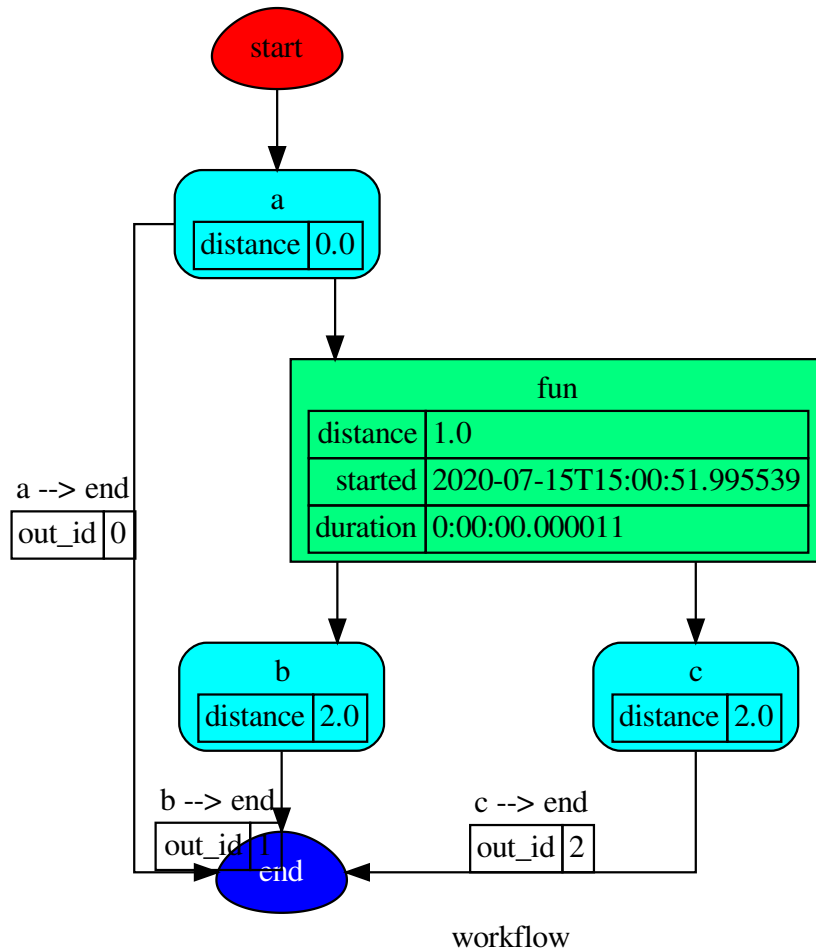
```
>>> o = dsp.dispatch(inputs={'d': {'a': 3}})
```



while, the Sub-dispatch is:

```

>>> sol = o.workflow.nodes['Sub-dispatch']['solution']
>>> sol
Solution([(('a', 3), ('b', 4), ('c', 2))])
>>> sol == o['e']
True
  
```



## Methods

<code>__init__</code>	Initializes the Sub-dispatch.
<code>blue</code>	Constructs a Blueprint out of the current object.
<code>copy</code>	
<code>get_node</code>	Returns a sub node of a dispatcher.
<code>plot</code>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<code>web</code>	Creates a dispatcher Flask app.

## `__init__`

SubDispatch.`__init__`(*dsp*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *wildcard=False*, *no\_call=False*, *shrink=False*, *rm\_unused\_nds=False*, *output\_type='all'*)  
 Initializes the Sub-dispatch.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **outputs** (*list[str], iterable*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.
- **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
- **no\_call** (*bool, optional*) – If True data node estimation function is not used.
- **shrink** (*bool, optional*) – If True the dispatcher is shrink before the dispatch.
- **rm\_unused\_nds** (*bool, optional*) – If True unused function and sub-dispatcher nodes are removed from workflow.
- **output\_type** (*str, optional*) – Type of function output:
  - 'all': a dictionary with all dispatch outputs.
  - 'list': a list with all outputs listed in *outputs*.
  - 'dict': a dictionary with any outputs listed in *outputs*.

### blue

SubDispatch.**blue** (*memo=None*)

Constructs a Blueprint out of the current object.

**Parameters** **memo** (*dict[T, schedula.utils.blue.Blueprint]*) – A dictionary to cache Blueprints.

**Returns** A Blueprint of the current object.

**Return type** *schedula.utils.blue.Blueprint*

### copy

SubDispatch.**copy** ()

### get\_node

SubDispatch.**get\_node** (*\*node\_ids, node\_attr=None*)

Returns a sub node of a dispatcher.

#### Parameters

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.

- `node_attr(str, None, optional)` – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When 'auto', returns the “default” attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the 'function' attribute.

When 'description', returns the “description” of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

When 'value\_type', returns the data node value's type.

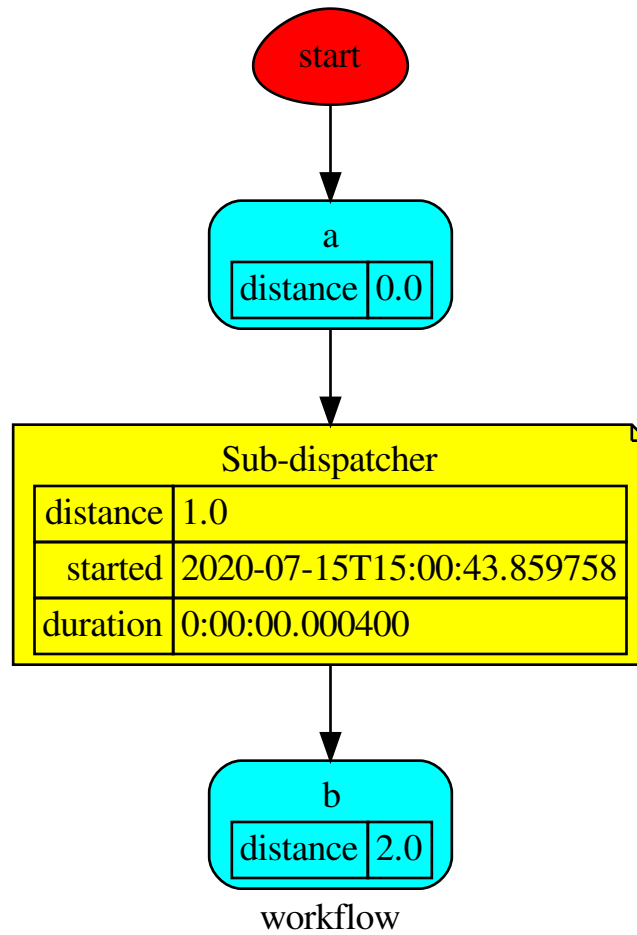
When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

**Example:**





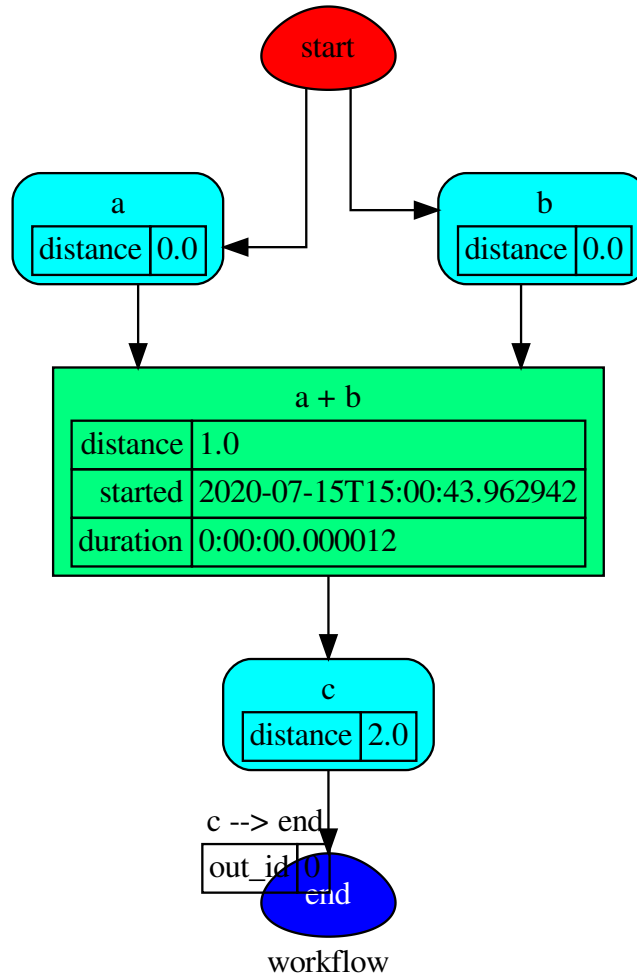
Get the sub node output:

```

>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
  
```

```

>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
  
```



## plot

SubDispatcher.**plot** (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.

- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict, optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool, optional*) – Add the site index as first page?
- **max\_lines** (*int, optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int, optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

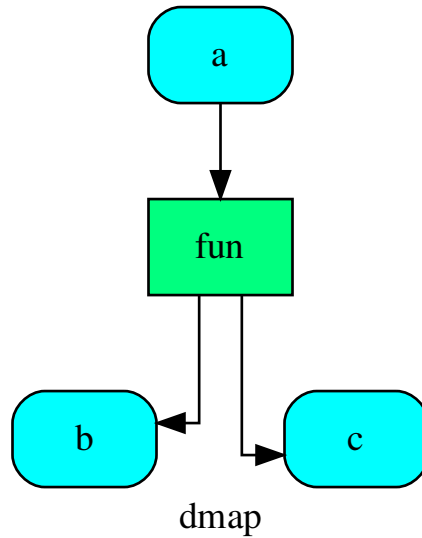
Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```

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```
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



## web

`SubDispatch.web` (*depth=-1, node\_data=None, node\_function=None, directory=None, sites=None, run=True*)  
Creates a dispatcher Flask app.

### Parameters

- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **directory** (*str, optional*) – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the backend server.
- **run** (*bool, optional*) – Run the backend server?

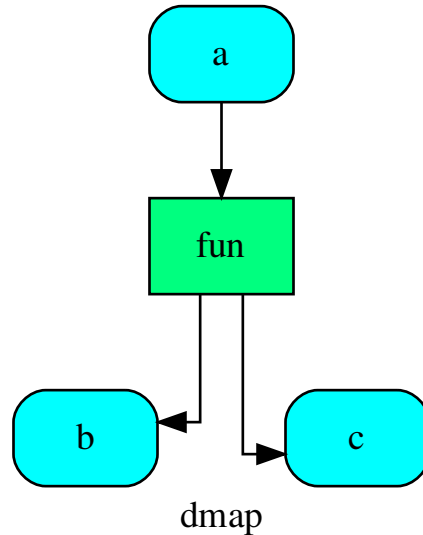
**Returns** A `WebMap`.

**Return type** `WebMap`

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```
>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
>>> requests.post(url, json={'args': (0,)}).json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
```

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

`__init__`(*dsp*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *wildcard=False*, *no\_call=False*, *shrink=False*, *rm\_unused\_nds=False*, *output\_type='all'*)  
 Initializes the Sub-dispatch.

**Parameters**

- *dsp* (*schedula.Dispatcher*) – A dispatcher that identifies the model

- adopted.
- **outputs** (*list[str], iterable*) – Ending data nodes.
  - **cutoff** (*float, int, optional*) – Depth to stop the search.
  - **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.
  - **wildcard** (*bool, optional*) – If True, when the data node is used as input and target in the ArciDispatch algorithm, the input value will be used as input for the connected functions, but not as output.
  - **no\_call** (*bool, optional*) – If True data node estimation function is not used.
  - **shrink** (*bool, optional*) – If True the dispatcher is shrink before the dispatch.
  - **rm\_unused\_nds** (*bool, optional*) – If True unused function and sub-dispatcher nodes are removed from workflow.
  - **output\_type** (*str, optional*) – Type of function output:
    - 'all': a dictionary with all dispatch outputs.
    - 'list': a list with all outputs listed in *outputs*.
    - 'dict': a dictionary with any outputs listed in *outputs*.

**blue** (*memo=None*)

Constructs a Blueprint out of the current object.

**Parameters** **memo** (*dict[T, schedula.utils.blue.Blueprint]*) – A dictionary to cache Blueprints.

**Returns** A Blueprint of the current object.

**Return type** *schedula.utils.blue.Blueprint*

## SubDispatchFunction

**class SubDispatchFunction** (*dsp, function\_id=None, inputs=None, outputs=None, cutoff=None, inputs\_dist=None, shrink=True, wildcard=True*)

It converts a *Dispatcher* into a function.

This function takes a sequence of arguments or a key values as input of the dispatch.

**Returns** A function that executes the dispatch of the given *dsp*.

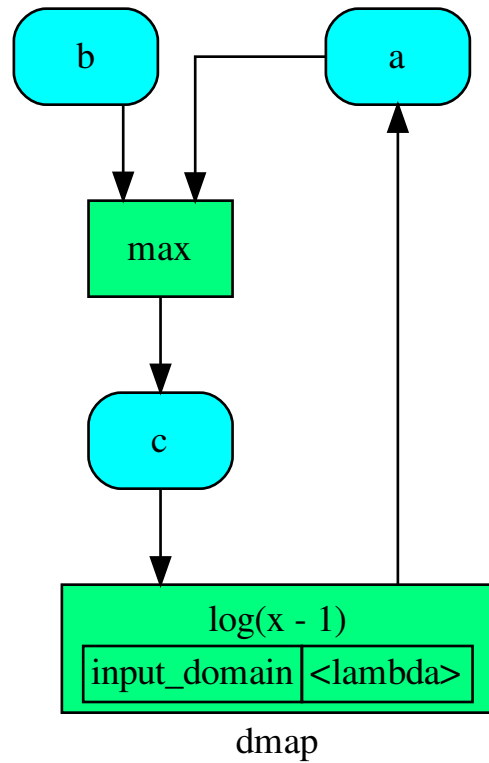
**Return type** callable

**See also:**

*dispatch()*, *shrink\_dsp()*

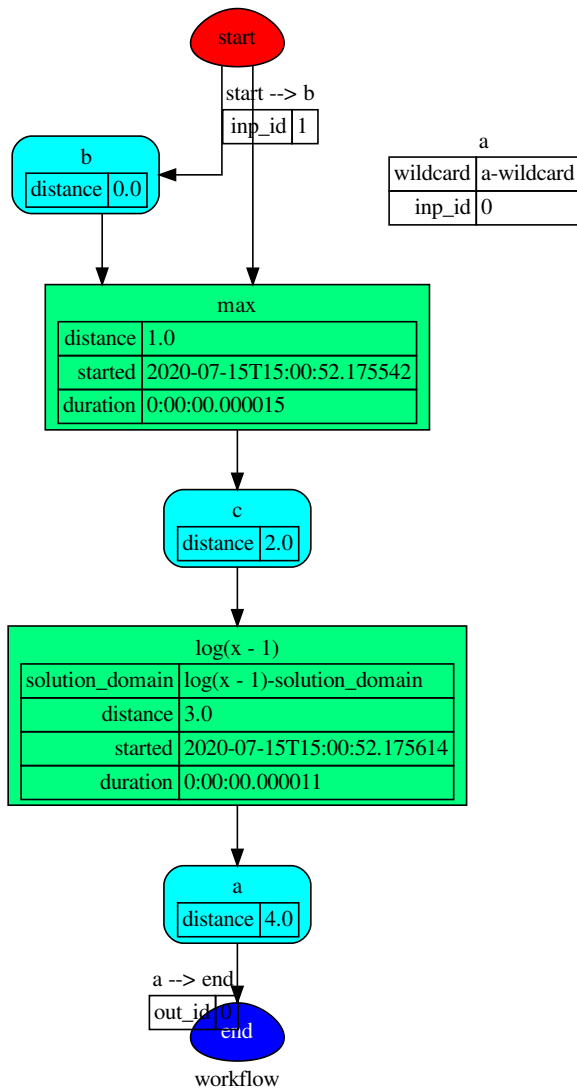
**Example:**

A dispatcher with two functions *max* and *min* and an unresolved cycle (i.e.,  $a \rightarrow \max \rightarrow c \rightarrow \min \rightarrow a$ ):



Extract a static function node, i.e. the inputs *a* and *b* and the output *a* are fixed:

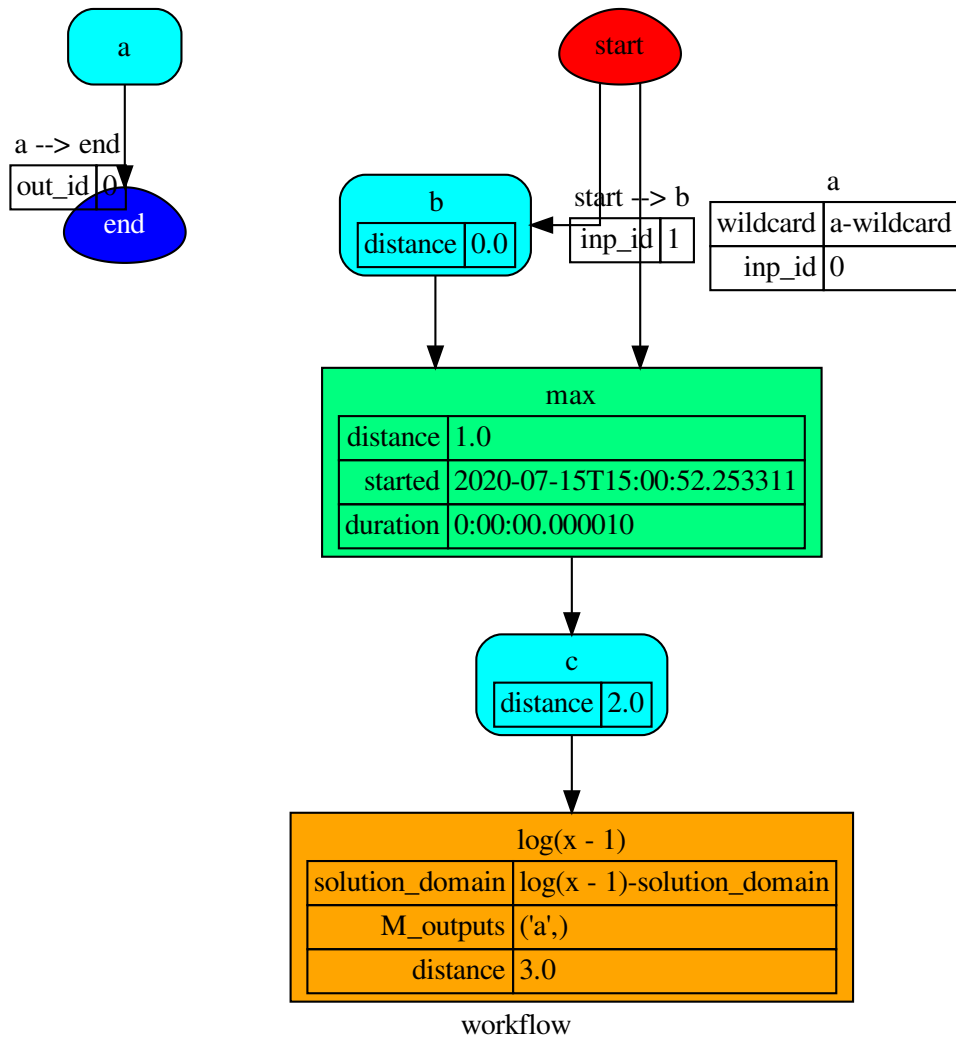
```
>>> fun = SubDispatchFunction(dsp, 'myF', ['a', 'b'], ['a'])
>>> fun.__name__
'myF'
>>> fun(b=1, a=2)
0.0
```



The created function raises a `ValueError` if un-valid inputs are provided:

```
>>> fun(1, 0) # doctest: +IGNORE_EXCEPTION_DETAIL
Traceback (most recent call last):
...
DispatcherError:
  Unreachable output-targets: ...
  Available outputs: ...
```





### Methods

<code>__init__</code>	Initializes the Sub-dispatch Function.
<code>blue</code>	Constructs a Blueprint out of the current object.
<code>copy</code>	
<code>get_node</code>	Returns a sub node of a dispatcher.
<code>plot</code>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<code>web</code>	Creates a dispatcher Flask app.

## `__init__`

`SubDispatchFunction.__init__(dsp, function_id=None, inputs=None, outputs=None, cutoff=None, inputs_dist=None, shrink=True, wildcard=True)`

Initializes the Sub-dispatch Function.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **function\_id** (*str, optional*) – Function name.
- **inputs** (*list[str], iterable, optional*) – Input data nodes.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.

## `blue`

`SubDispatchFunction.blue(memo=None)`

Constructs a Blueprint out of the current object.

**Parameters** **memo** (*dict[T, schedula.utils.blue.Blueprint]*) – A dictionary to cache Blueprints.

**Returns** A Blueprint of the current object.

**Return type** *schedula.utils.blue.Blueprint*

## `copy`

`SubDispatchFunction.copy()`

## `get_node`

`SubDispatchFunction.get_node(*node_ids, node_attr=None)`

Returns a sub node of a dispatcher.

### Parameters

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.
- **node\_attr** (*str, None, optional*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When ‘auto’, returns the “default” attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the ‘function’ attribute.

When 'description', returns the "description" of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

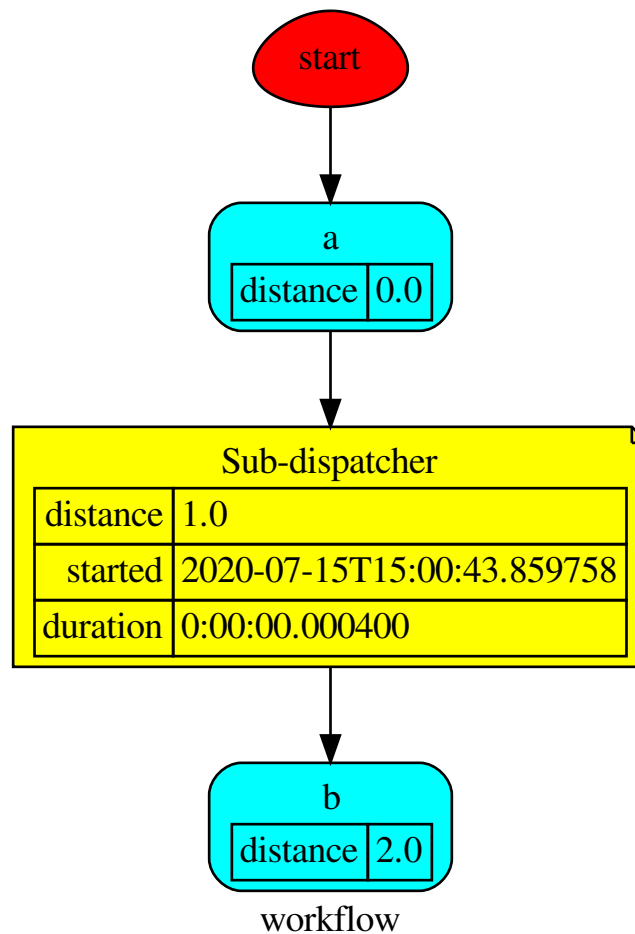
When 'value\_type', returns the data node value's type.

When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

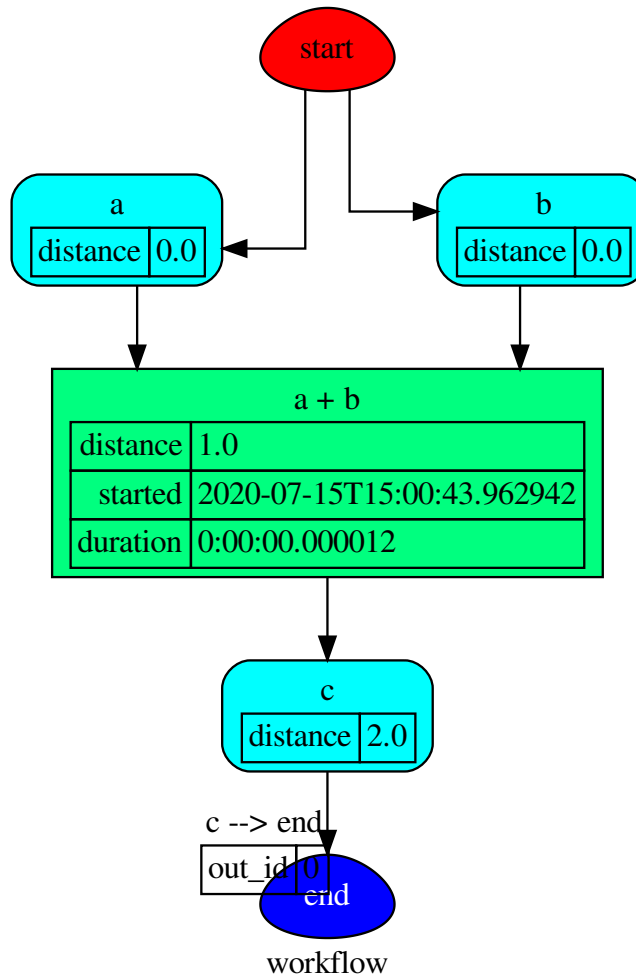
**Example:**



Get the sub node output:

```
>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
```

```
>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
```



## plot

SubDispatchFunction.**plot** (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict, optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool, optional*) – Add the site index as first page?
- **max\_lines** (*int, optional*) – Maximum number of lines for rendering node attributes.

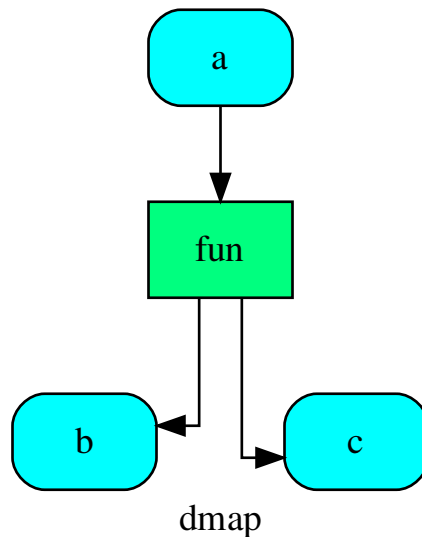
- **max\_width** (*int*, *optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** `schedula.utils.drw.SiteMap`

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



## web

`SubDispatchFunction.web` (*depth=-1*, *node\_data=None*, *node\_function=None*, *directory=None*, *sites=None*, *run=True*)

Creates a dispatcher Flask app.

### Parameters

- **depth** (*int*, *optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str]*, *optional*) – Data node attributes to view.

- **node\_function** (*tuple*[*str*], *optional*) – Function node attributes to view.
- **directory** (*str*, *optional*) – Where is the generated Flask app root located?
- **sites** (*set*[*Site*], *optional*) – A set of *Site* to maintain alive the back-end server.
- **run** (*bool*, *optional*) – Run the backend server?

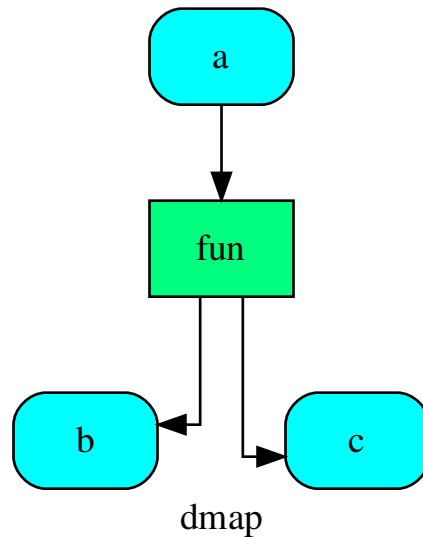
**Returns** A WebMap.

**Return type** *WebMap*

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```
>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
```

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```
>>> requests.post(url, json={'args': (0,)}) .json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
```

---

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

---

`__init__` (*dsp*, *function\_id=None*, *inputs=None*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *shrink=True*, *wildcard=True*)  
 Initializes the Sub-dispatch Function.

#### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **function\_id** (*str*, *optional*) – Function name.
- **inputs** (*list[str]*, *iterable*, *optional*) – Input data nodes.
- **outputs** (*list[str]*, *iterable*, *optional*) – Ending data nodes.
- **cutoff** (*float*, *int*, *optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float]*, *optional*) – Initial distances of input data nodes.

#### Attributes

---

`var_keyword`

---

#### `var_keyword`

`SubDispatchFunction.var_keyword = 'kw'`

### SubDispatchPipe

**class** `SubDispatchPipe` (*dsp*, *function\_id=None*, *inputs=None*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *no\_domain=True*, *wildcard=True*)

It converts a *Dispatcher* into a function.

This function takes a sequence of arguments as input of the dispatch.

**Returns** A function that executes the pipe of the given *dsp*.

**Return type** callable

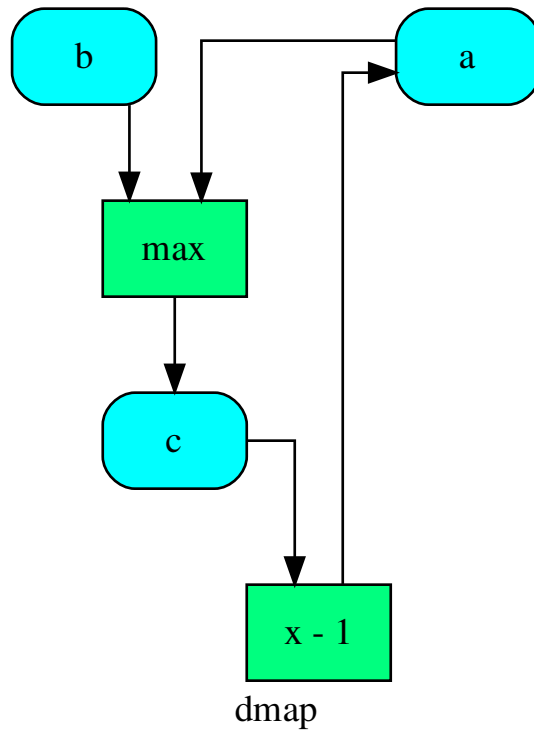
**See also:**

`dispatch()`, `shrink_dsp()`

**Example:**

A dispatcher with two functions *max* and *min* and an unresolved cycle (i.e.,  $a \rightarrow \max \rightarrow c \rightarrow \min \rightarrow a$ ):

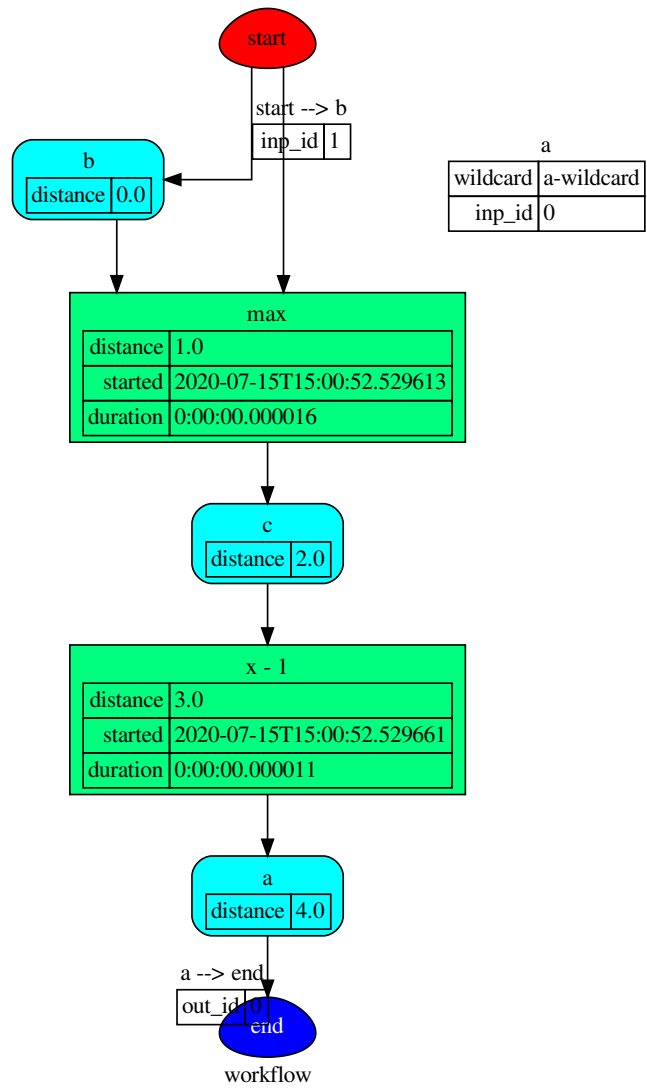




Extract a static function node, i.e. the inputs *a* and *b* and the output *a* are fixed:

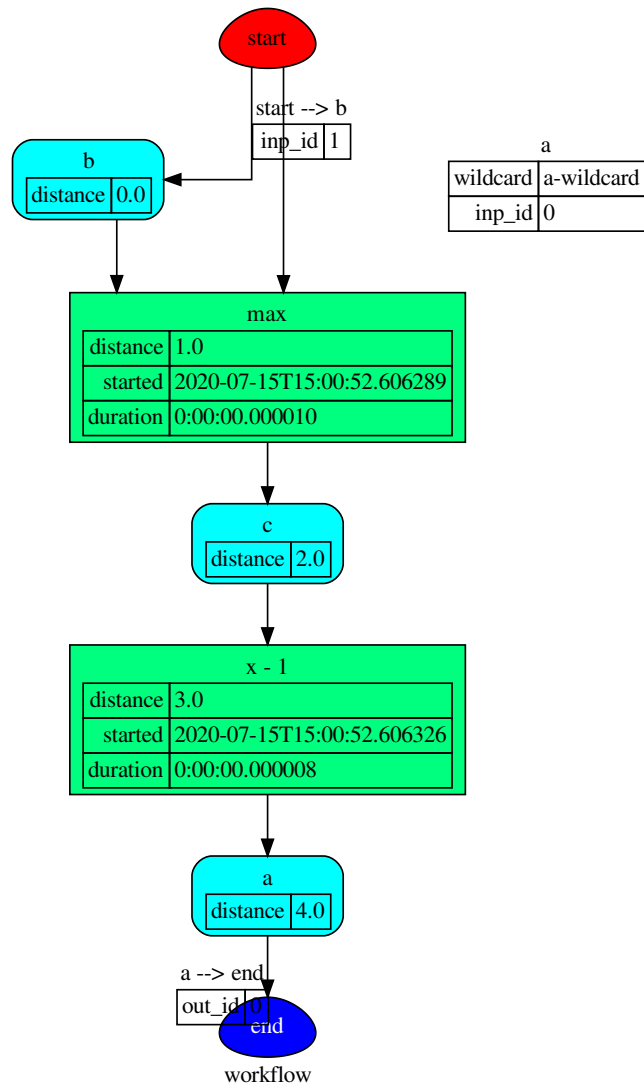
```

>>> fun = SubDispatchPipe(dsp, 'myF', ['a', 'b'], ['a'])
>>> fun.__name__
'myF'
>>> fun(2, 1)
1
    
```



The created function raises a ValueError if un-valid inputs are provided:

```
>>> fun(1, 0)
0
```



## Methods

<code>__init__</code>	Initializes the Sub-dispatch Function.
<code>blue</code>	Constructs a Blueprint out of the current object.
<code>copy</code>	
<code>get_node</code>	Returns a sub node of a dispatcher.
<code>plot</code>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<code>web</code>	Creates a dispatcher Flask app.

## `__init__`

`SubDispatchPipe.__init__(dsp, function_id=None, inputs=None, outputs=None, cutoff=None, inputs_dist=None, no_domain=True, wildcard=True)`

Initializes the Sub-dispatch Function.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **function\_id** (*str*) – Function name.
- **inputs** (*list[str], iterable*) – Input data nodes.
- **outputs** (*list[str], iterable, optional*) – Ending data nodes.
- **cutoff** (*float, int, optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float], optional*) – Initial distances of input data nodes.

## `blue`

`SubDispatchPipe.blue(memo=None)`

Constructs a Blueprint out of the current object.

**Parameters** **memo** (*dict[T, schedula.utils.blue.Blueprint]*) – A dictionary to cache Blueprints.

**Returns** A Blueprint of the current object.

**Return type** *schedula.utils.blue.Blueprint*

## `copy`

`SubDispatchPipe.copy()`

## `get_node`

`SubDispatchPipe.get_node(*node_ids, node_attr=None)`

Returns a sub node of a dispatcher.

### Parameters

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.
- **node\_attr** (*str, None, optional*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When ‘auto’, returns the “default” attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the ‘function’ attribute.

When 'description', returns the "description" of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

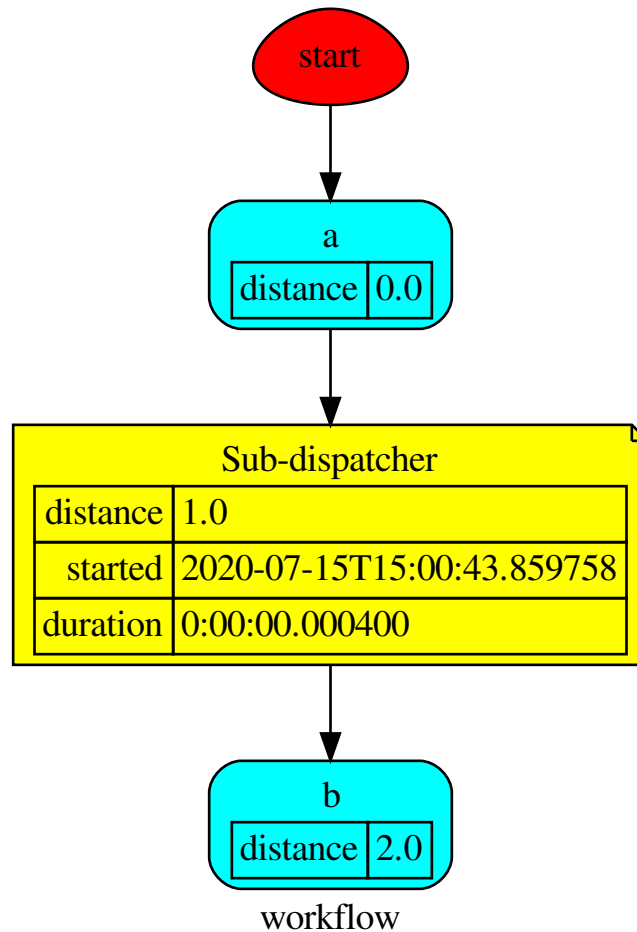
When 'value\_type', returns the data node value's type.

When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

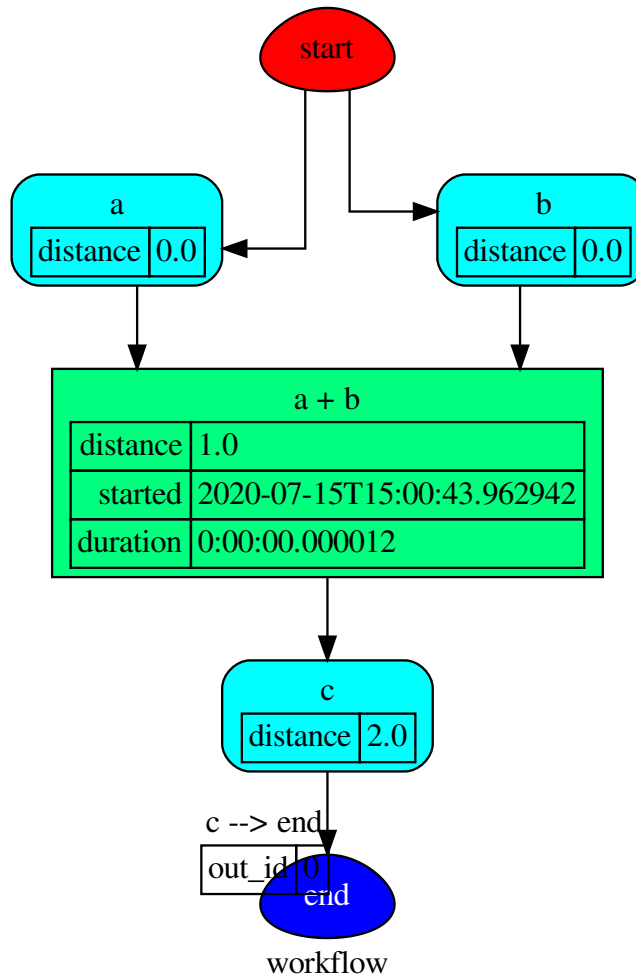
**Example:**



Get the sub node output:

```
>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
```

```
>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
```



## plot

SubDispatchPipe.**plot** (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str, optional*) – (Sub)directory for source saving and rendering.
- **format** (*str, optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str, optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str, optional*) – Encoding for saving the source.
- **graph\_attr** (*dict, optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict, optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict, optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool, optional*) – Add the site index as first page?
- **max\_lines** (*int, optional*) – Maximum number of lines for rendering node attributes.

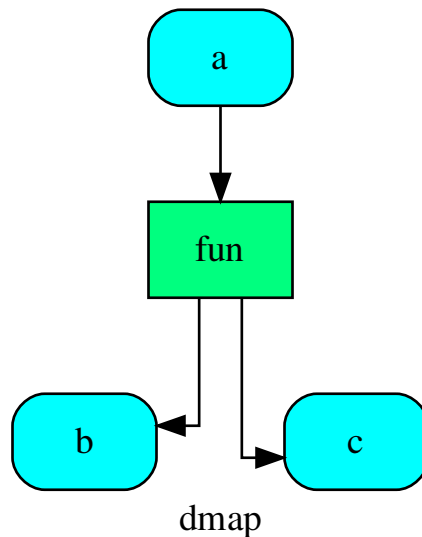
- **max\_width** (*int*, *optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



## web

`SubDispatchPipe.web` (*depth=-1*, *node\_data=None*, *node\_function=None*, *directory=None*, *sites=None*, *run=True*)  
Creates a dispatcher Flask app.

### Parameters

- **depth** (*int*, *optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str]*, *optional*) – Data node attributes to view.



- `node_function` (*tuple*[*str*], *optional*) – Function node attributes to view.
- `directory` (*str*, *optional*) – Where is the generated Flask app root located?
- `sites` (*set*[*Site*], *optional*) – A set of *Site* to maintain alive the back-end server.
- `run` (*bool*, *optional*) – Run the backend server?

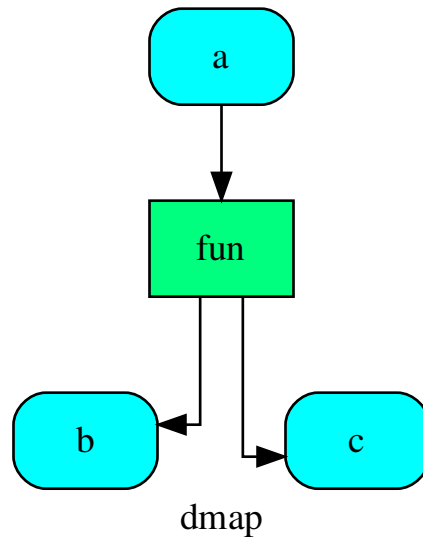
**Returns** A `WebMap`.

**Return type** `WebMap`

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```
>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
```

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```
>>> requests.post(url, json={'args': (0,)}) .json()['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
```

---

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

---

**\_\_init\_\_** (*dsp*, *function\_id=None*, *inputs=None*, *outputs=None*, *cutoff=None*, *inputs\_dist=None*, *no\_domain=True*, *wildcard=True*)  
 Initializes the Sub-dispatch Function.

**Parameters**

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **function\_id** (*str*) – Function name.
- **inputs** (*list[str]*, *iterable*) – Input data nodes.
- **outputs** (*list[str]*, *iterable*, *optional*) – Ending data nodes.
- **cutoff** (*float*, *int*, *optional*) – Depth to stop the search.
- **inputs\_dist** (*dict[str, int | float]*, *optional*) – Initial distances of input data nodes.

**Attributes**

---

*var\_keyword*

---

**var\_keyword**

SubDispatchPipe.**var\_keyword** = None

**add\_args**

**class add\_args** (*func*, *n=1*, *callback=None*)

**Methods**

---

**\_\_init\_\_** Initialize self.

---

**\_\_init\_\_**

**add\_args.\_\_init\_\_** (*func*, *n=1*, *callback=None*)  
 Initialize self. See help(type(self)) for accurate signature.

**\_\_init\_\_** (*func*, *n=1*, *callback=None*)  
 Initialize self. See help(type(self)) for accurate signature.

## inf

### class inf

Class to model infinite numbers for workflow distance.

#### Methods

count	Return number of occurrences of value.
format	
index	Return first index of value.

#### count

`inf.count()`  
Return number of occurrences of value.

#### format

**static** `inf.format(val)`

#### index

`inf.index()`  
Return first index of value.  
Raises ValueError if the value is not present.

`__init__()`  
Initialize self. See help(type(self)) for accurate signature.

#### Attributes

inf	Alias for field number 0
num	Alias for field number 1

#### inf

`inf.inf`  
Alias for field number 0

#### num

`inf.num`  
Alias for field number 1

## 7.2.9 exc

Defines the dispatcher exception.

### Exceptions

---

<code>DispatcherAbort</code>
<code>DispatcherError</code>
<code>ExecutorShutdown</code>
<code>SkipNode</code>

---

#### DispatcherAbort

**exception** `DispatcherAbort`

#### DispatcherError

**exception** `DispatcherError` (*\*args, sol=None, ex=None, \*\*kwargs*)

#### ExecutorShutdown

**exception** `ExecutorShutdown`

#### SkipNode

**exception** `SkipNode` (*\*args, ex=None, \*\*kwargs*)

## 7.2.10 gen

It contains classes and functions of general utility.

These are python-specific utilities and hacks - general data-processing or numerical operations.

### Functions

---

<code>counter</code>	Return a object whose <code>__call__()</code> method returns consecutive values.
----------------------	--

---

#### counter

**counter** (*start=0, step=1*)

Return a object whose `__call__()` method returns consecutive values.

##### Parameters

- **start** (*int, float, optional*) – Start value.
- **step** (*int, float, optional*) – Step value.

## Classes

---

*Token*

It constructs a unique constant that behaves like a string.

---

### Token

**class Token** (\*args)

It constructs a unique constant that behaves like a string.

Example:

```
>>> s = Token('string')
>>> s
string
>>> s == 'string'
False
>>> s == Token('string')
False
>>> {s: 1, Token('string'): 1}
{string: 1, string: 1}
>>> s.capitalize()
'String'
```

### Methods

<code>__init__</code>	Initialize self.
<code>capitalize</code>	Return a capitalized version of the string.
<code>casefold</code>	Return a version of the string suitable for caseless comparisons.
<code>center</code>	Return a centered string of length width.
<code>count</code>	Return the number of non-overlapping occurrences of substring sub in string S[start:end].
<code>encode</code>	Encode the string using the codec registered for encoding.
<code>endswith</code>	Return True if S ends with the specified suffix, False otherwise.
<code>expandtabs</code>	Return a copy where all tab characters are expanded using spaces.
<code>find</code>	Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end].
<code>format</code>	Return a formatted version of S, using substitutions from args and kwargs.
<code>format_map</code>	Return a formatted version of S, using substitutions from mapping.
<code>index</code>	Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end].
<code>isalnum</code>	Return True if the string is an alpha-numeric string, False otherwise.
<code>isalpha</code>	Return True if the string is an alphabetic string, False otherwise.

Continued on next page

Table 57 – continued from previous page

<code>isascii</code>	Return True if all characters in the string are ASCII, False otherwise.
<code>isdecimal</code>	Return True if the string is a decimal string, False otherwise.
<code>isdigit</code>	Return True if the string is a digit string, False otherwise.
<code>isidentifier</code>	Return True if the string is a valid Python identifier, False otherwise.
<code>islower</code>	Return True if the string is a lowercase string, False otherwise.
<code>isnumeric</code>	Return True if the string is a numeric string, False otherwise.
<code>isprintable</code>	Return True if the string is printable, False otherwise.
<code>isspace</code>	Return True if the string is a whitespace string, False otherwise.
<code>istitle</code>	Return True if the string is a title-cased string, False otherwise.
<code>isupper</code>	Return True if the string is an uppercase string, False otherwise.
<code>join</code>	Concatenate any number of strings.
<code>ljust</code>	Return a left-justified string of length width.
<code>lower</code>	Return a copy of the string converted to lowercase.
<code>lstrip</code>	Return a copy of the string with leading whitespace removed.
<code>maketrans</code>	Return a translation table usable for <code>str.translate()</code> .
<code>partition</code>	Partition the string into three parts using the given separator.
<code>replace</code>	Return a copy with all occurrences of substring <code>old</code> replaced by <code>new</code> .
<code>rfind</code>	Return the highest index in <code>S</code> where substring <code>sub</code> is found, such that <code>sub</code> is contained within <code>S[start:end]</code> .
<code>rindex</code>	Return the highest index in <code>S</code> where substring <code>sub</code> is found, such that <code>sub</code> is contained within <code>S[start:end]</code> .
<code>rjust</code>	Return a right-justified string of length width.
<code>rpartition</code>	Partition the string into three parts using the given separator.
<code>rsplit</code>	Return a list of the words in the string, using <code>sep</code> as the delimiter string.
<code>rstrip</code>	Return a copy of the string with trailing whitespace removed.
<code>split</code>	Return a list of the words in the string, using <code>sep</code> as the delimiter string.
<code>splitlines</code>	Return a list of the lines in the string, breaking at line boundaries.
<code>startswith</code>	Return True if <code>S</code> starts with the specified prefix, False otherwise.
<code>strip</code>	Return a copy of the string with leading and trailing whitespace remove.
<code>swapcase</code>	Convert uppercase characters to lowercase and lowercase characters to uppercase.

Continued on next page

Table 57 – continued from previous page

<code>title</code>	Return a version of the string where each word is titlecased.
<code>translate</code>	Replace each character in the string using the given translation table.
<code>upper</code>	Return a copy of the string converted to uppercase.
<code>zfill</code>	Pad a numeric string with zeros on the left, to fill a field of the given width.

### `__init__`

`Token.__init__ (*args)`

Initialize self. See `help(type(self))` for accurate signature.

### `capitalize`

`Token.capitalize ()`

Return a capitalized version of the string.

More specifically, make the first character have upper case and the rest lower case.

### `casefold`

`Token.casefold ()`

Return a version of the string suitable for caseless comparisons.

### `center`

`Token.center ()`

Return a centered string of length width.

Padding is done using the specified fill character (default is a space).

### `count`

`Token.count (sub [, start [, end ]]) → int`

Return the number of non-overlapping occurrences of substring sub in string S[start:end]. Optional arguments start and end are interpreted as in slice notation.

### `encode`

`Token.encode ()`

Encode the string using the codec registered for encoding.

**encoding** The encoding in which to encode the string.

**errors** The error handling scheme to use for encoding errors. The default is ‘strict’ meaning that encoding errors raise a `UnicodeEncodeError`. Other possible values are ‘ignore’, ‘replace’ and ‘xmlcharrefreplace’ as well as any other name registered with `codecs.register_error` that can handle `UnicodeEncodeErrors`.

## endswith

`Token.endswith(suffix[, start[, end]])` → bool

Return True if S ends with the specified suffix, False otherwise. With optional start, test S beginning at that position. With optional end, stop comparing S at that position. suffix can also be a tuple of strings to try.

## expandtabs

`Token.expandtabs()`

Return a copy where all tab characters are expanded using spaces.

If tabsize is not given, a tab size of 8 characters is assumed.

## find

`Token.find(sub[, start[, end]])` → int

Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Return -1 on failure.

## format

`Token.format(*args, **kwargs)` → str

Return a formatted version of S, using substitutions from args and kwargs. The substitutions are identified by braces ('{' and '}').

## format\_map

`Token.format_map(mapping)` → str

Return a formatted version of S, using substitutions from mapping. The substitutions are identified by braces ('{' and '}').

## index

`Token.index(sub[, start[, end]])` → int

Return the lowest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Raises ValueError when the substring is not found.

## isalnum

`Token.isalnum()`

Return True if the string is an alpha-numeric string, False otherwise.

A string is alpha-numeric if all characters in the string are alpha-numeric and there is at least one character in the string.



## isalpha

`Token.isalpha()`

Return True if the string is an alphabetic string, False otherwise.

A string is alphabetic if all characters in the string are alphabetic and there is at least one character in the string.

## isascii

`Token.isascii()`

Return True if all characters in the string are ASCII, False otherwise.

ASCII characters have code points in the range U+0000-U+007F. Empty string is ASCII too.

## isdecimal

`Token.isdecimal()`

Return True if the string is a decimal string, False otherwise.

A string is a decimal string if all characters in the string are decimal and there is at least one character in the string.

## isdigit

`Token.isdigit()`

Return True if the string is a digit string, False otherwise.

A string is a digit string if all characters in the string are digits and there is at least one character in the string.

## isidentifier

`Token.isidentifier()`

Return True if the string is a valid Python identifier, False otherwise.

Use `keyword.iskeyword()` to test for reserved identifiers such as “def” and “class”.

## islower

`Token.islower()`

Return True if the string is a lowercase string, False otherwise.

A string is lowercase if all cased characters in the string are lowercase and there is at least one cased character in the string.

## isnumeric

`Token.isnumeric()`

Return True if the string is a numeric string, False otherwise.

A string is numeric if all characters in the string are numeric and there is at least one character in the string.

### **isprintable**

`Token.isprintable()`

Return True if the string is printable, False otherwise.

A string is printable if all of its characters are considered printable in `repr()` or if it is empty.

### **isspace**

`Token.isspace()`

Return True if the string is a whitespace string, False otherwise.

A string is whitespace if all characters in the string are whitespace and there is at least one character in the string.

### **istitle**

`Token.istitle()`

Return True if the string is a title-cased string, False otherwise.

In a title-cased string, upper- and title-case characters may only follow uncased characters and lowercase characters only cased ones.

### **isupper**

`Token.isupper()`

Return True if the string is an uppercase string, False otherwise.

A string is uppercase if all cased characters in the string are uppercase and there is at least one cased character in the string.

### **join**

`Token.join()`

Concatenate any number of strings.

The string whose method is called is inserted in between each given string. The result is returned as a new string.

Example: `'.'.join(['ab', 'pq', 'rs']) -> 'ab.pq.rs'`

### **ljust**

`Token.ljust()`

Return a left-justified string of length width.

Padding is done using the specified fill character (default is a space).

## lower

`Token.lower()`

Return a copy of the string converted to lowercase.

## lstrip

`Token.lstrip()`

Return a copy of the string with leading whitespace removed.

If `chars` is given and not `None`, remove characters in `chars` instead.

## maketrans

**static** `Token.maketrans()`

Return a translation table usable for `str.translate()`.

If there is only one argument, it must be a dictionary mapping Unicode ordinals (integers) or characters to Unicode ordinals, strings or `None`. Character keys will be then converted to ordinals. If there are two arguments, they must be strings of equal length, and in the resulting dictionary, each character in `x` will be mapped to the character at the same position in `y`. If there is a third argument, it must be a string, whose characters will be mapped to `None` in the result.

## partition

`Token.partition()`

Partition the string into three parts using the given separator.

This will search for the separator in the string. If the separator is found, returns a 3-tuple containing the part before the separator, the separator itself, and the part after it.

If the separator is not found, returns a 3-tuple containing the original string and two empty strings.

## replace

`Token.replace()`

Return a copy with all occurrences of substring `old` replaced by `new`.

**count** Maximum number of occurrences to replace. `-1` (the default value) means replace all occurrences.

If the optional argument `count` is given, only the first `count` occurrences are replaced.

## rfind

`Token.rfind(sub[, start[, end]])` → int

Return the highest index in `S` where substring `sub` is found, such that `sub` is contained within `S[start:end]`. Optional arguments `start` and `end` are interpreted as in slice notation.

Return `-1` on failure.

## rindex

`Token.rindex(sub[, start[, end]])` → int

Return the highest index in S where substring sub is found, such that sub is contained within S[start:end]. Optional arguments start and end are interpreted as in slice notation.

Raises ValueError when the substring is not found.

## rjust

`Token.rjust()`

Return a right-justified string of length width.

Padding is done using the specified fill character (default is a space).

## rpartition

`Token.rpartition()`

Partition the string into three parts using the given separator.

This will search for the separator in the string, starting at the end. If the separator is found, returns a 3-tuple containing the part before the separator, the separator itself, and the part after it.

If the separator is not found, returns a 3-tuple containing two empty strings and the original string.

## rsplit

`Token.rsplit()`

Return a list of the words in the string, using sep as the delimiter string.

**sep** The delimiter according which to split the string. None (the default value) means split according to any whitespace, and discard empty strings from the result.

**maxsplit** Maximum number of splits to do. -1 (the default value) means no limit.

Splits are done starting at the end of the string and working to the front.

## rstrip

`Token.rstrip()`

Return a copy of the string with trailing whitespace removed.

If chars is given and not None, remove characters in chars instead.

## split

`Token.split()`

Return a list of the words in the string, using sep as the delimiter string.

**sep** The delimiter according which to split the string. None (the default value) means split according to any whitespace, and discard empty strings from the result.

**maxsplit** Maximum number of splits to do. -1 (the default value) means no limit.

## splitlines

`Token.splitlines()`

Return a list of the lines in the string, breaking at line boundaries.

Line breaks are not included in the resulting list unless `keepends` is given and true.

## startswith

`Token.startswith(prefix[, start[, end]])` → bool

Return True if S starts with the specified prefix, False otherwise. With optional start, test S beginning at that position. With optional end, stop comparing S at that position. `prefix` can also be a tuple of strings to try.

## strip

`Token.strip()`

Return a copy of the string with leading and trailing whitespace remove.

If `chars` is given and not None, remove characters in `chars` instead.

## swapcase

`Token.swapcase()`

Convert uppercase characters to lowercase and lowercase characters to uppercase.

## title

`Token.title()`

Return a version of the string where each word is titlecased.

More specifically, words start with uppercased characters and all remaining cased characters have lower case.

## translate

`Token.translate()`

Replace each character in the string using the given translation table.

**table** Translation table, which must be a mapping of Unicode ordinals to Unicode ordinals, strings, or None.

The table must implement lookup/indexing via `__getitem__`, for instance a dictionary or list. If this operation raises `LookupError`, the character is left untouched. Characters mapped to None are deleted.

## upper

`Token.upper()`

Return a copy of the string converted to uppercase.

## zfill

`Token.zfill()`

Pad a numeric string with zeros on the left, to fill a field of the given width.

The string is never truncated.

`__init__(*args)`

Initialize self. See `help(type(self))` for accurate signature.

## 7.2.11 graph

It contains the *DiGraph* class.

### Classes

---

*DiGraph*

---

### DiGraph

`class DiGraph(nodes=None, adj=None)`

#### Methods

<code>__init__</code>	Initialize self.
<code>add_edge</code>	
<code>add_edges_from</code>	
<code>add_node</code>	
<code>add_nodes_from</code>	
<code>copy</code>	
<code>has_edge</code>	
<code>remove_edge</code>	
<code>remove_edges_from</code>	
<code>remove_node</code>	
<code>remove_nodes_from</code>	
<code>subgraph</code>	

#### `__init__`

`DiGraph.__init__(nodes=None, adj=None)`

Initialize self. See `help(type(self))` for accurate signature.

#### `add_edge`

`DiGraph.add_edge(u, v, **attr)`

**add\_edges\_from**

`DiGraph.add_edges_from(ebunch_to_add)`

**add\_node**

`DiGraph.add_node(n, **attr)`

**add\_nodes\_from**

`DiGraph.add_nodes_from(nodes_for_adding)`

**copy**

`DiGraph.copy()`

**has\_edge**

`DiGraph.has_edge(u, v)`

**remove\_edge**

`DiGraph.remove_edge(u, v)`

**remove\_edges\_from**

`DiGraph.remove_edges_from(ebunch)`

**remove\_node**

`DiGraph.remove_node(n)`

**remove\_nodes\_from**

`DiGraph.remove_nodes_from(nodes)`

**subgraph**

`DiGraph.subgraph(nodes)`

`__init__(nodes=None, adj=None)`

Initialize self. See help(type(self)) for accurate signature.

## Attributes

adj
edges
nodes
pred
succ

### adj

DiGraph.**adj**

### edges

DiGraph.**edges**

### nodes

DiGraph.**nodes**

### pred

DiGraph.**pred**

### succ

DiGraph.**succ**

## 7.2.12 imp

Fixes ImportError for MicroPython.

## 7.2.13 io

It provides functions to read and save a dispatcher from/to files.

## Functions

<i>load_default_values</i>	Load Dispatcher default values in Python pickle format.
<i>load_dispatcher</i>	Load Dispatcher object in Python pickle format.
<i>load_map</i>	Load Dispatcher map in Python pickle format.
<i>save_default_values</i>	Write Dispatcher default values in Python pickle format.
<i>save_dispatcher</i>	Write Dispatcher object in Python pickle format.
<i>save_map</i>	Write Dispatcher graph object in Python pickle format.



## load\_default\_values

### load\_default\_values (dsp, path)

Load Dispatcher default values in Python pickle format.

Pickles are a serialized byte stream of a Python object. This format will preserve Python objects used as nodes or edges.

#### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **path** (*str, file*) – File or filename to write. File names ending in .gz or .bz2 will be uncompressed.

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher()
>>> dsp.add_data('a', default_value=1)
'a'
>>> dsp.add_function(function=max, inputs=['a', 'b'], outputs=['c'])
'max'
>>> save_default_values(dsp, file_name)

>>> dsp = Dispatcher(dmap=dsp.dmap)
>>> load_default_values(dsp, file_name)
>>> dsp.dispatch(inputs={'b': 3})['c']
3
```

## load\_dispatcher

### load\_dispatcher (path)

Load Dispatcher object in Python pickle format.

Pickles are a serialized byte stream of a Python object. This format will preserve Python objects used as nodes or edges.

**Parameters** **path** (*str, file*) – File or filename to write. File names ending in .gz or .bz2 will be uncompressed.

**Returns** A dispatcher that identifies the model adopted.

**Return type** schedula.Dispatcher

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher()
>>> dsp.add_data('a', default_value=1)
'a'
>>> dsp.add_function(function=max, inputs=['a', 'b'], outputs=['c'])
'max'
>>> save_dispatcher(dsp, file_name)

>>> dsp = load_dispatcher(file_name)
>>> dsp.dispatch(inputs={'b': 3})['c']
3
```

## load\_map

**load\_map** (*dsp, path*)

Load Dispatcher map in Python pickle format.

### Parameters

- **dsp** (*schedula.scheduler.Dispatcher*) – A dispatcher that identifies the model to be upgraded.
- **path** (*str, file*) – File or filename to write. File names ending in .gz or .bz2 will be uncompressed.

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher()
>>> dsp.add_function(function=max, inputs=['a', 'b'], outputs=['c'])
'max'
>>> save_map(dsp, file_name)

>>> dsp = Dispatcher()
>>> load_map(dsp, file_name)
>>> dsp.dispatch(inputs={'a': 1, 'b': 3})['c']
3
```

## save\_default\_values

**save\_default\_values** (*dsp, path*)

Write Dispatcher default values in Python pickle format.

Pickles are a serialized byte stream of a Python object. This format will preserve Python objects used as nodes or edges.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **path** (*str, file*) – File or filename to write. File names ending in .gz or .bz2 will be compressed.

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher()
>>> dsp.add_data('a', default_value=1)
'a'
>>> dsp.add_function(function=max, inputs=['a', 'b'], outputs=['c'])
'max'
>>> save_default_values(dsp, file_name)
```

## save\_dispatcher

**save\_dispatcher** (*dsp, path*)

Write Dispatcher object in Python pickle format.

Pickles are a serialized byte stream of a Python object. This format will preserve Python objects used as nodes or edges.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.

- **path** (*str*, *file*) – File or filename to write. File names ending in .gz or .bz2 will be compressed.

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher()
>>> dsp.add_data('a', default_value=1)
'a'
>>> dsp.add_function(function=max, inputs=['a', 'b'], outputs=['c'])
'max'
>>> save_dispatcher(dsp, file_name)
```

## save\_map

**save\_map** (*dsp*, *path*)

Write Dispatcher graph object in Python pickle format.

Pickles are a serialized byte stream of a Python object. This format will preserve Python objects used as nodes or edges.

### Parameters

- **dsp** (*schedula.Dispatcher*) – A dispatcher that identifies the model adopted.
- **path** (*str*, *file*) – File or filename to write. File names ending in .gz or .bz2 will be compressed.

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher()
>>> dsp.add_function(function=max, inputs=['a', 'b'], outputs=['c'])
'max'
>>> save_map(dsp, file_name)
```

## 7.2.14 sol

It provides a solution class for dispatch result.

### Classes

---

*Solution*

Solution class for dispatch result.

---

### Solution

```
class Solution (dsp=None, inputs=None, outputs=None, wildcard=False, cutoff=None, inputs_dist=None, no_call=False, rm_unused_nds=False, wait_in=None, no_domain=False, _empty=False, index=(-1,), full_name=())
```

Solution class for dispatch result.

### Methods

<code>__init__</code>	Initialize self.
<code>clear</code>	
<code>copy</code>	
<code>fromkeys</code>	Create a new ordered dictionary with keys from iterable and values set to value.
<code>get</code>	Return the value for key if key is in the dictionary, else default.
<code>get_node</code>	Returns a sub node of a dispatcher.
<code>get_sub_dsp_from_workflow</code>	Returns the sub-dispatcher induced by the workflow from sources.
<code>items</code>	
<code>keys</code>	
<code>move_to_end</code>	Move an existing element to the end (or beginning if last is false).
<code>plot</code>	Plots the Dispatcher with a graph in the DOT language with Graphviz.
<code>pop</code>	value.
<code>popitem</code>	Remove and return a (key, value) pair from the dictionary.
<code>result</code>	Set all asynchronous results.
<code>setdefault</code>	Insert key with a value of default if key is not in the dictionary.
<code>update</code>	If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]
<code>values</code>	
<code>web</code>	Creates a dispatcher Flask app.

### `__init__`

`Solution.__init__(dsp=None, inputs=None, outputs=None, wildcard=False, cutoff=None, inputs_dist=None, no_call=False, rm_unused_nds=False, wait_in=None, no_domain=False, _empty=False, index=(-1, ), full_name=())`  
 Initialize self. See help(type(self)) for accurate signature.

### `clear`

`Solution.clear()` → None. Remove all items from od.

### `copy`

`Solution.copy()` → a shallow copy of od

### `fromkeys`

`Solution.fromkeys()`  
 Create a new ordered dictionary with keys from iterable and values set to value.

## get

`Solution.get()`

Return the value for key if key is in the dictionary, else default.

## get\_node

`Solution.get_node(*node_ids, node_attr=None)`

Returns a sub node of a dispatcher.

### Parameters

- **node\_ids** (*str*) – A sequence of node ids or a single node id. The id order identifies a dispatcher sub-level.
- **node\_attr** (*str, None, optional*) – Output node attr.

If the searched node does not have this attribute, all its attributes are returned.

When 'auto', returns the "default" attributes of the searched node, which are:

- for data node: its output, and if not exists, all its attributes.
- for function and sub-dispatcher nodes: the 'function' attribute.

When 'description', returns the "description" of the searched node, searching also in function or sub-dispatcher input/output description.

When 'output', returns the data node output.

When 'default\_value', returns the data node default value.

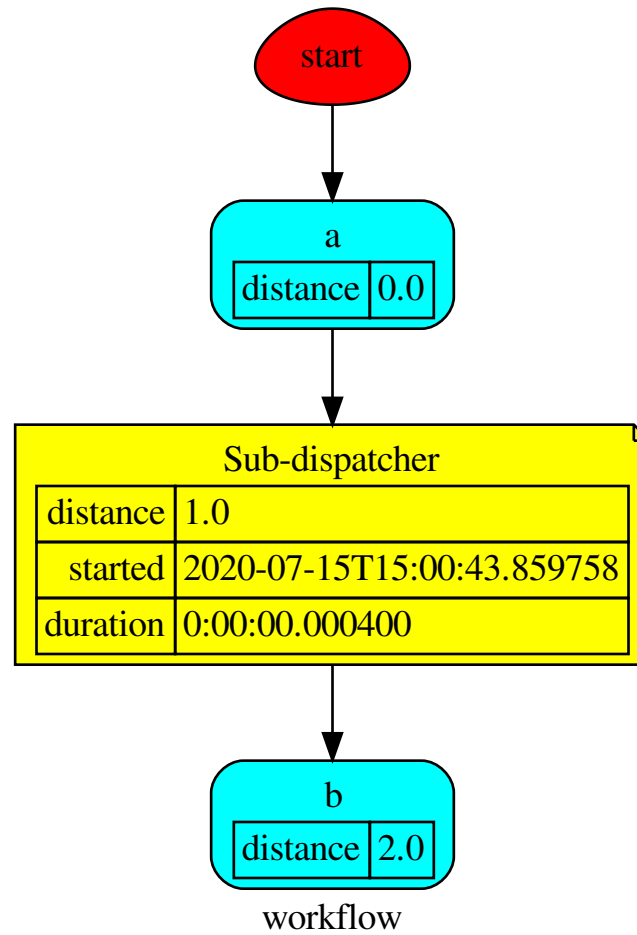
When 'value\_type', returns the data node value's type.

When *None*, returns the node attributes.

**Returns** Node attributes and its real path.

**Return type** (T, (str, ..))

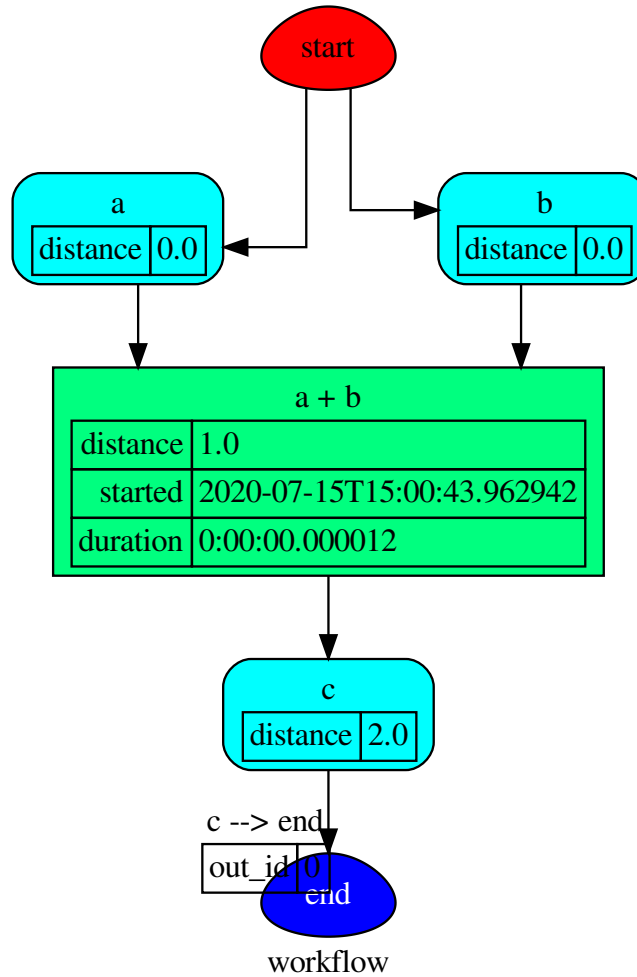
**Example:**



Get the sub node output:

```
>>> dsp.get_node('Sub-dispatcher', 'c')
(4, ('Sub-dispatcher', 'c'))
>>> dsp.get_node('Sub-dispatcher', 'c', node_attr='type')
('data', ('Sub-dispatcher', 'c'))
```

```
>>> sub_dsp, sub_dsp_id = dsp.get_node('Sub-dispatcher')
```



### get\_sub\_dsp\_from\_workflow

`Solution.get_sub_dsp_from_workflow(sources, reverse=False, add_missing=False, check_inputs=True)`

Returns the sub-dispatcher induced by the workflow from sources.

The induced sub-dispatcher of the dsp contains the reachable nodes and edges evaluated with breadth-first-search on the workflow graph from source nodes.

#### Parameters

- **sources** (*list[str], iterable*) – Source nodes for the breadth-first-search. A container of nodes which will be iterated through once.
- **reverse** (*bool, optional*) – If True the workflow graph is assumed as reversed.

- **add\_missing** (*bool, optional*) – If True, missing function’ inputs are added to the sub-dispatcher.
- **check\_inputs** (*bool, optional*) – If True the missing function’ inputs are not checked.

**Returns** A sub-dispatcher.

**Return type** *schedula.dispatcher.Dispatcher*

## items

`Solution.items()` → a set-like object providing a view on D’s items

## keys

`Solution.keys()` → a set-like object providing a view on D’s keys

## move\_to\_end

`Solution.move_to_end()`

Move an existing element to the end (or beginning if last is false).

Raise `KeyError` if the element does not exist.

## plot

`Solution.plot` (*workflow=None, view=True, depth=-1, name=None, comment=None, format=None, engine=None, encoding=None, graph\_attr=None, node\_attr=None, edge\_attr=None, body=None, node\_styles=None, node\_data=None, node\_function=None, edge\_data=None, max\_lines=None, max\_width=None, directory=None, sites=None, index=False*)

Plots the Dispatcher with a graph in the DOT language with Graphviz.

### Parameters

- **workflow** (*bool, optional*) – If True the latest solution will be plotted, otherwise the dmap.
- **view** (*bool, optional*) – Open the rendered directed graph in the DOT language with the sys default opener.
- **edge\_data** (*tuple[str], optional*) – Edge attributes to view.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **node\_styles** (*dict[str|Token, dict[str, str]]*) – Default node styles according to graphviz node attributes.
- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **name** (*str*) – Graph name used in the source code.



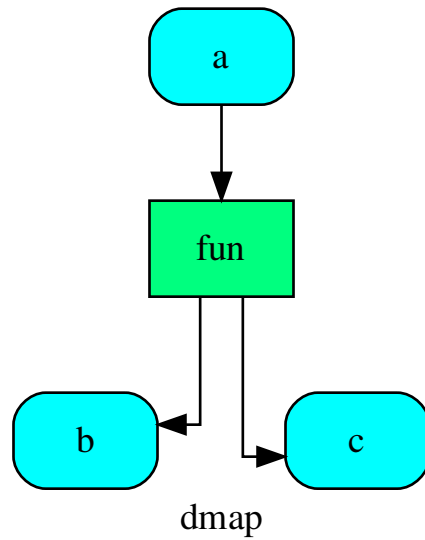
- **comment** (*str*) – Comment added to the first line of the source.
- **directory** (*str*, *optional*) – (Sub)directory for source saving and rendering.
- **format** (*str*, *optional*) – Rendering output format ('pdf', 'png', ...).
- **engine** (*str*, *optional*) – Layout command used ('dot', 'neato', ...).
- **encoding** (*str*, *optional*) – Encoding for saving the source.
- **graph\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs for the graph.
- **node\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs set for all nodes.
- **edge\_attr** (*dict*, *optional*) – Dict of (attribute, value) pairs set for all edges.
- **body** (*dict*, *optional*) – Dict of (attribute, value) pairs to add to the graph body.
- **directory** – Where is the generated Flask app root located?
- **sites** (*set* [*Site*], *optional*) – A set of *Site* to maintain alive the back-end server.
- **index** (*bool*, *optional*) – Add the site index as first page?
- **max\_lines** (*int*, *optional*) – Maximum number of lines for rendering node attributes.
- **max\_width** (*int*, *optional*) – Maximum number of characters in a line to render node attributes.
- **view** – Open the main page of the site?

**Returns** A SiteMap.

**Return type** *schedula.utils.drw.SiteMap*

Example:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
>>> dsp.plot(view=False, graph_attr={'ratio': '1'})
SiteMap([(Dispatcher, SiteMap())])
```



### pop

`Solution.pop(k[, d])` → *v*, remove specified key and return the corresponding value. If key is not found, *d* is returned if given, otherwise `KeyError` is raised.

### popitem

`Solution.popitem()`

Remove and return a (key, value) pair from the dictionary.

Pairs are returned in LIFO order if `last` is `true` or FIFO order if `false`.

### result

`Solution.result(timeout=None)`

Set all asynchronous results.

**Parameters** `timeout` (*float*) – The number of seconds to wait for the result if the futures aren't done. If `None`, then there is no limit on the wait time.

**Returns** Update `Solution`.

**Return type** *Solution*

## setdefault

`Solution.setdefault()`

Insert key with a value of default if key is not in the dictionary.

Return the value for key if key is in the dictionary, else default.

## update

`Solution.update([E], **F)` → None. Update D from dict/iterable E and F.

If E is present and has a `.keys()` method, then does: for k in E: D[k] = E[k] If E is present and lacks a `.keys()` method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]

## values

`Solution.values()` → an object providing a view on D's values

## web

`Solution.web(depth=-1, node_data=None, node_function=None, directory=None, sites=None, run=True)`

Creates a dispatcher Flask app.

### Parameters

- **depth** (*int, optional*) – Depth of sub-dispatch plots. If negative all levels are plotted.
- **node\_data** (*tuple[str], optional*) – Data node attributes to view.
- **node\_function** (*tuple[str], optional*) – Function node attributes to view.
- **directory** (*str, optional*) – Where is the generated Flask app root located?
- **sites** (*set[Site], optional*) – A set of *Site* to maintain alive the backend server.
- **run** (*bool, optional*) – Run the backend server?

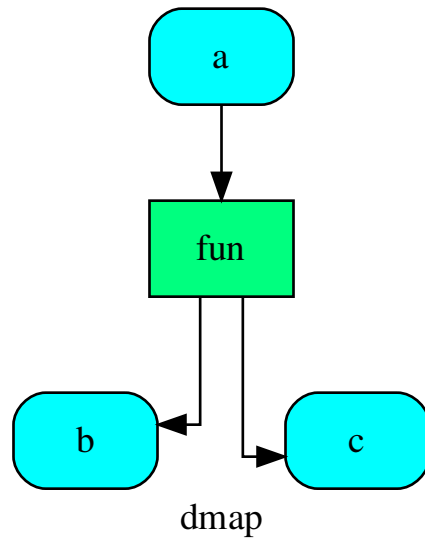
**Returns** A `WebMap`.

**Return type** `WebMap`

Example:

From a dispatcher like this:

```
>>> from schedula import Dispatcher
>>> dsp = Dispatcher(name='Dispatcher')
>>> def fun(a):
...     return a + 1, a - 1
>>> dsp.add_function('fun', fun, ['a'], ['b', 'c'])
'fun'
```



You can create a web server with the following steps:

```

>>> webmap = dsp.web()
>>> print("Starting...\n"); site = webmap.site().run(); site
Starting...
Site(WebMap([(Dispatcher, WebMap())]), host='localhost', ...)
>>> import requests
>>> url = '%s/%s/%s' % (site.url, dsp.name, fun.__name__)
>>> requests.post(url, json={'args': (0,)}) .json() ['return']
[1, -1]
>>> site.shutdown() # Remember to shutdown the server.
True
  
```

---

**Note:** When *Site* is garbage collected, the server is shutdown automatically.

---

```

__init__(dsp=None, inputs=None, outputs=None, wildcard=False, cutoff=None, inputs_dist=None,
         no_call=False, rm_unused_nds=False, wait_in=None, no_domain=False, _empty=False,
         index=(-1, ), full_name=())
  Initialize self. See help(type(self)) for accurate signature.
  
```

### Attributes

---

<i>pipe</i>	Returns the full pipe of a dispatch run.
-------------	--

---

## pipe

### `Solution.pipe`

Returns the full pipe of a dispatch run.

### **result** (*timeout=None*)

Set all asynchronous results.

**Parameters** **timeout** (*float*) – The number of seconds to wait for the result if the futures aren't done. If None, then there is no limit on the wait time.

**Returns** Update Solution.

**Return type** *Solution*

### **get\_sub\_dsp\_from\_workflow** (*sources, reverse=False, add\_missing=False, check\_inputs=True*)

Returns the sub-dispatcher induced by the workflow from sources.

The induced sub-dispatcher of the dsp contains the reachable nodes and edges evaluated with breadth-first-search on the workflow graph from source nodes.

#### **Parameters**

- **sources** (*list[str], iterable*) – Source nodes for the breadth-first-search. A container of nodes which will be iterated through once.
- **reverse** (*bool, optional*) – If True the workflow graph is assumed as reversed.
- **add\_missing** (*bool, optional*) – If True, missing function' inputs are added to the sub-dispatcher.
- **check\_inputs** (*bool, optional*) – If True the missing function' inputs are not checked.

**Returns** A sub-dispatcher.

**Return type** *schedula.dispatcher.Dispatcher*

## pipe

Returns the full pipe of a dispatch run.

## 7.2.15 web

It provides functions to build a flask app from a dispatcher.

### Classes

---

*FolderNodeWeb*

---

*WebFolder*

---

*WebMap*

---

*WebNode*

---

### FolderNodeWeb

**class FolderNodeWeb** (*folder, node\_id, attr, \*\*options*)

## Methods

<code>__init__</code>	Initialize self.
<code>dot</code>	
<code>href</code>	
<code>items</code>	
<code>parent_ref</code>	
<code>render_funcs</code>	
<code>render_size</code>	
<code>style</code>	
<code>yield_attr</code>	

### `__init__`

FolderNodeWeb.**\_\_init\_\_** (*folder, node\_id, attr, \*\*options*)  
 Initialize self. See help(type(self)) for accurate signature.

### `dot`

FolderNodeWeb.**dot** (*context=None*)

### `href`

FolderNodeWeb.**href** (*context, link\_id*)

### `items`

FolderNodeWeb.**items** ()

### `parent_ref`

FolderNodeWeb.**parent\_ref** (*context, node\_id, attr=None*)

### `render_funcs`

FolderNodeWeb.**render\_funcs** ()

### `render_size`

FolderNodeWeb.**render\_size** (*out*)

### `style`

FolderNodeWeb.**style** ()

## yield\_attr

FolderNodeWeb.**yield\_attr** (*name*)

**\_\_init\_\_** (*folder, node\_id, attr, \*\*options*)

Initialize self. See help(type(self)) for accurate signature.

## Attributes

---

counter
edge_data
max_lines
max_width
node_data
node_function
node_map
node_styles
re_node
title
type

---

### counter

FolderNodeWeb.**counter** = <method-wrapper '\_\_next\_\_' of itertools.count object>

### edge\_data

FolderNodeWeb.**edge\_data** = ()

### max\_lines

FolderNodeWeb.**max\_lines** = 5

### max\_width

FolderNodeWeb.**max\_width** = 200

### node\_data

FolderNodeWeb.**node\_data** = ()

### node\_function

FolderNodeWeb.**node\_function** = ('+function',)

### node\_map

FolderNodeWeb.**node\_map** = {'': ('dot', 'table'), '!': ('dot', 'table'), '\*': ('link'

### node\_styles

FolderNodeWeb.**node\_styles** = {'error': {empty: {'fillcolor': 'gray', 'label': 'empt.

### re\_node

FolderNodeWeb.**re\_node** = **regex.Regex**('^(*[.\*+! ]?*)(*[\\w ]+*)(*?>\\|*(*[\\w ]+*)*?\$'*, flags=reg

### title

FolderNodeWeb.**title**

### type

FolderNodeWeb.**type**

## WebFolder

**class WebFolder** (*item, dsp, graph, obj, name=""*, workflow=False, digraph=None, parent=None, *\*\*options*)

### Methods

<code>__init__</code>	Initialize self.
<code>dot</code>	
<code>view</code>	

### `__init__`

WebFolder.**\_\_init\_\_** (*item, dsp, graph, obj, name=""*, workflow=False, digraph=None, parent=None, *\*\*options*)

Initialize self. See help(type(self)) for accurate signature.

### `dot`

WebFolder.**dot** (*context=None*)

### `view`

WebFolder.**view** (*filepath, context=None*)



`__init__` (*item, dsp, graph, obj, name="*, *workflow=False, digraph=None, parent=None, \*\*options*)  
 Initialize self. See help(type(self)) for accurate signature.

## Attributes

counter
digraph
ext
filename
inputs
label_name
name
outputs
title
view_id

### counter

`WebFolder.counter` = <method-wrapper `'__next__'` of `itertools.count` object>

### digraph

`WebFolder.digraph` = {'body': {'splines': 'ortho', 'style': 'filled'}, 'edge\_attr':

### ext

`WebFolder.ext` = ''

### filename

`WebFolder.filename`

### inputs

`WebFolder.inputs`

### label\_name

`WebFolder.label_name`

### name

`WebFolder.name`

## outputs

WebFolder.**outputs**

## title

WebFolder.**title**

## view\_id

WebFolder.**view\_id**

## WebMap

**class WebMap**

### Methods

<code>__init__</code>	Initialize self.
<code>add_items</code>	
<code>app</code>	
<code>clear</code>	
<code>copy</code>	
<code>fromkeys</code>	Create a new ordered dictionary with keys from iterable and values set to value.
<code>get</code>	Return the value for key if key is in the dictionary, else default.
<code>get_dsp_from</code>	
<code>get_sol_from</code>	
<code>items</code>	
<code>keys</code>	
<code>move_to_end</code>	Move an existing element to the end (or beginning if last is false).
<code>pop</code>	value.
<code>popitem</code>	Remove and return a (key, value) pair from the dictionary.
<code>render</code>	
<code>rules</code>	
<code>setdefault</code>	Insert key with a value of default if key is not in the dictionary.
<code>site</code>	
<code>site_index</code>	
<code>update</code>	If E is present and has a .keys() method, then does: for k in E: D[k] = E[k] If E is present and lacks a .keys() method, then does: for k, v in E: D[k] = v In either case, this is followed by: for k in F: D[k] = F[k]
<code>values</code>	

## `__init__`

`WebMap.__init__()`  
 Initialize self. See `help(type(self))` for accurate signature.

## `add_items`

`WebMap.add_items(item, workflow=False, depth=-1, folder=None, **options)`

## `app`

`WebMap.app(root_path=None, depth=-1, mute=False, **kwargs)`

## `clear`

`WebMap.clear()` → None. Remove all items from od.

## `copy`

`WebMap.copy()` → a shallow copy of od

## `fromkeys`

`WebMap.fromkeys()`  
 Create a new ordered dictionary with keys from iterable and values set to value.

## `get`

`WebMap.get()`  
 Return the value for key if key is in the dictionary, else default.

## `get_dsp_from`

`static WebMap.get_dsp_from(item)`

## `get_sol_from`

`static WebMap.get_sol_from(item)`

## `items`

`WebMap.items()` → a set-like object providing a view on D's items

## keys

`WebMap.keys()` → a set-like object providing a view on D's keys

## move\_to\_end

`WebMap.move_to_end()`

Move an existing element to the end (or beginning if last is false).

Raise `KeyError` if the element does not exist.

## pop

`WebMap.pop(k[, d])` → v, remove specified key and return the corresponding value. If key is not found, d is returned if given, otherwise `KeyError` is raised.

## popitem

`WebMap.popitem()`

Remove and return a (key, value) pair from the dictionary.

Pairs are returned in LIFO order if last is true or FIFO order if false.

## render

`WebMap.render(*args, **kwargs)`

## rules

`WebMap.rules(depth=-1, index=True)`

## setdefault

`WebMap.setdefault()`

Insert key with a value of default if key is not in the dictionary.

Return the value for key if key is in the dictionary, else default.

## site

`WebMap.site(root_path=None, depth=-1, index=True, view=False, **kw)`

## site\_index

`WebMap.site_index(**kwargs)`

## update

`WebMap.update([E], **F) → None`. Update D from dict/iterable E and F.

If E is present and has a `.keys()` method, then does: for k in E: `D[k] = E[k]` If E is present and lacks a `.keys()` method, then does: for k, v in E: `D[k] = v` In either case, this is followed by: for k in F: `D[k] = F[k]`

## values

`WebMap.values()` → an object providing a view on D's values

`__init__()`

Initialize self. See `help(type(self))` for accurate signature.

## Attributes

---

`include_folders_as_filenames`

---

`nodes`

---

`options`

---

### include\_folders\_as\_filenames

`WebMap.include_folders_as_filenames = False`

### nodes

`WebMap.nodes`

### options

`WebMap.options = {'digraph', 'edge_data', 'max_lines', 'max_width', 'node_data', 'node'`

## WebNode

`class WebNode(folder, node_id, item, obj, dsp_node_id)`

### Methods

---

`__init__` Initialize self.

---

`render`

---

`view`

---

`__init__`

`WebNode.__init__(folder, node_id, item, obj, dsp_node_id)`

Initialize self. See `help(type(self))` for accurate signature.

## render

`WebNode.render(*args, **kwargs)`

## view

`WebNode.view(filepath, *args, **kwargs)`

`__init__(folder, node_id, item, obj, dsp_node_id)`  
Initialize self. See `help(type(self))` for accurate signature.

## Attributes

---

`counter`

---

`ext`

---

`filename`

---

`name`

---

`title`

---

`view_id`

---

## counter

`WebNode.counter = <method-wrapper '__next__' of itertools.count object>`

## ext

`WebNode.ext = ''`

## filename

`WebNode.filename`

## name

`WebNode.name`

## title

`WebNode.title`

## view\_id

`WebNode.view_id`

## 7.3 ext

It provides sphinx extensions.

Extensions:

<i>autosummary</i>	It is a patch to sphinx.ext.autosummary.
<i>dispatcher</i>	It provides dispatcher sphinx documenter and directive.

### 7.3.1 autosummary

It is a patch to sphinx.ext.autosummary.

#### Functions

<i>generate_autosummary_docs</i>
<i>get_members</i>
<i>process_generate_options</i>
<i>setup</i>

#### generate\_autosummary\_docs

**generate\_autosummary\_docs** (*sources*, *output\_dir=None*, *suffix='.rst'*, *warn=<function \_simple\_warn>*, *info=<function \_simple\_info>*, *base\_path=None*, *builder=None*, *template\_dir=None*, *app=None*)

#### get\_members

**get\_members** (*app*, *obj*, *typ*, *include\_public=()*, *imported=False*)

#### process\_generate\_options

**process\_generate\_options** (*app*)

#### setup

**setup** (*app*)

### 7.3.2 dispatcher

It provides dispatcher sphinx documenter and directive.

Extensions:

<i>documenter</i>	Dispatcher documenter.
<i>graphviz</i>	Dispatcher directive.

## documenter

Dispatcher documenter.

## Functions

---

<code>add_autodocumenter</code>	
<code>contains_doctest</code>	
<code>get_grandfather_content</code>	
<code>get_grandfather_offset</code>	
<code>setup</code>	Setup <i>dispatcher</i> Sphinx extension module.

---

### add\_autodocumenter

**add\_autodocumenter** (*app*, *cls*)

### contains\_doctest

**contains\_doctest** (*text*)

### get\_grandfather\_content

**get\_grandfather\_content** (*content*, *level=2*)

### get\_grandfather\_offset

**get\_grandfather\_offset** (*content*)

### setup

**setup** (*app*)  
Setup *dispatcher* Sphinx extension module.

## Classes

---

<code>DispatcherDirective</code>	
<code>DispatcherDocumenter</code>	Specialized Documenter subclass for dispatchers.

---

### DispatcherDirective

**class DispatcherDirective** (*name*, *arguments*, *options*, *content*, *lineno*, *content\_offset*, *\*args*,  
*\*\*kwargs*)



## Methods

<code>__init__</code>	Initialize self.
<code>add_name</code>	Append <code>self.options['name']</code> to <code>node['names']</code> if it exists.
<code>assert_has_content</code>	Throw an ERROR-level <code>DirectiveError</code> if the directive doesn't have contents.
<code>debug</code>	
<code>directive_error</code>	Return a <code>DirectiveError</code> suitable for being thrown as an exception.
<code>error</code>	
<code>info</code>	
<code>run</code>	
<code>severe</code>	
<code>warning</code>	

### `__init__`

`DispatcherDirective.__init__(name, arguments, options, content, lineno, content_offset, *args, **kwargs)`  
 Initialize self. See `help(type(self))` for accurate signature.

### `add_name`

`DispatcherDirective.add_name(node)`  
 Append `self.options['name']` to `node['names']` if it exists.  
 Also normalize the name string and register it as explicit target.

### `assert_has_content`

`DispatcherDirective.assert_has_content()`  
 Throw an ERROR-level `DirectiveError` if the directive doesn't have contents.

### `debug`

`DispatcherDirective.debug(message)`

### `directive_error`

`DispatcherDirective.directive_error(level, message)`  
 Return a `DirectiveError` suitable for being thrown as an exception.

Call “`raise self.directive_error(level, message)`” from within a directive implementation to return one single system message at level *level*, which automatically gets the directive block and the line number added.

Preferably use the `debug`, `info`, `warning`, `error`, or `severe` wrapper methods, e.g. `self.error(message)` to generate an ERROR-level directive error.

### error

DispatcherDirective.**error** (*message*)

### info

DispatcherDirective.**info** (*message*)

### run

DispatcherDirective.**run** ()

### severe

DispatcherDirective.**severe** (*message*)

### warning

DispatcherDirective.**warning** (*message*)

**\_\_init\_\_** (*name, arguments, options, content, lineno, content\_offset, \*args, \*\*kwargs*)  
Initialize self. See help(type(self)) for accurate signature.

### Attributes

<code>config</code>	Reference to the Config object.
<code>env</code>	Reference to the BuildEnvironment object.
<code>final_argument_whitespace</code>	
<code>has_content</code>	
<code>optional_arguments</code>	
<code>required_arguments</code>	

### config

DispatcherDirective.**config**  
Reference to the Config object.

### env

DispatcherDirective.**env**  
Reference to the BuildEnvironment object.

### final\_argument\_whitespace

DispatcherDirective.**final\_argument\_whitespace** = True

### has\_content

DispatcherDirective.**has\_content** = True

### optional\_arguments

DispatcherDirective.**optional\_arguments** = 0

### required\_arguments

DispatcherDirective.**required\_arguments** = 1

## DispatcherDocumenter

**class DispatcherDocumenter** (*directive, name, indent=""*)  
Specialized Documenter subclass for dispatchers.

### Methods

<code>__init__</code>	Initialize self.
<code>add_content</code>	Add content from docstrings, attribute documentation and user.
<code>add_directive_header</code>	Add the directive header and options to the generated content.
<code>add_line</code>	Append one line of generated reST to the output.
<code>can_document_member</code>	Called to see if a member can be documented by this documenter.
<code>check_module</code>	Check if <i>self.object</i> is really defined in the module given by <i>self.modname</i> .
<code>document_members</code>	Generate reST for member documentation.
<code>filter_members</code>	Filter the given member list.
<code>format_args</code>	Format the argument signature of <i>self.object</i> .
<code>format_name</code>	Format the name of <i>self.object</i> .
<code>format_signature</code>	Format the signature (arguments and return annotation) of the object.
<code>generate</code>	Generate reST for the object given by <i>self.name</i> , and possibly for its members.
<code>get_attr</code>	getattr() override for types such as Zope interfaces.
<code>get_doc</code>	Decode and return lines of the docstring(s) for the object.
<code>get_object_members</code>	Return ( <i>members_check_module, members</i> ) where <i>members</i> is a list of ( <i>membername, member</i> ) pairs of the members of <i>self.object</i> .
<code>get_real_modname</code>	Get the real module name of an object to document.
<code>get_sourcename</code>	
<code>import_object</code>	Import the object given by <i>self.modname</i> and <i>self.objpath</i> and set it as <i>self.object</i> .

Continued on next page

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<code>parse_name</code>	Determine what module to import and what attribute to document.
<code>process_doc</code>	Let the user process the docstrings before adding them.
<code>resolve_name</code>	Resolve the module and name of the object to document given by the arguments and the current module/class.

### `__init__`

`DispatcherDocumenter.__init__(directive, name, indent=)`  
 Initialize self. See `help(type(self))` for accurate signature.

### `add_content`

`DispatcherDocumenter.add_content(more_content, no_docstring=False)`  
 Add content from docstrings, attribute documentation and user.

### `add_directive_header`

`DispatcherDocumenter.add_directive_header(sig)`  
 Add the directive header and options to the generated content.

### `add_line`

`DispatcherDocumenter.add_line(line, source, *lineno)`  
 Append one line of generated reST to the output.

### `can_document_member`

**classmethod** `DispatcherDocumenter.can_document_member(member, *args, **kwargs)`  
 Called to see if a member can be documented by this documenter.

### `check_module`

`DispatcherDocumenter.check_module()`  
 Check if `self.object` is really defined in the module given by `self.modname`.

### `document_members`

`DispatcherDocumenter.document_members(all_members=False)`  
 Generate reST for member documentation.  
 If `all_members` is True, do all members, else those given by `self.options.members`.

## filter\_members

DispatcherDocumenter.**filter\_members** (*members*, *want\_all*)

Filter the given member list.

Members are skipped if

- they are private (except if given explicitly or the private-members option is set)
- they are special methods (except if given explicitly or the special-members option is set)
- they are undocumented (except if the undoc-members option is set)

The user can override the skipping decision by connecting to the `autodoc-skip-member` event.

## format\_args

DispatcherDocumenter.**format\_args** ()

Format the argument signature of *self.object*.

Should return None if the object does not have a signature.

## format\_name

DispatcherDocumenter.**format\_name** ()

Format the name of *self.object*.

This normally should be something that can be parsed by the generated directive, but doesn't need to be (Sphinx will display it unparsed then).

## format\_signature

DispatcherDocumenter.**format\_signature** ()

Format the signature (arguments and return annotation) of the object.

Let the user process it via the `autodoc-process-signature` event.

## generate

DispatcherDocumenter.**generate** (*more\_content=*None, *\*\*kw*)

Generate reST for the object given by *self.name*, and possibly for its members.

If *more\_content* is given, include that content. If *real\_modname* is given, use that module name to find attribute docs. If *check\_module* is True, only generate if the object is defined in the module name it is imported from. If *all\_members* is True, document all members.

## get\_attr

DispatcherDocumenter.**get\_attr** (*obj*, *name*, *\*defargs*)

getattr() override for types such as Zope interfaces.

### **get\_doc**

`DispatcherDocumenter.get_doc(encoding=None, ignore=1)`  
Decode and return lines of the docstring(s) for the object.

### **get\_object\_members**

`DispatcherDocumenter.get_object_members(want_all)`  
Return *(members\_check\_module, members)* where *members* is a list of *(membername, member)* pairs of the members of *self.object*.  
If *want\_all* is True, return all members. Else, only return those members given by *self.options.members* (which may also be none).

### **get\_real\_modname**

`DispatcherDocumenter.get_real_modname()`  
Get the real module name of an object to document.  
It can differ from the name of the module through which the object was imported.

### **get\_sourcename**

`DispatcherDocumenter.get_sourcename()`

### **import\_object**

`DispatcherDocumenter.import_object()`  
Import the object given by *self.modname* and *self.objpath* and set it as *self.object*.  
Returns True if successful, False if an error occurred.

### **parse\_name**

`DispatcherDocumenter.parse_name()`  
Determine what module to import and what attribute to document.  
Returns True and sets *self.modname*, *self.objpath*, *self.fullname*, *self.args* and *self.retann* if parsing and resolving was successful.

### **process\_doc**

`DispatcherDocumenter.process_doc(docstrings)`  
Let the user process the docstrings before adding them.

## resolve\_name

DispatcherDocumenter.**resolve\_name** (*modname, parents, path, base*)

Resolve the module and name of the object to document given by the arguments and the current module/class.

Must return a pair of the module name and a chain of attributes; for example, it would return ('zipfile', ['ZipFile', 'open']) for the zipfile.ZipFile.open method.

**\_\_init\_\_** (*directive, name, indent=*)

Initialize self. See help(type(self)) for accurate signature.

## Attributes

blue_cache	
code	
content_indent	
default_opt	
directivetype	
documenters	Returns registered Documenter classes
is_doctest	
member_order	
objtype	
option_spec	
priority	
titles_allowed	

### blue\_cache

DispatcherDocumenter.**blue\_cache** = {}

### code

DispatcherDocumenter.**code** = None

### content\_indent

DispatcherDocumenter.**content\_indent** = ''

### default\_opt

DispatcherDocumenter.**default\_opt** = {'depth': 0, 'view': False}

### directivetype

DispatcherDocumenter.**directivetype** = 'data'

## documenters

`DispatcherDocumenter.documenters`  
Returns registered Documenter classes

## is\_doctest

`DispatcherDocumenter.is_doctest = False`

## member\_order

`DispatcherDocumenter.member_order = 40`

## objtype

`DispatcherDocumenter.objtype = 'dispatcher'`

## option\_spec

`DispatcherDocumenter.option_spec = {'annotation': <function annotation_option>, 'code`

## priority

`DispatcherDocumenter.priority = -10`

## titles\_allowed

`DispatcherDocumenter.titles_allowed = False`

### `get_real_modname()`

Get the real module name of an object to document.

It can differ from the name of the module through which the object was imported.

### `classmethod can_document_member(member, *args, **kwargs)`

Called to see if a member can be documented by this documenter.

### `add_directive_header(sig)`

Add the directive header and options to the generated content.

### `parse_name()`

Determine what module to import and what attribute to document.

Returns True and sets `self.modname`, `self.objpath`, `self.fullname`, `self.args` and `self.retann` if parsing and resolving was successful.

### `generate(more_content=None, **kw)`

Generate reST for the object given by `self.name`, and possibly for its members.

If `more_content` is given, include that content. If `real_modname` is given, use that module name to find attribute docs. If `check_module` is True, only generate if the object is defined in the module name it is imported from. If `all_members` is True, document all members.



**import\_object ()**

Import the object given by *self.modname* and *self.objpath* and set it as *self.object*.

Returns True if successful, False if an error occurred.

**format\_signature ()**

Format the signature (arguments and return annotation) of the object.

Let the user process it via the `autodoc-process-signature` event.

**add\_content (more\_content, no\_docstring=False)**

Add content from docstrings, attribute documentation and user.

**graphviz**

Dispatcher directive.

**Functions**

---

<i>html_visit_dispatcher</i>	
<i>setup</i>	Setup <i>dsp</i> Sphinx extension module.
<i>warn_for_deprecated_option</i>	

---

**html\_visit\_dispatcher**

**html\_visit\_dispatcher** (*self, node*)

**setup**

**setup** (*app*)

Setup *dsp* Sphinx extension module.

**warn\_for\_deprecated\_option**

**warn\_for\_deprecated\_option** (*\*args, \*\*kwargs*)

**Classes**

---

<i>DispatcherSphinxDirective</i>
----------------------------------

---

**DispatcherSphinxDirective**

**class DispatcherSphinxDirective** (*name, arguments, options, content, lineno, content\_offset, block\_text, state, state\_machine*)

**Methods**

<code>__init__</code>	Initialize self.
<code>add_name</code>	Append self.options['name'] to node['names'] if it exists.
<code>assert_has_content</code>	Throw an ERROR-level DirectiveError if the directive doesn't have contents.
<code>debug</code>	
<code>directive_error</code>	Return a DirectiveError suitable for being thrown as an exception.
<code>error</code>	
<code>info</code>	
<code>run</code>	
<code>severe</code>	
<code>warning</code>	

### `__init__`

DispatcherSphinxDirective.**\_\_init\_\_**(*name, arguments, options, content, lineno, content\_offset, block\_text, state, state\_machine*)  
 Initialize self. See help(type(self)) for accurate signature.

### `add_name`

DispatcherSphinxDirective.**add\_name**(*node*)  
 Append self.options['name'] to node['names'] if it exists.  
 Also normalize the name string and register it as explicit target.

### `assert_has_content`

DispatcherSphinxDirective.**assert\_has\_content**()  
 Throw an ERROR-level DirectiveError if the directive doesn't have contents.

### `debug`

DispatcherSphinxDirective.**debug**(*message*)

### `directive_error`

DispatcherSphinxDirective.**directive\_error**(*level, message*)  
 Return a DirectiveError suitable for being thrown as an exception.  
 Call “raise self.directive\_error(level, message)” from within a directive implementation to return one single system message at level *level*, which automatically gets the directive block and the line number added.  
 Preferably use the *debug*, *info*, *warning*, *error*, or *severe* wrapper methods, e.g. `self.error(message)` to generate an ERROR-level directive error.

## error

DispatcherSphinxDirective.**error** (*message*)

## info

DispatcherSphinxDirective.**info** (*message*)

## run

DispatcherSphinxDirective.**run** ()

## severe

DispatcherSphinxDirective.**severe** (*message*)

## warning

DispatcherSphinxDirective.**warning** (*message*)

**\_\_init\_\_** (*name, arguments, options, content, lineno, content\_offset, block\_text, state, state\_machine*)  
Initialize self. See help(type(self)) for accurate signature.

## Attributes

<code>config</code>	Reference to the Config object.
<code>env</code>	Reference to the BuildEnvironment object.
<code>final_argument_whitespace</code>	
<code>has_content</code>	
<code>img_opt</code>	
<code>option_spec</code>	
<code>optional_arguments</code>	
<code>required_arguments</code>	

## config

DispatcherSphinxDirective.**config**  
Reference to the Config object.

## env

DispatcherSphinxDirective.**env**  
Reference to the BuildEnvironment object.

### **final\_argument\_whitespace**

`DispatcherSphinxDirective.final_argument_whitespace = False`

### **has\_content**

`DispatcherSphinxDirective.has_content = True`

### **img\_opt**

`DispatcherSphinxDirective.img_opt = {'height': <function length_or_unitless>, 'width': <function length_or_unitless>}`

### **option\_spec**

`DispatcherSphinxDirective.option_spec = {'align': <function align_spec>, 'alt': <function alt_spec>}`

### **optional\_arguments**

`DispatcherSphinxDirective.optional_arguments = 1`

### **required\_arguments**

`DispatcherSphinxDirective.required_arguments = 1`

## **Functions**

---

*setup*

Setup *dispatcher* Sphinx extension module.

---

### **setup**

**setup** (*app*)

Setup *dispatcher* Sphinx extension module.

### 8.1 v1.2.0 (2020-04-08)

#### 8.1.1 Feat

- (dispatcher): Avoid failure when functions does not have the name.
- (ubuild): Add compiled and not compiled code.
- (sol): Improve speed importing functions directly for *heappop* and *heappush*.
- (dispatcher): Avoid failure when functions does not have the name.
- (dsp): Simplify repr of inf numbers.
- (micropython): Pin specific MicroPython version *v1.12*.
- (micropython): Add test using *.mpy* files.
- (setup): Add *MicroPython* support.
- (setup): Drop *dill* dependency and add *io* extra.
- (github): Add pull request templates.

#### 8.1.2 Fix

- (test): Skip micropython tests.
- (ext): Update code for sphinx 3.0.0.
- (sphinx): Remove documentation warnings.
- (utils): Drop unused *pairwise* function.
- (dsp): Avoid fringe increment in *SubDispatchPipe*.

## 8.2 v1.1.1 (2020-03-12)

### 8.2.1 Feat

- (github): Add issue templates.
- (exc): Add base exception to *DispatcherError*.
- (build): Update build script.

## 8.3 v1.1.0 (2020-03-05)

### 8.3.1 Feat

- (core): Drop *networkx* dependency.
- (core): Add *ProcessPoolExecutor*.
- (asy): Add *ExecutorFactory* class.
- (asy): Split *asy* module.
- (core): Add support for python 3.8 and drop python 3.5.
- (asy): Check if *stopper* is set when getting executor.
- (asy): Add *mp\_context* option in *ProcessExecutor* and *ProcessPoolExecutor*.

### 8.3.2 Fix

- (alg): Correct pipe generation when *NoSub* found.
- (asy): Remove un-useful and dangerous states before serialization.
- (asy): Ensure wait of all executor futures.
- (asy): Correct bug when future is set.
- (asy): Correct init and shutdown of executors.
- (sol): Correct raise exception order in *sol.result*.
- (travis): Correct tests collector.
- (test): Correct test for multiple async.

## 8.4 v1.0.0 (2020-01-02)

### 8.4.1 Feat

- (doc): Add code of conduct.
- (examples): Add new example + formatting.
- (sol): New *raises* option, if *raises=""* no warning logs.
- (web): Add query param *data* to include/exclude data into the server JSON response.

- (sphinx): Update dispatcher documenter and directive.
- (drw): Add wildcard rendering.

### 8.4.2 Fix

- (test): Update test cases.
- (dsp): Correct pipe extraction for wildcards.
- (setup): Add missing *drw* files.

## 8.5 v0.3.7 (2019-12-06)

### 8.5.1 Feat

- (drw): Update the *index* GUI of the plot.
- (appveyor): Drop *appveyor* in favor of *travis*.
- (travis): Update travis configuration file.
- (plot): Add node link and id in graph plot.

### 8.5.2 Fix

- (drw): Render dot in temp folder.
- (plot): Add *quiet* arg to *\_view* method.
- (doc): Correct missing gh links.
- (core) #17: Correct deprecated Graph attribute.

## 8.6 v0.3.6 (2019-10-18)

### 8.6.1 Fix

- (setup) #17: Update version networkx.
- (setup) #13: Build universal wheel.
- (alg) #15: Escape % in node id.
- (setup) #14: Update tests requirements.
- (setup): Add env *ENABLE\_SETUP\_LONG\_DESCRIPTION*.

## 8.7 v0.3.4 (2019-07-15)

### 8.7.1 Feat

- (binder): Add *@jupyterlab/plotly-extension*.

- (binder): Customize *Site.\_repr\_html\_* with env *SCHEDULA\_SITE\_REPR\_HTML*.
- (binder): Add *jupyter-server-proxy*.
- (doc): Add binder examples.
- (gen): Create super-class of *Token*.
- (dsp): Improve error message.

### **8.7.2 Fix**

- (binder): Simplify *processing\_chain* example.
- (setup): Exclude *binder* and *examples* folders as packages.
- (doc): Correct binder data.
- (doc): Update examples for binder.
- (doc): Add missing requirements binder.
- (test): Add *state* to fake directive.
- (import): Remove stub file to enable autocomplete.
- Update to canonical pypi name of beautifulsoup4.

## **8.8 v0.3.3 (2019-04-02)**

### **8.8.1 Feat**

- (dispatcher): Improve error message.

### **8.8.2 Fix**

- (doc): Correct bug for sphinx AutoDirective.
- (dsp): Add dsp as kwargs for a new Blueprint.
- (doc): Update PEP and copyright.

## **8.9 v0.3.2 (2019-02-23)**

### **8.9.1 Feat**

- (core): Add stub file.
- (sphinx): Add Blueprint in Dispatcher documenter.
- (sphinx): Add BlueDispatcher in documenter.
- (doc): Add examples.
- (blue): Customizable memo registration of blueprints.



## 8.9.2 Fix

- (sphinx): Correct bug when “ is in csv-table directive.
- (core): Set module attribute when `__getattr__` is invoked.
- (doc): Correct utils description.
- (setup): Improve keywords.
- (drw): Correct tooltip string format.
- (version): Correct import.

## 8.10 v0.3.1 (2018-12-10)

### 8.10.1 Fix

- (setup): Correct long description for pypi.
- (dsp): Correct bug `DispatchPipe` when dill.

## 8.11 v0.3.0 (2018-12-08)

### 8.11.1 Feat

- (blue, dispatcher): Add method `extend` to extend Dispatcher or Blueprint with Dispatchers or Blueprints.
- (blue, dsp): Add `BlueDispatcher` class + remove `DFun` util.
- (core): Remove `weight` attribute from `Dispatcher` struc.
- (dispatcher): Add method `add_func` to `Dispatcher`.
- (core): Remove `remote_links` attribute from dispatcher data nodes.
- (core): Implement callable raise option in `Dispatcher`.
- (core): Add feature to dispatch asynchronously and in parallel.
- (setup): Add python 3.7.
- (dsp): Use the same `dsp.solution` class in `SubDispatch` functions.

### 8.11.2 Fix

- (dsp): Do not copy solution when call `DispatchPipe`, but reset solution when copying the obj.
- (alg): Correct and clean `get_sub_dsp_from_workflow` algorithm.
- (sol): Ensure `bool` output from `input_domain` call.
- (dsp): Parse arg and kw using `SubDispatchFunction.__signature__`.
- (core): Do not support python 3.4.
- (asy): Do not dill the Dispatcher solution.
- (dispatcher): Correct bug in removing remote links.

- (core): Simplify and correct Exception handling.
- (dsp): Postpone `__signature__` evaluation in `add_args`.
- (gen): Make Token constant when pickled.
- (sol): Move callback invocation in `_evaluate_node`.
- (core) #11: Lazy import of modules.
- (sphinx): Remove warnings.
- (dsp): Add missing `code` option in `add_function` decorator.

### 8.11.3 Other

- Refact: Update documentation.

## 8.12 v0.2.8 (2018-10-09)

### 8.12.1 Feat

- (dsp): Add `inf` class to model infinite numbers.

## 8.13 v0.2.7 (2018-09-13)

### 8.13.1 Fix

- (setup): Correct bug when `long_description` fails.

## 8.14 v0.2.6 (2018-09-13)

### 8.14.1 Feat

- (setup): Patch to use `sphinxcontrib.restbuilder` in `setup long_description`.

## 8.15 v0.2.5 (2018-09-13)

### 8.15.1 Fix

- (doc): Correct link `docs_status`.
- (setup): Use text instead rst to compile `long_description` + add logging.

## 8.16 v0.2.4 (2018-09-13)

### 8.16.1 Fix

- (sphinx): Correct bug sphinx==1.8.0.
- (sphinx): Remove all sphinx warnings.

## 8.17 v0.2.3 (2018-08-02)

### 8.17.1 Fix

- (des): Correct bug when SubDispatchFunction have no *outputs*.

## 8.18 v0.2.2 (2018-08-02)

### 8.18.1 Fix

- (des): Correct bug of `get_id` when tuple ids nodes are given as input or outputs of a `sub_dsp`.
- (des): Correct bug when tuple ids are given as *inputs* or *outputs* of `add_dispatcher` method.

## 8.19 v0.2.1 (2018-07-24)

### 8.19.1 Feat

- (setup): Update *Development Status* to 5 - *Production/Stable*.
- (setup): Add additional `project_urls`.
- (doc): Add changelog to `rtd`.

### 8.19.2 Fix

- (doc): Correct link `docs_status`.
- (des): Correct bugs `get_des`.

## 8.20 v0.2.0 (2018-07-19)

### 8.20.1 Feat

- (doc): Add changelog.
- (travis): Test extras.
- (des): Avoid using sphinx for `getargspec`.

- (setup): Add `extras_require` to setup file.

### 8.20.2 Fix

- (setup): Correct bug in `get_long_description`.

## 8.21 v0.1.19 (2018-06-05)

### 8.21.1 Fix

- (dsp): Add missing content block in note directive.
- (drw): Make sure to plot same sol as function and as node.
- (drw): Correct format of started attribute.

## 8.22 v0.1.18 (2018-05-28)

### 8.22.1 Feat

- (dsp): Add `DispatchPipe` class (faster pipe execution, it overwrite the existing solution).
- (core): Improve performances replacing `datetime.today()` with `time.time()`.

## 8.23 v0.1.17 (2018-05-18)

### 8.23.1 Feat

- (travis): Run coveralls in python 3.6.

### 8.23.2 Fix

- (web): Skip Flask logging for the doctest.
- (ext.dispatcher): Update to the latest Sphinx 1.7.4.
- (des): Use the proper dependency (i.e., `sphinx.util.inspect`) for `getargspec`.
- (drw): Set socket option to reuse the address (host:port).
- (setup): Correct dill requirements `dill>=0.2.7.1` → `dill!=0.2.7`.

## 8.24 v0.1.16 (2017-09-26)

### 8.24.1 Fix

- (requirements): Update dill requirements.

## 8.25 v0.1.15 (2017-09-26)

### 8.25.1 Fix

- (networkx): Update according to networkx 2.0.

## 8.26 v0.1.14 (2017-07-11)

### 8.26.1 Fix

- (io): pin dill version  $\leq 0.2.6$ .
- (abort): abort was setting `Exception.args` instead of `sol` attribute.

### 8.26.2 Other

- Merge pull request [#9](#) from ankostis/fixabortex.

## 8.27 v0.1.13 (2017-06-26)

### 8.27.1 Feat

- (appveyor): Add python 3.6.

### 8.27.2 Fix

- (install): Force update `setuptools`  $\geq 36.0.1$ .
- (exc): Do not catch `KeyboardInterrupt` exception.
- (doc) [#7](#): Catch exception for sphinx 1.6.2 (listeners are moved in `EventManager`).
- (test): Skip empty error message.

## 8.28 v0.1.12 (2017-05-04)

### 8.28.1 Fix

- (drw): Catch dot error and log it.

## 8.29 v0.1.11 (2017-05-04)

### 8.29.1 Feat

- (dsp): Add `add_function` decorator to add a function to a dsp.

- (dispatcher) #4: Use *kk\_dict* function to parse inputs and outputs of *add\_dispatcher* method.
- (dsp) #4: Add *kk\_dict* function.

### **8.29.2 Fix**

- (doc): Replace type function with callable.
- (drw): Folder name without ext.
- (test): Avoid Documentation of DspPlot.
- (doc): fix docstrings types.

## **8.30 v0.1.10 (2017-04-03)**

### **8.30.1 Feat**

- (sol): Close sub-dispatcher solution when all outputs are satisfied.

### **8.30.2 Fix**

- (drw): Log error when dot is not able to render a graph.

## **8.31 v0.1.9 (2017-02-09)**

### **8.31.1 Fix**

- (appveyor): Setup of lmx1.
- (drw): Update plot index.

## **8.32 v0.1.8 (2017-02-09)**

### **8.32.1 Feat**

- (drw): Update plot index + function code highlight + correct plot outputs.

## **8.33 v0.1.7 (2017-02-08)**

### **8.33.1 Fix**

- (setup): Add missing *package\_data*.

## 8.34 v0.1.6 (2017-02-08)

### 8.34.1 Fix

- (setup): Avoid setup failure due to `get_long_description`.
- (drw): Avoid to plot unneeded weight edges.
- (dispatcher): `get_sub_dsp_from_workflow` set correctly the remote links.

## 8.35 v0.1.5 (2017-02-06)

### 8.35.1 Feat

- (exl): Drop exl module because of formulas.
- (sol): Add input value of filters in solution.

### 8.35.2 Fix

- (drw): Plot just one time the filer attribute in workflow `+filers|solution_filters` .

## 8.36 v0.1.4 (2017-01-31)

### 8.36.1 Feat

- (drw): Save autoplot output.
- (sol): Add filters and function solutions to the workflow nodes.
- (drw): Add filters to the plot node.

### 8.36.2 Fix

- (dispatcher): Add missing function data inputs edge representation.
- (sol): Correct value when apply filters on setting the node output.
- (core): `get_sub_dsp_from_workflow` blockers can be applied to the sources.

## 8.37 v0.1.3 (2017-01-29)

### 8.37.1 Fix

- (dsp): Raise a `DispatcherError` when the pipe workflow is not respected instead `KeyError`.
- (dsp): Unresolved references.

## 8.38 v0.1.2 (2017-01-28)

### 8.38.1 Feat

- (dsp): add\_args \_set\_doc.
- (dsp): Remove parse\_args class.
- (readme): Appveyor badge status == master.
- (dsp): Add \_format option to *get\_unused\_node\_id*.
- (dsp): Add wildcard option to *SubDispatchFunction* and *SubDispatchPipe*.
- (drw): Create sub-package drw.

### 8.38.2 Fix

- (dsp): combine nested dicts with different length.
- (dsp): are\_in\_nested\_dicts return false if nested\_dict is not a dict.
- (sol): Remove defaults when setting wildcards.
- (drw): Misspelling *outpus* -> *outputs*.
- (directive): Add exception on graphviz patch for sphinx 1.3.5.

## 8.39 v0.1.1 (2017-01-21)

### 8.39.1 Fix

- (site): Fix ResourceWarning: unclosed socket.
- (setup): Not log sphinx warnings for long\_description.
- (travis): Wait until the server is up.
- (rtd): Missing requirement dill.
- (travis): Install first - pip install -r dev-requirements.txt.
- (directive): Tagname from \_img to img.
- (directive): Update minimum sphinx version.
- (readme): Badge svg links.

### 8.39.2 Other

- Add project descriptions.
- (directive): Rename schedula.ext.dsp\_directive -> schedula.ext.dispatcher.
- Update minimum sphinx version and requests.



## CHAPTER 9

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### Indices and tables

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