SCOOP Documentation

Release dev

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CONTENTS

SCOOP (Scalable COncurrent Operations in Python) is a distributed task module allowing concurrent parallel programming on various environments, from heterogeneous grids to supercomputers.

Our philosophy is based on these ideas:

- The **future** is parallel;
- **Simple** is beautiful;
- **Parallelism** should be simpler.

These tenets are translated concretely in a minimum number of functions allowing maximum parallel efficiency while keeping at minimum the inner knowledge required to use them. It is implemented with Python 3 in mind while being compatible with 2.6+ to allow fast prototyping without sacrificing efficiency and speed.

CHAPTER

ONE

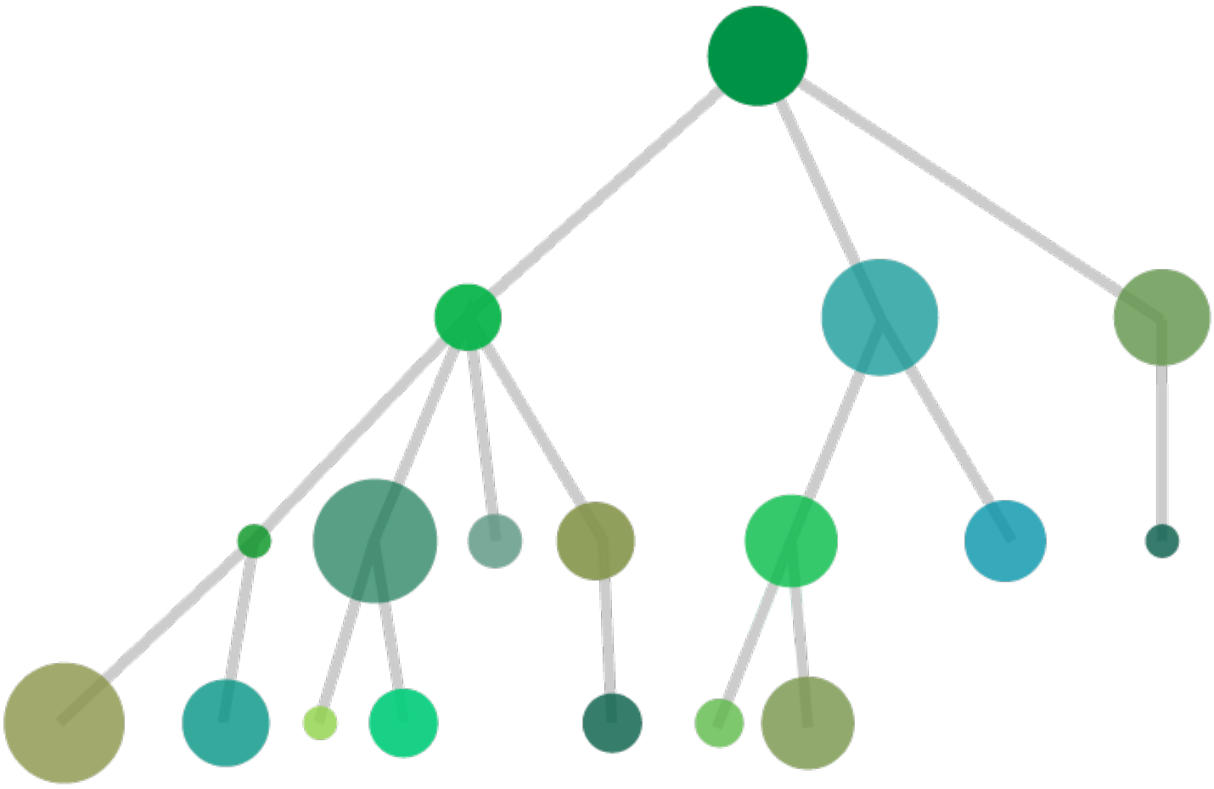
FEATURES

SCOOP has many features and advantages over Futures, multiprocessing and similar modules, such as:

- Harness the power of **multiple computers** over network;
- Ability to spawn subtasks within tasks;
- API compatible with **PEP 3148**;
- Parallelizing serial programs with only minor modifications;
- Efficient load-balancing.

1.1 Anatomy of a SCOOPed program

SCOOP can handle multiple diversified multi-layered tasks. You can submit your different functions and data simultaneously and effortlessly while the framework executes them locally or remotely. Contrarily to most multiprocessing frameworks, it allows to launch subtasks within tasks.



Through SCOOP, you can simultaneously execute tasks that are of different nature (Discs of different colors) or different by complexity (Discs radiuses). The module will handle the physical considerations of parallelization such as task distribution over your resources (load balancing), communications, etc.

1.2 Applications

The common applications of SCOOP consist of, but is not limited to:

- Evolutionary Algorithms
- Monte Carlo simulations
- Data mining
- Data processing
- I/O processing
- Graph traversal

CHAPTER

TWO

MANUAL

2.1 Install

2.1.1 Requirements

The software requirements for SCOOP are as follows:

- Python >= 2.6 or >= 3.2
- Distribute >= 0.6.2
- Greenlet >= 0.3.4
- pyzmq and libzmq >= 2.2.0
- **ssh** for remote execution

2.1.2 Installation

To install SCOOP and its other dependencies, use pip as such:

```
pip install scoop
```

Note: If you are using Windows, you may want to install pyzmq using the installer available at their download page. This installer installs libzmq alongside pyzmq.

Remote usage

Because remote host connection needs to be done without a prompt, you must use ssh keys to allow passwordless authentication. You should make sure that your public ssh key is contained in the `~/.ssh/authorized_keys` file on the remote systems (Refer to the ssh manual). If you have a shared `/home/` over your systems, you can do as such:

```
[~]$ mkdir ~/.ssh; cd ~/.ssh
[.ssh]$ ssh-keygen -t dsa
[.ssh]$ cat id_dsa.pub >> authorized_keys
```

Note: If your remote hosts needs special configuration (non-default port, some specified username, etc.), you should do it in your ssh client configuration file (by default `~/.ssh/config`).

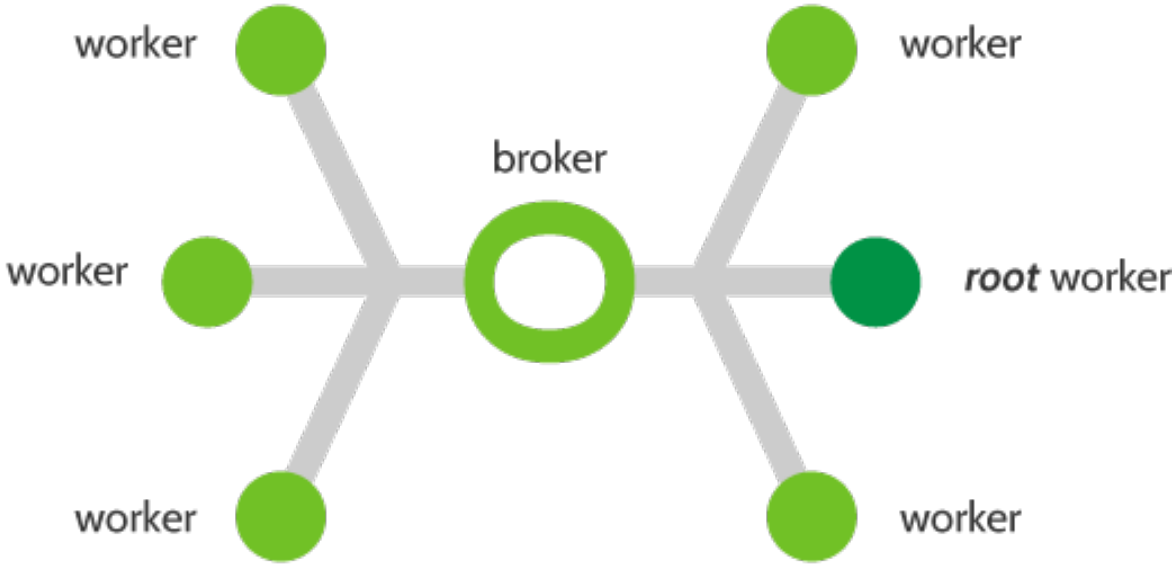
2.2 Usage

2.2.1 Nomenclature

Keyword	Description
Future(s)	The Future class encapsulates the asynchronous execution of a callable.
Broker	Process dispatching Futures.
Worker	Process executing Futures.
Root	The worker executing the root Future, your main program.

2.2.2 Architecture diagram

The future(s) distribution over workers is done by a variation of the Broker pattern. In such a pattern, workers act as independant elements that interact with a broker to mediate their communications.



2.2.3 Mapping API

The philosophy of SCOOP is loosely built around the *futures* module proposed by **PEP 3148**. It primarily defines a `map()` and a `submit()` function allowing asynchroneous computation that SCOOP will propagate to its workers.

Map

A *map()* function applies multiple parameters to a single function. For example, if you want to apply the *abs()* function to every number of a list:

```
import random
data = [random.randint(-1000, 1000) for r in range(1000)]

# Without Map
result = []
for i in data:
  result.append(abs(i))
```

```
# Using a Map
result = list(map(abs, data))
```

SCOOP's `map()` returns a generator iterating over the results in the same order as its inputs. It can thus act as a parallel substitute to the standard *map()*, for instance:

```
# Script to be launched with: python -m scoop scriptName.py
import random
from scoop import futures
data = [random.randint(-1000, 1000) for r in range(1000)]

if __name__ == '__main__':
    # Python's standard serial function
    dataSerial = list(map(abs, data))

    # SCOOP's parallel function
    dataParallel = list(futures.map(abs, data))

    assert dataSerial == dataParallel
```

Warning: In your root program, you *must* check `if __name__ == __main__` as shown above. Failure to do so will result in every worker trying to run their own instance of the program. This ensures that every worker waits for parallelized tasks spawned by the root worker.

Note: Your callable function passed to SCOOP must be picklable in its entirety.

Note that the pickle module is limited to **top level functions and classes** as stated in the documentation.

Note: Functions executed using SCOOP must return a value.

Note: Keep in mind that objects are not shared between workers and that changes made to an object in a function are not seen by other workers.

Submit

SCOOP's `submit()` returns a `Future` instance. This allows a finer control over the Futures, such as out-of-order results retrieval.

2.2.4 Reduction API

mapReduce

The `mapReduce()` function of SCOOP allows to parallelize a reduction function after applying the aforementionned `map()` function. It returns a single value.

A reduction function takes the map results and applies a function cumulatively to it. For example, applying *reduce(lambda x, y: x+y, ["a", "b", "c", "d"])* would execute *((("a")+"b")+"c")+"d")* give you the result *"abcd"*

Read the standard Python reduce function for more information.

A common reduction usage consist of a sum as the following example:

```
# Script to be launched with: python -m scoop scriptName.py
import random
import operator
from scoop import futures
data = [random.randint(-1000, 1000) for r in range(1000)]


if __name__ == '__main__':
    # Python's standard serial function
    serialSum = sum(map(abs, data))

    # SCOOP's parallel function
    parallelSum = futures.mapReduce(abs, operator.add, data)

    assert serialSum == parallelSum
```

Note: You can pass any arbitrary reduction function, not only operator ones.

2.2.5 Object sharing API

Sharing constant objects between workers is available using the `shared` module.

Its functionnalities are summarised as such:

```
from scoop import futures, shared

def myParallelFunc(inValue):
    myValue = shared.getConst('myValue')
    return inValue + myValue


if __name__ == '__main__':
    shared.setCont(myValue=5)
    print(list(futures.map(myParallelFunc, range(10))))
```

Note: A constant can only be defined once on the entire pool of workers.

2.2.6 Examples

Examples are available in the `examples/` directory of SCOOP.

Please refer to the *Examples* page where detailed explanations are available.

2.2.7 How to launch SCOOP programs

The scoop module spawns the needed broker and workers on a given list of computers, including remote ones via **ssh**.

Programs using SCOOP need to be launched with the *`-m scoop`* parameter passed to Python, as such:

```
cd scoop/examples/
python -m scoop fullTree.py
```

Here is a list of the parameters that can be passed to SCOOP:

```
python -m scoop --help
usage: python -m scoop [-h]
                       [--hosts [HOSTS [HOSTS ...]] | --hostfile HOSTFILE]
                       [--path PATH] [--nice NICE]
                       [--verbose] [--log LOG] [-n N]
                       [-e] [--broker-hostname BROKER_HOSTNAME]
                       [--python-executable PYTHON_EXECUTABLE]
                       [--pythonpath PYTHONPATH]
                       executable ...

Starts a parallel program using SCOOP.

positional arguments:
  executable            The executable to start with SCOOP
  args                  The arguments to pass to the executable

optional arguments:
  -h, --help            show this help message and exit
  --hosts [HOSTS [HOSTS ...]], --host [HOSTS [HOSTS ...]]
                        The list of hosts. The first host will execute the
                        root program. (default is 127.0.0.1)
  --hostfile HOSTFILE   The hostfile name
  --path PATH, -p PATH  The path to the executable on remote hosts (default
                        is local directory)
  --nice NICE           *nix niceness level (-20 to 19) to run the executable
  --verbose, -v         Verbosity level of this launch script (-vv for more)
  --log LOG             The file to log the output (default is stdout)
  -n N                  Total number of workers to launch on the hosts.
                        Workers are spawned sequentially over the hosts.
                        (ie. -n 3 with 2 hosts will spawn 2 workers on the
                        first host and 1 on the second.) (default: Number of
                        CPUs on current machine)
  -e                    Activate ssh tunnels to route toward the broker
                        sockets over remote connections (may eliminate routing
                        problems and activate encryption but slows down
                        communications)
  --broker-hostname BROKER_HOSTNAME
                        The externally routable broker hostname / ip (defaults
                        to the local hostname)
  --python-executable PYTHON_EXECUTABLE
                        The python executable with which to execute the script
  --pythonpath PYTHONPATH
                        The PYTHONPATH environment variable (default is
                        current PYTHONPATH)
```

A remote workers example may be as follow:

```
python -m scoop --hostfile hosts -vv -n 6 your_program.py [your arguments]
```

Argument	Meaning
-m scoop	**Mandatory** Uses SCOOP to run program.
–hostfile	hosts is a file containing a list of host to launch SCOOP
-vv	Double verbosity flag.
-n 6	Launch a total of 6 workers.
your_program.py	The program to be launched.
[your arguments]	The arguments that needs to be passed to your program.

Note: Your local hostname must be externally routable for remote hosts to be able to connect to it. If you don't have a DNS properly set up on your local network or a system hosts file, consider using the *--broker-hostname* argument to provide your externally routable IP or DNS name to SCOOP. You may as well be interested in the *-e* argument for testing purposes.

Hostfile format

You can specify the hosts with a hostfile and pass it to SCOOP using the *--hostfile* argument. The hostfile should use the following syntax:

```
hostname_or_ip 4
other_hostname 5
third_hostname 2
```

The name being the system hostname and the number being the number of workers to launch on this host.

Using a list of host

You can also use a list of host with the *--host [...]* flag. In this case, you must put every host separated by a space the number of time you wish to have a worker on each of the node. For example:

```
python -m scoop --host machine_a machine_a machine_b machine_b your_program.py
```

This example would start two workers on *machine_a* and two workers on *machine_b*.

Choosing the number of workers

The number of workers started should be equal to the number of cores you have on each machine. If you wish to start more or less workers than specified in your hostfile or in your hostlist, you can use the *-n* parameter.

Note: The *-n* parameter overrides any previously specified worker amount.

If *-n* is less than the sum of workers specified in the hostfile or hostlist, the workers are launched in batch by host until the parameter is reached. This behavior may ignore latters hosts.

If *-n* is more than the sum of workers specified in the hostfile or hostlist, the remaining workers are distributed using a Round-Robin algorithm. Each host will increment its worker amount until the parameter is reached.

Be aware that tinkering with this parameter may hinder performances. The default value choosen by SCOOP (one worker by physical core) is generaly a good value.

2.2.8 Startup scripts (cluster or grid)

You must provide a startup script on systems using a scheduler. Here are some example startup scripts using different grid task managers. They are available in the `examples/submitFiles` directory.

Note: **Please note that these are only examples**. Refer to the documentation of your scheduler for the list of arguments needed to run the task on your grid or cluster.

Torque (Moab & Maui)

Here is an example of a submit file for Torque:

```
#!/bin/bash
## Please refer to your grid documentation for available flags. This is only an example.
#PBS -l procs=16
#PBS -V
#PBS -N SCOOPJob

# Path to your executable. For example, if you extracted SCOOP to $HOME/downloads/scoop
cd $HOME/downloads/scoop/examples

# Add any addition to your environment variables like PATH. For example, if your local python instal
export PATH=$HOME/python/bin:$PATH

# If, instead, you are using the python offered by the system, you can stipulate it's library path v
#export PYTHONPATH=$HOME/wanted/path/lib/python+version/site-packages/:$PYTHONPATH
# Or use VirtualEnv via virtualenvwrapper here:
#workon yourenvironment

# Launch SCOOP using the hosts
python -m scoop -vv fullTree.py
```

Sun Grid Engine (SGE)

Here is an example of a submit file for SGE:

```
#!/bin/bash
## Please refer to your grid documentation for available flags. This is only an example.
#$ -l h_rt=300
#$ -pe test 16
#$ -S /bin/bash
#$ -cwd
#$ -notify

# Path to your executable. For example, if you extracted SCOOP to $HOME/downloads/scoop
cd $HOME/downloads/scoop/examples

# Add any addition to your environment variables like PATH. For example, if your local python instal
export PATH=$HOME/python/bin:$PATH

# If, instead, you are using the python offered by the system, you can stipulate it's library path v
#export PYTHONPATH=$HOME/wanted/path/lib/python+version/site-packages/:$PYTHONPATH
# Or use VirtualEnv via virtualenvwrapper here:
#workon yourenvironment

# Launch the remotes workers
python -m scoop -vv fullTree.py
```

2.2.9 Pitfalls

Program scope

As a good Python practice (see **PEP 395**), you should always wrap the executable part of your program using:

```
if __name__ == '__main__':
```

This is mandatory when using parallel frameworks such as multiprocessing or SCOOP. Every worker execute your main module with a *__name__* variable different than *__main__* then awaits orders given by the root node to execute available functions.

Also, only functions or classes declared at the top level of your program are picklables. This is a limitation of Python's pickle module. Here are some examples of non-working map invocations:

```
from scoop import futures


class myClass(object):
    @staticmethod
    def myFunction(x):
        return x


if __name__ == '__main__':
    def mySecondFunction(x):
        return x

    # Both of these calls won't work because Python pickle won't be able to
    # pickle or unpickle the function references.
    wrongCall1 = futures.map(myClass.myFunction, [1, 2, 3, 4, 5])
    wrongCall2 = futures.map(mySecondFunction, [1, 2, 3, 4, 5])
```

Evaluation laziness

The `map()` and `submit()` will distribute their Futures both locally and remotely. Futures executed locally will be computed upon access (iteration for the `map()` and `result()` for `submit()`). Futures distributed remotely will be executed right away.

Large datasets

Every parameter sent to a function by a `map()` or `submit()` gets serialized and sent within the Future to its worker. It results in slow speeds and network overload when sending large elements as a parameter to your function(s).

You should consider using a global variable in your module scope for passing large elements; it will then be loaded on launch by every worker and won't overload your network.

Incorrect:

```
from scoop import futures


def mySum(inData):
    """The worker will receive all its data from network."""
    return sum(inData)

if __name__ == '__main__':
    data = [[i for i in range(x, x + 1000)] for x in range(0, 8001, 1000)]
    results = list(futures.map(mySum, data))
```

Better:

```
from scoop import futures

data = [[i for i in range(x, x + 1000)] for x in range(0, 8001, 1000)]


def mySum(inIndex):
    """The worker will only receive an index from network."""
    return sum(data[inIndex])

if __name__ == '__main__':
    results = list(futures.map(mySum, range(len(data))))
```

SCOOP and greenlets

Warning: Since SCOOP uses greenlets to schedule and run futures. Programs that use their own greenlets won't work with SCOOP. However, you should consider replacing the greenlets in your code by SCOOP functions.

2.3 Examples

You can find the examples detailed on this page and more in the `examples/` directory of SCOOP.

Please check the *API Reference* for any implentation detail of the proposed functions.

2.3.1 Introduction to the `map()` function

A core concept of task-based parallelism as presented in SCOOP is the map. An introductory example to map working is presented in `examples/mapDoc.py`.

```
1 from __future__ import print_function
2 from scoop import futures
3
4 def helloWorld(value):
5     return "Hello World from Future #{0}".format(value)
6
7 if __name__ == "__main__":
8     returnValues = list(futures.map(helloWorld, range(16)))
9     print("\n".join(returnValues))
```

Line *1* allows Python 2 users to have a print function compatible with Python 3.

On line *2*, SCOOP is imported.

On line *4-5*, the function that will be mapped is declared.

The condition on line *7* is a safety barrier that prevents the main program to be executed on every workers. It ensures that the map is issued only by one worker, the root.

The `map()` function is located on line *8*. It launches the *helloWorld* function 16 times, each time with a different argument value selected from the *range(16)* argument. This method is compatible with the standard Python *map()* function and thus can be seamlessly interchanged without modifying its arguments.

The example then prints the return values of every calls on line *9*.

You can launch this program using **python -m scoop**. The output should look like this:

```
~/scoop/examples$ python -m scoop -n 8 mapDoc.py
Hello World from Future #0
Hello World from Future #1
Hello World from Future #2
[...]
```

Note: Results of a map are always ordered even if their computation was made asynchronously on multiple computers.

Note: You can toy around with the previous example by changing the second parameter of the `map()` function. Is it working with string arrays, pure strings or other variable types?

2.3.2 Computation of π

A Monte-Carlo method to calculate π using SCOOP to parallelize its computation is found in `examples/piCalc.py`. You should familiarize yourself with Monte-Carlo methods before going forth with this example.

First, we need to import the needed functions as such:

```
1 from math import hypot
2 from random import random
3 from scoop import futures
```

Figure 2.1: Image from Wikipedia made by CaitlinJo that shows the Monte Carlo computation of π.

The Monte-Carlo method is then defined. It spawns two pseudo-random numbers that are fed to the hypot function which calculates the hypotenuse of its parameters. This step computes the Pythagorean equation ($\sqrt{x^2 + y^2}$) of the given parameters to find the distance from the origin (0,0) to the randomly placed point (which X and Y values were generated from the two pseudo-random values). Then, the result is compared to one to evaluate if this point is inside or outside the unit disk. If it is inside (have a distance from the origin lesser than one), a value of one is produced (red dots in the figure), otherwise the value is zero (blue dots in the figure). The experiment is repeated `tries` number of times with new random values.

The function returns the number times a pseudo-randomly generated point fell inside the unit disk for a given number of tries.

```
1 def test(tries):
2     return sum(hypot(random(), random()) < 1 for _ in range(tries))
```

One way to obtain a more precise result with a Monte-Carlo method is to perform the method multiple times. The following function executes repeatedly the previous function to gain more precision. These calls are handled by SCOOP using it's `map()` function. The results, that is the number of times a random distribution over a 1x1 square hits the unit disk over a given number of tries, are then summed and divided by the total of tries. Since we only covered the upper right quadrant of the unit disk because both parameters are positive in a cartesian map, the result must be multiplied by 4 to get the relation between area and circumference, namely π.

```
1 def calcPi(nbFutures, tries):
2     expr = futures.map(test, [tries] * nbFutures)
3     return 4. * sum(expr) / float(nbFutures * tries)
```

As *previously stated*, you *must* wrap your code with a test for the __main__ name.

```
if __name__ == "__main__":
    print("pi = {}".format(calcPi(3000, 5000)))
```

You can now run your code using the command **python -m scoop**.

2.3.3 Sharing Constant

One usage of shared constants is to halt a computation when a worker has found a solution such as a brute forcing example.

```
from itertools import product, tee
import string
from scoop import futures, shared

# Create the hash to brute force
HASH_TO_FIND = hash("SCO")


def generateHashes(iterator):
    """Compute hashes of given iterator elements"""
    for combination in iterator:
        # Stop as soon as a worker finds the solution
        if shared.getConst('Done', timeout=0):
            return False

        # Compute the current combination hash
        currentString = "".join(combination).strip()
        if hash(currentString) == HASH_TO_FIND:
            # Share to every other worker that the solution has been found
            shared.setConst(Done=True)
            return currentString

    # Report that computing has not ended
    return False


if __name__ == "__main__":
    # Generate possible characters
    possibleCharacters = []
    possibleCharacters.extend(list(string.ascii_uppercase))
    possibleCharacters.extend(' ')

    # Generate the solution space.
    stringIterator = product(possibleCharacters, repeat=3)

    # Partition the solution space into iterators
    # Keep in mind that the tee operator evaluates the whole solution space
    # making it pretty memory inefficient.
    SplittedIterator = tee(stringIterator, 1000)

    # Parallelize the solution space evaluation
    results = futures.map(generateHashes, SplittedIterator)

    # Loop until a solution is found
    for result in results:
        if result:
            break
```

```
48
49      print(result)
```

2.3.4 Overall example

The `examples/fullTree.py` example holds a wrap-up of available SCOOP functionnalities. It notably shows that SCOOP is capable of handling twisted and complex hierarchical requirements.

Getting acquainted with the previous examples is fairly enough to use SCOOP, no need to dive into this complicated example.

2.4 API Reference

2.4.1 Futures module

The following methods are part of the futures module. They can be accessed like so:

```
from scoop import futures

results = futures.map(func, data)
futureObject = futures.submit(func, arg)
...
```

More informations are available in the *Usage* document.

scoop.futures.**as_completed**(*fs*, *timeout=None*)

An iterator over the given futures that yields each as it completes.

Parameters

- **fs** – The sequence of Futures (possibly created by another instance) to wait upon.
- **timeout** – The maximum number of seconds to wait [To be done in future version of SCOOP]. If None, then there is no limit on the wait time.

Returns An iterator that yields the given Futures as they complete (finished or cancelled).

scoop.futures.**map**(*func*, **iterables*, ***kargs*)

Equivalent to map(func, *iterables, ...) but *func* is executed asynchronously and several calls to func may be made concurrently. The returned iterator raises a TimeoutError if *__next__()* is called and the result isn't available after timeout seconds from the original call to *map()* [To be done in future version of SCOOP]. If timeout is not specified or None then there is no limit to the wait time. If a call raises an exception then that exception will be raised when its value is retrieved from the iterator.

Parameters

- **func** – Any picklable callable object (function or class object with *__call__* method); this object will be called to execute the Futures. The callable must return a value.
- **iterables** – Iterable objects; each will be zipped to form an iterable of arguments tuples that will be passed to the callable object as a separate Future.
- **timeout** – The maximum number of seconds to wait [To be done in future version of SCOOP]. If None, then there is no limit on the wait time.
- **kargs** – A dictionary of additional keyword arguments that will be passed to the callable object.

Returns A generator of map results, each corresponding to one map iteration.

scoop.futures.**mapReduce**(*mapFunc*, *reductionOp*, **iterables*, ***kargs*)

Exectues the `map()` function and then applies a reduction function to its result. The reduction function will cumulatively merge the results of the map function in order to get a final single value.

Parameters

- **mapFunc** – Any picklable callable object (function or class object with *__call__* method); this object will be called to execute the Futures. The callable must return a value.
- **reductionOp** – Any picklable callable object (function or class object with *__call__* method); this object will be called to reduce the Futures results. The callable must support two parameters and return a single value.
- **iterables** – Iterable objects; each will be zipped to form an iterable of arguments tuples that will be passed to the callable object as a separate Future.
- **timeout** – The maximum number of seconds to wait [To be done in future version of SCOOP]. If None, then there is no limit on the wait time.
- **kargs** – A dictionary of additional keyword arguments that will be passed to the mapFunc callable object.

Returns A single value.

scoop.futures.**mapScan**(*mapFunc*, *reductionOp*, **iterables*, ***kargs*)

Exectues the `map()` function and then applies a reduction function to its result while keeping intermediate reduction values.

Parameters

- **mapFunc** – Any picklable callable object (function or class object with *__call__* method); this object will be called to execute the Futures. The callable must return a value.
- **reductionOp** – Any picklable callable object (function or class object with *__call__* method); this object will be called to reduce the Futures results. The callable must support two parameters and return a single value.
- **iterables** – Iterable objects; each will be zipped to form an iterable of arguments tuples that will be passed to the callable object as a separate Future.
- **timeout** – The maximum number of seconds to wait [To be done in future version of SCOOP]. If None, then there is no limit on the wait time.
- **kargs** – A dictionary of additional keyword arguments that will be passed to the mapFunc callable object.

Returns Every return value of the reduction function applied to every mapped data sequentially ordered.

scoop.futures.**shutdown**(*wait=True*)

This function is here for compatibility with *futures* (PEP 3148).

Parameters **wait** – Unapplied parameter.

scoop.futures.**submit**(*func*, **args*, ***kargs*)

Submit an independent parallel `Future` that will either run locally or remotely as *func(*args, **kargs)*.

Parameters

- **func** – Any picklable callable object (function or class object with *__call__* method); this object will be called to execute the Future. The callable must return a value.
- **args** – A tuple of positional arguments that will be passed to the callable object.

- **kargs** – A dictionary of additional keyword arguments that will be passed to the callable object.

Returns A future object for retrieving the Future result.

On return, the Future can be pending execution locally but may also be transfered remotely depending on load or on remote distributed workers. You may carry on with any further computations while the Future completes. Result retrieval is made via the `result()` function on the Future.

`scoop.futures.`**`wait`**(*fs*, *timeout=None*, *return_when='ALL_COMPLETED'*)

Wait for the futures in the given sequence to complete.

Parameters

- **fs** – The sequence of Futures (possibly created by another instance) to wait upon.
- **timeout** – The maximum number of seconds to wait [To be done in future version of SCOOP]. If None, then there is no limit on the wait time.
- **return_when** – Indicates when this function should return. The options are:

FIRST_COMPLETED	Return when any future finishes or is cancelled.
FIRST_EXCEPTION	Return when any future finishes by raising an exception. If no future raises an exception then it is equivalent to ALL_COMPLETED.
ALL_COMPLETED	Return when all futures finish or are cancelled.

Returns A named 2-tuple of sets. The first set, named 'done', contains the futures that completed (is finished or cancelled) before the wait completed. The second set, named 'not_done', contains uncompleted futures.

2.4.2 Future class

The `submit()` function returns a `Future` object. This instance possess the following methods.

class `scoop._types.`**`Future`**(*parentId*, *callable*, **args*, ***kargs*)

This class encapsulates an independent future that can be executed in parallel. A future can spawn other parallel futures which themselves can recursively spawn other futures.

`add_done_callback`(*callable*, *inCallbackType='standard'*, *inCallbackGroup=None*)

Attach a callable to the future that will be called when the future is cancelled or finishes running. Callable will be called with the future as its only argument.

Added callables are called in the order that they were added and are always called in a thread belonging to the process that added them. If the callable raises an Exception then it will be logged and ignored. If the callable raises another BaseException then behavior is not defined.

If the future has already completed or been cancelled then callable will be called immediately.

`cancel`()

If the call is currently being executed then it cannot be cancelled and the method will return False, otherwise the call will be cancelled and the method will return True.

`cancelled`()

True if the call was successfully cancelled, False otherwise.

`done`()

True if the call was successfully cancelled or finished running, False otherwise.

`exception`(*timeout=None*)

Return the exception raised by the call. If the call hasn't yet completed then this method will wait up to timeout seconds [To be done in future version of SCOOP]. If the call hasn't completed in timeout seconds

then a TimeoutError will be raised. If timeout is not specified or None then there is no limit to the wait time.

If the future is cancelled before completing then CancelledError will be raised.

If the call completed without raising then None is returned.

Returns The exception raised by the call.

result(*timeout=None*)
Return the value returned by the call. If the call hasn't yet completed then this method will wait up to ''timeout" seconds [To be done in future version of SCOOP]. If the call hasn't completed in timeout seconds then a TimeoutError will be raised. If timeout is not specified or None then there is no limit to the wait time.

If the future is cancelled before completing then CancelledError will be raised.

If the call raised an exception then this method will raise the same exception.

Returns The value returned by the call.

running()
True if the call is currently being executed and cannot be cancelled.

2.4.3 Shared module

This module provides the `setConst()` and `getConst()` functions allowing arbitrary object sharing between futures.

scoop.shared.**getConst**(*name*, *timeout=0.1*)
Get a constant that was shared beforehand.

Parameters

- **name** – The name of the shared variable to retrieve.
- **timeout** – The maximum time to wait in seconds for the propagation of the variable.

Returns The shared object.

Usage: value = getConst('name')

scoop.shared.**setConst**(***kwargs*)
Set a constant that will be shared to every workers.

Parameters ****kwargs** – One or more combination(s) key=value. Key being the variable name and value the object to share.

Returns None.

Usage: setConst(name=value)

2.4.4 SCOOP Constants

The following variables are available to a program that was launched using SCOOP.

Note: Please note that using these is considered as advanced usage. You should not use these for other purposes than debugging.

Constants	Description
scoop.IS_ORIGIN	Boolean value. True if current instance is the root worker.
scoop.WORKER_NAME	String value. Name of the current instance.
scoop.BROKER_NAME	String value. Name of the broker to which this instance is attached.
scoop.BROKER_ADDRESS	String value. Address of the socket communicating work information.
scoop.META_ADDRESS	String value. Address of the socket communicating meta information.
scoop.SIZE	Integer value. Size of the current worker pool.
scoop.DEBUG	Boolean value. True if debug mode is enabled, false otherwise.
scoop.worker	2-tuple. Unique identifier of the current instance in the pool.

2.5 Contributing

2.5.1 Reporting a bug

You can report a bug on the issue tracker on google code or on the mailing list.

2.5.2 Retrieving the latest code

You can check the latest sources with the command:

```
hg clone https://code.google.com/p/scoop/
```

Bear in mind that this development code may be partially broken or unfinished. To get a stable version of the code, update to a release tag using *hg update <tag name>*.

2.5.3 Coding guidelines

Most of those conventions are base on Python PEP8.

> *A style guide is about consistency. Consistency with this style guide is important. Consistency within a project is more important. Consistency within one module or function is most important.*

Code layout

Same as PEP8.

Imports

Standard library imports must be first, followed by SCOOP imports and finally custom modules. Each section should be separated by an empty line as such:

```
import system

from scoop import futures

import myModule
```

Whitespace in Expressions and Statements

Same as PEP8.

Comments

Same as PEP8

Documentation Strings

Same as PEP8

Naming Conventions

- **Module**: lowercase convention.
- **Class**: CapWords (upper camel case) convention (ie. AnExample).
- **Function /** Procedure: mixedCase (lower camel case) convention. First word should be an action verb.
- **Variable**: lower_case_with_underscores convention. Should be as short possible as.

If a name already exists in the standard library, an underscore is appended to it. (ie. a custom *range* function could be called *range_*. A custom *type* function could be called *type_*.)

CHAPTER

THREE

INDICES AND TABLES

- *genindex*
- *modindex*
- *search*

PYTHON MODULE INDEX

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