sim-core-0.1 README

Luca Bandelli (l.bandelli@student.rug.nl)

December 10, 2020

Contents

1 Intro

This document acts as technical appendix for the bachelor project pos-sim-0.1

It gives hands on instruction to use the library and reproduce the experiments.

For documentation of the actual code see `http://139.162.161.39/thesis/build/html/index.html`.

2 Standard mode

1. Installation

   This section applies for GNU/linux systems. It should also work on OSX (mac) if a python (>3) and pip are installed.

   Clone the repo (`https://github.com/bandoos/bachelor-project`) of the project to a location we will refer to as `$PROJECT_ROOT`

   The alternative is using the provided Docker images, which will work on GNU/linux, OSX and windows. See the **Docker mode** section for instructions.

   NOTE about using virtualenv

Using virtualenv to avoid python libraries versions conflicts is encouraged.

if virtualenv is not installed on your system yet it can be installed with pip

```
$ pip install -user virtualenv
```

check installation

```
$ virtualenv -version
```

create an env directory

```
$ mkdir sim-core-env
$ cd sim-core-env
$ virtualenv venv
```

then from sim-core-env activate the environment

```
$ source ./venv/bin/activate
```

The terminal prompt should now display the name of the environment to signal it is active.

The code is bundled as a python package so, from the root folder of the project run:

```
$ pip install -user -e ./
```

This will use `pip` to install (for the current user) the dependencies of the project from PyPI, and add this project to the `$PYTHONPATH` so it can be executed on your system.

Thought this is not necessary for the basic functionality some features rely on `$HOME/.local/bin` to be in the `$PATH`. This is typically the case with standard linux distribution, but the install command will warn if this is not the case for you.

If using virtualenv once the environment is activated the `$PATH` is manipulated appropriately automatically.

If `.local/bin` is in your `$PATH` then the main entry point for the simulation executable is available as:

```
$ sim-stake [OPTIONS]
```

If `.local/bin` is not in your $PATH then from the `$PROJECT_ROOT` run:

```
$ python -m sim.core.main [OPTIONS].
```

In that case remember that you should always be in `$PROJECT_ROOT` and substitute `sim-stake` with `python -m sim.core.main` in the following sections.

2. Usage You can see its usage information with:

```
$ sim-stake -help
```

```
usage: sim-stake [-h] [-id ID]
                 -m M -T T
                 -c C -times TIMES
                 -stake_f {eq,beta,pareto}
                 -sim {random,const,geom,log_const,log_geom}
```

```
Run a sim-stake-batch

optional arguments:
  -h, -help            show this help message and exit
  -id ID               unique id for the experiment

required arguments:
  -m M                 INTEGER: Indicate the number of nodes [m] (valid if >= 2)
  -T T                 INTEGER: Indicate max epoch time [T] (valid if >= 2)
  -c C                 FLOAT: Indicate total load factor "c" [R=cT] (valid if > 0)
  -times TIMES         INTEGER: Redudancy factor (valid if > 0)
  -stake_f {eq,beta,pareto} STRING: Generator function for inital stake distrib.
  -sim {random,const,geom,log_const,log_geom} STRING: Indicate simulator class
```

So the program requires a flag for each simulation parameter, plus an optional id argument. The id argument is not necessary for basic usage, and i suggest using the docker setup for batch execution anyways (which manages experiment ids independently) so it may be removed in subsequent releases.

3. Test the installation

   An example of well formed command would be:

   ```
   $ sim-stake -m 3 -T 200 -c 0.5 -stake_f eq -sim random -times 10
   ```

   Which would run the simulation with:

   - $m = 3$ nodes
   - for $T = 200$ epochs,
   - with a load factor $c = 0.5$
   - initial stake $stake_f = eq$
   - $sim = random$ scheme,
   - repeating the experiment 10 times ($times = 10$)

   A csv is produced on standard output which looks like (may overflow page on pdf):

   ```
   m,T,c,R,sim,stake_f,var_0,var_T,gini_0,gini_T,under_target,avg_loss,over_target,avg_gain
   3,200,0.4,80.0,random,eq,0.0,0.0001354807,0.0,0.0164609053,0.6666666667,-0.0082304527,0.3333333333,0.01
   3,200,0.4,80.0,random,eq,0.0,0.0013222917,0.0,0.0592592593,0.6666666667,-0.0230452675,0.3333333333,0.04
   3,200,0.4,80.0,random,eq,0.0,0.0007207573,0.0,0.0427983539,0.6666666667,-0.0181069959,0.3333333333,0.03
   3,200,0.4,80.0,random,eq,0.0,0.0008833342,0.0,0.046090535,0.6666666667,-0.0205761317,0.3333333333,0.041
   3,200,0.4,80.0,random,eq,0.0,0.0006557266,0.0,0.0362139918,0.6666666667,-0.0181069959,0.3333333333,0.03
   3,200,0.4,80.0,random,eq,0.0,0.0008508188,0.0,0.0427983539,0.6666666667,-0.0205761317,0.3333333333,0.04
   3,200,0.4,80.0,random,eq,0.0,5.4192e-06,0.0,0.0032921811,0.3333333333,-0.0032921811,0.6666666667,0.0016
   3,200,0.4,80.0,random,eq,0.0,0.0003305729,0.0,0.0296296296,0.3333333333,-0.0230452675,0.6666666667,0.01
   3,200,0.4,80.0,random,eq,0.0,0.0002655422,0.0,0.0263374486,0.6666666667,-0.0106995885,0.3333333333,0.02
   3,200,0.4,80.0,random,eq,0.0,0.0005581805,0.0,0.0362139918,0.3333333333,-0.0329218107,0.6666666667,0.01
   ```

All simulation parameters are reported for each row along with the observed result metrics, so that each result is fully characterized by its csv output (i.e. 2 outputs can merged in a single dataframe without loss of information)

Use output redirection to save the results to a file for later inspection:

```
$ sim-stake -m 3 -T 200 -c 0.5 -stake_f eq -sim random -times 10 > some_name.csv
```

(a) NOTE Running the simulation as saw above works for simple tests with a single parameters combination. For a full fledged experiment with parameter manipulation see either section 4 (using as library) or section 3 (docker mode).

4. Using as library

   Once installed the code can also be used as library. In the module **sim.core.main** exposes a `run` function that accepts the parameters you would provide on the command line as a dictionary (without the `-` prefix on parameters name).

   In a python script of your choice:

```python
import sim.core.main as simulation

params = {'m':3,
          'T':300,
          'c':0.5,
          'stake_f':'eq',
          'sim':'random',
          'times':10}

simulation.run(params)
```

   The run function accepts 2 other optional named parameters:

   - `out_fn` (default = sys.stdout.write)
   - `header` (default = True)

   The `out_fn` will be called for each simulation repetition passing a string being the comma separated values (parameter + response metrics) i.e. `times` times once per line of the output csv.

   The `header` boolean controls whether the header of the csv should be produced before the first run results.

   (a) Simple experiment

   A simple experiment can be conducted by writing a procedure that runs several simulations:

   Let's say we want to manipulate the number of nodes m:

```python
import sim.core.main as simulation

ms = range(2,10)
```

```
params = {'m':None,
          'T':300,
          'c':0.5,
          'stake_f':'eq',
          'sim':'random',
          'times':10}

header = True
for m in ms:
    params['m'] = m
    simulation.run(params,header=header)
    if header:
        header=False
```

Note that we ensure that the header is only produced on the first parameter combination so we get a valid csv as output.

5. Experiment definition grammar

   Although the above is sufficient for simple experiments, relying on procedural code may hide the essence of the experiment in complex scenarios, rendering difficult to infer what is tested. A more declarative approach ensures readability and clarity.

   In order to define experiment in a pleasant way a module was defined to provide a definition grammar for complex experiments.

   The fundamental idea is providing a callable data structure that represents the Cartesian product of named sets. Once called the ds will expand to a list of dictionaries where each key assumes one of the values of its set.

   The `sim.executor.batch.ibatch` module provides the constructor `P` for these Cartesian expansions.

```
from pprint import pprint
from sim.executor.batch.ibatch import P

p1 = P({'a':{True,False},
        'b':{True,False}})

pprint(p1())
```

   Which produces the following output:

```
[{'a': True, 'b': True},
 {'a': True, 'b': False},
 {'a': False, 'b': True},
 {'a': False, 'b': False}]
```

Typically the values of the dictionary provided to the P constructor will be sets (thus ensuring no duplicates) but any iterable or callable that returns an iterable is fine, so the following is acceptable:

```
from pprint import pprint
from sim.executor.batch.ibatch import P

def i_could_be_a_very_complex_function():
    "...complex compute..."
    return {True,False}

p2 = P({'n': range(1,4),
        'b': i_could_be_a_very_complex_function})

pprint(p2())
```

Which produces:

```
[{'b': False, 'n': 1},
 {'b': True, 'n': 1},
 {'b': False, 'n': 2},
 {'b': True, 'n': 2},
 {'b': False, 'n': 3},
 {'b': True, 'n': 3}]
```

If we only desire a segments of the product (i.e. some value should only be matched with specific ones) then chaining 2 separate P constructor suffices. To chain constructors just use the + operator:

```
from pprint import pprint
from sim.executor.batch.ibatch import P

p3 = P({'mode': {"a"},
        'sub_mode': {"a1","a2"}})

p4 = P({'mode': {"b"},
        'sub_mode':{"b1","b2"}})

p5 = p3 + p4

pprint(p5())

[{'mode': 'a', 'sub_mode': 'a1'},
 {'mode': 'a', 'sub_mode': 'a2'},
 {'mode': 'b', 'sub_mode': 'b1'},
 {'mode': 'b', 'sub_mode': 'b2'}]
```

A real experiment definition for the simulation could be:

```
from sim.executor.batch.ibatch import P
REPETITIONS=10
REDUNDANCY=2
batch = P({'m':  [10 ** i for i in range(1,4)], # 3 elems
           'T':  [10 ** i for i in range(2,4)], # 2 elems
           'c':  [0.001, 0.01, 0.1, 0.5, 1, 2, 10, 100], # 8
           'sim':        ['const','geom','log_const','log_geom','random'], # 5 elmes
           'stake_f':    ['eq','beta','pareto'], # 3 elems
           'times':      [REPETITIONS],
           'redundancy': range(REDUNDANCY) })
```

Which will generate $3 * 2 * 8 * 5 * 3 = 720$ unique parameters configurations, which are replicated `REDUNDANCY` times (thus 1440 runs) each of which tests the configuration `REPETITIONS` times (thus 14'400 total simulations).

'redundancy' in this case is a dummy key, the actual simulation will not read its value, but it still multiplies the number of generated parameter dictionaries. The reason for having both 'times' and 'redundancy' should become clear when the distributed multiprocess facility is introduced; in a single process environment one should just use 'times'.

the above experiment could be run as follows:

```
import sim.core.main as simulation
header = True
for params in batch():
    simulation.run(params,header=header)
    if header:
        header=False
```

A large experiment like the one above may take very long to terminate which is why the software is meant to be run in a distributed multiprocess fashion thanks to celery `https://github.com/celery/celery`.

6. Experiment definition convention We adopt the following convention to define experiments:

   create a python file in `$PROJECT_ROOT/executor/experiments/`

   define the experiment via arbitrary code or using the above presented grammar and assign the callable or iterable that generates the configurations to a toplevel variable called `batch`.

   Note that you can define experiments wherever you want as long as the file is in the `$PYTHONPATH` and a `batch` callable or iterable is present.

   The main experiment presented in the paper is located in module `sim.executor.experiments.exp_0`.

   This convention will be important later on in section 3.

3 Docker mode

If not already present on your system install docker: `https://docs.docker.com/get-docker/`

On linux you may want to use your usual package manager. On linux, after installation, you need to add your user to the `docker` group to be able to run docker images without root privileges. (This is strongly encouraged rather than using sudo!!)

```
# usermod -append -G docker <your-user>
```

On macos and windows (using the desktop version of docker) the docker-compose utility ships by default. On linux you will have to install it separately: `https://docs.docker.com/compose/install/`

It quiet intuitively allows to compose docker images/containers.

1. Ensuring docker installation

   Test the docker installation

   ```
   $ docker run -rm hello-world
   ```

   This can take a while the first time, but it should then produce some useful information about docker and exit.

2. Installing the project's image

   The docker image for this project ships with a fully functional archlinux system with all the necessary requirements installed plus some packages and tweaks to make the experience pleasant like tab-completion on the project's commands.

   Using a pre-built image is suggested; download it from `http://139.162.161.39/thesis/images/pos-sim-core-latest.tar.gz` (to check the sha sums see section 7.)

   The compressed image is about 1 GB.

   once downloaded load it to the docker engine with

   ```
   $ docker load < pos-sim-core-latest.tar.gz
   ```

   ** Launch the system Once the image is successfully loaded enter the `$PROJECT_ROOT/compose` folder and run:

   ```
   $ docker-compose up
   ```

   This will start the container and mount the `$PROJECT_ROOT/compose/data` directory to the container's `~/data` dir. This location can be used as a (persitent) bridge between your system and the container.

   The above command will hang until you decide to stop it, when so hit CTRL-C to send the shutdown signal, the system will process it and shutdown gracefully.

   Note this is named container so only one instance at a time can run, that is more than sufficient to run many simulations in parallel within the container though!

3. Start a session You can start a terminal session within the running system (from another terminal) with

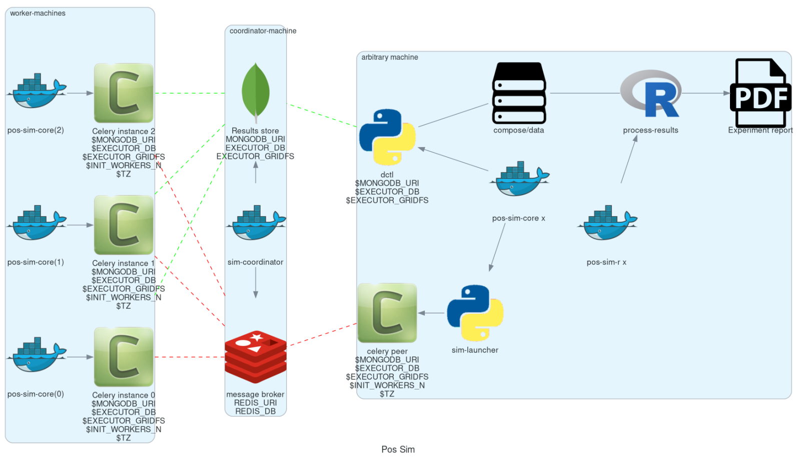
   ```
   $ docker exec -it pos-sim-core /bin/zsh
   ```

   This will open a terminal within the container.

Inside you find a copy of `$PROJECT_ROOT`.

All of the project commands are in the `$PATH` there so they can be called directly. If in doubt you can list them with `$ ls ~/.scripts`

4 Multiprocess distributed execution



To allow for large scale simulations facilities are provided to run multiple simulations in parallel on multiple machines thanks to Celery (v4.4.3) `https://docs.celeryproject.org/en/4.4.3/getting-started/resources.html` coordinated by Redis `https://redis.io/` and storing results on Mongodb `https://www.mongodb.com/`.

While a setup without docker for this use case is possible it involves installing the project, mongodb and redis to your system, and since the purpose of this facility is to deploy easily on several possibly heterogeneous systems the easiest and more reliable solution is to just have a docker engine on each machine and rely on the provided images.

Note that no knowledge about redis or mongodb is required to carry out the experiments as utilities are provided for the necessary interactions.

1. Coordination

   On one machine the **sim-coordinator** system should be run. Assuming docker and docker-compose are available on the machine simply enter `$PROJECT_ROOT/sim-coordinator` and run

   ```
   $ docker-compose up
   ```

   Note that this uses the official redis and mongodb images so no `docker load` is needed in this case.

This will start the database and redis instances on predefined ports (see section 5 if you want to change the port numbers for any reason.)

the above command will hang until CTRL-C is pressed which will start the graceful shutdown.

The workers running the project's code will receive jobs to execute from redis and produce results to the database.

Inside of `$PROJECT_ROOT/sim-coordinator` 2 folders are present:

- `$PROJECT_ROOT/sim-coordinator/mongo-volume`
- `$PROJECT_ROOT/sim-coordinator/reids-data`

Similarly to `$PROJECT_ROOT/sim-coordinator/compose/data` these act as bridges with your host system. The database will persist the data the **mongo-volume** dir and redis (which by default is not persistent) will do so in the **redis-data** dir if configure to be persistent.

No further actions need to be taken with regard to the coordination system.

2. Workers

   On each machine that should be targeted by the job distribution mechanism follow sections 2 and 3 to boot the worker environment.

   Once you have a session terminal ensure that the system configuration is correct for your needs (see section 5), and then simply run:

   ```
   $ run-worker
   ```

   to have the machine join the distributed system. This will hang until you hit CTRL-C, and will print information about the system and then log events.

3. Launcher

   A launcher is provided in the module `sim.executor.launcher` which is linked in `.scripts/sim-launcher` for convenience.

   You can use the launcher from any of the machines that have a running (and correctly configured) instance of the project's docker image. Another option is launching from a machine (e.g. a laptop) that will not have a worker running so long as it is properly configured to contact the distributed system coordinator (see section 5).

   it synopsis is as follows:

   ```
   usage: sim-launcher [-h] [-exp-module EXP_MODULE] [-async]

   optional arguments:
     -h, -help            show this help message and exit
     -exp-module EXP_MODULE
     -async, -a
   ```

The `-exp-module` option controls which experiment will be loaded and distributed on worker machines. If not provided a small default experiment is chosen to test the system. The value provided for the experiment module should be a fully qualified python module name such as `sim.executor.experiments.exp_0` just like in an **import** statement, pointing to a module in the `$PYTHONPATH`. The `batch` variable within that module will be looked up according to the convention presented in section 6.

If `-async` is not provided then the launcher will block until the experiment completes. If `-async` is provided then the launcher will exit as soon as the dispatching completes, you can then monitor the progress as explained in section 6

Once an experiment is successfully launched the coordinator will distribute the necessary jobs to complete the experiment to the available workers.

The launcher program outputs some information about the dispatched experiment. In particular it outputs a python dictionary whose `batch_uuid` key is what we are interested in for fetching results later on as explained in section 4. (If the `-async` flag is on the look for `_batch_uuid`)

4. Retrieving results

   In distributed mode the database is used to store results as they are produced.

   Once an experiment is finished you can use the utility provided in `$PROJECT_ROOT/.scripts/dctl` that helps to fetch all the aggregated results of a full experiment from the database as a csv.

   Within the docker environment this is linked to `~/.local/bin` so you can use it directly

   ```
   $ dtcl [cmd] [options]
   ```

   in custom environment from `$PROJECT_ROOT` use it by invoking the full with path

   ```
   .scripts/dtcl [cmd] [options]
   ```

   It provides 2 cmd(s):

   - `dctl fs ls` List the experiment results csv that are available in the system.
   - `dctl fs get <batch_uuid>.csv` Get a result by name.

   Note that from the docker environment tab-completion is available for the file name, so you just need to remember the first few characters of the `batch_uuid` and then press tab to complete.

   Redirect the output of `dctl fs get` to a file in to save the results. If you are running dctl in the docker environment redirect to `~/compose/data/<filename>.csv` to have the results visible on the host system. (Remeber `compose/data` acts as bridge - so called docker volume - between the virtual system in the docker and your host system).

   ```
   $ dctl fs get batch_uuid.csv > destination/name.csv
   ```

   substitute `batch_uuid`, `destination` and `name` appropriately.

5. Configuring the distributed system

   The distributed system is configured via the following environment variables:

(a) `MONGDB_URI` Defines the address of the database in the following format:
mongdb://<ip-adress>:<ip-port>
so for example assuming the coordinator was launched on a machine on 192.168.178.31 on the default port:
mongodb://192.168.178.31:27020
default **mongodb://0.0.0.0:27020**

(a) `EXECUTOR_GRIDFS` The name of the internal database to use as distributed filesystem, the default is **executor-gridfs**
(b) `EXECUTOR_DB` The name of the internal database to use for task metadata and partial results, default is **from-celery**
(c) `REDIS_URI` Similar to `MONGODB_URI` but for the redis server, default is **redis://0.0.0.0:6399**
(d) `REDIS_DB` The number (redis uses integers to identify the dbs) of the redis internal database to use. Default 2
(e) `INIT_WORKERS` The number of workers (processes) to run concurrently if the machine is used as worker node.
(f) `TZ` The timezone to use (must be consistent on all machines for proper coordination). Defaults to **Europe/Amsterdam**, must be a valid timezone value.

Ideally you want to modify only the URI(s), `TZ` and `INIT_WORKERS`.

the suggested manner of configuration is putting all the values in a .env file like the following:

```
MONGODB_URI=mongodb://0.0.0.0:27020
EXECUTOR_GRIDFS=executor-gridfs
EXECUTOR_DB=from_celery

REDIS_URI=redis://0.0.0.0:6399
REDIS_DB=2

INIT_WORKERS_N=4

TZ=Europe/Amsterdam
```

Environment variables must be established for each running terminal session. An utility is provided in `$PROJECT_ROOT/.scripts/source-env.sh`, use it as follows from `$PROJECT_ROOT`

```
$ source .scripts/source-env.sh <path-to-env-file>
```

The default .env file is located at `$PROJECT_ROOT/compose/defaults.env`.

Please note that you have to source your (or the default) .env file for each session! In each session use the config doctor from section 5a to ensure the system is configured correctly.

NOTE: To streamline configuration you can edit `$PROJECT_ROOT/compose/defaults.env` before distributing the project to your machines, the variables in this file will be loaded automatically when you start a pos-sim-core docker by following instruction in section 2. If you then still need to change them at runtime you will have to soruce the file from inside the container again as explained above.

(a) Config doctor

Another utility is provided at which will validate the configuration and verify that the coordination services are reachable.

It requires no arguments as it reads the environment vars.

You can invoke the `config-doctor` by running:

```
$ python -m sim.executor.config-doctor
```

6. Monitoring the distributed system

The status of the distributed system can be monitored with a web-ui provided by `flower` (`https://flower.readthedocs.io/en/latest/`).

Start a new session on one of the machines running the project's docker images (not the coordinator!)

```
$ docker exec -it pos-sim-core /bin/zsh
```

once the session starts run:

```
$ launch-flower
```

If no active worker is found this may log some warnings like: `'stats' inspect method failed`, don't worry, as soon as a worker connects the system will heal automatically.

The docker exposes port 5555 so you can open a browser on that machine (outside of docker that is) and point it to `http://0.0.0.0:5555`

Note that the graphs are not retroactive so keep a tab open on the graph page and do not reload.

5 Results analysis

Experiment results are analyzed with R code. Compiling R dependencies may take a lot of time (nearly 30 minutes for the dependencies of `analyze.Rmd` on an medium tier laptop), and errors in the process may harm the reproducibility of the analysis. Therefore a third docker image is provided which ships with all the dependencies compiled in it, and when run exposes an R-studio web interface to run (and possibly customize) the analysis.

Whether you produced results via single process code, or via the distributed system you will have one or more csv files with results to analyze.

If running via the distributed system use `dctl` utility **??** to retrieve form the database with the desired csv.

The analysis can be performed by the R script provided in `$PROJECT_ROOT/pos-sim-r/analyze.Rmd`.

You should run the analysis docker on the machine where you downloaded the results via `dctl` or transfer the csv files to another machine and then use that one.

Copy the results csv file to `$PROJECT_ROOT/pos-sim-r/data/exp_data/`.

NOTE: `$PROJECT_ROOT/pos-sim-r/data` is a docker volume that will be mounted when the image is run, so you can copy from your host system with `cp` or drag/drop and the changes will be reflected inside the container.

NOTE: The analysis script will merge all files that it finds in the `exp_data` directory so be careful to only have the files you desire in there later when you run the script. If you create other data folders you can control which is used by ediding the first cell of `analyze.Rmd` where **data.folder** is defined.

Download the image from `http://139.162.161.39/thesis/images/pos-sim-r-latest.tar.gz` (to check the sha sums see section 7.)

Load the image to the docker engine:

```
$ docker load < pos-sim-r-latest.tar.gz
```

Enter `$PROJECT_ROOT/pos-sim-r`. Edit the **defaults.env** file to change the default password ('foobarbaz') for the R-studio server. (The username is always 'rstudio'). Now run

```
$ docker-compose up
```

As usual this will hang until you stop it with CTRL-C

Point a browser to R-studio web-ui on `http://localhost:8787`. It will ask to login with password you provided in **defaults.env**.

enter the `projects` folder and Open the analyze.Rmd file, press 'knit'.

Alternatively run from the rstudio terminal: `$ make render`.

Assuming valid data is found in `projects/exp_data` within the docker, the analyze.Rmd will produce a pdf/markdown/html (depending on kint options, defaults to html) file that presents all the results. The file will be saved in the docker `projects/` folder and is therefore also present on your host machine in `$PROJECT_ROOT/pos-sim-r/data`.

The main experiment discussed in the project's paper is at: `http://139.162.161.39/thesis/analyze.html`

Yours will be available locally: at `http://localhost:8787/files/projects/analyze.html`

6 Project structure

```
PROJECT_ROOT
.
|- compose
|   |- data
|   |   `- .gitgignore
|   |- defaults.env
|   |- docker-compose.yml
|   |- vars.env
|   `- vars.wan.env
|- Dockerfile
|- .dockerignore
|- doc_source
|   |- conf.py
|   |- index.rst
|   `- _static
|- .gitignore
|- Makefile
|- pipinstalls.txt
|- pos-sim-r
|   |- data
|   |   |- analyze.html
|   |   |- analyze.Rmd
|   |   |- exp_data
|   |   |   `- .gitkeep
|   |   |- figure
|   |   |   |- .gitkeep
|   |   |   `- score_contour.jpg
|   |   |- makefile
|   |   `- make.r
|   |- defaults.env
|   |- docker.build.sh
|   |- docker-compose.yml
|   |- Dockerfile
|   `- install_deps.r
|- README.html
|- README.md
|- README.org
|- README.pdf
|- .scripts
|   |- add-aur.sh
|   |- dctl
|   |- get-batch-file
|   |- install.sh
|   |- launch-flower
|   |- list-batch-files
|   |- revoke-sudo.sh
|   |- run-worker
|   |- sim-launcher
|   |- sim-stake1
|   |- source-env.sh
|   |- tabulate.sh
|   `- welcome.sh
|- setup.cfg
|- setup.py
|- sim
|   |- cmd
|   |   `- ucmd.py
|   |- core
|   |   |- abstract_sim.py
|   |   |- base_object.py
|   |   |- boot_exp.py
|   |   |- decorators.py
|   |   |- ecdf.py
|   |   |- implem.py
|   |   |- __init__.py
|   |   |- main.py
|   |   |- node.py
|   |   |- parser.py
|   |   |- plot.py
|   |   |- rew_f.py
|   |   |- sel_f.py
|   |   |- sim_0.py
|   |   |- stake_f.py
|   |   `- utils.py
|   |- executor
|   |   |- batch
|   |   |   `- ibatch.py
|   |   |- celeryconf.py
|   |   |- config-doctor.py
|   |   |- db
|   |   |   |- cmd.py
|   |   |   |- fs.py
|   |   |   |- logger.py
|   |   |   `- parser.py
|   |   |- dbdriver.py
|   |   |- experiments
|   |   |   |- exp_01.py
|   |   |   |- exp_0.py
|   |   |   |- exp_365.py
|   |   |   |- exp_const_geom_pt2.py
|   |   |   |- exp_const_geom.py
|   |   |   |- exp_log.py
|   |   |   `- foo.py
|   |   |- launcher.py
|   |   |- logger.py
|   |   `- tasks.py
|   `- parser
|       `- aparse.py
|- sim-coordinator
|   |- docker-compose.yml
|   |- mongo-volume
|   |   |- .gitignore
|   |   `- README.txt
|   `- redis-data
|       |- .gitignore
|       `- README.txt
```

```
`- todo.org

20 directories, 86 files
```

1. Locs

Language	Files	Lines	Blank	Comment	Code
Python	41	3121	776	316	2029
`./executor/dbdriver.py`		381	96	23	262
`./executor/tasks.py`		168	44	12	112
`./core/boot_exp.py`		144	32	3	109
`/core/test/stake-sim-0.py`		159	35	15	109
`executor/config-doctor.py`		137	33	0	104
`./executor/launcher.py`		195	55	39	101
`./core/sim_0.py`		144	35	11	98
`/executor/batch/ibatch.py`		145	41	10	94
`./core/abstract_sim.py`		123	29	14	80
`./parser/aparse.py`		113	23	13	77
`./core/plot.py`		88	16	4	68
`./core/decorators.py`		78	12	1	65
`./core/implem.py`		94	23	10	61
`./executor/db/fs.py`		94	30	9	55
`./core/utils.py`		64	12	1	51
`./core/node.py`		62	13	3	46
`./core/main.py`		67	18	5	44
`./core/base_object.py`		66	16	9	41
`./cmd/ucmd.py`		54	11	3	40
`./core/parser.py`		54	14	1	39
`./core/test/random1.py`		46	15	0	31
`./core/sel_f.py`		42	8	6	28
`./core/stake_f.py`		50	11	12	27
`./executor/celeryconf.py`		37	11	0	26
`./executor/db/parser.py`		32	7	0	25
`./executor/db/cmd.py`		43	15	6	22
`./core/test/batch.py`		63	16	25	22
`./executor/test/ctx.py`		39	16	2	21
`nts/exp_const_geom_pt2.py`		36	10	7	19
`riments/exp_const_geom.py`		39	11	9	19
`./core/ecdf.py`		32	3	10	19
`or/experiments/exp_365.py`		33	9	7	17
`utor/experiments/exp_0.py`		34	10	7	17
`tor/experiments/exp_01.py`		34	10	7	17
`or/experiments/exp_log.py`		39	11	11	17
`./core/rew_f.py`		27	9	2	16
`./core/test/tx.py`		21	6	1	14
`./core/__init__.py`		10	3	0	7
`./executor/db/logger.py`		15	3	8	4
`./executor/logger.py`		17	3	10	4
`ecutor/experiments/foo.py`		2	1	0	1

7 Images sha256sum

run `$ sha256sum /path/to/file.tar.gz`

```
dbe608295d63480a21421f24b7582dea8f70613b383d783e46b0d7683e675ca pos-sim-core-latest.tar.gz
d9d564c2b26b3df8d105235d0ae4f2fe98d45d52620021b5a7d08617b730cd78 pos-sim-r-latest.tar.gz
```