An open-source job management framework for parameter-space exploration

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Typical research workflow

**essential in research activities**

- consider a model()
- write a source code()
- write a script for analysis()

```
while ( necessary ) {
    select a suitable parameter set()
    execute simulation run()
    take a note to remember what we are doing()
    wait for completion of the simulation run()
    transfer the simulation results to suitable folders()
    keep a note to remember what is done()
    analyze results()
    create a graph()
}
```

- write a paper()
- present in a meeting()

**tend to be a bottleneck**
- comparison of many models, parameters, jobs…
- prone to human-errors
- iteration can be longer as the amount of computation grows
SSH login is required many times to submit jobs

everything is very messy

difficult to trace

we must repeat what we have done when we find a bug in the simulation code

After a few months, the simulation results are no longer traceable
# OACIS

Organizing Assistant for Comprehensive and Interactive Simulations

## Simulators

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Available as an Open-Source software under the MIT license [https://github.com/crest-cassia/oacis](https://github.com/crest-cassia/oacis)

developed by Discrete-Event Simulation Research Team, R-CCS
System Overview

Workers downloads results.
Results are stored in file storage and DB.

You can access simulation results.

Remote hosts executes simulation jobs.
Workers creates shell scripts and submit jobs via SSH.

Handles requests from users.

Users can create jobs via Web-browser.

Ruby on Rails + MongoDB, Unix-based OS
Data-structure overview

Simulator

ParameterSet

Run

Analysis

- seed: xxxx

- seed: yyyy

- seed: zzzz

- seed: aaaa

- seed: bbbb

- seed: cccc

- seed: dddd

- seed: eeee

Analyzer

AnalyzerA

AnalyzerB

Analysis

Analysis 1

Analysis 2

Analysis 3

Analysis 4
### List of Parameter Sets

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Parameter Set
/Users/murase/program/oacis/public/Result_development/537180f4b93f9652b90002d5/5423e009b93f96b620000023

Plot on (net_size=10000, p_tri=0.05, p_jump=0.0005, p_death=0.0005, delta=1.0, t_max=25000, shuffle_fraction=0.005)

Plot type: figure viewer
X-Axis: p_death
Y-Axis: shuffle_fraction
Result: plot_all/degree_distribution.png

Irrelevant parameters:
- net_size
- p_tri
- p_jump
- p_death
- delta
- t_max
- shuffle_fraction

URL:
http://localhost:3000/parameter_sets/5423e009b93f96b620000023

Action: 
Command-line based execution

A command is embedded into a shell script. We can implement simulators in any language.
Sharing data

• To share the data, we provide “read-only” mode.
• To share data, you may prepare another read-only instance.

Each simulation result and plot has an URL.
Software Stack

• server side
  • Ruby
  • Ruby on Rails
  • MongoDB
• front-end
  • D3.js
  • jQuery
  • twitter-bootstrap

~ 12,000 lines for app
~ 12,000 lines for unit tests
APIs

Python and Ruby APIs are available for automate your workflows.

```ruby
sim = Simulator.where(name: "my_simulator").first
host = Host.where(name: "localhost").first

p1_values = [1.0,2.0,3.0,4.0,5.0]
p2_values = [2.0,4.0,6.0,8.0,10.0]

p1_values.each do |p1|
  p2_values.each do |p2|
    parameter = {
      "p1" => p1,
      "p2" => p2
    }
    ps = sim.find_or_create_parameter_set(parameter)
    ps.find_or_create_runs_up_to(5, submitted_to: host)
  end
end
```
Sensitivity Analysis

Identifying the input factors that affect simulation outputs

Agent simulation of evacuations from Tsunami
Use cases

• modeling social networks
  • Y. Murase et al. (2014, 2015), Torok et al. (2016), Jo et al. (2016)
• agent-based simulation of stock markets
  • Kusada et al. (2014), Torii et al. (2015)
• agent-based simulation of traffic and pedestrians
  • Matsushima (2016), Tsuji (2015), Uchitane et al. (2016), Yoshioka et al.
• studies on open evolving systems
  • Shimada et al. (2014, 2015), Murase et al. (2015)
• molecular dynamics simulation of granular material
  • Kuwabara et al.
• first-principle calculation of condensed matter physics
  • Pham et al. (2017)
• simulation of rescue robots
  • Takayanagi et al. (2016), Takami et al. (2017)
Development History

- **v1.15.2** (2013/4)
- **v1.14.0** (2014/4)
- **v1.13.0** (2015/4)
- **v1.12.0** (2016/4)
- **v1.11.0** (2016/4)
- **v1.10.1** (2016/4)
- **v1.9.0** (2016/4)
- **v1.8.0** (2016/4)
- **v1.7.0** (2016/4)
- **v2.0.0** (2017/4)
- **v2.1.0** (2017/4)
- **v2.2.0** (2017/4)
- **v2.3.0** (2017/4)
- **v2.4.0** (2017/4)
- **v2.5.0** (2017/4)
- **v2.6.0** (2017/4)
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- **v2.12.0** (2018/4)
- **v2.13.2** (2018/4)
- **v3.0.0** (2019/4)
- **v3.1.0** (2019/4)
- **v3.2.1** (2019/4)
- **v3.3.0** (2019/4)
- **v3.4.0** (2019/4)
Conclusion

https://github.com/crest-cassia/oacis