

Разработка симулятора вычислительного кластера

Выполнил: Макогон Артём Аркадьевич, БПМИ206

Руководитель: Сухорослов Олег Викторович, к.т.н, доцент НИУ ВШЭ

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Testing of cluster scheduling algorithms



- Compute clusters are widely used for complex calculations.
- Scheduling algorithms are crucial for their performance.
- These algorithms are the subject of active research.

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- > Using real clusters is expensive and time-consuming.

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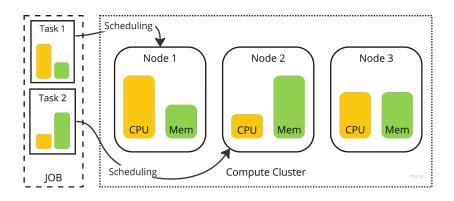


✓ **Simulators** are used for effective development.

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Cluster architecture



Simple model of cluster architecture

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Two approaches for simulation



Standard Workload Format (SWF)

CPU/memory resources

Custom workloads

CPU/memory/disk/network resources

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Two approaches for simulation



Standard Workload Format (SWF)

- CPU/memory resources
- Given execution time and resources
- Workload is calculated

Custom workloads

- CPU/memory/disk/network resources
- Given workload and resources
- Execution time is calculated

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Two approaches for simulation



Standard Workload Format (SWF)

- CPU/memory resources
- Given execution time and resources
- Workload is calculated
- Used in famous cluster traces (e.g. Google traces)

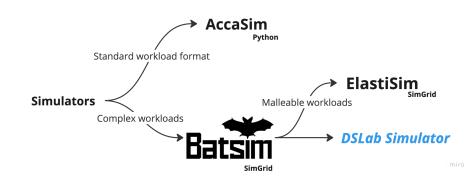
Custom workloads

- CPU/memory/disk/network resources
- Given workload and resources
- Execution time is calculated
- NDA

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Literature Review Existing Simulators





Existing cluster simulators

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Literature Review

BatSim



- Based on SimGrid simulator platform.
- Supports SWF and custom workloads defined as JSON profile.
- Supports connecting scheduling algorithms using inter-process communication.

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Literature Review





```
"jobs": [
 {"id": "job1", ... "res": 4, "profile": "sequence"},
],
"profiles": {
  "homogeneous": {
    "type": "parallel_homogeneous",
    "cpu": 10e6,
    "com": 1e6
  },
  "sequence": {
    "type": "composed",
    "repeat" : 4,
    "seq": ["simple", "homogeneous", "simple"]
 },
```

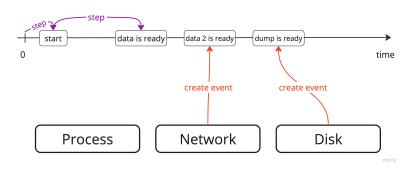
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Methods



- Fast & scalable simulation platform
- Written in Rust

 Provides models of compute/network/storage



Discrete-event modeling in DSLab

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Methods



Asynchronous event management. Rust futures combiners

```
async fn process_task(&self, req:
    TaskRequest) {
    let mut task = TaskInfo {req};
        self.download_data(args.node_1)
        self.download_data(args.node_2)

self.read_data(&task).await;
self.run_task(&task).await;
self.write_data(&task).await;
self.upload_result(&task).await;
}
```

Example of sequent task execution

Example of parallel tasks execution

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Methods JobProfile trait



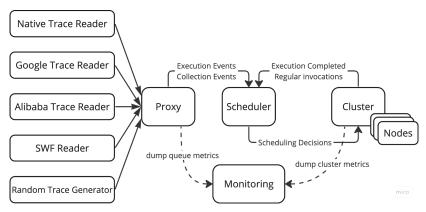
```
pub trait JobProfile {
   async fn run(self: Box<Self>, ctx: JobContext)
}
```

Job trait description

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Methods Simulator architecture





Simulator architecture

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Expected Results

Fast and scalable compute cluster simulator



- ✓ SWF-based simulation
- Custom workload simulation
- Support reading workload traces from popular sources (Google, Alibaba)
- Support for collecting metrics during the simulation and writing them to a file with the results
- High performance, support for cluster modeling from 1-10K servers

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References



- The standard workload format specification. https://www.cs.huji.ac.il/labs/parallel/workload/swf.html
- Dslab repository. https://github.com/osukhoroslov/dslab
- 3. BatSim docs.
 https://batsim.readthedocs.io/en/latest/

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