Transparent Autonomicity for OpenMP Applications

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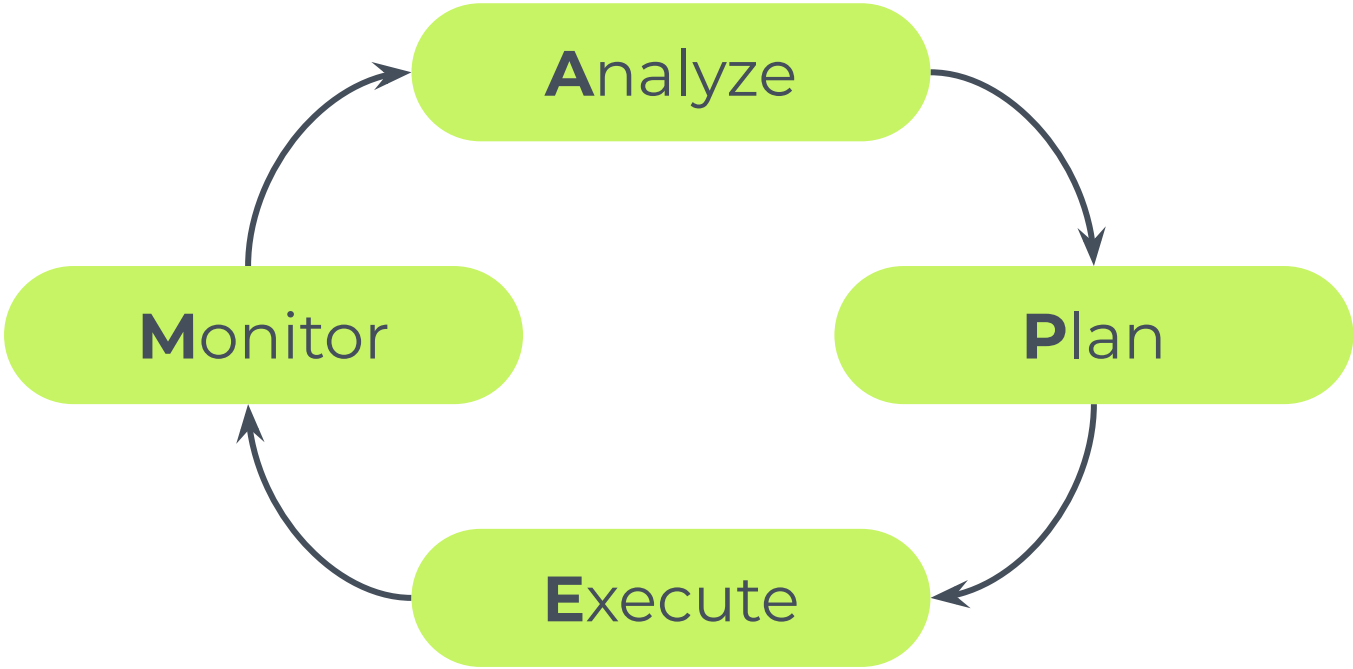
BACKGROUND & MOTIVATION

AUTONOMICITY (MAPE LOOP)



MONITOR

Black-Box

Instrumentation
(Manual/Static/Dynamic)

Runtime calls intercept

Programming **API**

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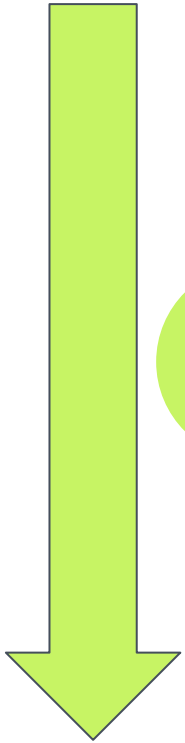


More Programming **Effort**
More **Control** (Better Solutions)

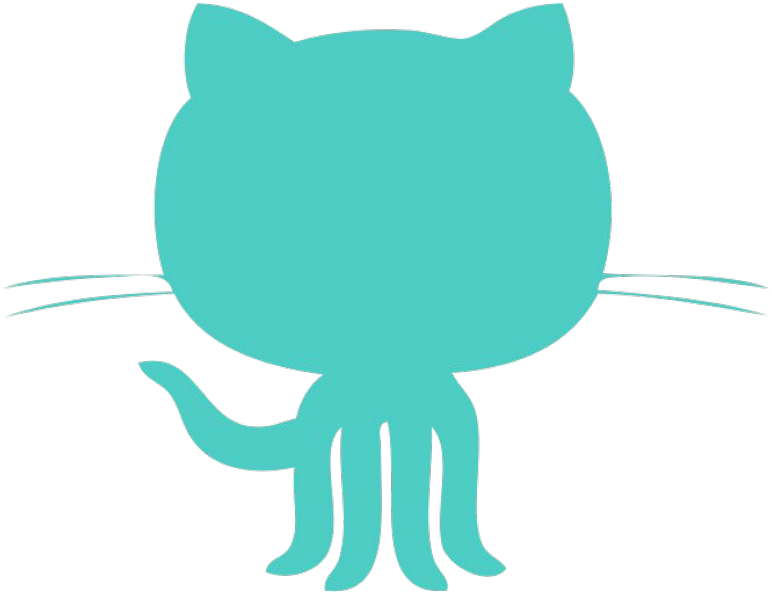
OPENMP TOOLS API

Track different **events** during the lifetime of an **OpenMP** application

Callbacks specify the code to be executed when the corresponding **event** occurs

export **LD_PRELOAD**=/path/to/callbacks_lib.so

NORNIR



http://danieledesensi.github.io/nornir/

NORNIR

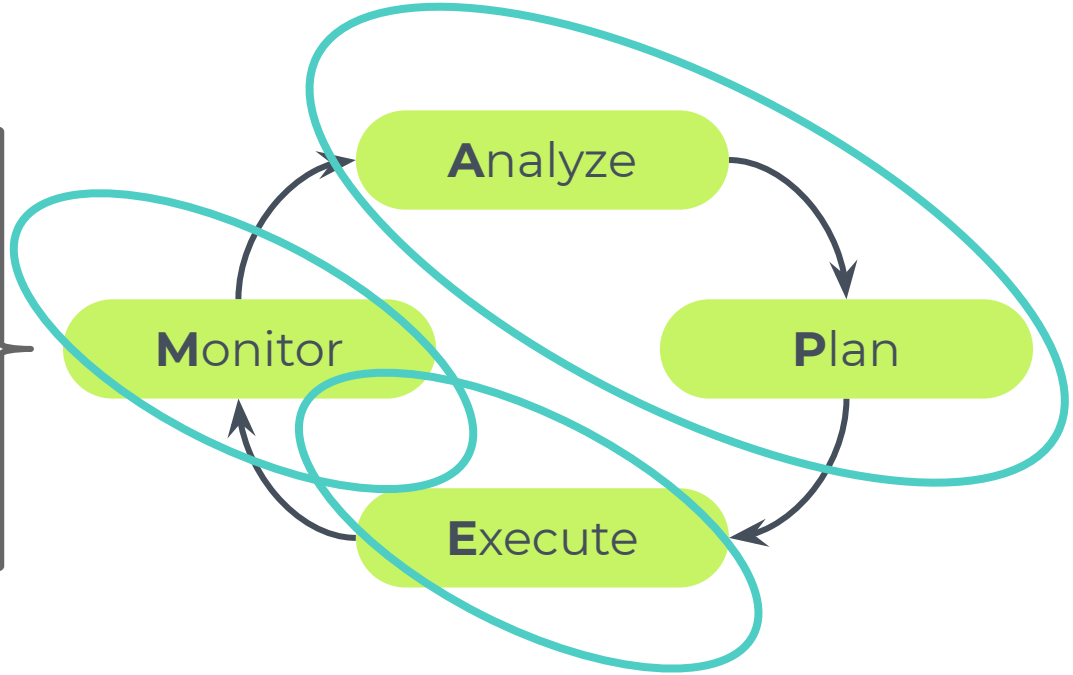
- 9 different **algorithms** (machine learning, heuristics, etc...)
- Fully **customizable** by implementing a few functions

Black-Box

Instrumentation (Manual)

Runtime calls intercept

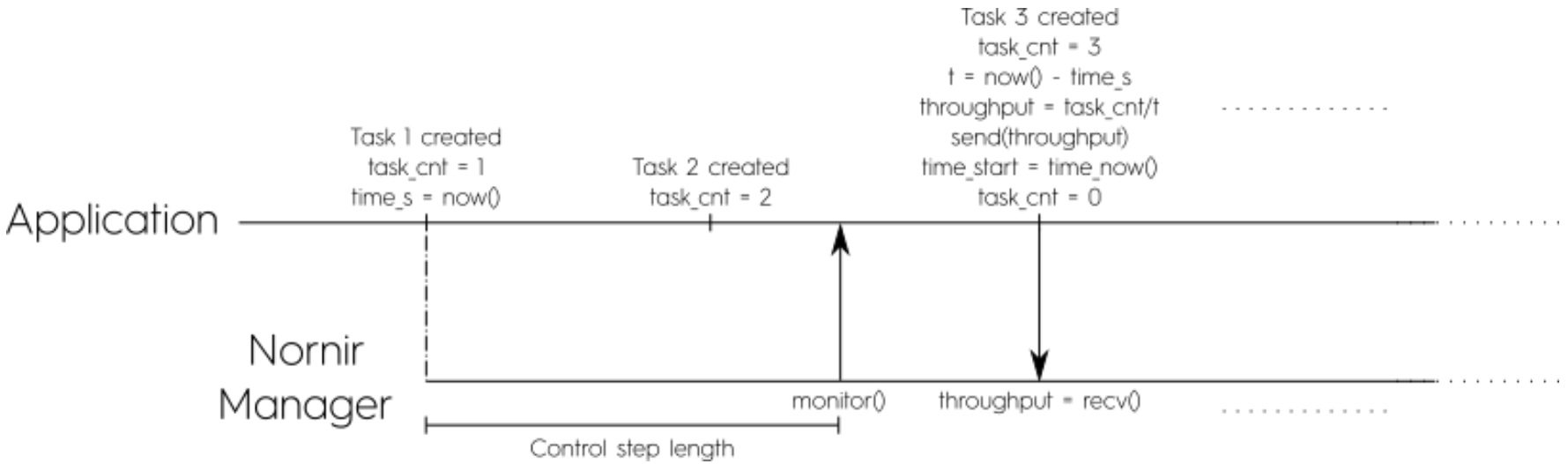
Programming **API**



Number of **cores**, DVFS, **Clock** Modulation, **Threads** Mapping, **SMT** Level

DESIGN & IMPLEMENTATION

NORNIR-APPLICATION INTERACTION



PARALLEL LOOPS

In applications composed by a **single parallel loop**, 1 task per core created, cannot monitor the progress

We extended OMPT implementation to track loop chunks scheduling events

We still have problems with **statically scheduled loops**

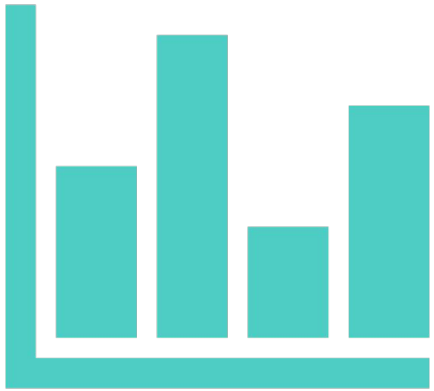
HOW TO USE

```
$> git clone ... && cd nornir
$> cmake && make && make install
$> nornir_openmp appName config.xml
```

- export LD_PRELOAD=/ompt/lib.so
- Starts *manager* process
- Starts *appName*

```
<?xml version="1.0" encoding="UTF-8"?>
<nornirParameters>
<requirements>
    <throughput>100</throughput>
    <powerConsumption>40</powerConsumption>
</requirements>
</nornirParameters>
```

EVALUATION



EVALUATION ENVIRONMENT

2 x Intel Xeon E5-2695 Ivy Bridge CPUs (**24 cores**)

2 **PARSEC**: blackscholes, bodytrack (native)
2 **NAS**: bt (class B), cg (class C)

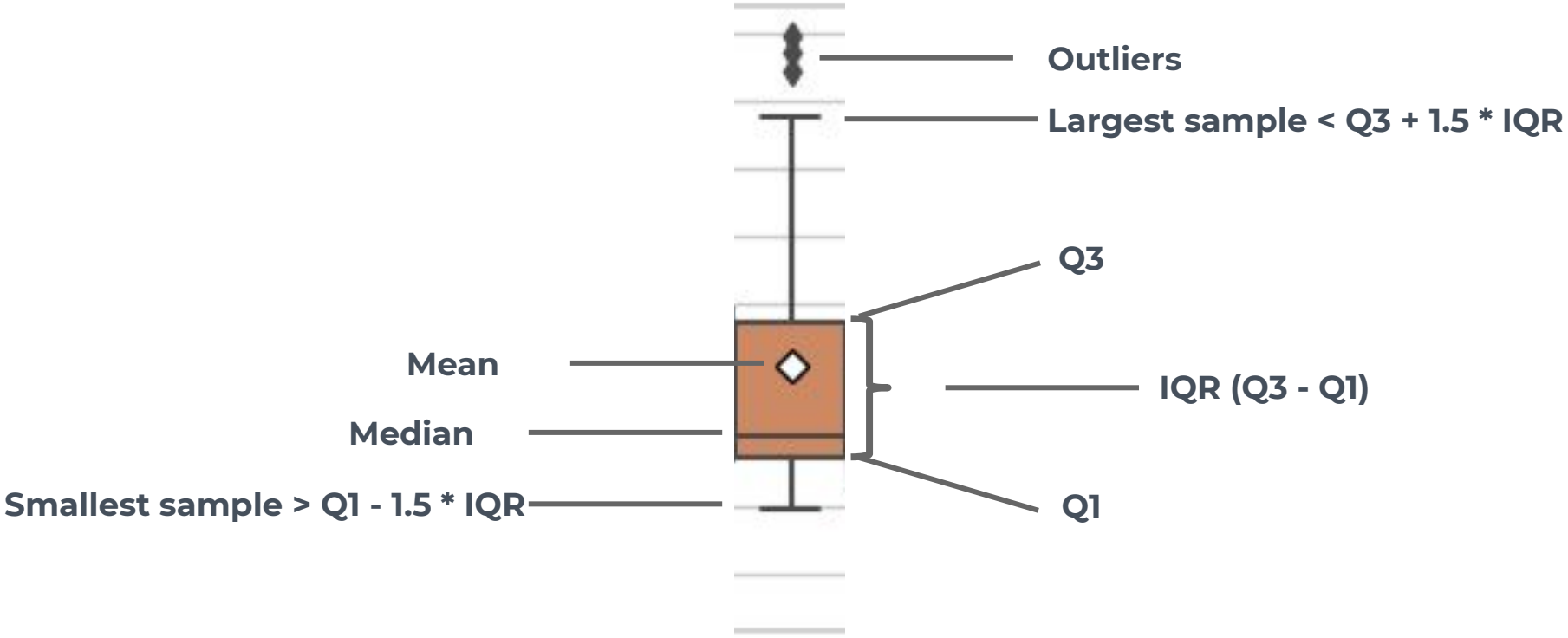
Tested on **different** performance
(and power consumption) **requirements**

e.g. maximum power consumption is P,
we set as requirement **0.2*P, 0.4*P, ..., 0.8*P, P**

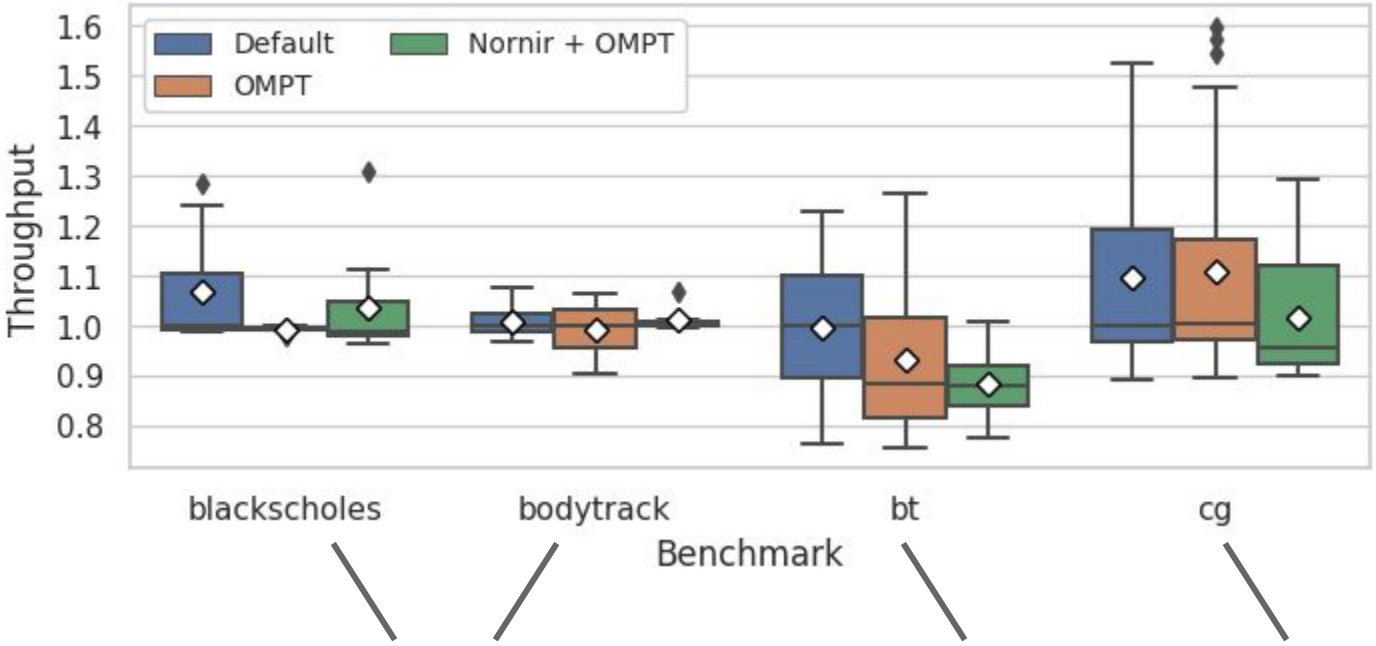
Analyze & Plan: ANALYTICAL_FULL
Execute: Number of cores and frequency scaling

RESULTS

Experiments repeated until **95% CI** lower than 5% of the sample mean



OVERHEAD ESTIMATION

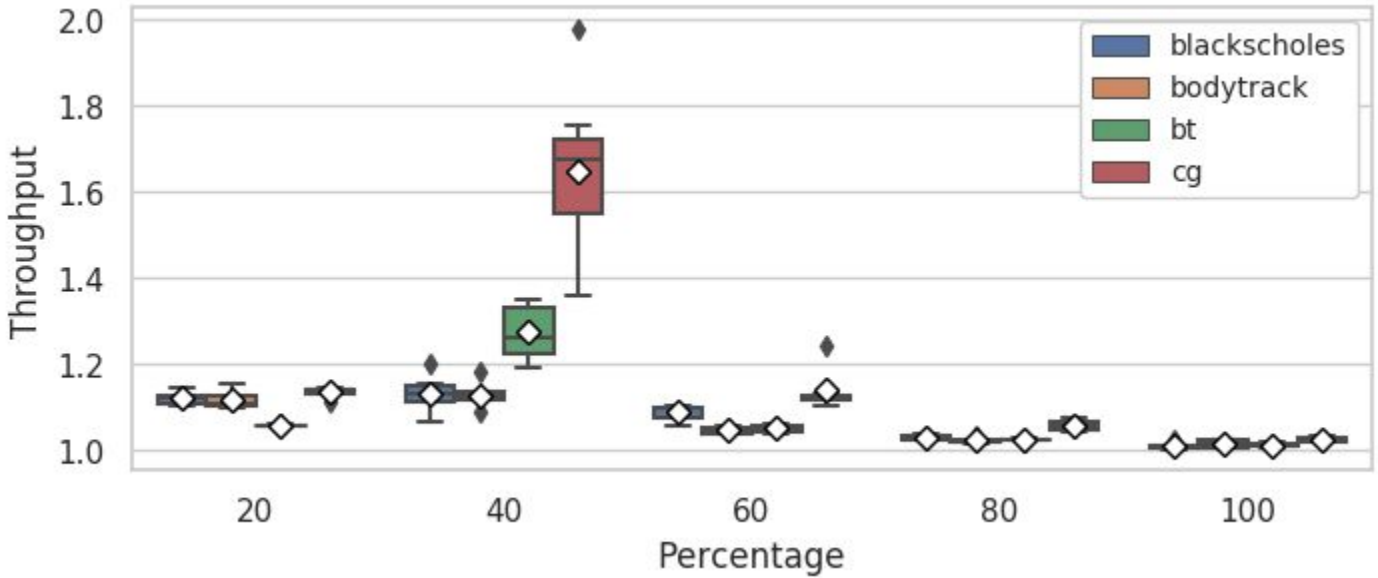


No overhead

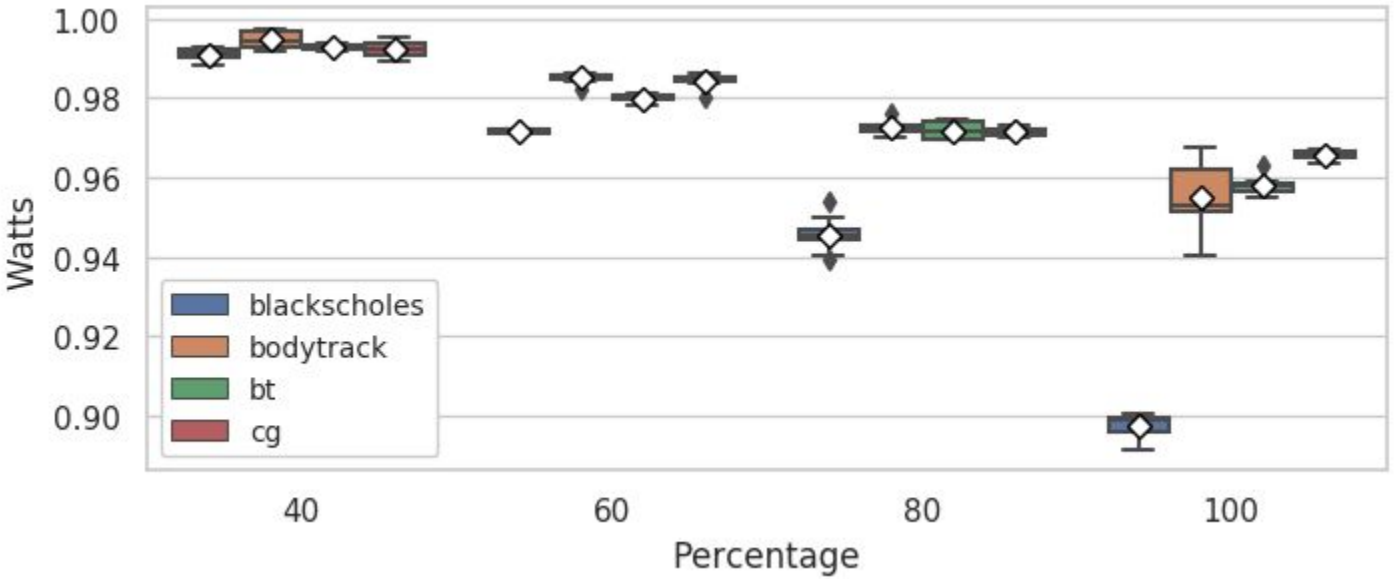
OMPT overhead

Nornir overhead

PERFORMANCE REQUIREMENTS



POWER CONSUMPTION REQUIREMENTS



CONCLUSIONS & FUTURE WORK

CONCLUSIONS

Performance monitoring in autonomic systems may require **effort** to the programmer

We extended **Nornir** to intercept **OpenMP** tasks by using OMPT API

We **extended OMPT** to track loop chunks scheduling

Accuracy and **overhead** evaluated on 4 different applications

We **enforced** power/performance **requirements without** any **modification** to the applications code

FUTURE WORK

Execute phase to dynamically change the number of OpenMP threads

Finer-grained performance monitoring

Validate over a **larger set of applications**

Thanks for your attention

and attend the demo session ;)

http://danieledesensi.github.io/nornir/

Daniele De Sensi

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Backup Slides

COLOR SCHEME

C7F464

4ECDC4

738498

454F5B