Characterizing the Energy Efficiency of Java's Thread-Safe Collections in a Multi-Core Environment


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Motivation (1/3)

- First, energy consumption is a concern for unwired devices and also for data centers

- Second, there is a large body of work in hardware/ architecture, OS, runtime systems
- However, little is known about the application level

Motivation (2/3)

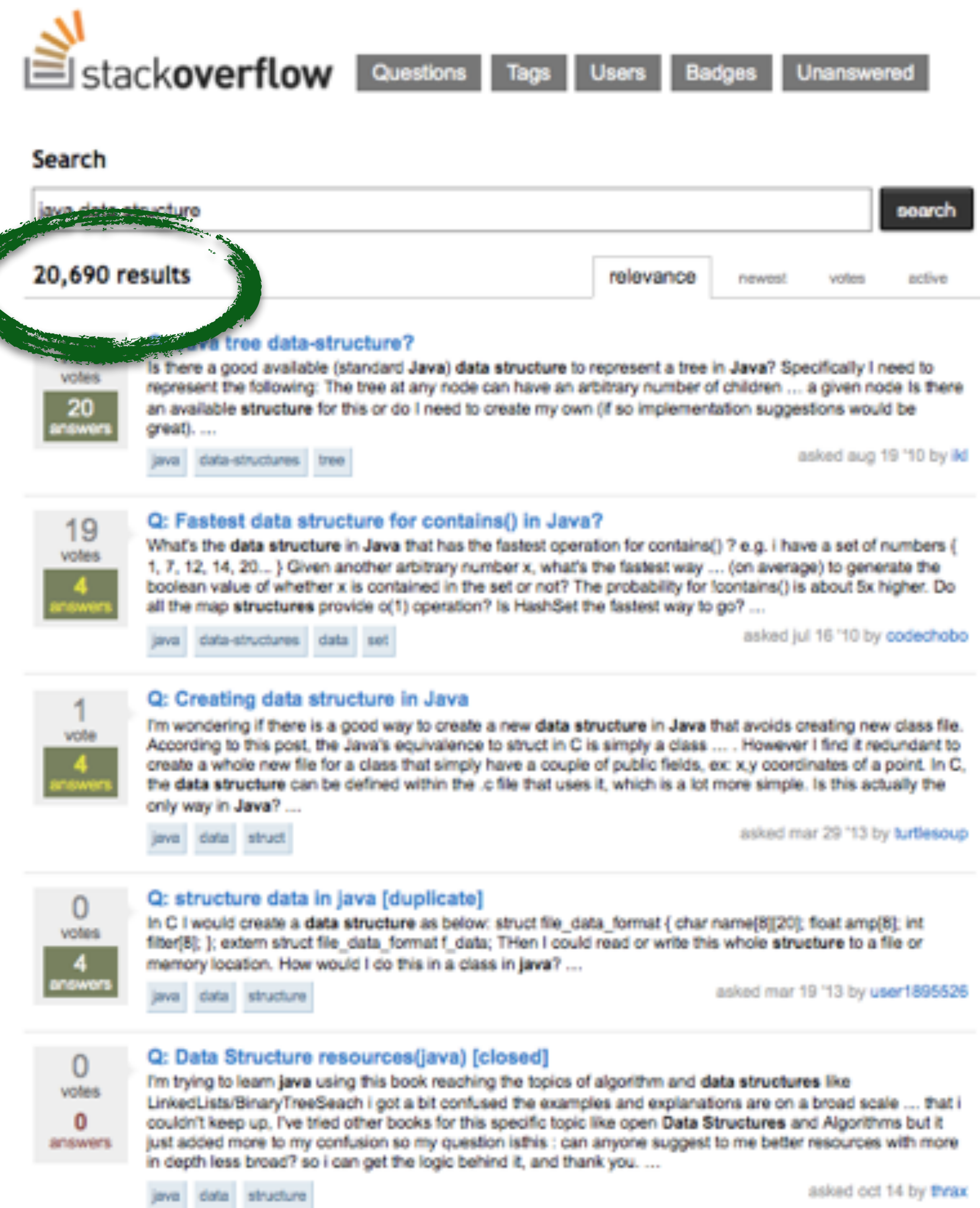
- First, multicore CPUs are ubiquitous
- Second, more cores used → more power dissipated
- However, little is known about the energy-efficiency of multicore programs

Motivation (3/3)

- Data structures are the fundamentals of computer programming

Bad programmers worry about the code. Good programmers worry about data structures and their relationships.

Linus Tolvards



Benchmarks

16 Java Collections

List
ArrayList
Vector
Collections.syncList()
CopyOnWriteArrayList

Set
LinkedHashSet
Collections.syncSet()
CopyOnWriteArraySet
ConcurrentSkipListSet
ConcurrentHashSet
ConcurrentHashSetV8

Map
LinkedHashMap
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Non thread-safe

Thread-safe

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x 3 Operations

Traversal	Insertion	Removal

2 Real-world Benchmarks

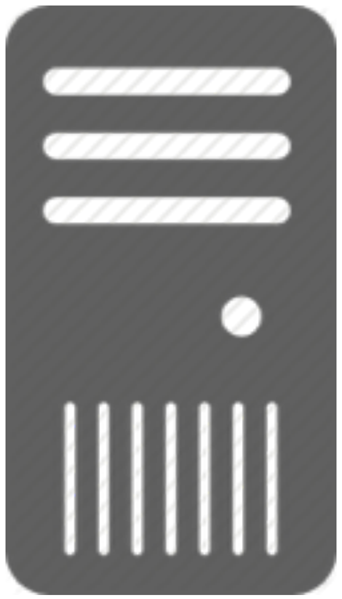
Tomcat

- A web server
- More than 170K lines of Java code
- More than 300 Hashtables

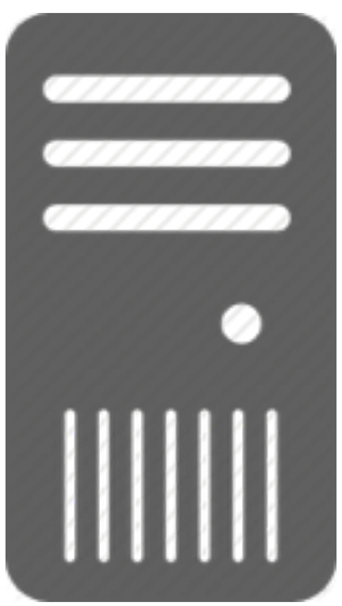
Xalan

- Parses XML in HTML documents
- More than 188K lines of Java code
- More than 140 Hashtables

Experimental Environments



AMD CPU: A 2×16-core, running Debian, 2.4 GHz, 64GB of memory, JDK version 1.7.0 11, build 21.



Intel CPU: A 2×8-core (32-cores w/ hyper-threading), running Debian, 2.60GHz, with 64GB of memory, JDK version 1.7.0 71, build 14.

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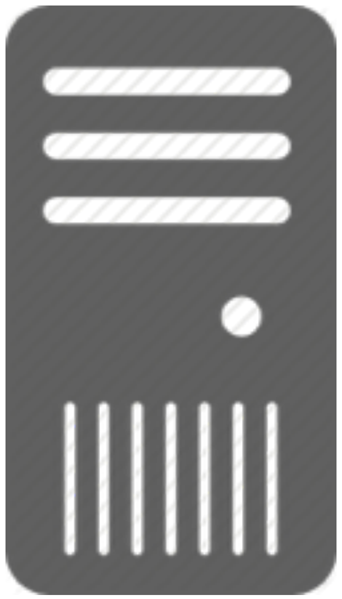

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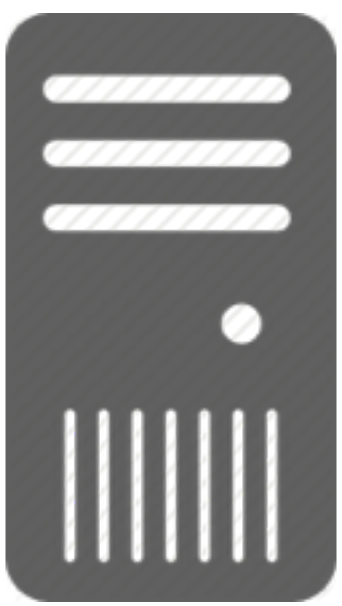
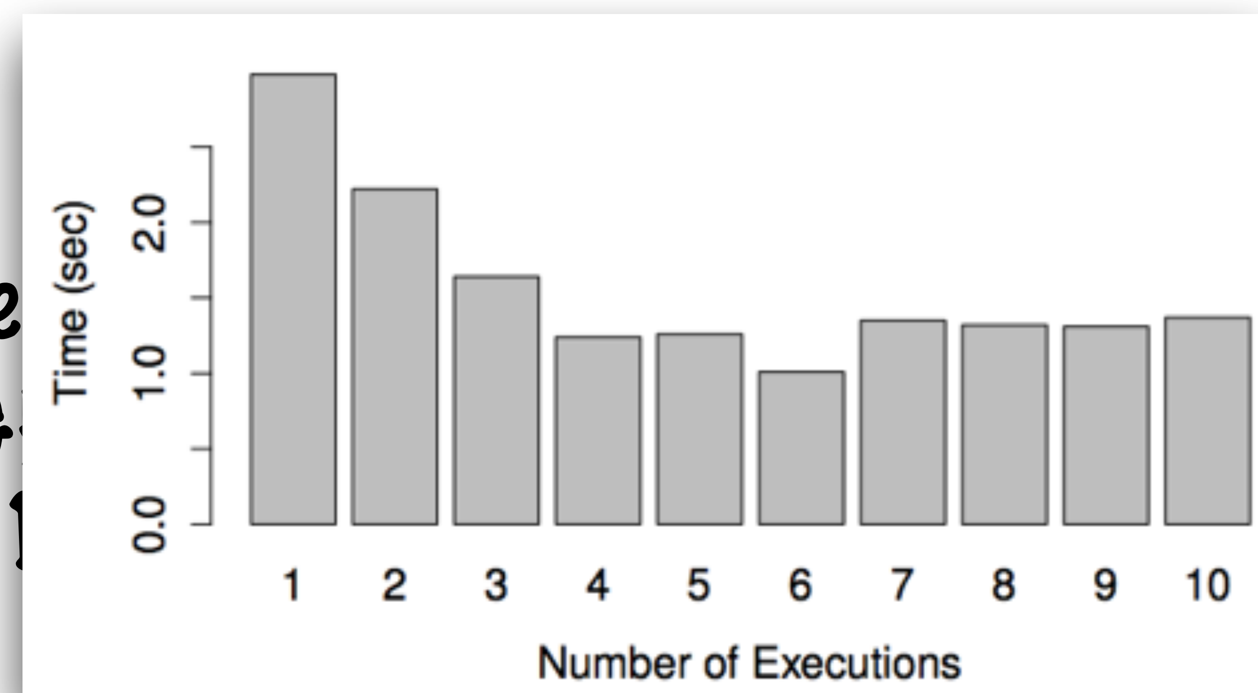


Intel CPU: A 2×8-core

running Debian, 2.60G

version 1.7.0 71, build 1



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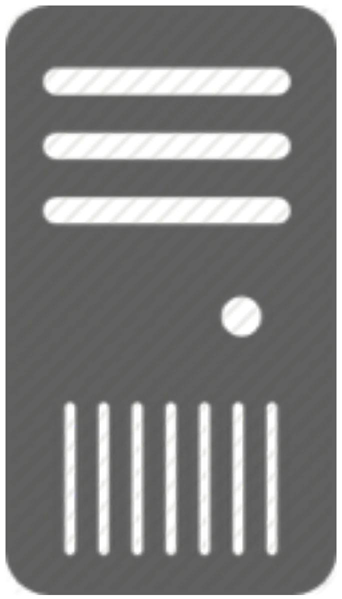

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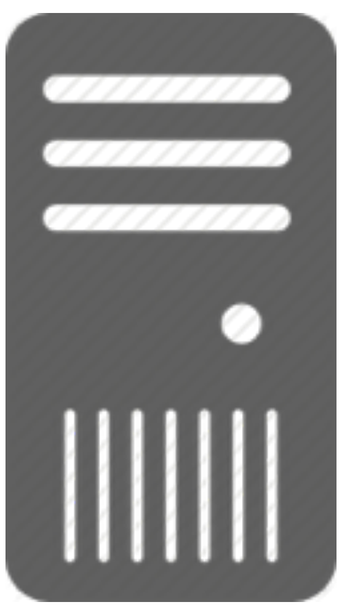

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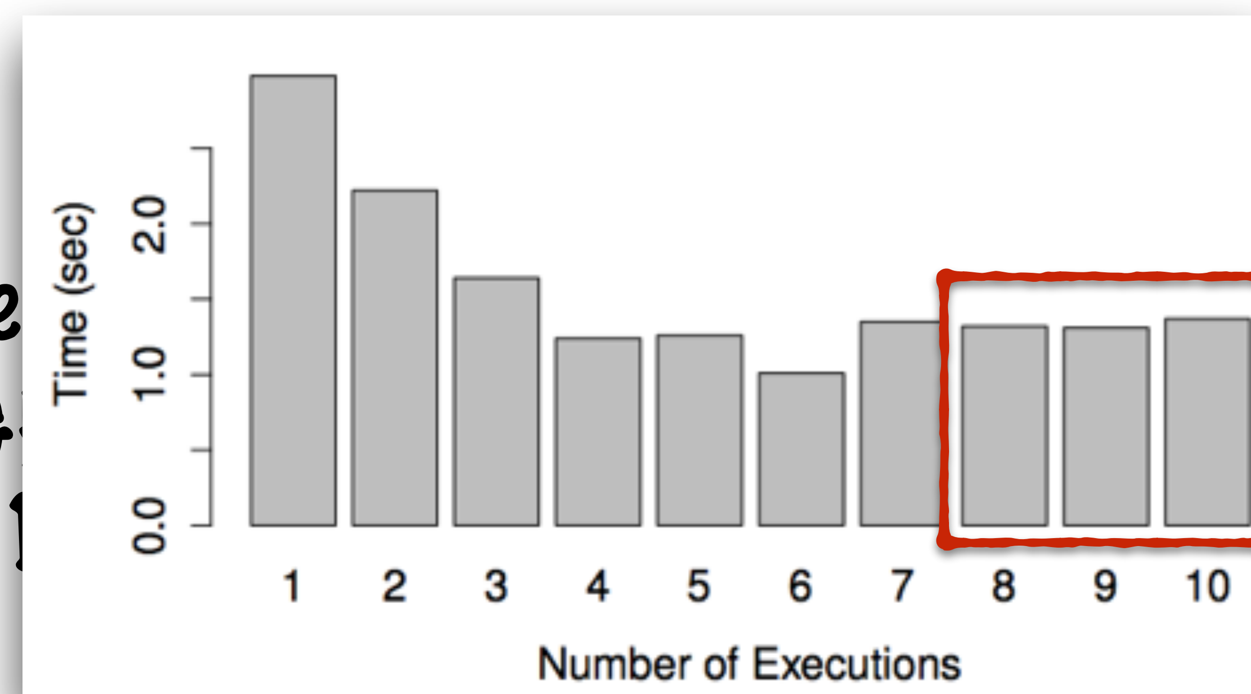

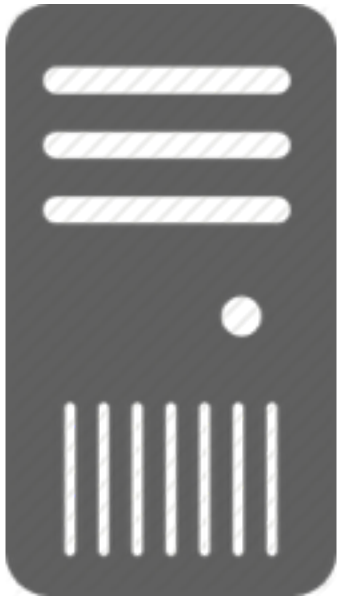

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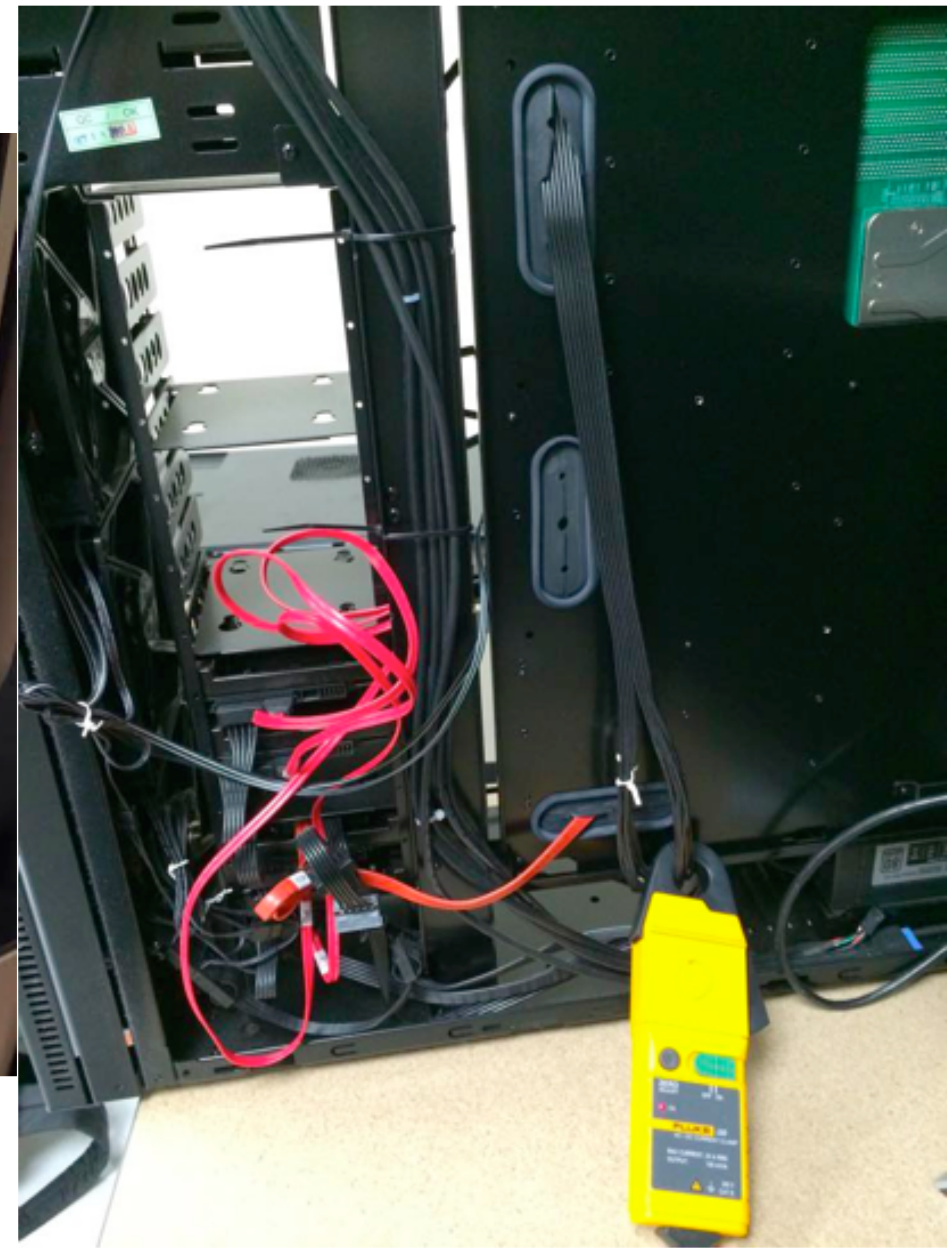

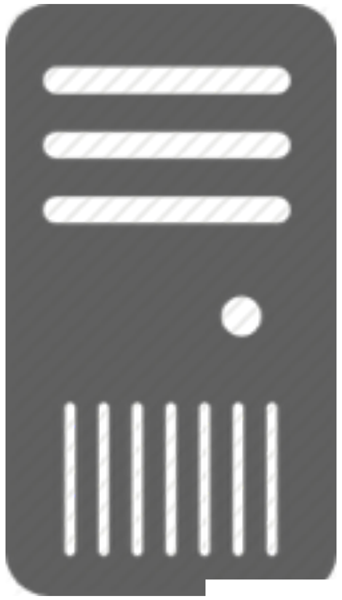

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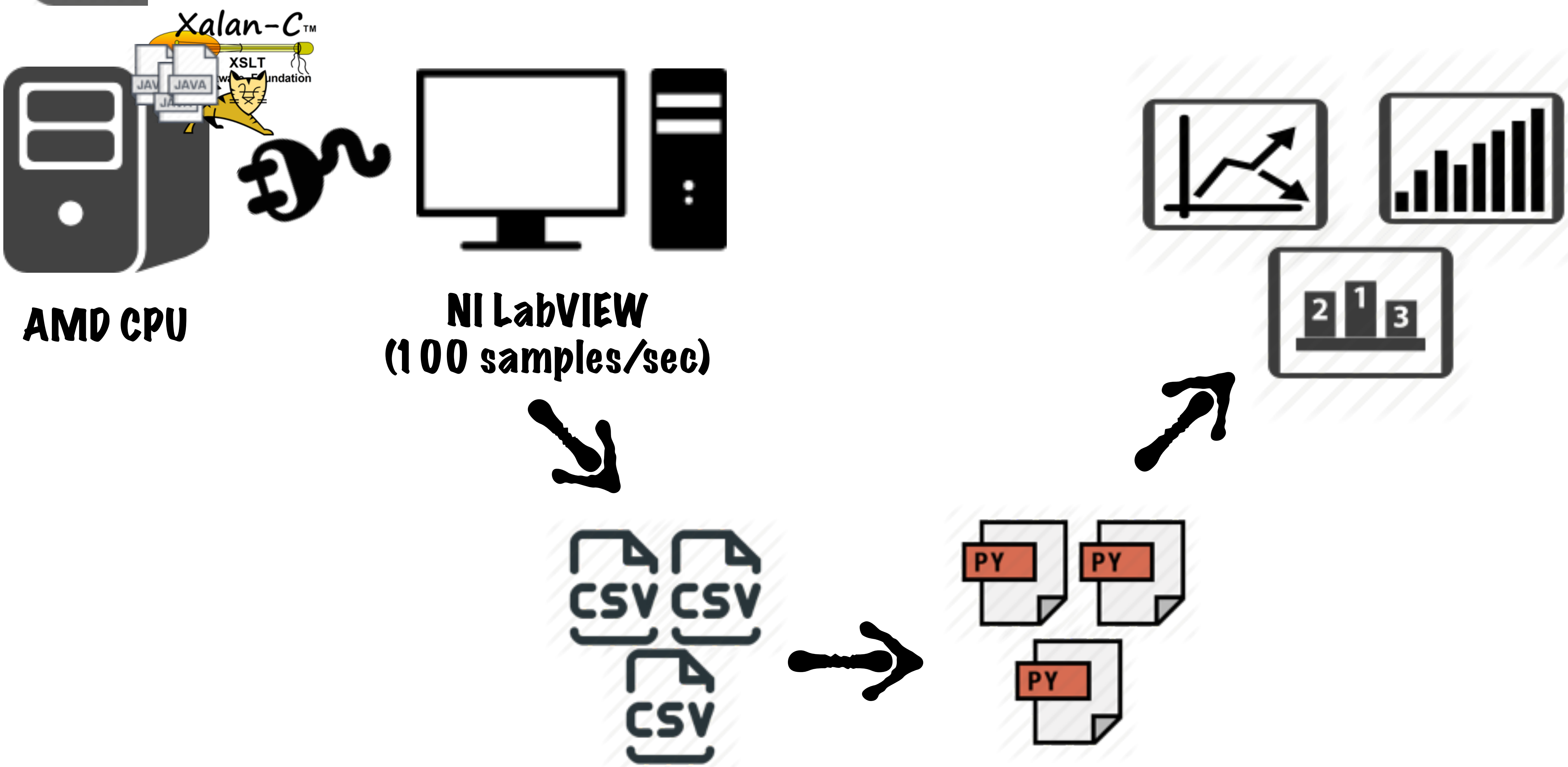

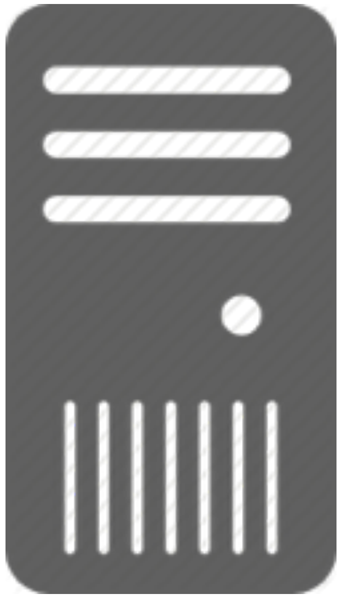

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jRAPL -- A framework for profiling energy consumption of Java programs

What is jRAPL?

jRAPL is framework for profiling Java programs running on CPUs with Running Average Power Limit (RAPL) support.

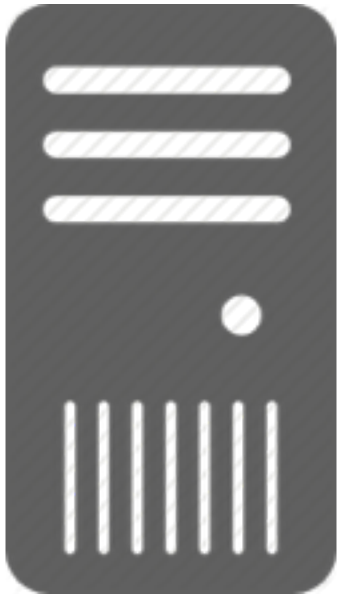
But, what is RAPL?

RAPL is a set of low-level interfaces with the ability to monitor, control, and get notifications of energy and power consumption data of different hardware levels.

Originally designed by Intel for enabling chip-level power management, RAPL is widely supported in today's Intel architectures, including Xeon server-level CPUs and the popular i5 and i7.

```
double beginning = EnergyCheck.statCheck();
doWork();
double end = EnergyCheck.statCheck();
```

K. Liu, G. Pinto, and D. Liu, "Data-oriented characterization of application-level energy optimization," in Proceedings of the 18th International Conference on Fundamental Approaches to Software Engineering, ser. FASE'15, 2015.



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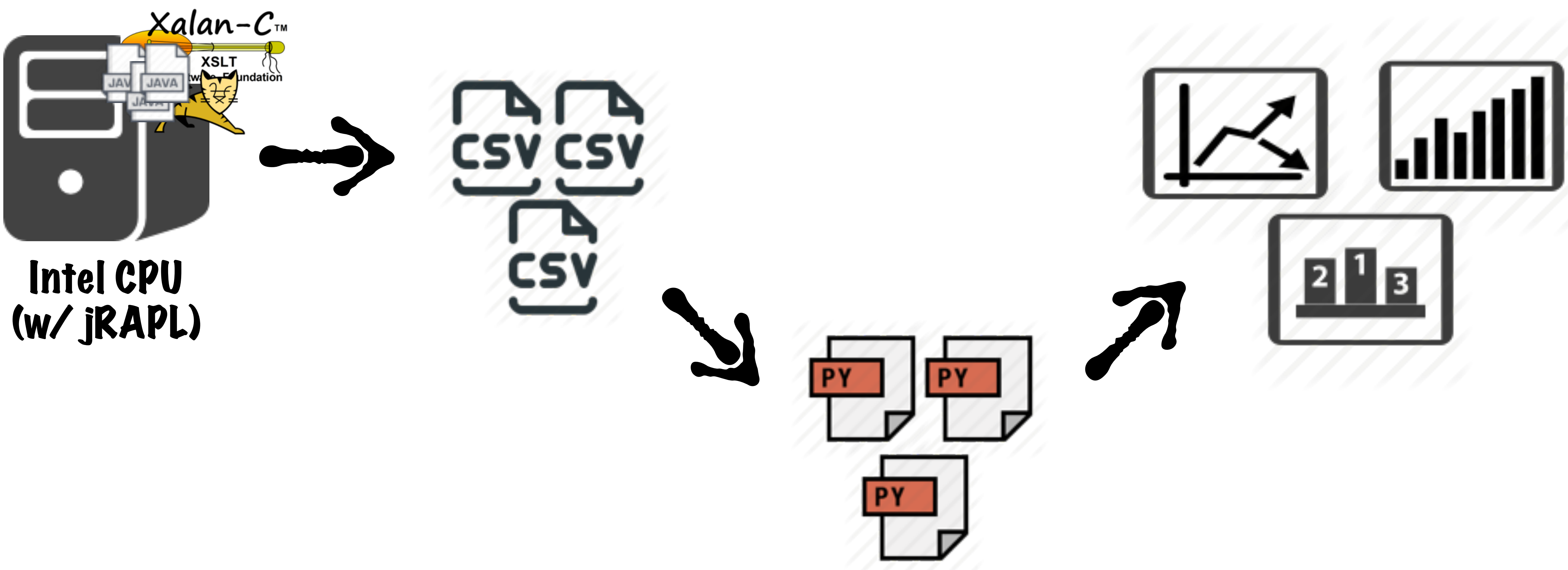
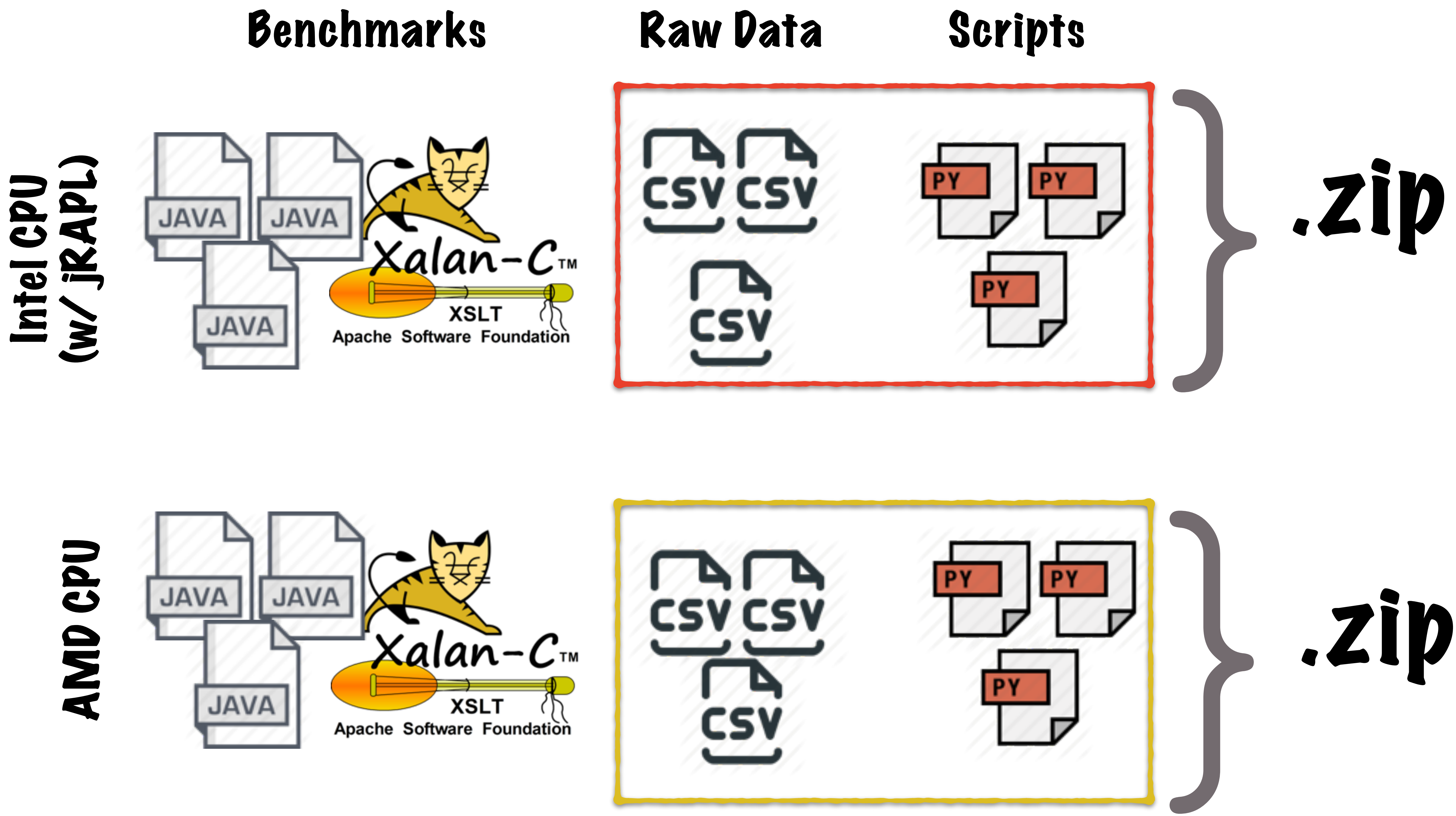


The Artifacts



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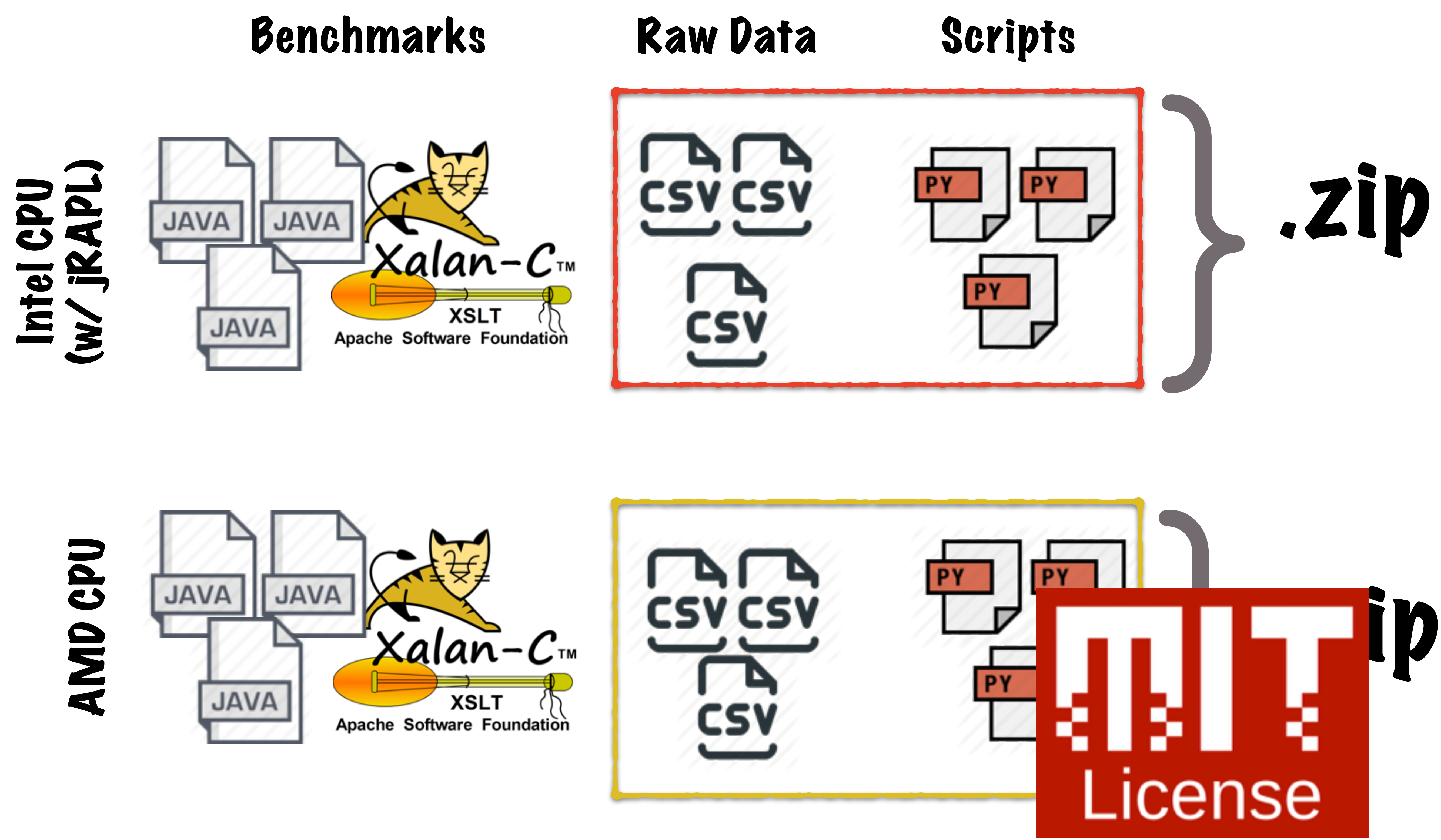
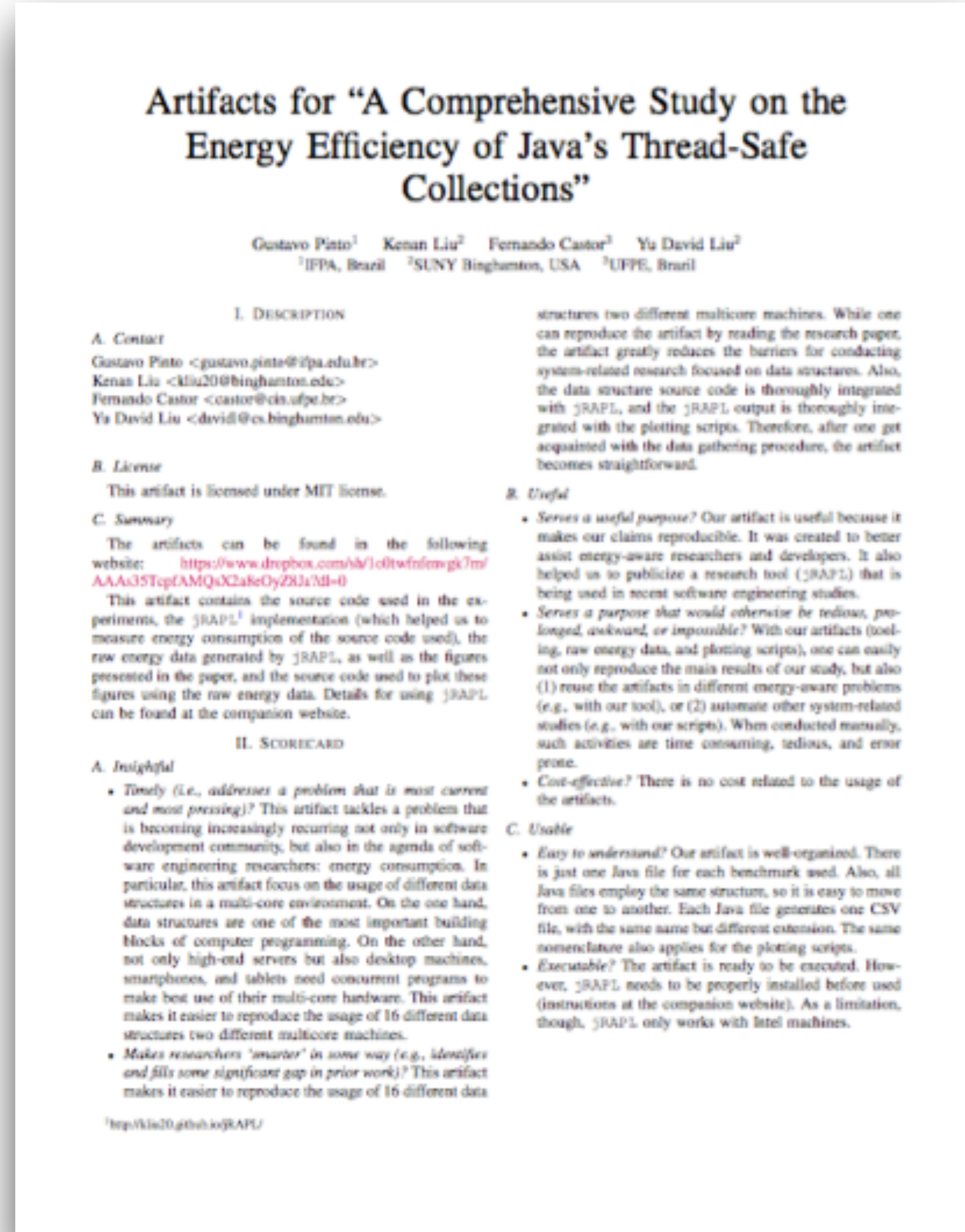


More details?


Artifacts for "A Comprehensive Study on the Energy Efficiency of Java's Thread-Safe Collections"

Gustavo Pinto[1] Kenan Liu[2] Fernando Castor[3] Yu David Liu[2]
[1]IFPA, Brazil [2]SUNY Binghamton, USA [3]UFPE, Brazil

I. Description

A. Contact

B. License

This artifact is licensed under MIT license.

C. Summary

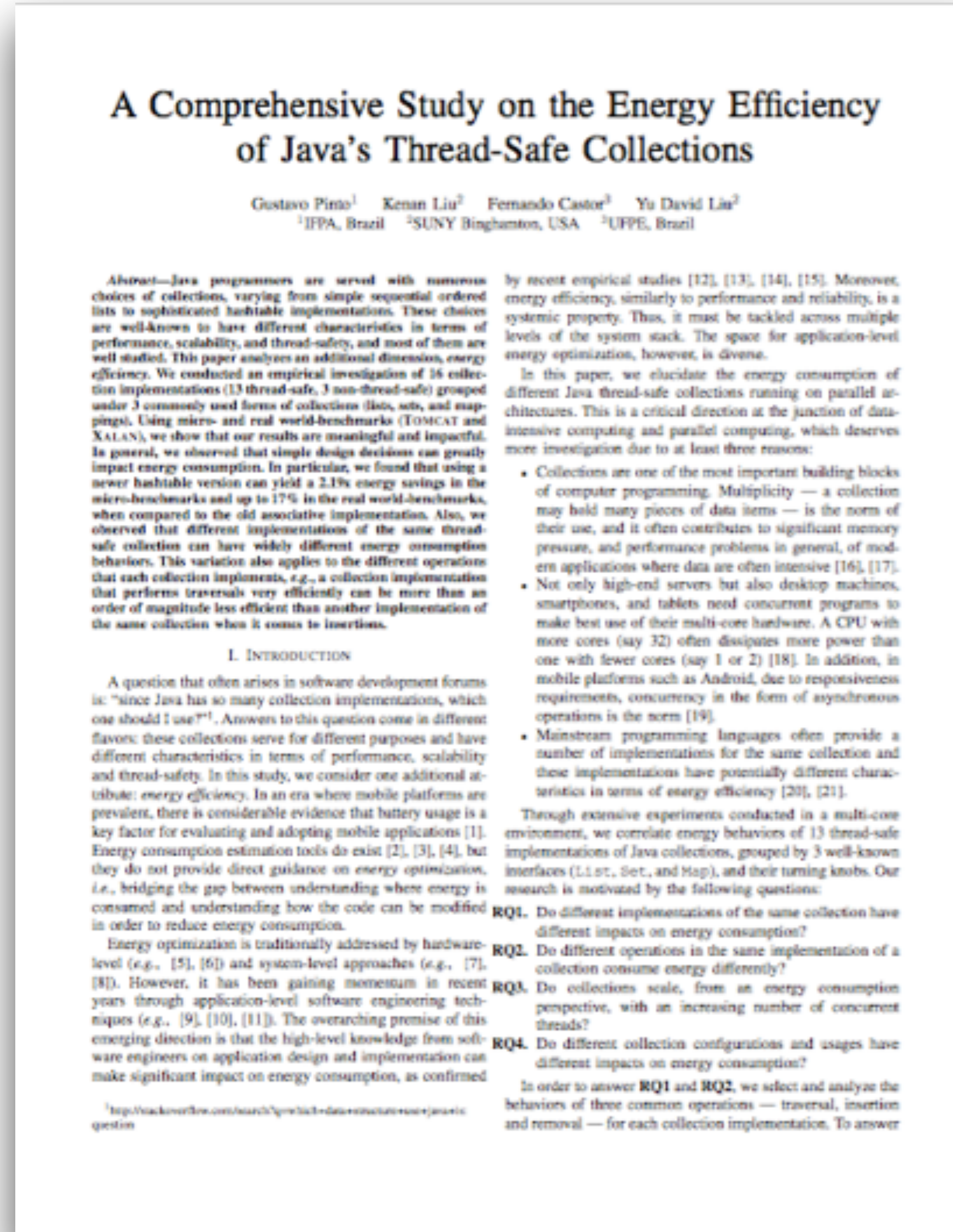
II. Scorecard

A. Insightful

B. Useful

C. Usable

Artifacts Paper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I. Introduction

Research Paper

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jRAPL(Java Running Average Power Limit)