Università della Svizzera italiana

Faculty of Informatics

AutoBench

Finding Workloads That You Need Using Pluggable Hybrid Analysis

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Research question

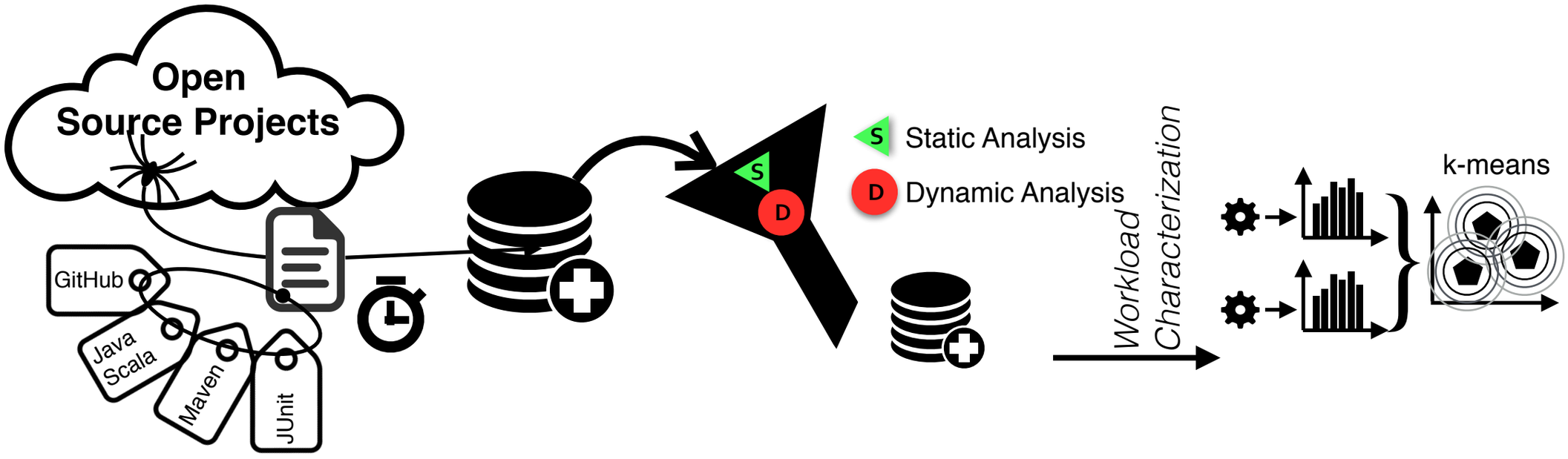
Can a **fully automated** process find **open-source workloads** that are suitable as **benchmarks** for **specific** evaluation needs?

- Definitions:
  - **Workload**: the execution profile of a running application
  - **Benchmark**: workload considered as reference for a given domain
- Motivation:
  - Lack of benchmark suites targeting **specific needs**
  - First steps towards **automatic benchmark synthesis**

AutoBench

- A methodology and toolchain to **automatically find workloads** and synthesize **benchmark suites** from open-source projects

  - Workloads = **Unit tests**



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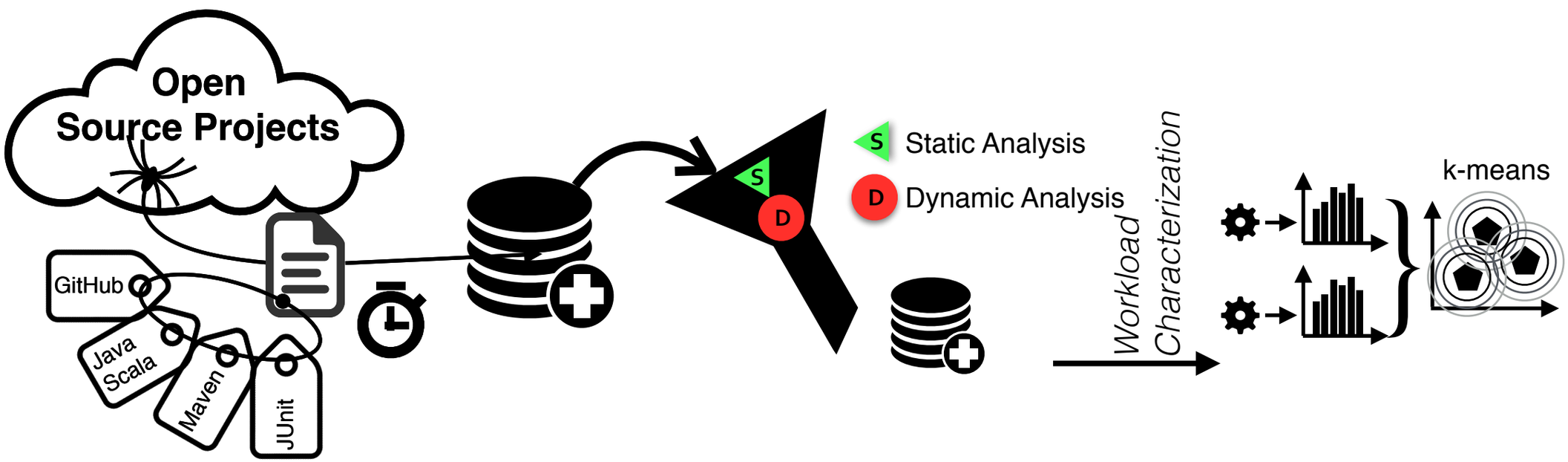
Open
Source Projects
GitHub
Java
Scala
Maven
JUnit
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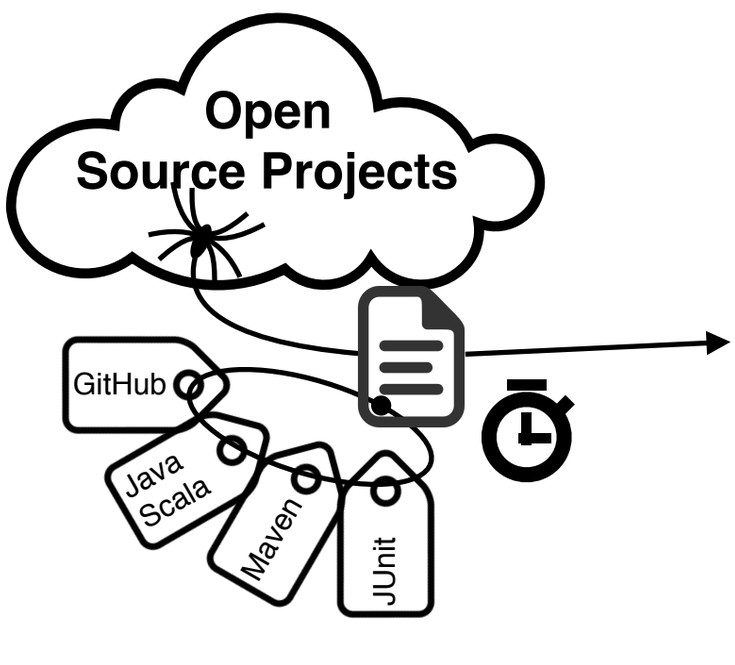
Static Analysis
Dynamic Analysis
Workload
Characterization
k-means

AutoBench



Finding

- Find a base of **executable** and **significative** workloads from **open-source** projects
  - **Significative:** workloads with execution time >= **T**

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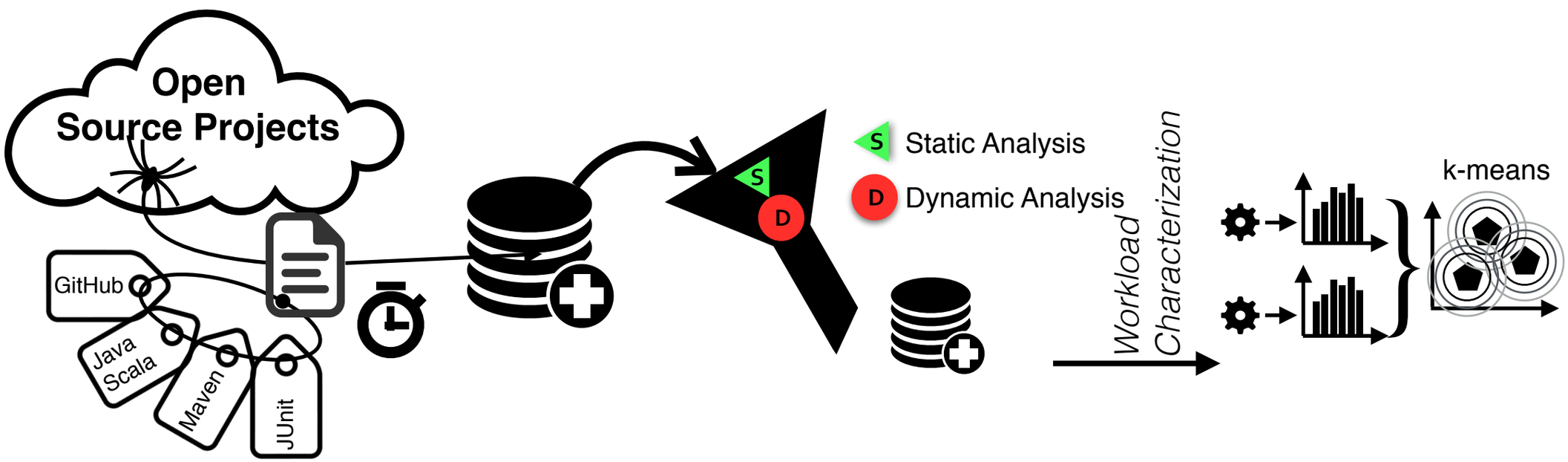

Finding

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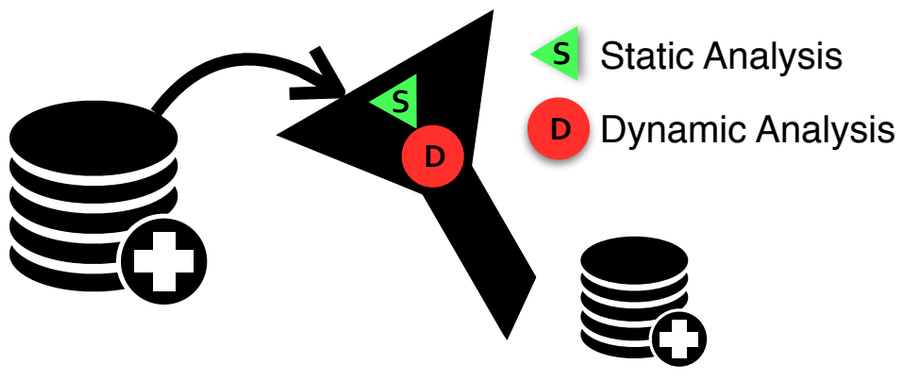

Finding **Filtering**

- Preserve only workloads matching **specific needs**
  - Filter pipeline
    - Static/dynamic analyses written by users
      - **Dynamic analysis** refines results of static analysis
    - Analyses reflect specific user requirements
    - Workloads must pass all filters to be considered **suitable**

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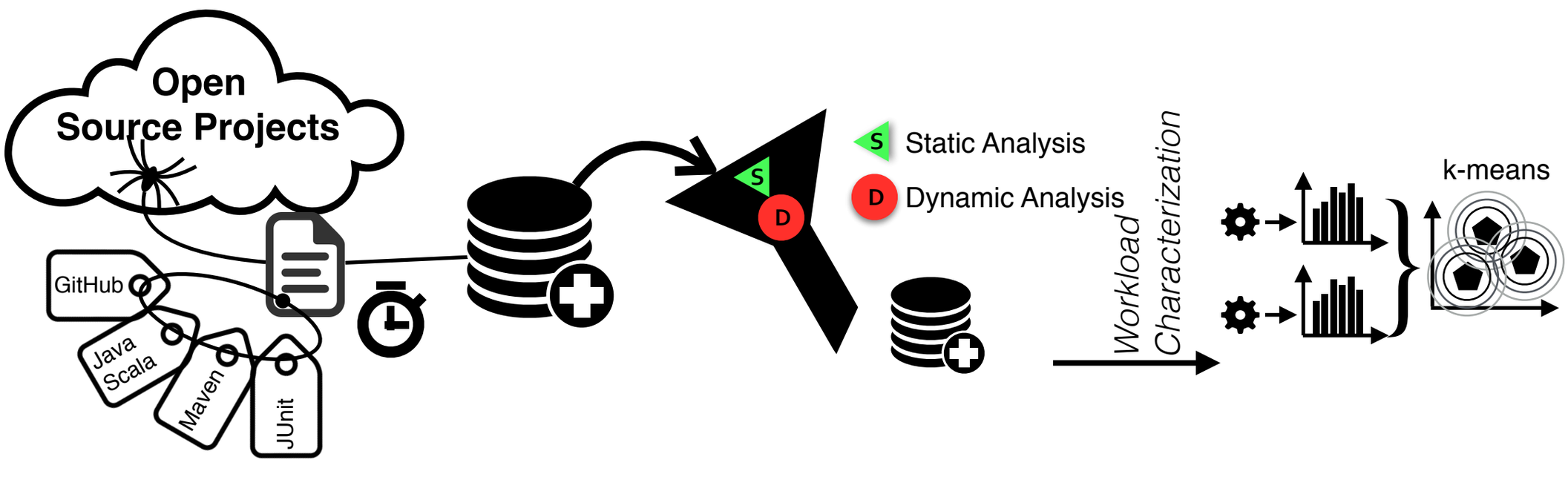

Finding

Filtering

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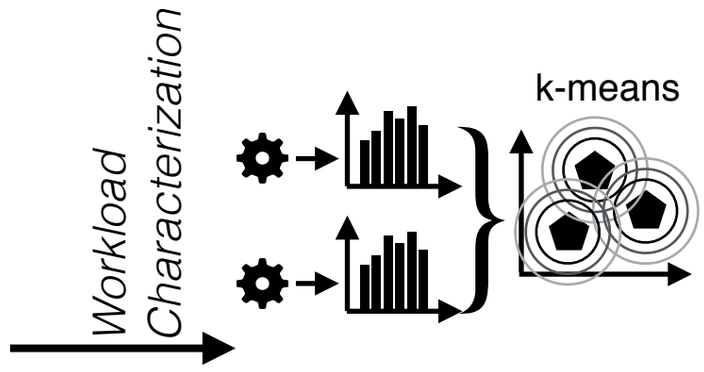

Finding **Filtering** **Characterization**

- Workload characterization identifies a **diverse** set of **K** benchmarks
- Diversity metrics:
  - Execution time
  - N. of object allocations
  - N. of method invocations
  - …

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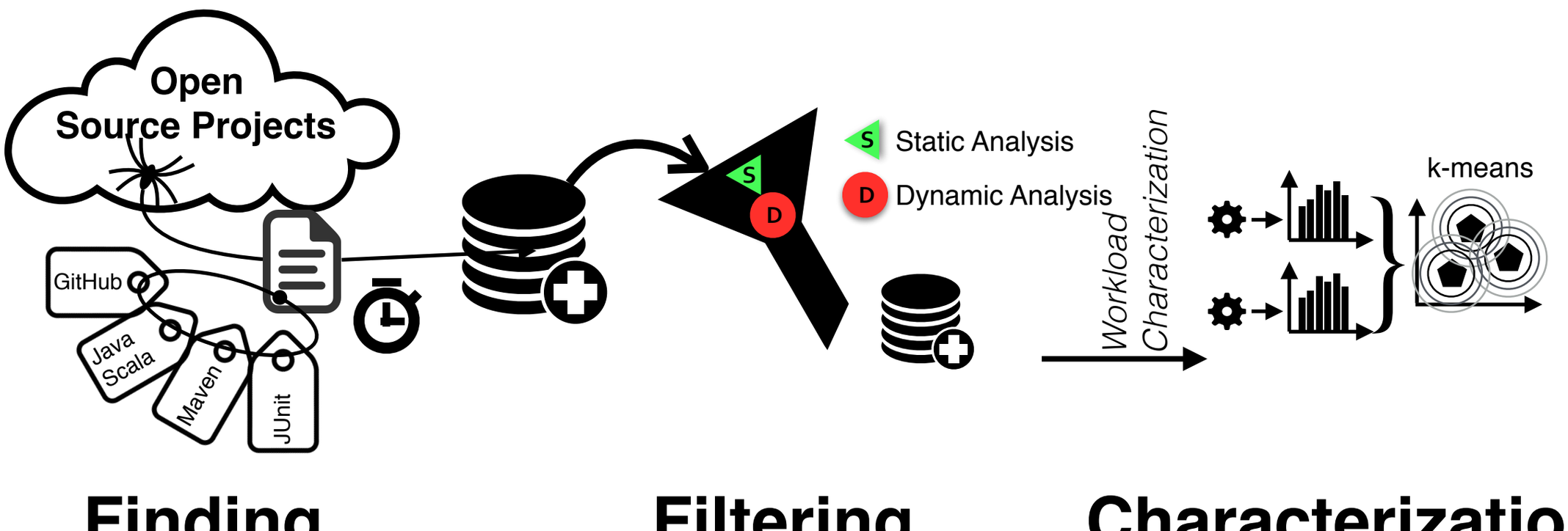


Finding

Filtering

Characterization

Evaluation

Can a fully automated process find open-source workloads that are suitable as benchmarks for specific evaluation needs?

1. **Significance**: Can we expect to find tests that are long enough to serve as benchmark workload?
2. **Suitability**: Can dynamic analysis improve identification of workloads matching a specific evaluation context?
3. **Diversity**: Can we find diversity in the workloads that would allow synthesizing a benchmark suite?

T = 1s **K = 12**

Evaluation

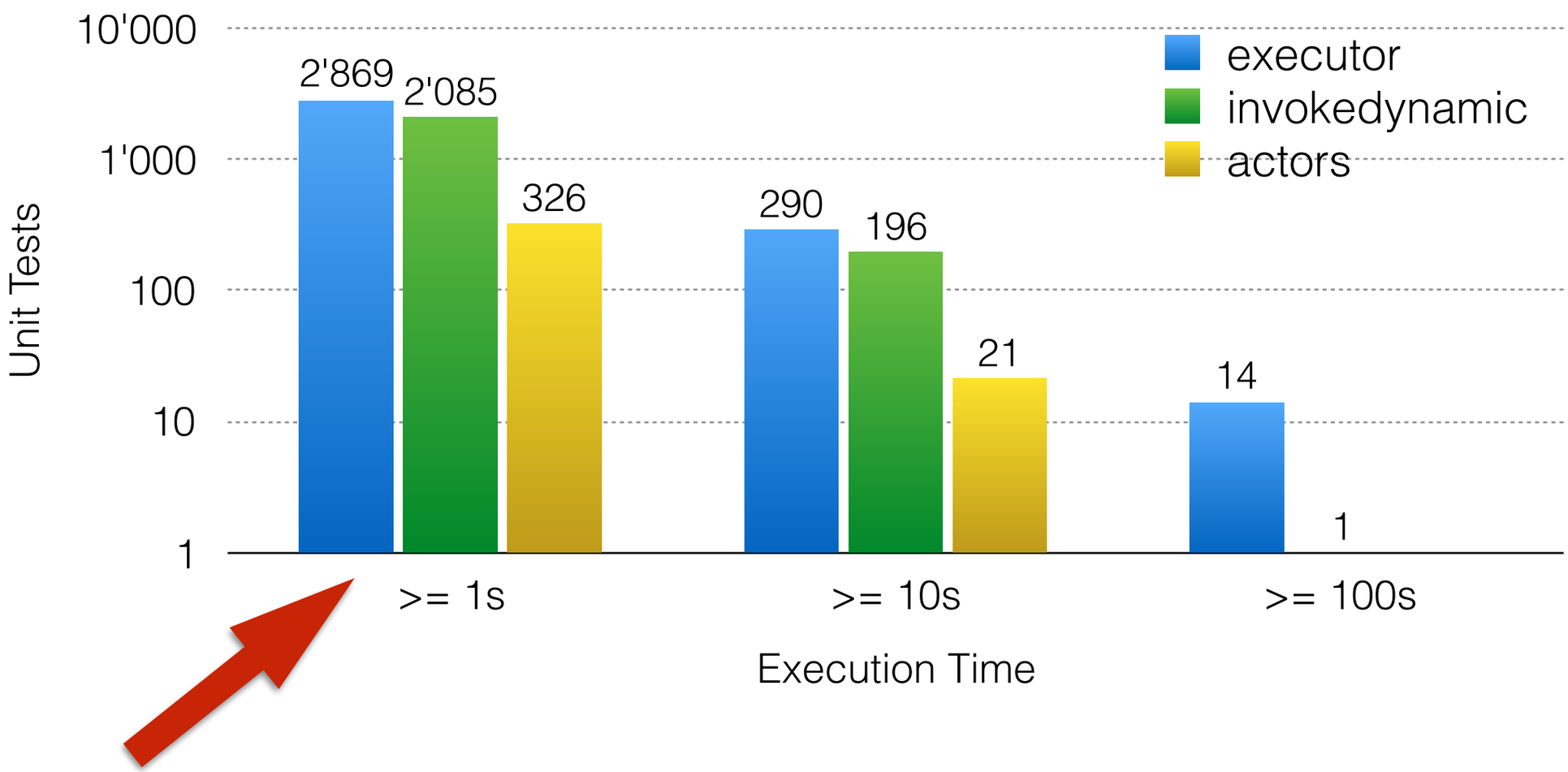
Can a fully automated process find open-source workloads that are suitable as benchmarks for specific evaluation needs?

Use cases:

- **executor**: benchmarks utilizing task execution frameworks in Java applications
- **invokedynamic**: benchmarks executing a specific Java bytecode instruction
- **actors**: benchmarks utilizing actor libraries in Java applications

Evaluation

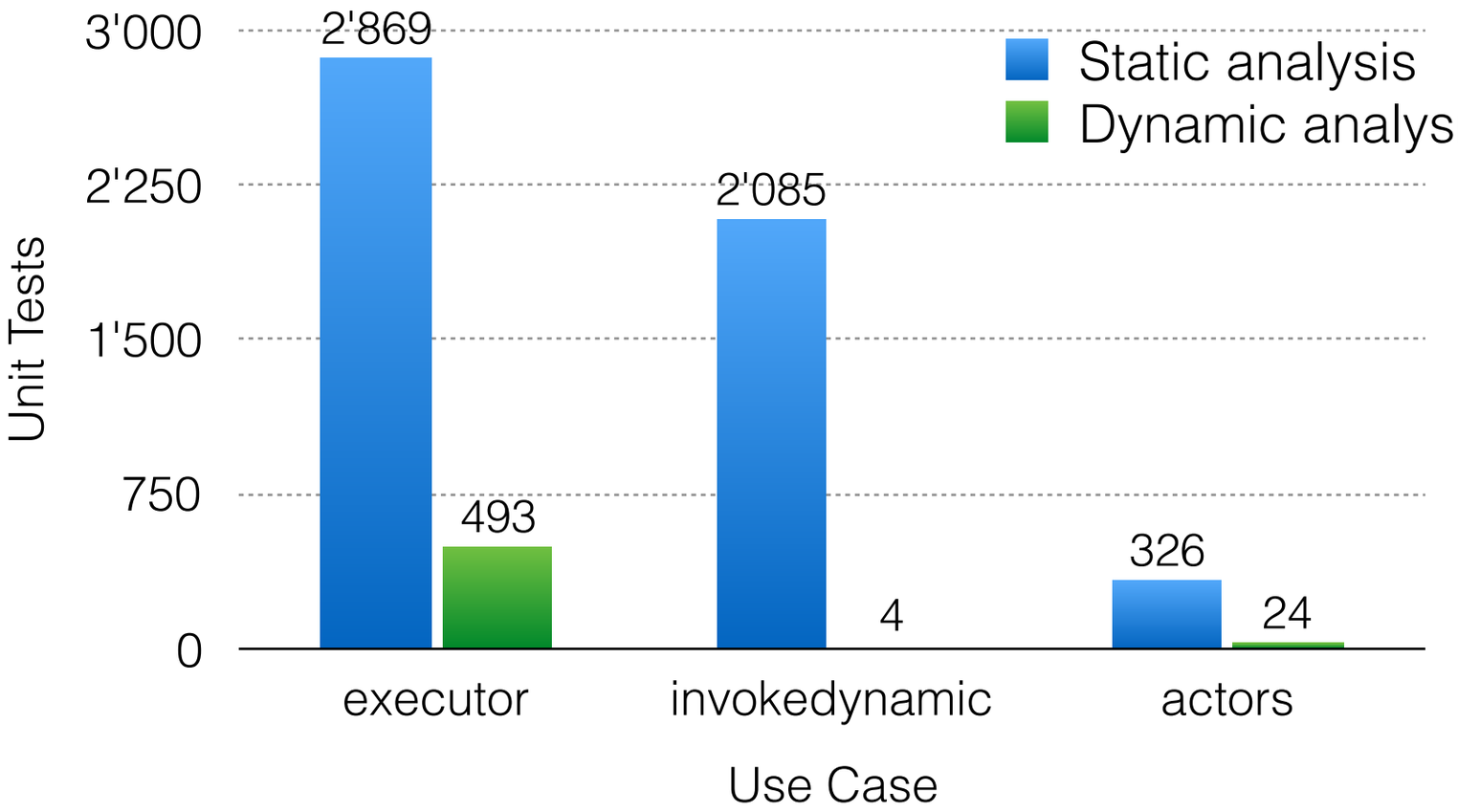
1. **Significance:** Can we expect to find tests that are long enough to serve as benchmark workload?



☑ In all use cases, a significant number of tests run for more than the time threshold

Evaluation

2. Suitability: Can dynamic analysis improve identification of workloads matching a specific evaluation context?



Stage	%
executor	17.18%
invokedynamic	0.19%
actors	7.36%

☑ Dynamic analysis is a fundamental tool for selecting only suitable workloads

Evaluation

3. Diversity: Can we find diversity in the workloads that would allow synthesizing a benchmark suite?

Executor: 493 unit tests after dynamic filtering

#	Project	Unit Test	Time [s]	Allocations	Invocations
1	prova	test/ws/prova/test2/ProvaWorkflowsTest.predicate_join	2.523	17938	469320
2	datacube	com/urbanairship/datacube/HBaseBackfillerTest.testMutationsWhileBackfilling	96.806	127961	7628592
3	jdeferred	org/jdeferred/impl/FilteredPromiseTest.testNoOpFilter	2.003	72	755
4	datacube	com/urbanairship/datacube/BackfillExampleTest.test	62.371	78728	4367224
5	cmb	com/comcast/cmb/test/unit/CassandraTest.testCassandraCounters	4.007	54	636
6	svarut	no/kommune/bergen/soa/svarut/ServiceContextTest.init	1.983	12510	205187
7	antlr4	org/antlr/v4/test/runtime/java/TestPerformance.testExpressionGrammar_1	1.212	109350	2595015
8	prova	test/ws/prova/test2/ProvaMessagingTest.ring_parallel	17.961	251119179	3144752537
9	pangool	com/datasalt/pangool/tuplemr/mapred/lib/output/TestMultipleOutputs.test	2.088	241759	12943082
10	prova	test/ws/prova/test2/ProvaFunctionalProgrammingTest.func_reactive_unfoldr_iteration_perf_large	2.690	78180455	928571592
11	graphdb	org/neo4j/backup/TestBackup.fullThenIncremental	2.159	11568	88334
12	prova	test/ws/prova/test2/ProvaMetadataTest.cep005	13.267	30393192	443299688

Evaluation

3. **Diversity:** Can we find diversity in the workloads that would allow synthesizing a benchmark suite?

☑ From 493 workload candidates to 12 representative and diverse ones

#	Project	Unit Test	Time [s]	Allocations	Invocations
1	prova	test/ws/prova/test2/ProvaWorkflowsTest.predicate_join	2.523	17938	469320
2	datacube	com/urbanairship/datacube/HBaseBackfillerTest.testMutationsWhileBackfilling	96.806	127961	7628592
3	jdeferred	org/jdeferred/impl/FilteredPromiseTest.testNoOpFilter	2.003	72	755
4	datacube	com/urbanairship/datacube/BackfillExampleTest.test	62.371	78728	4367224
5	cmb	com/comcast/cmb/test/unit/CassandraTest.testCassandraCounters	4.007	54	636
6	svarut	no/kommune/bergen/soa/svarut/ServiceContextTest.init	1.983	12510	205187
7	antlr4	org/antlr/v4/test/runtime/java/TestPerformance.testExpressionGrammar_1	1.212	109350	2595015
8	prova	test/ws/prova/test2/ProvaMessagingTest.ring_parallel	17.961	251119179	3144752537
9	pangool	com/datasalt/pangool/tuplemr/mapred/lib/output/TestMultipleOutputs.test	2.088	241759	12943082
10	prova	test/ws/prova/test2/ProvaFunctionalProgrammingTest.func_reactive_unfoldr_iteration_perf_large	2.690	78180455	928571592
11	graphdb	org/neo4j/backup/TestBackup.fullThenIncremental	2.159	11568	88334
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Discussion

- Investigate representativeness of unit tests wrt. real-world workloads
- Recognize and filter out "garbage" projects
- Recognize and filter out workloads with non-deterministic execution profile
- Replace execution time with other metrics to measure significance

Conclusions

- We investigated the feasibility of using **unit tests as workloads** in custom benchmarks
- **AutoBench**: a methodology and toolchain to find, filter, and classify workloads from open-source projects
- Encouraging results towards **automatic generation of benchmark suites** for specific needs.
- Future work:
  - DSL for expressing workload properties and optimization goals
  - Ranking of similar workloads instead of filtering

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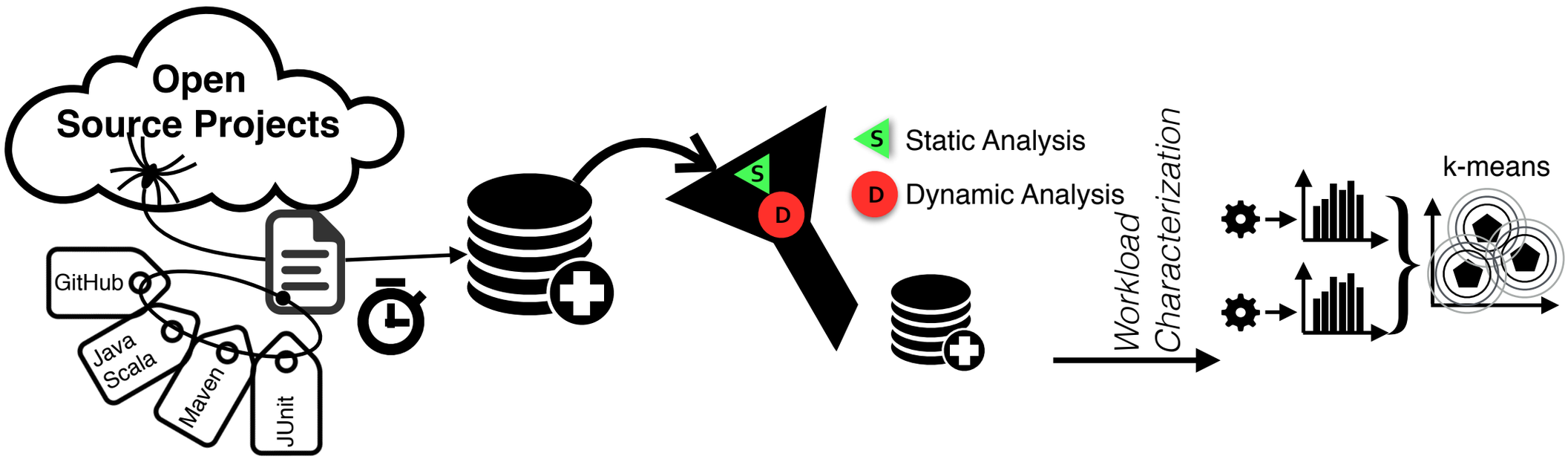

- More information in:
  - Yudi Zheng, Andrea Rosà, Luca Salucci, Yao Li, Haiyang Sun, Omar Javed, Lubomír Bulej, Lydia Y. Chen, Zhengwei Qi and Walter Binder. “AutoBench: Finding Workloads That You Need Using Pluggable Hybrid Analyses”. In IEEE SANER 2016 (ERA paper).
  - Slides: `http://inf.usi.ch/phd/rosaa/autobench_saner16.pdf`
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