Graphalytics:
A Big Data Benchmark for Graph-Processing Platforms

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Delft University of Technology
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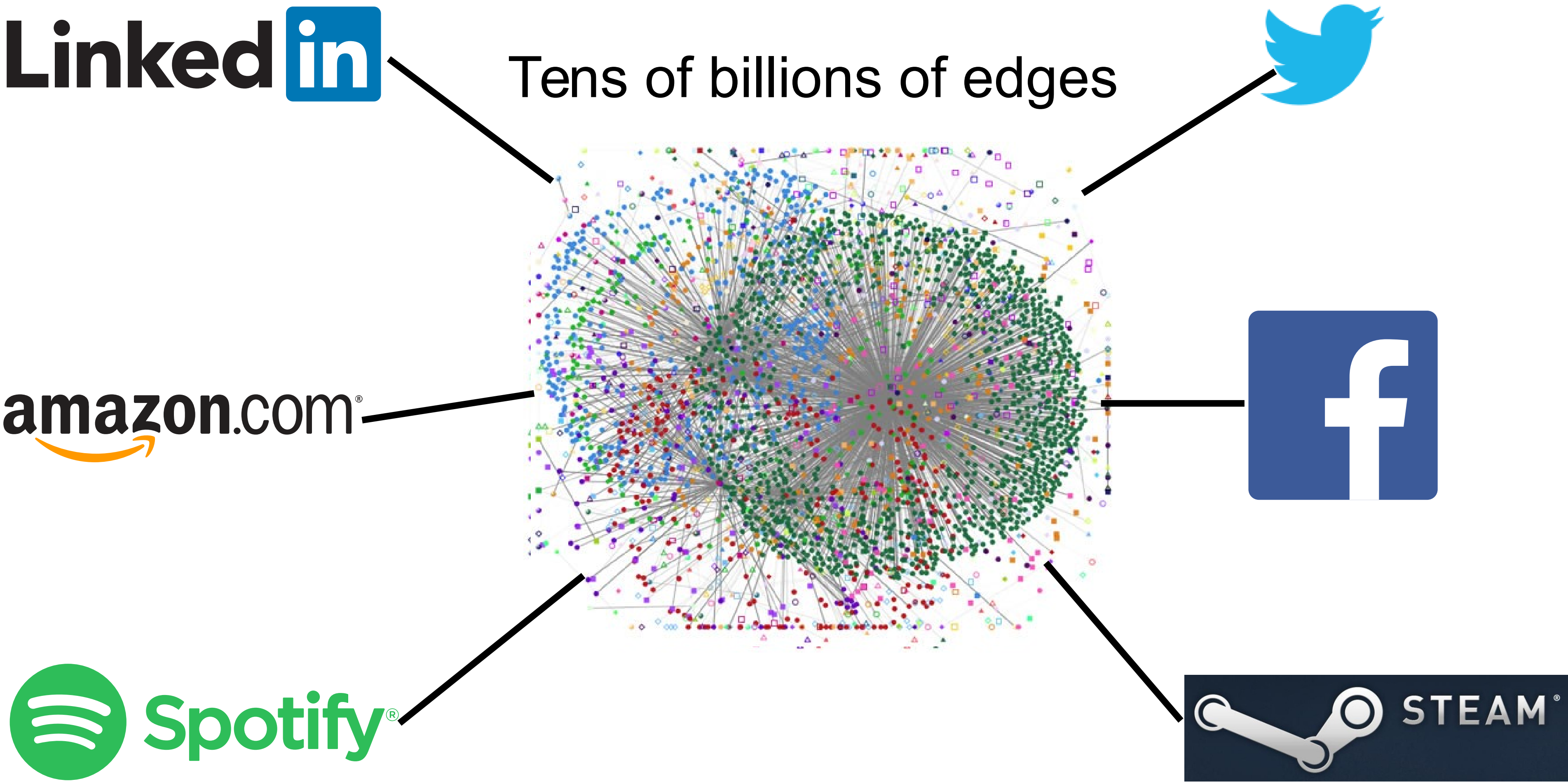
OpenLink Software
CWI

The data deluge: large-scale graphs



Tens of billions of edges

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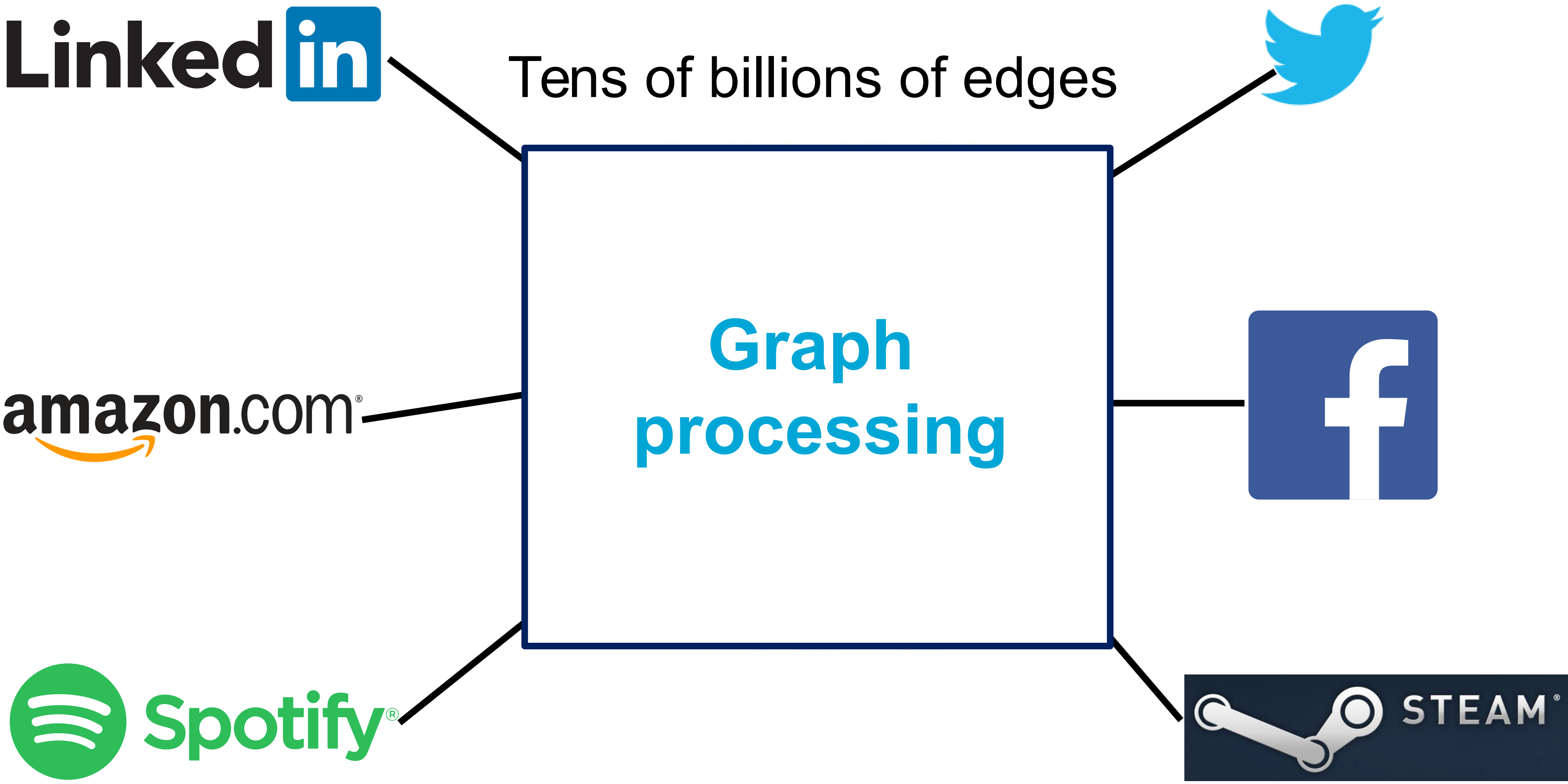

Tens of billions of edges

Graph processing

Platform diversity

hadoop

Oracle Labs
PGX

Neo4j

APACHE
GIRAPH

GraphLab

Spark
GraphX

Yet another benchmark?

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- Lack of benchmarks for generic graph processing platforms

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- Graph500
  - BFS
  - Kroneker graph

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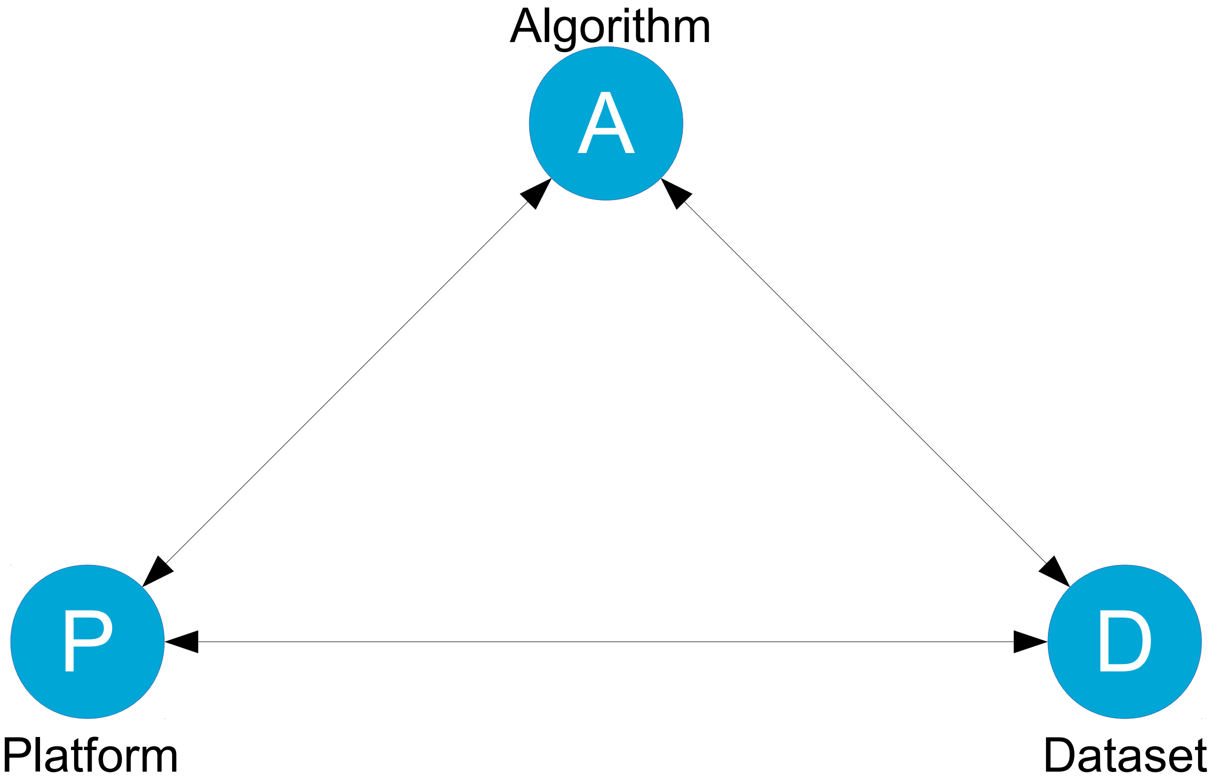
- Lack of benchmarks for generic graph processing platforms
- Graph500
  - BFS
  - Kroneker graph
- Several academic studies
  - Specific to graph or RDF databases
  - Ad hoc setup, difficult to extend

P-A-D triangle



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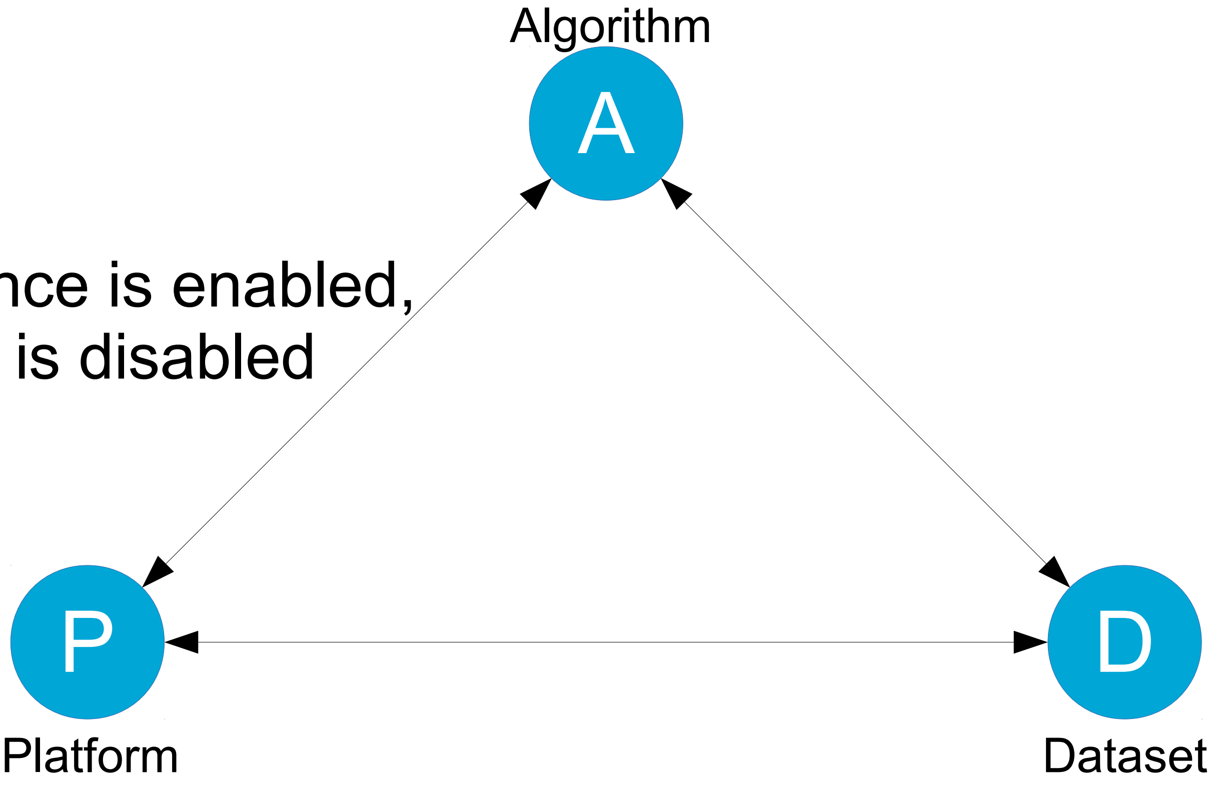

Performance is enabled, portability is disabled

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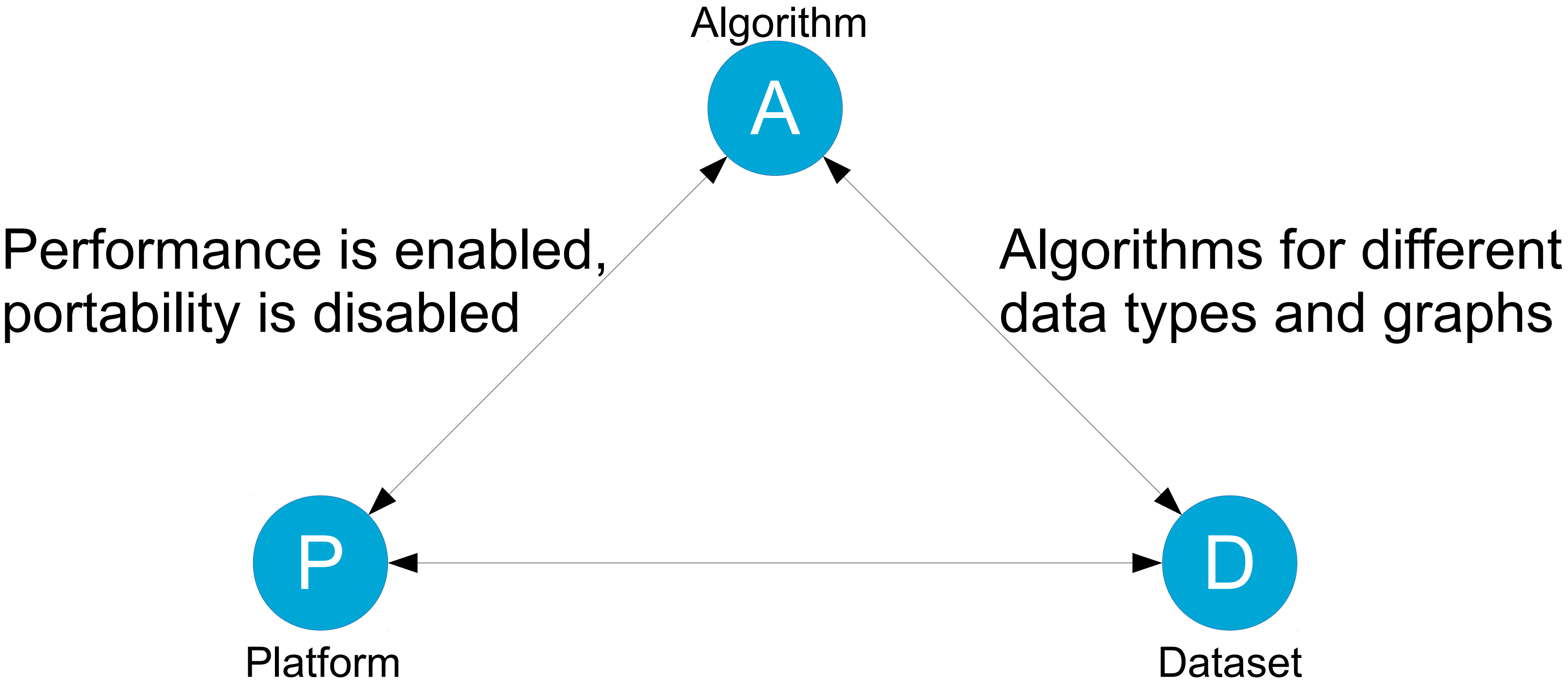


Algorithm

A

Performance is enabled, portability is disabled

Algorithms for different data types and graphs

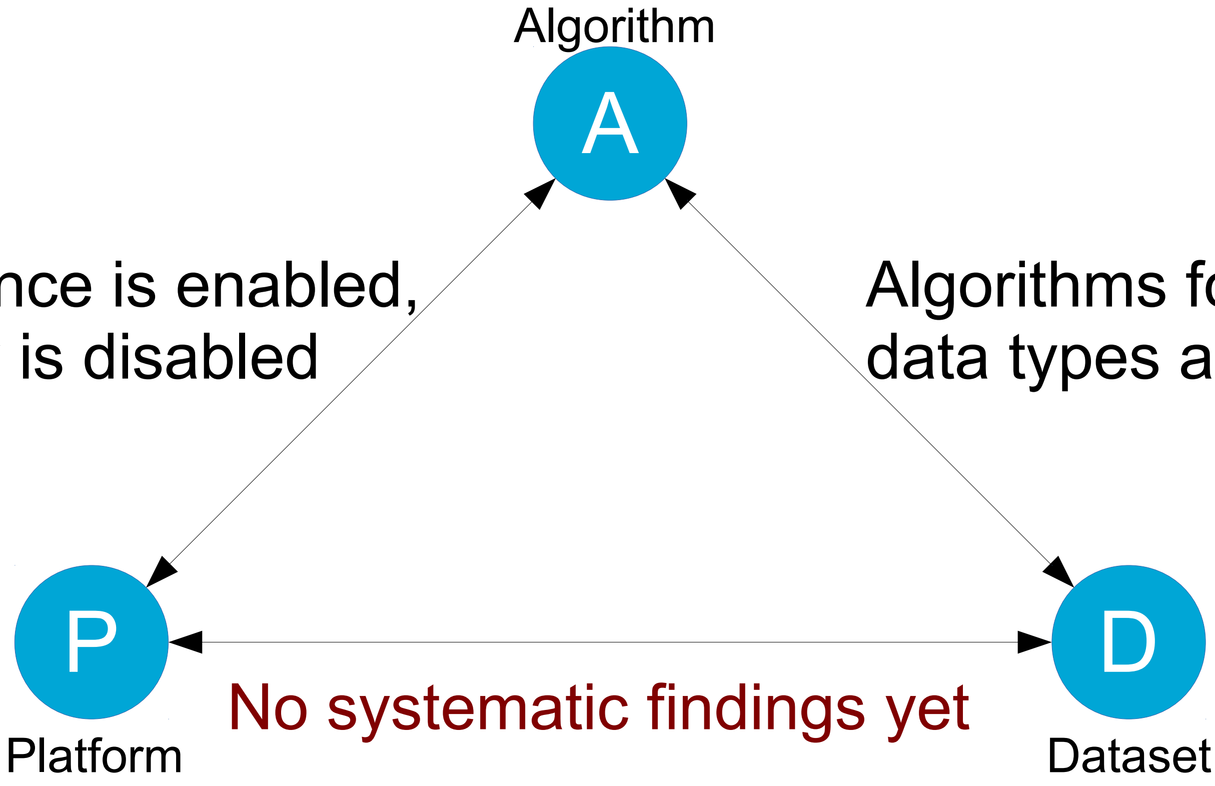
P

Platform

D

Dataset

P-A-D triangle

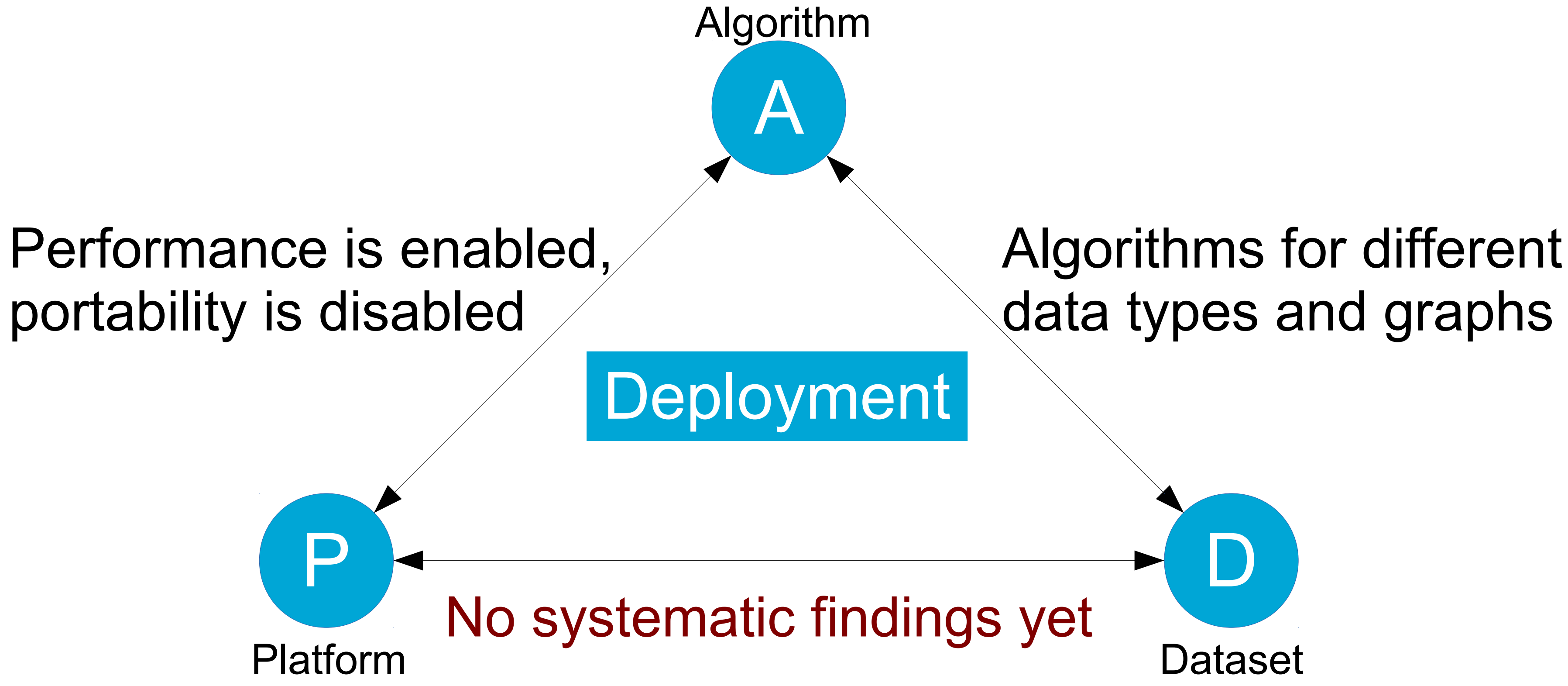


Performance is enabled, portability is disabled

Algorithms for different data types and graphs

No systematic findings yet

P-A-D triangle



Graphalytics

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- The first comprehensive benchmark for big data graph-processing platforms

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LDBC The graph & RDF benchmark reference

spec Research

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LDBC The graph & RDF benchmark reference

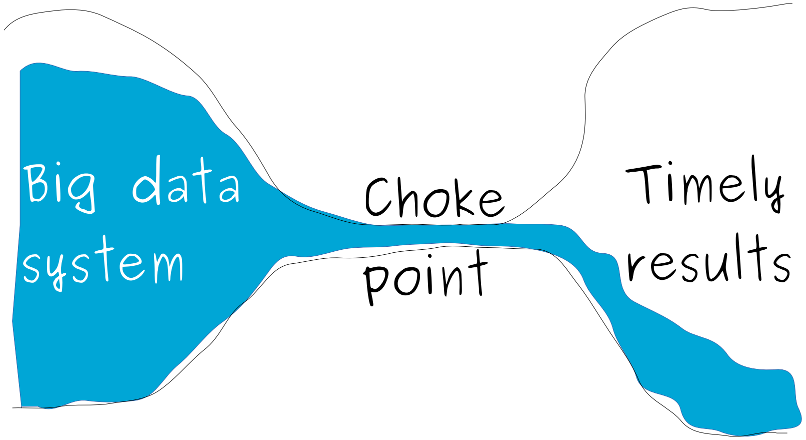
spec Research

- Co-sponsored by Oracle

Choke points

Choke points

- Technological challenges for platforms



Choke points

- Technological challenges for platforms
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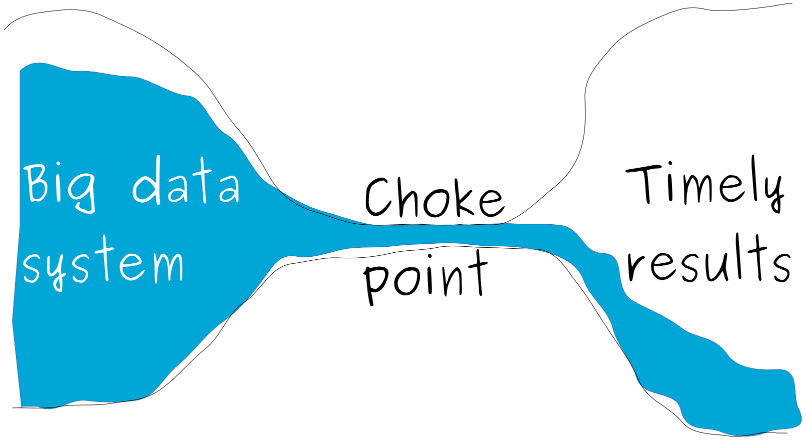

Choke points

- Technological challenges for platforms
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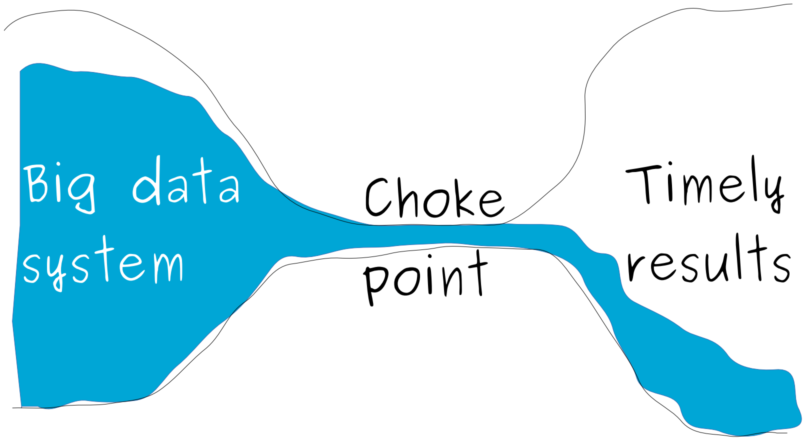
- Real-world scenarios are enhanced to stress choke points
  - Prevent tunnel vision
  - Advance state of the art



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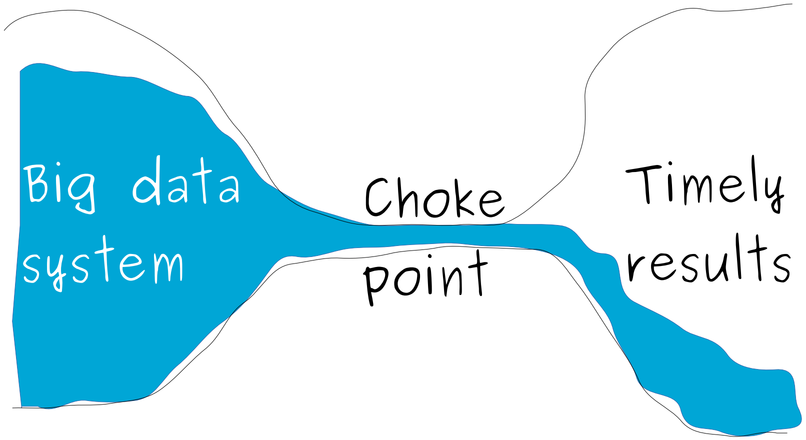

Erling et al., The LDBC Social Network Benchmark: Interactive Workload , SIGMOD 2015

Examples of choke points

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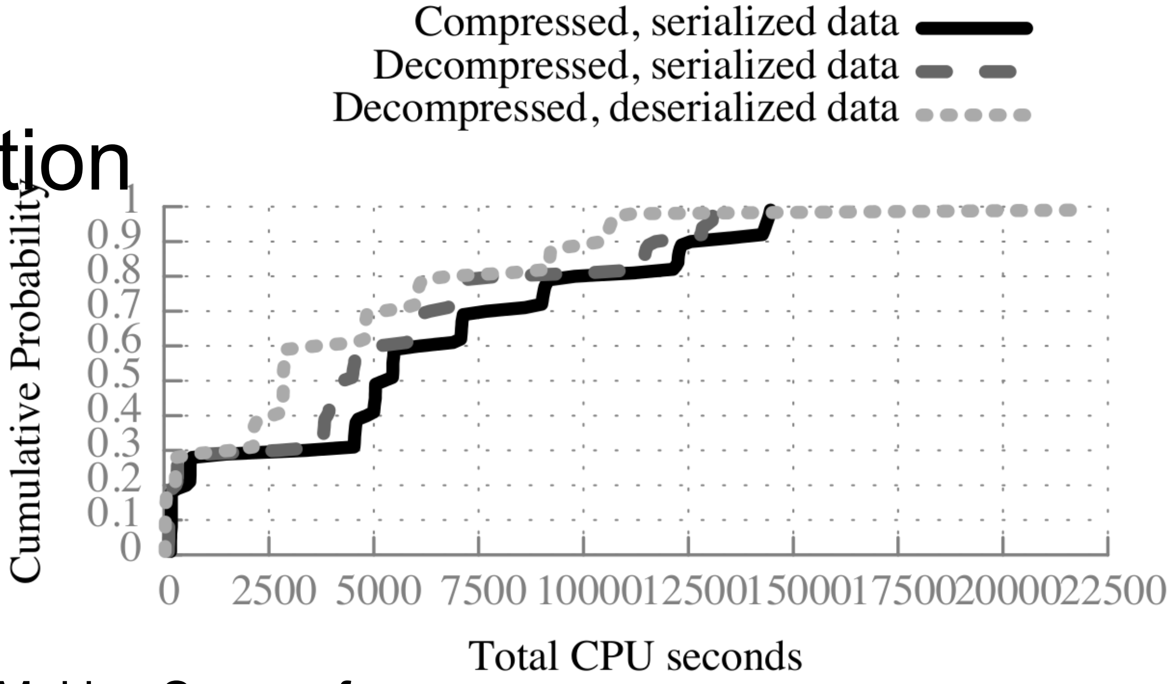
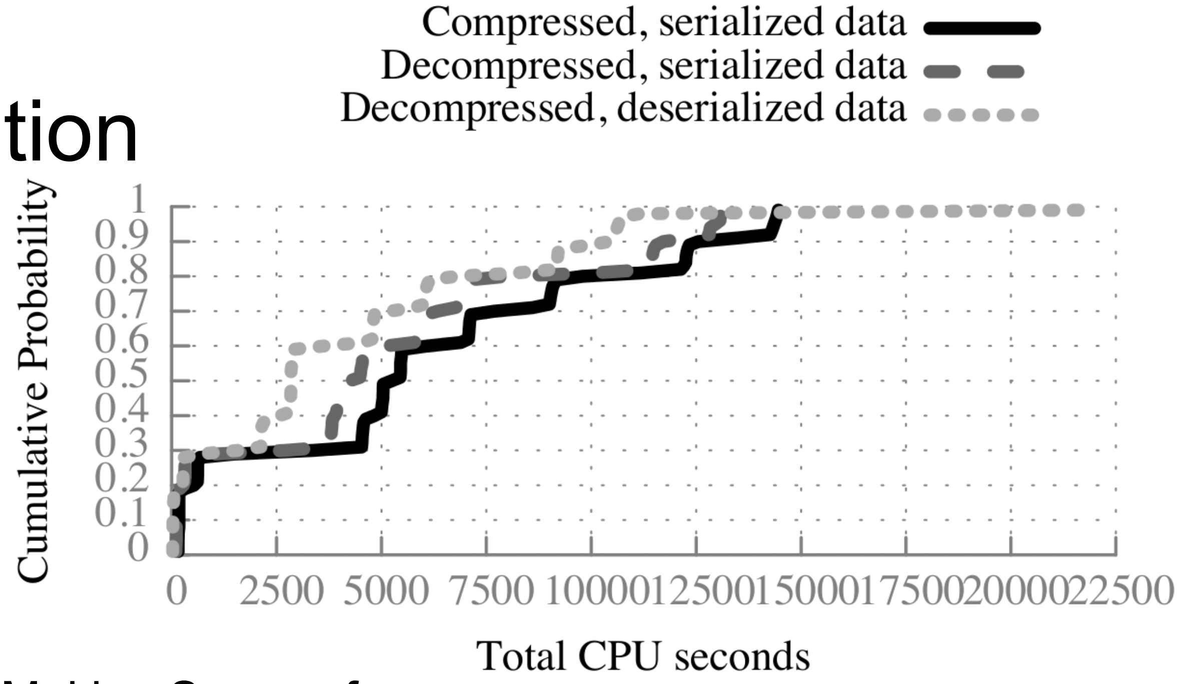


Ousterhout et al., “Making Sense of Performance in Data Analytics Frameworks”, NSDI 2015

Examples of choke points

- Network utilization
- Memory footprint
- Access locality
- Skewed execution
- CPU?
- Others?



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  - Synthetic social network similar to Facebook

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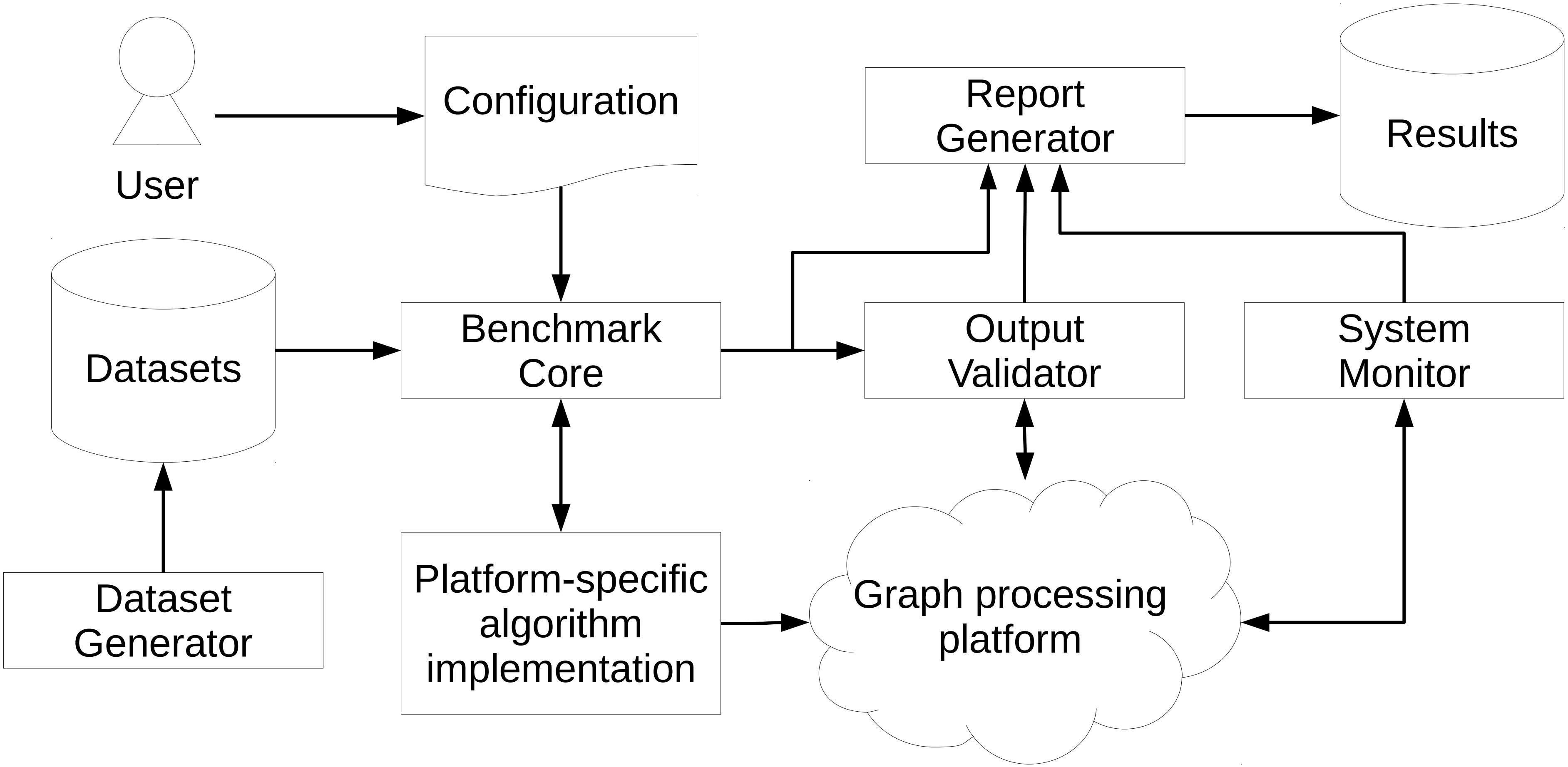

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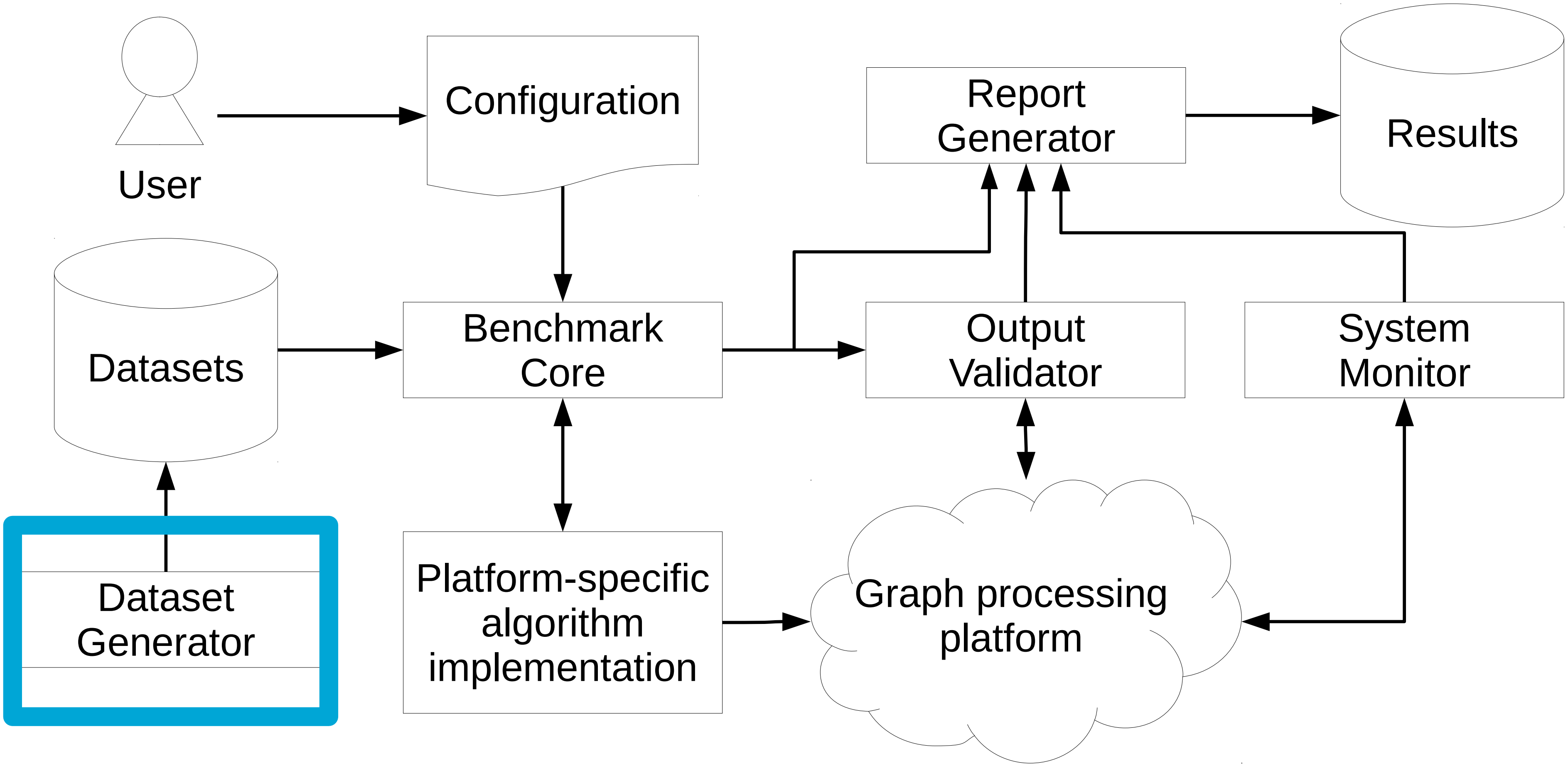

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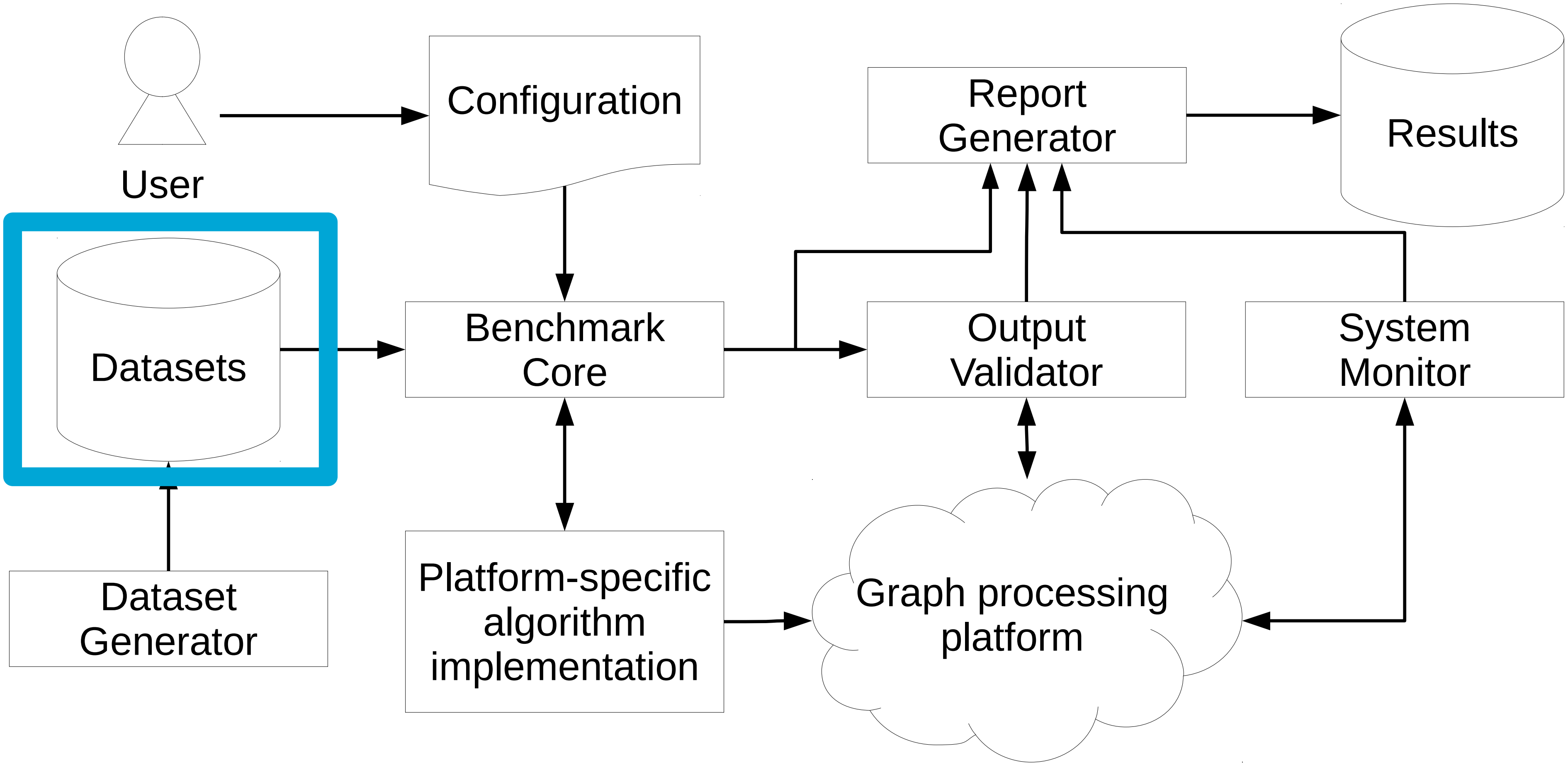

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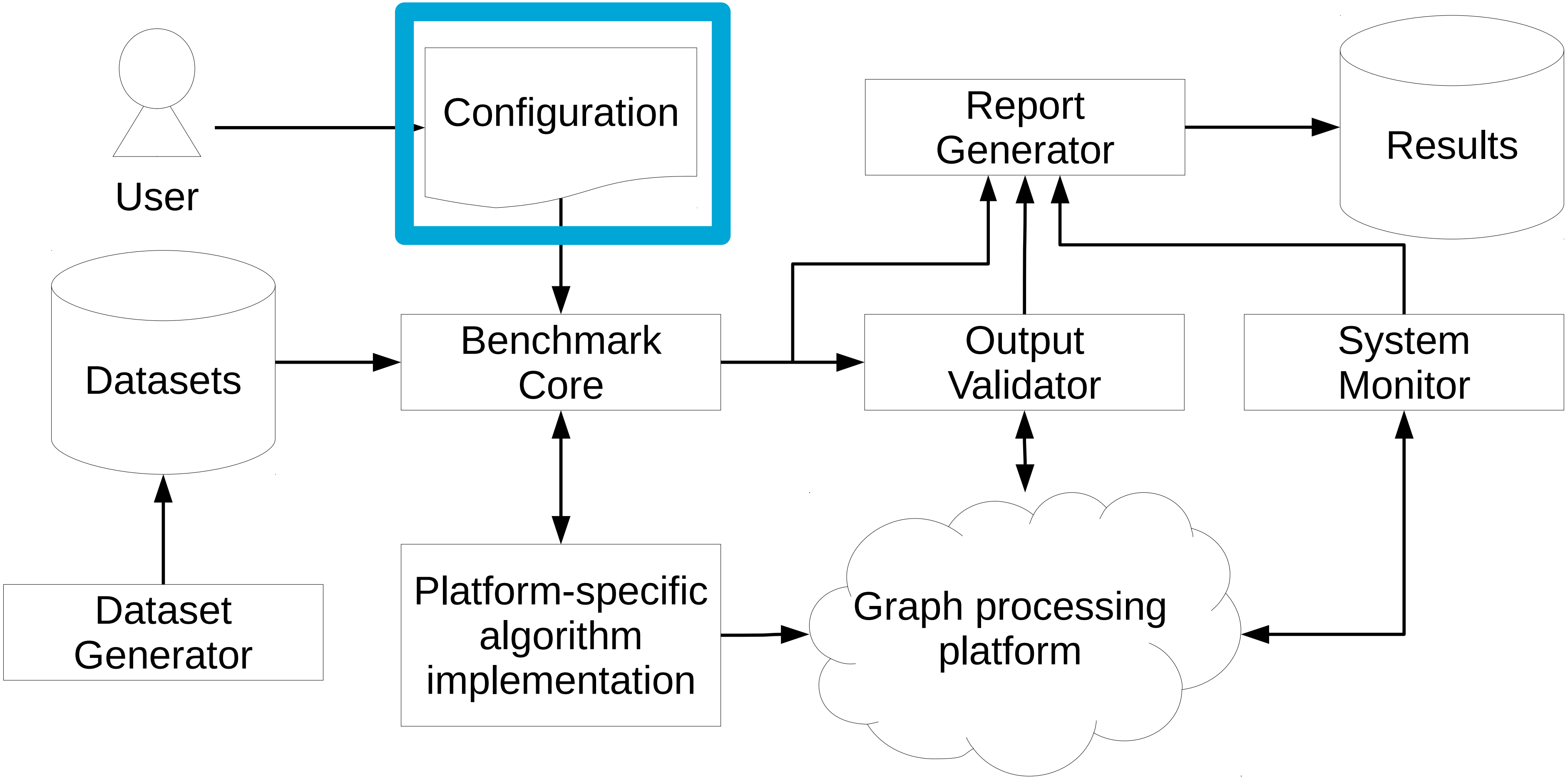

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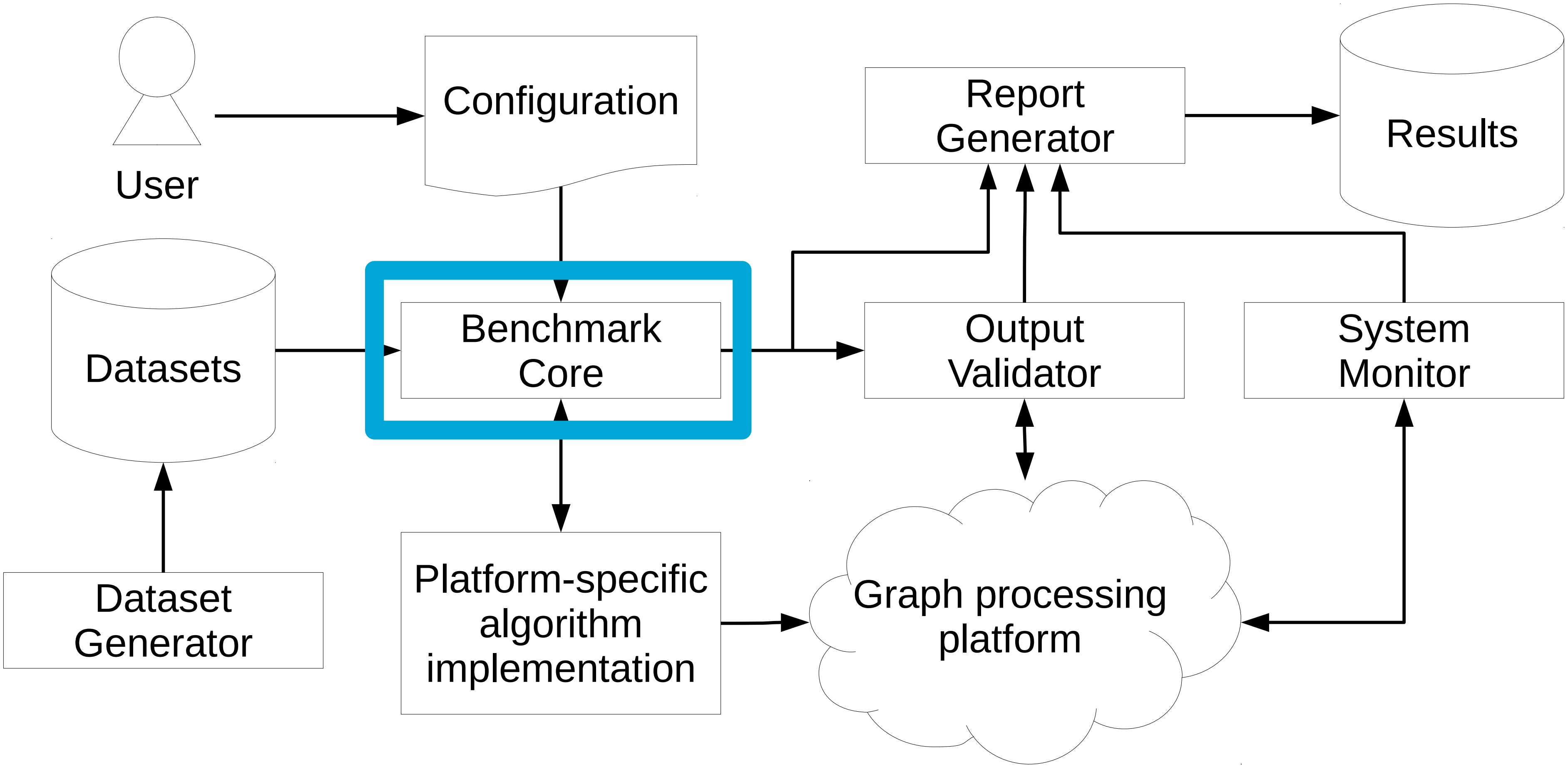

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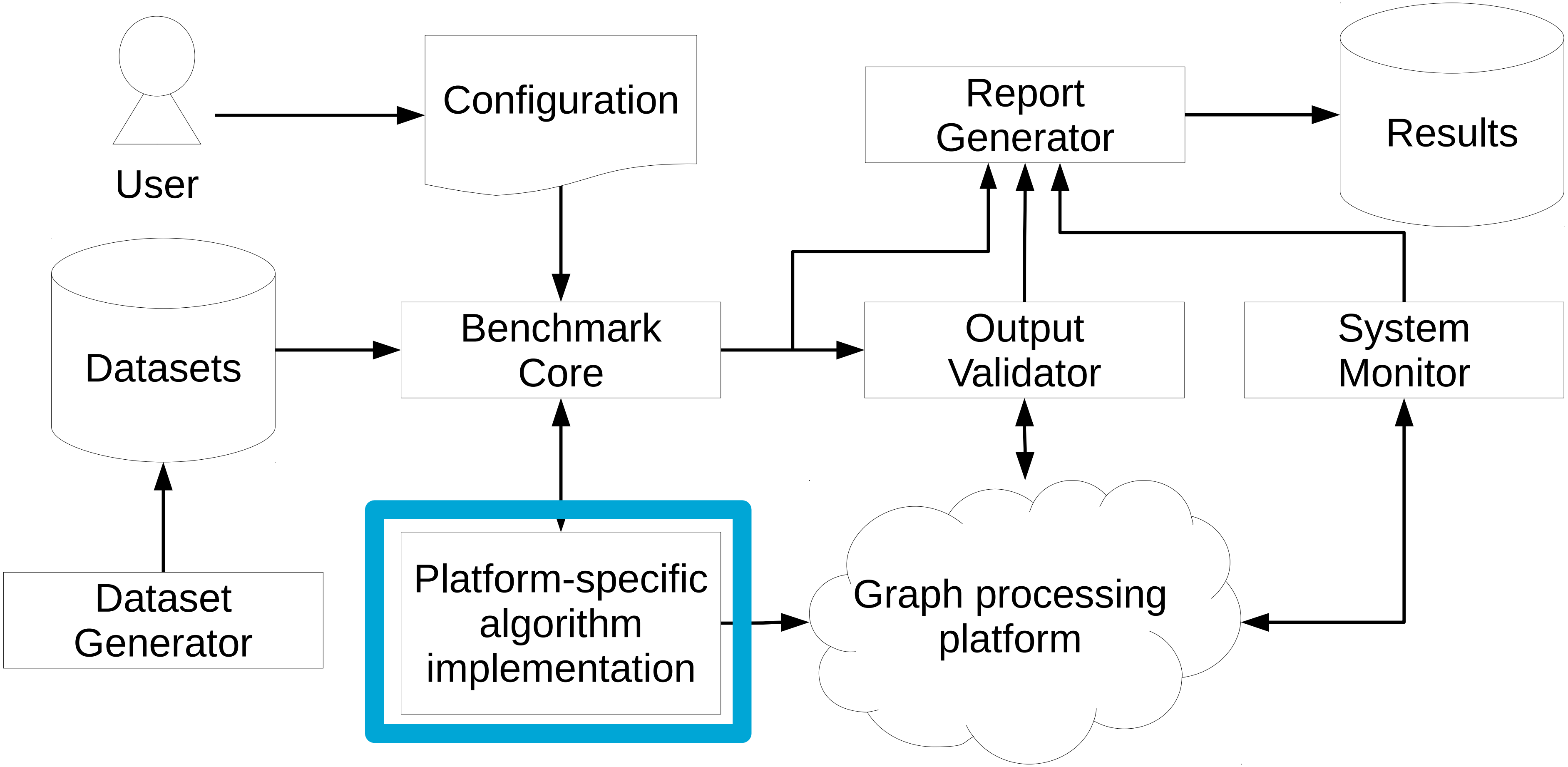

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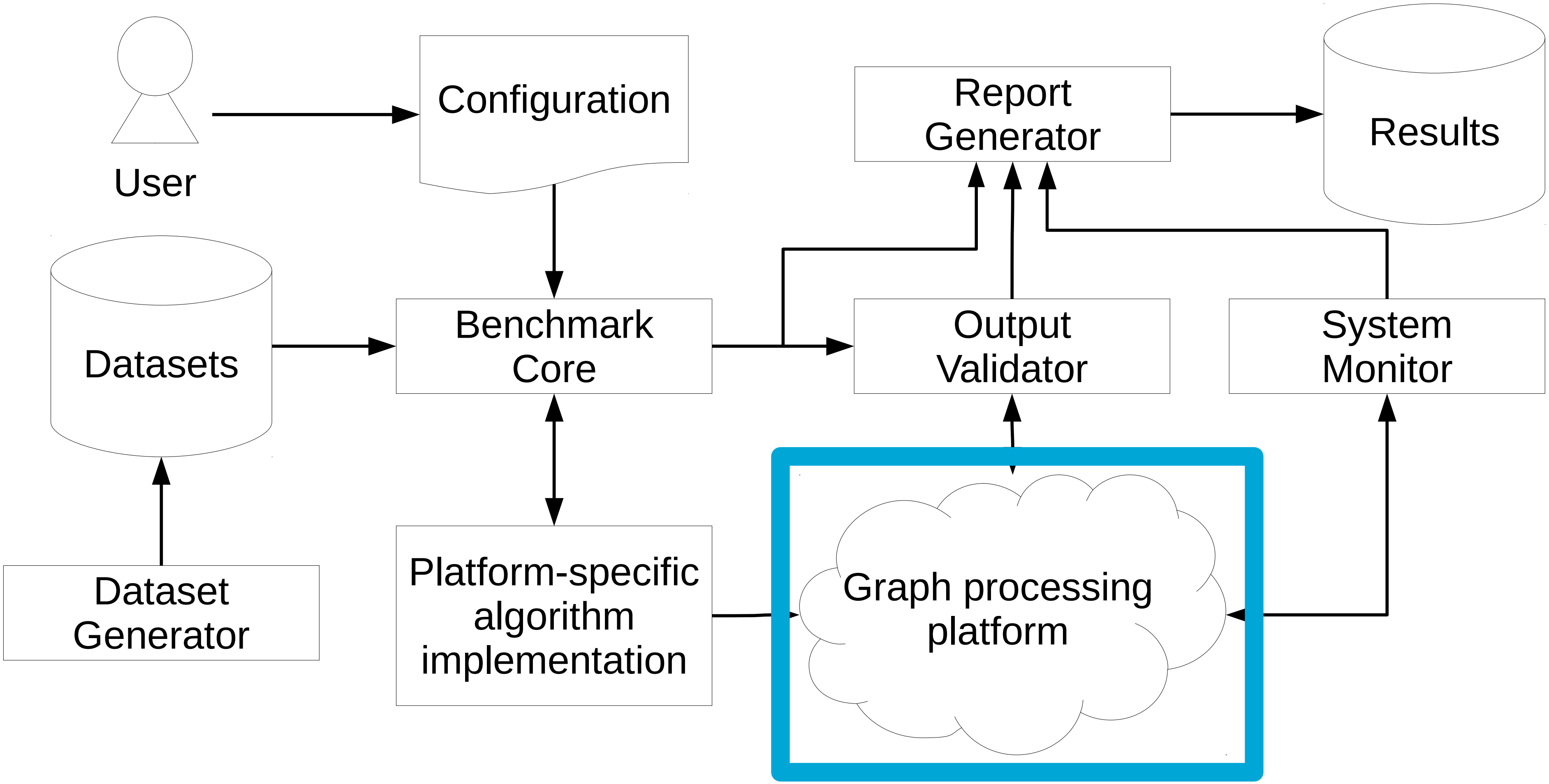
Advanced benchmark harness



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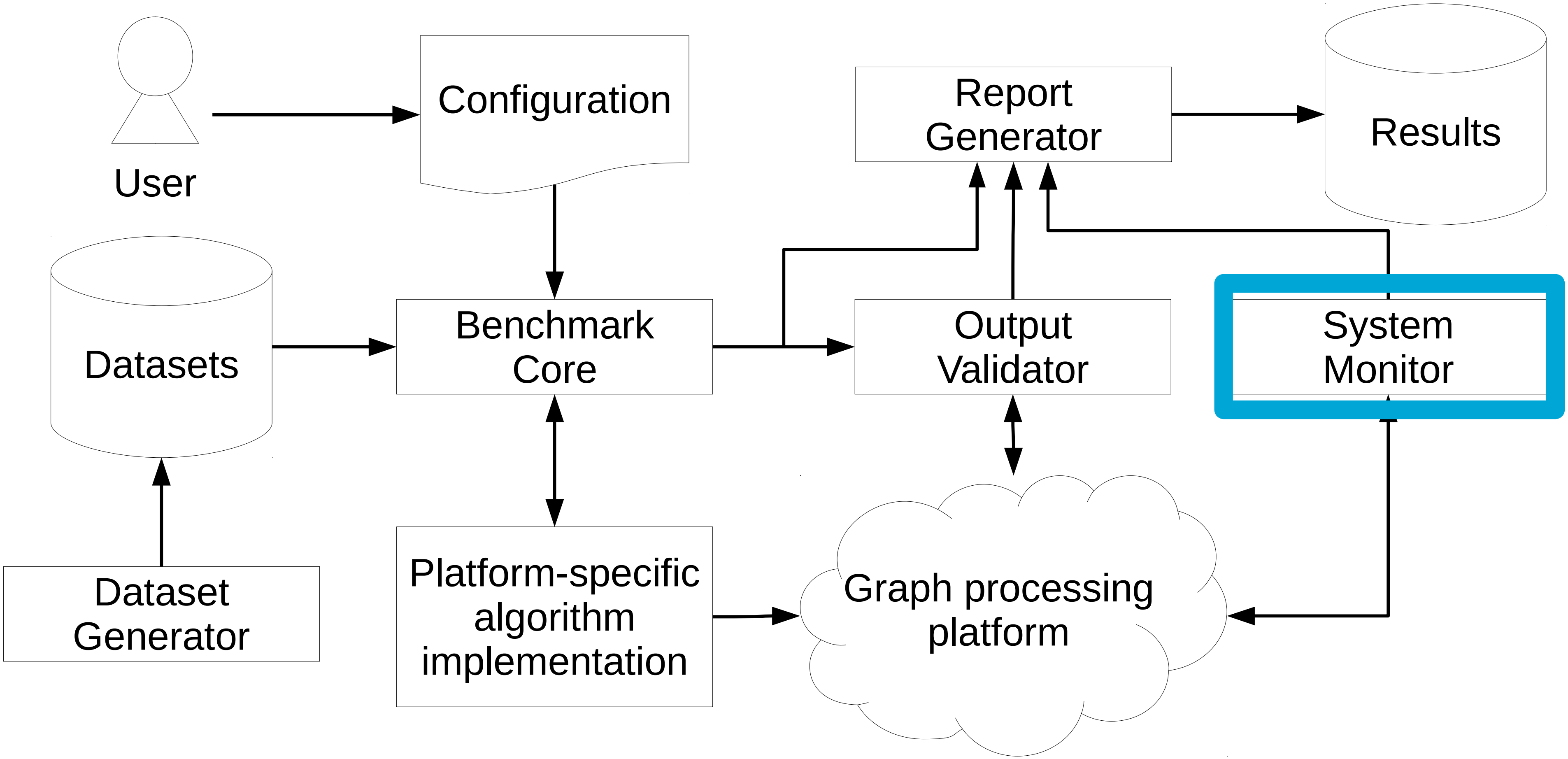

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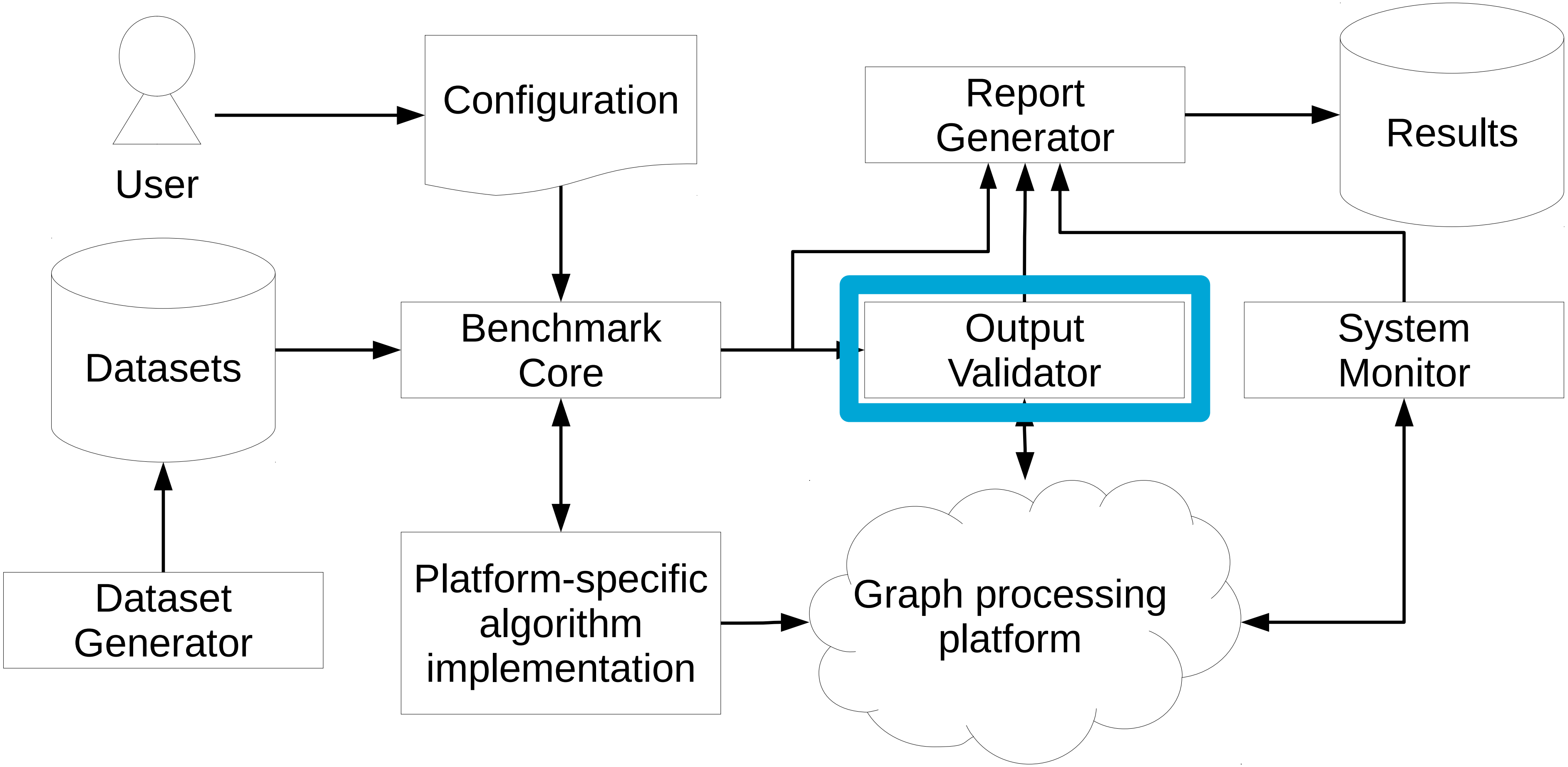

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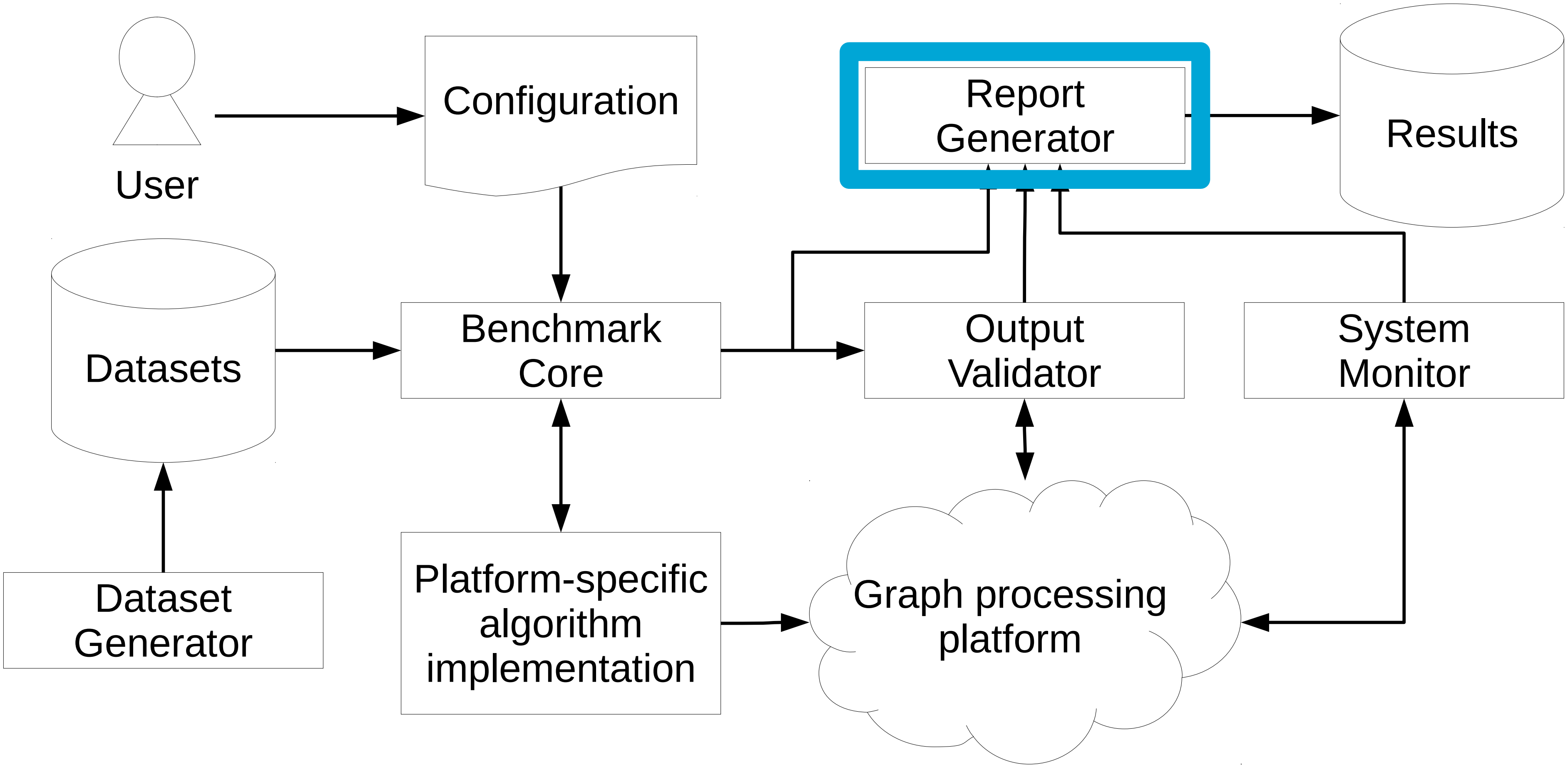

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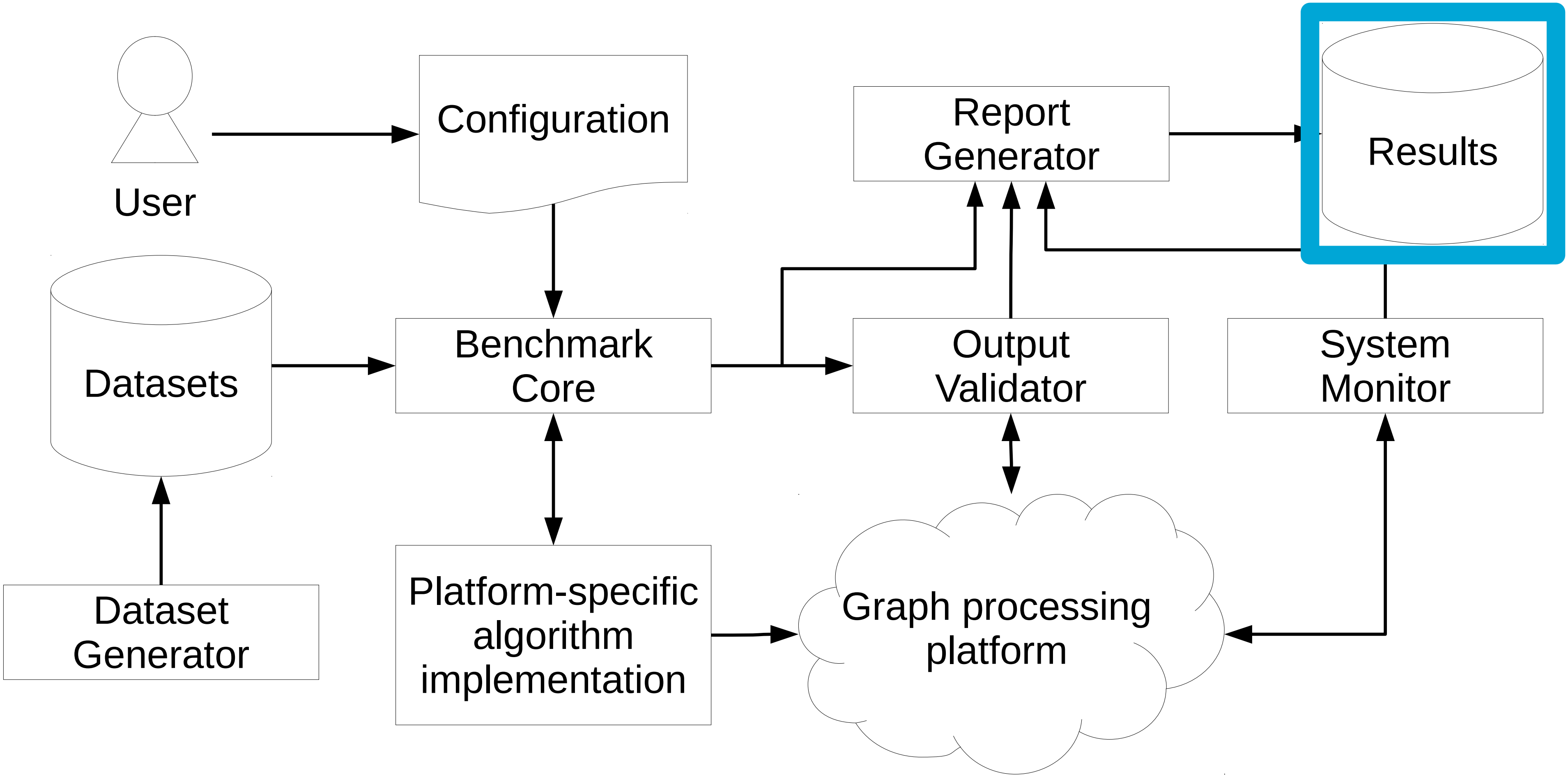

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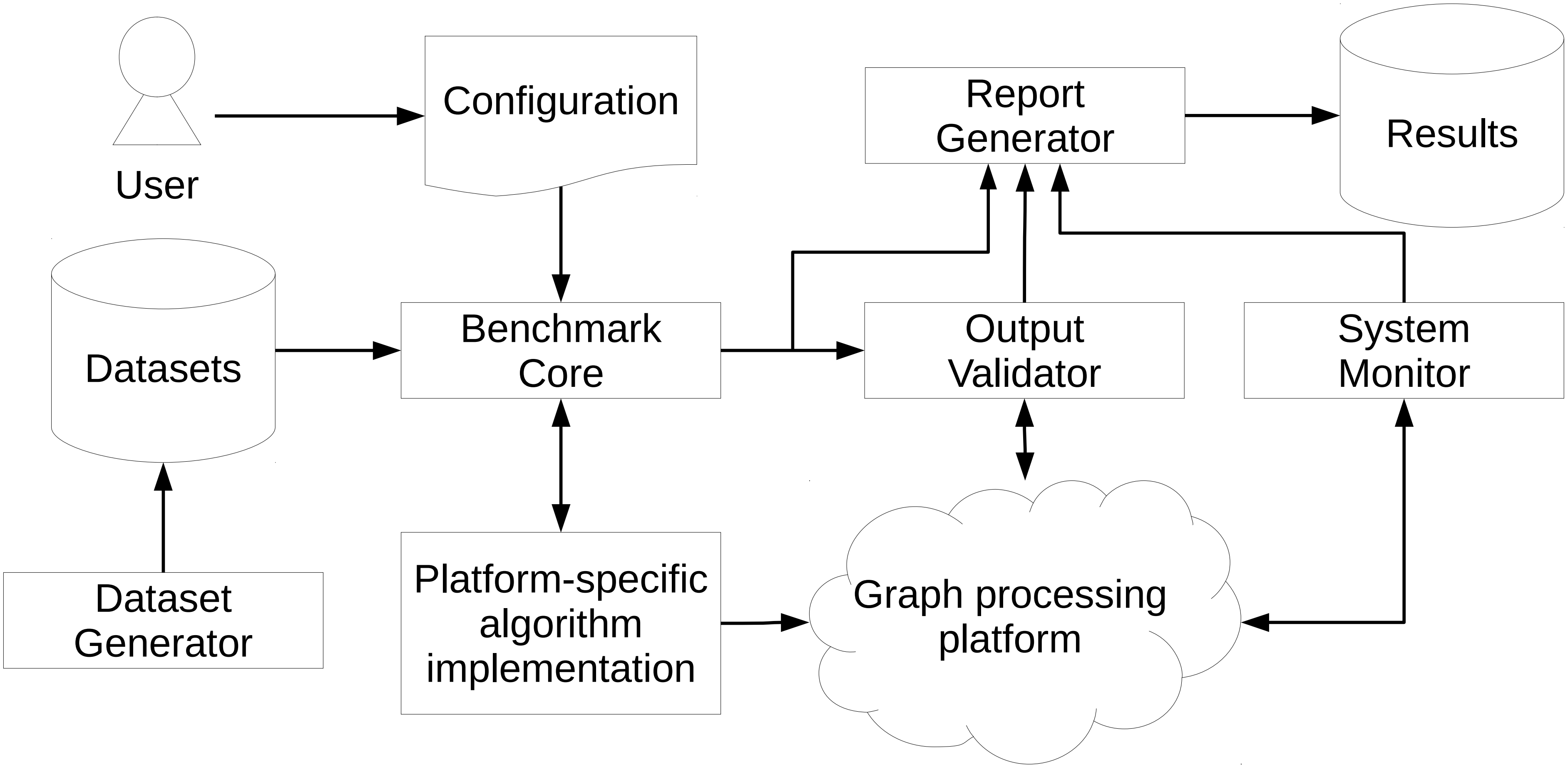


Supported algorithms

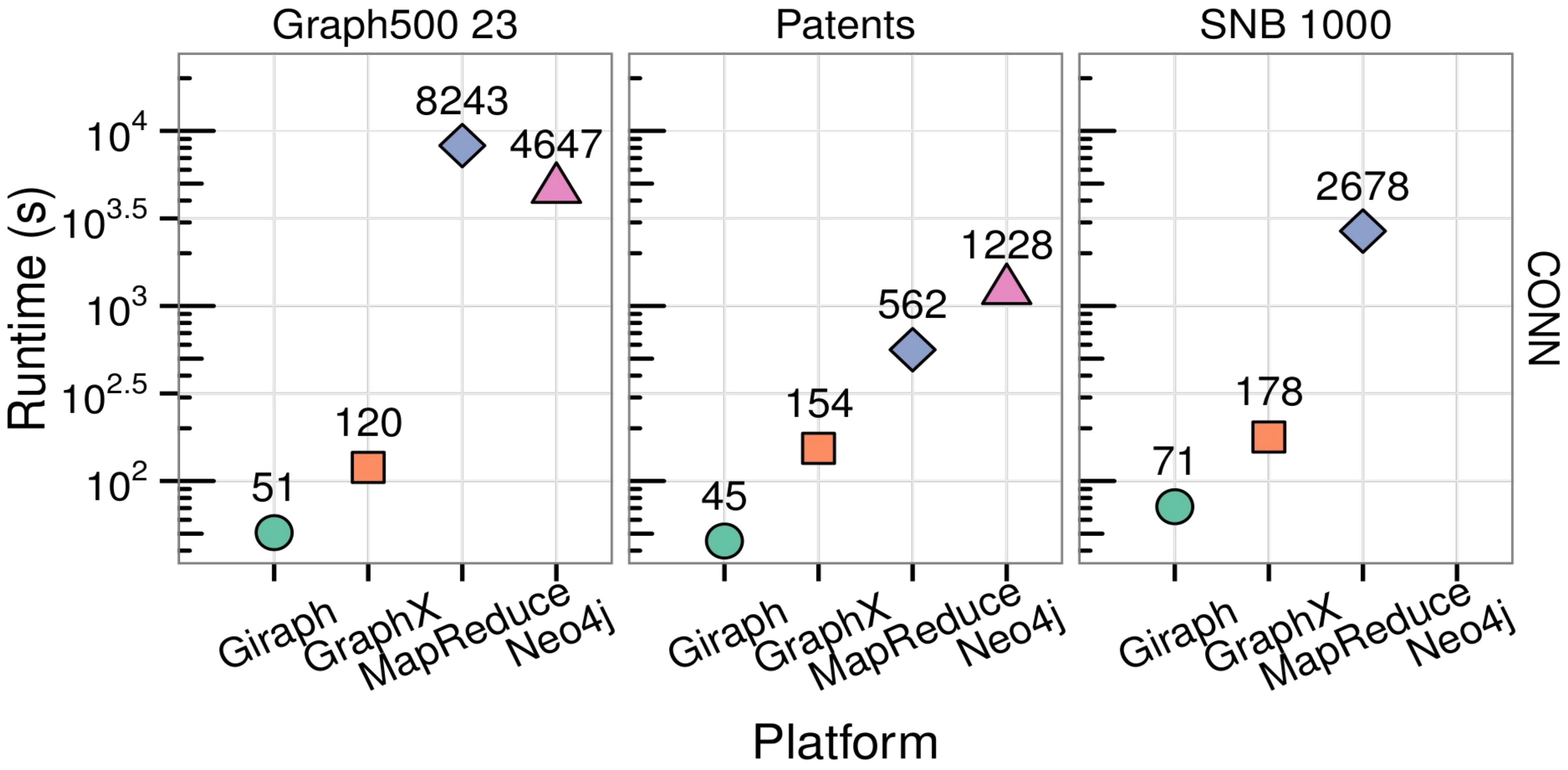
ID	Algorithm	Class	Use (%)
BFS	Breadth-first search	Traversal	46
STATS	Local clustering coefficient	Statistics	16
CONN	Weakly connected components	Connected components	13
CD	Label propagation	Community detection	5
EVO	Forest fire evolution	Evolution	4

Guo et al., How Well Do Graph-Processing Platforms Perform? An Empirical Performance Evaluation and Analysis, IPDPS 2014

Experimental setup

- DAS-4 cluster
  - Typical big data setup
  - 11 nodes, 24 GiB RAM, 2 x 8-core Xeon E5620
  - 1 Gbit/s Ethernet
- Single machine
  - HPC-like setup
  - 192 GiB RAM, 2 x 8-core Xeon E5-2450 v2

Runtime


Graph500 23
Patents
SNB 1000
Runtime (s)
10^4
$10^{3.5}$
10^3
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10^2
8243
4647
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GraphX
MapReduce
Neo4j
Platform

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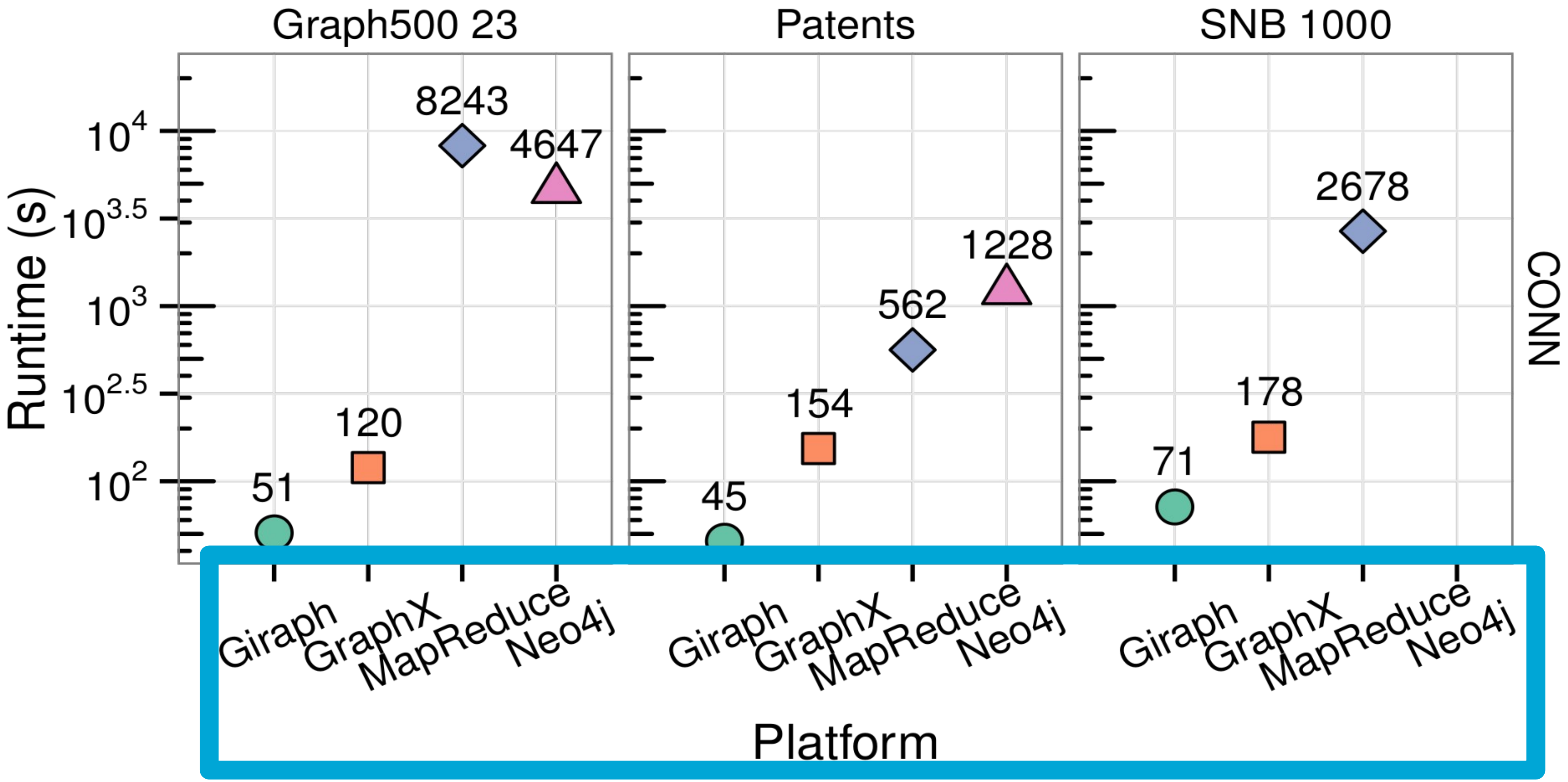
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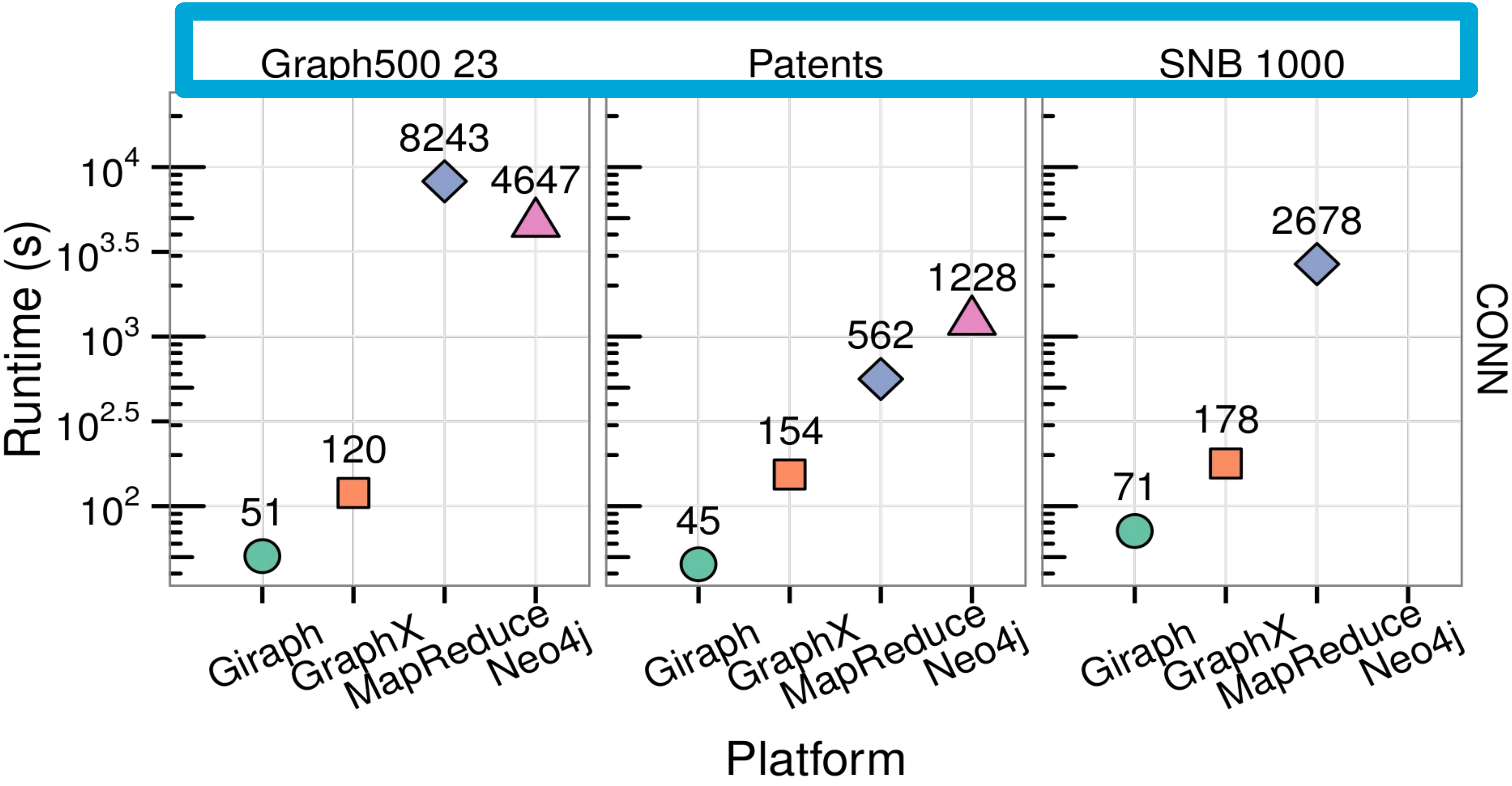
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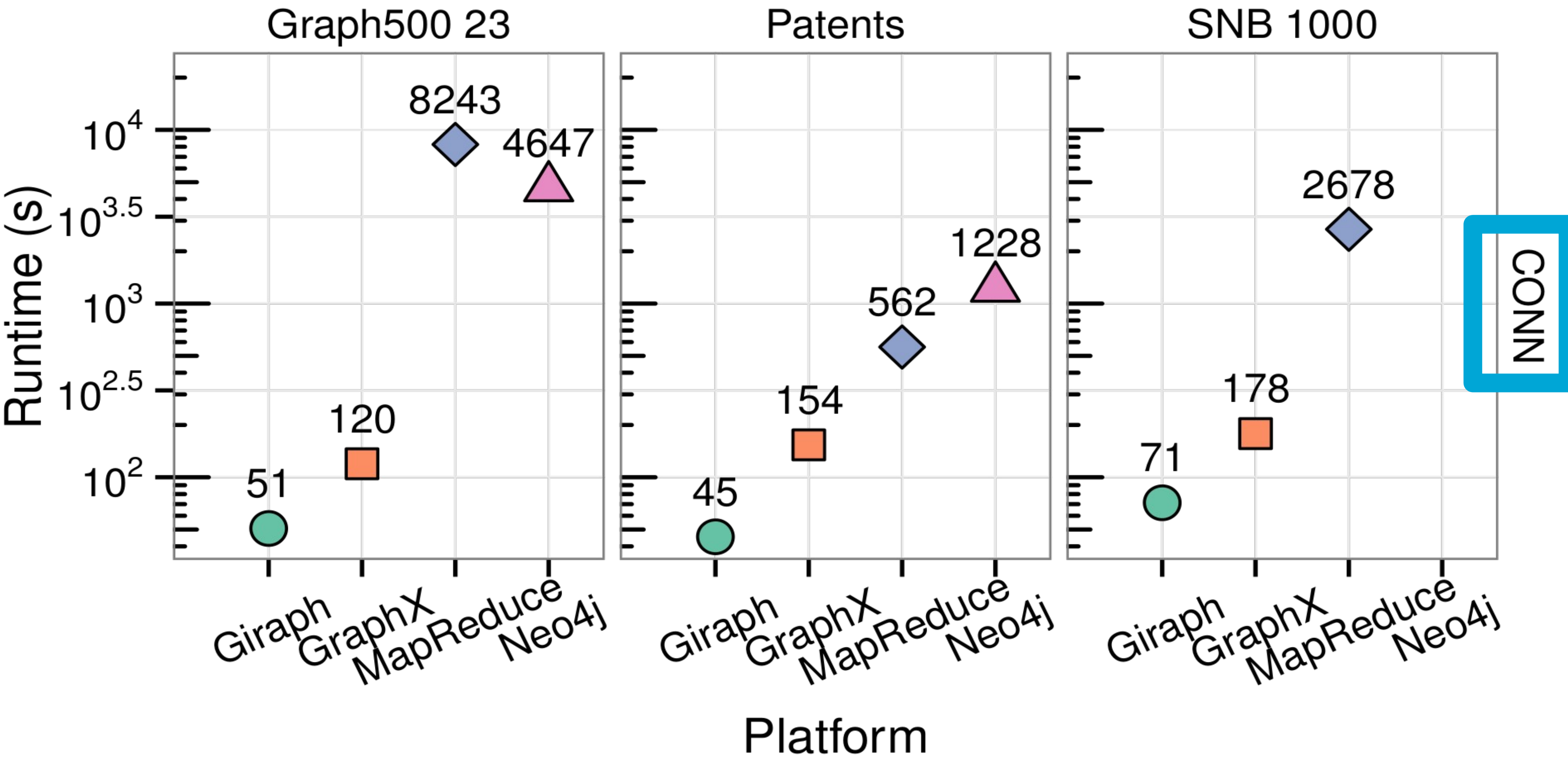
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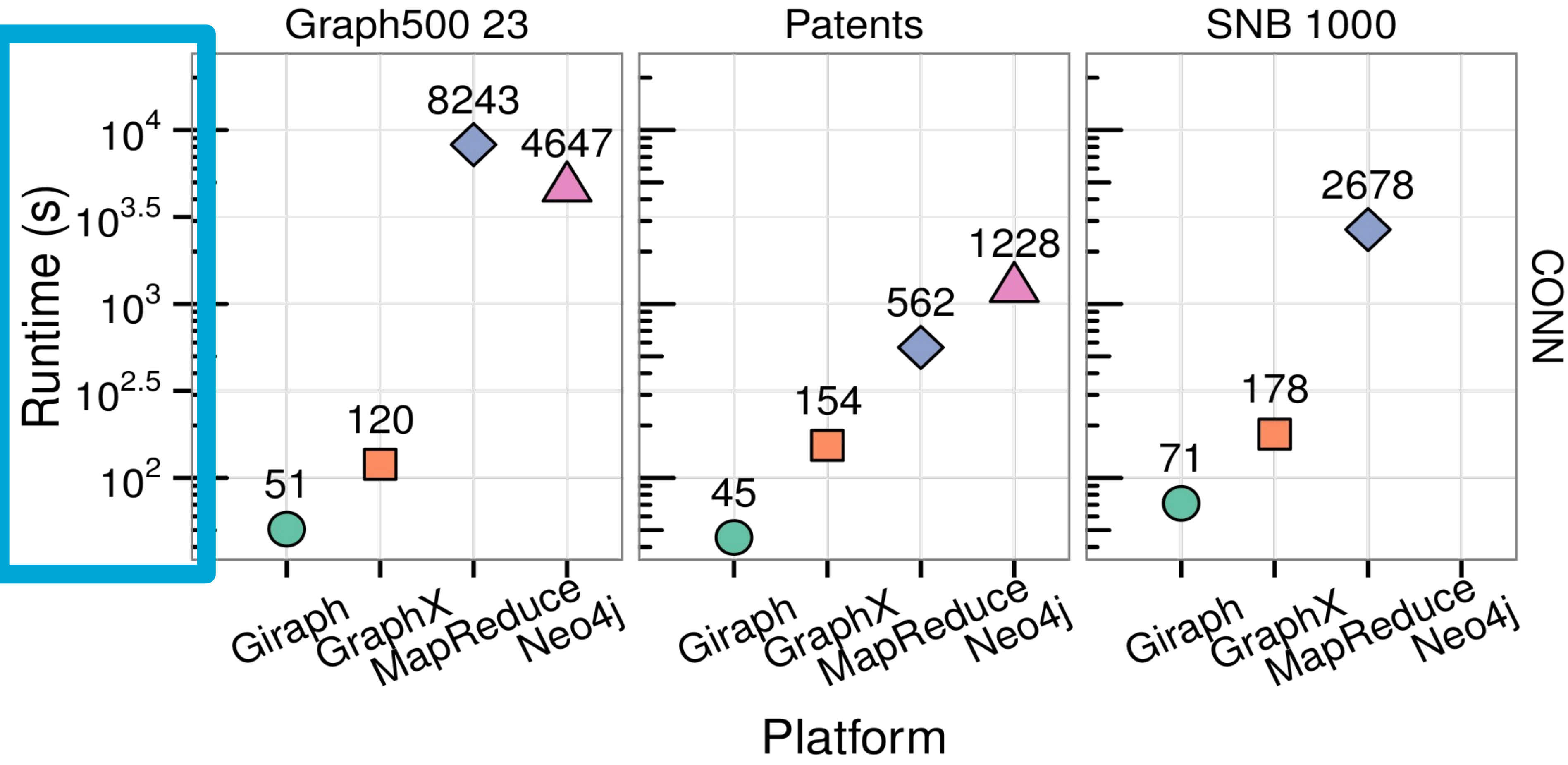

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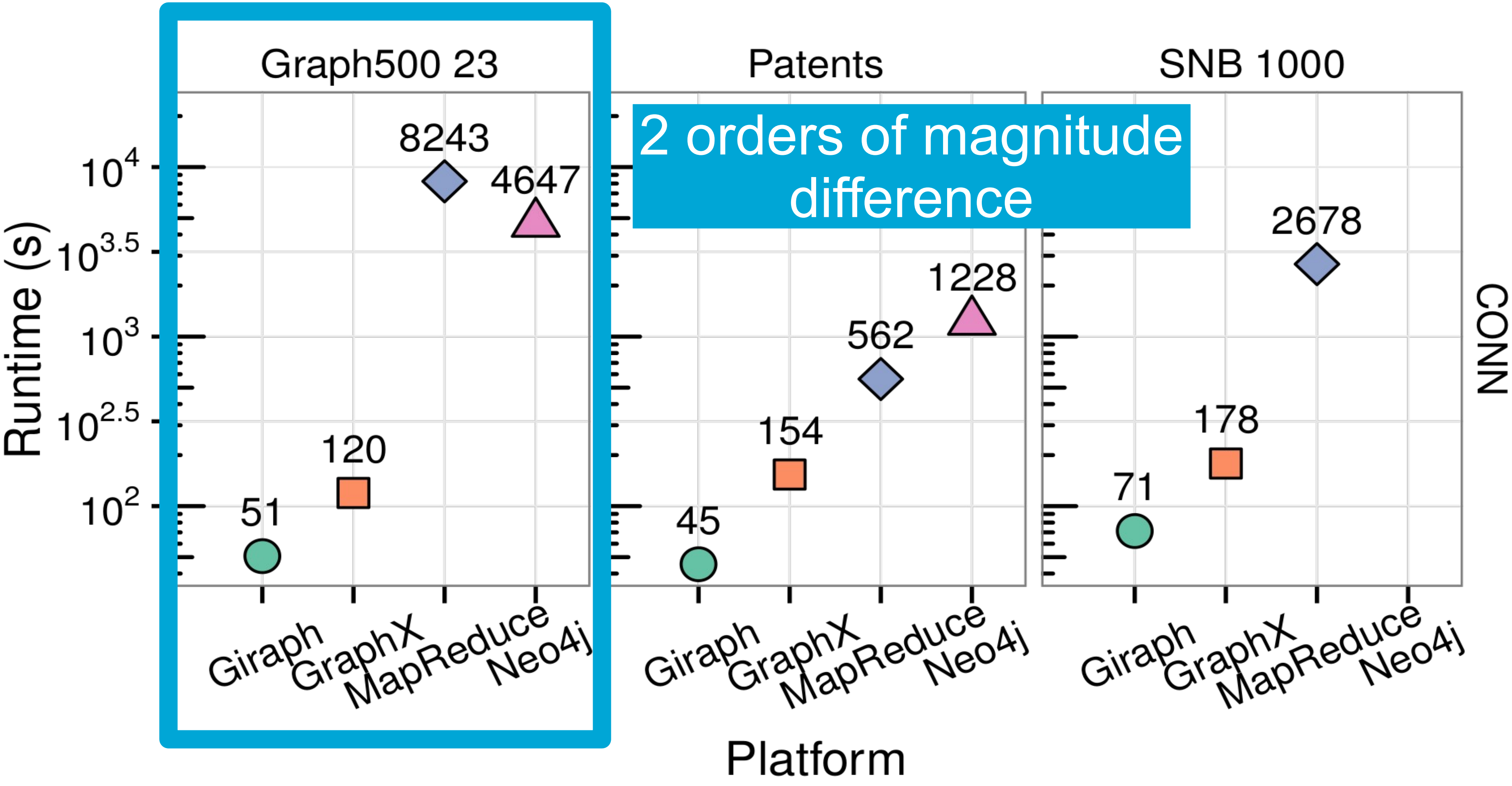
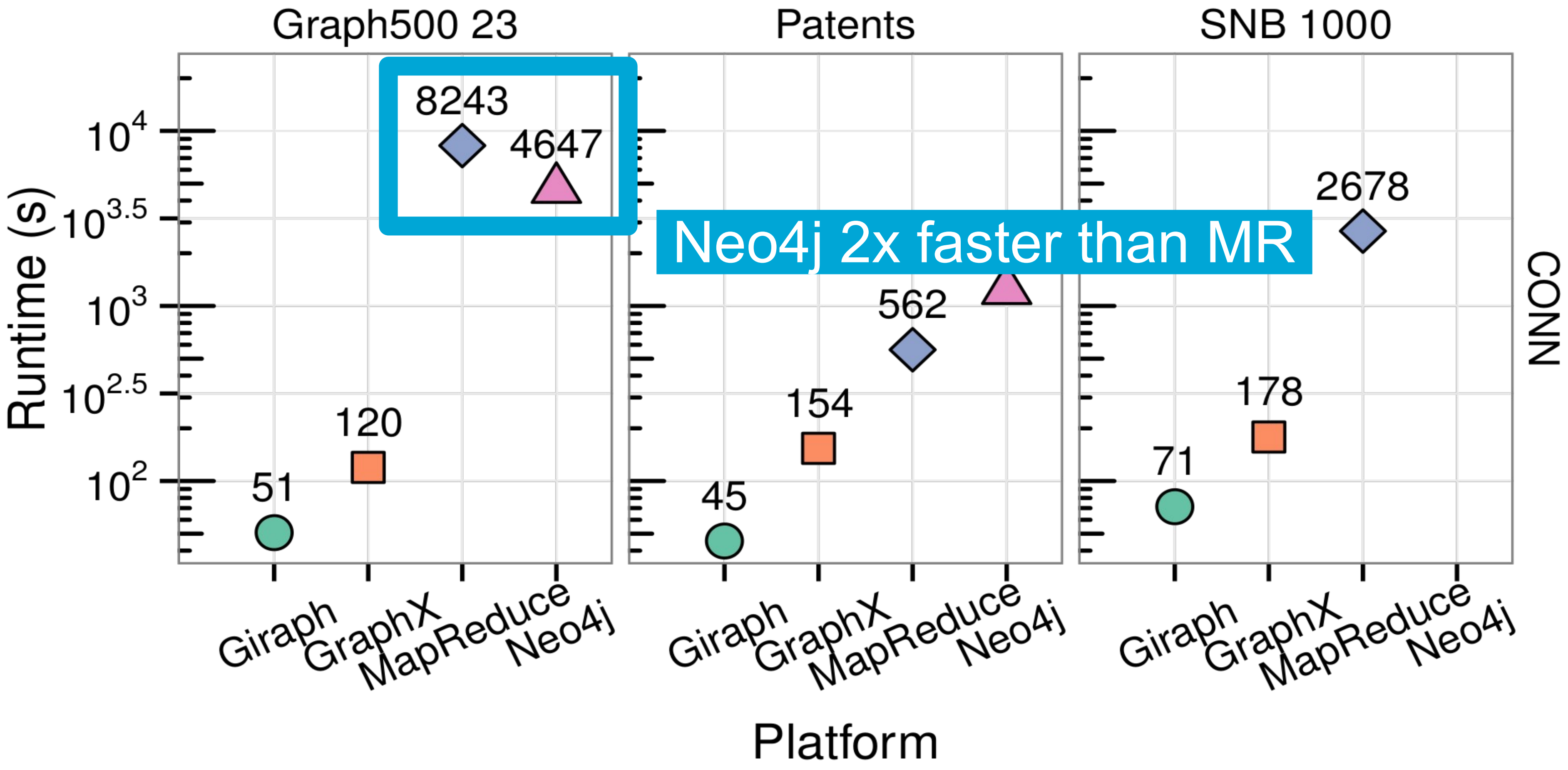


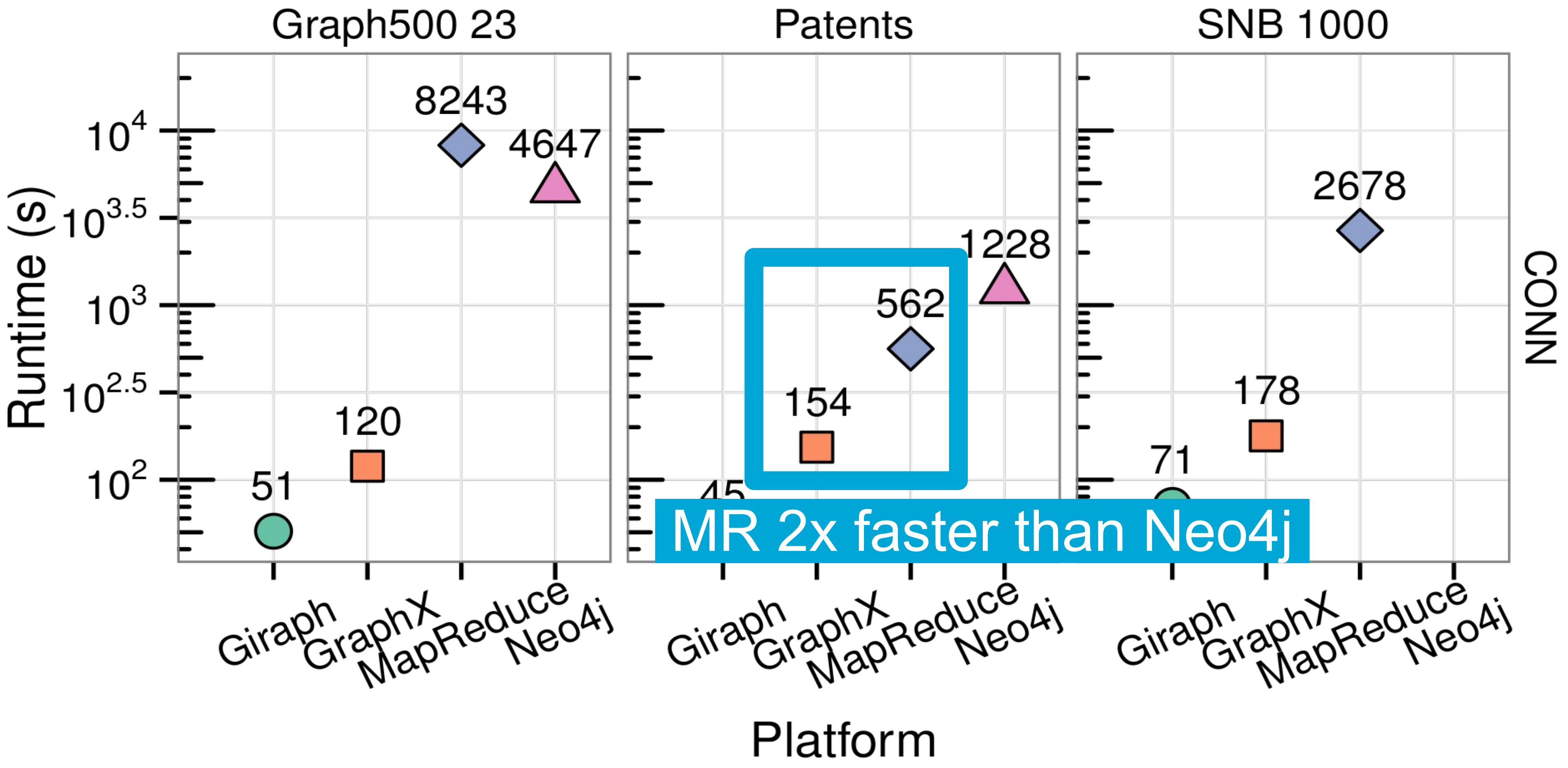
2 orders of magnitude difference

Runtime



Neo4j 2x faster than MR

Runtime



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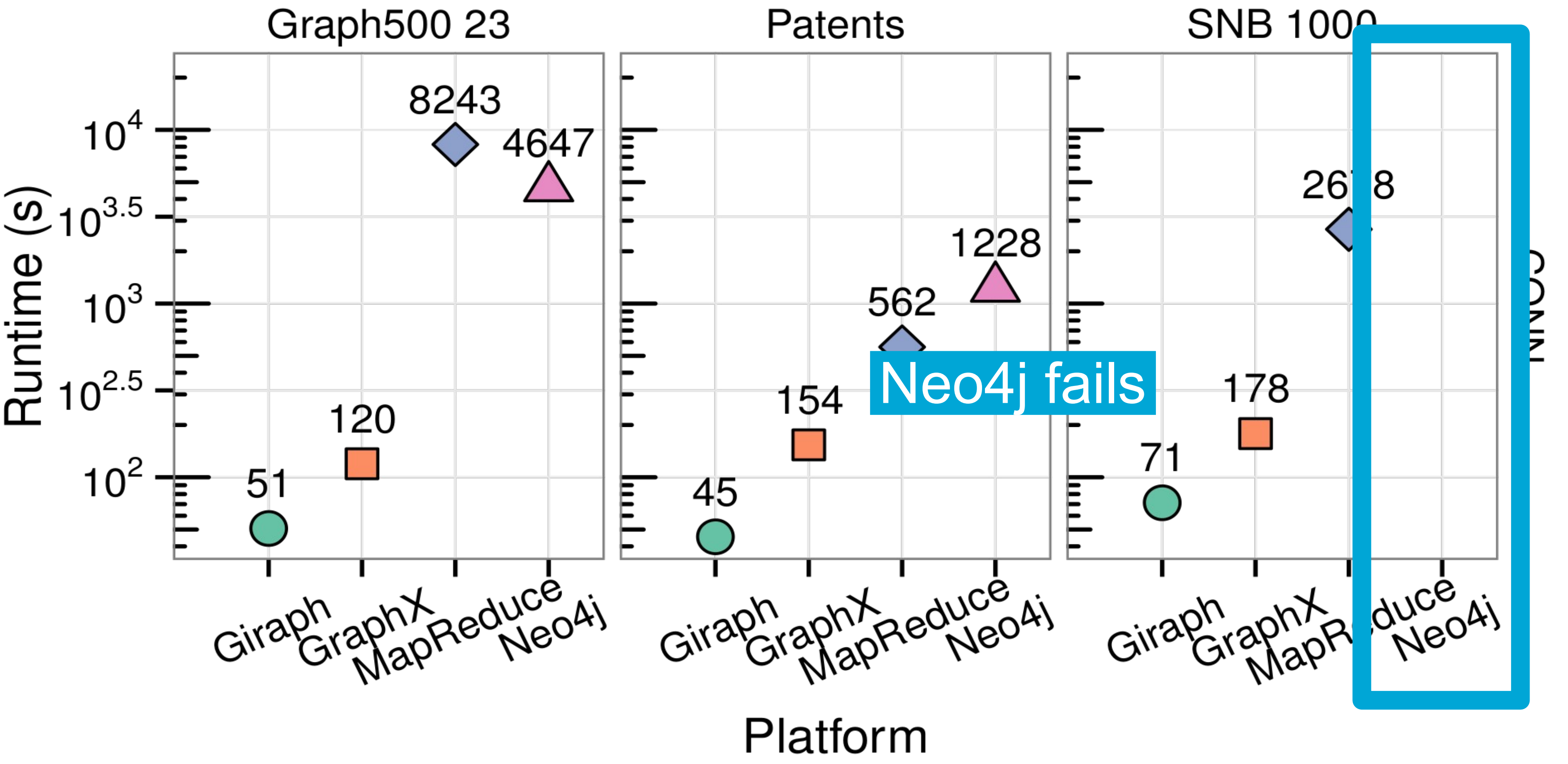
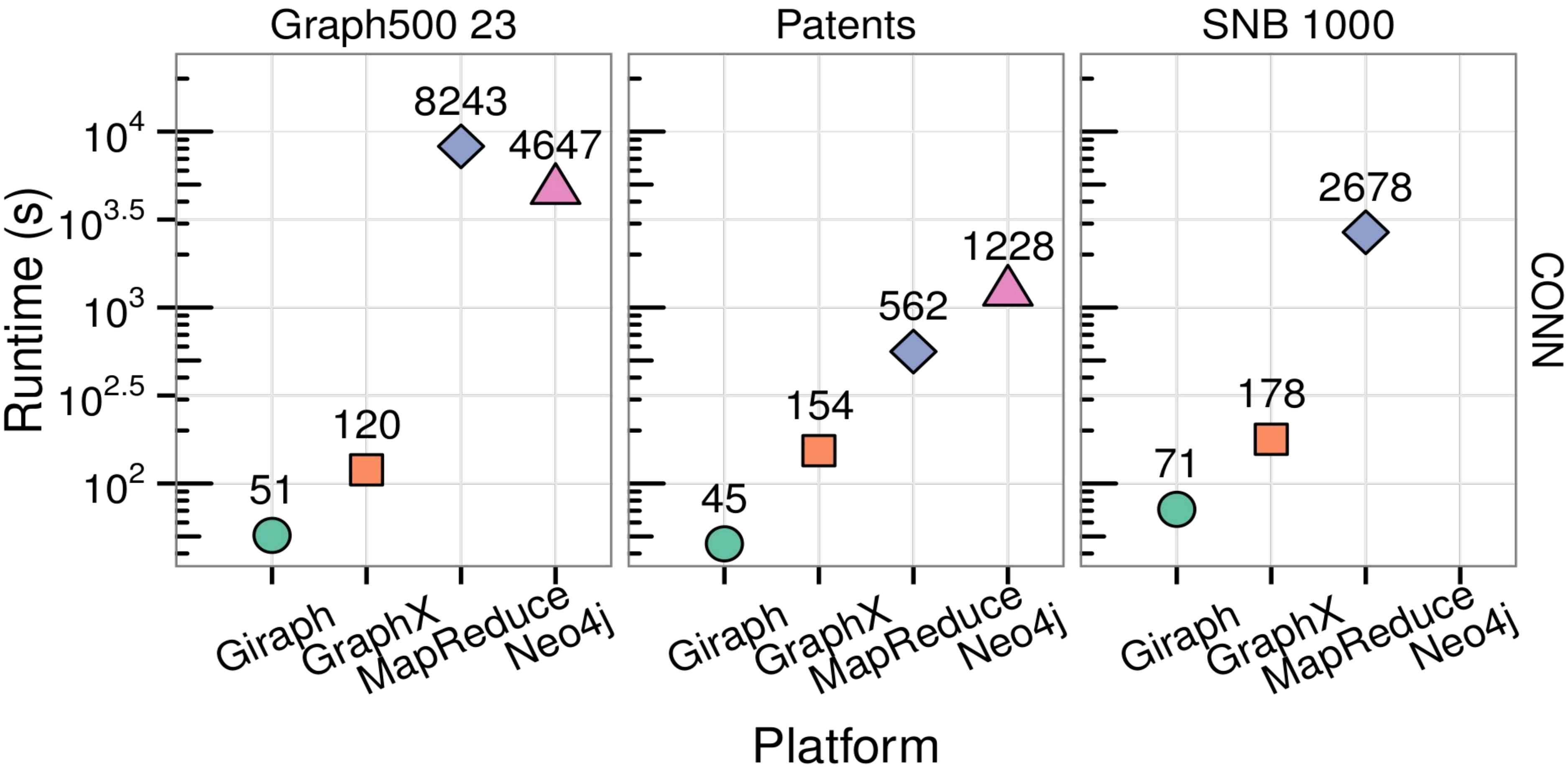


Neo4j fails

Runtime



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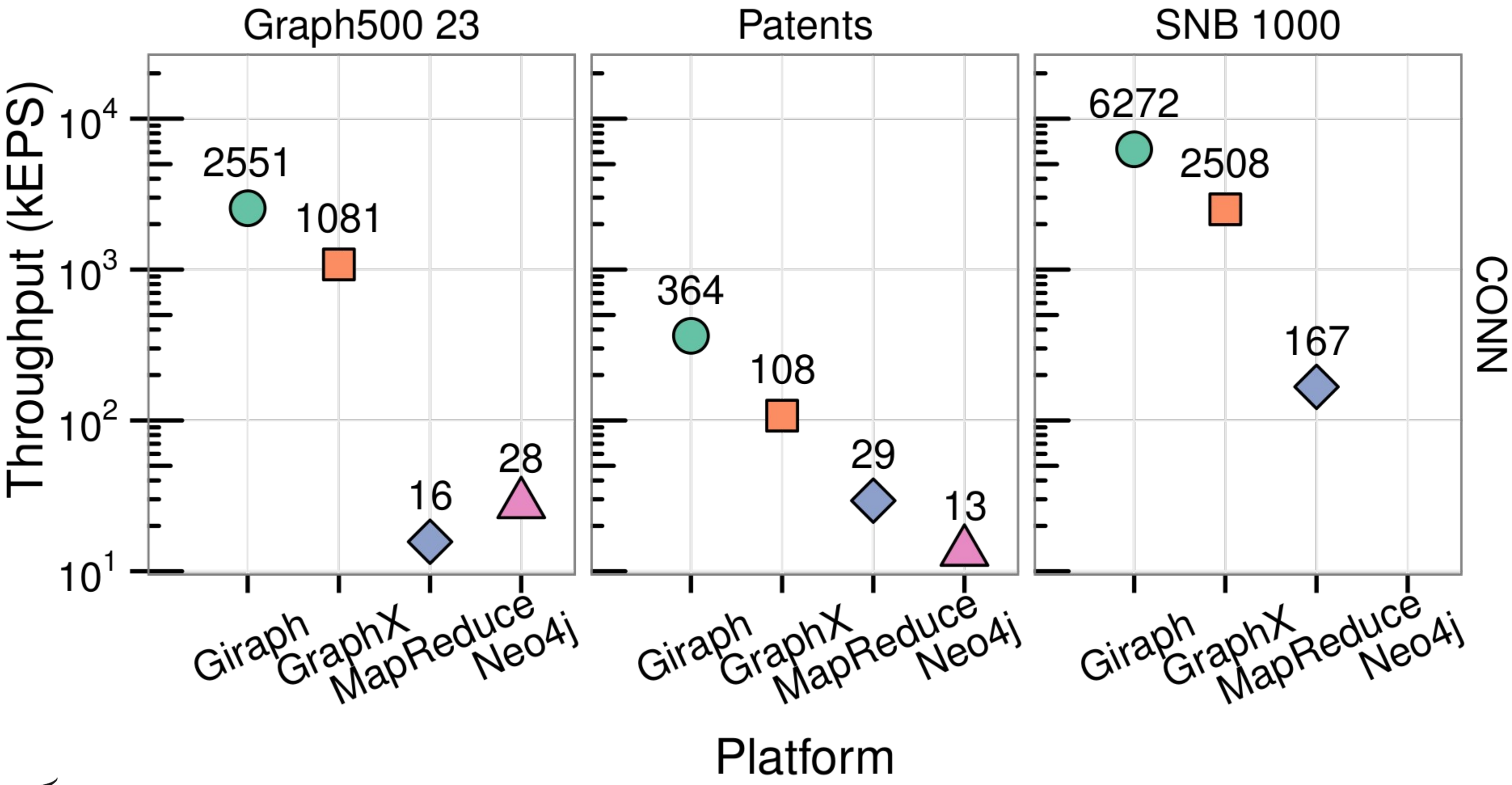

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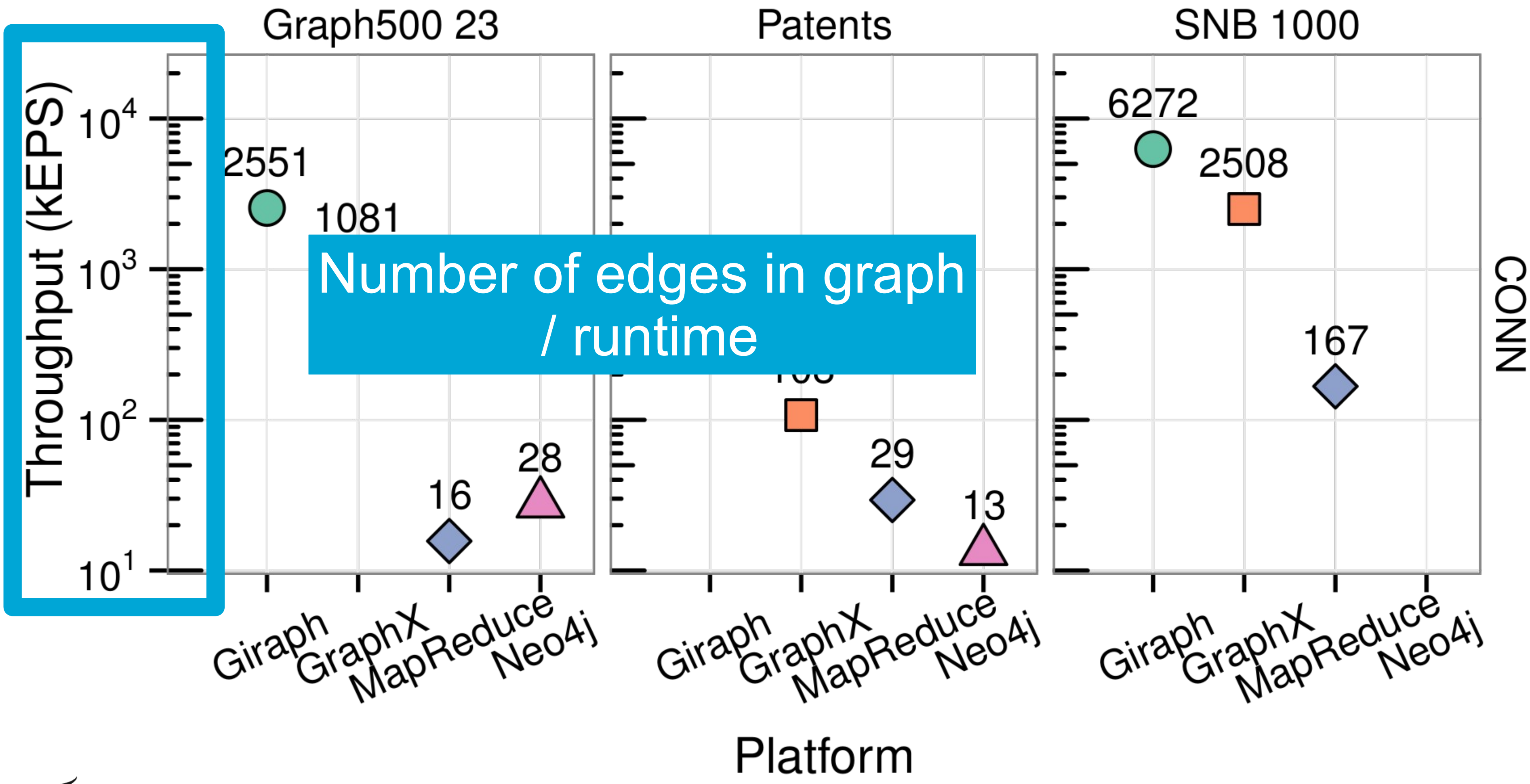
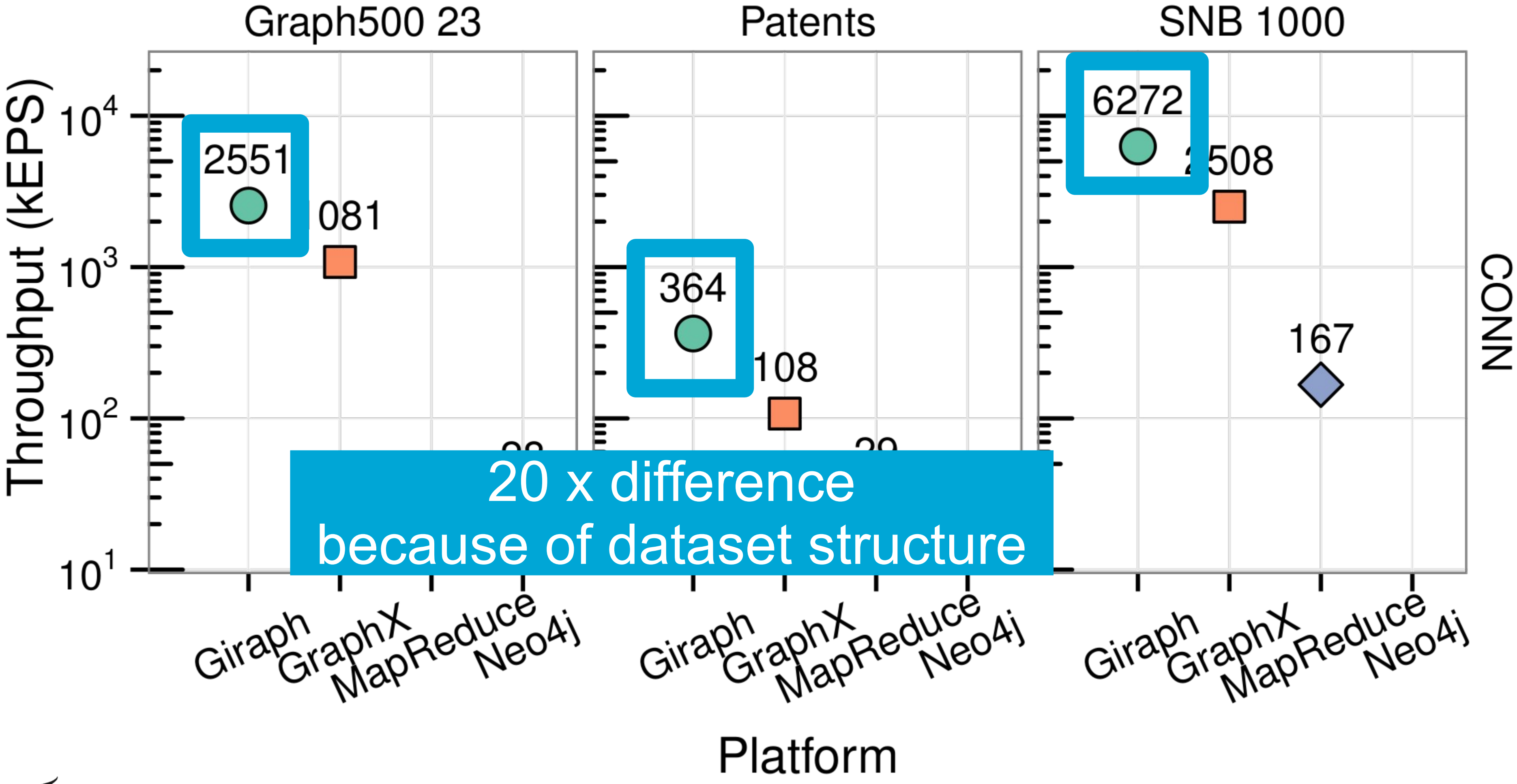


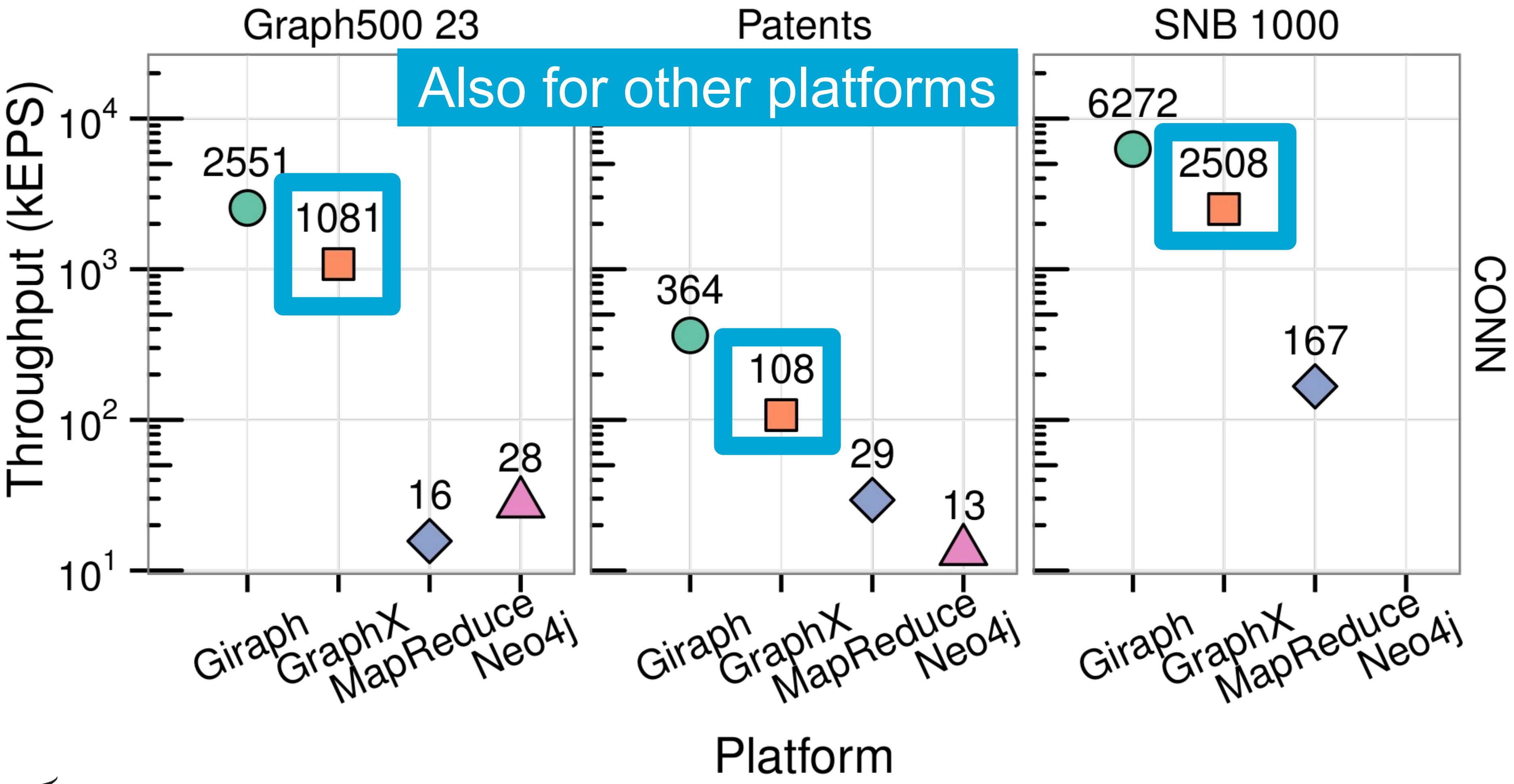
Number of edges in graph / runtime

Edge-normalized performance



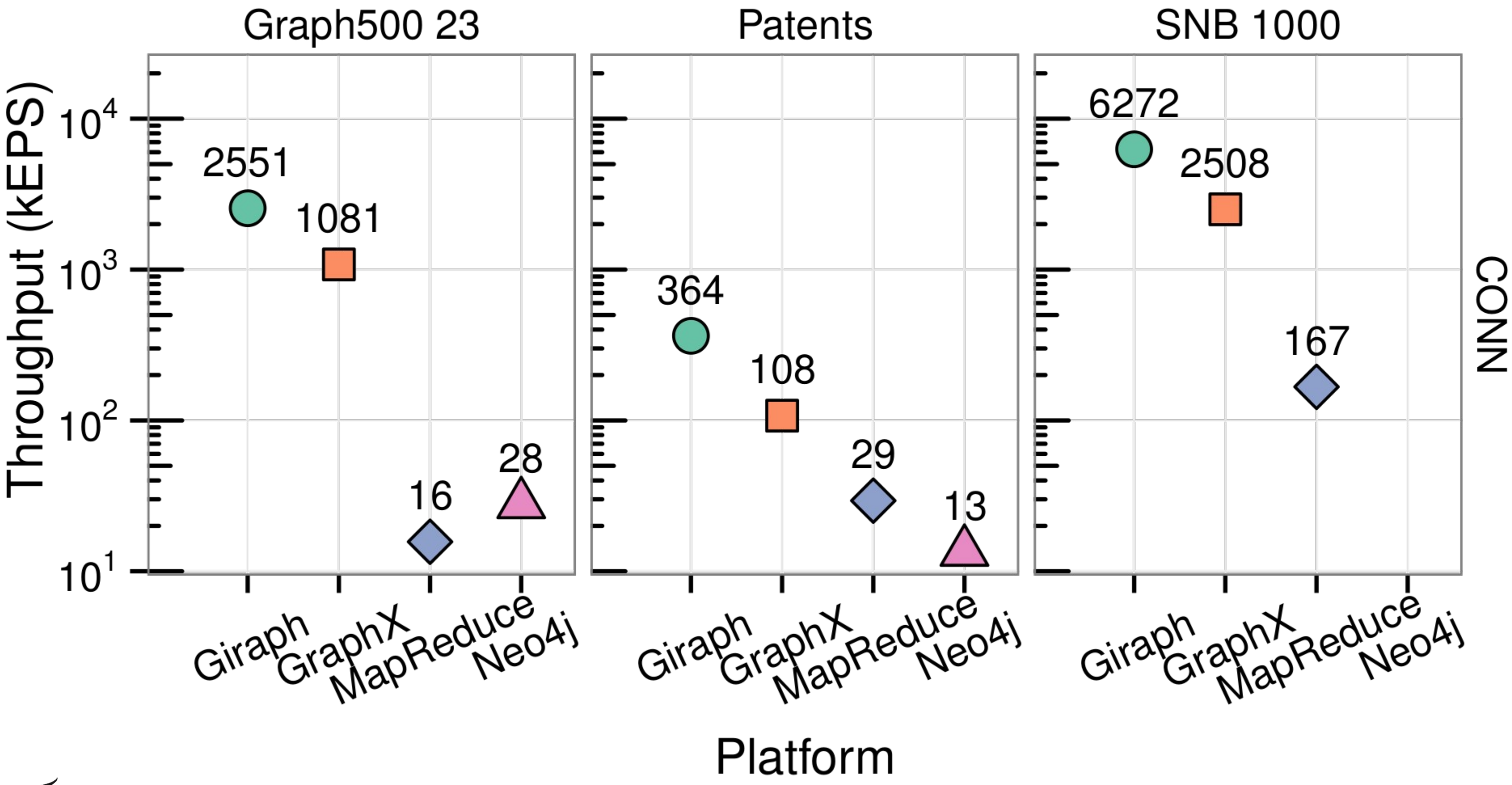
20 x difference
because of dataset structure

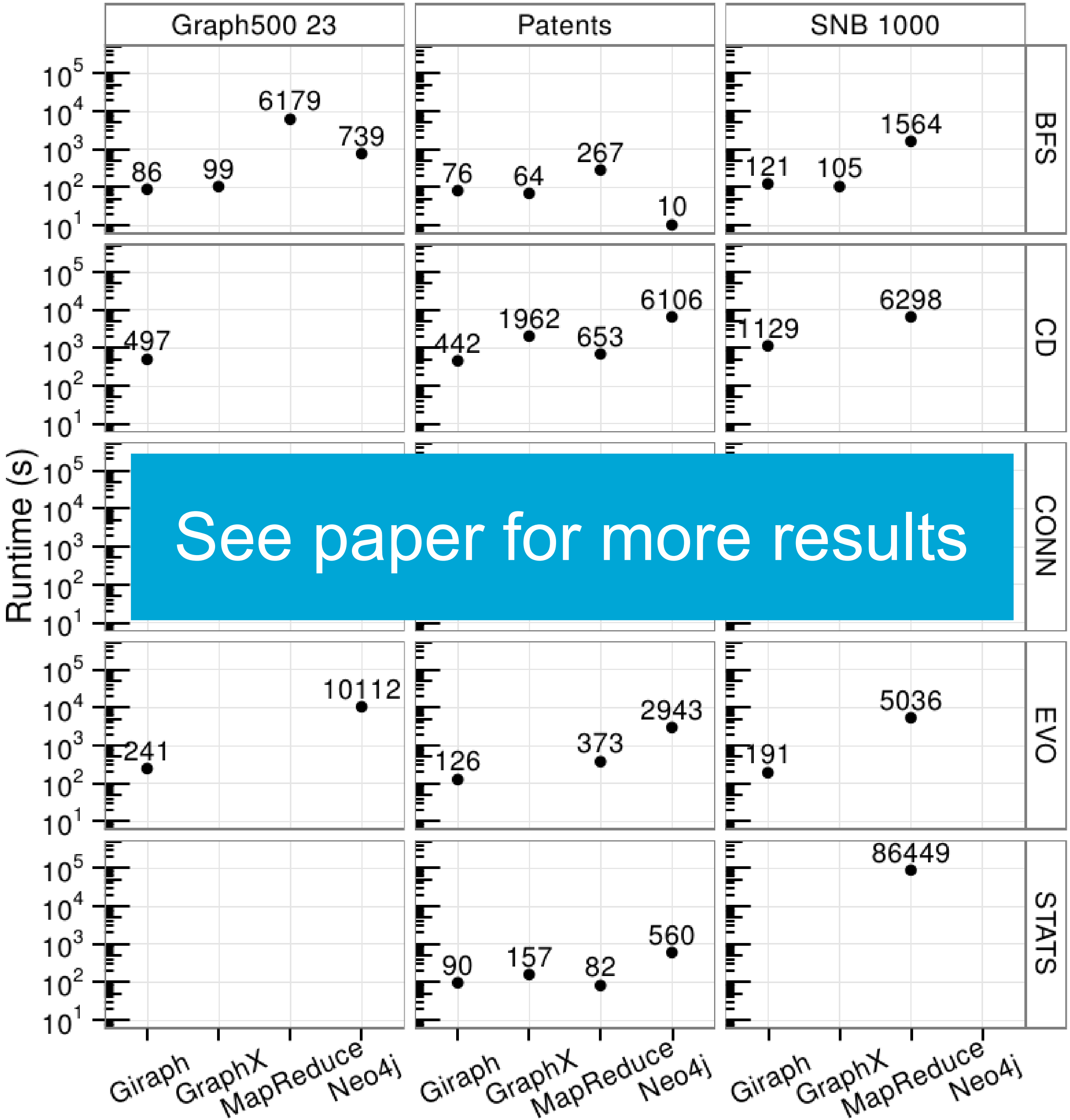
Edge-normalized performance



Also for other platforms

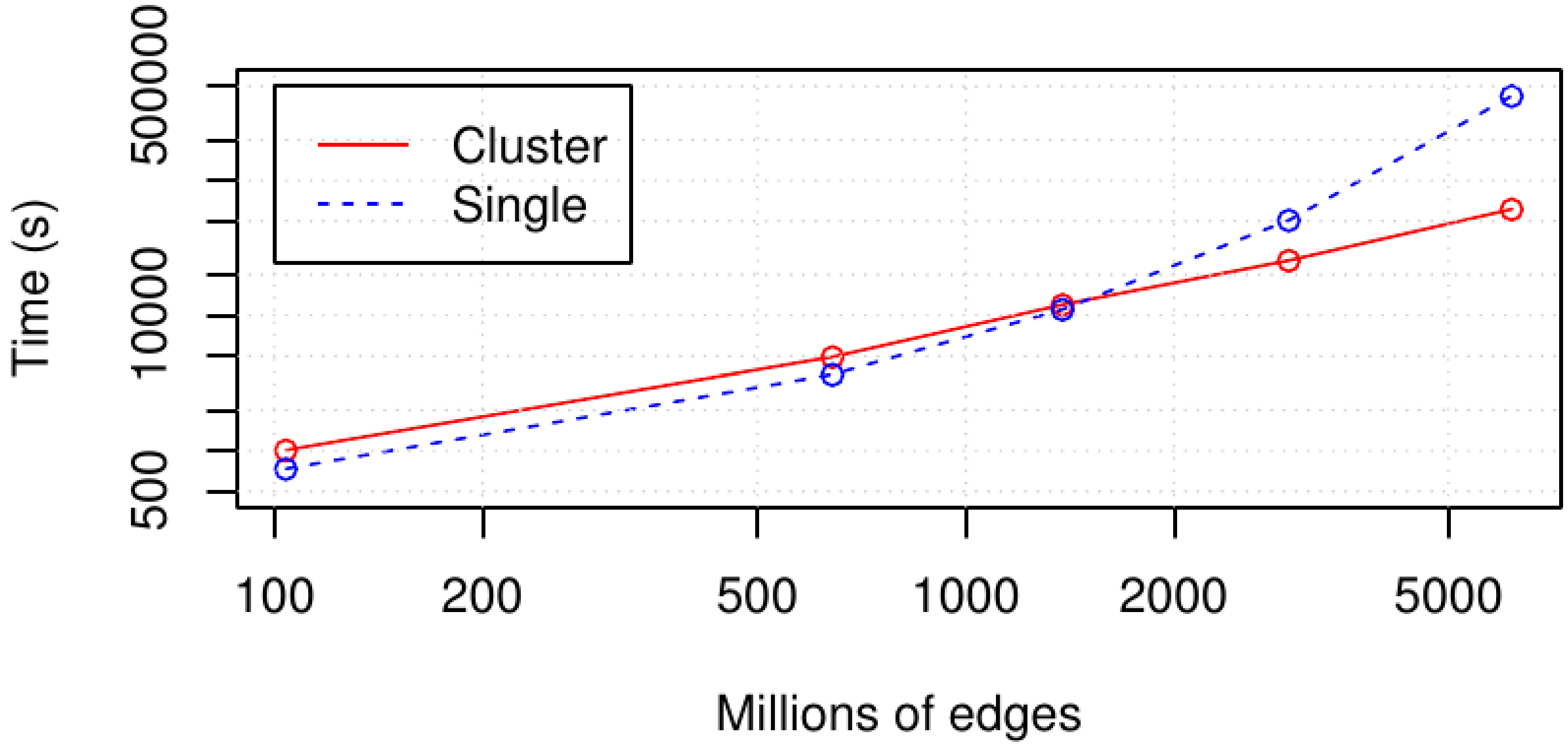
Edge-normalized performance





See paper for more results

Datagen scalability



Conclusion

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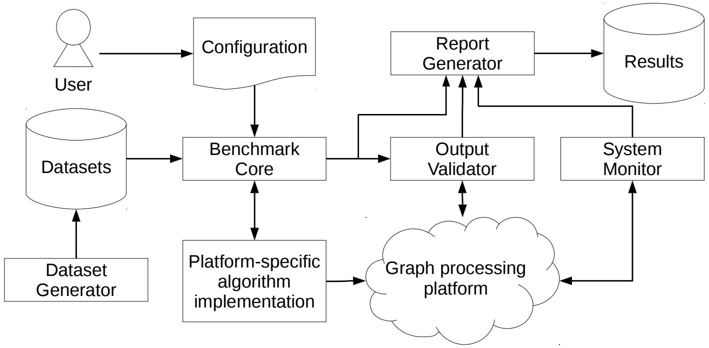
- Use Graphalytics to:
  - Compare
  - Tune
  - Re-design



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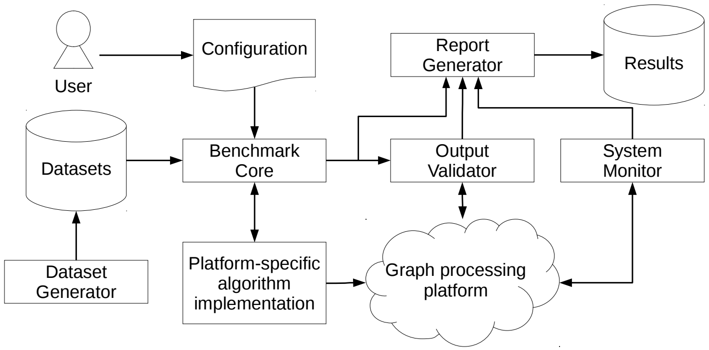

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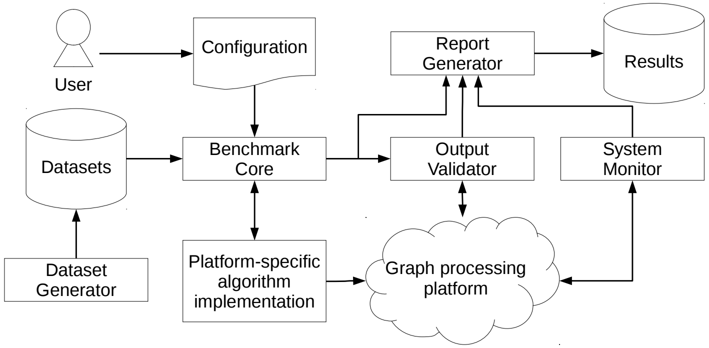

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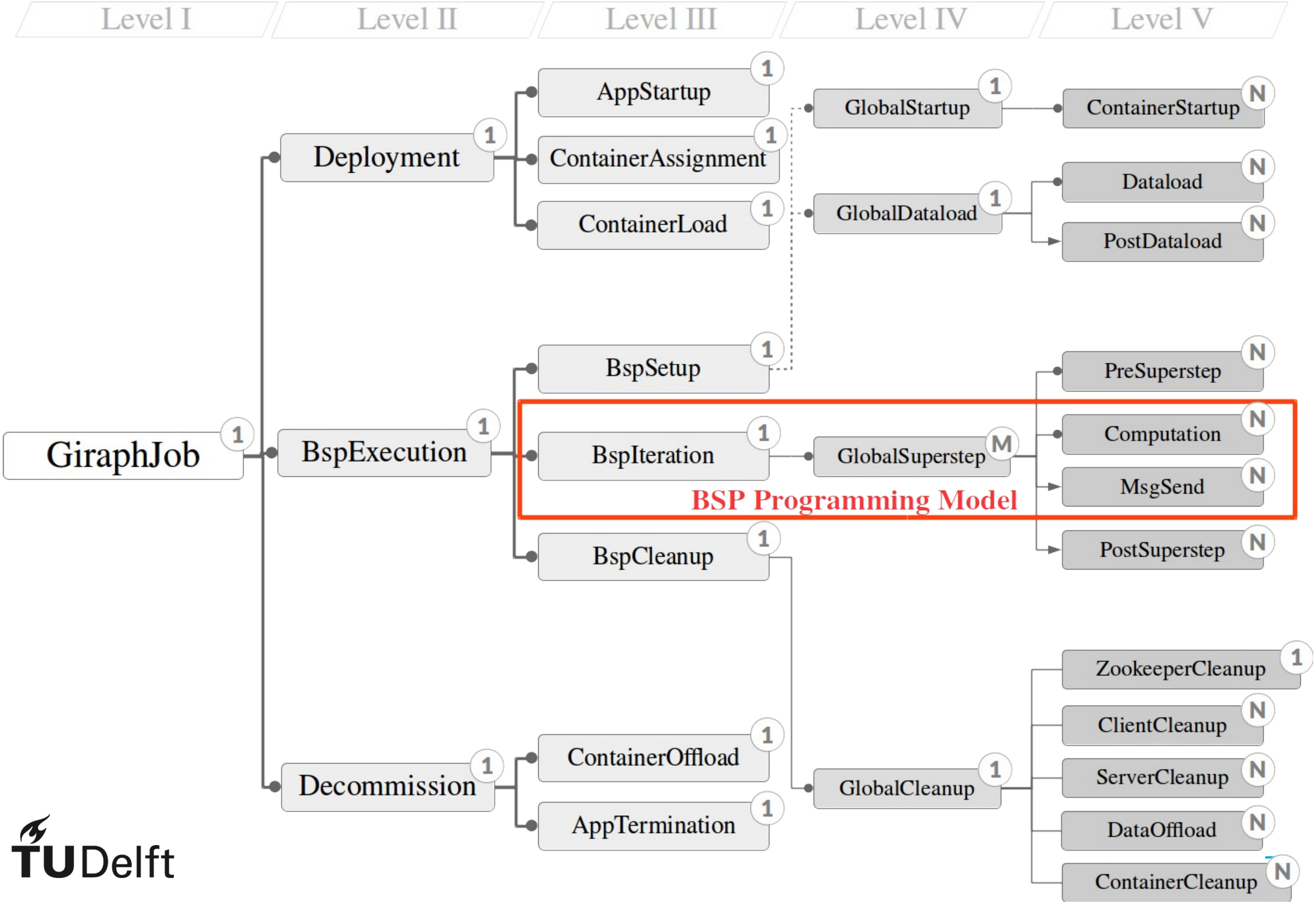
- SPEC RG standardization coming

Performance evaluation – Granular



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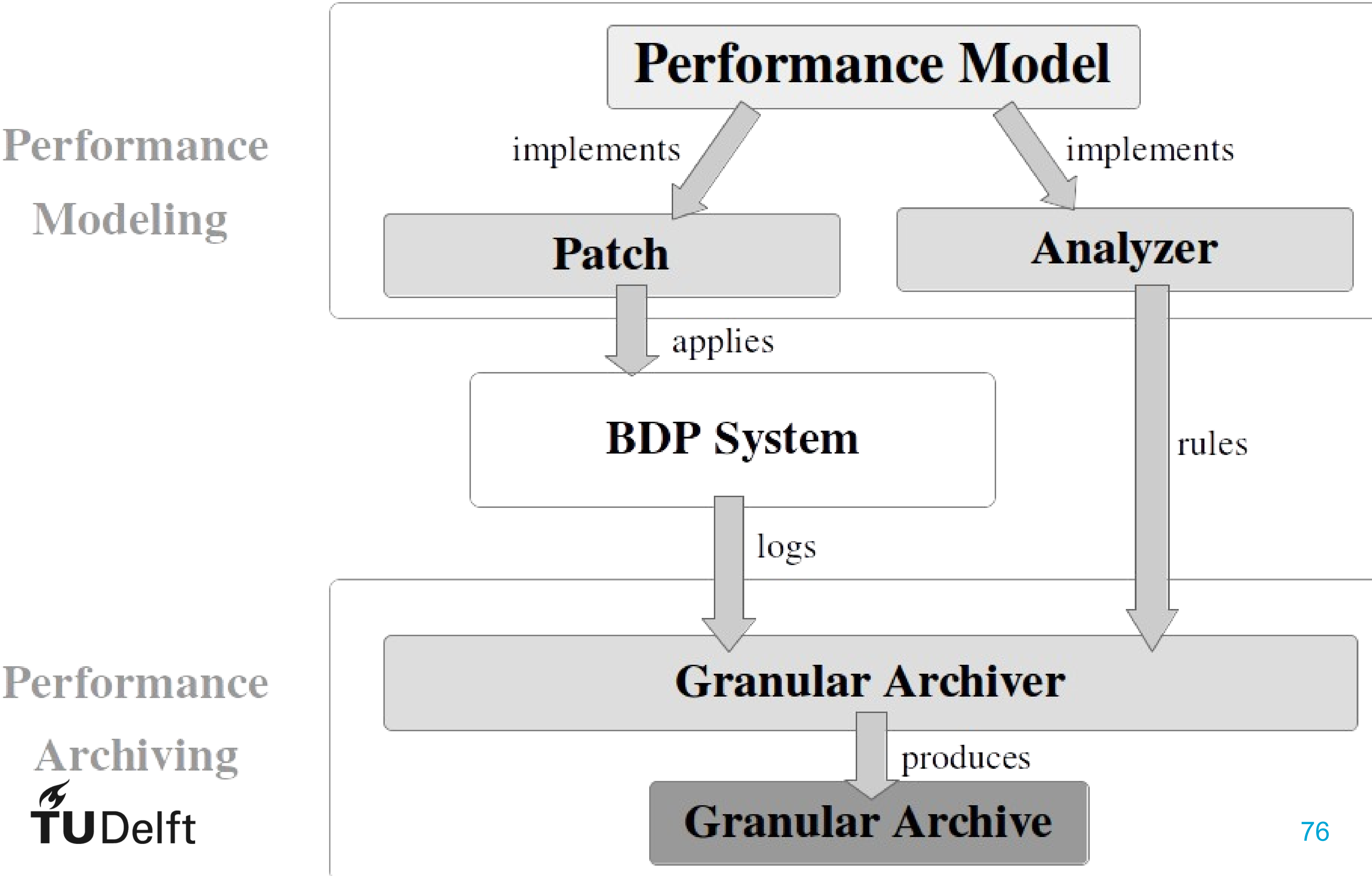
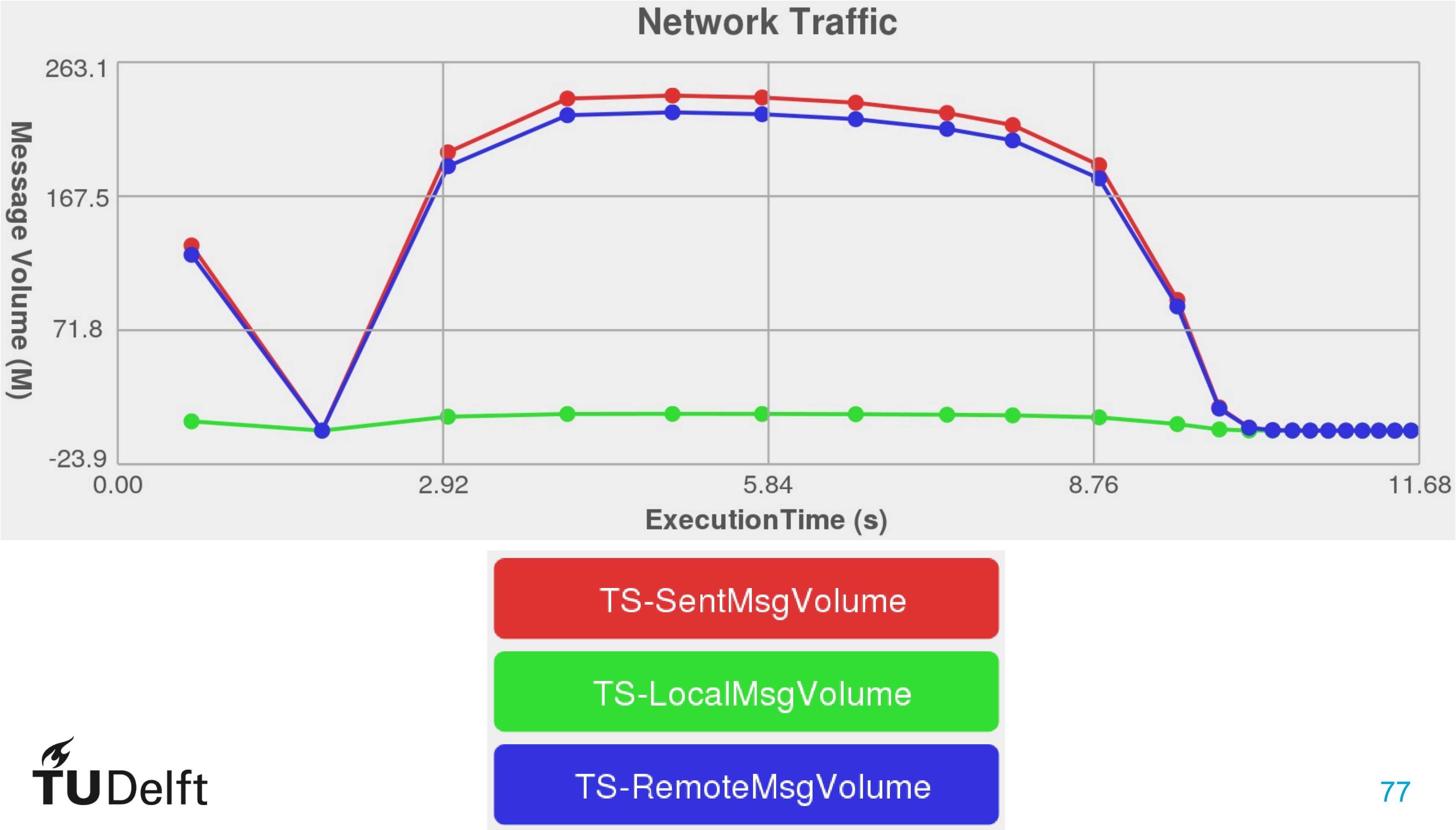
Deploying Granular



Granular results



Thank you!

mihai@mihaic.ro

graphalytics.ewi.tudelft.nl

GitHub

github.com/tudelft-atlarge/graphalytics