PageRank in Apache Flink

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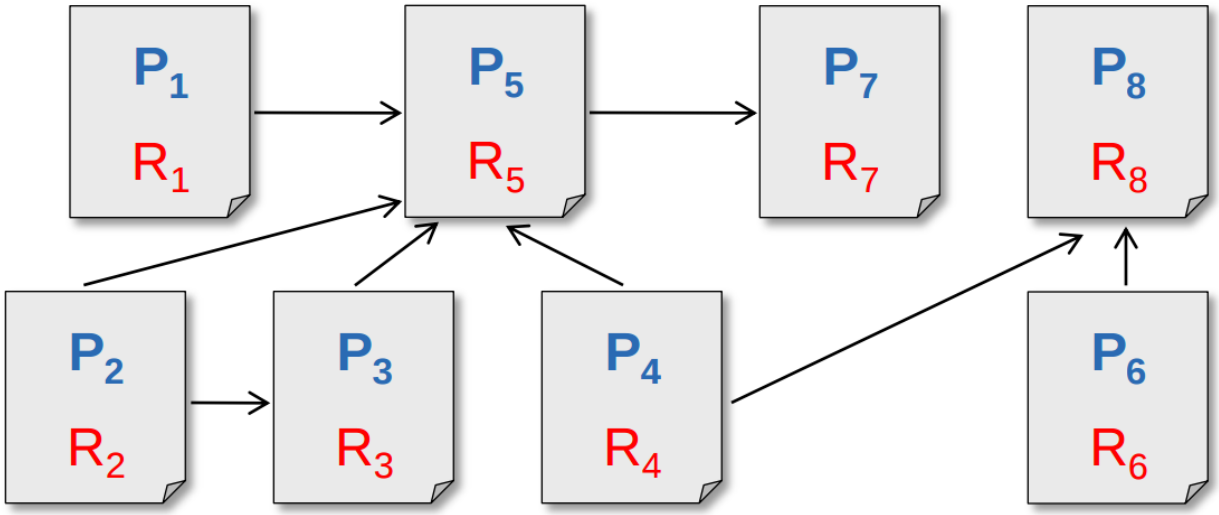
Agenda

Pagerank



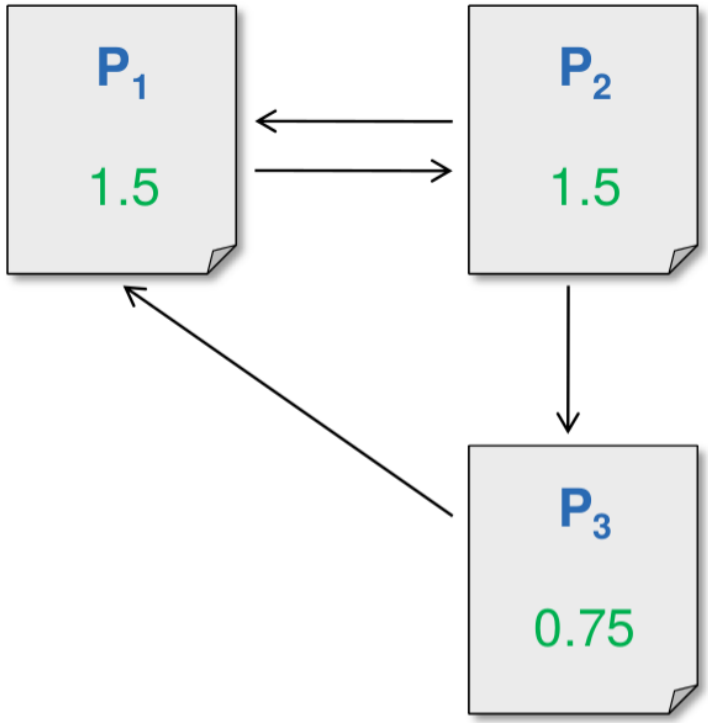
PageRank example 1 [6]

- A page has a high PageRank R if
  - there are many pages linking to it
  - or, if there are some pages with a high PageRank linking to it

PageRank

$$R(P_i) = \sum_{P_j \in B_i} \frac{R(P_j)}{L_j}$$

- where
  - B_i is the set of pages that link to page P_i
  - L_j is the number of outgoing links for page P_j linking to it



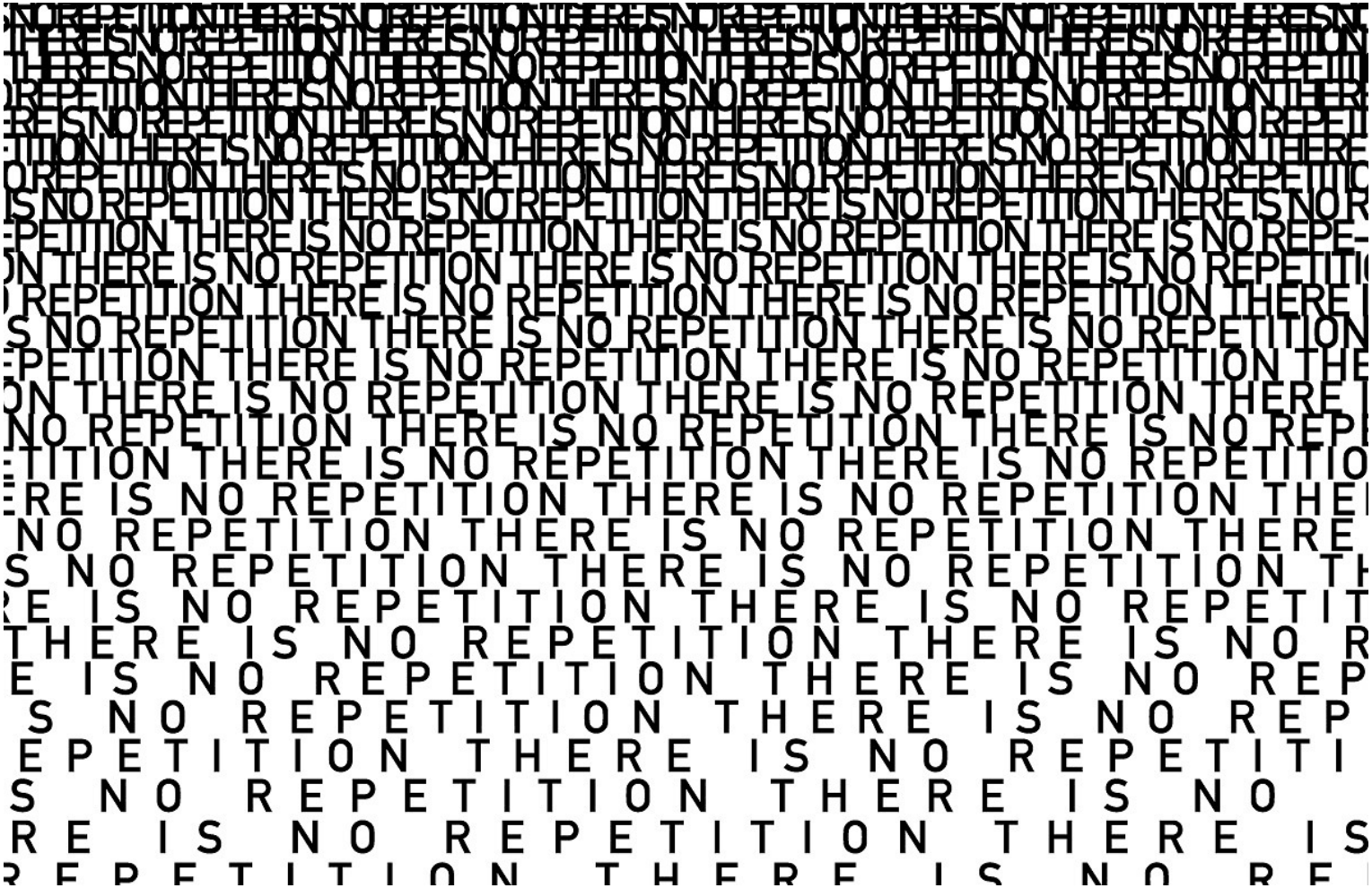
PageRank example 2 [6]

[4]

Apache Flink

- Open source framework for distributed Big Data Analytics
- Exploits:
  - data streaming
  - in-memory processing
  - iteration operators

  to improve performance
- Formerly Stratosphere (Flink means agile)
- Developed here at TU Berlin

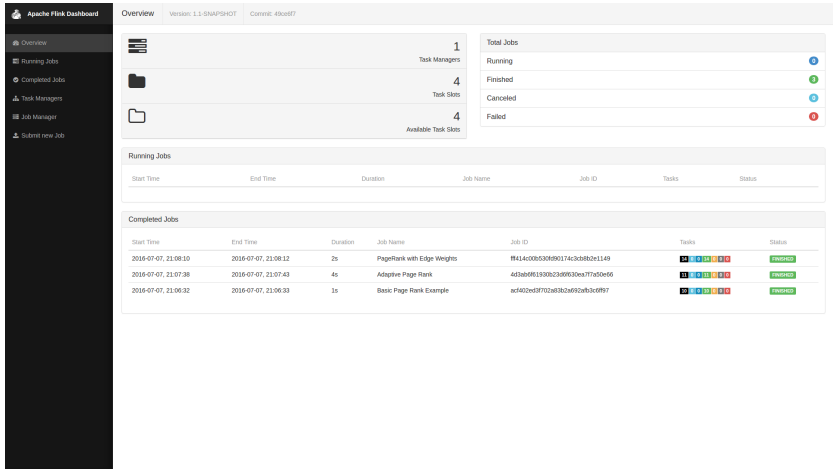


[7]

Apache Flink: 2 possible setups

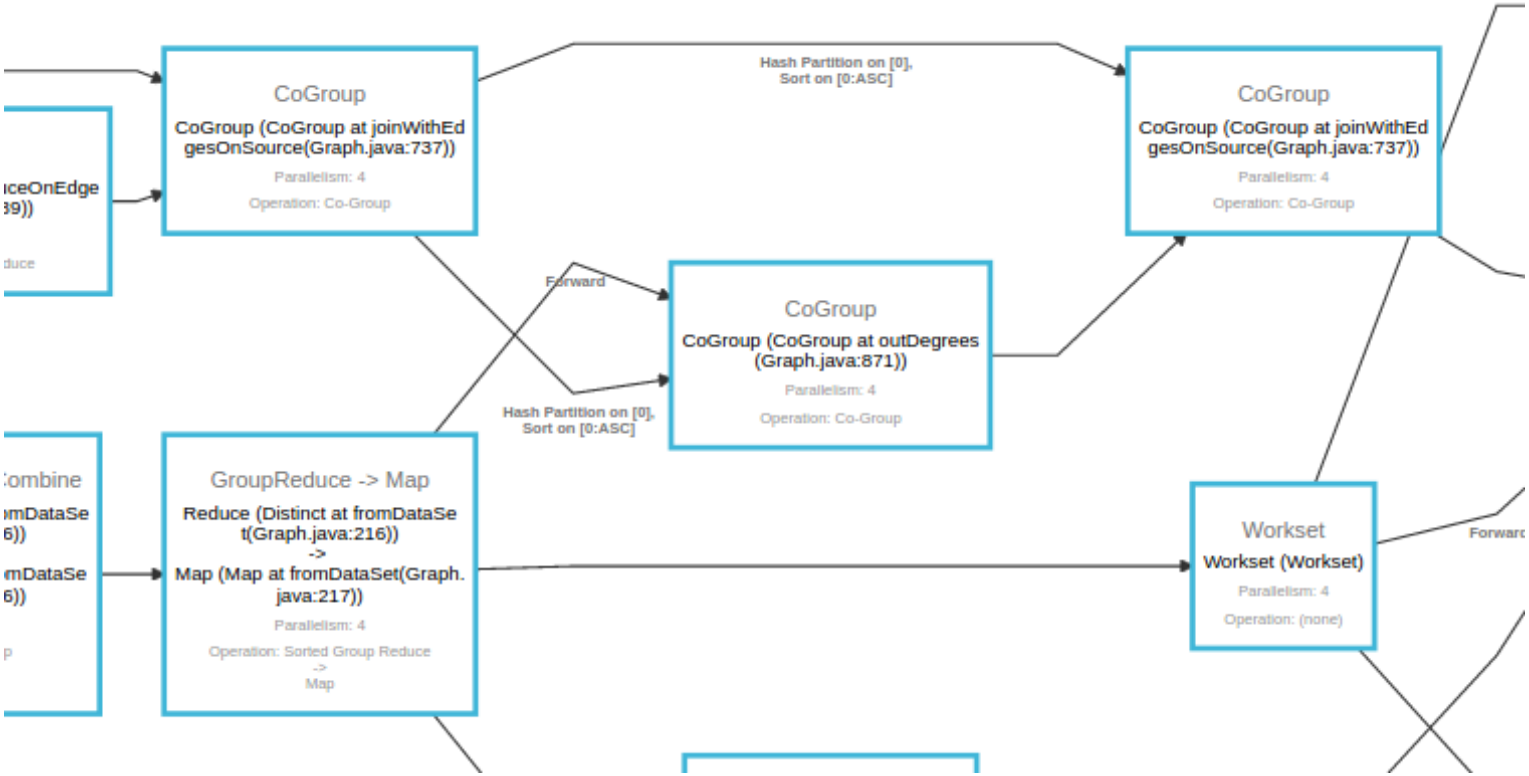
```xml
<dependencies>

    <dependency>
        <groupId>org.apache.flink</groupId>
        <artifactId>flink-java</artifactId>
        <version>${flink.version}</version>
    </dependency>


    <dependency>
        <groupId>org.apache.flink</groupId>
        <artifactId>flink-streaming-java_2.10</artifactId>
        <version>${flink.version}</version>
    </dependency>


    <dependency>
        <groupId>org.apache.flink</groupId>
        <artifactId>flink-gelly_2.10</artifactId>
        <version>${flink.version}</version>
    </dependency>

    <dependency>
        <groupId>org.apache.flink</groupId>
        <artifactId>flink-table_2.10</artifactId>
        <version>${flink.version}</version>
    </dependency>
```

Maven



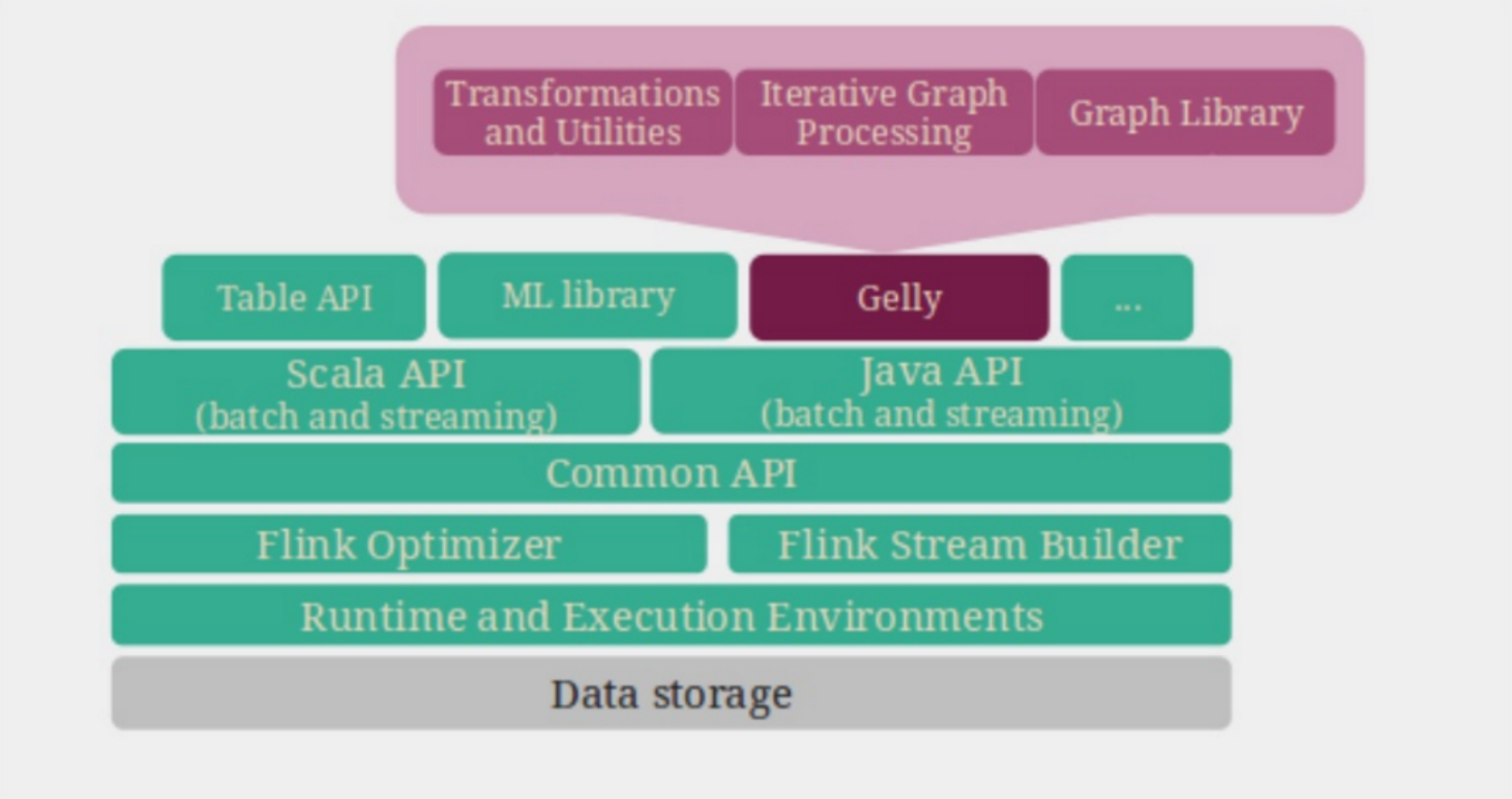
Binary version (self compiled)

Demo



Visualisation of a Flink job

Apache Flink: Gelly



Gelly

Apache Flink: Gelly

- Large-scale graph processing API
- On top of Flink's Java API
- Off-the shelf library methods (e.g. PageRank)
- Iterative algorithms

Agenda

General experiment setup

Experiment 1:

1. Data file with graph (and PageRank solution)

   ⇓

2. Use Flink and Graphlab implemention to compute PageRank

   ⇓

3. Compare with solution

General experiment setup

Experiment 1:

1. Data file with graph (and PageRank solution)

   ⇓

2. Use Flink and Graphlab implemention to compute PageRank

   ⇓

3. Compare with solution

Experiment 2:

1. Data file with huge graph (no solution yet)

   ⇓

2. Use Flink and Graphlab implemention to compute PageRank

   ⇓

3. Compare with each other

Experiment 1 data

Data from a former Hadoop toolkit (Cloud9, now Bespin):

Name	# vertices	# edges
Small	93	195
Medium	316	430
Large	1458	3545

Experiment 2 data

Webgraph from `snap.stanford.edu/data/`

Name	# vertices	# edges
web-Google	875713	5105039

Agenda

Flink algorithm 1

dataArtisans logo, [1]

- An exercise from dataArtisans
- Uses the standard Gelly implementation
- # input nodes = # output nodes

Flink algorithm 2

dataArtisans

- A case study implementation from dataArtisans
- A custom implementation
- # input nodes = # output nodes

Flink algorithm 3

- An example from the Apache Flink repository
- A custom implementation
- # input nodes != # output nodes $\rightarrow$ filters

Turi PageRank algorithm

Turi logo, [8]

- Used the standard implementation
- Builds a graph out of the edges dataset

Comparing the algorithms

As part of the experimental setup, I implemented a test harness to compare the two PageRank solutions.

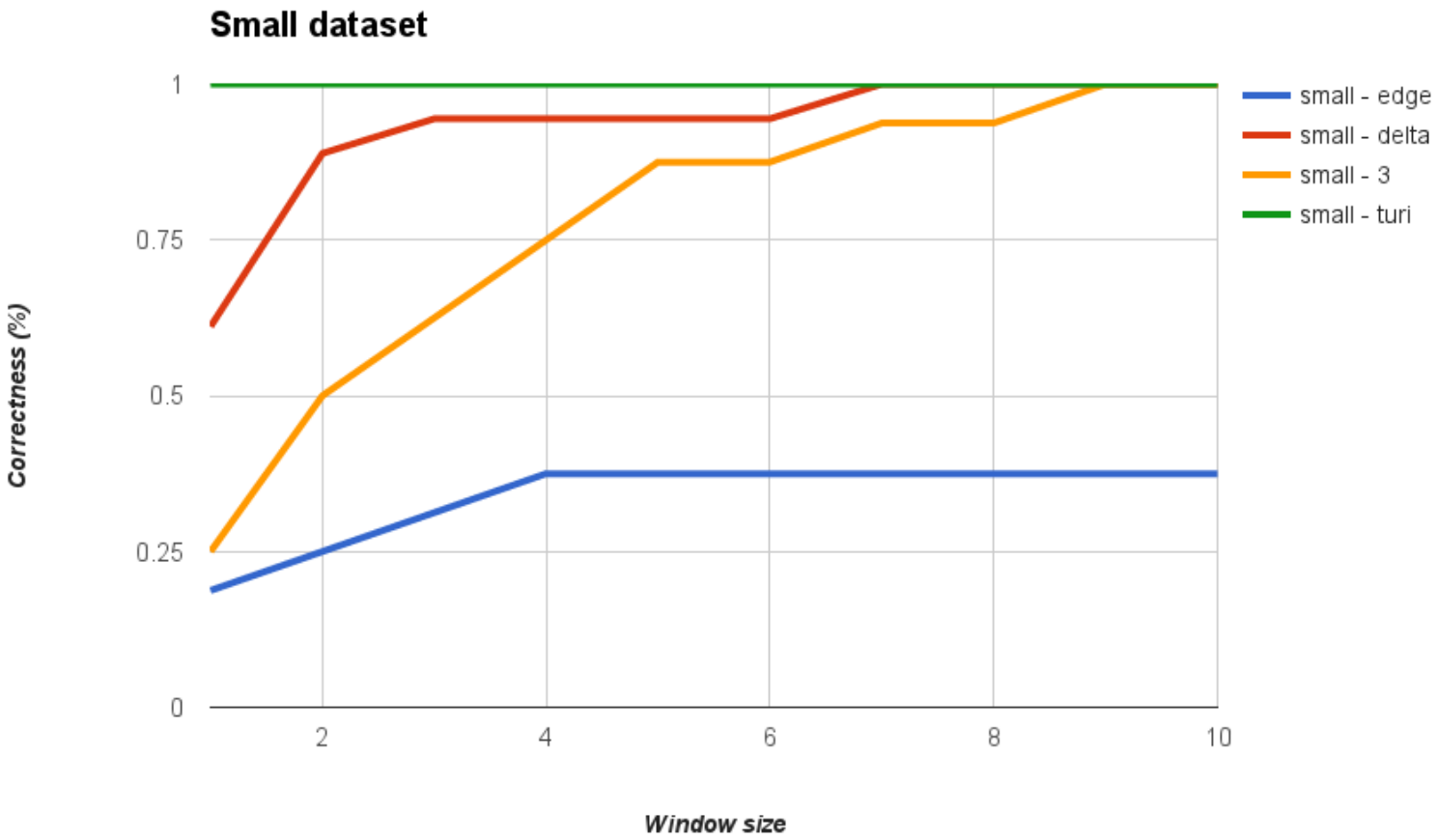
- It can handle list of diffrence sizes.
- It takes care of equal PageRank values (they maybe sorted in different way).
- Has a modifiable window to compare solutions.

Agenda

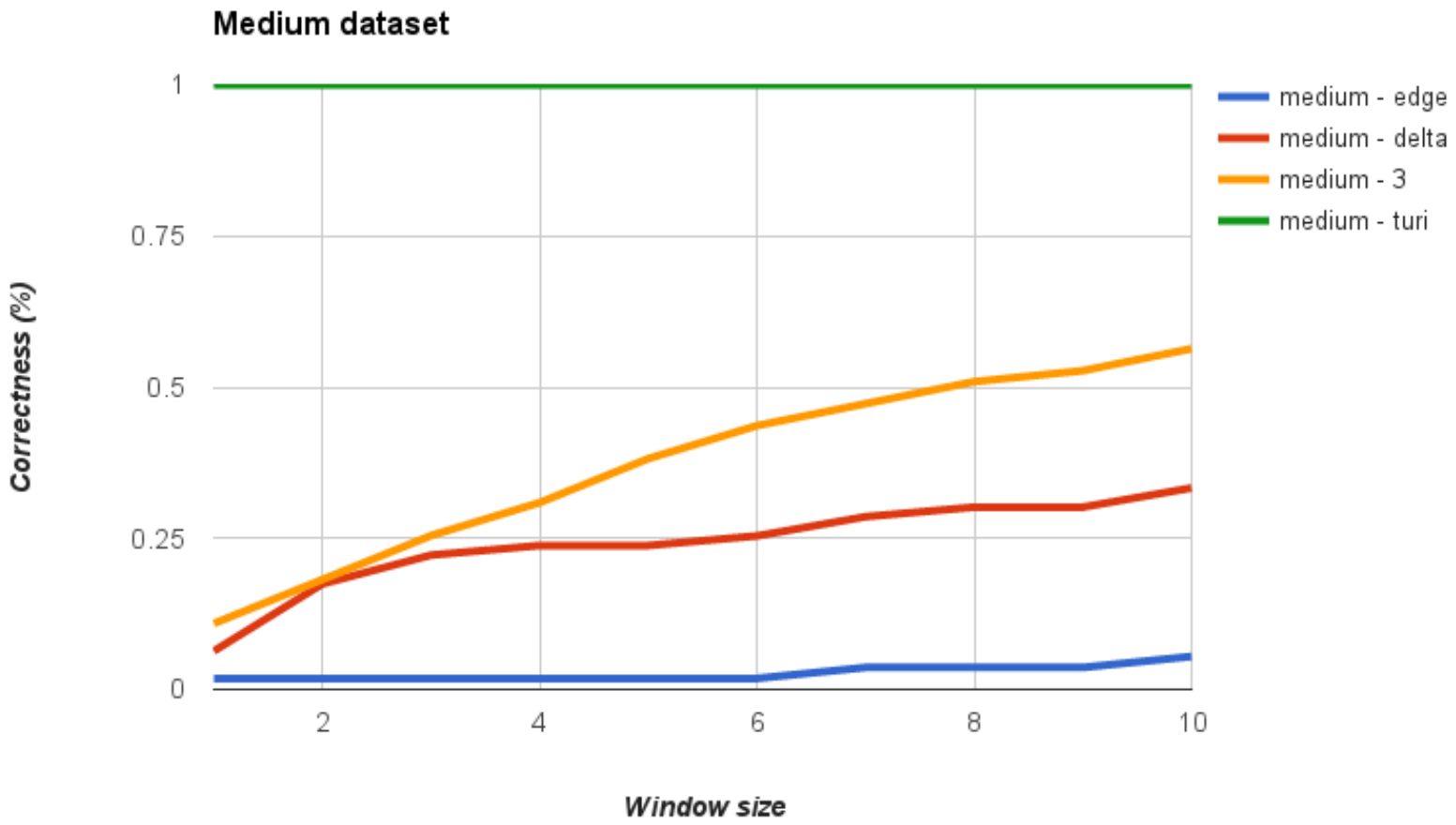
Results: experiment 1

Any expectations?

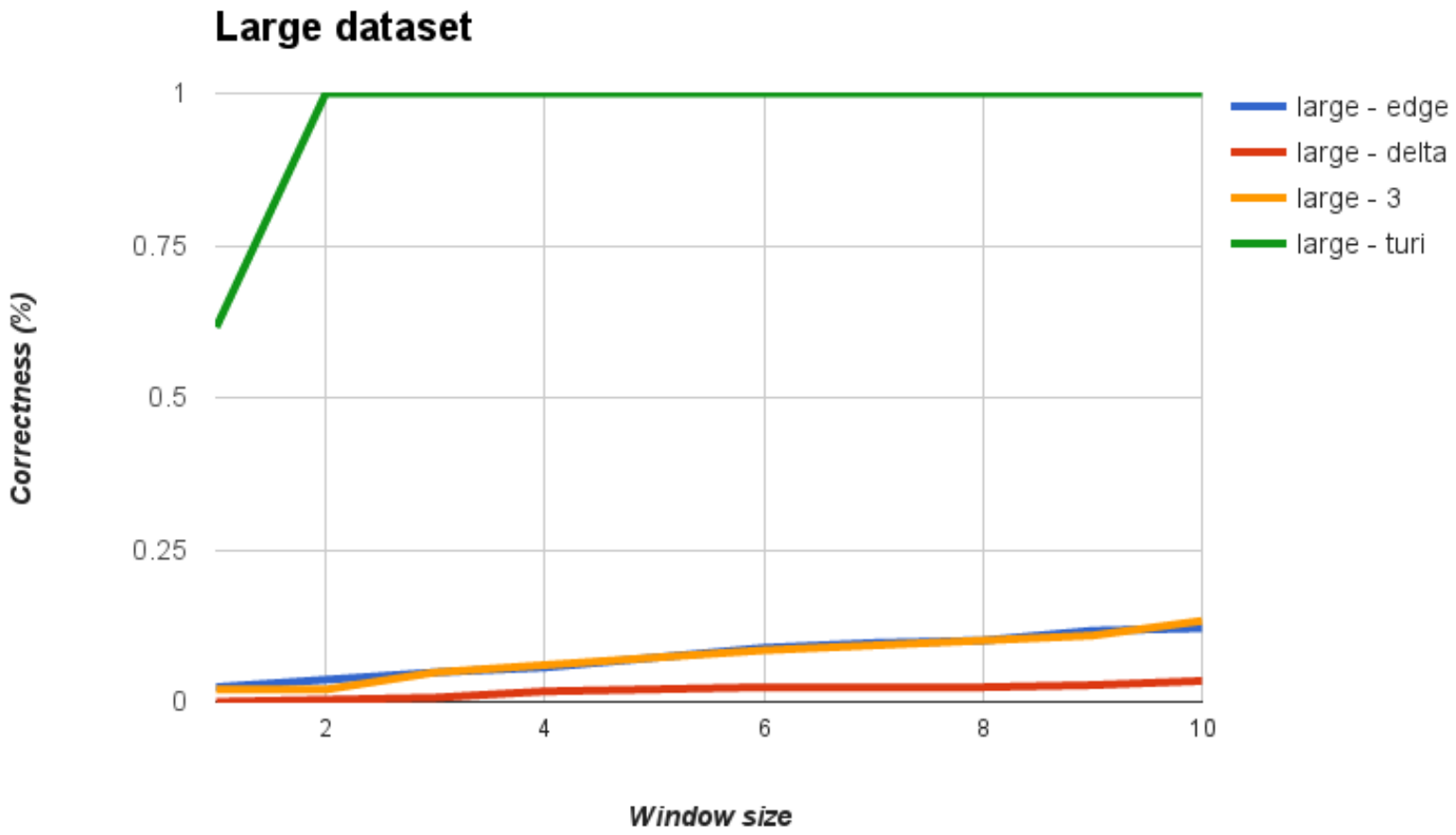
Results: experiment 1



Results: experiment 1



Results: experiment 1



These results are ...?

Why are the results so bad?

... Bad

Why are the results so bad?

Any ideas?

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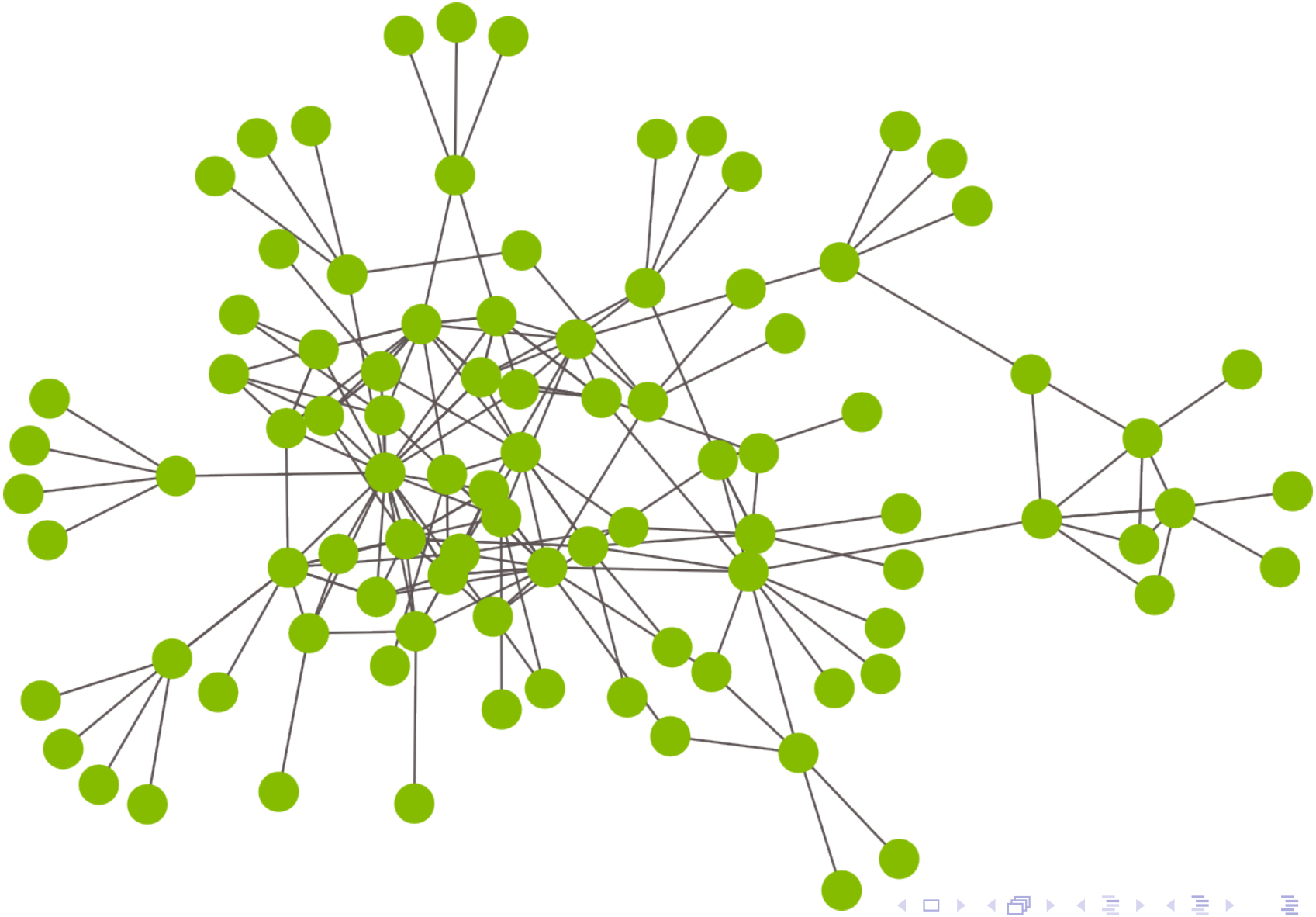

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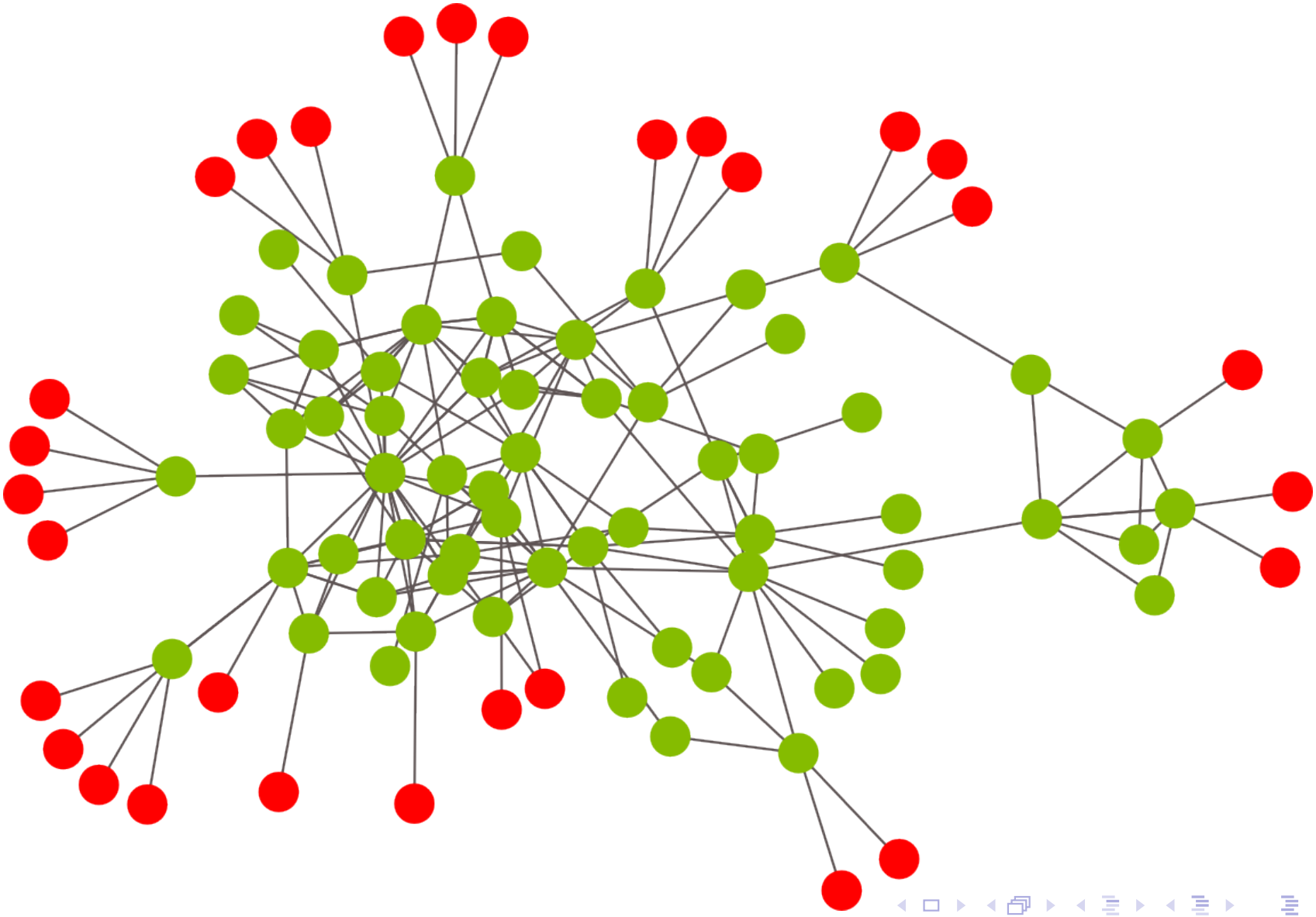

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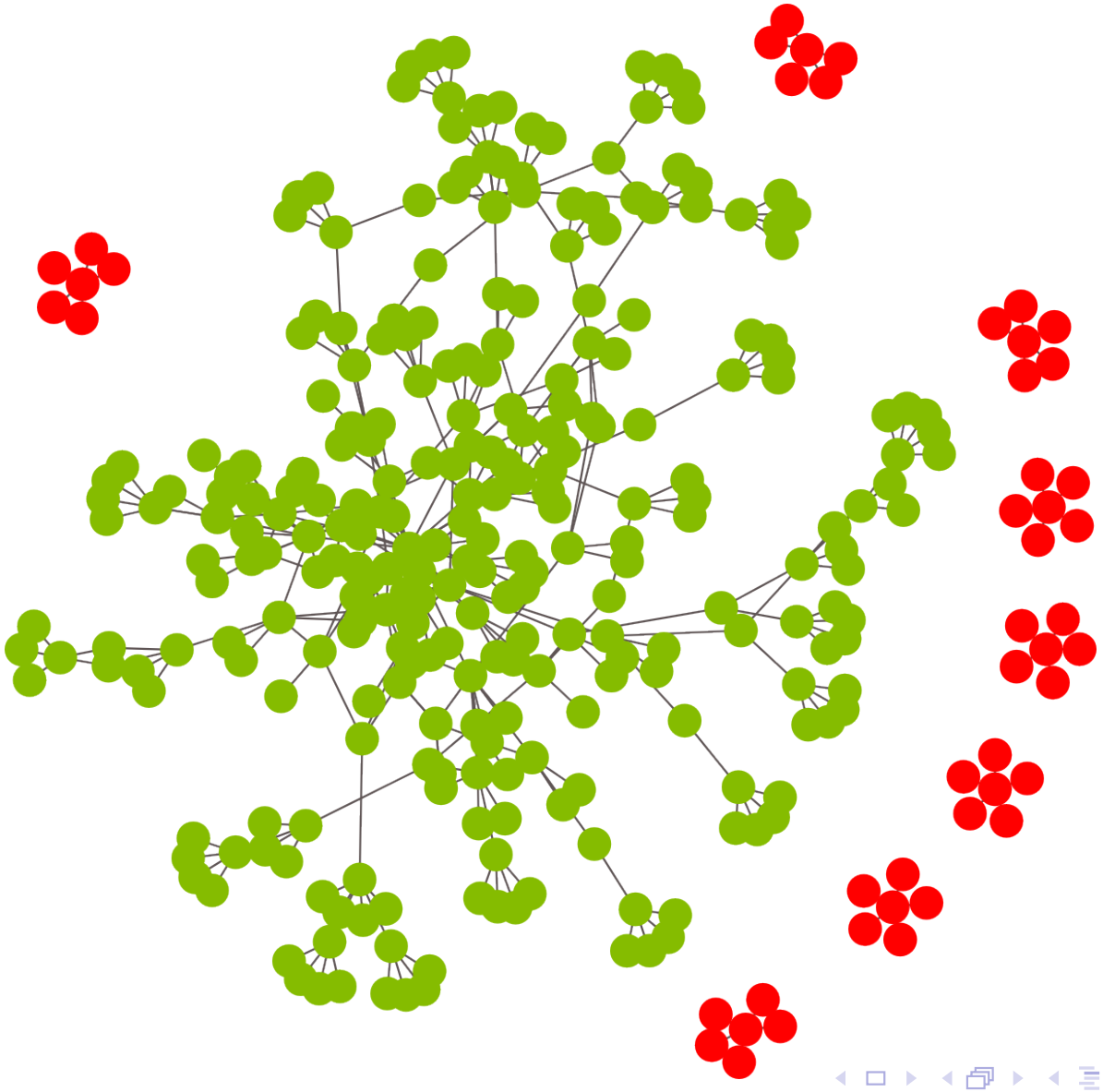
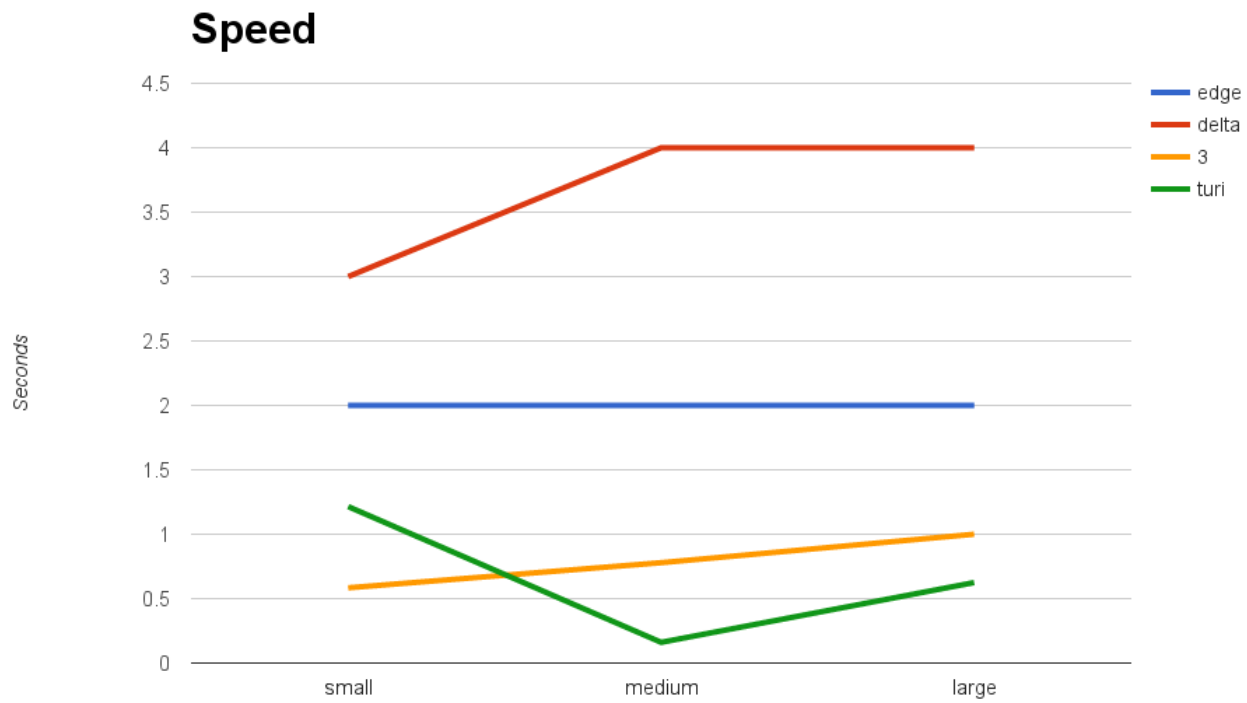


Why are the results so bad?

- Implementations expext an incoming and outging edge for every node
- Dangling nodes
- Spider traps

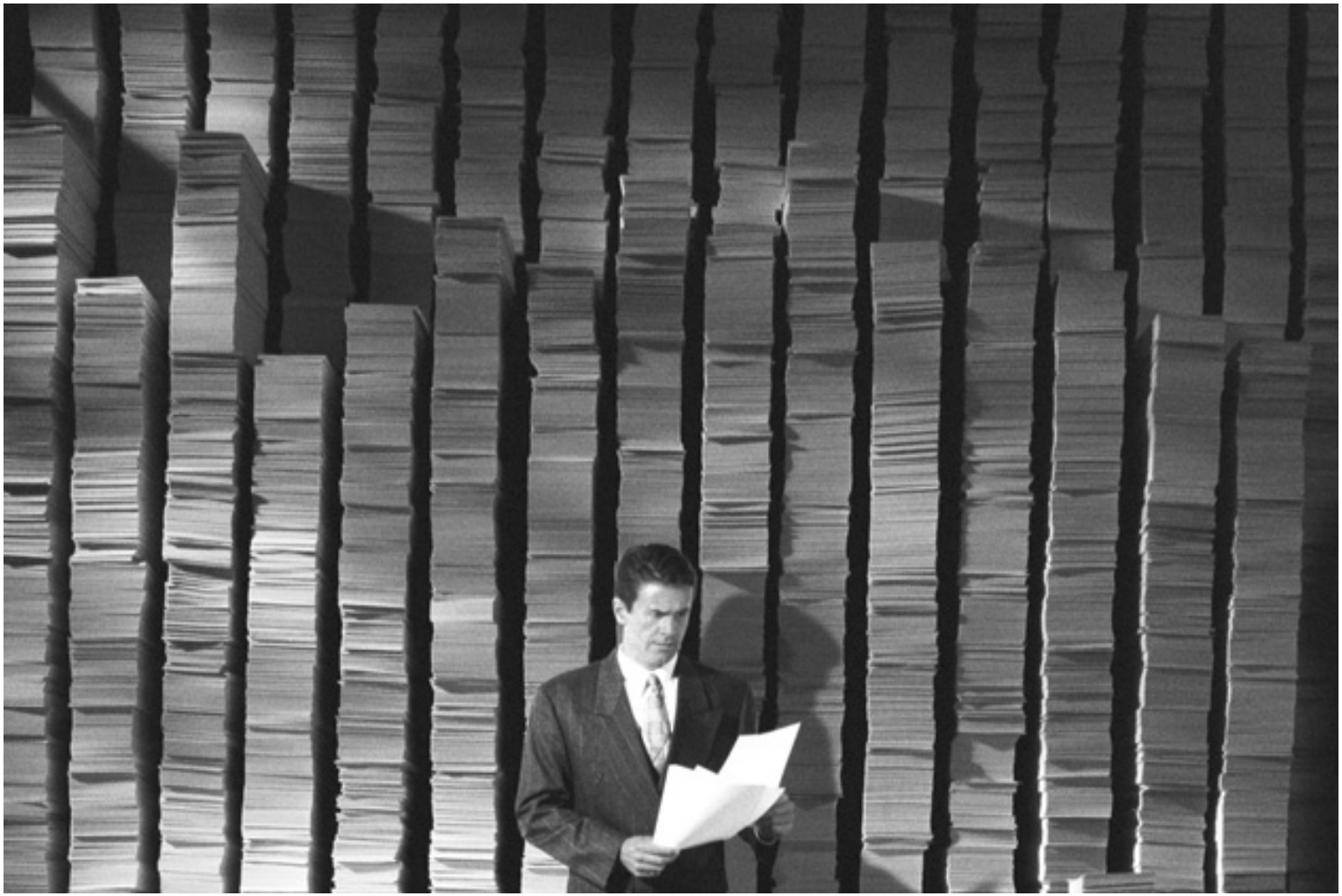
$\rightarrow$ they are all basic implementations
$\rightarrow$ Turi has a advanced implementation

Speed of experiment 1



→ no huge differences with Turi

Experiment 2



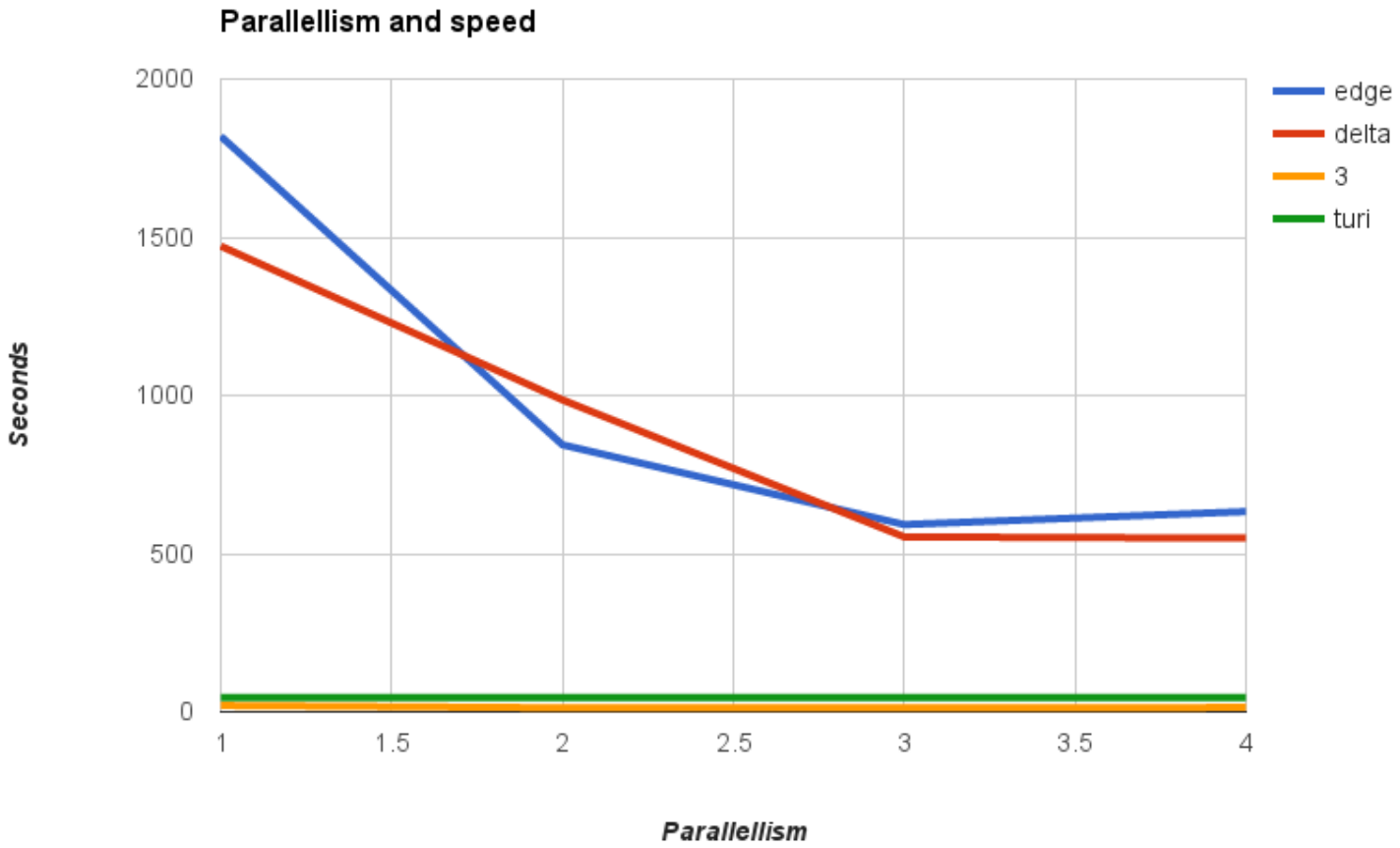
Speed of experiment 2

Algorithm	Edge	Delta	3	Turi
Time (s)	633	549	14	45

- First two algortihms are a lot slower $\backsim$ 10 times.
- Algorithm 3 cheats with the filtering


SLOW

Speed of experiment 2



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Conclusion

- Use Apache Flink when:
  - ✓ When you have an awfull amount of data
  - ✓ When you can run flink on a cluster

Conclusion

- Use Apache Flink when:
  - ✓ When you have an awfull amount of data
  - ✓ When you can run flink on a cluster
- Do not use Apache Flink when:
  - ✓ When there is ”only“ a lot of data
  - ✓ When you don’t want to lose time setting up Flink
  - ✓ You don’t understand the build-in algorithms well
  - ✓ You want extensive documentation

A `flink` Flink is `flink`

Thank you for your attention

Questions?

The code and data can be found on:
`http://flink.wardschodts.ws`

References I

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Inc Turi. *Turi*. URL: %5Curl%7Bhttps://www.google.com/search?q=repeat&source=lnms&tbm=isch&sa=X&ved=0ahUKEwi4laH2tuLNAhVnB8AKHTPQCU4Q_AUICCgB&biw=1590&bih=765#tbm=isch&q=no+repetition&imgrc=h1qwLbEEezv8SM:%7D.