Framework for profiling Critical Path related Algorithms

RP#66

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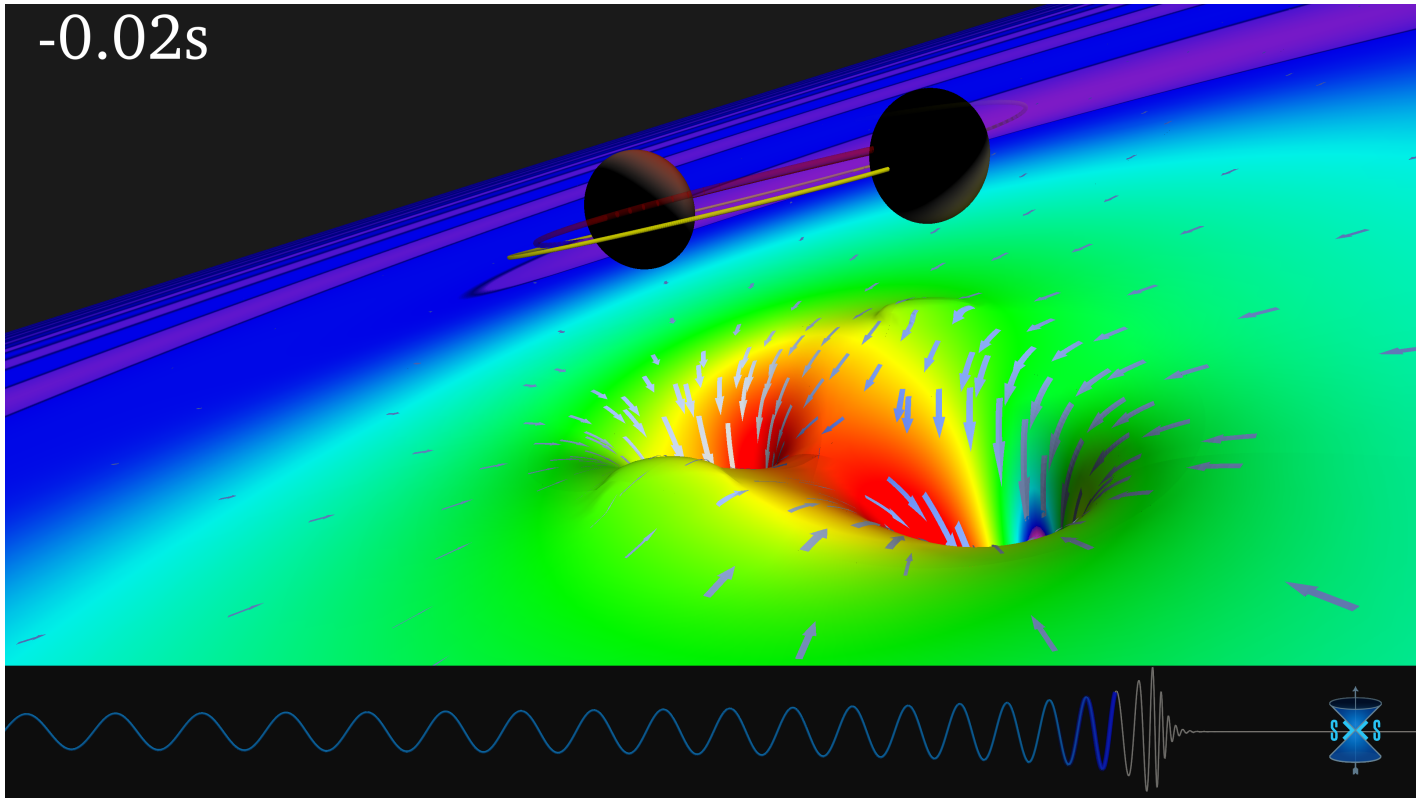
Context

LIGO Gravitational wave detection analysis

- Data to be processed
  - Deadline
  - Order
- Time critical problem



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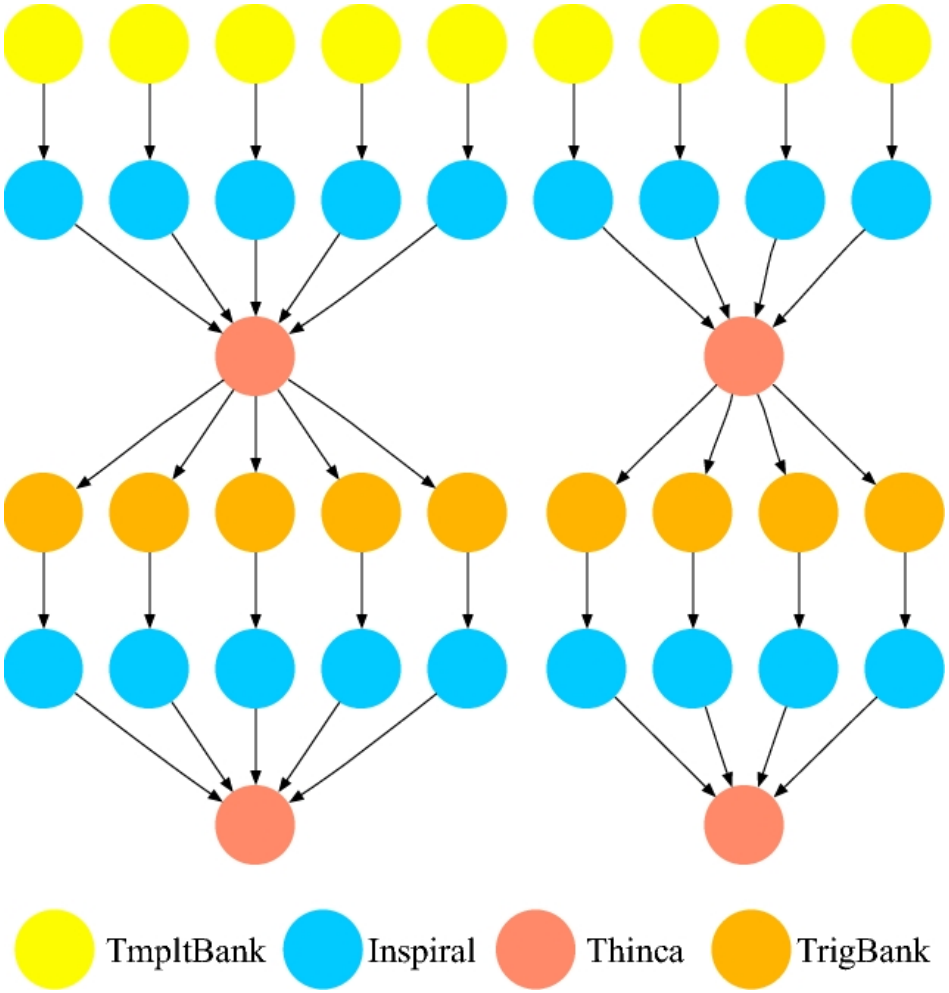
Context

LIGO Gravitational wave detection analysis

- Defines a task graph



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Context

Critical Path related Algorithms

- "Deadline-constrained workflow scheduling algorithms for Infrastructure as a Service Clouds" (2013)
  Saeid Abrishami and Mahmoud Naghibzadeh and Dick H.J. Epema
  Cited **311** times.
- Critical path related algorithms i.e. **IC-PCP**

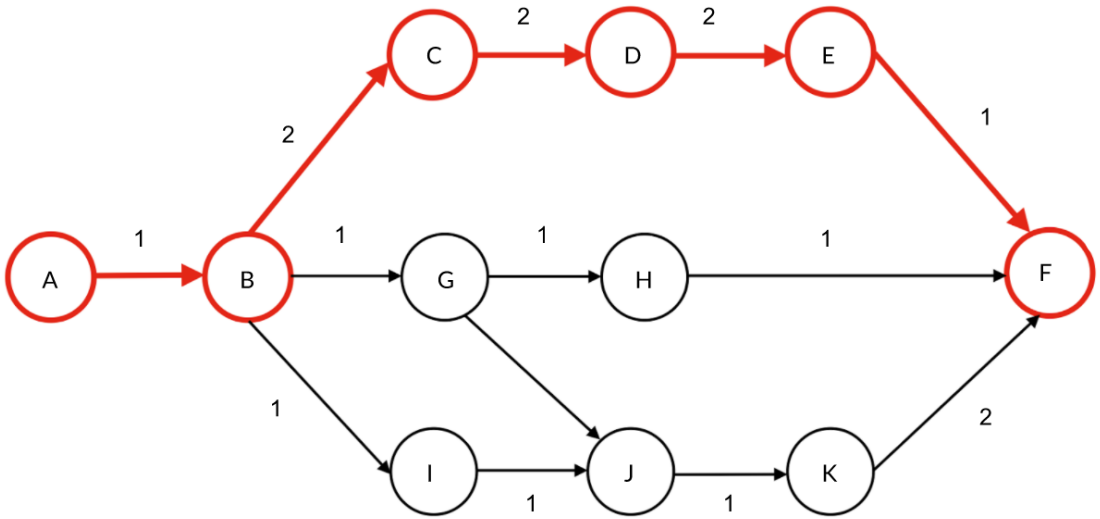

Figure: Critical Path on a Directed Acyclic Graph

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Complexity of the problem

Multi-parameter problem:

Complexity of the problem

Multi-parameter problem:

- Time constraints

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Complexity of the problem

Multi-parameter problem:

- Time constraints
- Performance model

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Complexity of the problem

Multi-parameter problem:

- Time constraints
- Performance model
- Cost constraints

Complexity of the problem

Multi-parameter problem:

- Time constraints
- Performance model
- Cost constraints
- Unlimited task graphs

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Research Question

Can we profile critical path related algorithms by the means of a framework ?

- *How relevant is a framework for profiling critical path related algorithms ?*
- *What are the challenges for such a framework ?*

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Motivation

Why a framework ?

- Compare algorithms performances
- Compare implementations of the same algorithm
- Manipulate and plot output data

What is the best implementation for the "Inspiral" (LIGO) task graph ?

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Prototype Architecture

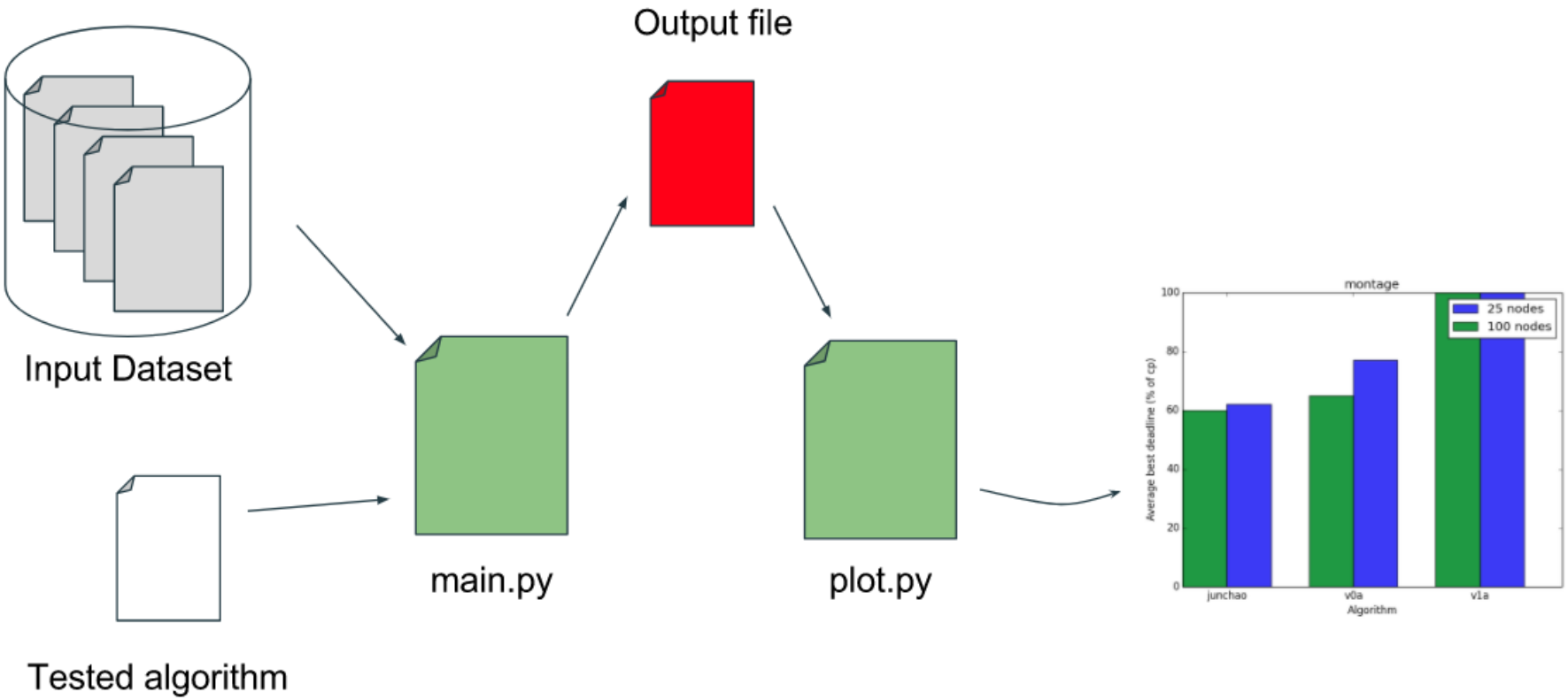

Figure: Prototype Architecture

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Prototype Inner Working

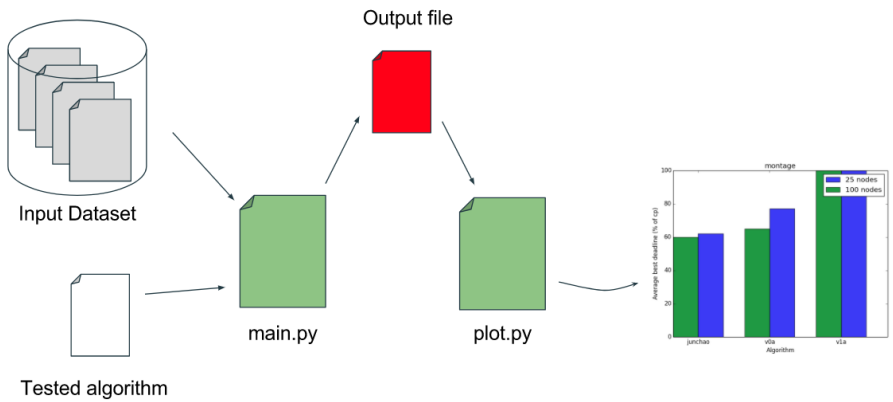

Figure: Prototype Architecture

1. Step 1: *main.py*
   - Browse input task-graph dataset
   - Run algorithm on dataset with specific parameters
   - Write the results in an output file
2. Step 2: *plot.py*
   - Browse output file lines
   - Structure the data
   - Plot the structured data

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File Formats

- Input task graph format
  - Topology

```
digraph dag {
    0 -> 3  [weight=0.0];
    0 -> 48 [weight=0.0];
    1 -> 101    [weight=5.0];
    2 -> 101    [weight=5.0];
    3 -> 4  [weight=6.0];
    3 -> 6  [weight=9.0];
```

  - Performance Model

```
0,12,9,8,7,5,11,12,19,12,15,15,13,8,11,12,17,10,16,7,7,16,15,18,17,14
0,24,18,16,14,10,22,24,38,24,30,30,26,16,22,24,34,20,32,14,14,32,30,36,34,28
0,36,27,24,21,15,33,36,57,36,45,45,39,24,33,36,51,30,48,21,21,48,45,54,51,42
```

  - VM prices

```
5,2,1
```

- Output file format

```
1.30.5;1;0;[22, 23, 24, 27, 29, 30];0.0302591323853
1.30.5;2;0;[22, 23, 24, 27, 29, 30];0.029815196991
1.30.5;3;0;[22, 23, 24, 27, 29, 30];0.0295469760895
1.30.5;4;0;[22, 23, 24, 27, 29, 30];0.0297148227692
1.30.5;5;0;[22, 23, 24, 27, 29, 30];0.0296459197998
1.30.5;6;0;[22, 23, 24, 27, 29, 30];0.0298428535461
1.30.5;7;0;[22, 23, 24, 27, 29, 30];0.0298299789429
```

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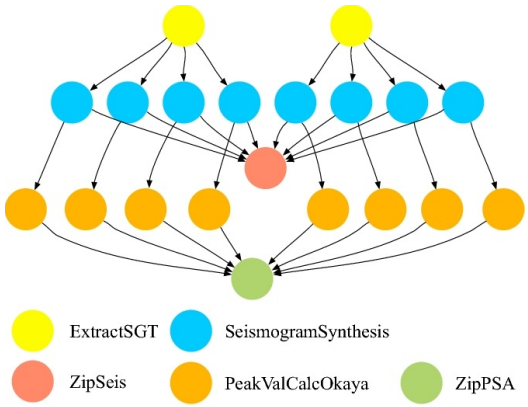
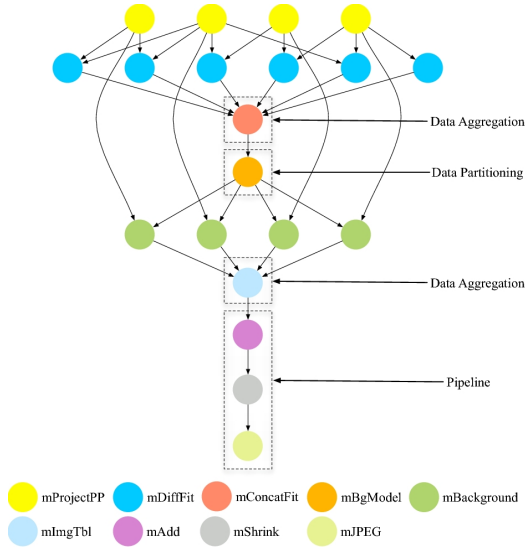
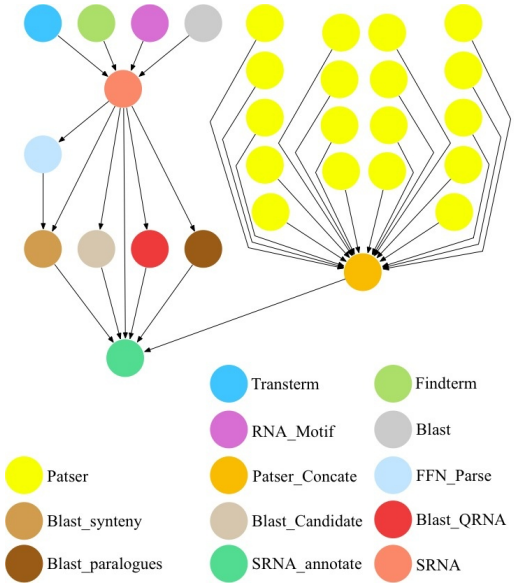
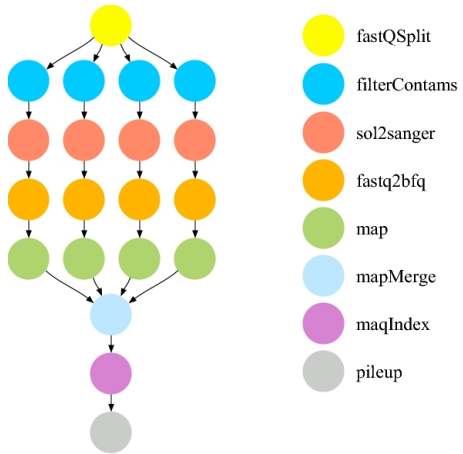
Input Data sets

Other topologies : Cybershake, Montage, Sipht, Epigenomics









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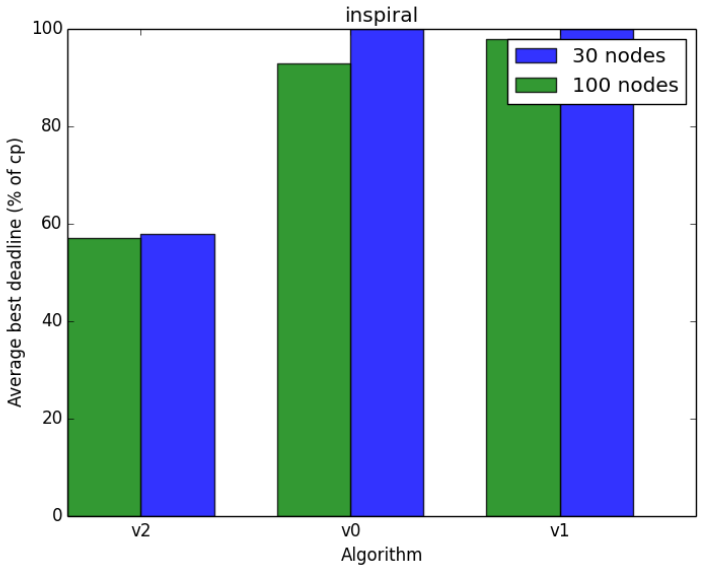
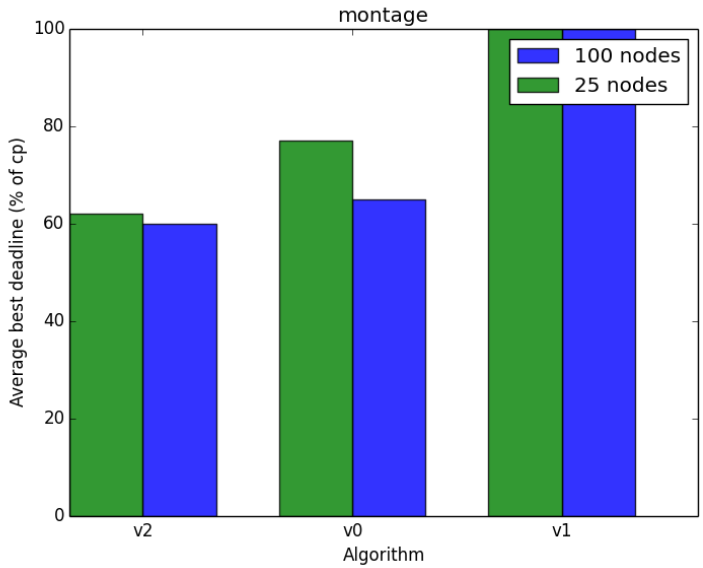
Experiment #1

- Assumption : "If the algorithm succeeds for a shorter deadline, then it will succeed for a longer one"
- Input datasets: Montage & Inspiral
- KPI : shortest deadline





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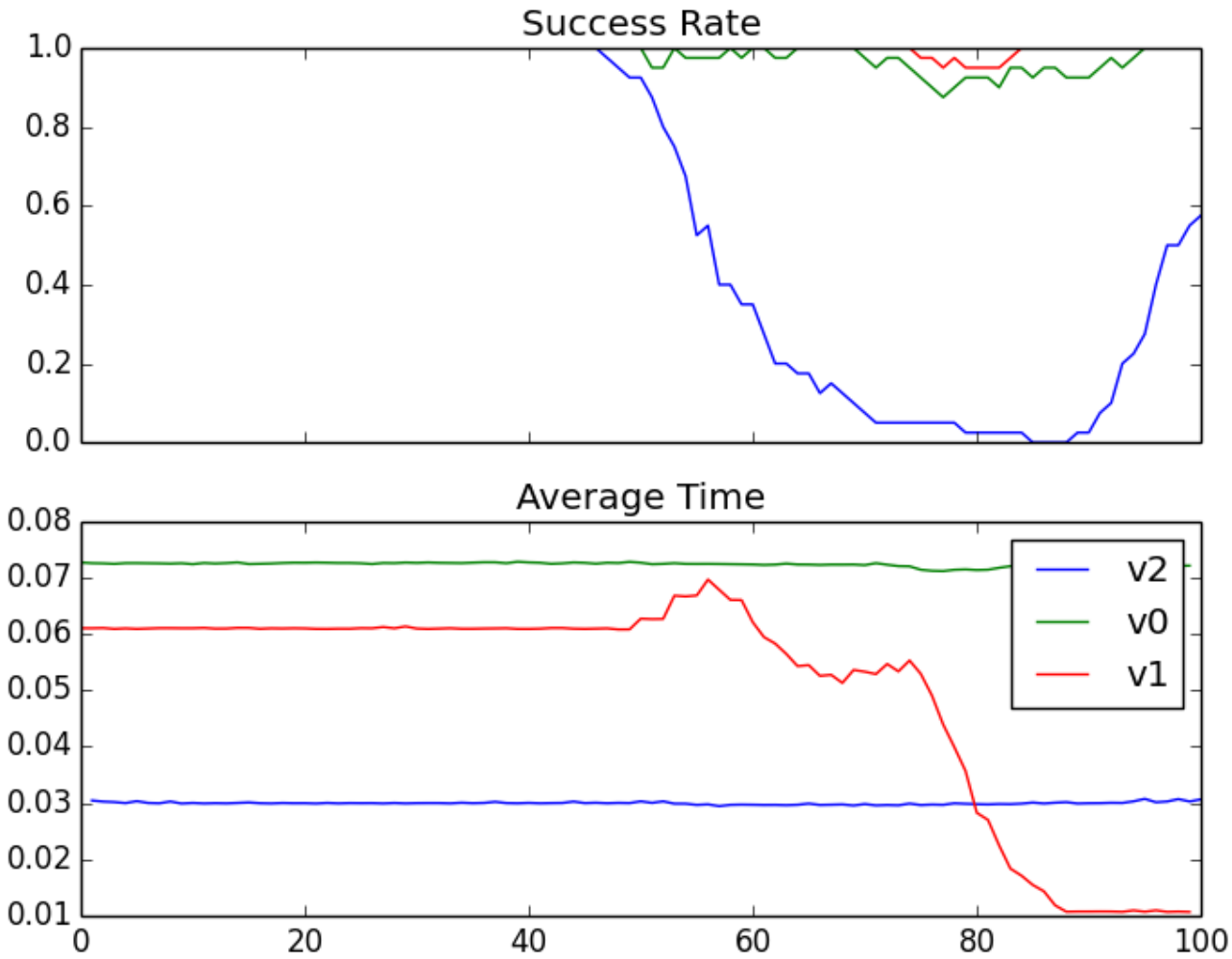
Experiment #2

- Input datasets: **Inspiral**
- KPI : Time and Success rate



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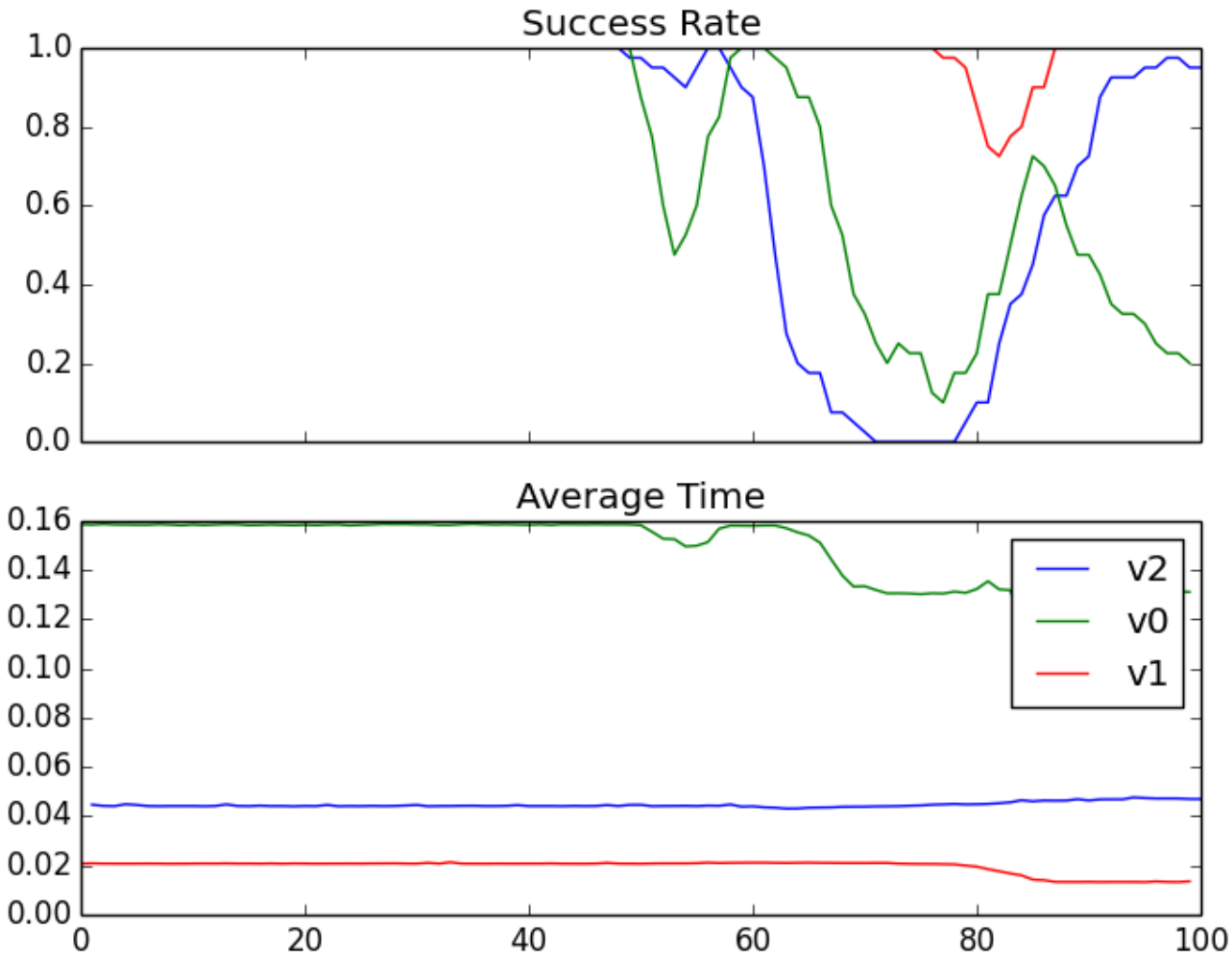
Experiment #2

- Input datasets: **Montage**
- Experiment #1 assumption : False



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Discussion

- Performance Model : not changeable
- Algorithms' codes have to be adapted
- Solution check is done by the algorithm (not the framework)
- Framework needs a lot of resources
- Output format : Cost ?

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Conclusion

Can we profile critical path related algorithms by the means of a framework ?

- Meaningful results
- Assumption proved wrong
- Empirical solution

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More motivations

But also...

- Store algorithms and results
- Authoritative source

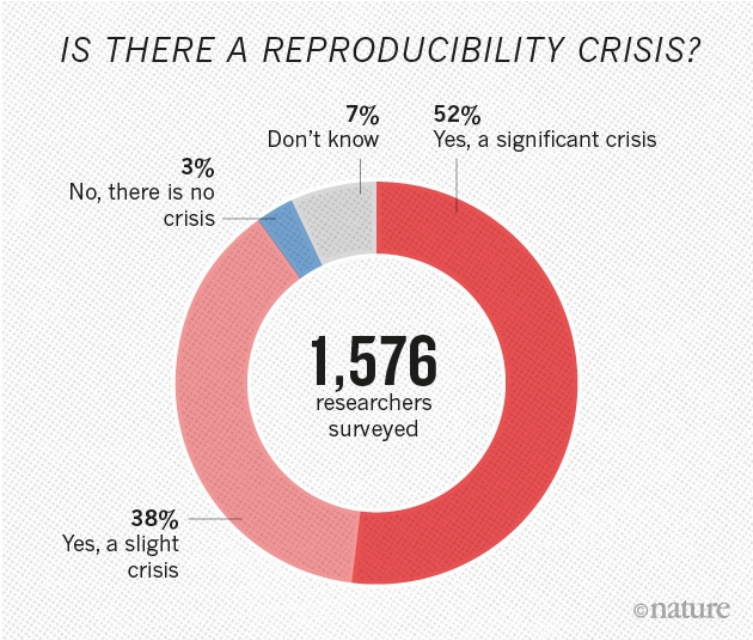

Figure: https://www.nature.com/news/1-500-scientists-lift-the-lid-on-reproducibility-1.19970

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Future Work

- Universal standards (challenge)
- Web-application
- Community databases
- New features:

Feature	Note
DAG Generator	Create and visualize new topologies
DAG Parsing	Manage different input topologies format
input checker	Check input algorithm parameters
Solution checker	Make sure the final solution is valid

Table: Framework features

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