

Algorithm Engineering – Exercise 3

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Presentation for Exercise 3, December 14th

Overview

In this presentation we will talk about:

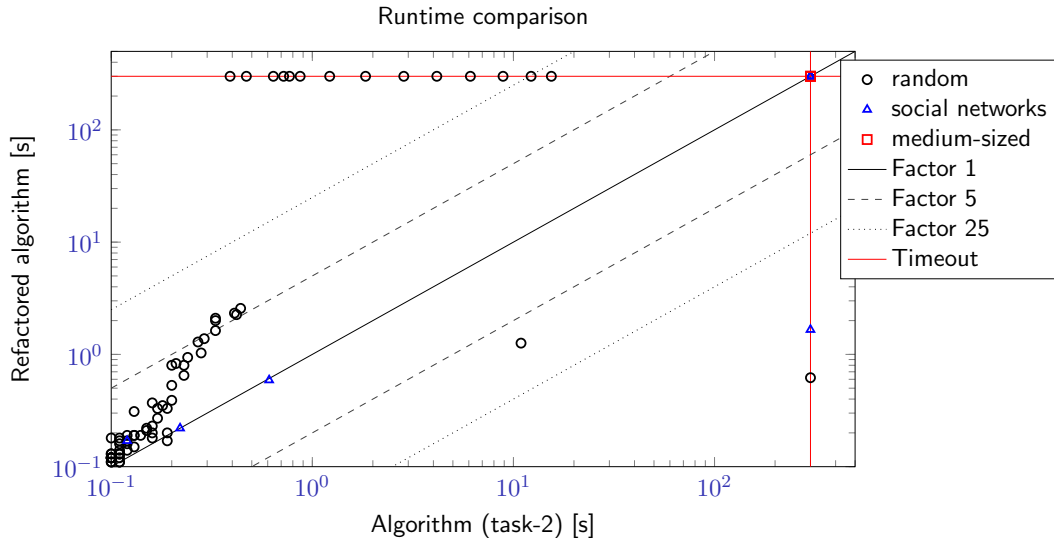
1. Overview
2. Refactoring
3. Changes in previous code
4. Implemented features
 - ▶ Zero Degree Rule
 - ▶ High Degree Rule
 - ▶ Buss Rule
 - ▶ One Degree Rule
 - ▶ Two Degree Rule
 - ▶ Domination Rule
 - ▶ Unconfined Rule
 - ▶ LP Reduction
5. Overall comparison with last iteration

Changes after refactoring

Before and **after**:

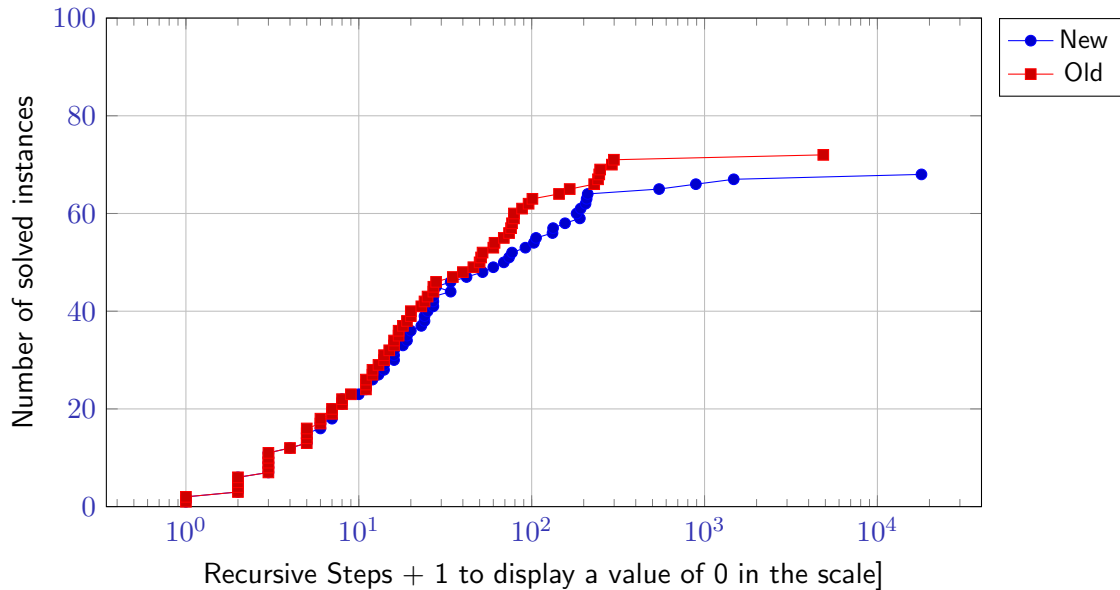
- ▶ **Hash map with adjacent vertices**
- ▶ **List of vertices**
- ▶ List of edges
- ▶ List of vertices' names as mapping
- ▶ Custom data structure with degree order

Refactoring

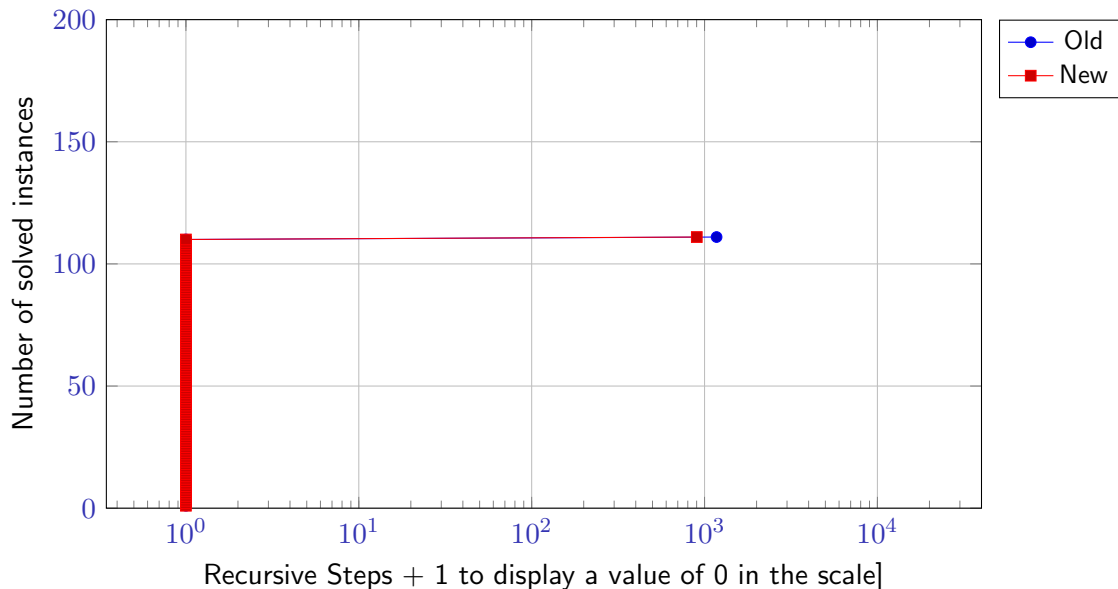


Changes in previous code

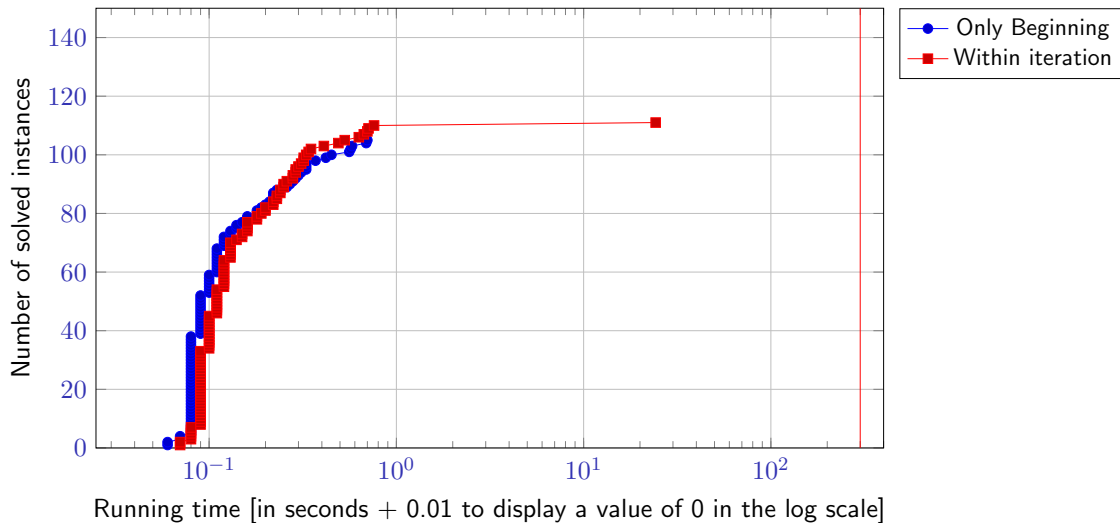
- ▶ Clique Bound: Implement new Clique Bound [VYI20]
 - ▶ New Algorithm : Build complement Graph and then sequential coloring (Heuristic: vertices ordered by degree for sequential coloring)
 - ▶ Old Algorithm : Build Cliques from vertices in non descending order of degree
- ▶ Bounds used also in every iteration



Old clique bound vs new one (with all rules and LP bound)



Bounds at the Beginning vs also in Iterations



Mistake in current code

In this version algorithm was reducing some vertices and testing existence of vertex cover with a provided bound:

```
vc_branch(int lowerbound){  
    Vertices vertices = graph.getVerticesAfterHighDegreeRule(k);  
    if (!graph.applyBussRule(lowerbound)){  
        return null;  
    }  
    ...  
}
```

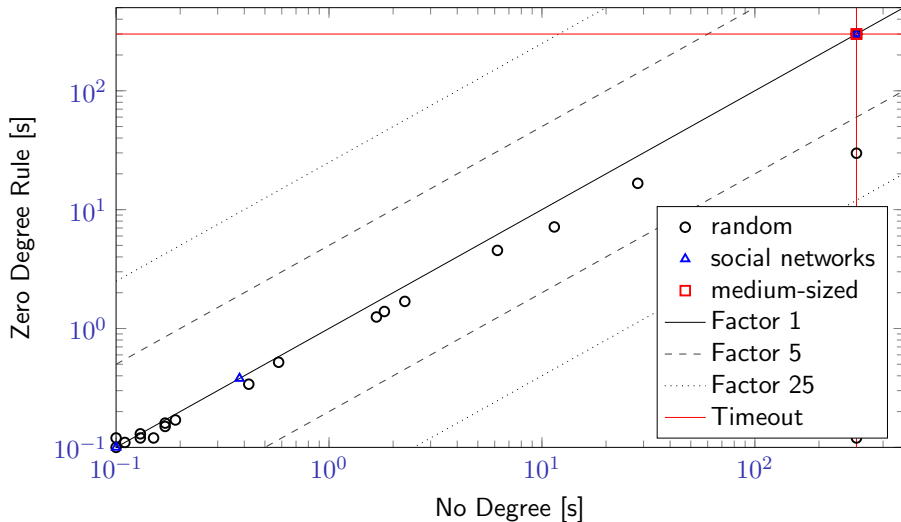
Mistake in current code

Correct version with putting vertices back and testing buss rule with a reduced bound:

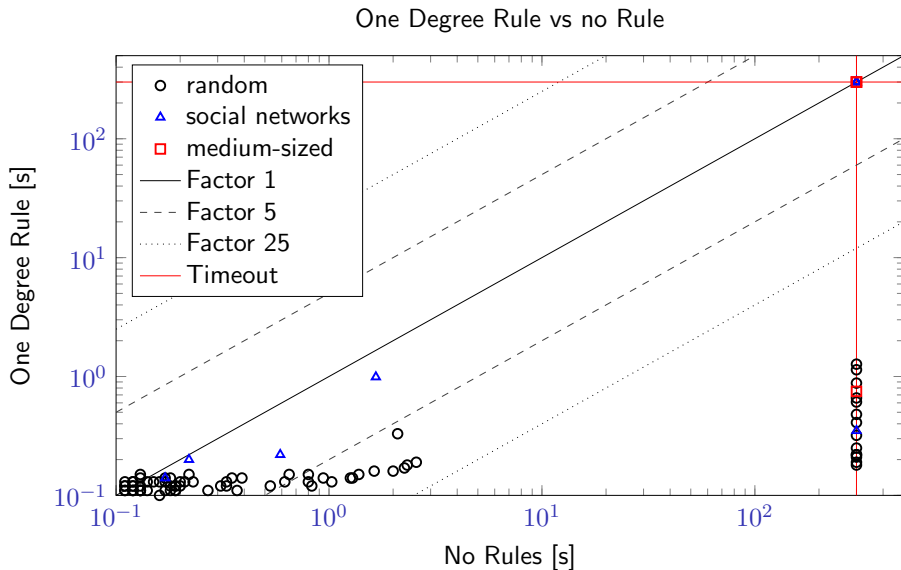
```
vc_branch(int lowerbound){  
    Vertices vertices = graph.getVerticesAfterHighDegreeRule(k);  
    if (!graph.applyBussRule(lowerbound - vertices.size())){  
        graph.putBack(vertices);  
        return null;  
    }  
    ...  
}
```

Zero Degree

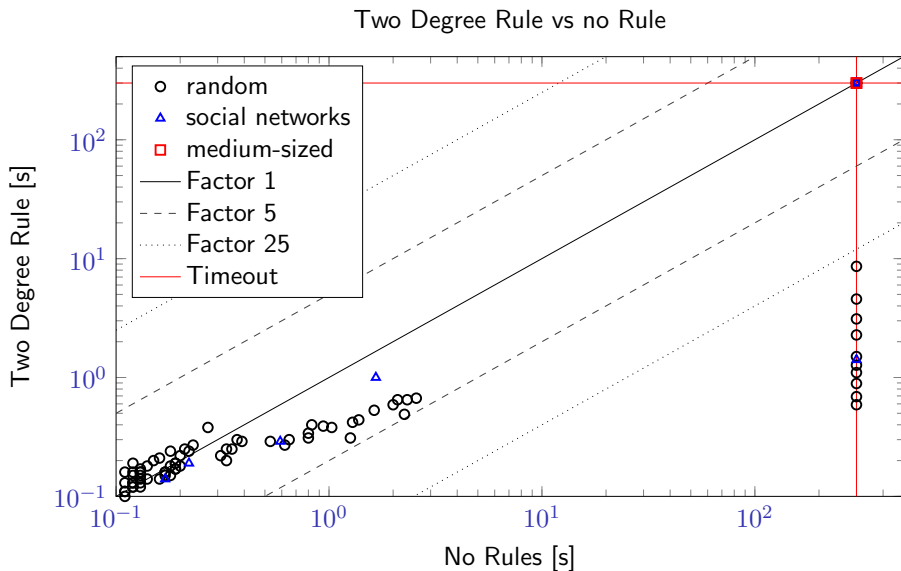
Zero Degree Rule vs no Rule



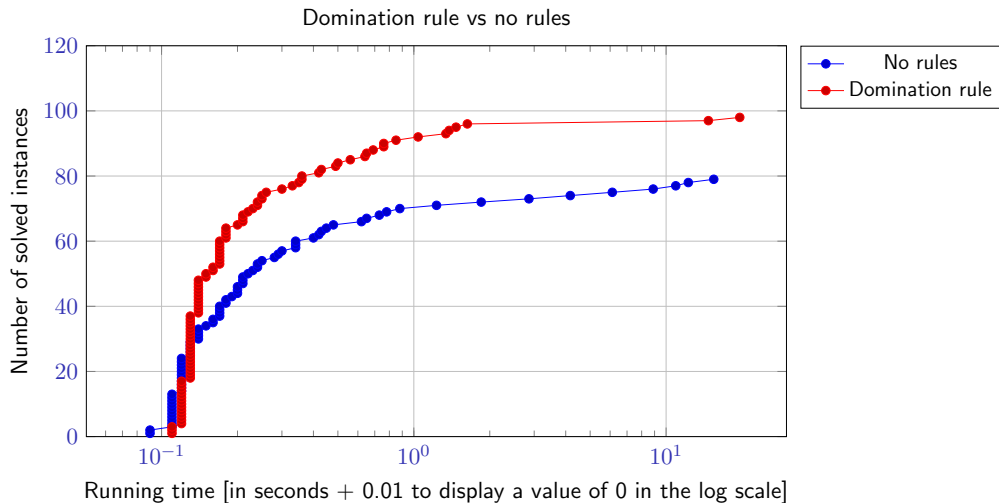
One Degree



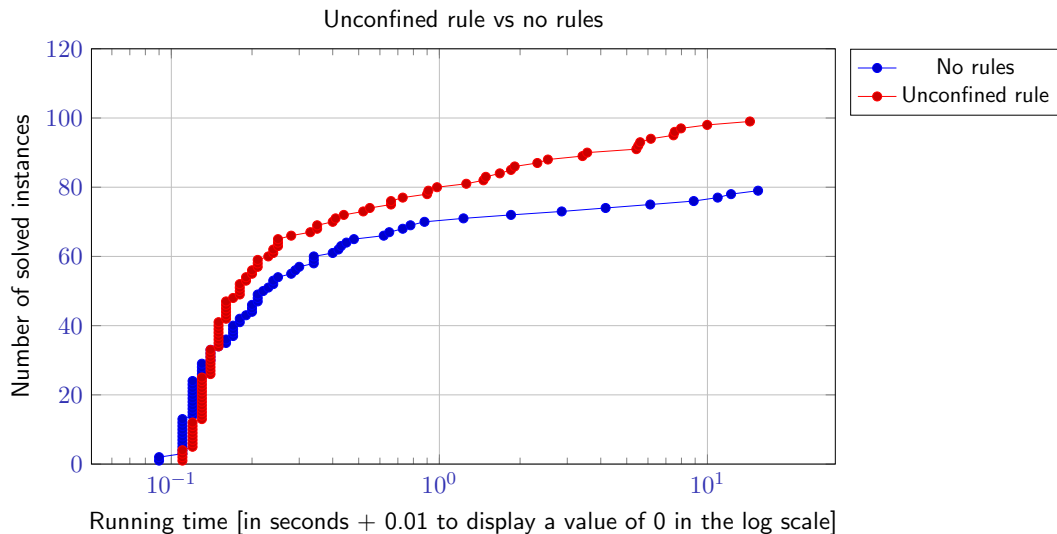
Two Degree



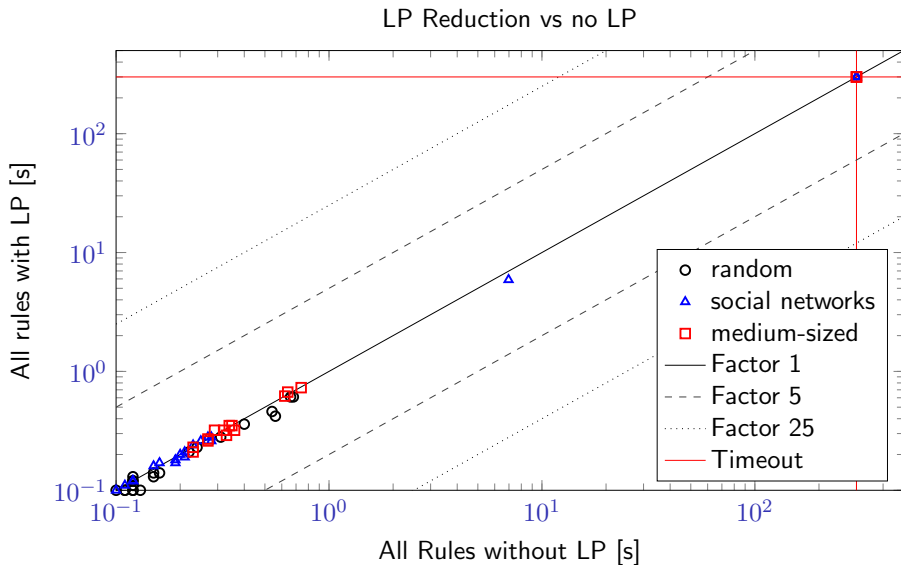
Domination Rule



Unconfined Rule



LP Reduction

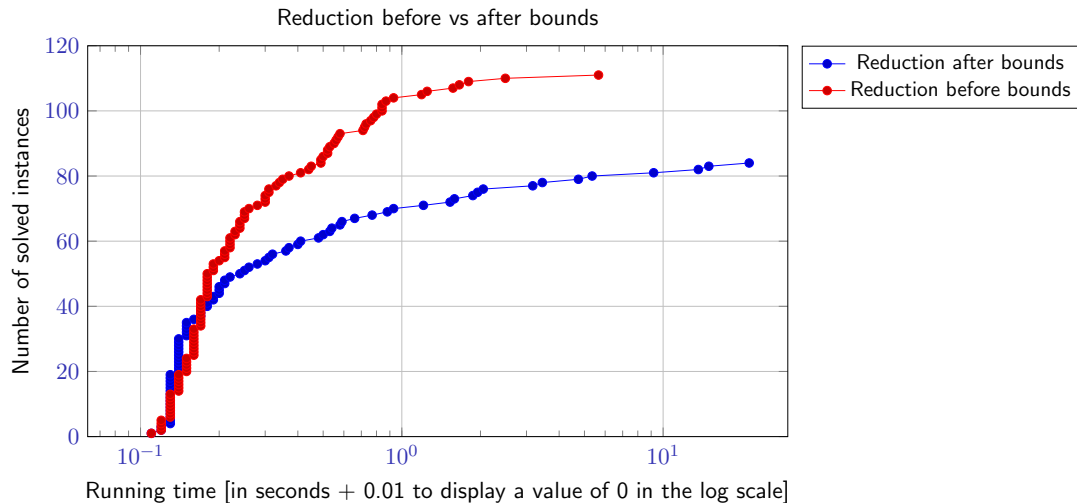


Experiments

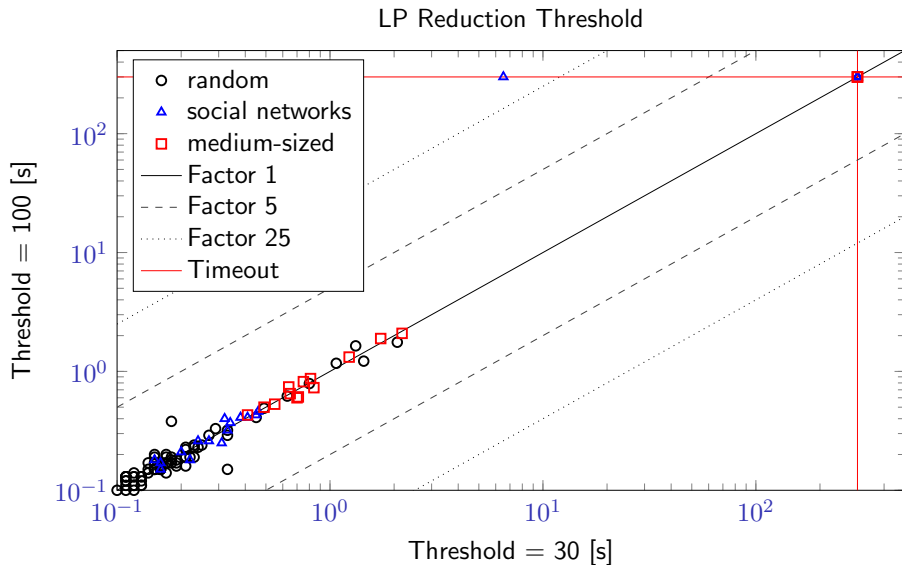
We have conducted the following experiments for this assignment:

1. Reduction before bounds vs after bounds
2. LP-Reduction Threshold
3. Changing order of rules
4. Sequential vs Parallel Rules

Experiment 1



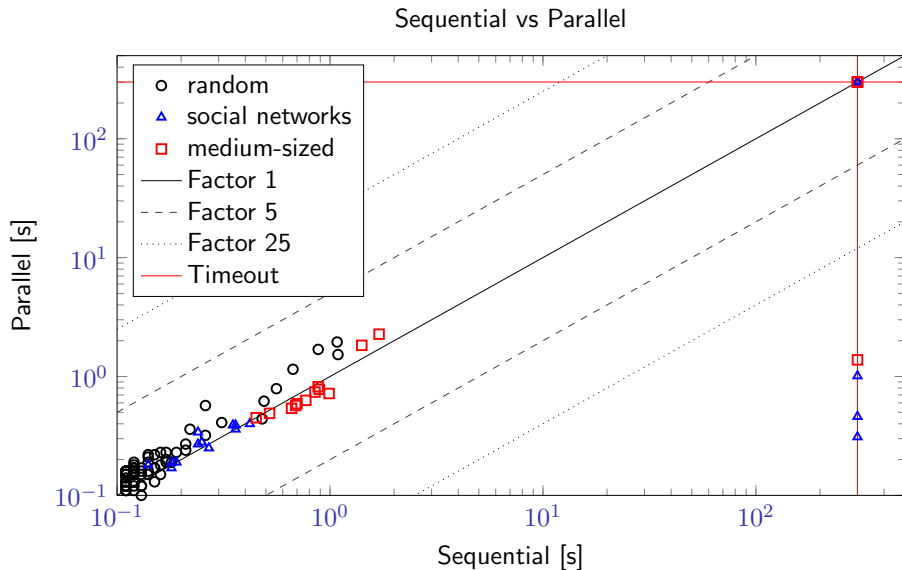
Experiment 2



Experiment 3

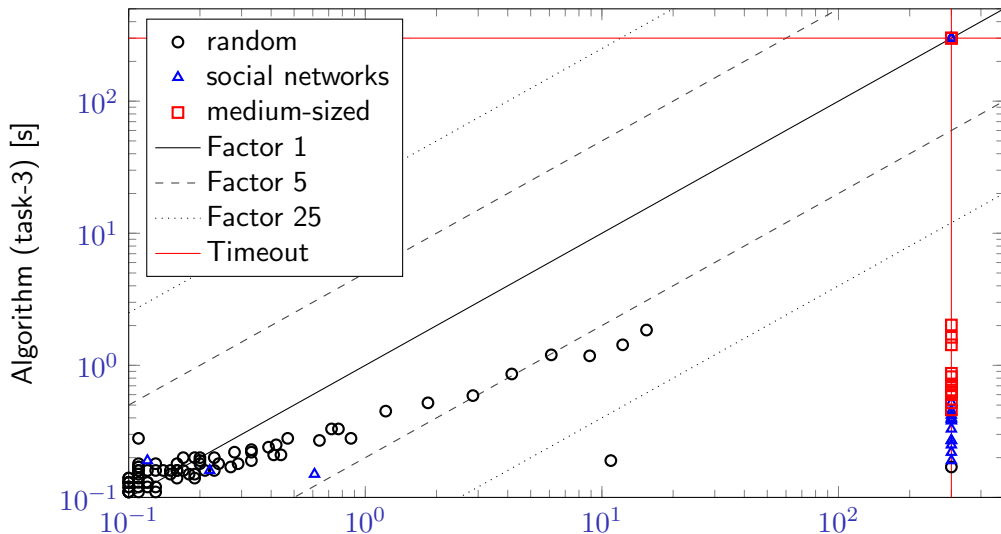


Experiment 4



Comparison

Runtime comparison



Thank you for your attention!
Questions or Feedback?

[VYI20] Vladyslav Verteletskyi, Tzu-Ching Yen, and Artur F. Izmaylov. “Measurement optimization in the variational quantum eigensolver using a minimum clique cover”. In: The Journal of Chemical Physics 152.12 (Mar. 2020), p. 124114. DOI: [10.1063/1.5141458](https://doi.org/10.1063/1.5141458). URL: <https://doi.org/10.1063%5C%2F1.5141458>.