NP Complete Project: Approximate Solution

Minimum Graph Coloring, CS 412

1 Variations In Approximation Algorithm

Because this greedy implementation uses a random approach to determine the order of vertices to color, there are occasionally variations in the output of the approximate solution.

Input:

```
8
0 1
0 4
1 4
1 3
2 3
3 4
3 5
4 5
```

Output:

Vertex	Exact	Approx. #1	Approx #2
Color Amt.	3	4	3
0	0	0	0
1	1	1	2
2	1	0	1
3	0	3	0
4	2	2	1
5	1	0	2

Table 1: Sample output of approximate solution with output of exact solution for reference on a small graph of 6 vertices.

Vertex	**Approx #1**	**Approx #2**	**Approx #3**
Color Amt.	3	4	5
0	0	3	1
1	2	0	2
2	1	2	0
3	2	0	2
4	1	2	1
5	0	1	4
6	1	3	3
7	0	0	0

8	2	2	1
9	0	0	0
10	1	1	1
11	2	2	2
12	0	0	0
13	1	1	0
14	1	1	1
15	0	0	2
16	1	1	0
17	2	2	2
18	0	0	1
19	1	1	0

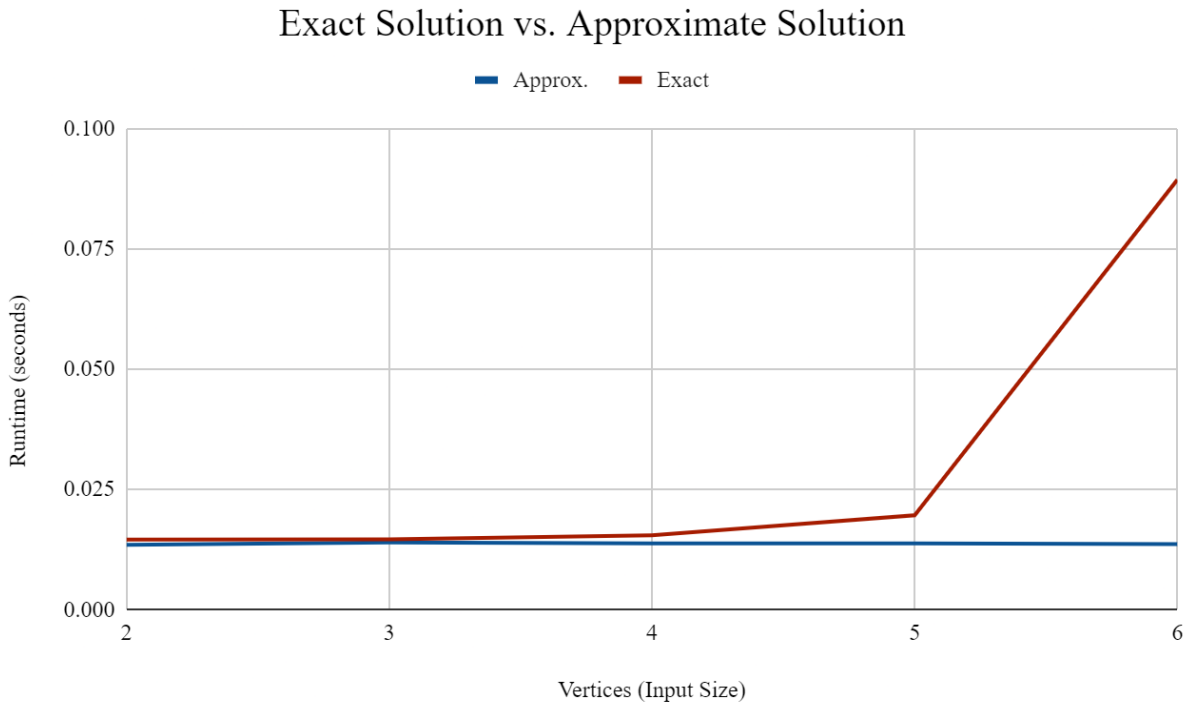
Table 2: Sample outputs of approximate solution for a graph with 20 vertices and 30 edges.

2 Runtime Comparison Between Exact and Approximate Solutions

The following chart displays the run-time comparison between the exact solution and the approximate solution on small, simple graphs. The approximate solution is considerably faster than the exact solution.

Vertices	Exact Time (seconds)	Approx. Time (seconds)
2	0.01457	0.0135
3	0.01462	0.0140
4	0.01551	0.0138
5	0.0197	0.0138
6	0.0894	0.01366
7	1.4177	0.01698
8	32.6536	0.01544
9	980.9655	0.01496

Table 3: Wall time of exact and approximate solution on small graphs.



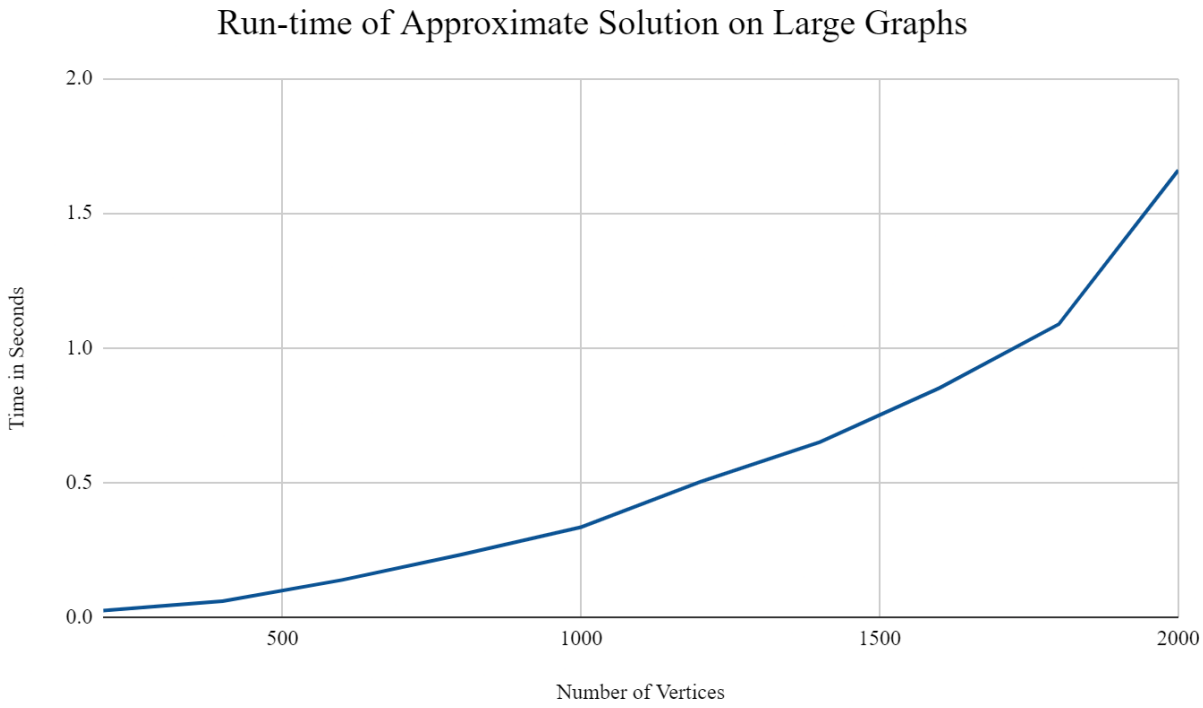
Graph 1: Wall time of exact and approximate solution on small graphs.

3 Runtime of Approximate Solution on Large Graphs

Each test file is a complete bipartite graph, created with the `generate_bipartite.py` script. For each test, the approximate solution was run 10 times with the lowest wall time recorded.

Vertices	Edges	Time in Seconds
200	9900	0.02469
400	39800	0.05954
600	89700	0.13789
800	159600	0.23224
1000	249500	0.3338
1200	359400	0.50261
1400	489300	0.6495
1600	639200	0.85038
1800	809100	1.08716
2000	999000	1.65855

Table 4: Wall time of approximate solution in seconds on large graphs as vertices increase by 200.



Graph 2: Wall time of program in seconds on large graphs as vertices increase by 200.