# Project: Shortest Path Algorithms

Group 25 – Aastha Dixit, Keerthi Bala Sundram, Maitri Jatakia, Monish Muthuvijayan

# Executive summary or abstract

This project provides the implementation of 4 algorithms – BFS, DAG, Djikstra’s and Bellman-Ford algorithms for finding the Shortest Paths of Directed graphs.

# Introduction

Shortest Path is a path from root to any vertex in the graph with the shortest path or the minimum weighted edges.

BFS algorithm will be used if the weights of all the edges are equal.

DAG will be used if the graph does not have any cycles.

Djiktra’s will be used if the graph is not a DAG but does not have negative weight edges.

For all other purposes we will use Bellman-Ford.

# Methodology

The algorithm BFS performs the breadth first search to traverse all the edges, updates the distance all the vertices and returns the shortest path. The DAG algorithm uses topological sorting(starting from the node with no incoming edges) finds the shortest path using the topologically sorted vertices. Djikstra’s algorithm would use indexed priority queue - minheap to find the priority of a vertex and according to the minheap and the vertex to the path if the vertex is not seen. Bellman-Ford uses the brute force approach, the algorithm will run for all vertices and edges to find the shortest path. To find the negative cycles we check if the count of number of times the loop executes with vertex still present in the queue it would mean that we have found a negative weight cycle.

# Development platform/experimental setup

Eclipse IDE running on 8GB RAM PC with i5 processor.

# Test results

Sample Input

30 256

1 2 8

1 13 -1

1 9 -5

1 7 -4

1 30 -1

1 6 -10

2 8 7

2 3 10

2 9 -1

3 6 5

3 9 2

3 8 -7

3 7 -4

4 5 5

4 9 3

4 27 -5

4 3 -6

4 21 -9

4 29 -10

4 11 -8

4 13 -5

4 17 -8

5 24 7

5 27 -10

5 28 -8

5 7 -5

5 2 -10

5 25 -6

5 1 -2

5 30 -10

5 3 -4

6 15 10

8 15 4

8 7 -1

8 6 -8

9 8 -1

9 15 -3

9 6 -3

10 24 8

10 25 10

10 5 -10

10 22 -3

10 6 -8

10 29 -10

10 19 -2

10 13 -7

10 17 -2

10 15 -10

10 8 -4

10 2 -3

10 7 -7

11 25 8

11 29 1

11 28 3

11 9 -2

11 15 -6

11 24 -5

11 7 -4

11 8 -4

11 22 -4

11 23 -2

11 18 -1

11 3 -3

11 21 -4

11 17 -6

11 30 -2

11 20 -5

11 2 -2

12 8 5

12 15 8

12 29 9

12 11 4

12 28 -2

12 13 -5

12 9 -1

12 17 -7

12 30 -3

12 3 -3

12 2 -7

12 6 -10

12 25 -7

13 24 5

13 28 -10

13 2 -4

13 27 -5

13 8 -5

13 6 -8

13 3 -1

13 15 -4

13 25 -9

14 20 2

14 12 10

14 17 5

14 1 7

14 2 7

14 8 2

14 16 10

14 23 -4

14 22 -3

14 27 -9

14 28 -3

14 10 -5

14 7 -2

16 4 1

16 12 4

16 1 3

16 17 10

16 6 4

16 8 6

16 15 -10

16 25 -7

16 22 -5

16 24 -6

16 18 -3

16 21 -4

16 30 -10

16 9 -7

16 29 -3

16 20 -7

16 28 -6

16 11 -5

16 3 -8

16 2 -3

17 13 8

17 15 4

17 20 1

17 30 6

17 23 9

17 1 4

17 8 3

17 9 7

17 7 -8

17 24 -10

17 3 -7

17 27 -2

18 24 5

18 29 3

18 5 4

18 1 1

18 8 1

18 9 -10

18 25 -5

18 27 -6

18 17 -3

18 21 -2

18 30 -6

18 2 -1

18 28 -9

19 18 7

19 20 8

19 24 1

19 2 8

19 11 5

19 30 7

19 21 4

19 6 -10

19 28 -3

19 16 -2

19 5 -8

19 7 -4

19 3 -5

20 2 2

20 13 9

20 7 5

20 9 -8

20 1 -7

20 27 -1

20 5 -2

20 15 -10

20 3 -9

21 8 1

21 9 5

21 15 8

21 5 8

21 29 6

21 28 8

21 3 3

21 17 -1

21 24 -5

21 13 -3

21 7 -3

21 25 -1

21 6 -3

21 20 -7

22 30 7

22 28 -2

22 2 -10

22 13 -9

22 23 -8

22 9 -6

22 5 -10

22 15 -4

22 20 -2

22 24 -6

22 27 -9

23 13 1

23 1 4

23 25 2

23 24 1

23 3 -9

23 8 -9

23 5 -7

23 9 -1

23 20 -10

24 8 9

24 2 2

24 27 -8

24 25 -6

24 28 -2

24 6 -6

24 7 -9

25 3 7

25 8 2

25 28 2

25 6 6

25 27 -6

25 9 -10

26 23 9

26 15 7

26 14 5

26 3 3

26 21 5

26 27 10

26 18 -10

26 13 -3

26 2 -8

26 19 -2

26 22 -6

26 7 -10

26 20 -4

26 11 -2

27 6 7

27 8 -10

27 28 -9

27 7 -7

27 3 -6

28 6 -2

29 1 7

29 3 10

29 23 8

29 9 -6

29 17 -8

29 27 -2

29 15 -5

29 2 -2

29 5 -3

29 8 -2

29 7 -4

29 6 -4

30 3 3

30 15 7

30 13 -3

30 8 -3

30 27 -10

30 25 -8

30 6 -8

Sample Output

DAG -255

1 0 -

2 -8 13

3 -25 27

4 INF -

5 INF -

6 -40 8

7 -33 8

8 -32 3

9 -23 25

10 INF -

11 INF -

12 INF -

13 -4 30

14 INF -

15 -30 6

16 INF -

17 INF -

18 INF -

19 INF -

20 INF -

21 INF -

22 INF -

23 INF -

24 1 13

25 -13 13

26 INF -

27 -19 25

28 -28 27

29 INF -

30 -1 1

# Discussion of results

The BFS algorithm runs in O(E+V) . Whereas DAG runs in O(E+V) time.

Djiktra’s algorithm has a time complexity of O(ElogV). Bellman-Ford being a brute force approach runs for O(E.V).

# Conclusion

Learning:

1. Bellman-Ford should only be used when no other approach solves the purpose.
2. DAG is a very efficient approach when there are no cycles in the graph
3. Djiksta’s can be used if graph is not a DAG, but have no non-negative edges.
4. BFS is suitable for cases when all edges have similar weights

# References

Class Notes/Group Forum

Youtube.com videos