CLASSMATE
Date
Page

ASSIGNMENT- 8

TITLE: BELLMAN FORD ALGORITHM

PROBLEM STATEMENT: Write a program to implement Bellman Ford algorithm using DS & verify time complexity.

THEORY:

- DYNAMIC PROGRAMMING:
Dynamic programming is the algorithm design technique for the optimisation problems. It follows Principle of optimality.

- PRINCIPLE OF OPTIMALITY:
The principle of optimality states that an optimal strategy of decisions has the property that whatever the initial state & decision are, the remaining decisions must constitute optimal storage sequence with regards to the stage resulting from the first decision.

- SHORTEST PATH PROBLEM:
Find the single source shortest path from a directed graph (acyclic) & weighted G(V,E) starting from source to all reachable vertices.

Bellman Ford works with negative weighted edges & gives error if negative cycle is found in graph.

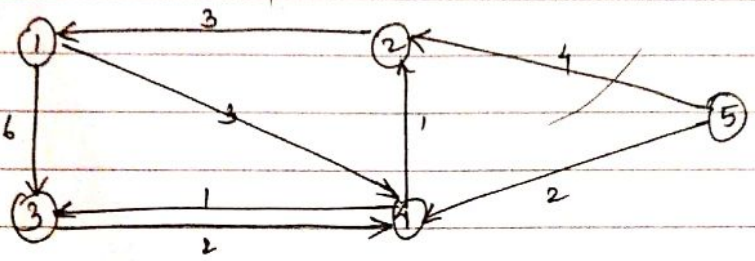
- ALGORITM :

The Bellman Ford uses edge relaxation to find single source shortest paths on directed graphs that may contain negative weight edges. The algorithm will also detect if there are any negative weights cycle.

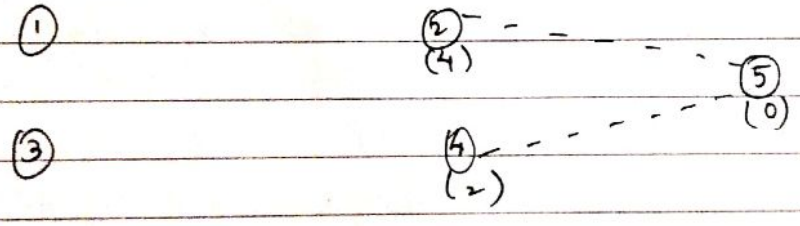
```
Bellman_Ford (G, w, s)
{ Initialise - single - source (G,s)
  for i = 1 to |G,V| - 1
        for each edge (u,v) ∈ G(E)
              relax (u, v, w)

  for each edge (u,v) ∈ G(E)
        if v[d] > u[d] + w(u,v)
              return false
}
return true
}

Initialise - single - source (G,s)
{ for each vertex v ∈ G(V)
        v[d] = ∞
        v[pi] = NIL
  s[d] = 0
}

Relax (u, v, w)
{ if v[d] < u[d] + w(u,v), then
        v[d] = u[d] + w(u,v)
        v[pi] = u
```

EXAMPLE:

Given the following graph

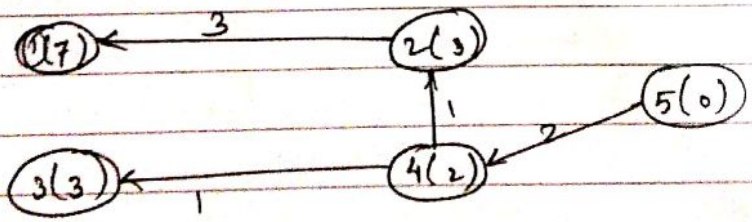


Using vertex 5 as source (setting its distance to 0), all other distances are ∞



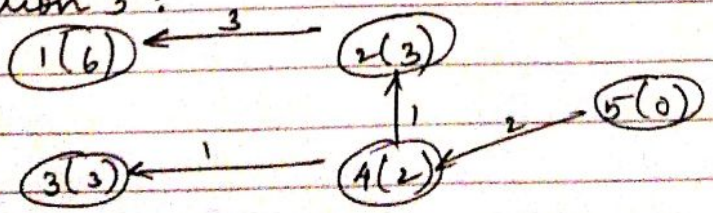
	1	2	3	4	5
d	∞	4	∞	2	0
n	-	5	-	5	-

Iteration 2:



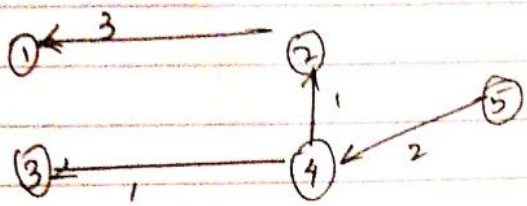
	1	2	3	4	5
d	7	3	3	2	0
n	2	4	4	5	-

Iteration 3:



	1	2	3	4	5
d	6	3	3	2	0
n	2	4	4	5	-

Iteration 4:



vertex	1	2	3	4	5
dist	6	3	3	2	0

- COMPLEXITY:
  $O(v + v \cdot E + v) = O(v \cdot E)$

Input : G(V, E) & source vertex
Output : shortest distance from source vertex

- CONCLUSION :
  In this assignment, we implemented Bellman-Ford algorithm to solve single source shortest path algorith