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15. Single Source Shortest Path : Bellman-Ford Algorithm

- Algorithm Bellman-Ford (G, w, s)

Input: Directed graph $G = (V, E)$;
Edge weights $\{w_e : e \in E\}$
vertex $s \in V$.

Output: For all vertices v reachable from s, v.d is set to the distance from s to v.

```
# Initialize-single-source:
for each vertex v ∈ G.V:
    v.d = ∞
    v.π = NIL
s.d = 0

for i = 1 to |G.V| - 1 :        (repeat |V|-1 times)
    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
```

Procedure RELAX (u, v, w)

```
if v.d > u.d + w(u,v):
    v.d = u.d + w(u,v)
    v.π = u
```

- The algorithm solves the single source shortest path problem of a directed graph $G = (V, E)$ in which the edge weights may be negative.
- Moreover, this algorithm can be applied to find the shortest path, if there does not exist any negative weighted cycle.