EXPERIMENT 6B

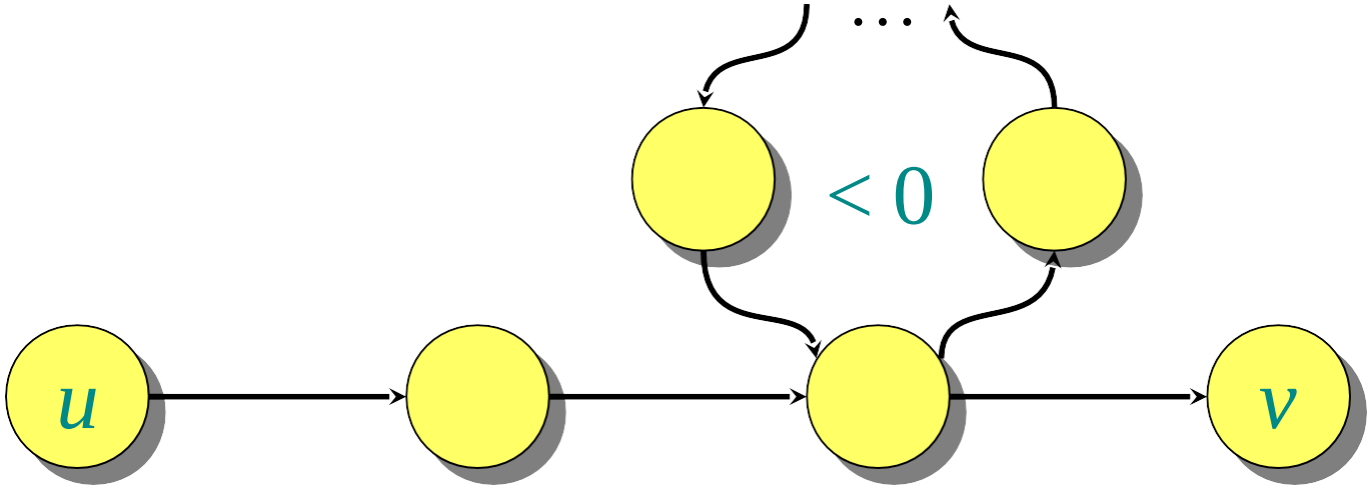
- b)Implementation of Bellman Ford Algorithm

Bellman-Ford Algorithm

- Dijkstra's doesn't work when there are negative edges:
  - Intuition – we can not be greedy any more on the assumption that the lengths of paths will only increase in the future
- Bellman-Ford algorithm detects negative cycles (returns *false*) or returns the shortest path-tree

NEGATIVE-WEIGHT CYCLES

Recall: If a graph $G = (V, E)$ contains a negative-weight cycle, then some shortest paths may not exist



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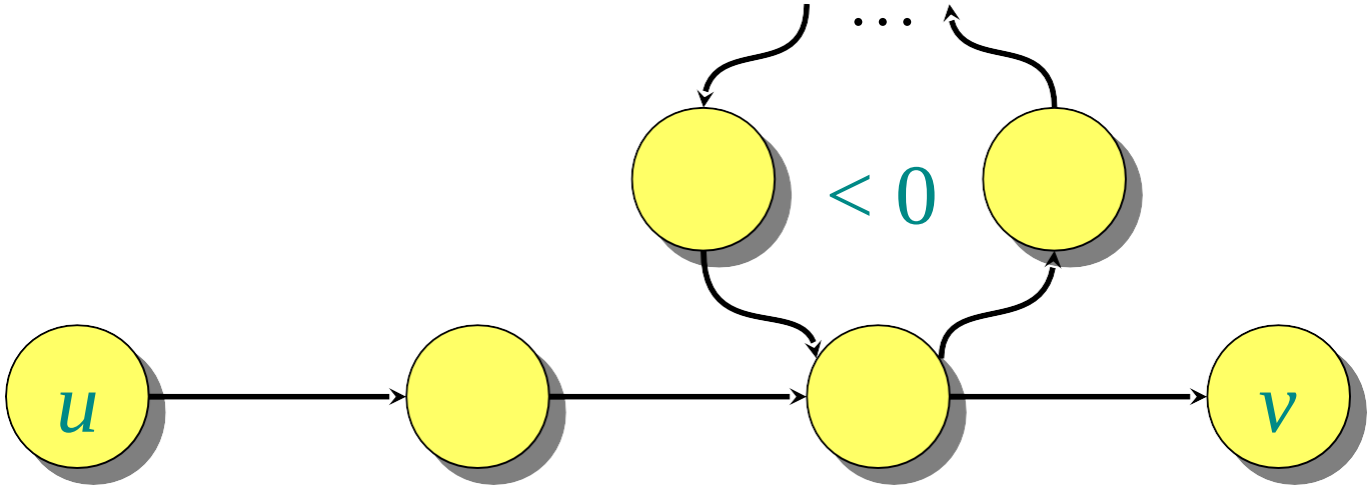


Bellman-Ford algorithm: Finds all shortest-path lengths from a ***source*** $s \in V$ to all $v \in V$ or determines that a negative-weight cycle exists.

BELLMAN-FORD ALGORITHM

$d[s] \leftarrow 0$
for each $v \in V - \{s\}$
    do $d[v] \leftarrow \infty$

} initialization

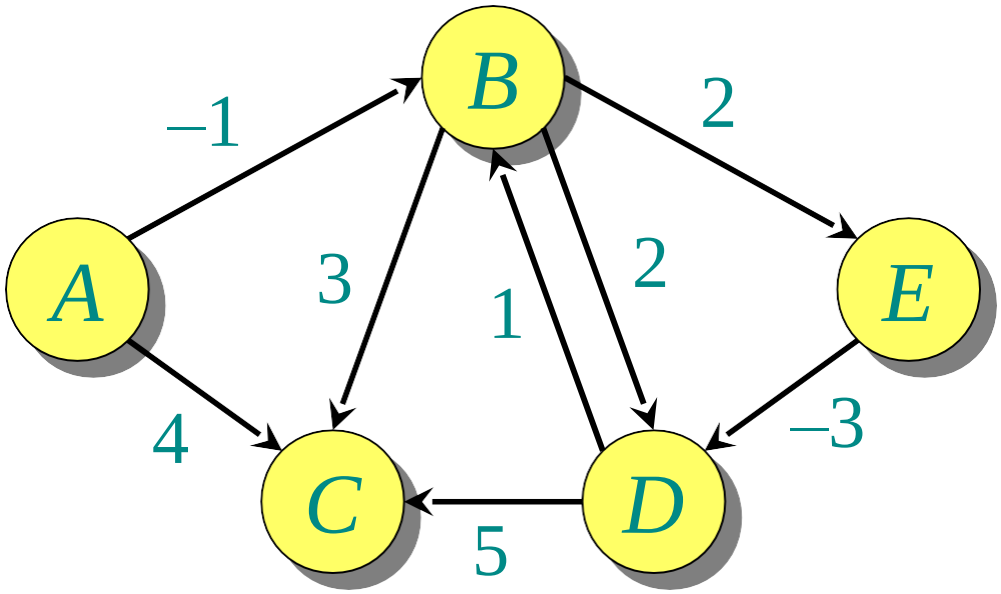
for $i \leftarrow 1$ **to** $|V| - 1$
    do for each edge $(u, v) \in E$
        do if $d[v] > d[u] + w(u, v)$
            then $d[v] \leftarrow d[u] + w(u, v)$

} ***relaxation step***

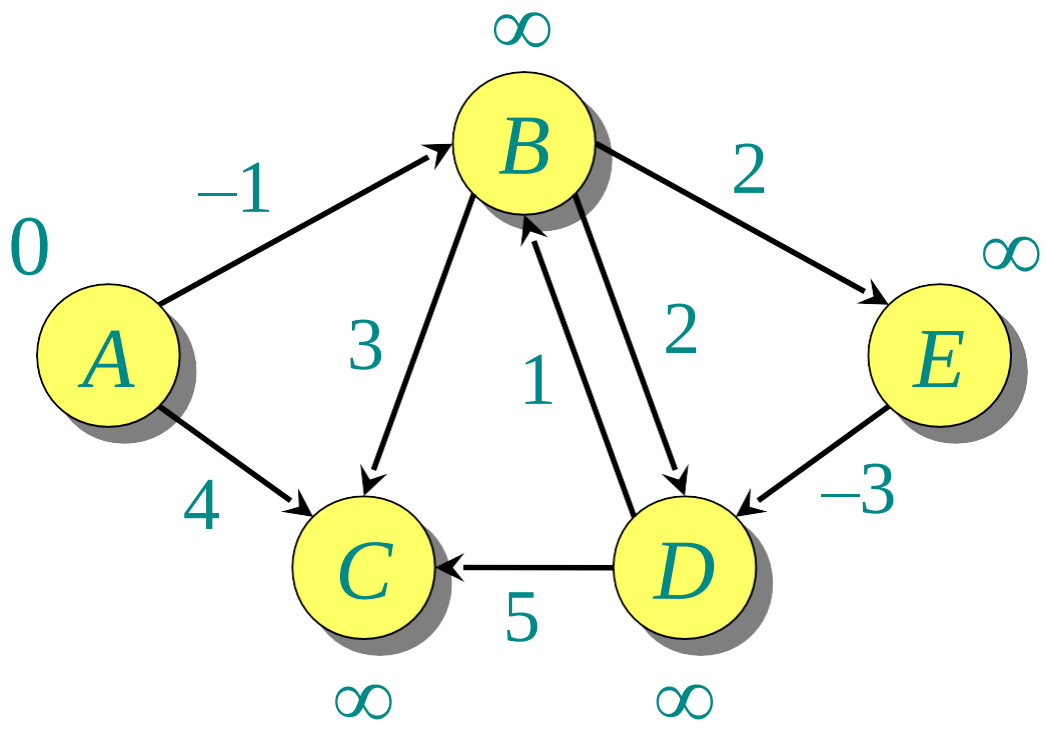
for each edge $(u, v) \in E$
    do if $d[v] > d[u] + w(u, v)$
        then report that a negative-weight cycle exists

At the end, $d[v] = \delta(s, v)$, if no negative-weight cycles.
Time = $O(VE)$.

Example of Bellman-Ford

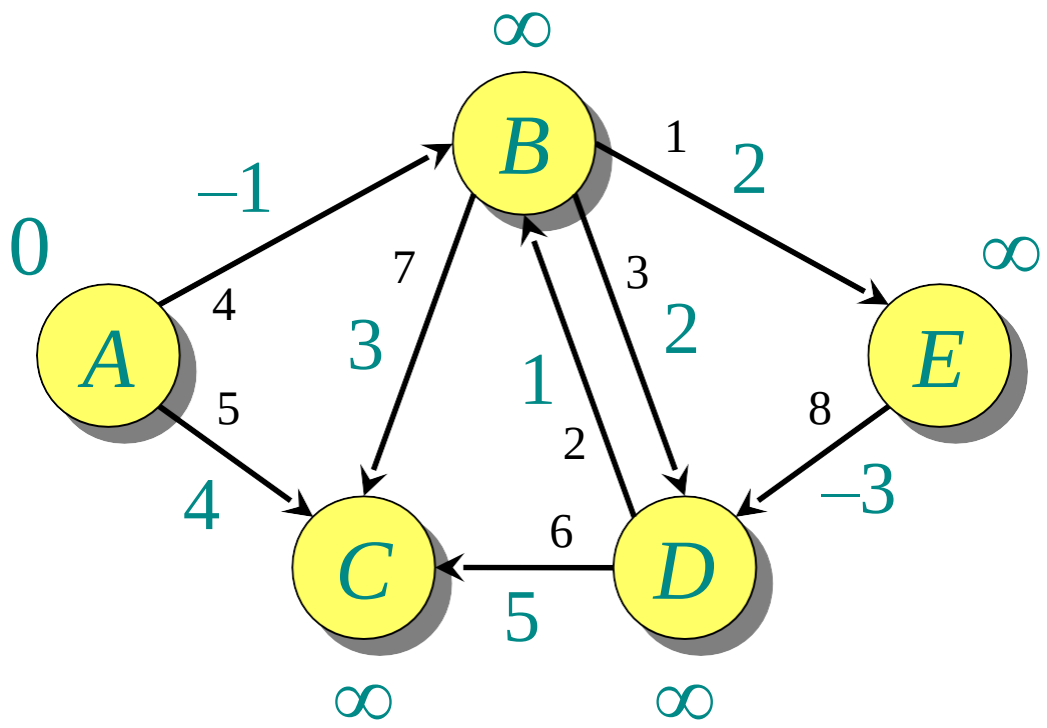


Example of Bellman-Ford



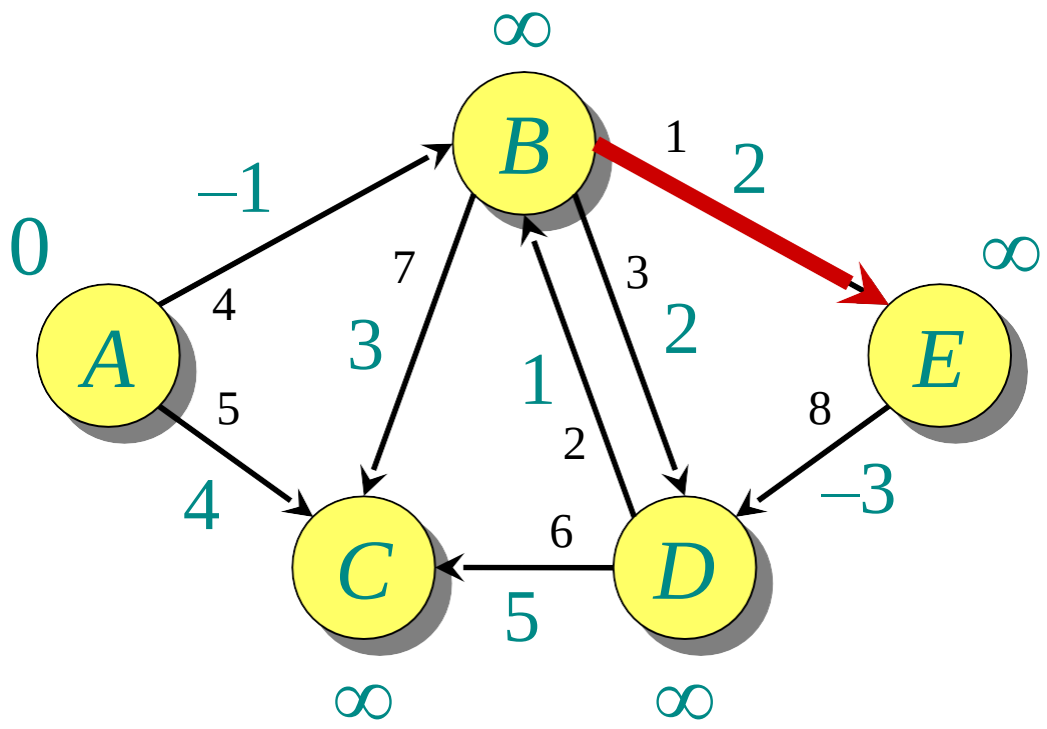
Initialization.

Example of Bellman-Ford

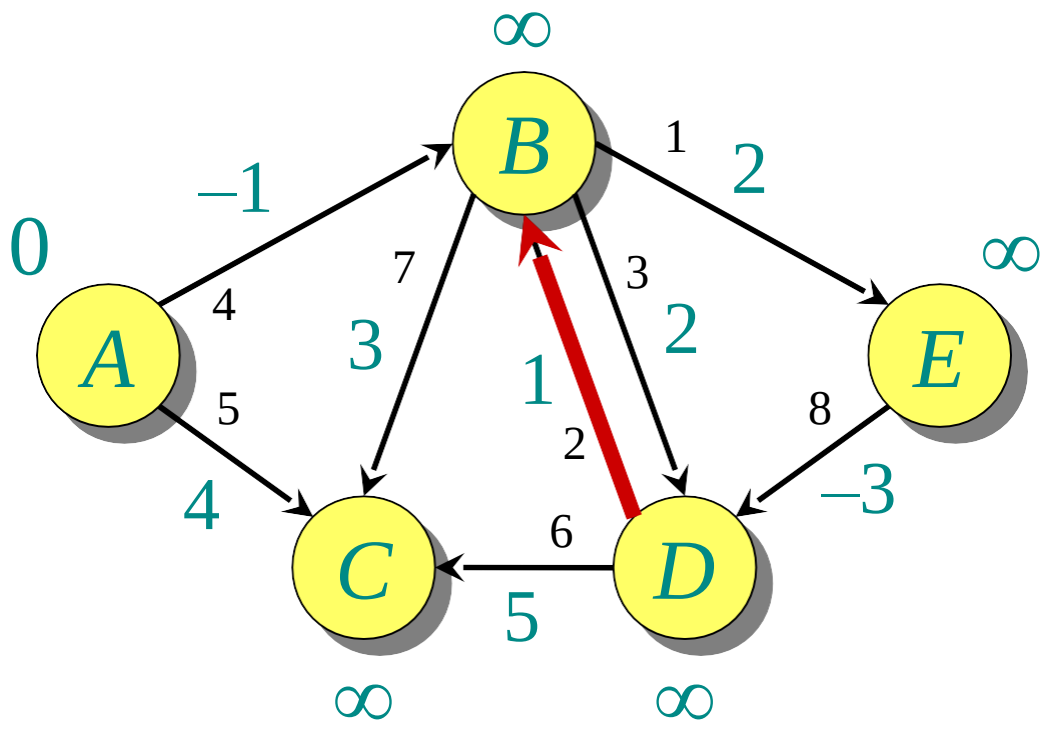


Order of edge relaxation.

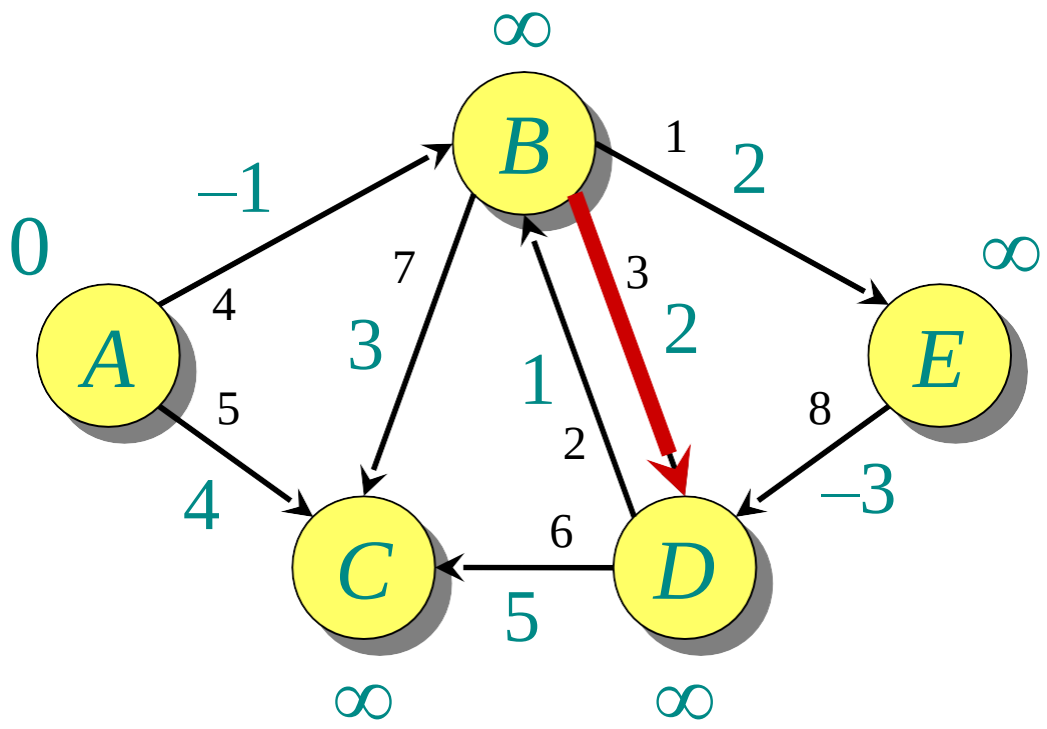
Example of Bellman-Ford



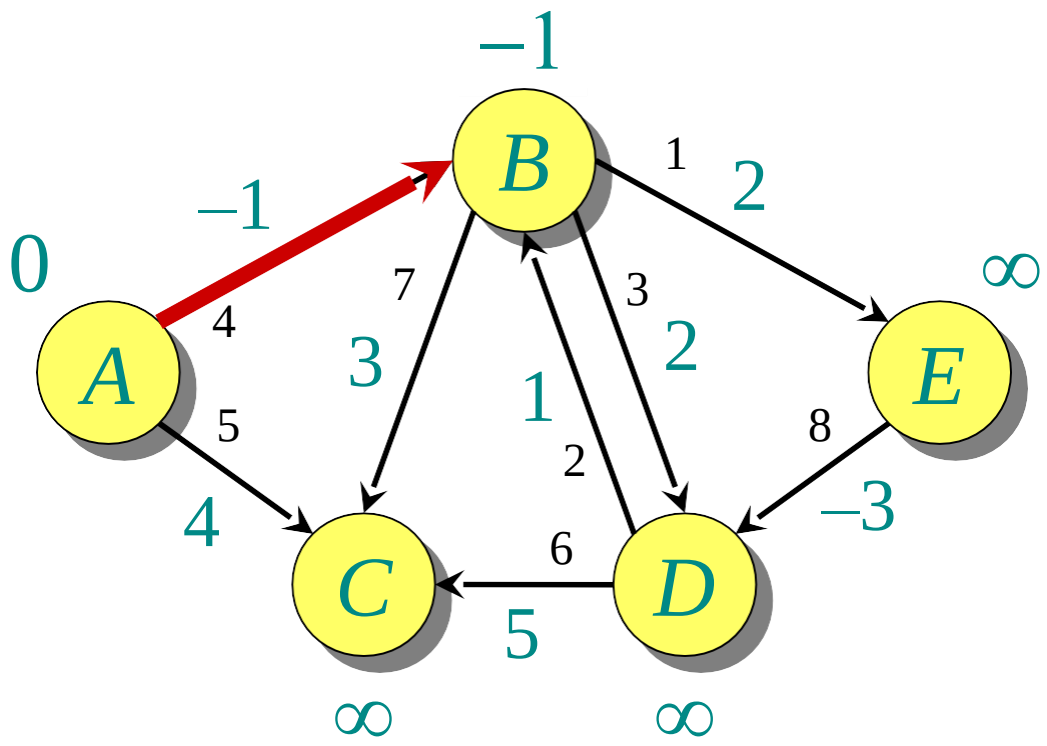
Example of Bellman-Ford



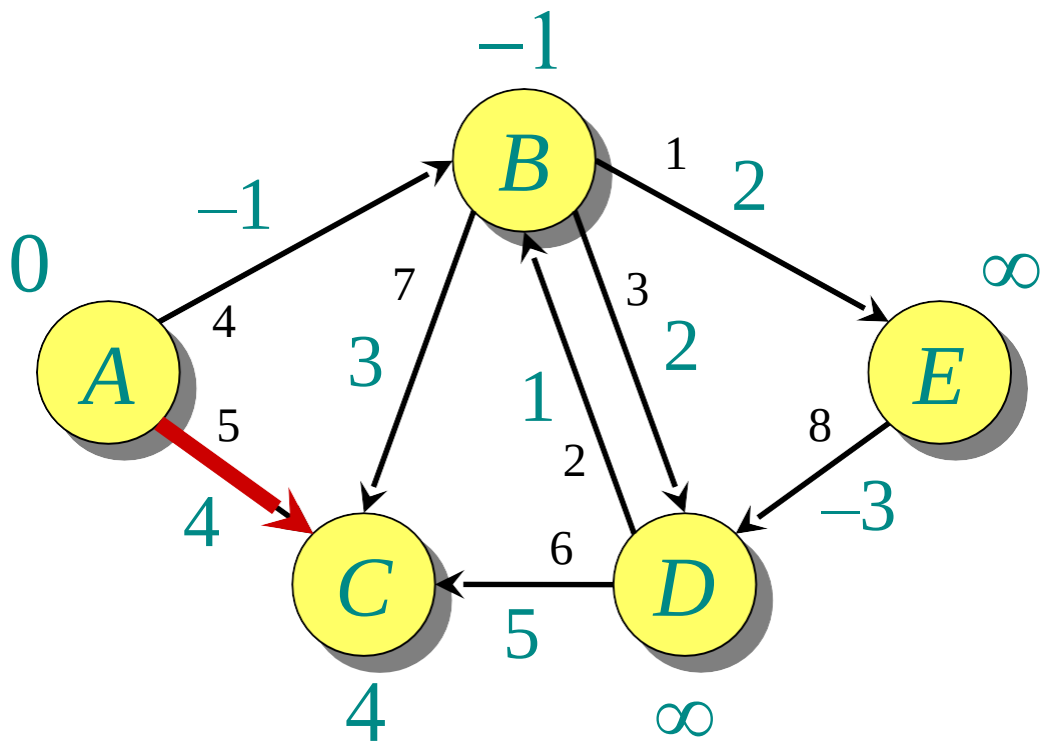
Example of Bellman-Ford



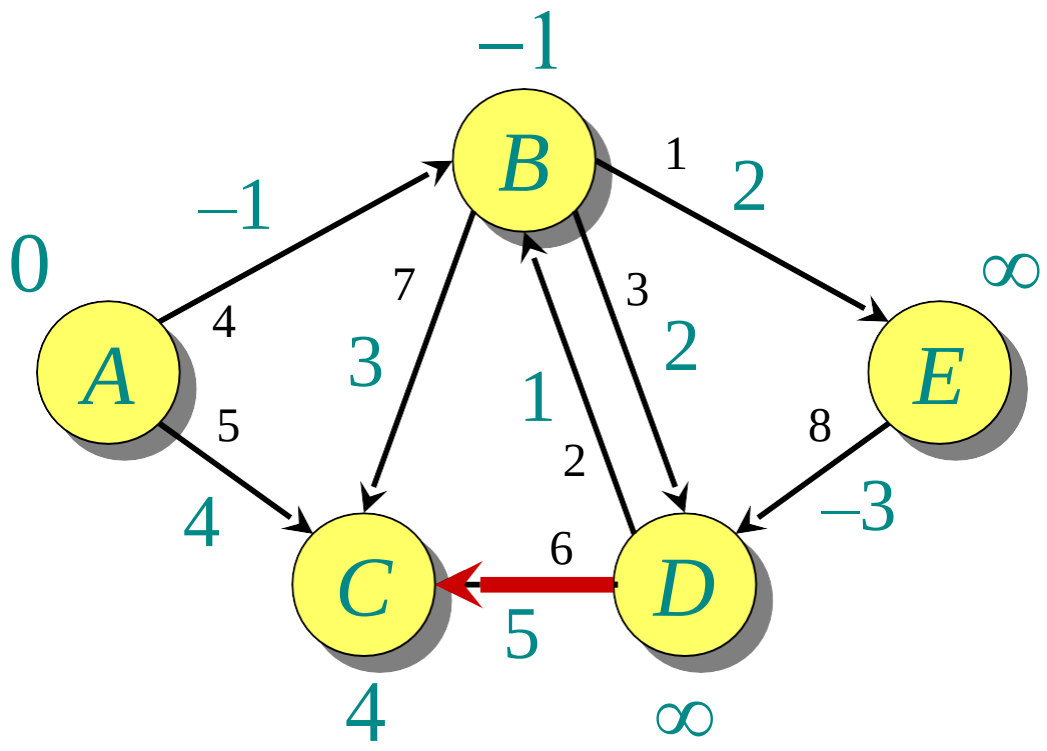
Example of Bellman-Ford



Example of Bellman-Ford



Example of Bellman-Ford



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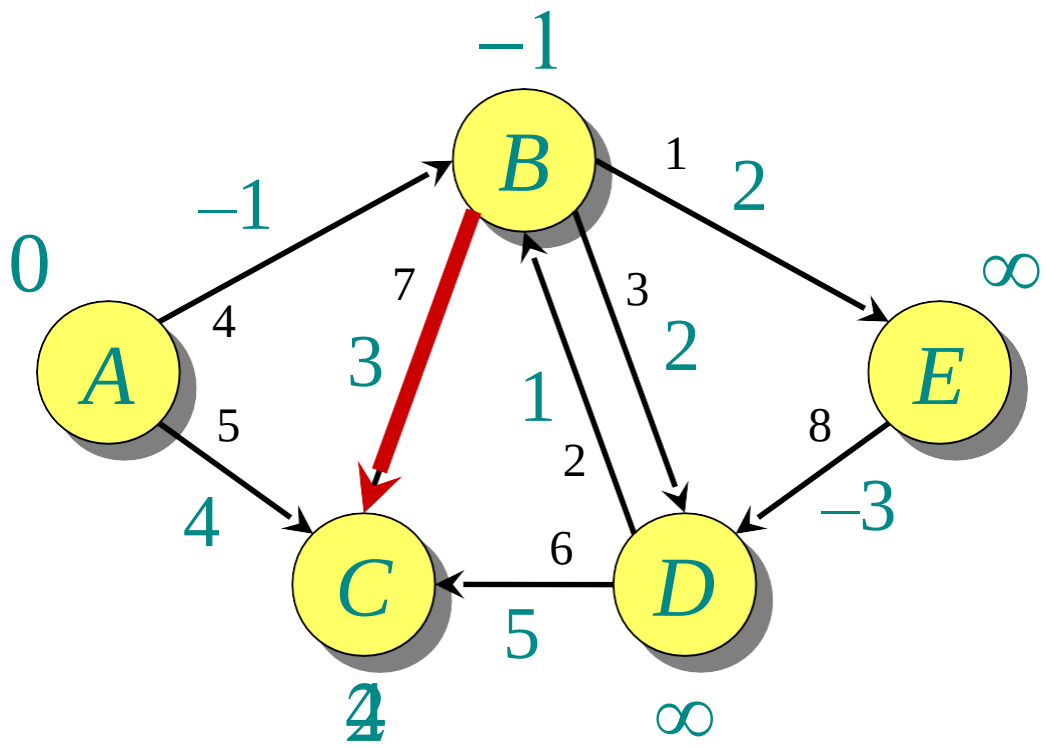
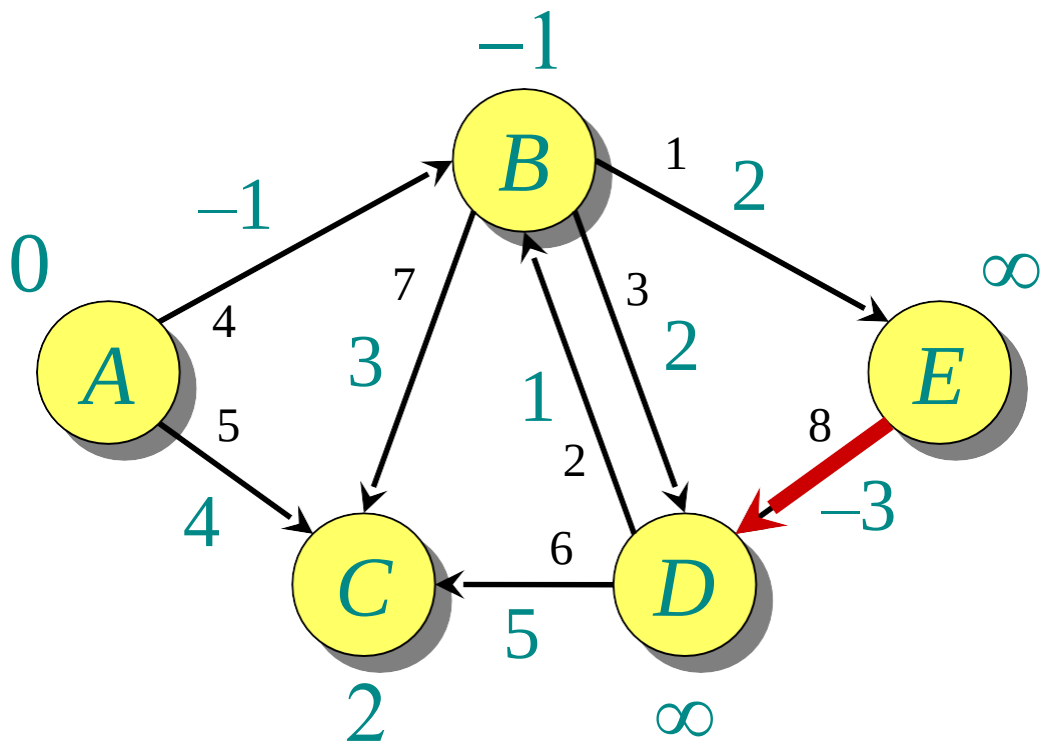


Example of Bellman-Ford



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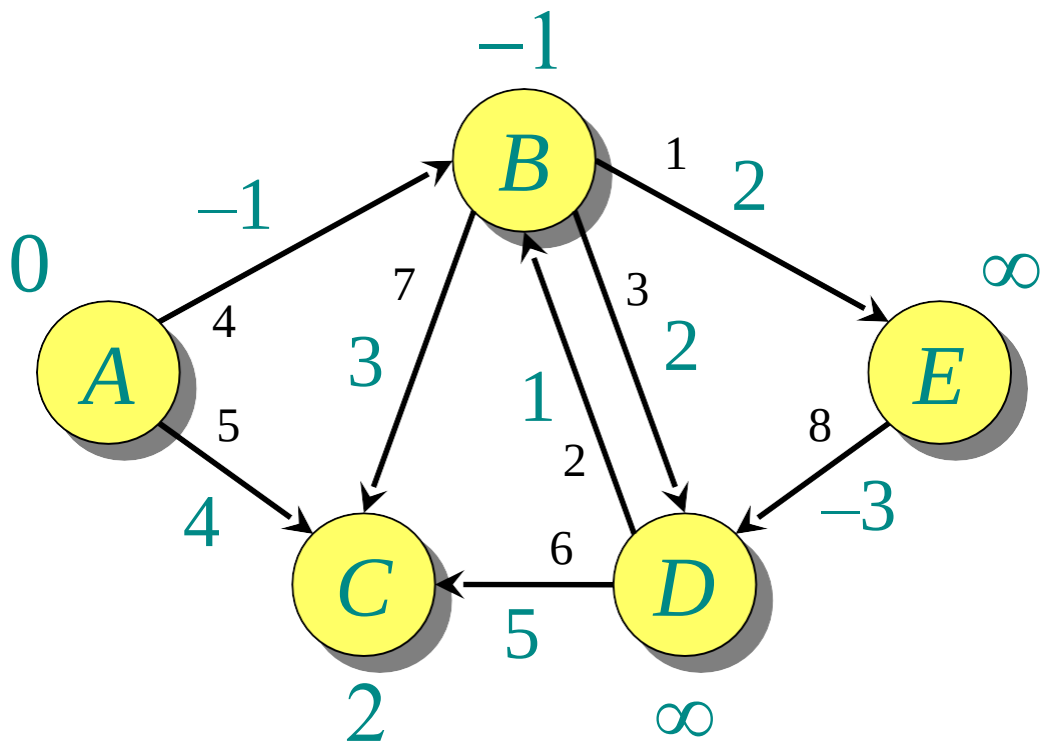
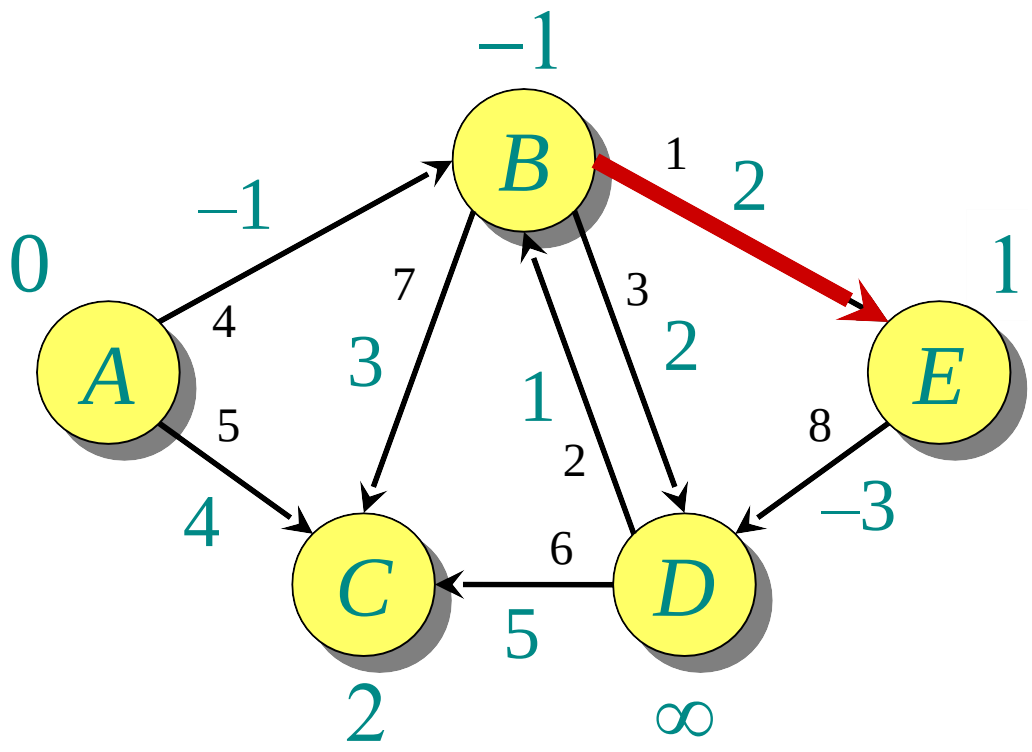
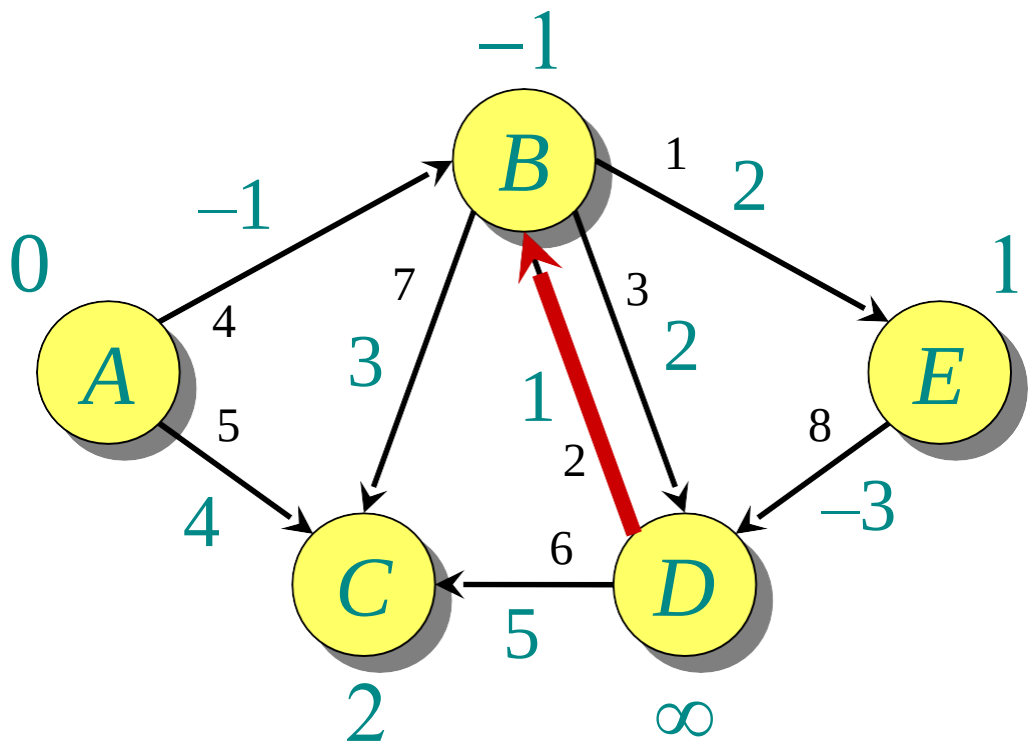


End of pass 1.

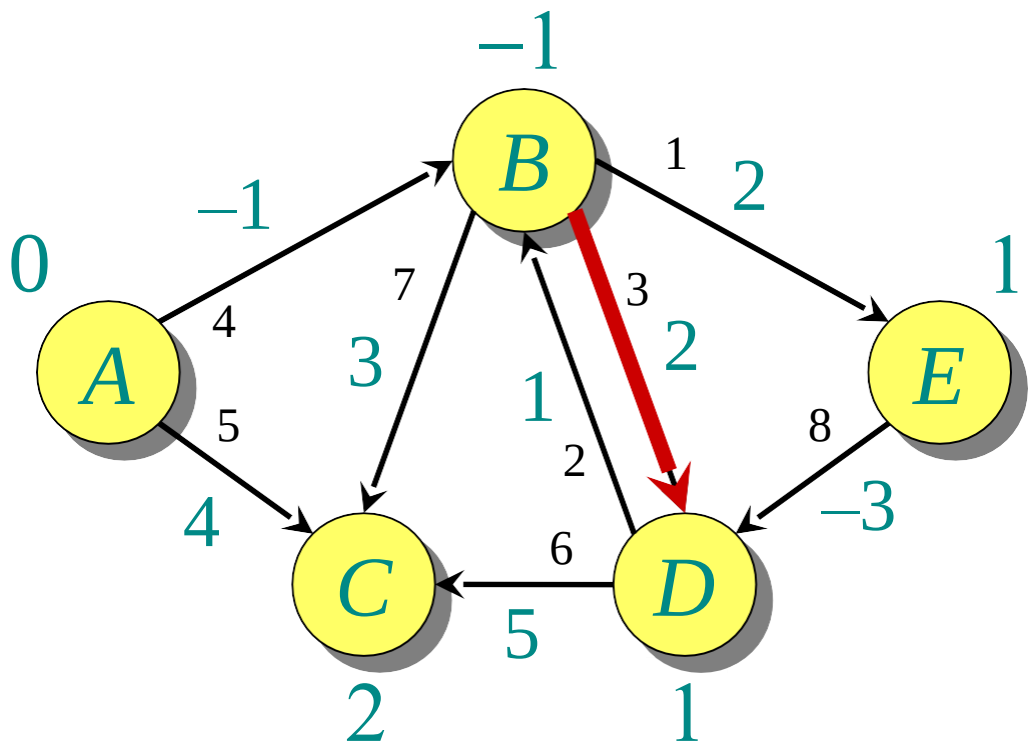
Example of Bellman-Ford



Example of Bellman-Ford



Example of Bellman-Ford



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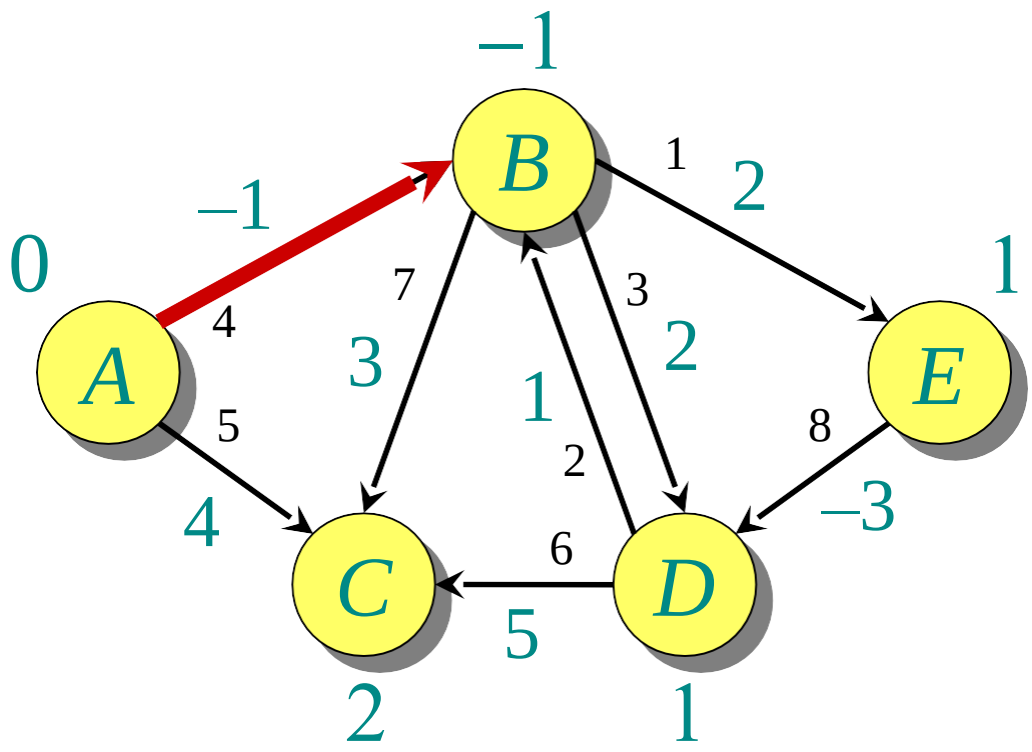
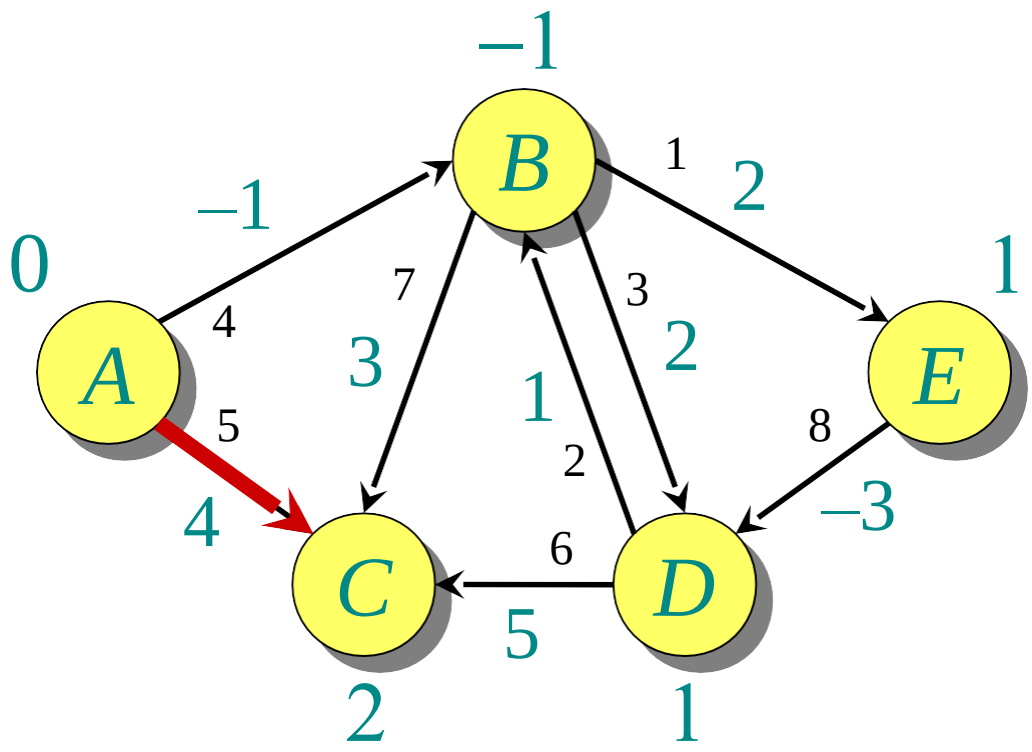
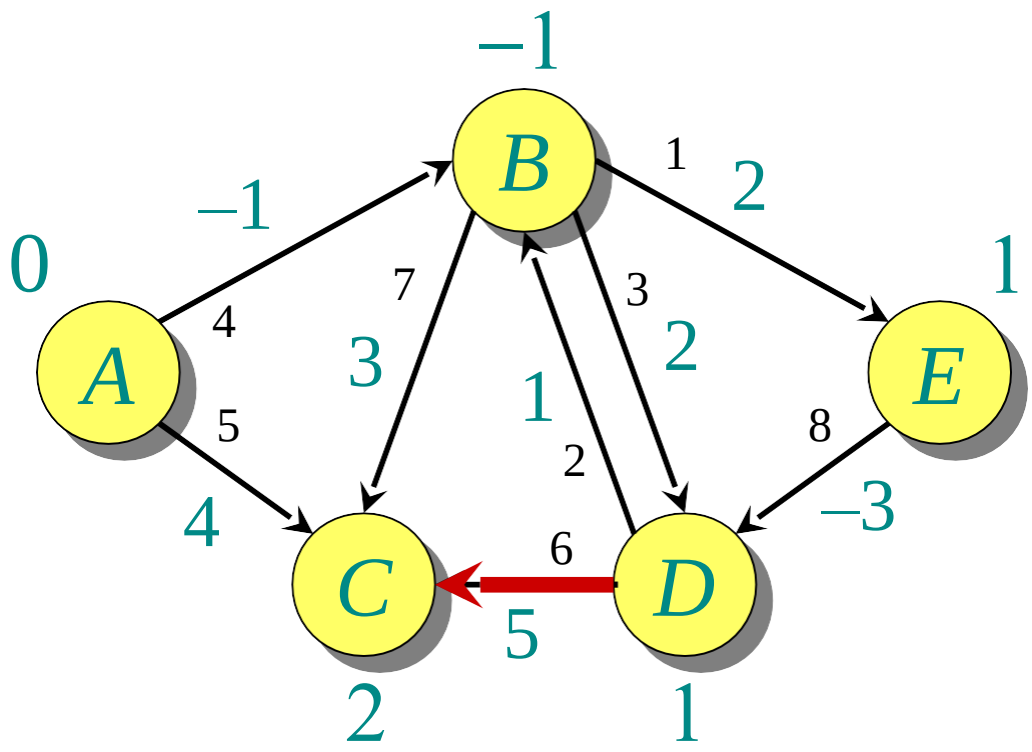


Example of Bellman-Ford



Example of Bellman-Ford



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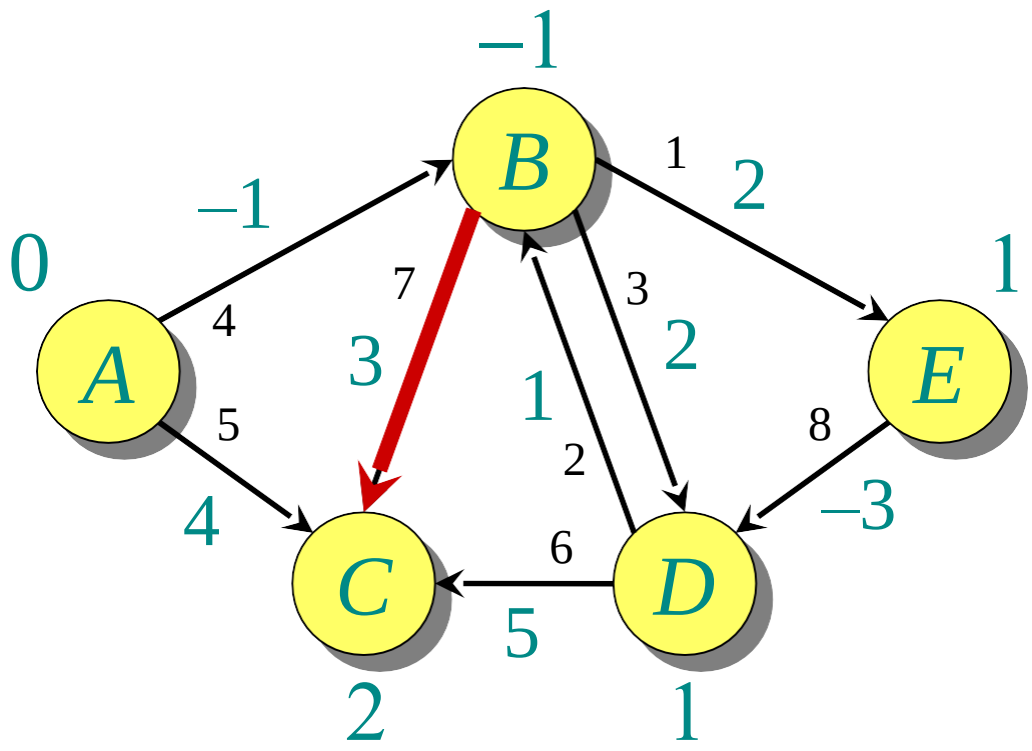
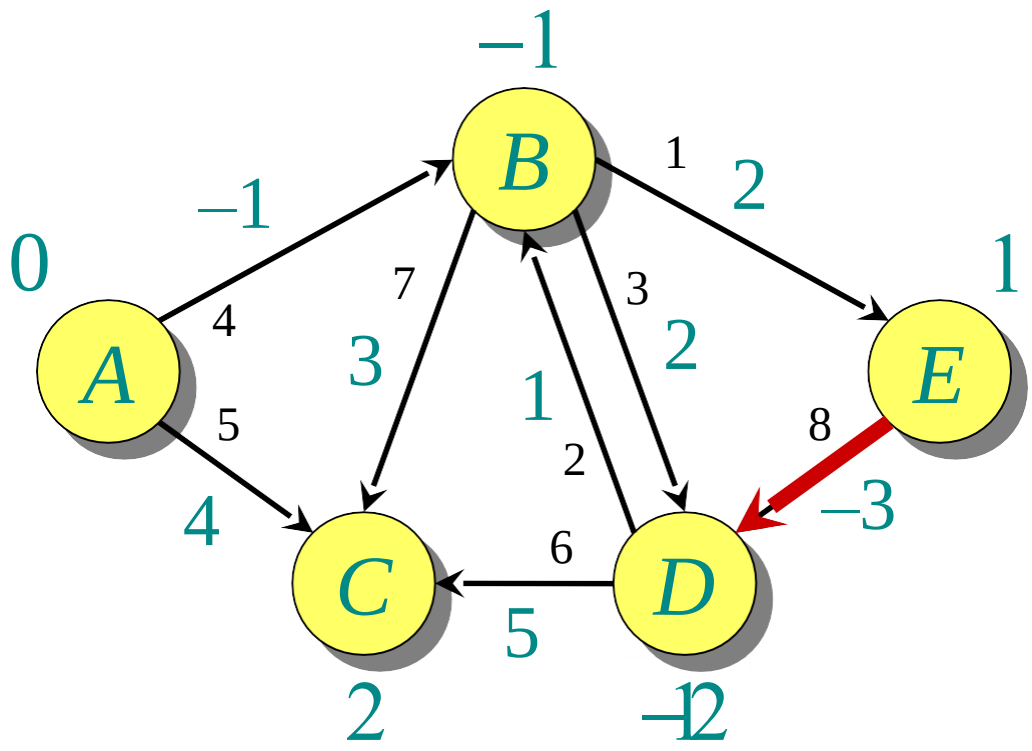


Example of Bellman-Ford



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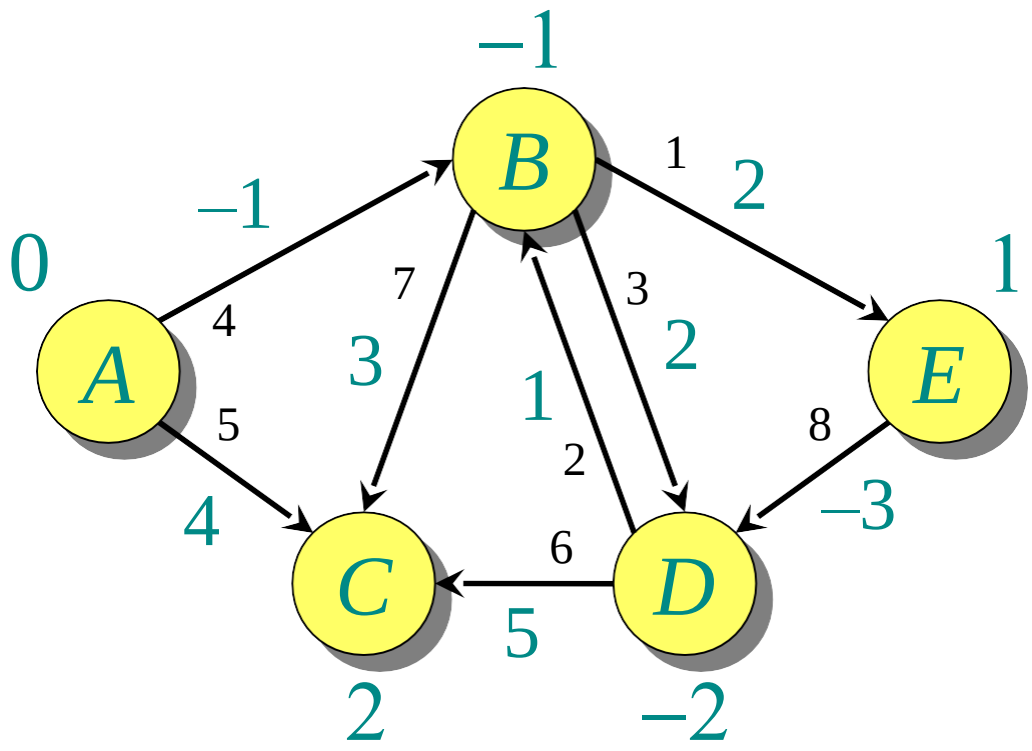
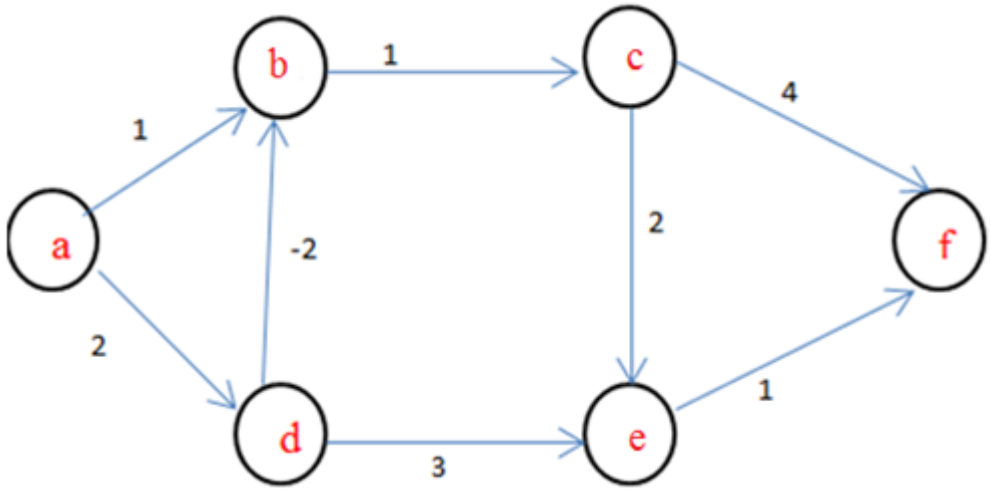


End of pass 2 (and 3 and 4).

Viva

- Write the relax algorithm.
- List the drawbacks of Bellman Ford algorithm.
- Identify the path that has minimum cost to travel from node a to node f.



- Can Bellman ford algorithm be solved by using greedy algorithm.
- Differentiate between bellman ford and dijkstra's algorithm.
- Reference

https://algs4.cs.princeton.edu/lectures/44DemoBellmanFord.pdf

Applications

Bellman-Ford in Practice

- Distance-vector routing protocol
  - Repeatedly relax edges until convergence
  - Relaxation is local!
- On the Internet:
  - Routing Information Protocol (RIP)
  - Interior Gateway Routing Protocol (IGRP)

photo by Ross Imlach, 2011
http://www.flickr.com/photos/rossimlach/5446205998/