Algorithms

Bellman-Ford Homework

Mostafa S. Ibrahim
Teaching, Training and Coaching for more than a decade!

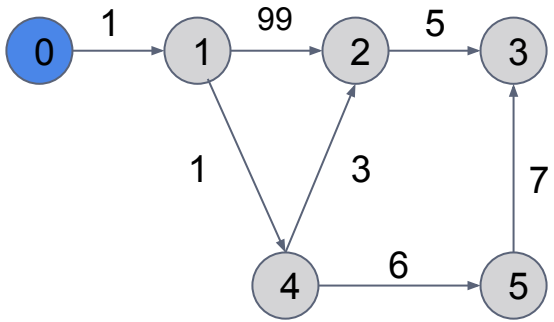
Artificial Intelligence & Computer Vision Researcher
PhD from Simon Fraser University - Canada
Bachelor / Msc from Cairo University - Egypt
Ex-(Software Engineer / ICPC World Finalist)

Problem #1: Improving Bellman-Ford

- Focus on the **last code** version of Bellman-Ford
- During the tracing, we noticed that the later iterations did nothing
- Introduce a very simple code improvement that will remove the majority of these unnecessary iterations

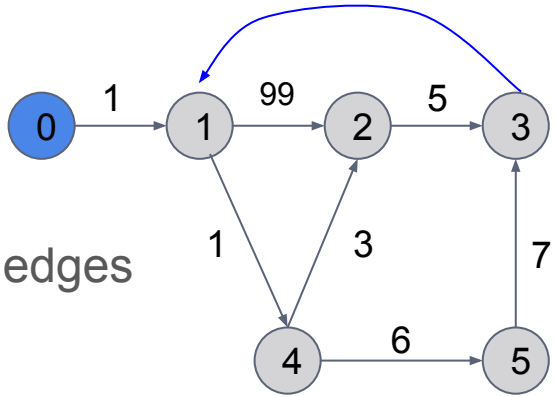
Problem #2: Building the Path

- Extend and test your code to allow us print the shortest path among the nodes
- E.g. test target = 3
  - 0 1 4 2 3

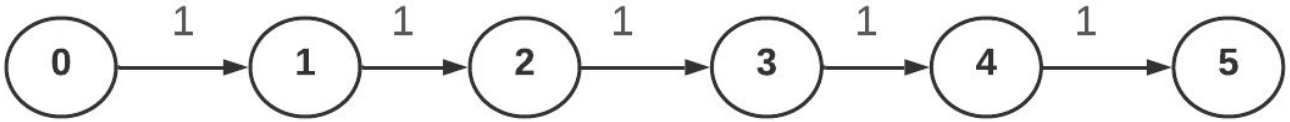


Problem #3: Detect Negative Cycles

- Find a (smart) observation to detect whether or not there's a negative cycle in a given graph; one that is reachable from the source node
- Change the code to return boolean TRUE to indicate a **negative** cycle
  - For the blue arc: 3-1
    - Value = 7 ⇒ positive cycle
      - No problem
    - Value = -1000
      - Negative cycle
- Hint: a path has a maximum of N-1 edges
  - So we relax with N-1 full iterations



Problem #4: Edge Order



- Assume the start node is 0
- Assume we have edges in the following 2 orders:
  - Edges1: {(0, 1), (1, 2), (2, 3), (3, 4), (4, 5)}
  - Edges2: {(4, 5), (3, 4), (2, 3), (1, 2), (0, 1)}
- How many iterations will it take before
  nothing else will be updated based on the edge list?
- Any comments?

Problem #5: Is Valid Definition?

- Recall our original definition: dist[] at kth iteration (1-based) means: the shortest path from the source to the N-1 nodes using **at most k edges**
- Consider the previous example: do you think our original definition still valid? Why or why not?
  What is the reason?
  Does this affect the correctness of shortest paths?

"Acquire knowledge and impart it to the people."

"Seek knowledge from the Cradle to the Grave."

Optional: no support / don’t ask

- How to get all the nodes that are in a negative cycle?
- How to get all the nodes that are reachable from a negative cycle?
- We learned these ones in Floyd Less, how about Bellman-Ford!