

# Computer Networks

## Computing Shortest Paths with Dijkstra (§5.2.2)



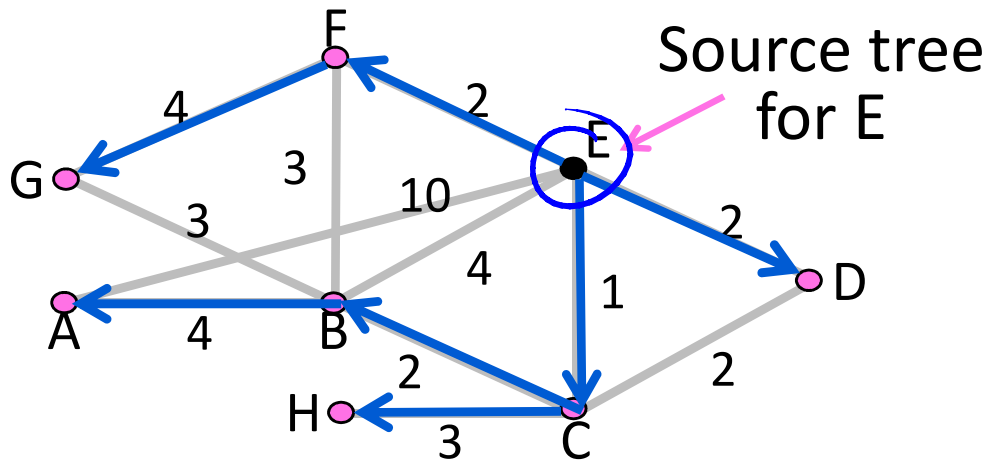
David Wetherall (djw@uw.edu)

Professor of Computer Science & Engineering

UNIVERSITY *of* WASHINGTON

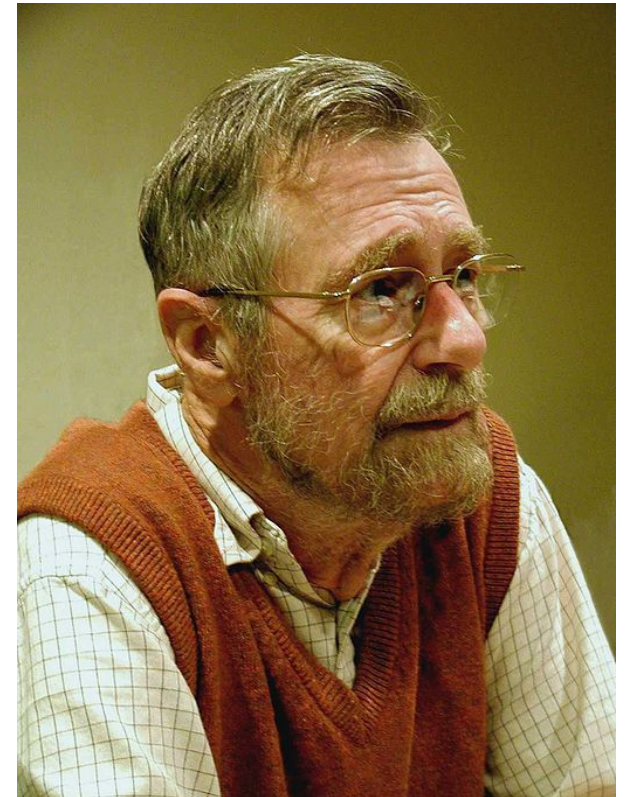
# Topic

- How to compute shortest paths given the network topology
  - With Dijkstra's algorithm



# Edsger W. Dijkstra (1930-2002)

- Famous computer scientist
  - Programming languages
  - Distributed algorithms
  - Program verification
- Dijkstra's algorithm, 1959
  - Single-source shortest paths, given network with non-negative link costs



By Hamilton Richards, CC-BY-SA-3.0, via Wikimedia Commons

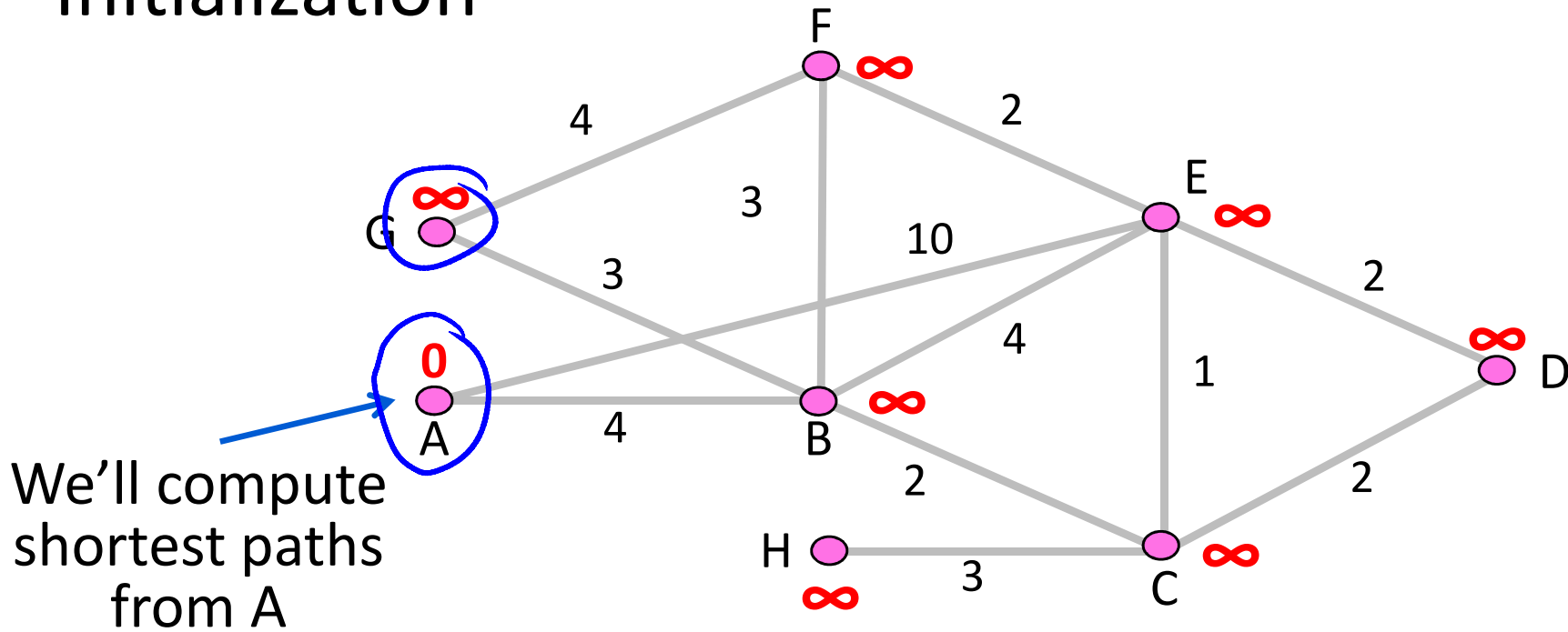
# Dijkstra's Algorithm

Algorithm:

- ~~✗~~ Mark all nodes tentative, set distances from source to 0 (zero) for source, and  $\infty$  (infinity) for all other nodes
- ~~✗~~ While tentative nodes remain:
  - Extract N, a node with lowest distance
  - Add link to N to the shortest path tree
  - Relax the distances of neighbors of N by lowering any better distance estimates

# Dijkstra's Algorithm (2)

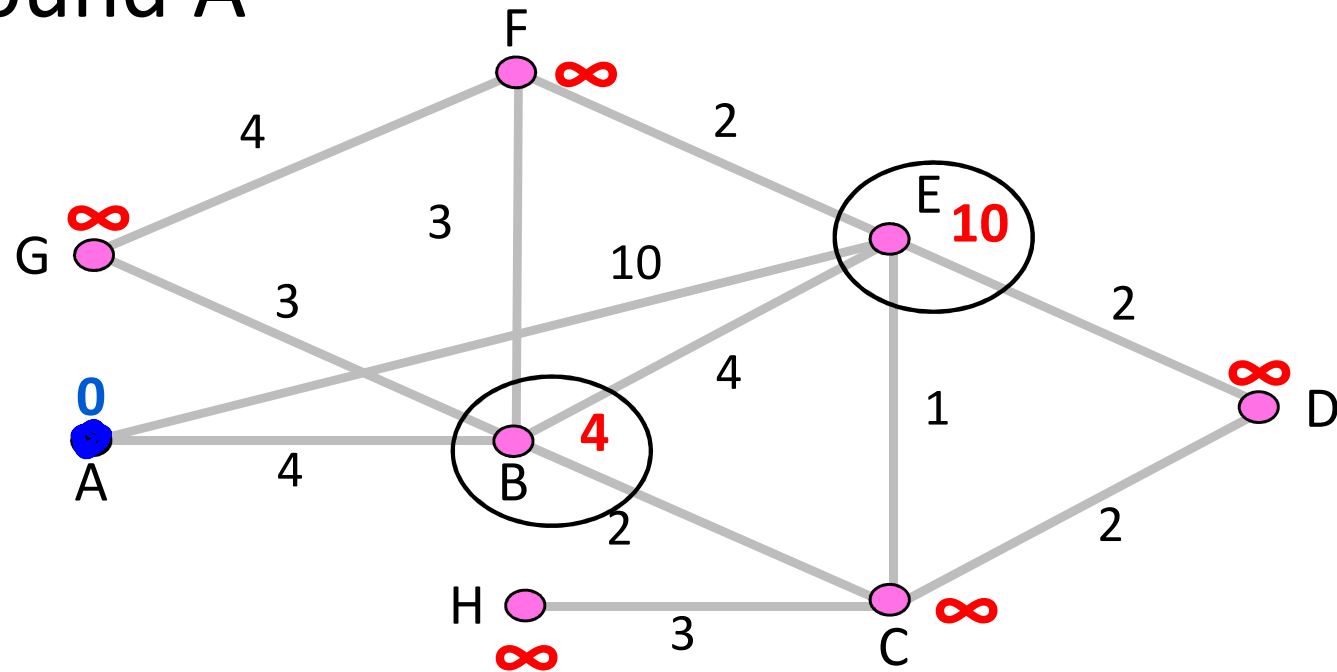
- Initialization



We'll compute shortest paths from A

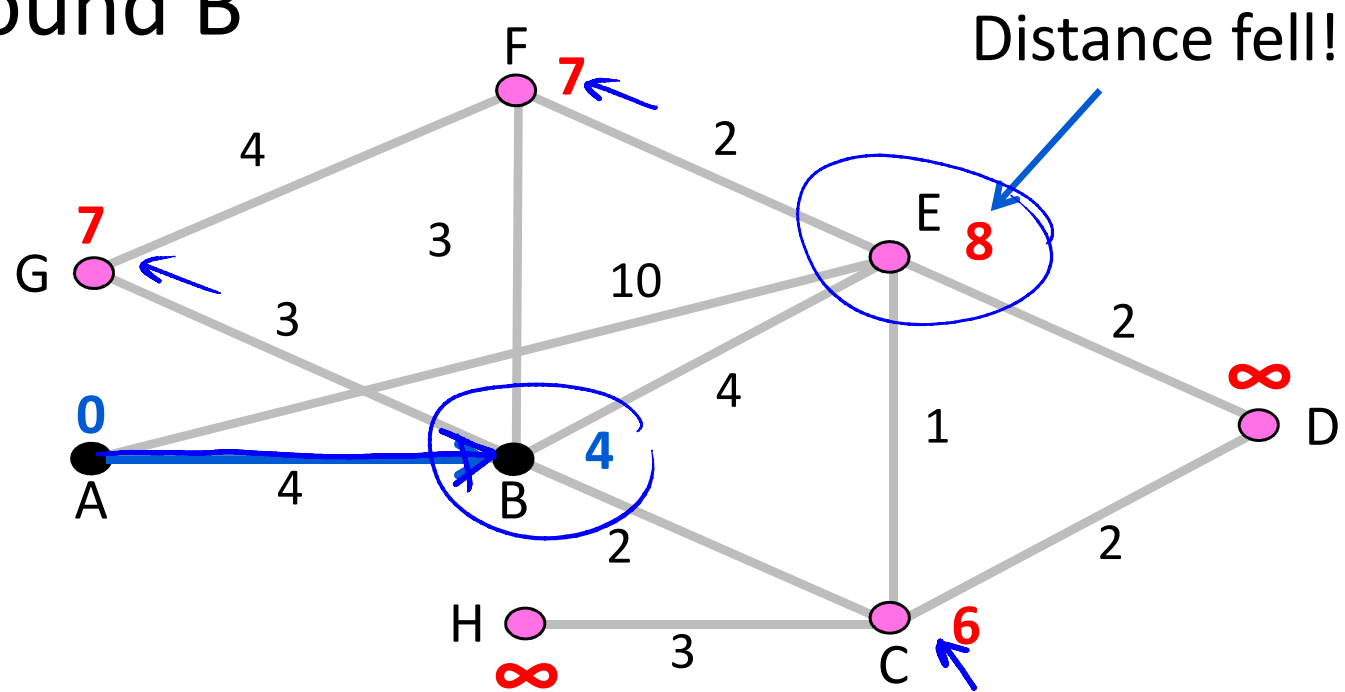
# Dijkstra's Algorithm (3)

- Relax around A



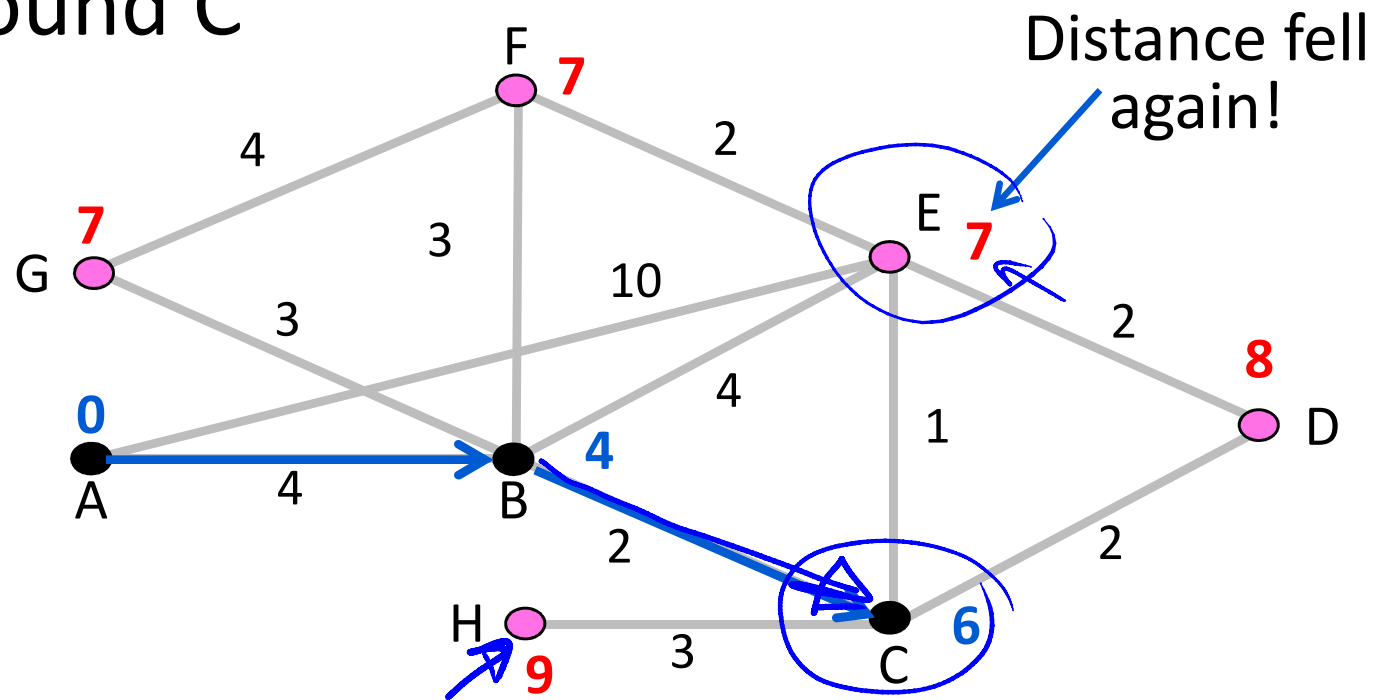
# Dijkstra's Algorithm (4)

- Relax around B



# Dijkstra's Algorithm (5)

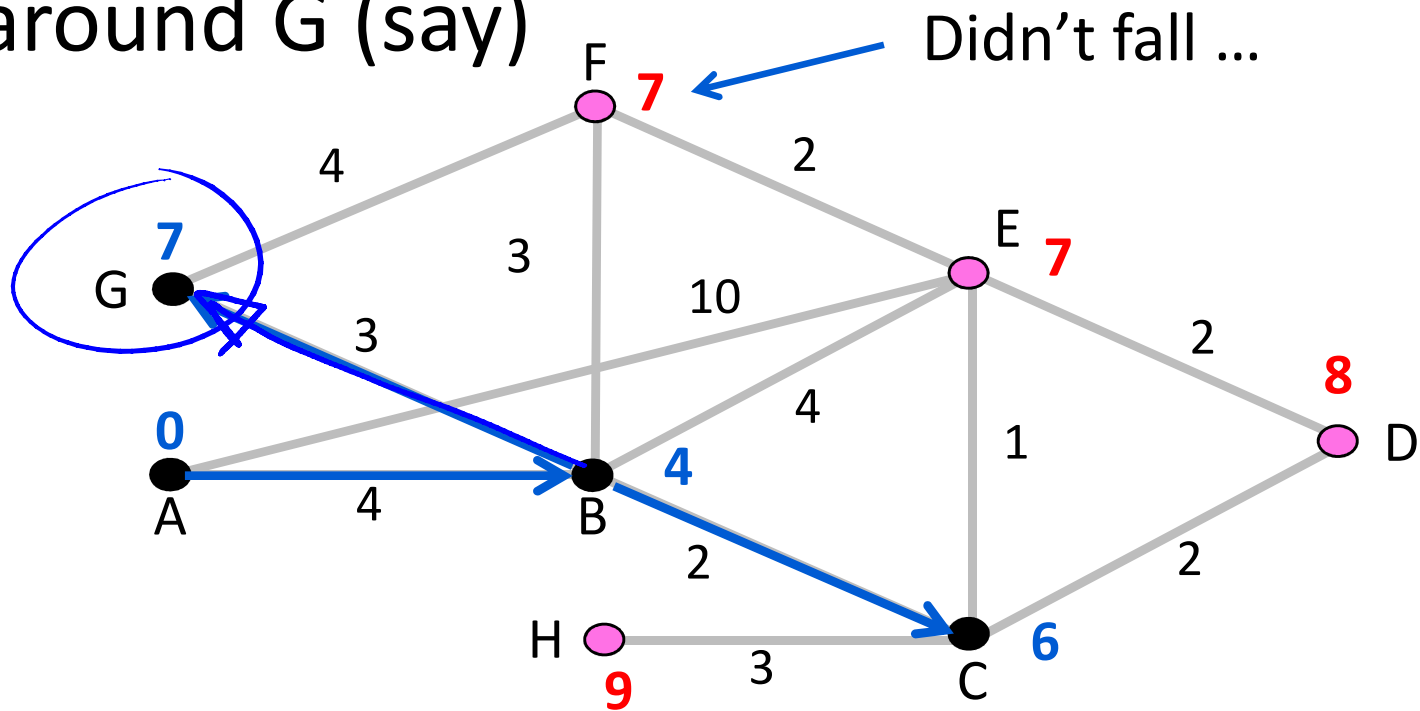
- Relax around C





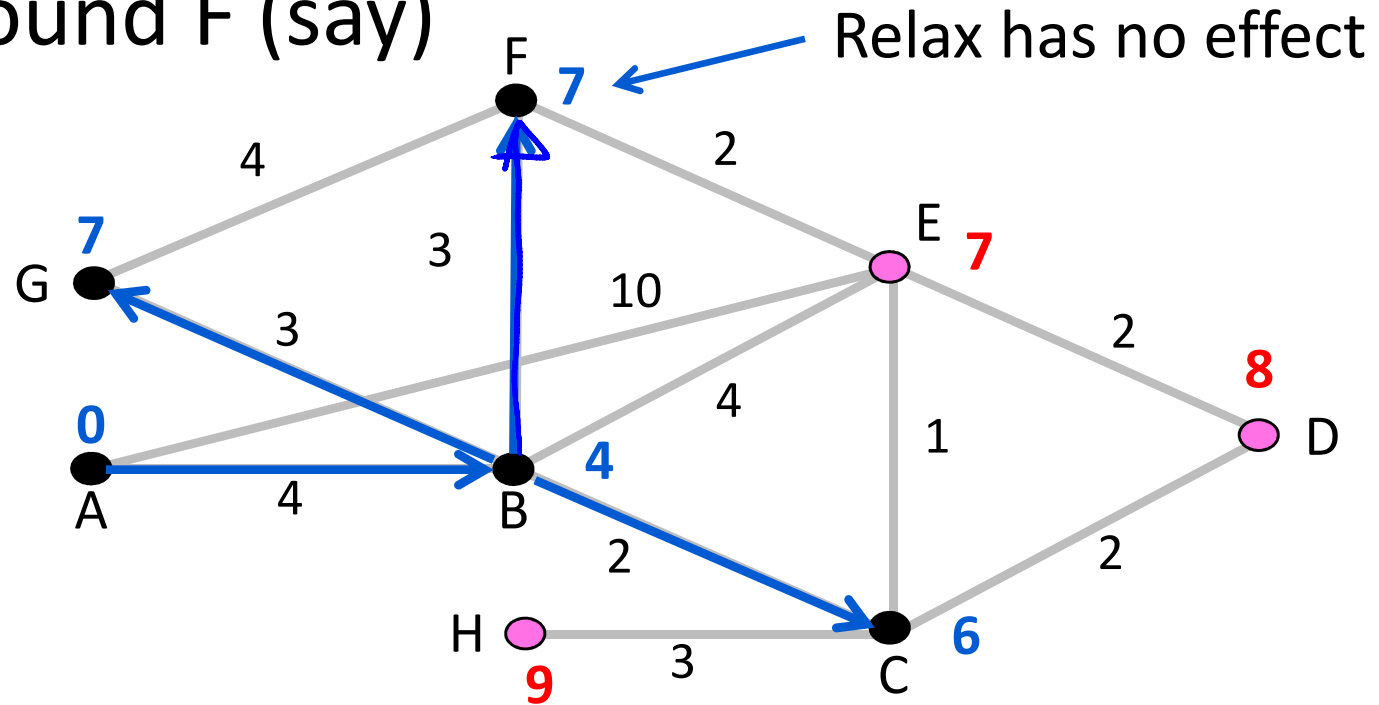
# Dijkstra's Algorithm (6)

- Relax around G (say)



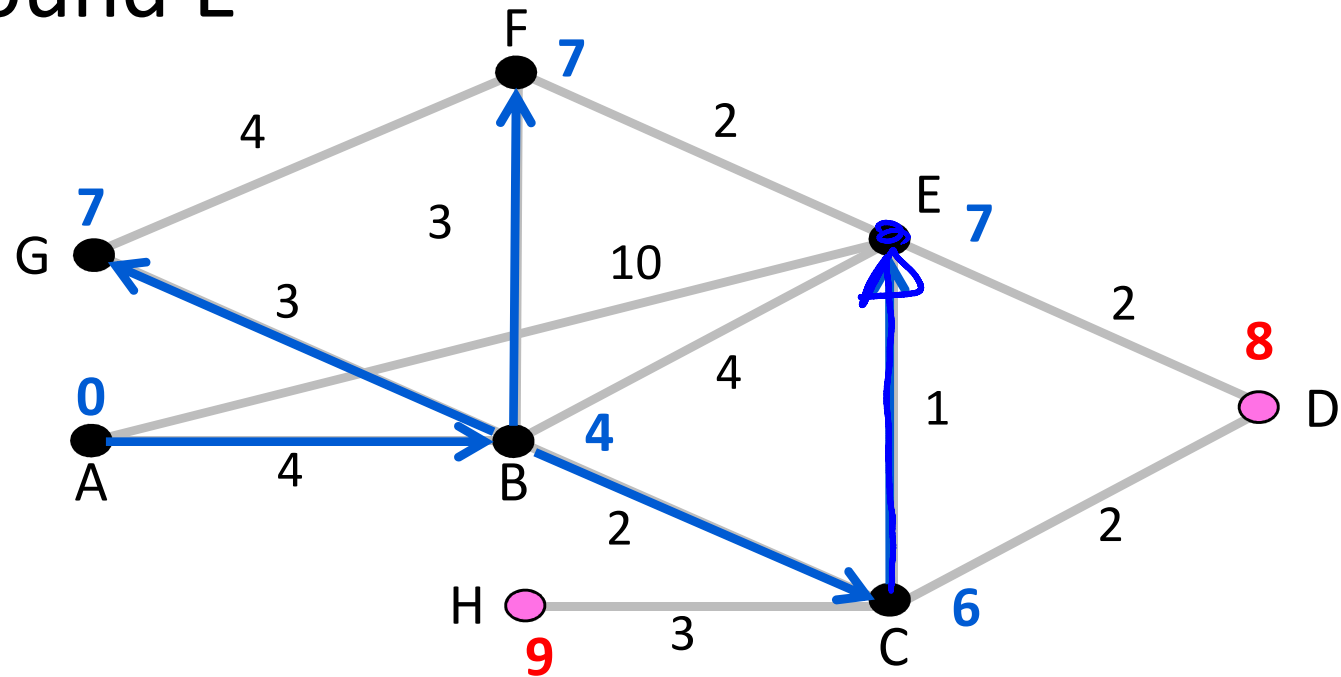
# Dijkstra's Algorithm (7)

- Relax around F (say)



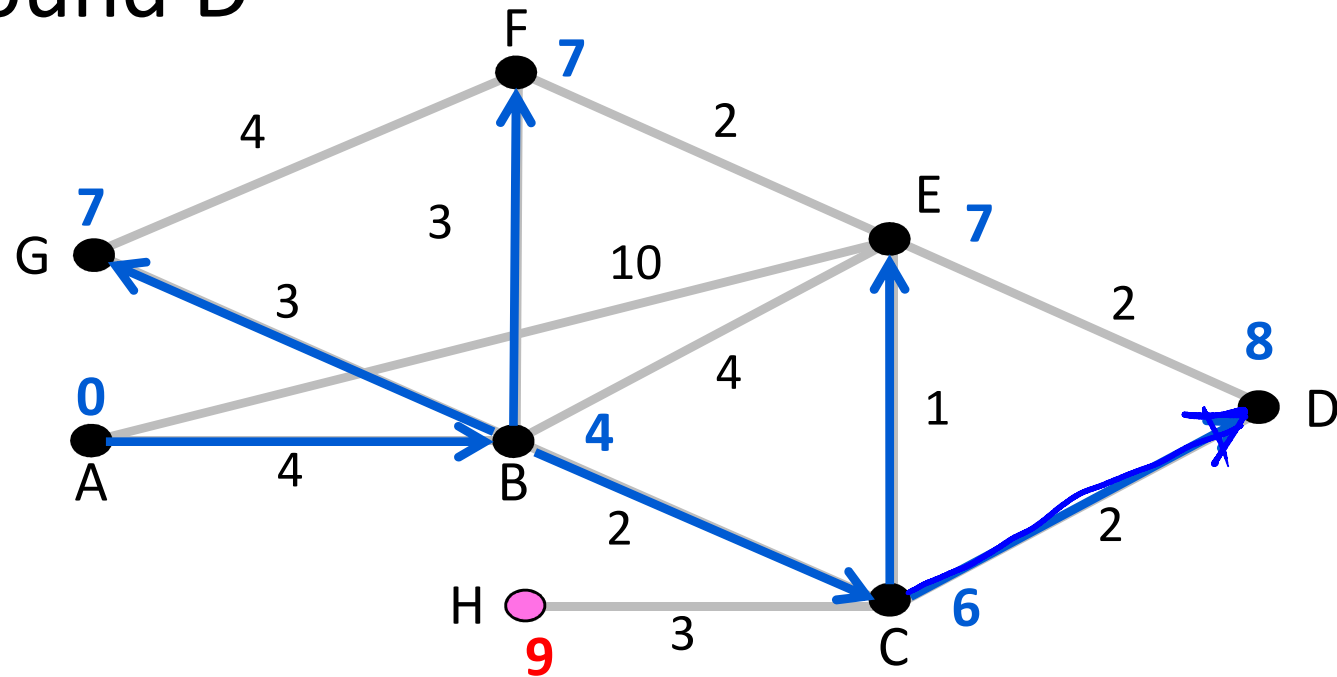
# Dijkstra's Algorithm (8)

- Relax around E



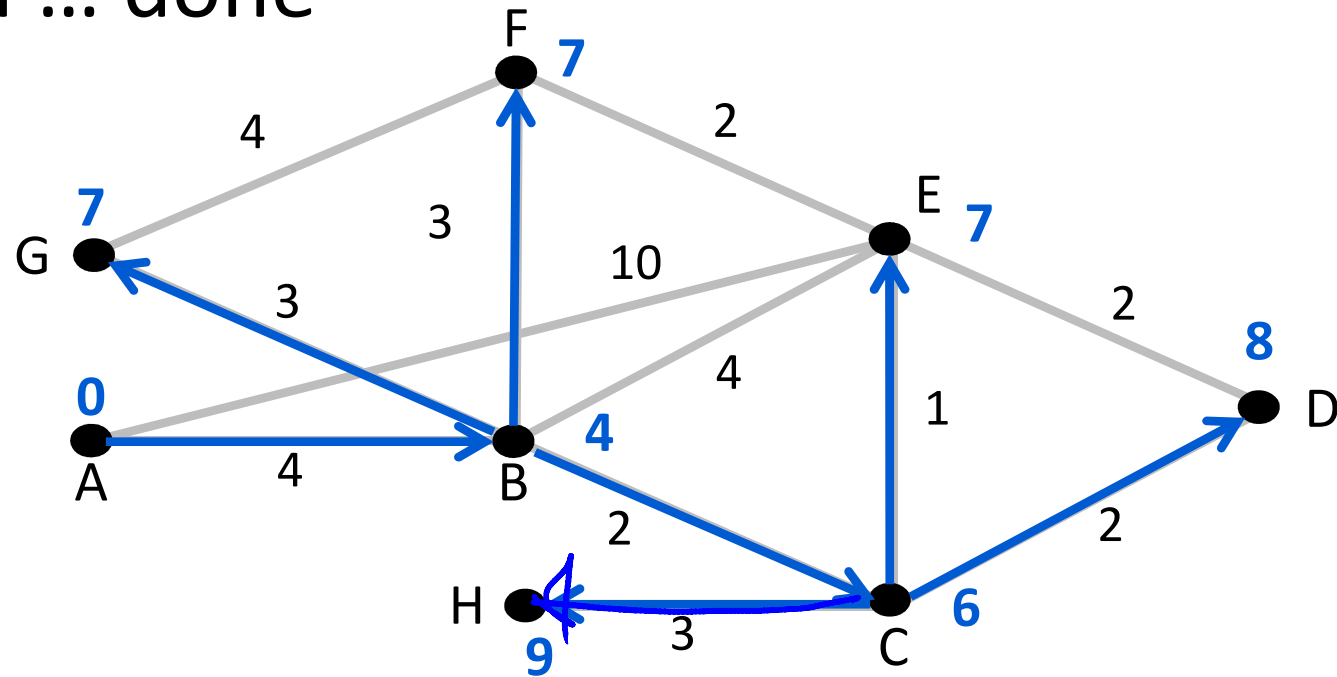
# Dijkstra's Algorithm (9)

- Relax around D



# Dijkstra's Algorithm (10)

- Finally, H ... done



# Dijkstra Comments

- Finds shortest paths in order of increasing distance from source
  - Leverages optimality property
- Runtime depends on efficiency of extracting min-cost node
  - Superlinear in network size (grows fast)
- Gives complete source/sink tree
  - More than needed for forwarding!
  - But requires complete topology

# END

© 2013 D. Wetherall

Slide material from: TANENBAUM, ANDREW S.; WETHERALL, DAVID J., COMPUTER NETWORKS, 5th Edition, © 2011.  
Electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, New Jersey