Module 7
Routing Overview

This Module

- Review of forwarding
- Overview of approaches
  - Distance Vector Routing
  - Link State Routing
Routing as a Shortest Path Problem

- Routing table entries: [destination network, next hop router]
- To decide which router is on the next hop, want to find the shortest path from the router to the destination network's router
- We'll first look at sequential solutions, then distributed
  - "Sequential": full network topology information is available
  - "Distributed": must distribute information and perform computation on each router
- We'll first look at the single-destination / all-sources problem, then all-destinations / all-sources
- One thing to look for:
  - each router obtains a consistent view
    - am forwarding on shortest path
    - shortest paths don’t have loops!
First Approach: Iterative

- **Bellman-Ford Algorithm**

- **Iterative:**
  - At each step, update [cost, next hop] for every router based on [cost] at neighbors
  - Starting conditions:
    - [0, -] at destination
    - [∞, -] at every other router

- **Running time: O(VE)**
  - V: number of vertices (routers)
  - E: number of edges (links)

Bellman-Ford Example

How long can it take to converge?
Second Approach: Greedy

- **Dijkstra’s Algorithm**
- **Greedy:**
  - Build the spanning tree by adding routers to the current spanning tree one at a time
  - Choose next the as-yet-unadded router whose distance to the destination is minimal
  - Starting conditions:
    - $[0,-]$ at destination
    - $[\infty,-]$ at every other router
    - Spanning tree is the destination router alone

- **Running time:** $O(E \log V)$
Dijkstra Example

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How do we know this works?
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Moving to the Internet

- Routing table reflects spanning tree from source to every destination
  - Not really a big change
    - Bellman-Ford: every destination is engaged in the procedure
    - Dijkstra: make the source the root, rather than the destination

- Have to distribute information
  - Bellman-Ford: neighbor information about current costs to each destination
  - Dijkstra: full topology/cost information

- The process is on-going
  - Not all routers boot at once

- Router/link failures can occur
  - Link cost data isn’t static