CS 225

Data Structures

April 28 – Dijkstra's Algorithm Analysis

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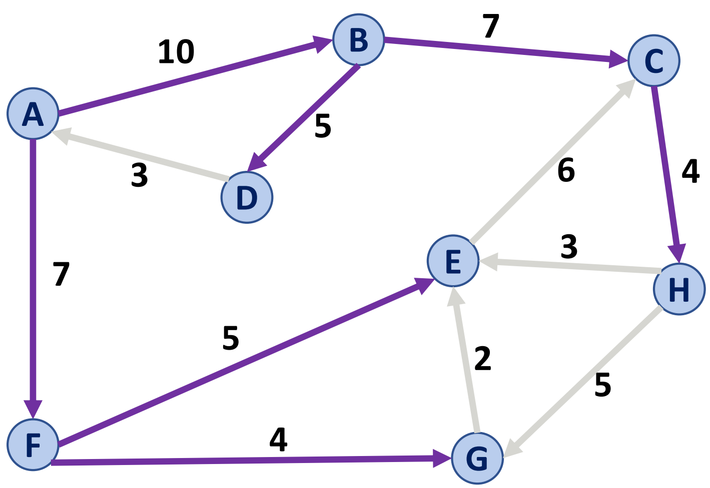
What is left

- Last Lab Starts today due Sunday
- Last Exam Friday in CBTF during lecture time
- Last MP finished yesterday
- 24-hour extensions
  - run for mp_intro, mp_stickers, mp_list*, mp_mosaics
  - run for mp_traversals and mp_mazes run by weekend
- 90% Regrade
  - form will be posted on Monday due by Wednesday.
  - Will grade the code in the repo on Wednesday May 5th at 11:59pm.
- Final Project Done by May 12th

  (This is a hard deadline due to timeline to grade)

Dijkstra's Algorithm (SSSP)



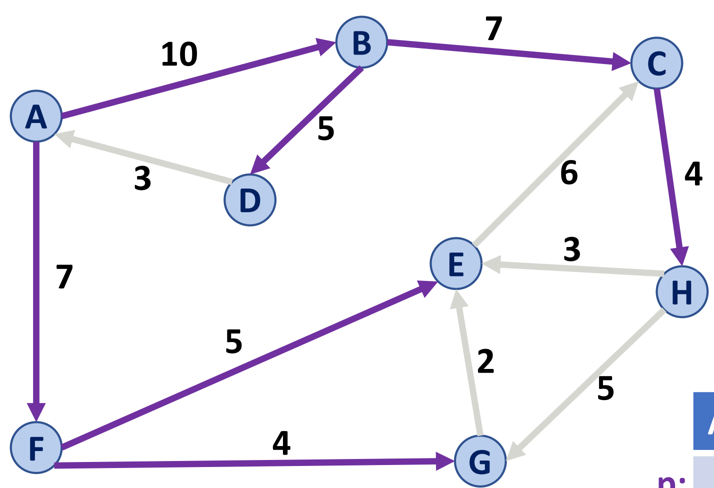

```
DijkstraSSSP(G, s):
  foreach (Vertex v : G):
    d[v] = +inf
    p[v] = NULL
  d[s] = 0

  PriorityQueue Q // min distance, defined by d[v]
  Q.buildHeap(G.vertices())
  Graph T         // "labeled set"

  repeat n times:
    Vertex u = Q.removeMin()
    T.add(u)
    foreach (Vertex v : neighbors of u not in T):
      if cost(u, v) + d[u] < d[v]:
        d[v] = cost(u, v) + d[u]
        p[v] = u
```

Dijkstra's Algorithm (SSSP)

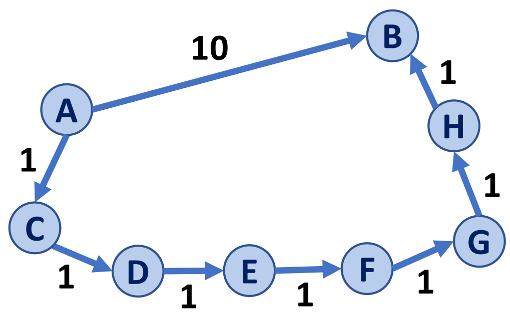
Dijkstra gives us the shortest path from our path (single source) to **every** connected vertex!



	A	B	C	D	E	F	G	H
p:	--	A	B	B	F	A	F	C
d:	0	10	17	15	12	7	11	21

Dijkstra’s Algorithm (SSSP)

Q: How does Dijkstra handle a single heavy-weight path vs. many light-weight paths?



Dijkstra’s Algorithm (SSSP)

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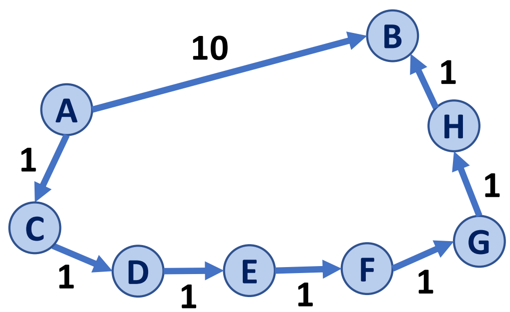

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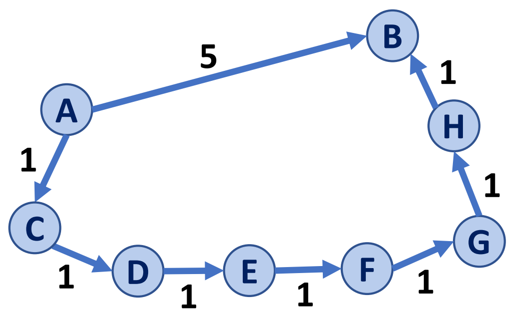
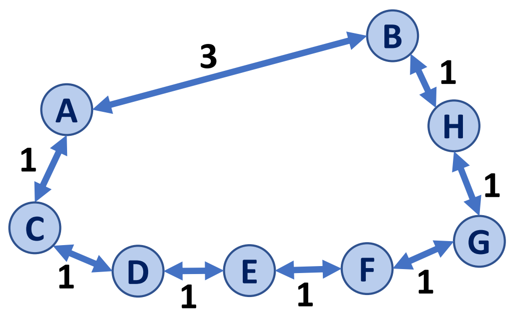


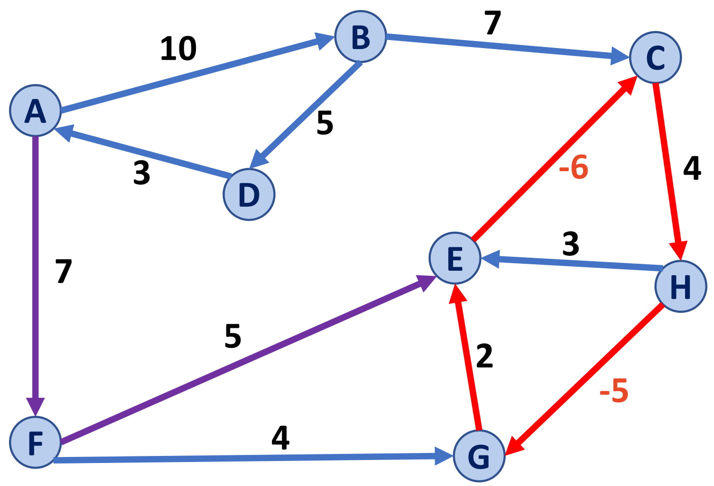
Dijkstra's Algorithm (SSSP)

Q: How does Dijkstra handle undirected graphs?



Dijkstra’s Algorithm (SSSP)

Q: How does Dijkstra handle negative weight cycles?

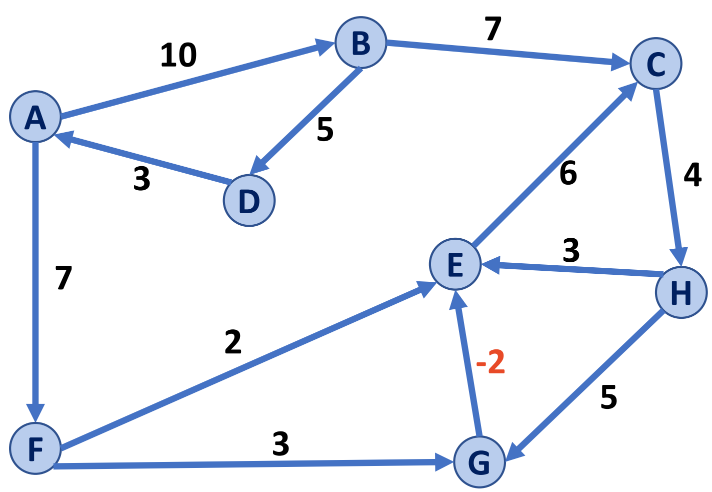


Shortest Path (A ➔ E): A → F → E → (C → H → G → E)*

Length: 12 Length: -5 (repeatable)

Dijkstra's Algorithm (SSSP)

Q: How does Dijkstra handle negative weight edges, without a negative weight cycle?



Dijkstra's Algorithm (SSSP)

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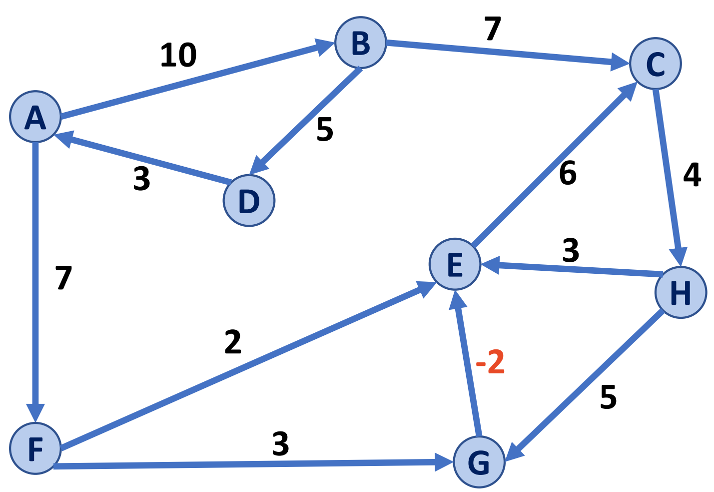

Dijkstra's Algorithm (SSSP)

What is Dijkstra's running time?

```
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        d[v] = cost(u, v) + d[u]
        p[v] = u

  return T
```
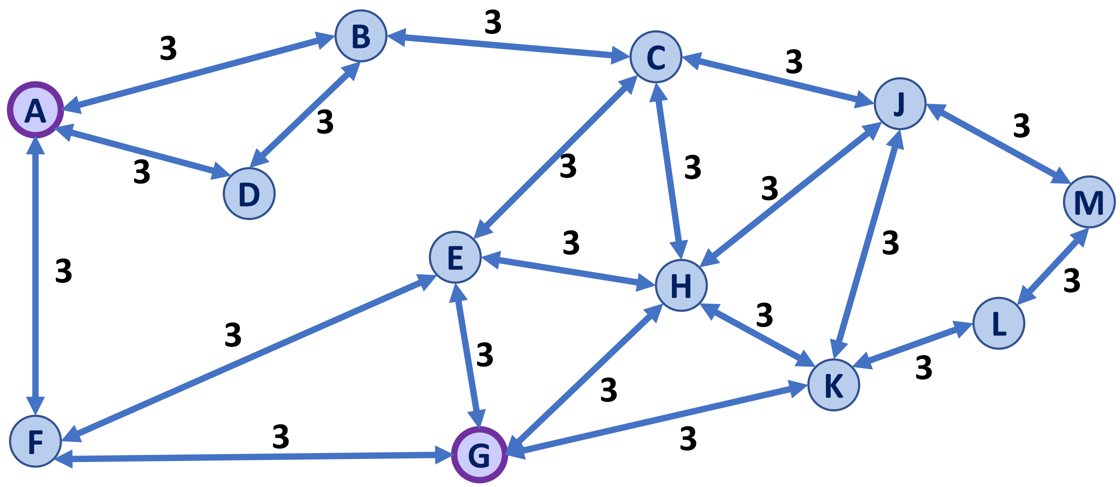

Landmark Path Problem

Suppose you want to travel from **A** to **G**.

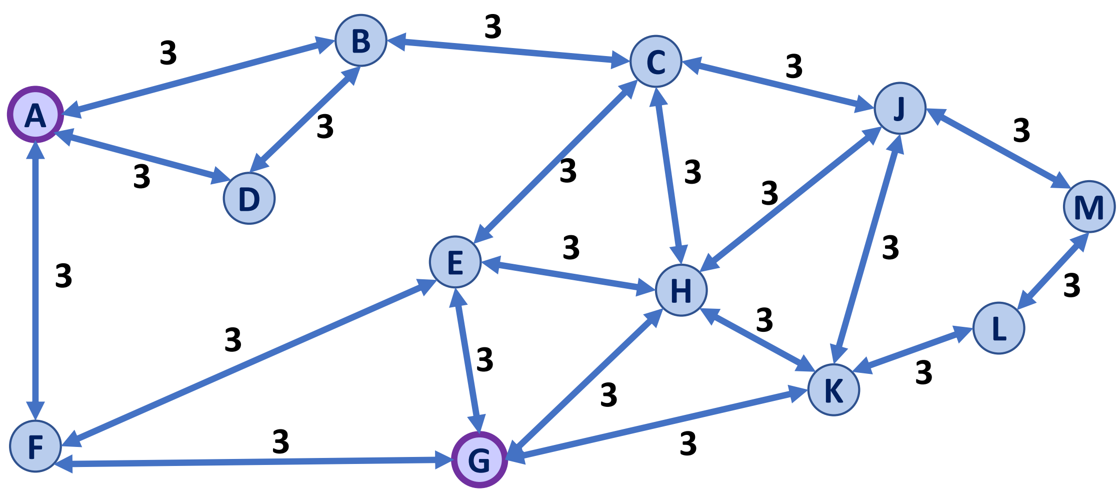
Q1: What is the shortest path from **A** to **G**?



Landmark Path Problem

Suppose you want to travel from **A** to **G**.

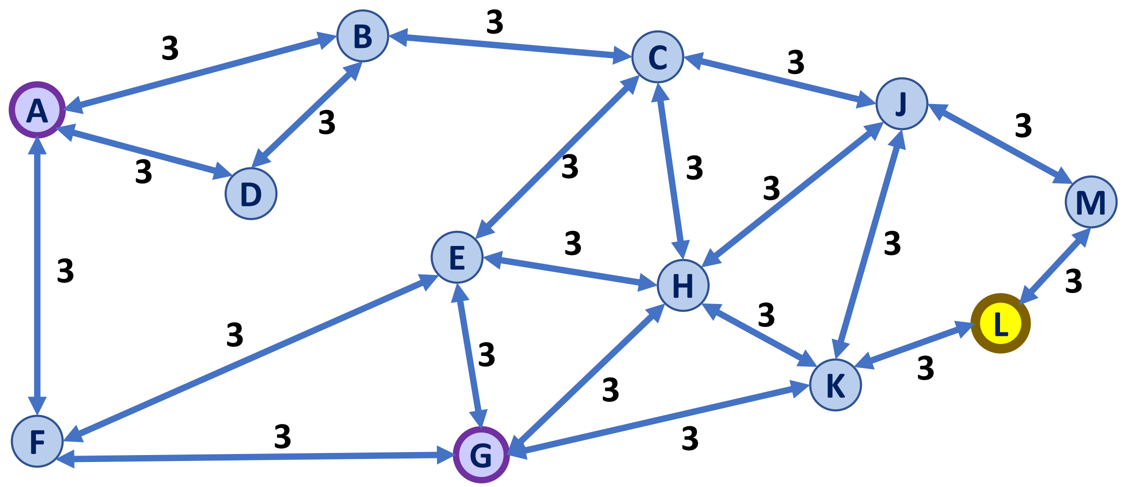
Q2: What is the fastest algorithm to use to find the shortest path?



Landmark Path Problem

In your journey between **A** and **G**, you also want to visit the landmark **L**.

Q3: What is the shortest path from **A** to **G** that visits **L**?



Landmark Path Problem

In your journey between **A** and **G**, you also want to visit the landmark **L**.

Q4: What is the fastest algorithm to find this path?

Q5: What are the specific call(s) to this algorithm?