Graph Algorithms

- **Topological Sort**
  - Produce a valid ordering of all nodes, given pair-wise constraints
  - Solution usually not unique
  - When is solution impossible?

- **Topological Sort Example: Getting an AB in CPS**
  - Express prerequisite structure
  - This example, CPS courses only: 6, 100, 104, 108, 110, 130
  - Ignore electives or outside requirements (can add later)

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Topological Sort

- **Topological Sort Algorithm**
  1. Find vertex with no incoming edges
  2. Remove (updating incoming edge counts) and Output
  3. Repeat 1 and 2 while vertices remain
     - Complexity?

- **Refine Algorithm**
  - Use priority queue?
  - Complexity?

- What is the minimum number of semesters required?
  - Develop algorithm

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Shortest Path (Unweighted)

- Mark all vertices with infinity (*) exec. starting vertex with 0
- Place starting vertex in queue
- Repeat until queue is empty:
  1. Remove a vertex from front of queue
  2. For each adjacent vertex marked with *,
     - process it,
     - mark it with source distance + 1
     - place it on the queue.

How do we get actual “Path”?
Shortest Path (Weighted): Dijkstra

1. Unmark all vertices and give infinite weight
2. Set weight of starting vertex at 0 and place in priority queue
3. Repeat until priority queue is empty:
   1. Remove a vertex from priority queue
      - Process and mark (weight now permanent)
   2. For each adjacent unmarked vertex
      - Set weight at lesser of current weight and
        (source weight + path weight)
      - (This may involve reducing previous weight setting)
      - Place in priority queue (if not there already)

How do we get actual “Path”?

Other Graph Algorithms

- Traveling Salesman
- Spanning Trees
- Paths with negative weights