

Data Structures and Algorithms

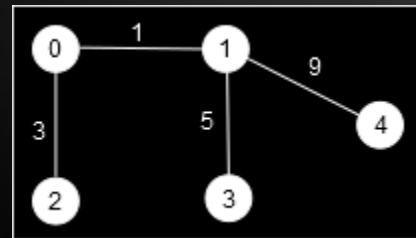
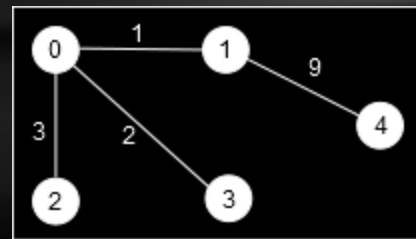
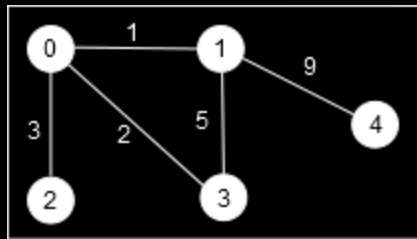
Lecture 11

“C makes it easy to shoot yourself in the foot; C++ makes it harder, but when you do, it blows away your whole leg.”

Bjarne Stroustrup

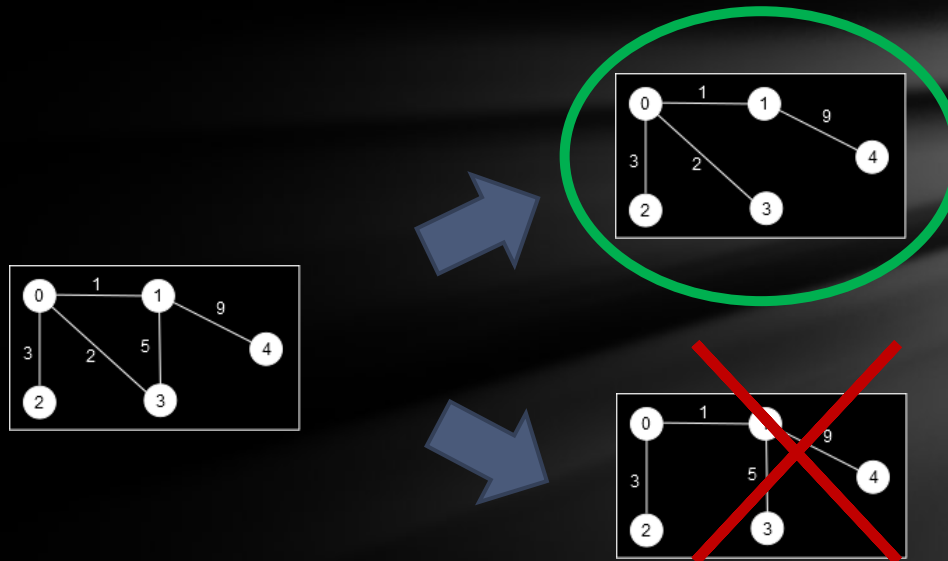
Graphs - Spanning tree

- Given a connected, undirected graph, a spanning tree of that graph is a subgraph that is a tree and connects all the vertices together
- A graph can have multiple spanning trees



Graphs - Minimum spanning tree

A **minimum spanning tree (MST)** or **minimum weight spanning tree** is then a spanning tree with weight less than or equal to the weight of every other spanning tree.



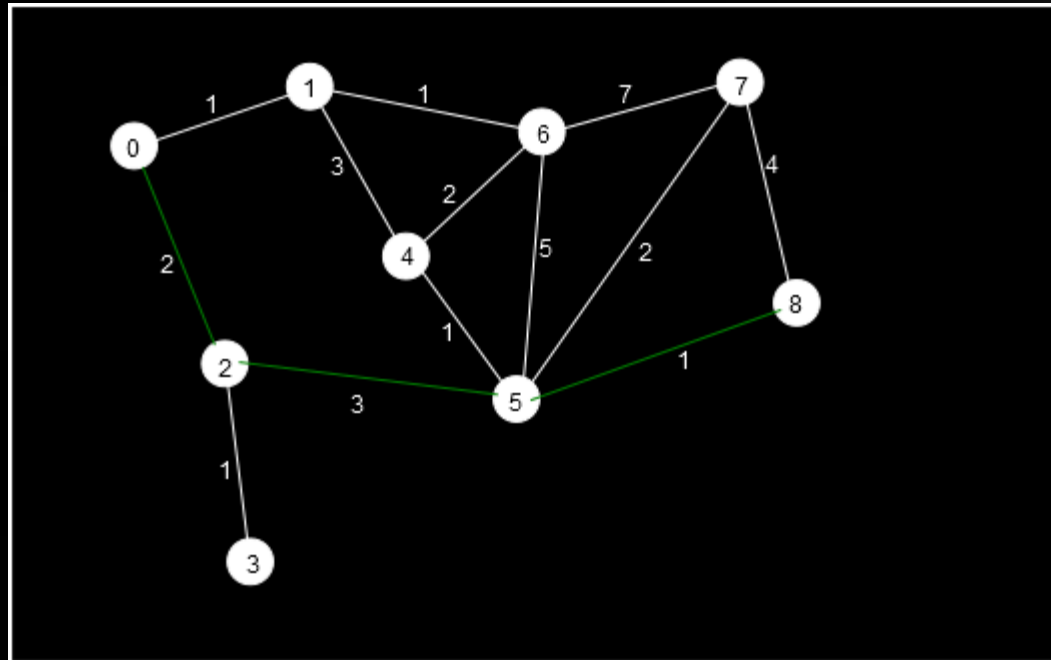
Two algorithms for determining the MST: Prim's algorithm and Kruskal's algorithm

Minimum spanning tree – Prim Algorithm

- Algorithm description:
 - Create two sets of vertexes: Visited and Unvisited
 - Repeat until Unvisited is empty:
 - Find the edge with the lowest cost that connects a vertex from Visited to a vertex from Unvisited
 - Add the vertex in Unvisited to Visited
- Question 1: What's the time complexity for this algorithm if the graph is stored as an adjacency matrix?
- Question 2: What's the time complexity for this algorithm if the graph is stored as a list of edges?
- Question 3: Think of real life application for a MST.

Graph – Routing Problems

- Shortest routes in a graph is a theoretical problem with many applications in real life: construction, networking, GPS applications, etc.



Routing Problems - Dijkstra's algorithm

- Algorithm purpose: find the shortest distance between an initial and a final node
- Algorithm description:
 - Mark the initial node with distance 0 and all the rest with infinity (or a really large value)
 - Create an empty set of visited nodes
 - Repeat until the destination node is visited or until all unvisited nodes have infinity distance to the initial node
 - Set the current node as the one with the smallest distance (to the initial node)
 - Mark all the unvisited neighbors of the current node with the minimum distance between their distance and the sum between the current node distance and the edge between the current node and the neighbor
 - Mark the current node as visited
- Question 1: What is the time complexity of this algorithm if the graph is defined as an adjacency matrix?
- Question 2: We know the shortest distance, how do we get the path?

Eulerian Graphs

- An Eulerian trail or Eulerian path is a trail in a graph which visits every edge exactly once
- An Eulerian circuit or Eulerian cycle is an Eulerian trail which starts and ends on the same vertex.
- Fun game to try:
<https://play.google.com/store/apps/details?id=com.ecapycsw.onetouchdrawing>
- Question: What are the requirements for an undirected graph in order to have an Eulerian path?
- Question: What are the requirements for an undirected graph in order to have an Eulerian cycle?

Graphs - Exercises

1. Implement Prim's algorithm for a user-specified graph
2. Implement Dijkstra's Algorithm for a user-specified graph
3. Implement an algorithm to print an Eulerian path for a graph or display "The specified graph does not have an Eulerian path" for a user-specified graph.

Thank you!