Bong Lee
CS 302
Asst 9

Graph Data Structure

Graph Summary

Graphs are a way to represent connection between elements or data. Graphs are made up of vertices and edges. The vertices are connected to each other via edges. The edges can either be uni-direction or bi-directional. Uni-directional graphs are called directed graph and bi-directional graphs are called undirected graph. An element in the graph is said to be adjacent to another element when an edge connects them without going through another element. A graph can be constructed by knowing all the adjacency of every element. There are two ways of representing the graph this way.

Adjacency Matrix vs Adjacency List

One way of representing a graph is through a matrix. The rows and columns represent the vertices and where they intersect on the matrix shows the presence or absence of edges between them. That number can be different depending on the type of graph and if weight is considered or not. Adjacency matrix allows for O(c) look up time for edges due to its array structure. The downside of using a matrix is that it requires $O(|V|^2)$ memory in order to create the matrix. It may not be a downside if there are enough edges between the vertices to fill the matrix, otherwise they would be unused memory.

If the graph is sparse, meaning small number of edges, using an adjacency list would be more efficient. Adjacency list represent a graph using a linked list like structure. An array holds the vertex names and the list of all the edges connected to that vertex. The structure is ideal for sparse graphs because only the edges present in the graph are represented in the data structure, therefore significantly reducing the memory requirements. One downside is that the lookup for edges may take longer due to the nature of list structure. A vertex may have many edges and going through each edge for a search may take $O(|E|)$.

Application for MST Algorithm

A very practical use of MST algorithm would be building roads between cities. Using MST algorithm would allow connecting cities with least amount of road laid. MST algorithm can also be used to find the quickest path between computer networks. Our internet speed would be abysmal if MST was not used to guide our networks.

Time Complexity

Prims MST Algorithm	O(E log V)
Print Matrix	$O(|V|^2)$
Print MST	$O(|V|)$