University of Nevada, Las Vegas Computer Science 477/677 Fall 2020

Assignment 8: Due Monday November 30, 2020

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. Your answers must be written in a pdf file and emailed to the graudate assistant, Tandreana Chua `chuat4@unlv.nevada.edu` , by midnight November 30. Your file must not exceed 10 megabytes, and must print out to at most 8 pages.

Unless otherwise specified, n refers to the number of vertices and m refers to the number of edges of a graph or directed graph.

1. Write pseudocode for an algorithm which solves the single source shortest path problem for a sparse weighted directed graph G. Assume that the graph is given to you as an array $In[n]$ of in-neighbor lists. Each item in each list $In[i]$ is an ordered pair (j, w), where w is the weight of the edge (j, i). If there are m edges, where $m \geq n$ and if, for each vertex i, the least weight path from 0 to i has at most k edges, the time complexity of your code must be $O(km)$. Your code must also halt with an error message if G has a negative cycle.

2. Let A be a virtual triangular array, where $A[i][j]$ is defined if and only if $0 \leq j \leq i < n$. The values of A are stored sequentially in main memory in row major order. $A[0][0]$ is stored at location B, and thus $A[1][1]$ is stored at location $B + 2$ and $A[n-1][n-1]$ is stored at location $B + \frac{n(n+1)}{2} - 1$. At what location in main memory is $A[45][10]$ stored? (No, you don't need to know the value of n to answer this question, as long as $n > 45$.)

3. A sparse array $A[N]$ can be stored efficiently using a search structure. We assume that there is some set of integers I such that $A[i] = 0$ unless $i \in I$. Since A is sparse, we will assume the cardinality of I is much smaller than N. The items stored in the search structure are ordered pairs of the form (i, x) where $A[i] = x$. Write pseudocode for fetch and store.

   Fetch(i) will return x if the search structure contains the ordered pair (i, x). Otherwise Fetch(i) will return 0.

   Store(i, x) will insert the pair (i, x) into the search structure. If the pair (i, y) for some y is already in the search structure, it will be overwritten.

4. Sketch the dag (directed acyclic graph) G given below as an array of sets of outneighbors. Then sketch the transitive closure and the transitive reduction of G.

   $\text{Out}[1] = \{2, 4\}$
   $\text{Out}[2] = \{3, 4, 6\}$
   $\text{Out}[3] = \{6\}$
   $\text{Out}[4] = \{5\}$
   $\text{Out}[5] = \{6\}$
   $\text{Out}[6] = \emptyset$