CISC 5835—Algorithms for Data Analytics
Fall, 2019

Chapter 3 Homework

In what follows, if you are asked to traverse a graph and you have a choice of vertices, you are to pick the one that is alphabetically first.

1. [20 points] Let G be the directed graph with vertices a, b, c, d, e, f and edges

$$(a,b),(b,c),(b,d),(c,a),(c,f),(d,e),(d,f),(e,f).$$

(a) [5 points] Draw G. Your answer should be a *planar* representation, i.e., one in which no edges cross each other. You can do this by putting vertices a, b, d, and f in one row, and vertices c and f in a second row, underneath the first row.

(b) [10 points] Do a depth-first search on G, starting at vertex a. Give the pre and post numbers of each vertex. Also, list the vertices in the order found by the DFS.

(c) [5 points] Classify each edge as a tree edge, forward edge, back edge, or cross edge.

2. [15 points] Let G be the directed graph with vertices a, b, c, d, e, f and edges

$$(a,b),(a,c),(b,c),(b,d),(c,f),(d,e),(d,f),(e,f)$$

Run the DFS-based topological sorting algorithm on G. Make sure to list the vertices in the proper topological order, i.e., if f, e, d, c, b, a is a topological ordering of the vertices, say so explicitly.

Note: If you decide to draw the graph, use a planar representation. See the suggestion in Problem 1.

3. [15 points] Let G be the directed graph with vertices a, b, c, d, e, f and edges

$$(a,b),(b,c),(b,d),(c,a),(c,f),(d,e),(d,f),(e,f).$$

Run the strongly connected components algorithm on G, answering the following questions:

(a) Which are source SCCs and which are sink SCCs?

(b) Draw the metagraph.

(c) Give a minimal set of edges that must be added to this graph to make it strongly connected.