# Assignment 9

CSCI 2200 Spring 2024

**Honor code:** *Work on this assignment alone or with one partner (highly encouraged). Partner policy: You and your partner will work together on the assignment throughout the whole process, you will write it and review it together, and will submit one assignment. You can talk to anyone in the class (collaboration level 1). It is not allowed to search online for the specific problems in this assignment—doing so violates academic honesty for the class.*

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1. Given an undirected graph $G = (V, E)$ as an adjacency list, describe and analyze an algorithm to find the number of connected components in $G$.

2. Given an undirected graph $G = (V, E)$ as an adjacency list, describe and analyze an algorithm to determine if $G$ contains a cycle.

3. Given an undirected graph $G = (V, E)$ as an adjacency list, describe and analyze an algorithm to determine if $G$ is a *tree*.

4. Given a directed graph $G = (V, E)$ as an adjacency list, describe and analyze an algorithm to determine if $G$ has a (directed) cycle, or is acyclic. (Note: A graph is called *acyclic* if it has no cycles. )

5. The *transpose* of a directed graph $G = (V, E)$ is a graph denoted by $G^T = (V, E^T)$, with the same set of vertices and all edges reversed. Describe an efficient algorithm for computing $G^T$ from $G$. Assume the graph is given as an adjacency list, and you want to compute the adjacency list of $G^T$. Analyze the running time of your algorithm. For full points, aim for linear time in terms of $G$, i.e. $O(|V| + |E|)$.

6. In a directed graph, two vertices $u$ and $v$ are said to be in the same *strongly connected component (SCC)* if $u$ can reach $v$ and $v$ can reach $u$. Describe a linear time algorithm for computing the *strong component* containing a given vertex $u$.

   *We expect: pseudocode, justification that the set of vertices computed represents the SCC of $u$, and run time analysis.*

7. Describe an algorithm which, given a directed graph $G$ and two arbitrary vertices $u, v$, determines whether $u$ and $v$ are in the same SCC.

   *We expect: pseudocode, justification and run time analysis.*