

Homework #6
CSCI 4041: Algorithms and Data Structures

Last revision April 24, 2020

This homework is about graph algorithms. It is worth **30 points**, and it will be due on Canvas at **11:55 PM** on **May 4, 2020**, the last day of instruction for this semester. **THIS IS THE LAST HOMEWORK ASSIGNMENT FOR THE COURSE.**

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1. Let G be a directed graph. It has a set of edges $G.E$, a set of vertexes $G.V$, and an adjacency structure $G.Adj$. It also has a vertex $r \in G.V$. We say that G is *rooted* at r if, for each vertex $v \in G.V$, there is exactly one path from r to v .

1a. (15 points.) Write a procedure IS-ROOTED that has G and r as its parameters. It returns TRUE if G is rooted at r . It returns FALSE otherwise.

Your procedure IS-ROOTED must use a graph traversal algorithm. Each vertex $u \in G.V$ has a Boolean attribute $u.mark$ that is either TRUE or FALSE. It has no other attributes, so do not compute them or use them. Also, the procedure VISIT is not needed here, so do not define it and do not call it.

1b. (5 points.) When does the best case for IS-ROOTED occur? How fast is IS-ROOTED in the best case? Express your answer using O or Θ notation. You need not prove that your answer is correct, but you must briefly explain it.

1c. (5 points.) When does the worst case for IS-ROOTED occur? How fast is IS-ROOTED in the worst case? Express your answer using O or Θ notation. You need not prove that your answer is correct, but you must briefly explain it.

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2. (5 points.) Let H be a directed graph. It has a set of edges $H.E$, a set of vertexes $H.V$, an adjacency structure $H.Adj$, and an adjacency matrix $H.M$. Now suppose that a graph algorithm uses the following loop. The loop calls the procedure S on all vertexes v that can be reached from a vertex u by following an edge.

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for each  $v \in H.Adj[u]$ 
     $S(v)$ 
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Write a different loop that does the same thing as this one, but uses $H.M$ instead of $H.Adj$.