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Problem 0

Points:

Acknowledgements

- (a) I did not work in a group.
- (b) I did not consult without anyone my group members.
- (c) I did not consult any non-class materials.

Problem 1

Points:

DFS Basics

(a) $A \rightarrow B \rightarrow D \rightarrow E \rightarrow G \rightarrow F \rightarrow C \rightarrow H \rightarrow I$

A	$(1, 12)$
B	$(2, 11)$
C	$(13, 18)$
D	$(3, 6)$
(b) E	$(4, 5)$
F	$(8, 9)$
G	$(7, 10)$
H	$(14, 17)$
I	$(15, 16)$

	Edge	Type
	(A, B)	Tree
	(A, E)	Forward
	(B, D)	Tree
	(D, E)	Tree
	(E, D)	Back
(c)	(B, G)	Tree
	(G, F)	Tree
	(G, D)	Cross
	(C, H)	Tree
	(H, I)	Tree
	(C, I)	Forward

Problem 2

Points:

Pre and Post Processing

(a) For our DFS algorithm, if $\text{post}(u) < \text{post}(v)$, then,

- Case 1 : $[\text{pre}(u), \text{post}(u)][\text{pre}(v), \text{post}(v)]$
- Case 2 : $[\text{pre}(v), [\text{pre}(u), \text{post}(u)]\text{post}(v)]$

These are the only 2 Cases for an undirected graph where $\text{post}(u) < \text{post}(v)$.

Since we know there is an edge between these 2 nodes, Case 1 can not happen because we must visit all the neighbors of a node before marking it as visited. That means, in Case 1, node u is marked visited before exploring edge v as it has $\text{post}(u) < \text{post}(v)$ which is violating the DFS rule of exploring all neighbor nodes before marking it visited. So, Case 2 is the only possible one, which yields v as the ancestor of u . The statement is True.

(b) First, Run Depth First Search Algorithm on the tree while also keeping the timestamps for the time when u is started to get explored (pre-number) and the time when u is finished getting explored (post-number). For every node u , $\text{pre}(u)$ denotes the time when we began exploring u and $\text{post}(u)$ denote the time when we finished it. This process will take linear time since the *Explore()* function will never be called on a Node more than once.

Now, to check whether u an ancestor of v , we have to check whether:

$$\text{pre}(u) < \text{pre}(v) \text{ and } \text{post}(u) > \text{post}(v)$$

If the above condition becomes True, then u is the ancestor of v . This condition will itself take a constant time because it is just comparing two numbers.

Problem 3

Points:

Linearization Basics

- (a)
- (b)
- (c)
- (d)