

HW-4: CSC241 (Data Structure and Algorithms)

Due Date: 04/23/2023 (11.59:59 PM)

Special Instruction

Your HW will be graded based on correctness and clarity. Keep your answer precise and to the point. If any question asks for justification of your answer/claim, you may receive a 0 if you merely provide an answer without justification. All sub questions carry equal weights unless specified otherwise. Finally, please check the HW rules at the end.

What to do: Reach to me ASAP if you have any confusion and/or have any emergency that may deter you to submit HW on time. Never hesitate to ask me if any of the previously discussed topics is unclear and you need some more discussion.

What not to do:

1. Ask to verify your solution
2. Ask to debug/analyze your code

Rules for ALL HW:

1. If any programming problem is given, the code must be written by yourself. DO NOT copy code from anywhere else.
2. You can discuss the problem sets and study together in group, but when it comes to formulating/writing solutions you must work alone independently; i.e., you should be able to explain your answer clearly to anyone else (including the TA and the instructor). Note that this says discuss in group — copying homework solutions from another student, from the Internet, solution sets of friends who have taken this course or one similar to it previously, or other sources will be considered **cheating** and referred to the university. At the beginning of each submission, you should explicitly list the people you worked with.

Question 1 (25 Points): Write a Java program that will take a directed graph as input (say G) and reverse the original graph (say G'). Then, determine the maximum in-degree and maximum out-degree. For example, see Fig 1(b), which is the reversed version of Fig. 1(a). In Fig 1(b), Node-0 has the maximum in-degree (3) and Node-4 and Node-5 have the maximum out-degree (2).

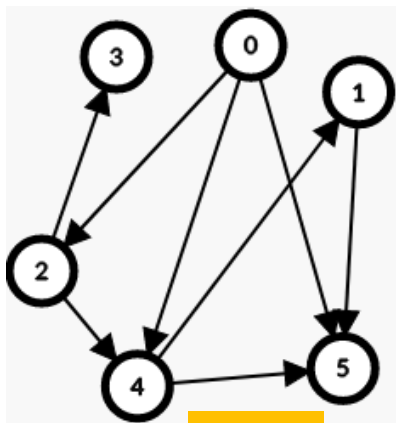


Fig. 1(a)

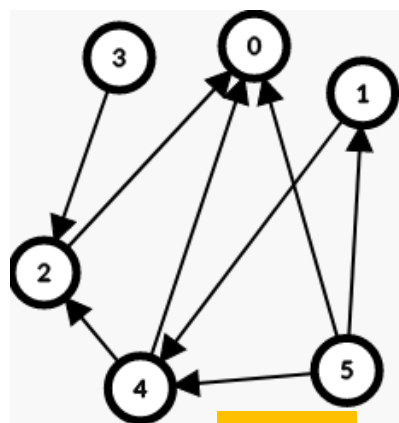


Fig. 1(b)

Sample Input : Graph shown in Fig 1(a)

Sample Output : Node-0 has the maximum in-degree of 3.

Node-5 have the maximum out-degree of 3.

You must test the following two graphs with your code and attach the output in the same format as shown above.

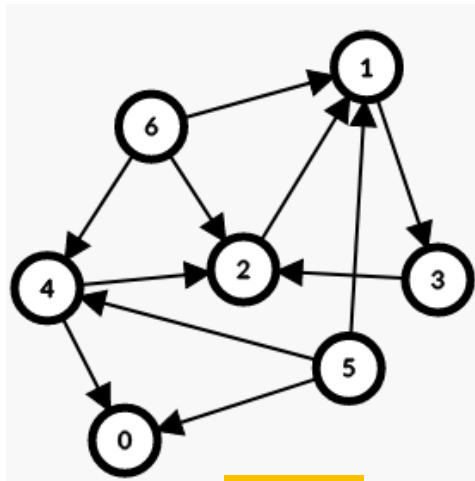


Fig. 1(c)

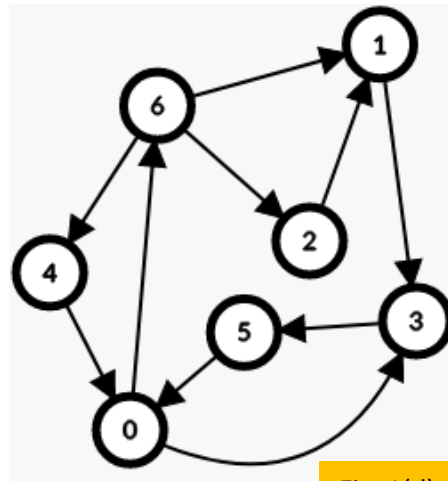


Fig. 1(d)

Sample Input 1: Graph shown in Fig 1(c)

Sample Output : ????

Sample Input 2: Graph shown in Fig 1(d)

Sample Output : ????

Special instructions for answer/code: In your code you must write the following two methods:

1. *datatype reverseGraph(param);* This method will reverse the original graph. The parameter *param* denotes the list of parameters (if any).
2. *datatype countInDegree(param);* This method will count the in-degree of the reversed graph. The parameter *param* denotes the list of parameters (if any).
3. *datatype countOutDegree(param);* This method will count the out-degree of the reversed graph. The parameter *param* denotes the list of parameters (if any).

Special instructions for submission: Please upload all of the following to D2L separately (not as one zip file):

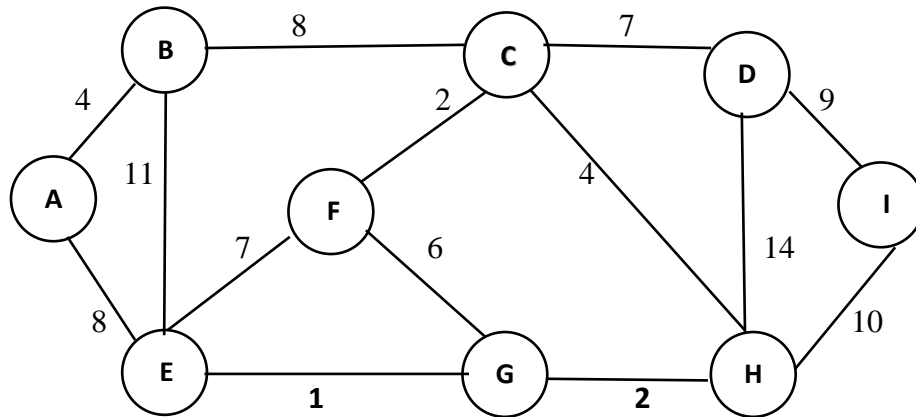
- A .pdf or .docx that contains your written answers. This file must show your typed code.
- Attach a screenshot of the output from your computer console/terminal.

Question 2 (25 Points): Apply prims algorithm on the graph given below to find the MST. Start the algorithm from node F. To earn full points, you must do the followings:

- I. Draw the MST. Clearly level the nodes and edges
- II. Show the final state of the following table. Check the slides taught in the class for reference.

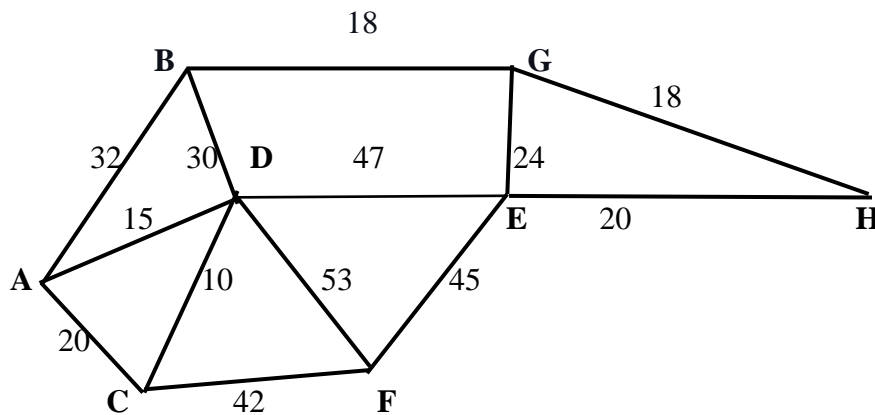
Node	Cost	Prev
A		
B		

	C		
	D		
	E		
	F		
	G		
	H		
	I		



Question 3 (25 Points): The mayor of Christchurch takes a mega project to build roads among eight towns. The streets cost **\$5000 per mile**, and the mayor wants to minimize the cost but must connect all towns. The following graph shows the geographical location of these towns and the length of roads (in mile). *For example, the road length between C and F is 42 miles.*

- What is the minimum length of the roads that connect all the towns? Show the updated graph that connect all the towns with minimum cost.
- What is the total cost of the project?



Question 4 (25 Points): A networking company uses a compression technique to encode the message before transmitting over the network. The message contains the following characters with their frequency. Assume that initially (before encoding) all characters require 3 bits to represent (a = 000, b = 001...). If the compression technique used is **Huffman Coding**,

Character	Frequency
<i>a</i>	12
<i>b</i>	2
<i>c</i>	7
<i>d</i>	13
<i>e</i>	14
<i>f</i>	85

(i) How these bits will be represented (show the tree)?

(iii) Determine how many bits will be saved in the message?

(iv) Decode this message according to the Huffman tree you have constructed: **1011011010**