

Programming Design, Spring 2014

Homework 11

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Submission. To submit your work, please upload the following file to the online grading system at <http://lckung.im.ntu.edu.tw/PD/>.

1. Your .cpp file for Problems 1.

Each student must submit her/his individual work. No hard copy. No late submission. The due time of this homework is 8:00am, May 26, 2013.

Problem 0

(0 point) Please read Chapters 12 and 13 of the textbook.¹ In any case, I strongly suggest you to read the textbook thoroughly before you start to do this homework.

Problem 1

(100 points) You have started a good business for selling apples. Moreover, you have built a computer software that can manage the routes and intersections in your business territory. Both are very good. Two of your best friends, Eren and Mikasa, also wanted to start their apple businesses in different countries. They asked you to share the software with them, and you agreed. You gave them the class `Network` you built for Homework 7 to them and allow them to use the class in anyway they like.

When Eren got the class, he also got the detailed documentation for the class. He found that there is one thing that should be modified: While your class allows for any kind of network topology, the network topology in the city he lives is a “star in a ring”. More precisely, there is a ring-type path surrounding the city and a central point in the city. All roads can be divided into two types: a ring road that connects two nodes on the ring or a star road that connects the central point and one boundary node. A illustration is provided in Figure 1. In this network, node 1 is the central node and nodes 2 to 7 are boundary nodes. Eren’s store locates at node 6 while two customers locate at nodes 3 and 4.

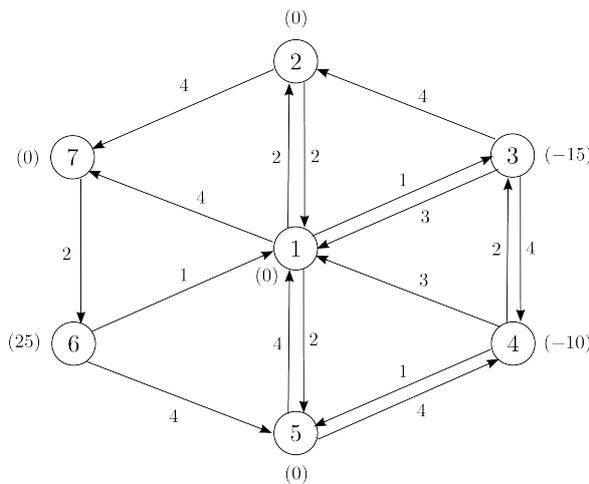


Figure 1: A star-ring network

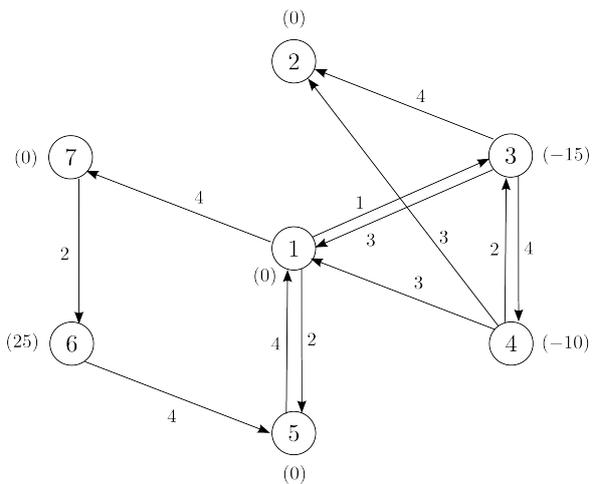


Figure 2: Another star-ring network

¹The textbook is *C++ How to Program: Late Objects Version* by Deitel and Deitel, seventh edition.

To make it precise, we say that a star-ring network follows the following definition:

Definition 1. *In a star-ring network, there is one central node and one or multiple boundary nodes. Moreover, each boundary node directly connects with at most two other boundary points.*

For example, if we want to keep the network in Figure 1 a star-ring network, we cannot build a road connecting nodes 5 and 7. Please note that the network in Figure 2 is also a star-ring network, by our definition. It is still a star-ring network if a road between nodes 5 and 7 is built.

Eren understood that the `addArc()` function implemented in your class adds an arc only when that the two endpoints both exist and the arc currently does not exist. However, this is not enough for his city and more conditions must be checked before an arc is added. Therefore, he tried to read the source codes to make modifications. However, he got shocked immediately: “The program is so complicated... How is it possible for me to modify it without generating any error?” He knew that he should modify `addArc()`, but `addArc()` is too complicated for him to modify. Moreover, he was not sure whether he should modify some other places. He needs your help.

In this problem, please use inheritance to help Eren. Write a class `StarRingNetwork` that inherits `Network`. Given that `Network` functions well for general networks, you do not need to worry about it. All you need to do is to override the function `addArc()` for a star-ring network. If the check is passed, simply call `Network::addArc()` to complete the task. Of course there is one last thing: Do not forget to change `private` to `protected` in `Network`. Using the class written by the TAs is fine.

How about Mikasa? We will try to discuss her problem in other Homework if we have time.

Input/output formats

The input/output formats for this problem are almost the same as those for Homework 7. Below are the only differences:

- The node with node ID 1 is the central node. Any other ID indicates that the corresponding node is a boundary node.
- If an AA task is assigned, you need to check whether adding this arc destroys the star-ring structure. In particular, you need to determine whether the addition gives any one of the two endpoints the third boundary neighboring node. If yes, do not add the arc; if no, add it.

Grading criteria

- 70 points are given based on the correctness of your output. Each correct line of output gives you two points. The input will be organized in the following way:
 - In the first part, there are only AN and AA tasks. Then five P tasks will be assigned to test your functions for adding nodes and arcs. In this part, all tasks are valid and should be effective.
 - In the second part, there are still only AN and AA tasks. However, some of these tasks should fail, either because nodes and arcs already exist or the star-ring structure is destroyed. Then fifteen P tasks will be assigned.
 - In the third part, all tasks are possible. Then fifteen P tasks will be assigned.

To make it easier to earn partial credits, the networks for the three parts are separated. More precisely, starting from the first AN or AA statement after the fifth P statement, we construct a new network and the network for the first five P statements will not be used anymore. The same thing happens again when we complete the twentieth P statement. Since then, we construct the third network.

- 30 points will be based on how you write your program, including the logic and format. Please try to write a robust, efficient, and easy-to-read program.