

PROGRAMMING PROJECT 1

Due: 24 / 03 / 2019 – 23:30 (No late submission)

In this project, you are required to implement some procedures in MIPS assembly language. You will use SPIM simulator [1] to develop and test your code. There will be three questions in the project which are unrelated.

QUESTION 1. (10 points) In this program you are required to implement a number series based on given inputs. Your program should take three inputs: a starting index, a number of integers in the list and the distance between two successive numbers in the list. After taking inputs, it should display the series and the summation of them. Please consider only positive numbers in the series! All the numbers in the series should fit in a word!

An example run:

Enter the first number in the series: 7

Enter the number of integers in the series: 5

Enter the offset between two successive integers in the series: 4

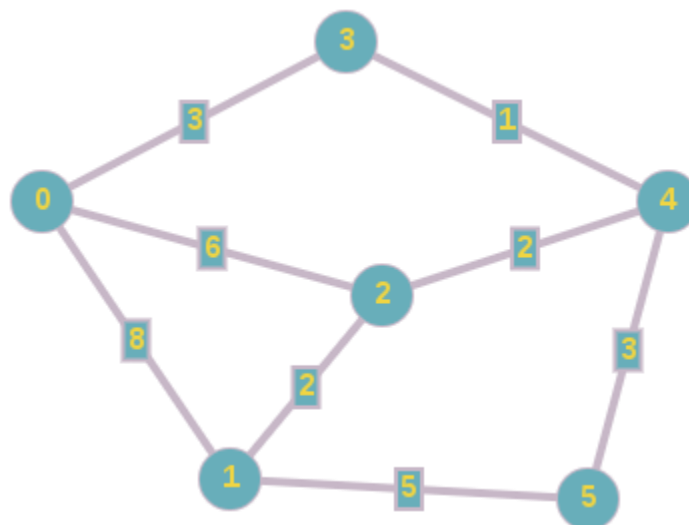
The series is: 7 11 15 19 24

The summation of the numbers is 76

QUESTION 2. (25 points) In this question, you are required to implement Prim's Minimum Spanning Tree Algorithm [2]. Given undirected graph with weighted edges, Prim's algorithm initially selects a random root node and adds unexplored vertices by sorting edge weights. Algorithm terminates when all the vertices are connected and the main constraint is that there is no cycle between vertices (For more information check a textbook on algorithms [2]). Your graph inputs will be in the following format:

[NodeID] [NodeID] [Edge1] [NodeID] [NodeID] [Edge2] [NodeID] [NodeID] [EdgeN]
emphasizing edges in the graph.

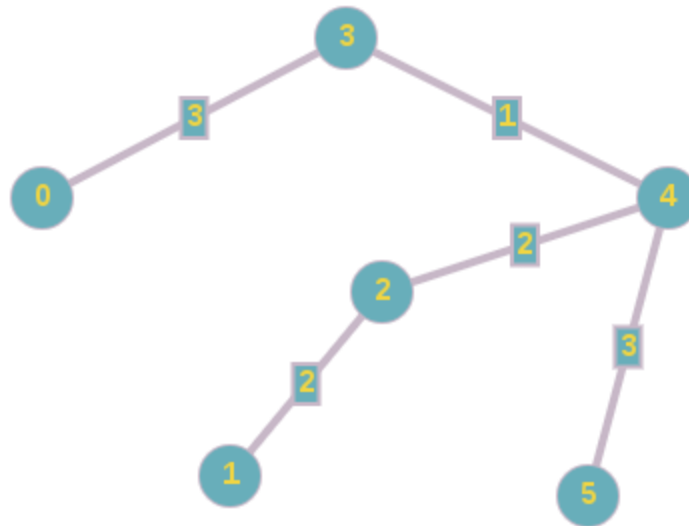
Example graph is given below:



Values in the graph indicating vertex id and edge weights. Input for the graph above given as follows:

0 1 8 0 2 6 0 3 3 1 2 2 1 5 5 2 4 2 3 4 1 4 5 3

Assuming that initially vertex 2 selected, Minimum Spanning Tree output of the Prim's algorithm would be as follows:



Output of the program must list only the selected edges in the graph and total weight as follows:

0 3 3
1 2 2
2 4 2
3 4 1
4 5 3

An example run:

Enter the graph: 0 1 8 0 2 6 0 3 3 1 2 2 1 5 5 2 4 2 3 4 1 4 5 3

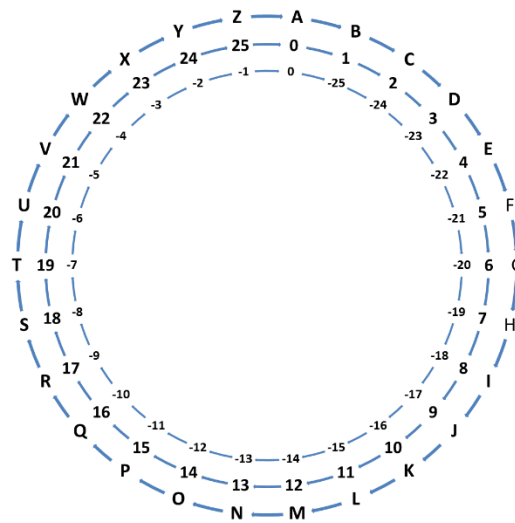
Minimum Spanning Tree:

0 3 3
1 2 2
2 4 2
3 4 1
4 5 3

Total weight is 11

Vertex id and weights can be 2 digits: 12, 19 etc.

QUESTION 3. (12 points) Write a MIPS program that performs string encryption or decryption based on taken arguments. Your program should take an input string and an integer offset value, then it should encode or decode input string based on a shift offset. It will take an integer offset and it will perform encryption if the value is positive and it will perform decryption if it is negative. The value of offset must be -25 to -1 (inclusive) and 1 to 25 (inclusive). Encoding/decoding scheme is given in the following figure:



Example Runs:

Enter an input string: I am an engineer!
Enter an offset value: 25
SOURCE: I AM AN ENGINEER!
PROCESSED: H ZL ZM DMFHMDDQ!

Enter an input string: I am an engineer!
Enter an offset value: -1
SOURCE: I AM AN ENGINEER!
PROCESSED: H ZL ZM DMFHMDDQ!

Enter an input string: Vdkbnld sn Lzqlzqz Tmhudqrhsx :)
Enter an offset value: -25
SOURCE: VDKBNLD SN LZQLZQZ TMHUDQRHSX :)
PROCESSED: WELCOME TO MARMARA UNIVERSITY :)

Enter an input string: Vdkbnld sn Lzqlzqz Tmhudqrhsx :)
Enter an offset value: 1
SOURCE: VDKBNLD SN LZQLZQZ TMHUDQRHSX :)
PROCESSED: WELCOME TO MARMARA UNIVERSITY :)

MENU (8 points): Your program should support a *Menu* including all questions above. A sample execution scenario given below:

```
Welcome to our MIPS project!
Main Menu:
1. Prim's Algorithm
2. Number Series
3. Encrypt/Decrypt
4. Exit
Please select an option: 1
```

These options must be printed inside a loop until “Exit” option is selected.
When the user select option 1, you should print the followings:

```
Enter the graph: 018026033122155242341453
Total weight is 11
```

```
Main Menu:
1. Prim's Algorithm
2. Number Series
3. Encrypt/Decrypt
4. Exit
Please select an option: 2
Enter the first number in the series: 7
Enter the number of integers in the series: 5
Enter the offset between two successive integers in the
series: 4
```

```
The series is: 7 11 15 19 24
The summation of the numbers is 76
```

```
Main Menu:
1. Prim's Algorithm
2. Number Series
3. Encrypt/Decrypt
4. Exit
Please select an option: 3
Enter an input string: I am an engineer!
Enter an offset value: 25
SOURCE: I AM AN ENGINEER!
```

```
PROCESSED: H ZL ZM DMFHMDDQ!
```

```
Main Menu:
```

- ```
1. Prim's Algorithm
2. Number Series
3. Encrypt/Decrypt
4. Exit
```

```
Please select an option: 4
```

```
Program ends. Bye :)
```

### **Assumptions and Requirements**

- The arguments to the procedures are stored in \$a registers; i.e., the first one is in \$a0, the second one is in \$a1, and so on.
- Only valid arguments are passed into the procedures. Therefore, you do not need to check the arguments for their validity.
- When you invoke a procedure, the values of all \$a registers should be preserved. Their values should be same at the end of the procedure call as they were at the time of call.
- You have to use QtSpim simulator in your implementation. Any other simulator is not allowed.
- You are required to submit a minimum 2-page report (**5 points**) explaining implementation details of your project. Your report will have three parts (one for each question) and it will also include screenshot of your sample runs, as well.
- You should submit a fully commented source code that includes details of your implementation. Note that the name of the file should include surnames of the group members. (ex: surname1\_surname2.s)
- Zip your fully commented source code file and the project report into a single file and submit the zip file via Canvas.

### **General Policies for the Project**

- *You have to work in groups of 2.* You will select your partner and the partner will not be changed throughout the semester. *It is not acceptable of a partner team to work with other teams.*
- *A portion of your project grade will be set with a Project Quiz.* Note that if you do not submit the project, you will not attend the Project Quiz
- Copying (partially or full) solutions from other students is a form of cheating. Copying (partially or full) solutions from Web including Github (and similar sites) is another form of cheating. It is NOT acceptable to copy (or start your) solutions from Web. **In case of any forms of cheating or copying among the groups, the penalties will be severe. Both Giver and Receiver are equally culpable and suffer equal penalties!!!**
- No late submission will be accepted!

### **References**

- [1] <http://spimsimulator.sourceforge.net/>

[2] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition (3rd ed.). The MIT Press.