Graph Theory and its Applications

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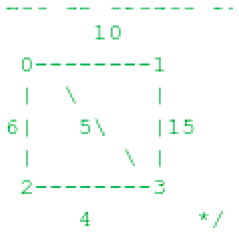
Assignment 1

1. Implement Fleury's Algorithm to find Euler's Circuit
2. Implement solution to Chinese Postman Problem
3. Implement Graph Coloring using Welsh Powell algorithm
4. To find MST
    - Implement Reverse Delete
    - Implement Boruvka’s algorithm
5. Maximum matching in Bipartite GrapSh
6. Implement Tarjan's algorithm to find Articulation points in a graph

Sample Inputs and Outputs

Boruvka

Sample Input:



```
4 5
0 1 10
0 2 6
0 3 5
1 3 15
2 3 4
```

Sample output:

```
Edge 0-3 included in MST
Edge 0-1 included in MST
Edge 2-3 included in MST
Weight of MST is 19
```

Chinese_Postman_Problem

The first two lines give n (number of vertices) and m (number of edges). Each of the next m lines has a tuple (u, v, c) representing an edge, where u and v are the endpoints (0-based indexing) of the edge and c is its cost.

Sample input:

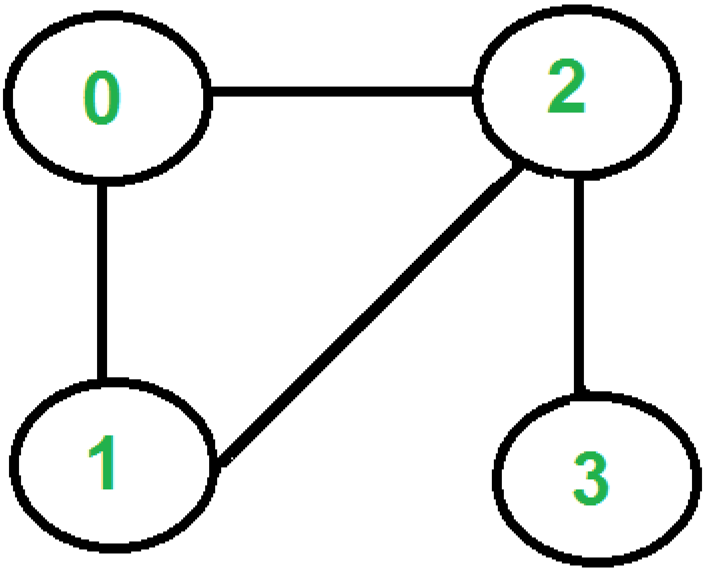
```
10
15
0 1 1
0 4 3
1 2 0
1 4 10
2 3 9
2 5 2
2 6 7
3 6 3
4 5 4
4 7 2
5 7 6
6 8 4
6 9 2
7 8 1
8 9 5
```

Sample output:

```
Solution cost: 62
Solution:
0 4 7 8 9 6 3 2 6 8 7 5 2 1 2 5 4 1 0
```

Fleury

Sample input:



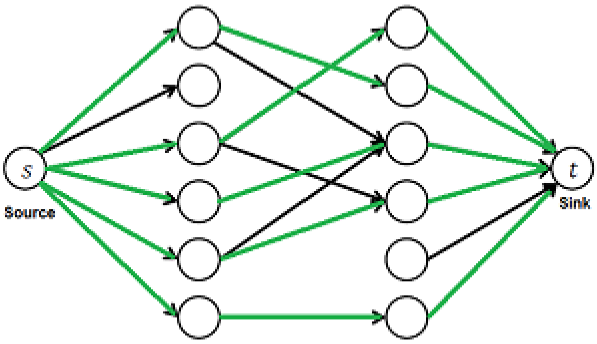
```
4 4
0 1
0 2
1 2
2 3
```

Sample output:

```
2-0  0-1  1-2  2-3
```

Maximum_Matching

Sample input:



The maximum flow from source to sink is five units. Therefore, maximum five people can get jobs.

```
0 1 1 0 0 0
1 0 0 1 0 0
0 0 1 0 0 0
```

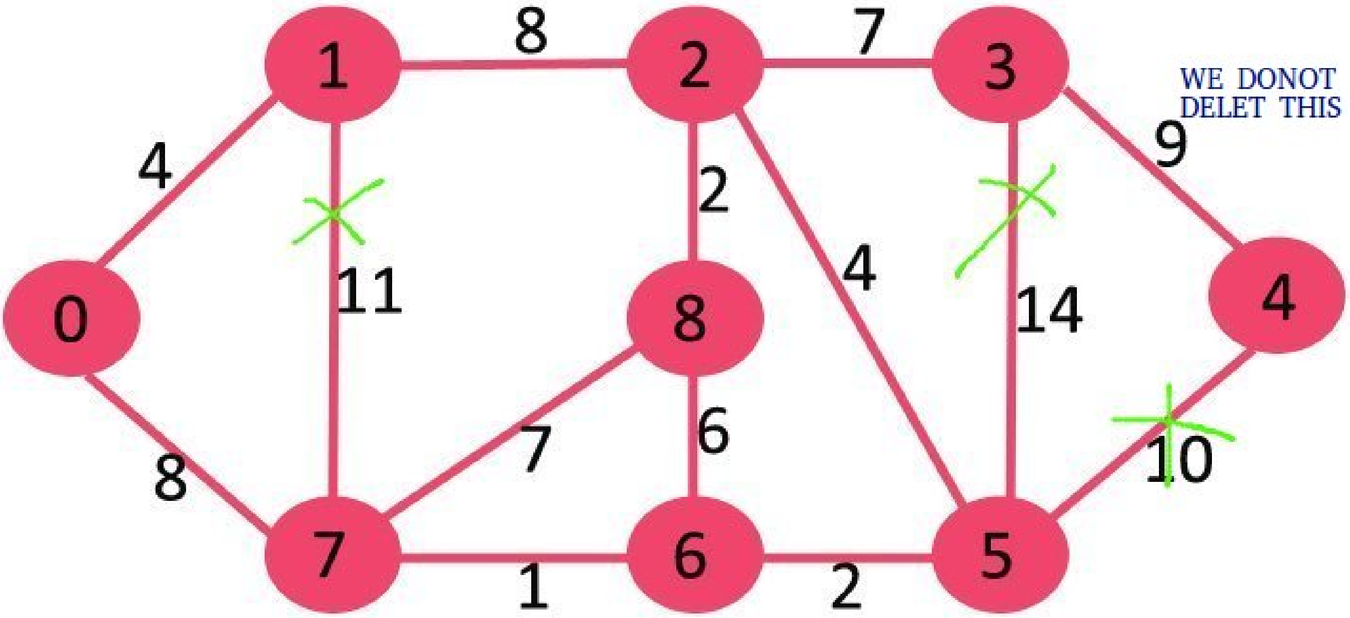
```
0 0 1 1 0 0
0 0 0 0 0 0
0 0 0 0 0 1
```

Sample output:

```
Maximum number of applicants that can get job is 5
```

Reverse_Delete

Sample input:



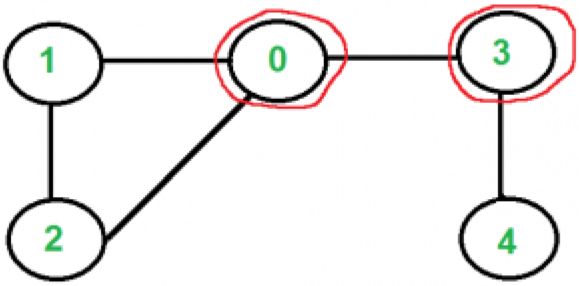
```
9 14
0 1 4
0 7 8
1 2 8
1 7 11
2 3 7
2 8 2
2 5 4
3 4 9
3 5 14
4 5 10
5 6 2
6 7 1
6 8 6
7 8 7
```

Sample output:

```
Edges in MST
(3, 4)
(0, 7)
(2, 3)
(2, 5)
(0, 1)
(5, 6)
(2, 8)
(6, 7)
Total weight of MST is 37
```

Tarjan

Sample input:



Articulation points are 0 and 3

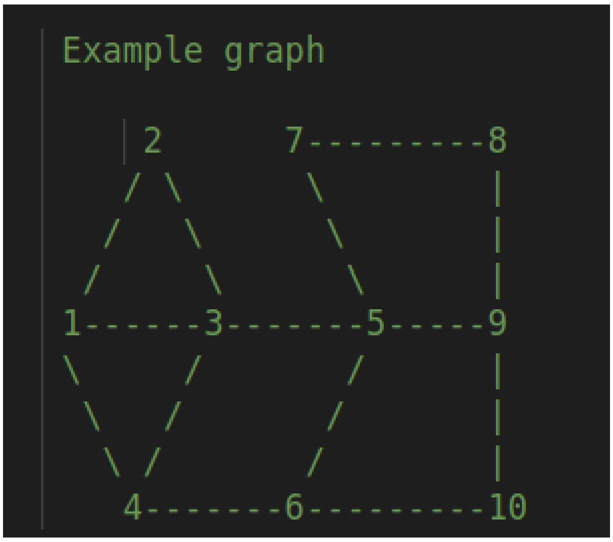
```
5 5
1 0
0 2
2 1
0 3
3 4
```

Sample output:

```
0 3
```

Welsh_Powell

Sample input:



```
Example graph

    2      7---------8
   / \      \        |
  /   \      \       |
 /     \      \      |
1------3-------5-----9
\     /       /      |
 \   /       /       |
  \ /       /        |
   4-------6---------10
```

```
0 1 1 1 0 0 0 0 0 0
1 0 1 0 0 0 0 0 0 0
1 1 0 1 1 0 0 0 0 0
1 0 1 0 0 1 0 0 0 0
0 0 1 0 0 1 1 0 1 0
0 0 0 1 1 0 0 0 1 1
0 0 0 0 1 0 0 1 0 0
0 0 0 0 0 0 1 0 1 0
0 0 0 0 1 0 0 1 0 1
0 0 0 0 0 1 0 0 1 0
```

Sample output:

```
C:color 1
F:color 1
G:color 1
K:color 1
E:color 2
A:color 2
J:color 2
L:color 2
D:color 3
B:color 3
Graph full colored
```

Running the Project

There are two ways of running this project.

Method 1:

Run the file using the bash script.

```
chmod a+rx run.sh
./run.sh
```

The run.sh file goes to each of the folders containing the implemented algorithm and runs the dedicated `Makefile`.

Output :

```
aditya@sped-machine:~/VSProjects/GTA_ASSIGNMENT$ ./run.sh
RUNNING  Boruvka
------------------------------------------------
g++ -O3 -o Boruvka main.cpp
./Boruvka < ../input_file > output.txt
rm Boruvka
------------------------------------------------
RUNNING  Chinese_Postman_Problem
------------------------------------------------
g++ -O3 -m64 -Wall -c ./Minimum-Cost-Perfect-Matching/Matching.cpp -o
Matching.o
g++ -O3 -m64 -Wall -c ./Minimum-Cost-Perfect-Matching/BinaryHeap.cpp -o
BinaryHeap.o
g++ -O3 -m64 -Wall -c ./Minimum-Cost-Perfect-Matching/Graph.cpp -o Graph.o
g++ -O3 -m64 -Wall -c Example.cpp -o Example.o
g++ -O3 -m64 -Wall Matching.o BinaryHeap.o Graph.o Example.o -o chinese
./chinese -f sample_input.txt > output.txt
rm Matching.o BinaryHeap.o Graph.o Example.o chinese
------------------------------------------------
RUNNING  Fleury
------------------------------------------------
g++ -o fleury main.cpp
./fleury > output.txt
rm fleury
------------------------------------------------
RUNNING  Maximum_Matching
------------------------------------------------
g++ -o MaximumMatching main.cpp
./MaximumMatching > output.txt
rm MaximumMatching
------------------------------------------------
RUNNING  Reverse_Delete
------------------------------------------------
g++ -o ReverseDelete main.cpp
./ReverseDelete < input.txt > output.txt
rm ReverseDelete
------------------------------------------------
RUNNING  Tarjan
------------------------------------------------
g++ -o Tarjan main.cpp
./Tarjan < input.txt > output.txt
rm Tarjan
------------------------------------------------
```

```
RUNNING  Welsh_Powell
------------------------------------------------
g++ -o WelshPowell main.cpp
./WelshPowell < input.txt > output.txt
rm WelshPowell
------------------------------------------------
```

Method 2:

Individually the `Makefile`s for each of the folders containing the algorithms.

```
cd <FOLDER>
make
```

To remove the generated files

```
make clean
```

Cleaning the Project

Run the clean bash script.

```
chmod a+rx clean.sh
./clean.sh
```

The clean.sh file goes to each of the folders containing the implemented algorithm and cleans it up.

Generating graph

Generate graph with

```
g++ -std=c++17 gen.cpp -o gen
./gen > input.txt
```