

CS515: Computer System Lab 2

Date: 10th Mar 2022

Assignment 7

Submission Filename: `assign7.c` or `assign7.cpp` and `assign7README.txt`

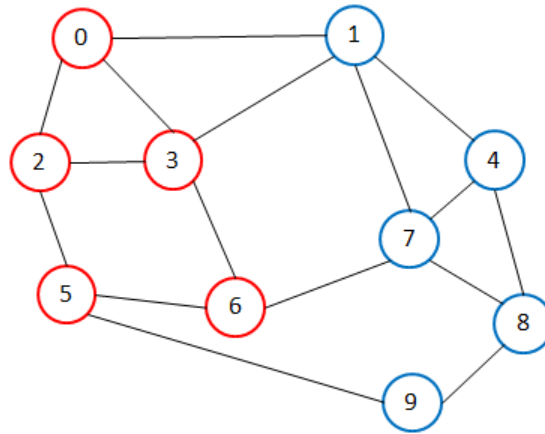
Due Date: 21st Mar 2022 9 am

1 Overview

Let $G = (V, E)$ be an undirected graph. Some vertices of G are red, and the others are blue. Let V_R denote the set of red vertices of G , and V_B the set of blue vertices of G . The vertex set V of G is the union of the two disjoint sets V_R and V_B . Likewise, the edge set E of G is the union of three mutually disjoint subsets: the set E_{RR} of edges with both endpoints red, the set E_{BB} of edges with both endpoints blue, and the set E_{RB} of edges with endpoints of two different colors. We have the two induced subgraphs: the red subgraph $G_R = (V_R, E_{RR})$, and the blue subgraph $G_B = (V_B, E_{BB})$.

A cycle in the red subgraph G_R is called a red cycle. Likewise, a cycle in the blue subgraph G_B is called a blue cycle. A red or a blue cycle is called **monochromatic**, since such a cycle consists of vertices of the same color. On the other hand, a cycle in G with vertices of both the colors is called **nonmonochromatic**. In this assignment, you need to write a program to identify the existence of **monochromatic** and **nonmonochromatic** cycles, and print some of them.

In the following figure, a graph is shown. A red cycle in the graph is (0,2,3,0). A blue cycle in the graph is (1,4,8,7,1). These cycles are **monochromatic**. Two **nonmonochromatic** cycles in the graph are (0,1,7,6,3,0) and (5,6,7,8,9,5). We assume that a cycle does not contain repeated vertices (except the first and the last ones).



2 Task to be carried out

Perform the following tasks.

2.1 Storing the Graph

You need to store the following information about an undirected graph.

- The number of vertices in the graph (an integer)
- The colors of the vertices (an array of characters r and b)
- The vertex numbers (an array of integers): Let G has n vertices. These vertices are naturally numbered as $0, 1, 2, 3, \dots, n-1$. The red subgraph in the above example has the vertex set $0, 2, 3, 5, 6$ and blue subgraph has vertex set $1, 4, 7, 8, 9$.
- The edges of the graph: Use the adjacency-list (not matrix) representation to store the edges. Since we are dealing with undirected graphs, for every undirected edge (u, v) , v must appear in the adjacency list of u , and u in the adjacency list of v .

2.2 Read and Print a Graph

Write a function *readgraph* to return a graph G constructed from user inputs. The user first enters the number n of vertices of G , followed by the colors of the vertices, and finally by the list of edges. Each edge is specified by a pair (u, v) . It is the responsibility of the user to avoid entering the same edge multiple times. When the user is done with entering the edges, -1 is entered as u in order to indicate the end of the input session.

2.3 Get the Red and Blue Subgraph

Write a function *getcolgraph*(G , *color*) that, given the graph G and a color (r or b), generates G_R or G_B as color suggests, and returns this subgraph.

2.4 DFS traversal in a graph, and detection of cycles

Write a recursive DFS function, and a multi-DFS function for an input graph. During the traversal, look for a back edge and if a back edge is detected, then the cycle causing this back edge is printed along with the colors of the vertices on the cycle. All cycles in a graph are not required to print by the multi-DFS traversal. It suffices to print atmost two cycles corresponding to the back edges.

3 Sample Input Output

```
10 //no of vertices
r b r r b r r b b b //color code of the vertices
//edge list terminated by -1
0 1, 0 2, 0 3, 1 3, 1 4, 1 7, 2 3, 2 5, 3 6, 4 7, 4 8, 5 6, 5 9, 6 7, 7 8, 8 9, -1
```

Original Graph

```
0-> 1, 2, 3
1-> 0, 3, 4, 7
2-> 0, 3, 5
3-> 0, 1, 2, 6
4-> 1, 7, 8
5-> 2, 6, 9
6-> 3, 5, 7
7-> 1, 4, 6, 8
8-> 4, 7, 9
9-> 5, 8
```

Red SubGraph

```
0-> 2, 3
2-> 0, 3, 5
3-> 0, 2, 6
5-> 2, 6
6-> 5
```

Blue SubGraph

```
1-> 4, 7
4-> 1, 7, 8
7-> 1, 4, 8
8-> 4, 7, 9
9-> 8
```

Red Cycles

```
0-2-3-0 color (r-r-r-r)
0-2-5-6-3-0 color (r-r-r-r-r-r)
```

Blue Cycles

```
1-4-8-7-1 color (b-b-b-b-b)
4-7-8 color (r-r-r)
```

```
Multi Color Cycles
0-1-7-6-3-0 color (r-b-b-r-r-r)
5-6-7-8-9-5 color (r-r-b-b-b-r)
```

4 Submission

You need to implement the program either using `c` or `c++`. You need to include the followings in your submission file-

- Your C or C++ code
- A README file (*assign7README.txt*) comprising all the necessary documentation is also required. You must also provide option for the input filename and output filename.
- Copying programs from others or from other sources and allowing others to copy your program will be equally penalized.