CS F222 Discrete Structures for CS
I Semester 2022-2023
BITS PILANI, Hyderabad Campus
Programming Assignment

Part B Deadline: Fri, Dec 9, 11am.

Note: All code submitted by you must be your own, i.e. written entirely by members of your team. E.g. you are not allowed to start from another team's Part A code and build on top of it for Part B. We will use sophisticated code comparison tools to enforce this, and violations will be flagged for further enquiry and possible disciplinary action.

Your code must compile and work correctly on https://www.onlinegdb.com/ , which uses gcc 9.3.0 c99

Objective:

The main objective of the assignment is to report if two undirected graphs are isomorphic or not.

The assignment will consist of two parts.

You can assume that the given graphs are not multigraphs. Your programs must be in C.

Part B:

Now, you have to determine if two given input graphs are isomorphic or not.

First, you have to check for some invariants, namely you have to check if the number of nodes, number of edges, degree sequence are same for both graphs or not.
If any of these invariant does not come out to be equal, the graph cannot be isomorphic, so in this case output just "Not Isomorphic" and terminate the program.

Now let's say all of the invariants are equal, then you have determine if the graphs are isomorphic or not.
You have to look at all permutations of the vertices and check if you can construct a bijection between the nodes of the two graphs for which the adjacency relation is preserved. See definition of graph isomorphism from class.

The names of the two input files containing each of the graphs would be given as command line arguments and you have to output to standard output (i,e, to the console, via printf).
The input format and the constraints would be same as Part 1.

If the graphs come out to isomorphic output "Isomorphic" and also output a bijective mapping of the nodes that preserves adjacency (explanation given below). If there are multiple correct bijections, output one of them.
However, if the graphs turn out to be non isomorphic output "Not Isomorphic, no bijection found."

Test Case 1:

Input 1 (a.txt):

```
5
6
1 2
1 3
4 5
3 5
2 3
1 4
```

Input 2 (c.txt):

```
5
6
1 5
1 4
4 5
3 4
2 3
1 2
```

Ouput (out-ac.txt):

```
Isomorphic.
1 1
2 5
3 4
4 2
5 3
```

Explanation (your program should not output this):

The given graphs are isomorphic.
Then there are 5 lines (for 5 nodes), which consist of a pair of node numbers indicating the bjection between the respective nodes in the two graphs.

Test Case 2:

Input 1 (b.txt):

```
7
10
1 2
1 5
1 4
2 3
3 4
4 8
5 6
```

```
5 8
6 7
7 8
```

Input 2 (d.txt):

```
8
10
1 2
1 4
1 5
2 3
3 4
3 7
5 6
6 7
7 8
5 8
```

Ouput (out-bd.txt):

```
Not Isomorphic, no bijection found.
```

Explanation:

The given graphs are not isomorphic even though they have the same degree sequence.

General Instructions:

- The code must be written in C only.
- This assignment will be done in groups of two students.
- Comment the name and ID of both team members at the starting of the program.
- Your program would be tested against more test cases other than the samples so you should take care of the edge cases.

Some Suggestions:

- You can use adjacency matrix as a data structure for your graph.
- You can use recursion to generate all the permutations of the sequence 1 to n.
- You can use different functions to organise different tasks so that your program becomes more readable and simpler.