COMP103 Data Structures and Algorithms

Tutorial 13: Graph

A. Graph Data Structure

1. List differences between tree and graph data structure are as shown in the table below. [7 marks]

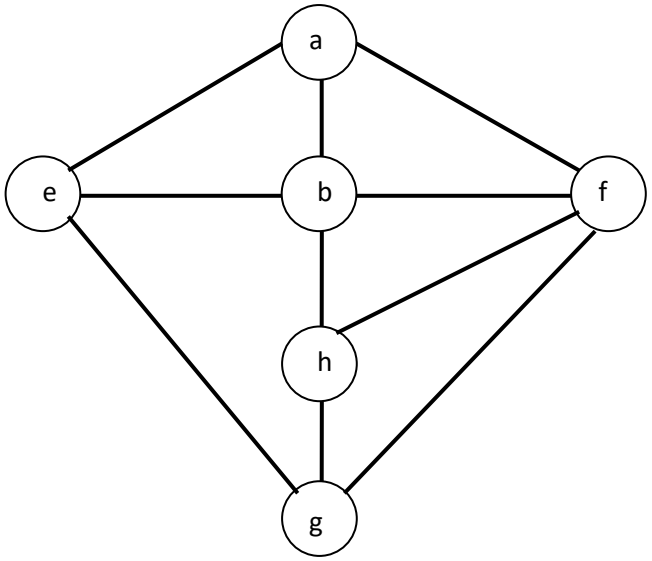
Criteria	**Tree**	**Graph**
Path		
Root node		
Loops		
Complexity		
Traversal techniques		
Number of edges		
Model type		

2. What is graph? Devise an expression that describe graph. [2 marks]
3. What are three types of graphs? Briefly describe their characteristics. [6 marks]
4. Classify graph according to its edge connections. [3 marks]
5. What is the number of edges present in a complete graph having n vertices? [2 marks]
6. Fill in the blanks given below for the terms used in the graph data structure. [3 marks]
   - A _____ in a graph is a list of nodes such that each node and its successor in the list are connected by an edge in the graph.
   - A _____ in a graph is a path whose first and last nodes are the same.
   - An _____ is one in which there is no cycle.

7. From the examples provided below, which one is classified as a weighted graph? [2 marks]
   - Road map connecting some cities in an island.
   - Social network of friendships among persons.

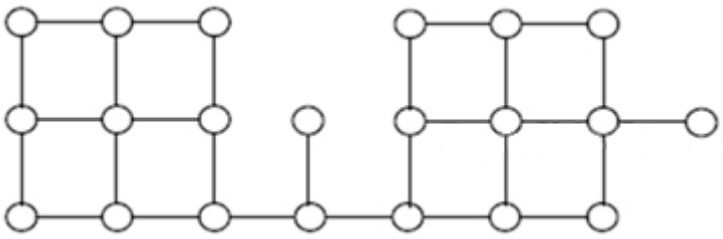
- Relationships between tables in a database system.
- Structural hierarchies of employees in a company.

8. How do you traverse graph? [2 marks]
9. What is breadth-first traversal in the graph data structure? [2 marks]
10. What is depth-first traversal in the graph data structure? [2 marks]
11. Consider the following graph among the following sequences:



List at least three sequences of depth-first traversals of the above graph. [2 marks]

12. Suppose depth-first search is executed on the graph below starting at some unknown vertex. Assume that a recursive call to visit a vertex is made only after first checking that the vertex has not been visited earlier. Then the maximum possible recursion depth (including the initial call) is: _____. [2 marks]



B. Graph Programming

1. Comment on the functionalities of the code segments given below. [5 marks]

   Program:

```
public class SNPerson implements Iterable<SNPerson>{
private String name;
private Set<SNPerson> friends;

public SNPerson(String nm){
this.name = nm;
this.friends = new HashSet<SNPerson>();
}
public String getName() { return name; }
public void addFriend(SNPerson fr) {friends.add(fr); }
public void removeFriend(SNPerson fr) {friends.remove(fr); }
public boolean hasFriend(SNPerson fr) { return friends.contains(fr); }
public Iterator<SNPerson> iterator() { return friends.iterator(); }
```

2. Compare the following three programs that are used to establish relationship between persons in the social network graph (i.e. set up edges among the nodes in the graph). We need to write both lines of the code for bidirectional link relationships between persons in the social network. For each program, identify its characteristics. [3 marks]

   Program 1:

```
public void addFriend(SNPerson fr) {
…
SNPerson P1 = new SNPerson("Jane");
SNPerson P2 = new SNPerson("Jay");
…
P1.addFriend(P2);
fr.addFriend(this);
}
```

   Program 2:

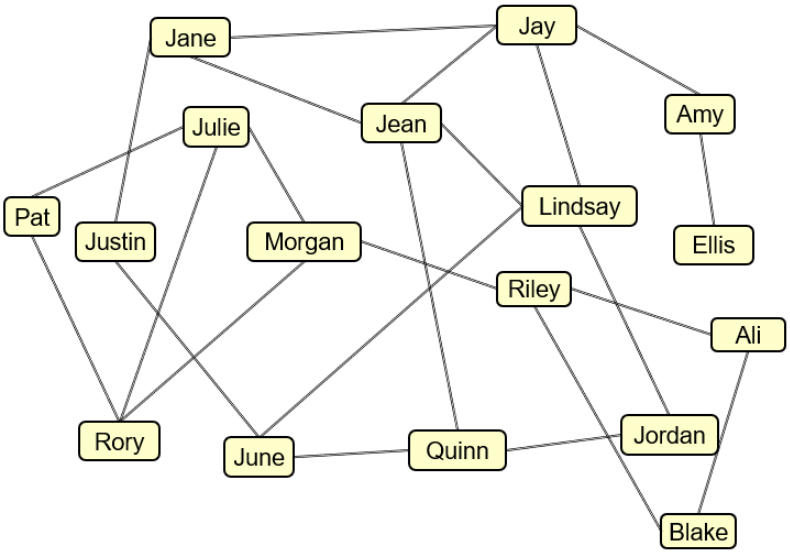
```
public void addFriend(SNPerson fr) {
…
SNPerson P1 = new SNPerson("Jane");
```

```
SNPerson P2 = new SNPerson("Jay");
…
P1.addFriend(P2);
}

public void addFriendship(SNPerson fr){
this.friends.add(fr);
fr.friends.add(this);
}
```

Program 3:

```
public void addFriend(SNPerson fr) {friends.add(fr); }
…
SNPerson P1=new SNPerson("Jane");
SNPerson P2=new SNPerson("Jay");
…
P1.addFriendship(P2);
}

public void addFriendship(SNPerson fr){
this.addFriend(fr);
fr.addFriend(this);
}
```

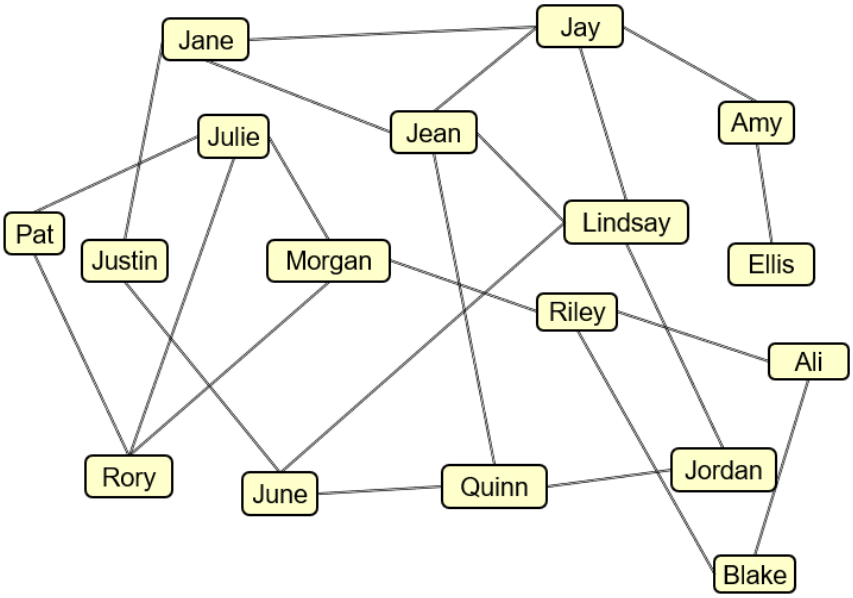
3. If the graph is as shown in the figure below, create the Java program that traverses its nodes and edges from node Jane. State the outcome of each program and comment on its characteristics.



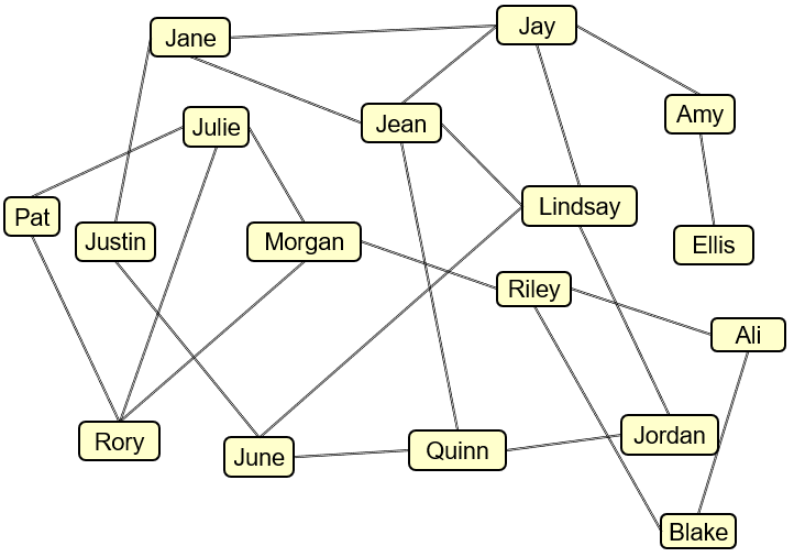
a. Keep the visited nodes in an array. [10 marks]

b. Keep the visited flag inside node. [10 marks]

4. If the social network graph is as shown in the figure below, design a program that will count the number of connected nodes. [6 marks]



5. Write a Java program for the social network graph that determine whether two people are connected in the network.



a. Recursive method. [10 marks]

b. Iterative method. [10 marks]