LABWORK 6:

GROUP : CE

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INTRODUCTION:

In this lab work, we have implemented graph data structure.We have done following operations.

(a) isEmpty(): Returns true if the graph is empty, and false otherwise

(b) isDirected(): Returns true if the graph is directed, and false otherwise

(c) addVertex(newVertex): Inserts a new vertex to the graph

(d) addEdge(vertex1, vertex2): Adds an edge from vertex1 to vertex2

(e) removeVertex(vertexToRemove): Remove a vertex from the graph

(f) removeEdge(vertex1, vertex2): Remove an edge from the graph

(g) numVertices(): Returns the number of vertices in the graph

(h) numEdges(): Returns the number of edges in the graph

(i) indegree(vertex): Returns the indegree of a vertex

(j) outdegree(vertex): Returns the outdegree of a vertex

(k) degree(vertex): Returns the degree of a vertex

(l) neighbours(vertex): Returns the neighbours of a vertex

(m) neighbour(vertex1, vertex2): Returns true if vertex2 is a neighbour of vertex1.

IMPLEMENTATION:

Using adjacency matrix representation of graph, we have implemented the above operations.
An adjacency matrix of a graph $G = (V, E)$ is a binary $|V|$ x $|V|$ matrix such that

$$aij = \begin{cases} 1 \text{ if there exists an edge from vi to vj } & 0 \text{ otherwise.} \end{cases}$$

- For isEmpty() : we have checked if there are any vertices or not.
- For isDirected(): we have checked what type of graph whether directed or undirected, user has used
- For addVertex(newVertex): we have added a new row and a new column for the vertex in the matrix.
- For addEdge(vertex1, vertex2): we have set the value of $a_{v1\ v2}$ as 1 where v1 is index of vertex1 and v2 is index of vertex2, for directed. And for undirected, we have also set the value of $a_{v2\ v1}$ as 1 in addition.
- For removeEdge(vertex1, vertex2): we have set the value of $a_{v1\ v2}$ as 0 where v1 is index of vertex1 and v2 is index of vertex2, for directed. And for undirected, we have also set the value of $a_{v2\ v1}$ as 0 in addition.
- For numVertices(): we have counted the number of vertices in the graph.
- For numEdges(): we have counted the number of 1's in the matrix and returned it for directed. And for undirected we have returned half of the counted 1's.
- For indegree(vertex): we have counted the number of index with a[x][vertex_index]=1, where 0<x<numofvertices
- For outdegree(vertex): we have counted the number of index with a[vertex_index][x]=1, where 0<x<numofvertices
- For degree(vertex): we have added the indegree and outdegree of vertex and returned it for directed graph, whereas returned half of it for undirected graph.
- For neighbour(vertex1, vertex2): we have returned true if $a_{v1\ v2}$ is 1, else false is returned.
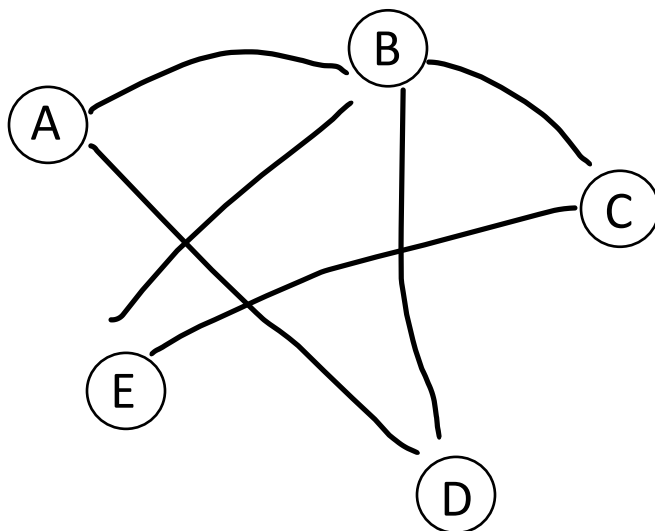
INPUT:

We have used the following graph in out program:

For directed:
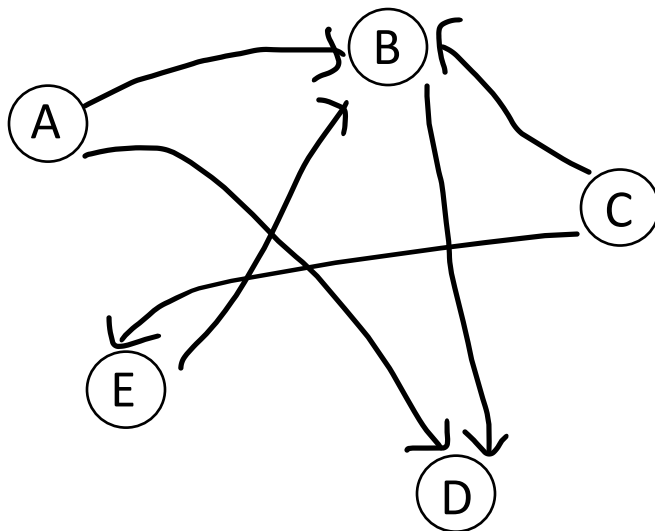
For undirected:

OUTPUT:

Below inserted are the screenshots of output of the program.

For undirected:

```
Is the graph directed? 0->not directed  1->directed
0
0
Is it empty?True
Displaying graph
Empty graph
Adding vertices in graph

The number of vertices are:5Adding edge A-B in graph
Edge added
Adding edge C-B in graph
Edge added
Adding edge B-D in graph
Edge added
Adding edge C-E in graph
Edge added
Adding edge A-D in graph
Edge added
Adding edge E-B in graph
Edge added
Displaying graph

     A   B   C   D   E
A    0   1   0   1   0
B    1   0   1   1   1
C    0   1   0   0   1
D    1   1   0   0   0
E    0   1   1   0   0

Is it directed?False
```

```
The number of edges in graph are6
Removing edge E-B in graph

     A   B   C   D   E
A    0   1   0   1   0
B    1   0   1   1   0
C    0   1   0   0   1
D    1   1   0   0   0
E    0   0   1   0   0

Indegree of B is 3
Outdegree of B is 3
Total degree of B is 3
Removing vertex E in graph

     A   B   C   D   -
A    0   1   0   1   -1
B    1   0   1   1   -1
C    0   1   0   0   -1
D    1   1   0   0   -1
-    -1  -1  -1  -1  -1
```

For directed:

```
Is the graph directed? 0->not directed  1->directed
1
0
Is it empty?True
Displaying graph
Empty graph
Adding vertices in graph

The number of vertices are:5Adding edge A-B in graph
Edge added
Adding edge C-B in graph
Edge added
Adding edge B-D in graph
Edge added
Adding edge C-E in graph
Edge added
Adding edge A-D in graph
Edge added
Adding edge E-B in graph
Edge added
Displaying graph

      A   B   C   D   E
A     0   1   0   1   0
B     0   0   0   1   0
C     0   1   0   0   1
D     0   0   0   0   0
E     0   1   0   0   0

Is it directed?True
```

```
The number of edges in graph are6
Removing edge E-B in graph

      A   B   C   D   E
A     0   1   0   1   0
B     0   0   0   1   0
C     0   1   0   0   1
D     0   0   0   0   0
E     0   0   0   0   0

Indegree of B is 2
Outdegree of B is 1
Total degree of B is 3
Removing vertex E in graph

      A   B   C   D   -
A     0   1   0   1   -1
B     0   0   0   1   -1
C     0   1   0   0   -1
D     0   0   0   0   -1
-    -1  -1  -1  -1  -1
```