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Representation of Graph

- In graph theory, a graph representation is a technique to store graph into the memory of computer.

- To represent a graph, we just need the set of vertices, and for each vertex the neighbors of the vertex (vertices which is directly connected to it by an edge). If it is a weighted graph, then the weight will be associated with each edge.

- There are different ways to optimally represent a graph, depending on the density of its edges, type of operations to be performed and ease of use.

Representation of Graph

Graphs can be represented into many ways, the two important ways are:-

- Adjacency Matrix
- Incidence Matrix

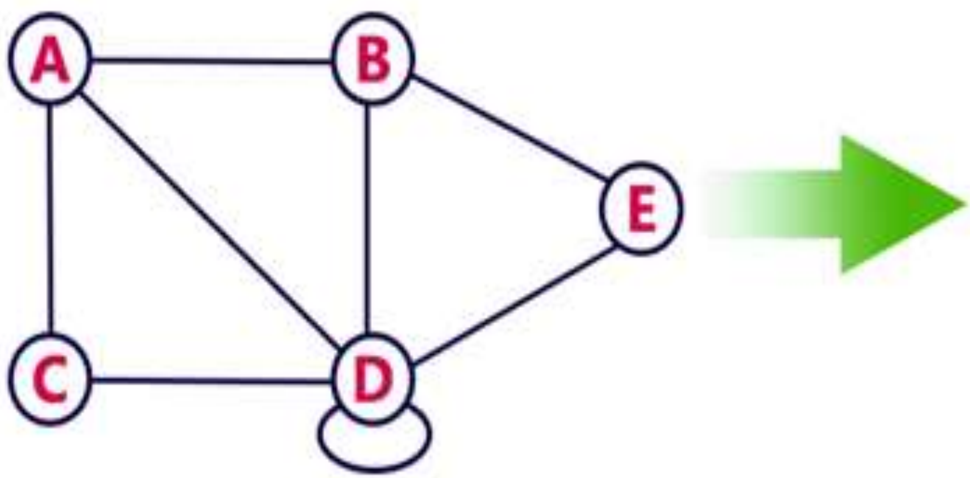
1. Adjacency Matrix

- Adjacency matrix is a sequential representation.
- It is used to represent which nodes are adjacent to each other. i.e. is there any edge connecting nodes to a graph.
- In this representation, we have to construct a nXn matrix A. If there is any edge from a vertex i to vertex j, then the corresponding element of A, $a^{i},^{j} = 1$, otherwise $a^{i},^{j} = 0$.
- If there is any weighted graph then instead of 1s and 0s, we can store the weight of the edge.

Example

Consider the following **undirected graph representation**:

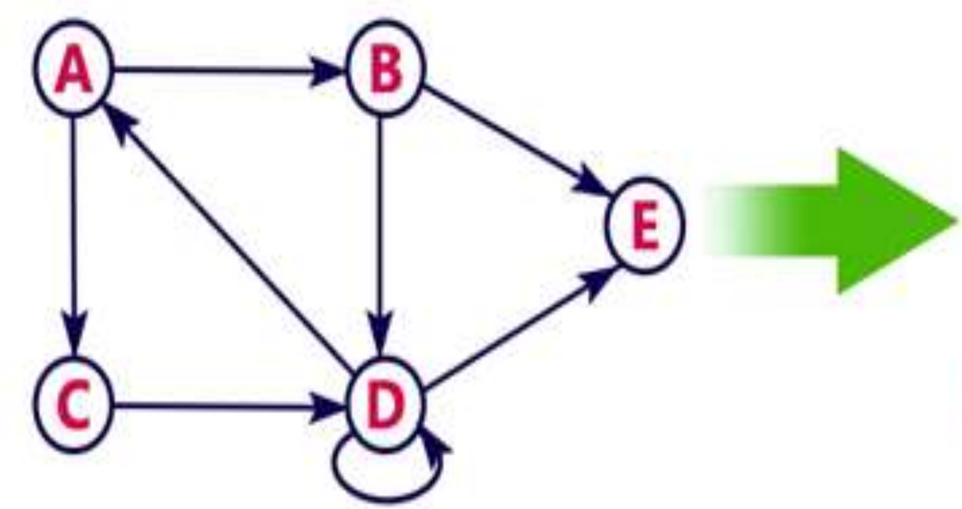
Undirected graph representation



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

Directed graph representation

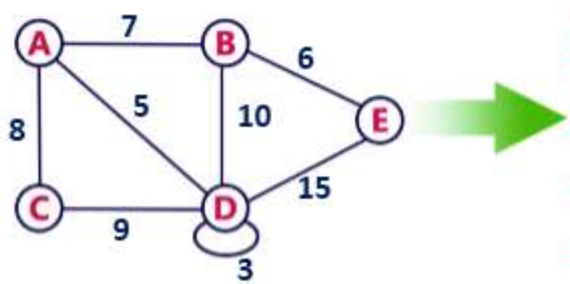
See the directed graph representation:



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

In the above examples, 1 represents an edge from row vertex to column vertex, and 0 represents no edge from row vertex to column vertex.

Undirected weighted graph representation



	A	B	C	D	E
A	0	7	8	5	0
B	7	0	0	10	6
C	8	0	0	9	0
D	5	10	9	3	15
E	0	6	0	15	0

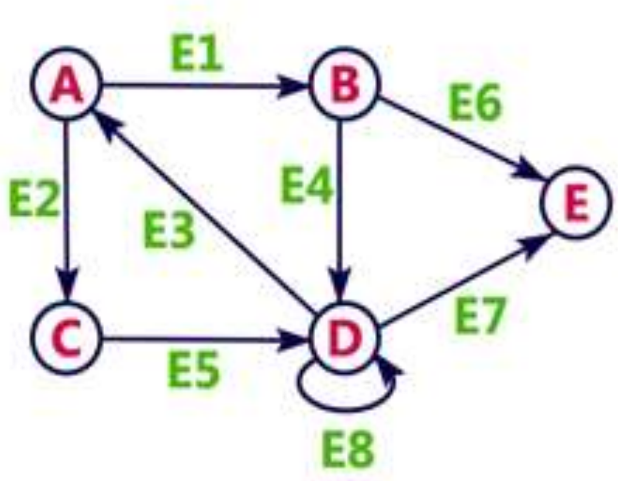
Pros: Representation is easier to implement and follow.
Cons: It takes a lot of space and time to visit all the neighbors of a vertex, we have to traverse all the vertices in the graph, which takes quite some time.

2. Incidence Matrix

- In **Incidence matrix representation**, graph can be represented using a matrix of size:
- Total number of vertices by total number of edges.
- It means if a graph has 4 vertices and 6 edges, then it can be represented using a matrix of 4X6 class. In this matrix, columns represent edges and rows represent vertices.

Example

Consider the following directed graph representation



	E1	E2	E3	E4	E5	E6	E7	E8
A	1	1	-1	0	0	0	0	0
B	-1	0	0	1	0	1	0	0
C	0	-1	0	0	1	0	0	0
D	0	0	1	-1	-1	0	1	1
E	0	0	0	0	0	-1	-1	0

This matrix is filled with either 0 or 1 or -1. Where,
0 is used to represent row edge which is not connected to column vertex.
1 is used to represent row edge which is connected as outgoing edge to column vertex.
-1 is used to represent row edge which is connected as incoming edge to column vertex.