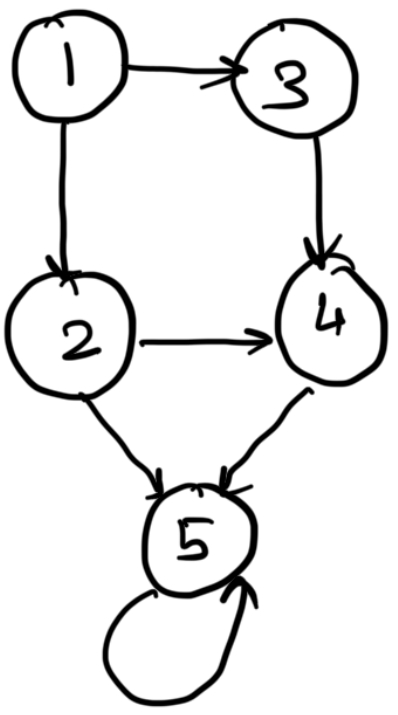
Graph: Data structure

- A graph is a non-linear data structure composed of 2 main components:

1. Vertices – Nodes → Entity / Objects
2. Edges – Connection - pair of vertices

$$G(V, E)$$



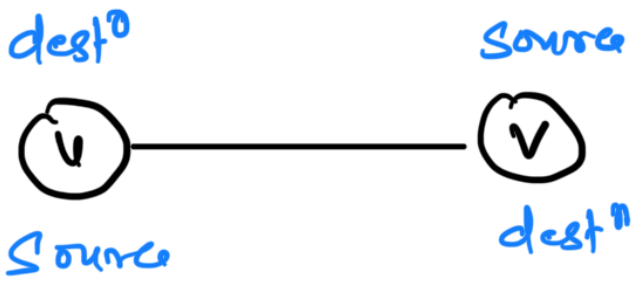
$V = \{1, 2, 3, 4, 5\}$

$E = \{(1,2), (1,3), (3,4), (2,4), (4,5), (2,5)\}$

Directed Graph

(u,v) ✓ destination correct

(v,u) → X X not correct



(u,v) } both are correct
(v,u)

Undirected Graph ↓ These graph have Symmetric relation

Components of Graph -

1. Vertex → fundamental unit of Graph
   → Can labeled or unlabeled

2. Edges → Ordered pair, → directed graph

Unordered pair → undirected graph

Graph Properties -

1. Number of edges - Undirected Graph

The no. of possible pairs in a 'n' vertex graph is $n(n-1)$.

$$\frac{n(n-1)}{2}$$ ← $(u,v) = (v,u)$ ↑ same

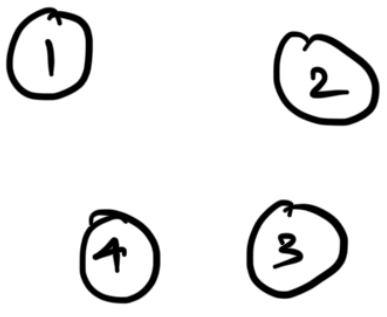
2. Number of edges - Directed Graph

The no. of possible pairs in a 'n' vertex graph is $n*(n-1)$

$(u,v) \neq (v,u)$ ↑ not same

$$\text{No. of edges} \leq n(n-1)$$

Types of Graph

1. 

Null graph

- No edges bet^n the vertices
- Set of isolated nodes without any relation

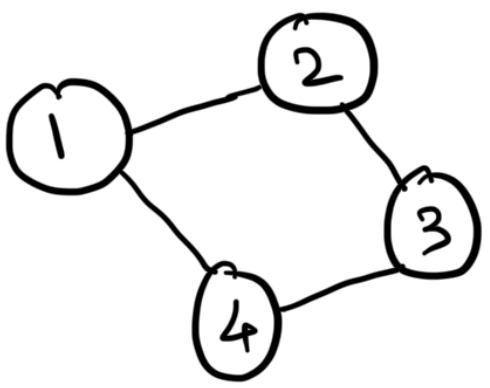
2. 

- A graph with only

Trivial Graph

- one vertex
- isolated vertex

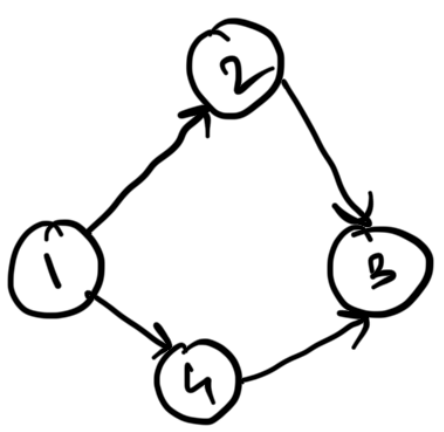
3.



Undirected Graph

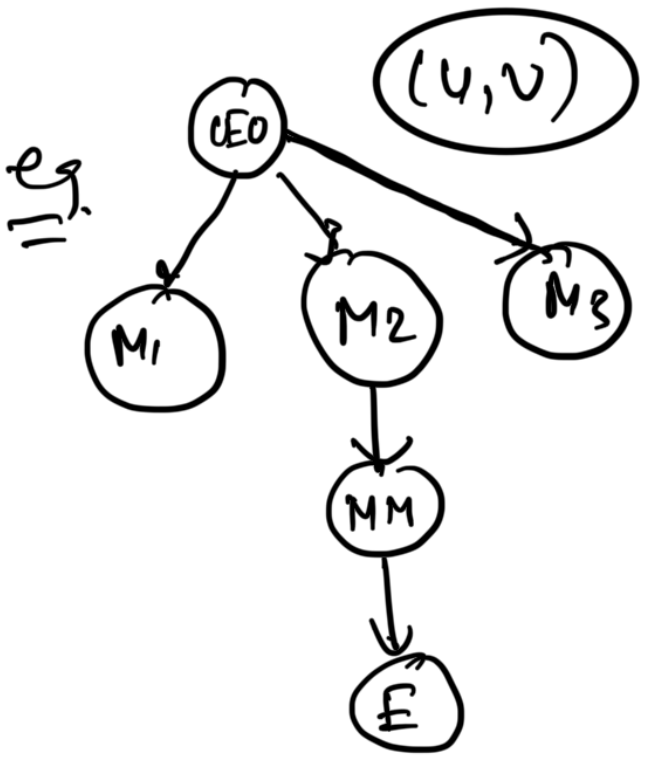
- Edges have no direction, but both connected vertices are treated equally
- Mutual Relationship
  - Social Media
  - Social N/w

4.



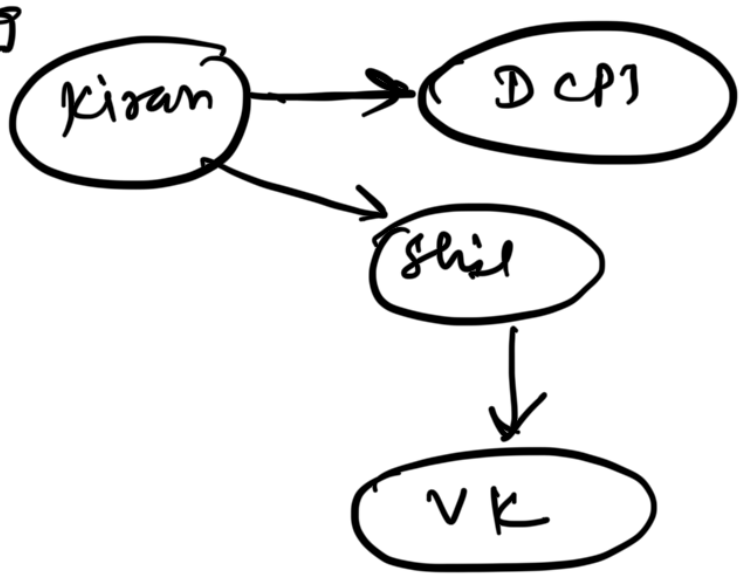
Directed Graph
(Digraph)

- Edges have direction
- source to destination
  (u) (v)
- one vertex points to another vertex
- Twitter follow relationship

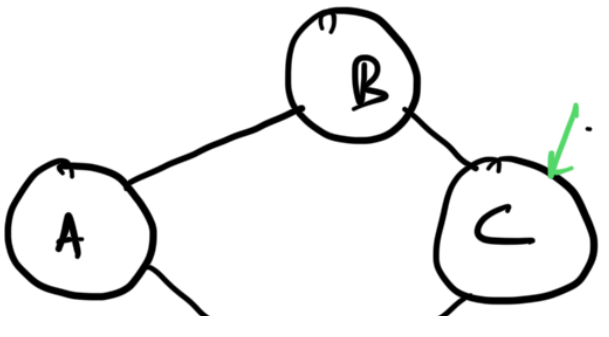


eg.

eg



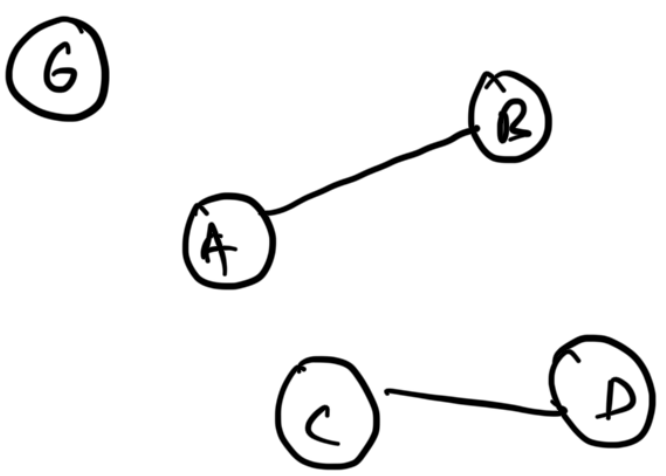
5



- Every node is reachable from any other node

Connected graph

- Network eg

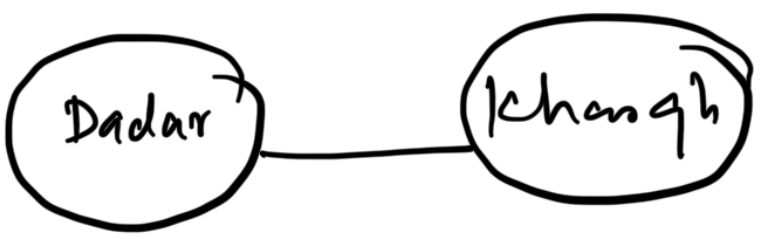


Disconnected graph

- Atleast one vertex is reachable

- eg. railway & Metro paths from same sourc to destination

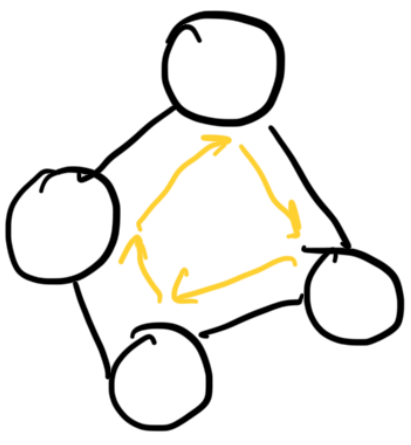
eg



Railway ——

Metro ——

⑦

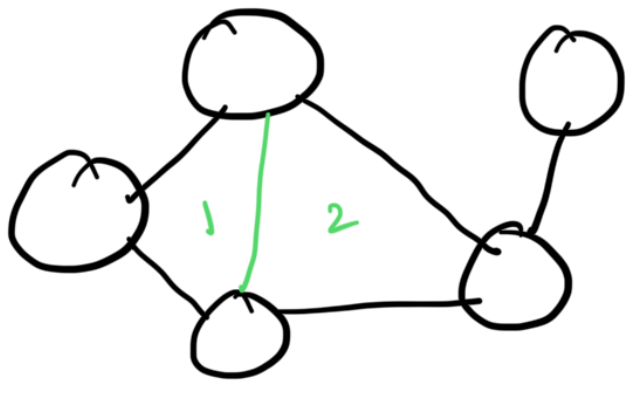


Cycle graph

- A graph where all vertices form a cycle

eg Roundtrip

⑧



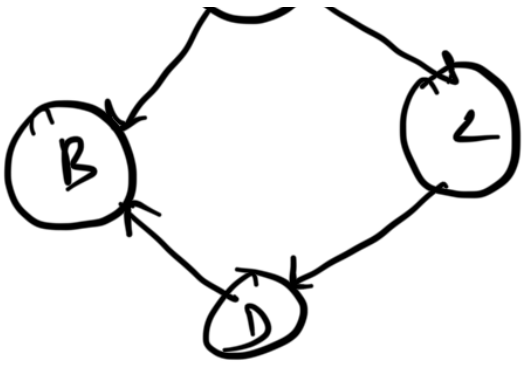
Cyclic graph

- A graph contains atleast 1 cycle

-

⑨

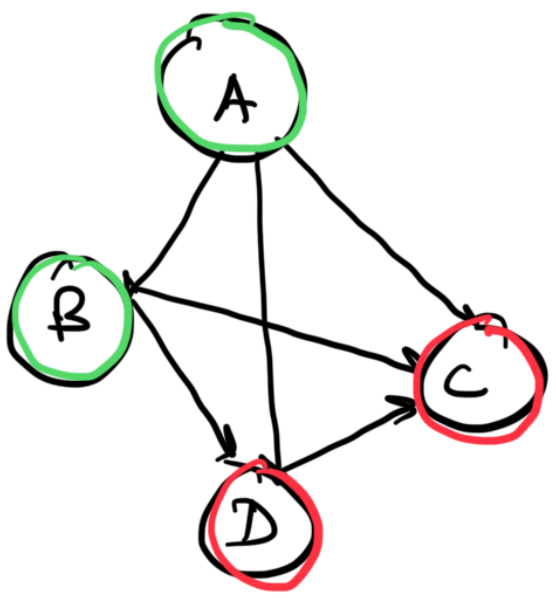
- Directed graph with



Directed Acyclic Graph

(DAG)

10



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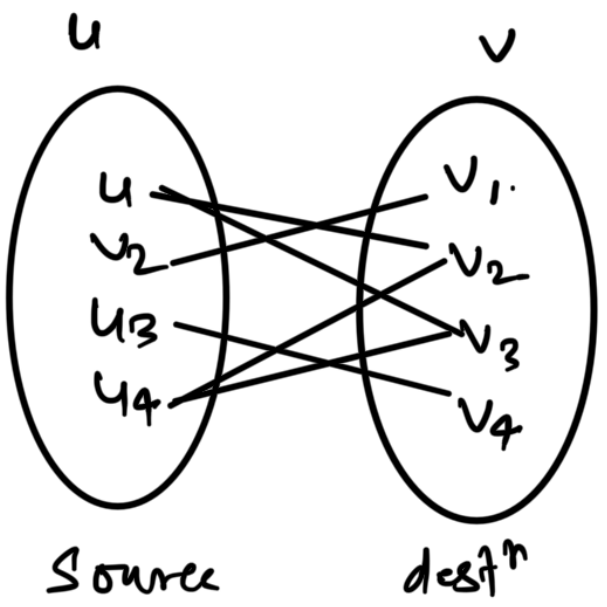
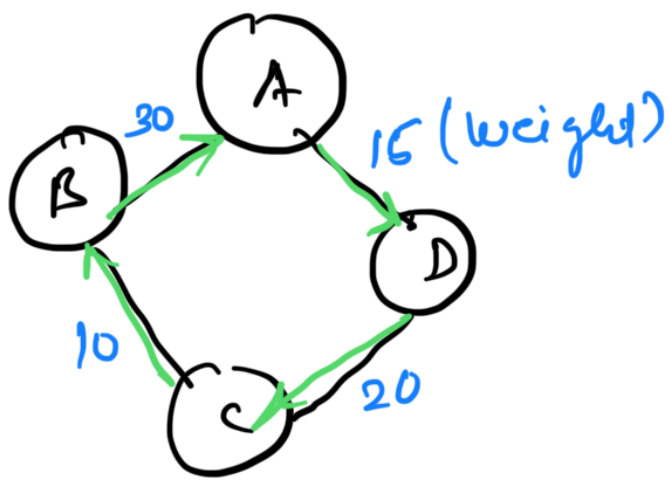


Bipartite Graph

– A graph which divides the vertices in two sets of vertex

11

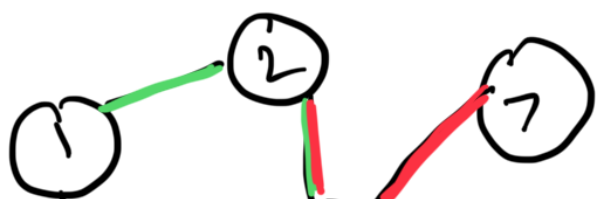


Weighted Graph

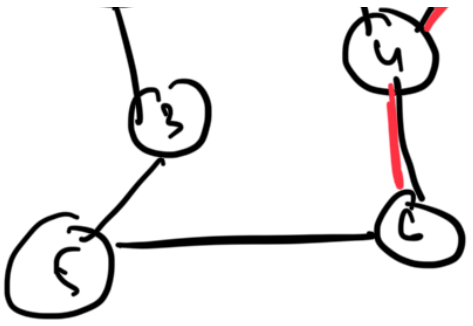
– Graph where edges carry weight

– weight ⇒ cost
Amount
distance
etc

Degree of the vertex: Indegree(N), Outdegree(N)

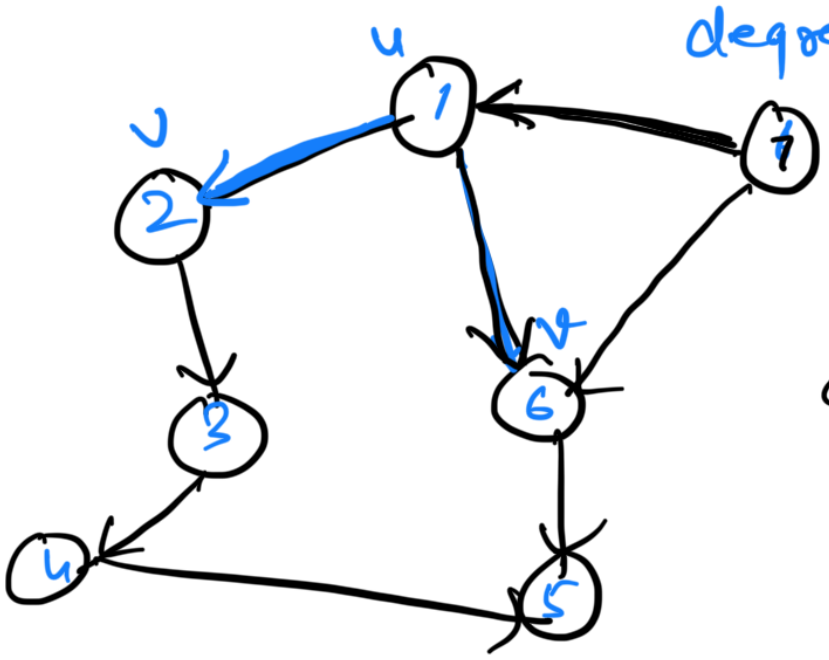


degree ⇒ source



degree(2) = 2

degree(4) = 3



degree(1)(u) ⇒ Outdegree

(v) ⇒ Indegree

degree(1) = 2

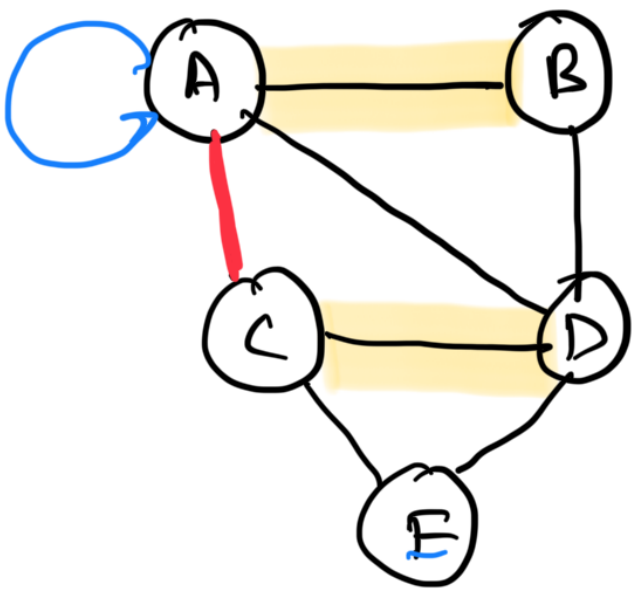
degree(1) = 1

Representation of Graph in data structures

1. Adjacency Matrix

2. Adjacency List

Adjacency Matrix (row, col) ⇒ (5 x 5)



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

JBR

Matrix consist of only 0 & 1 {0,1}

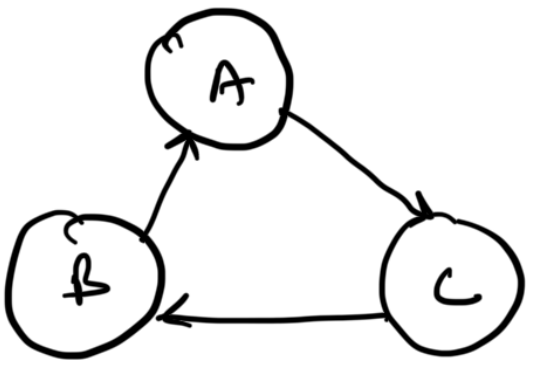
Undirected

Space Complexity = Rows x Cols

= n x n

$= O(n^2)$

Adjancy matrix ⇒ Symmetric matrix



Directed graph

Adjacency Matrix

	A	B	C
A	0	0	1
B	1	0	0
C	0	1	0

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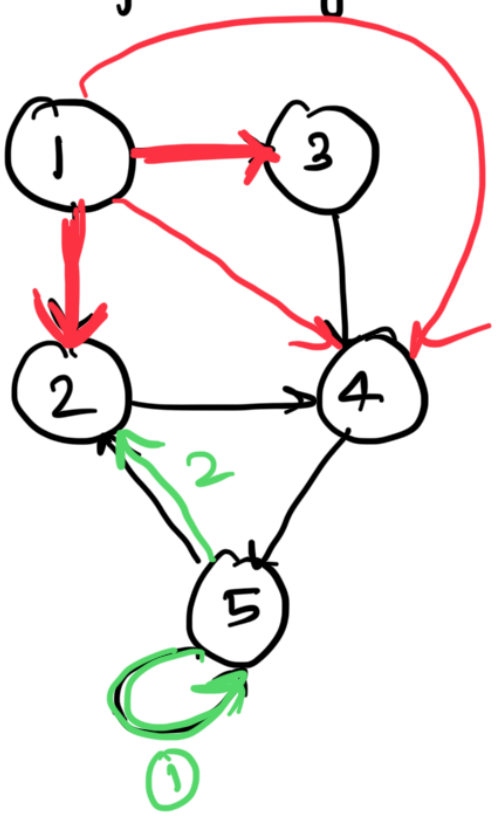
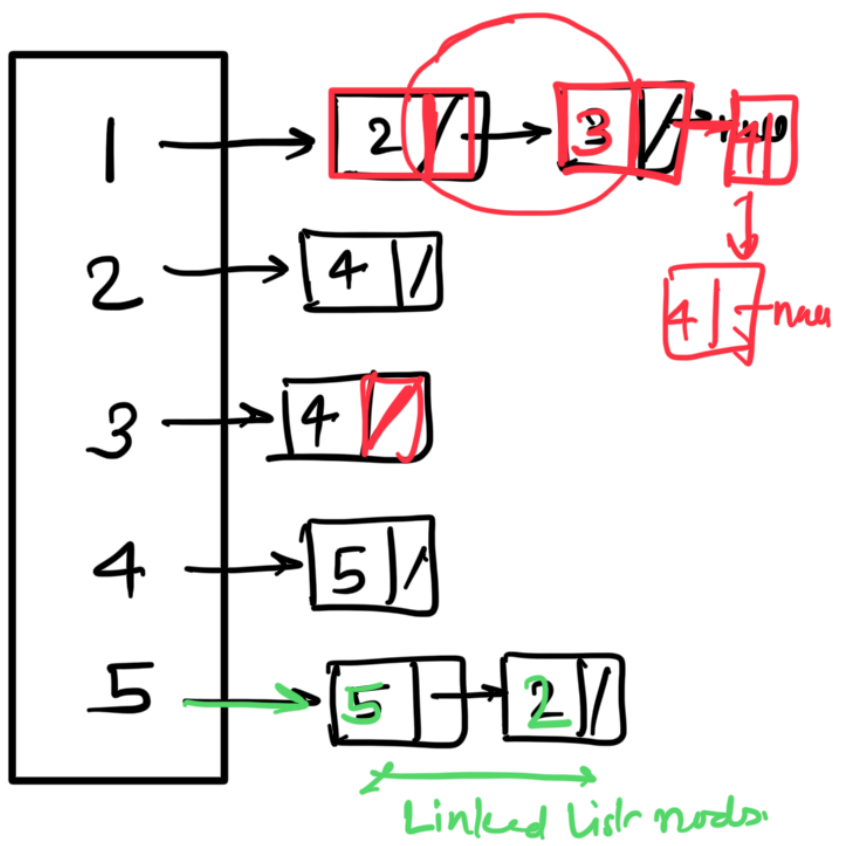
2. Adjacency List





Space Complexity = No. of edges

$= |E|$

$= O(|E|)$

$= O(n)$