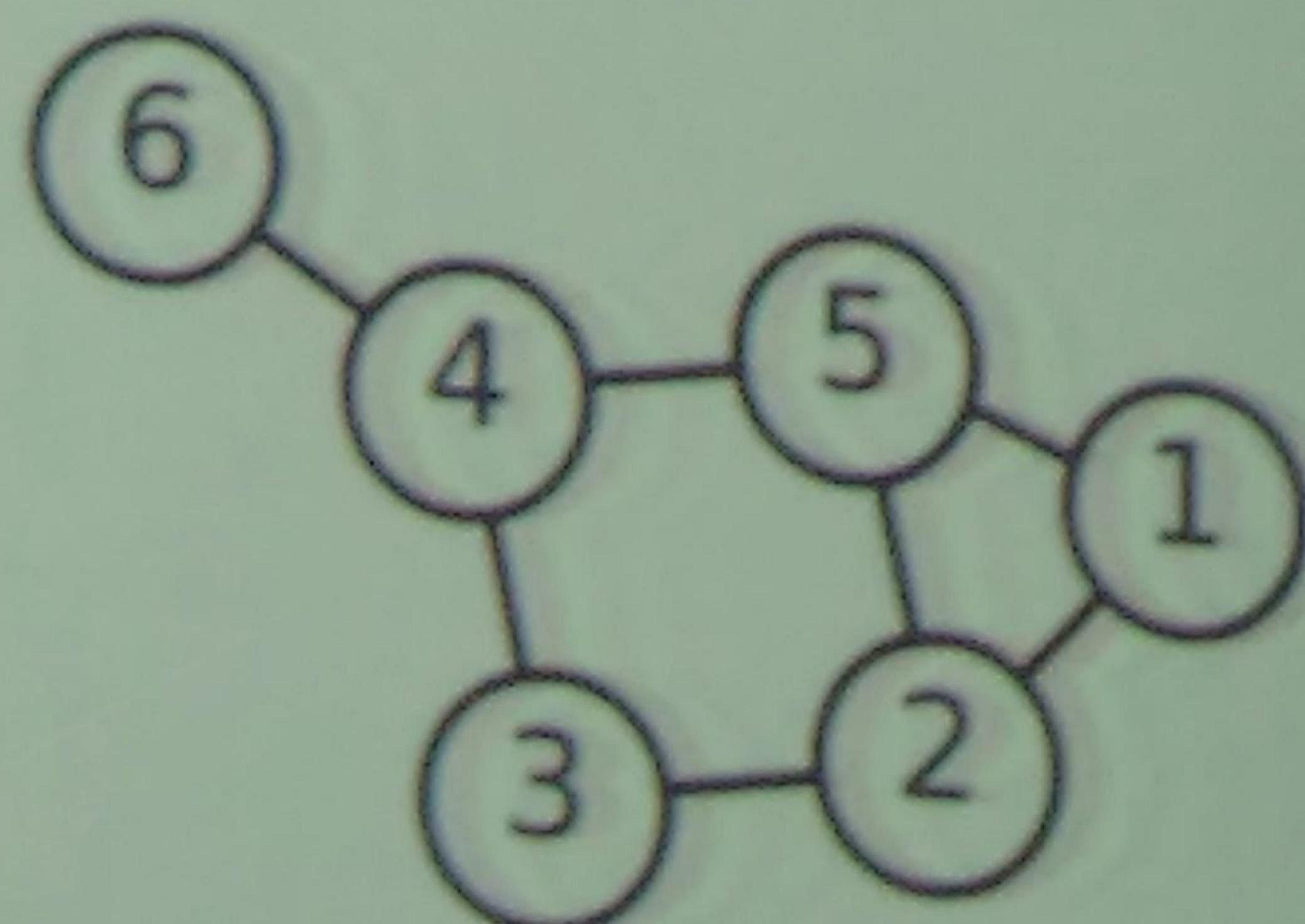


# Graphs are really useful in biology

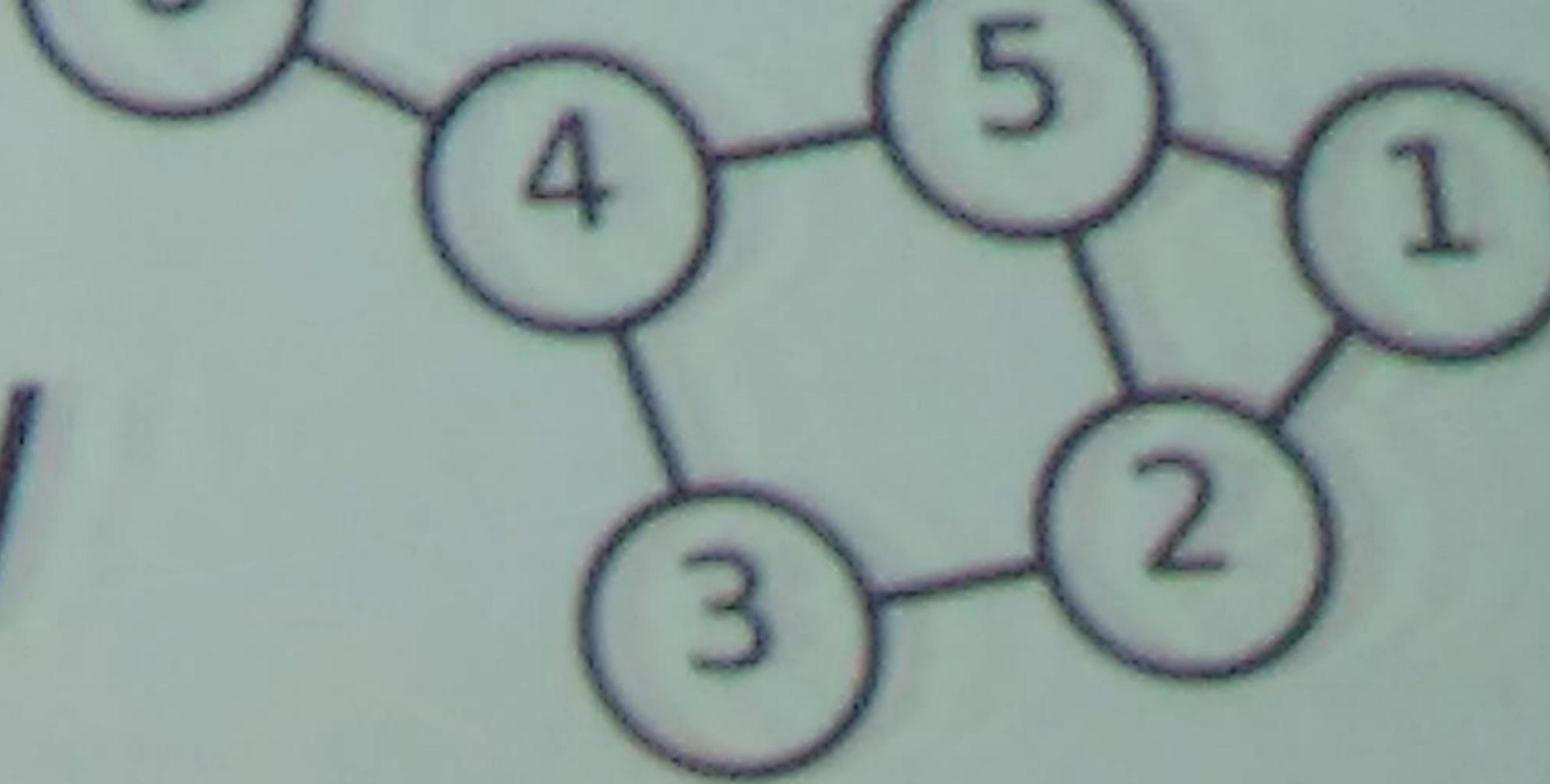
Vertices (or nodes) usually represent things  
Edges (or links) represent interactions

## Examples:

- social interactions
- food webs
- protein-protein interactions
- genetic regulatory interactions
- epidemic spread



# Basic Terminology



Edges may be **directed** or not

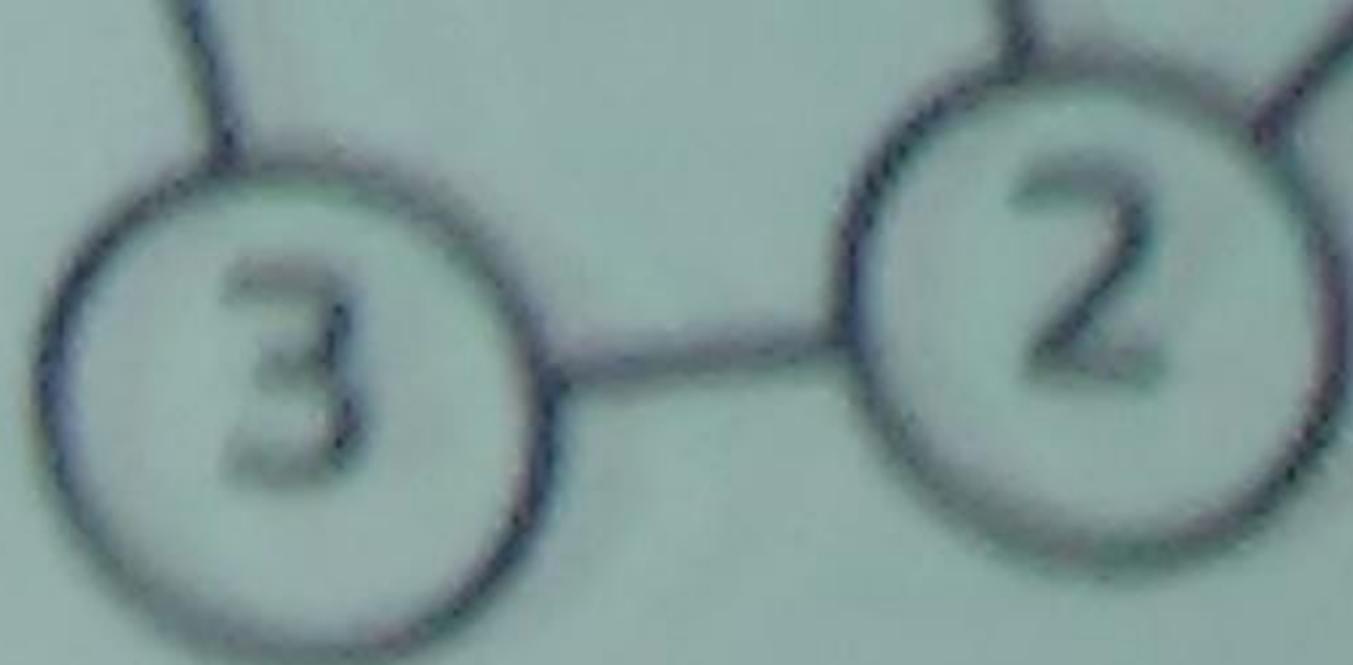
Edges may be **weighted** or not

The **degree** of a node is the number of edges it has

Distance is counted as number of links between 2 nodes

The **diameter** is the number of links between the two furthest nodes

A **component** is a set of nodes that are connected by links



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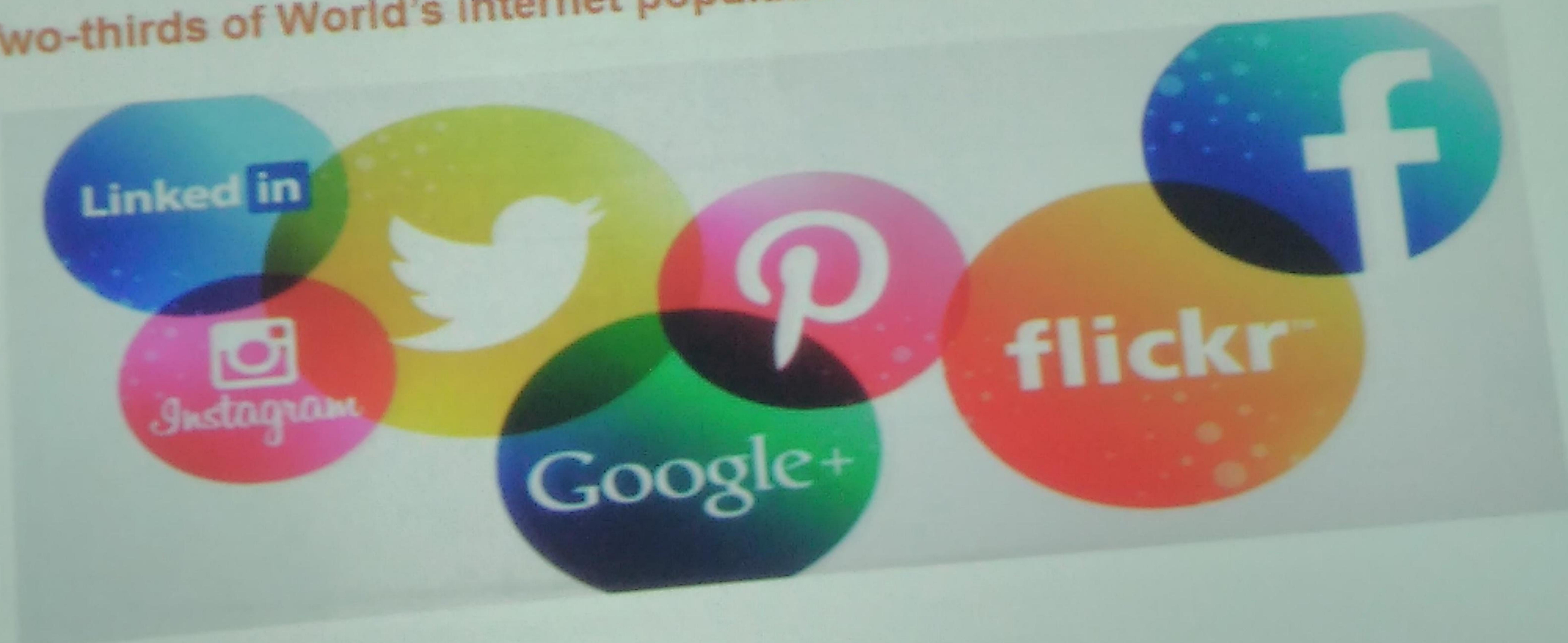
Click to add notes

- The **degree distribution** gives the degree of each node in the graph
- **Random networks** are made by taking a set of nodes and connecting them randomly so that the degree is normally distributed
- A **scale free network** has a degree with a **power law distribution**. Informally, there are many nodes with a few edges, and only a few nodes with many edges.

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- Social network represented by a large graph consisting of vertices and edges.
- Identification of the most influential node in the network is important.
- Disseminating information in the network.
- Central node of a network or with highest degree node is considered as the most influential node.
- The existing methods do not consider the local structure of network.

- Emerging areas of technology in ongoing research field
- Relationship between set of connected entities
- Person to person interaction on a global platform
- Distributed network with random connection between users
- Two-thirds of World's internet population visit a social network



NIT Arunachal Pradesh, India

- **Social Networks:** Role detection, popularity estimation from communities based on common interests, locations, occupation etc.
- **Biological Networks:** Drug response estimation based on functional groupings.
- **Citation Networks:** Estimation of common research interests, research trends etc. from communities based on co-cited papers.
- **Literature Network:** Find the protagonist and antagonist from any literature.
- **Graph Coarsening:** Summarization or mapping a graph onto a similar smaller graph.
- **E-Commerce:** Recommendation systems for communities of customers based on similar interests.

## Definition of Social Network

---

- Undirected graph  $G(V, E)$  where  $V=\{v_1, v_2, v_3, \dots, v_n\}$  is the set of nodes and  $E=\{e_1, e_2, e_3, \dots, e_n\}$  is the set of edges.
- In a social network, each node represents an actor and edge represents the relationship between the actors.
- We assume the representational graph without any self-loops and no parallel edges. Each node  $v_i \in V$ , has its own influence in the network.

# Random Graphs

## Assumption

Probability that a pair of vertices has an edge is same for all possible pairs of Vertices

## Assuming:

n, number of vertices; and

p, probability of connection between a pair of vertices

then:

Expected number of edges in the graph( $e$ )

$$e = pn(n-1)/2$$

Expected mean degree

$$K = p(n-1)$$

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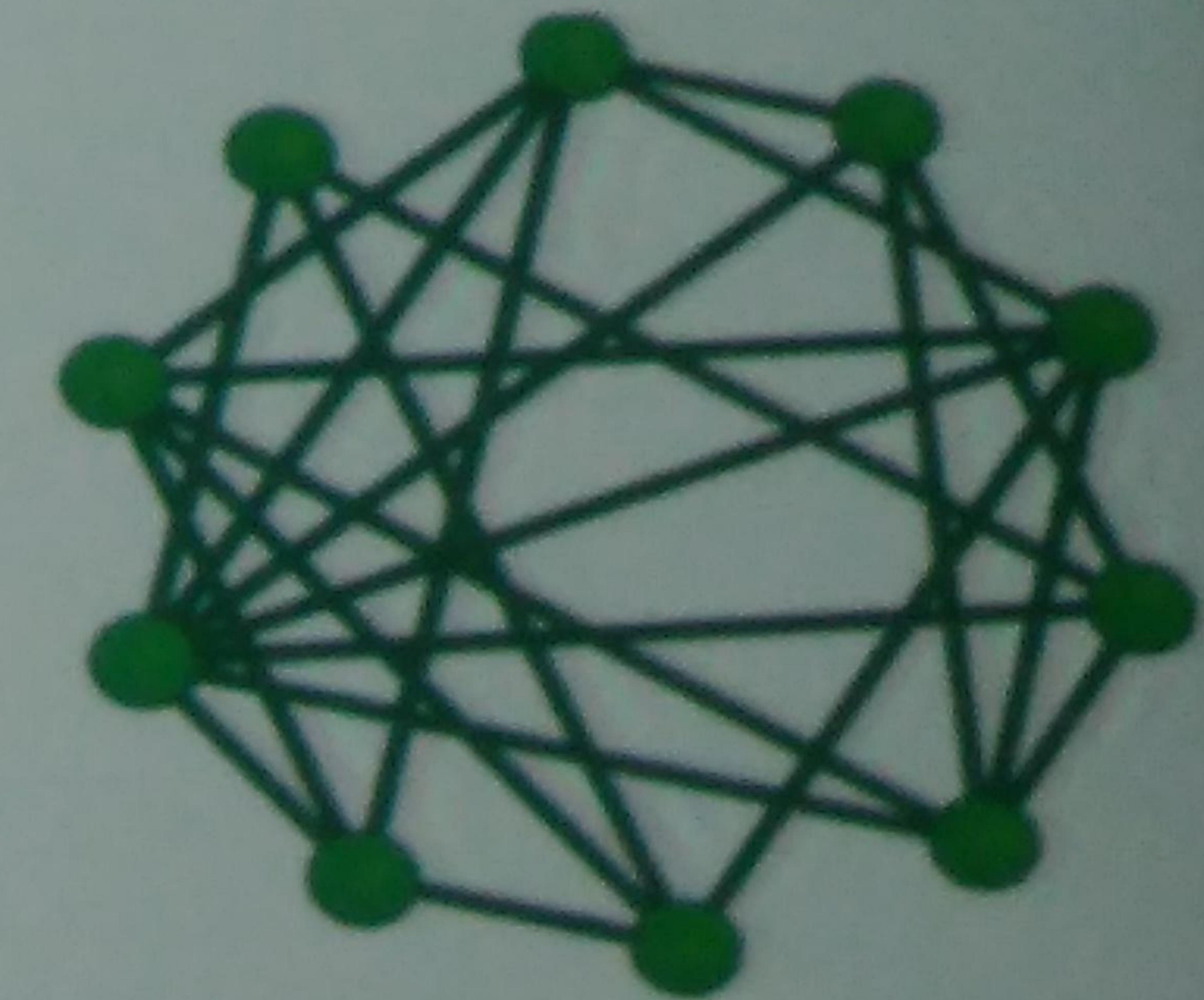


Figure: A random graph with 10 nodes and  $p = 0.5$

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**Communities are held together by common interest. It may be a hobby, something the community members are passionate about, a common goal, a common project, or merely the preference for a similar lifestyle, geographical location, or profession.**

## **Properties**

- Users create some community between themselves according to some common interests
- Intra density is higher than inter density.
- Community may be assortative or dissassortative
- Each community should have an influential node
- Central nodes are likely to be more influential

Real networks are not random i.e. probability of connection is not same

Assuming:

High level of order and organization.

Degree distribution follows a power-law:  $P(d)=cd^{-\gamma}$

$\gamma$  is a constant term varies in between 0 and 1

Degree distribution in real life network is less than the random network due to high degree of cohesiveness

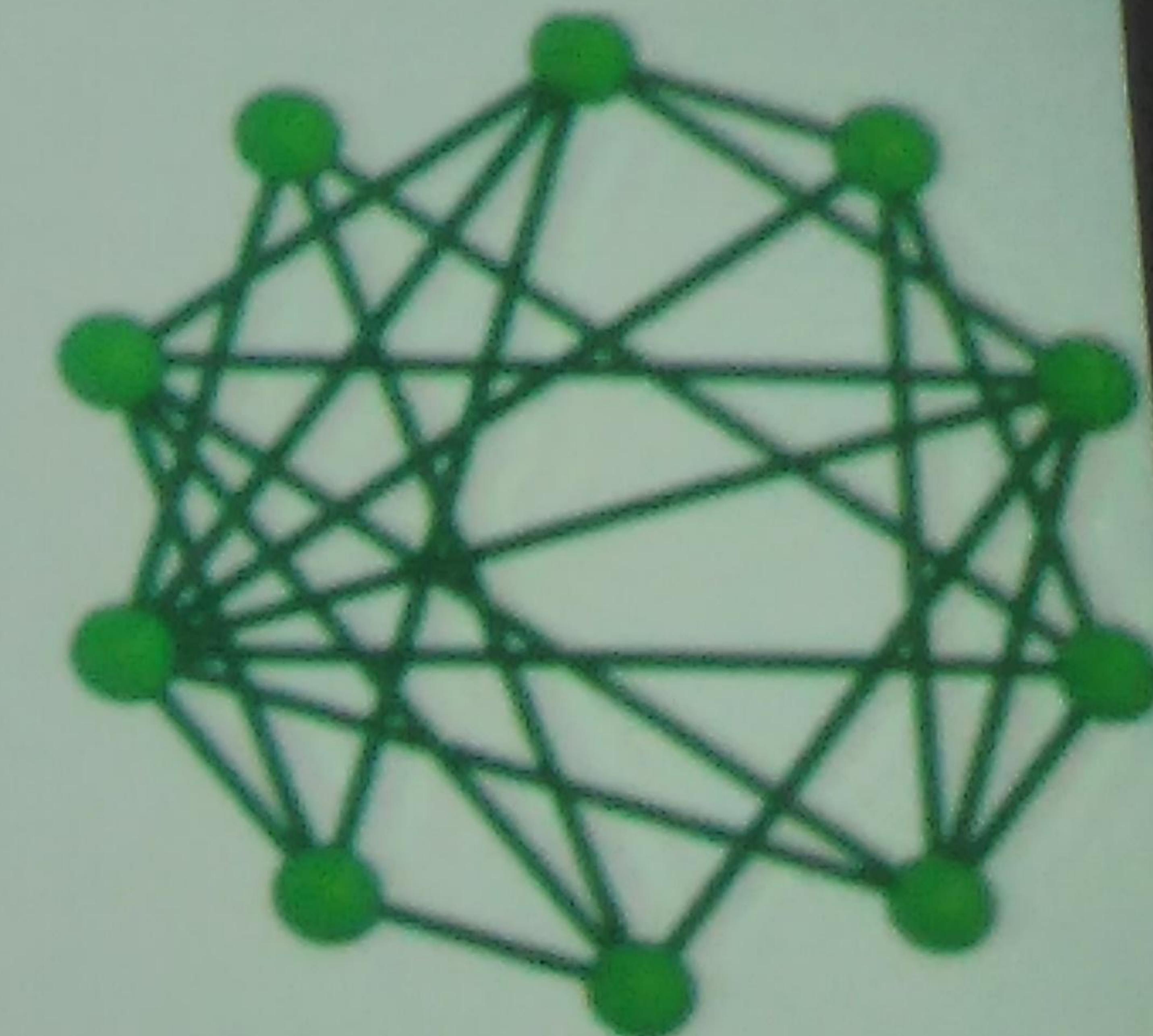


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