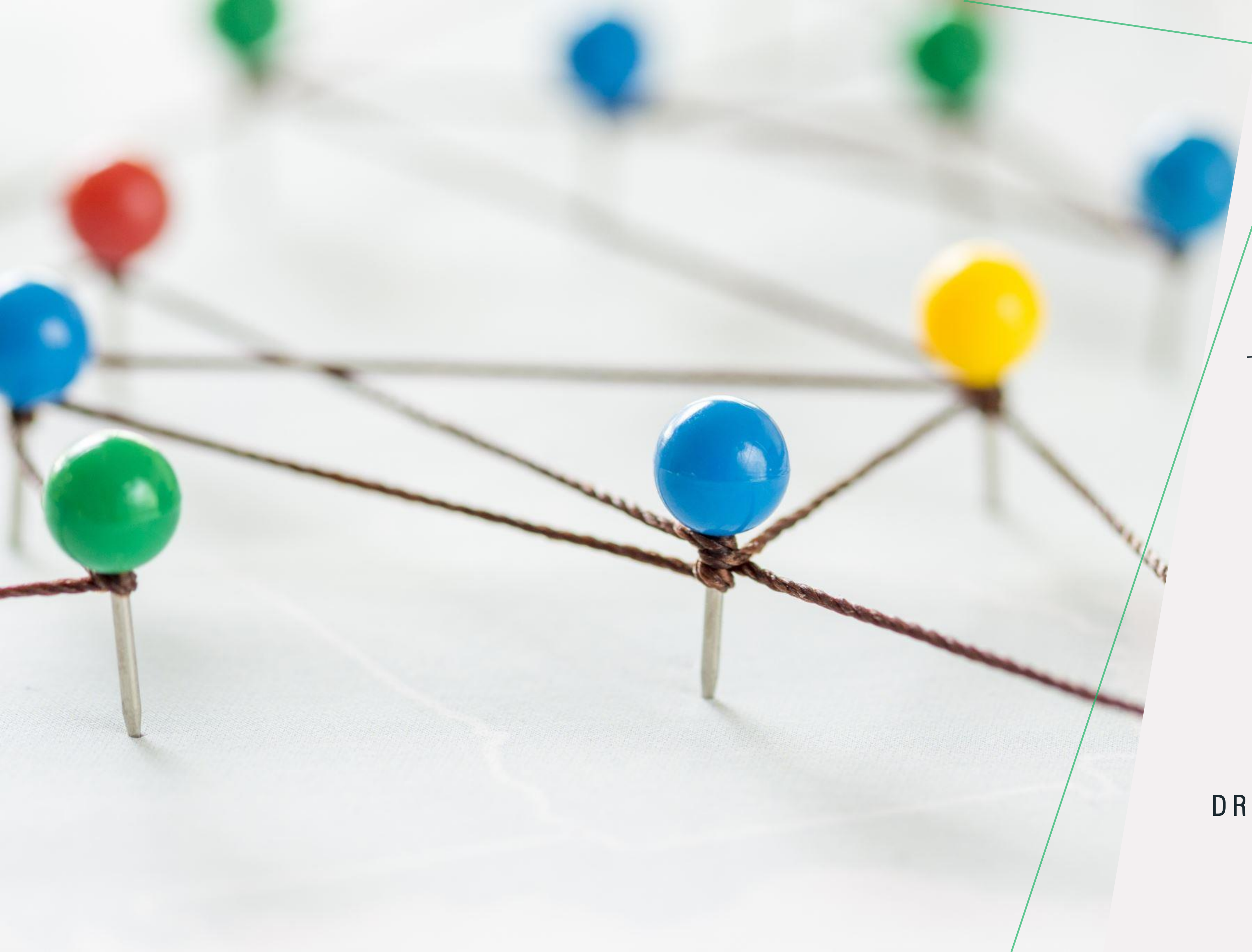


SOCIAL NETWORK ANALYSIS

Mphil DataScience
Course No.

COURSE INSTRUCTOR:

DR.ARJUMAND BANO SOOMRO

> "Social networks aren't about Web sites. They're about experiences."

—Mike DiLorenzo, NHL Social Media Marketing Director

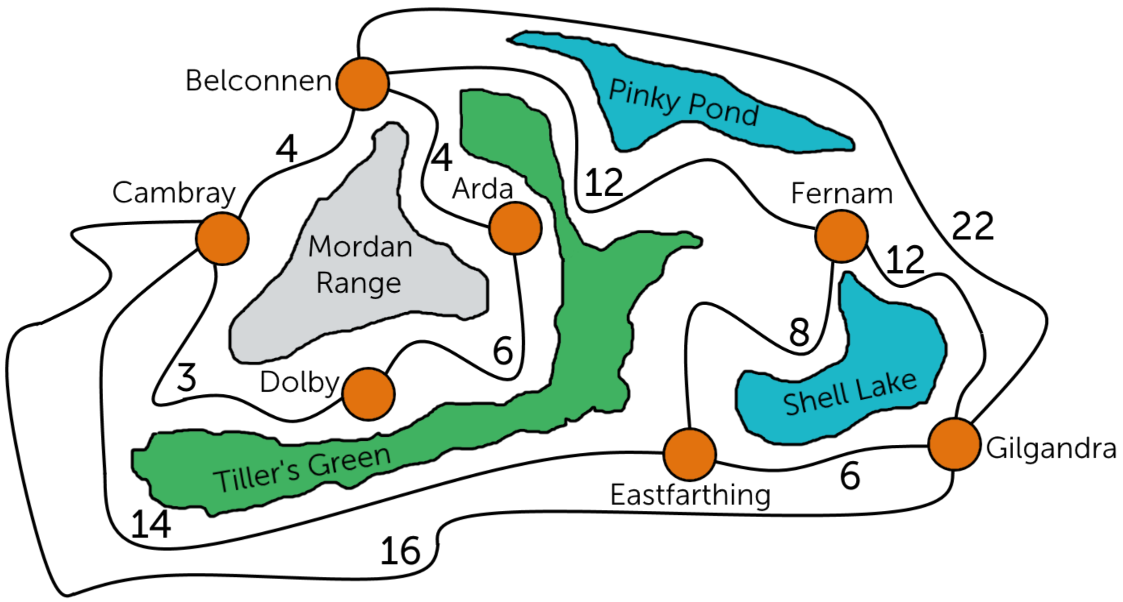
REINFORCEMENT

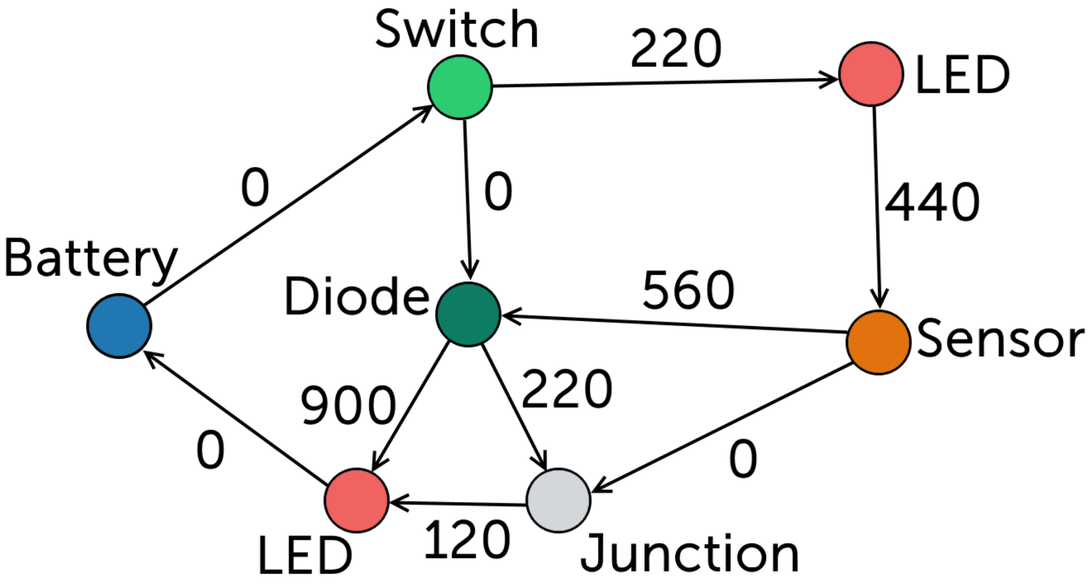
- thinking about examples of your own life that may be conceptualized as a (social) network.

GRAPHS & NETWORKS

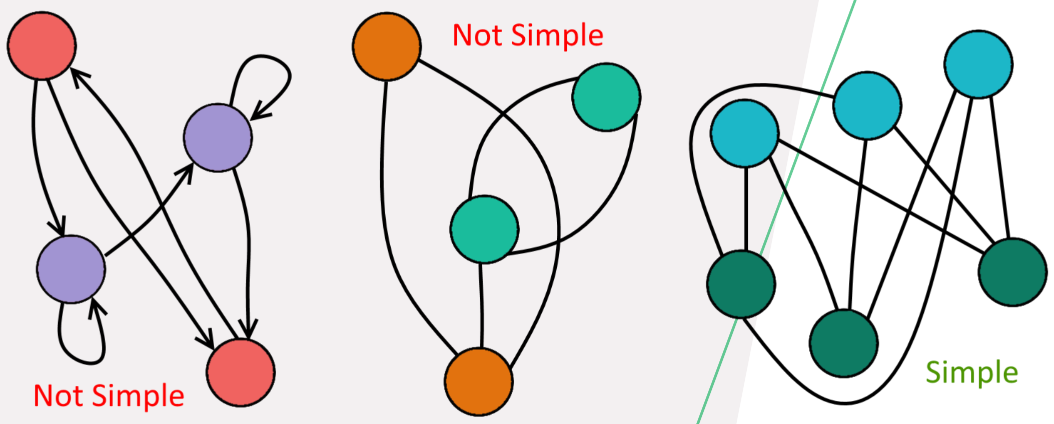
- Graphs and networks are mathematical structures used to model relationships between objects.
- Graphs represent relationships between objects in a structured way. This makes it easier to analyze and understand how different entities interact.

- Networks are real-world applications of graphs.
- They take the abstract concept of a graph and apply it to practical scenarios.





GRAPHS & NETWORKS

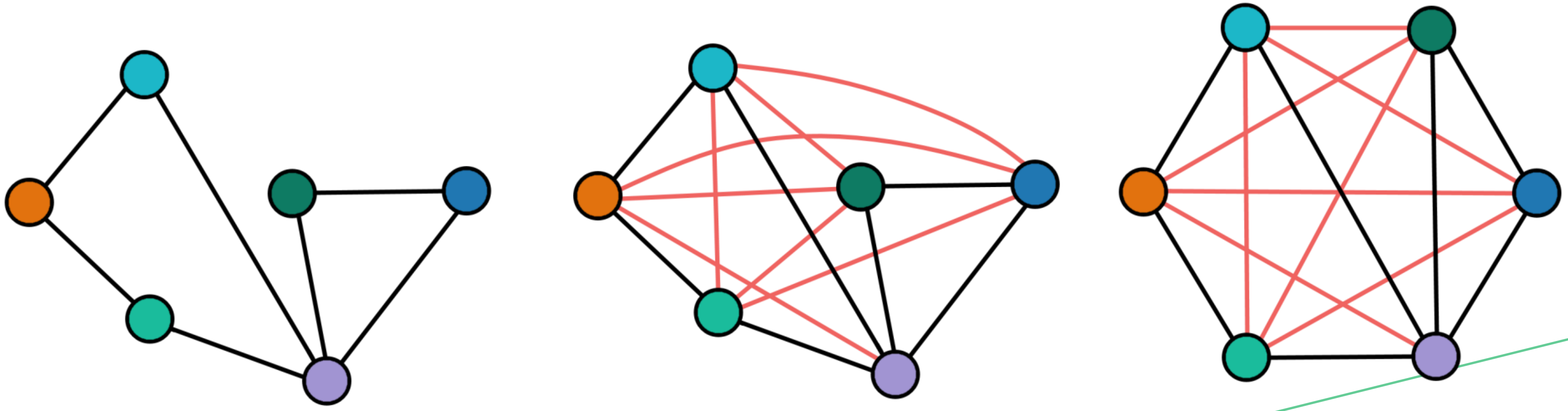


SIMPLE GRAPH

- A graph is called a simple graph if it has:
  - no loops, and
  - no multiple edges.

SUBGRAPH

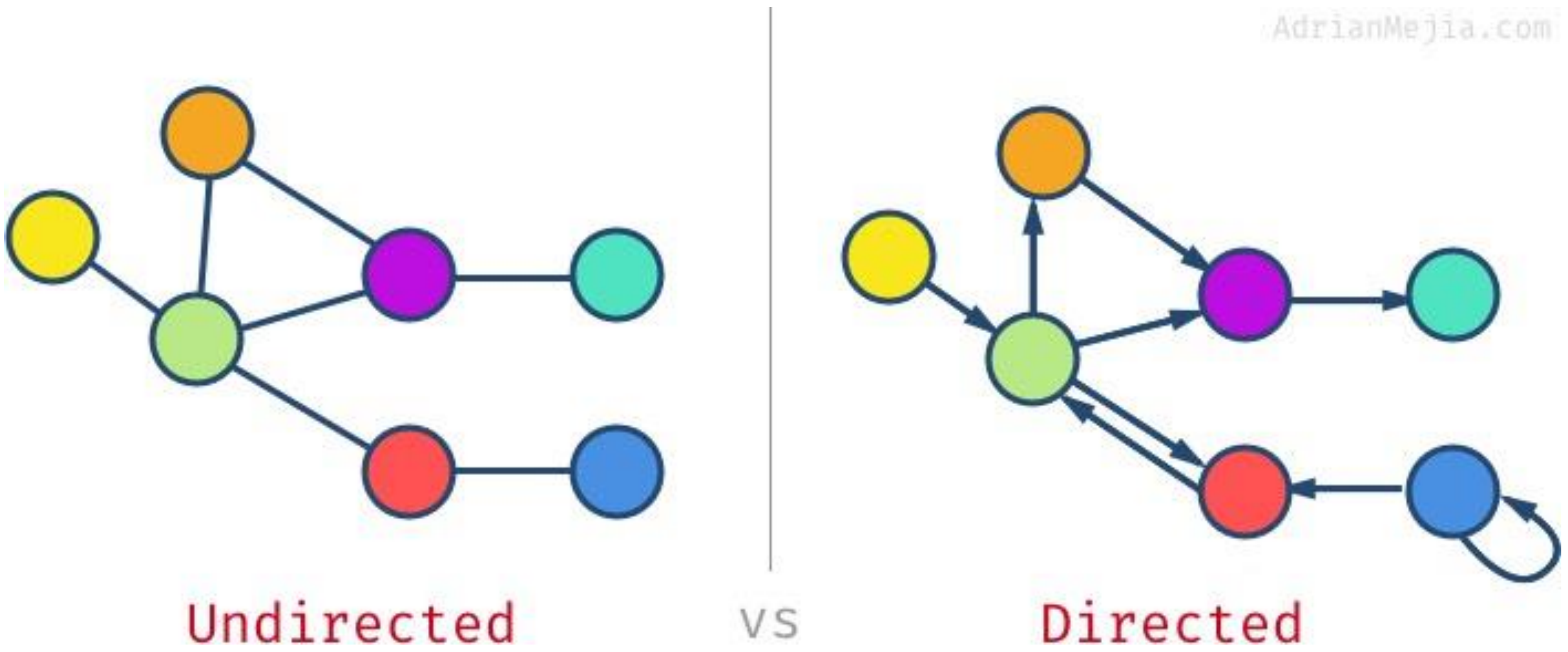
- A graph is called a subgraph (or subnetwork) when all vertices and edges are also the vertices and edges of another graph.
- If we take a graph and delete some edges or some of its vertices (and all edges connected to it), we obtain a subgraph of the original.
- For example, any simple graph that has n vertices is a subgraph of the complete graph with n vertices - we can just add or delete edges to get from one to the other:



TYPES OF GRAPHS

- **Undirected Graphs**
- Undirected graphs are the simplest type of graphs. In these graphs, edges have no direction. This means the relationship between any two vertices is mutual.
- Social Networks: Undirected graphs are used to model social networks where people are represented by nodes and the connections between them are represented by edges.

- ! A <-> B or A – B
- ! A and B like each other
- ! A and B are siblings
- ! A and B are co-authors


AdrianMejia.com
Undirected
vs
Directed

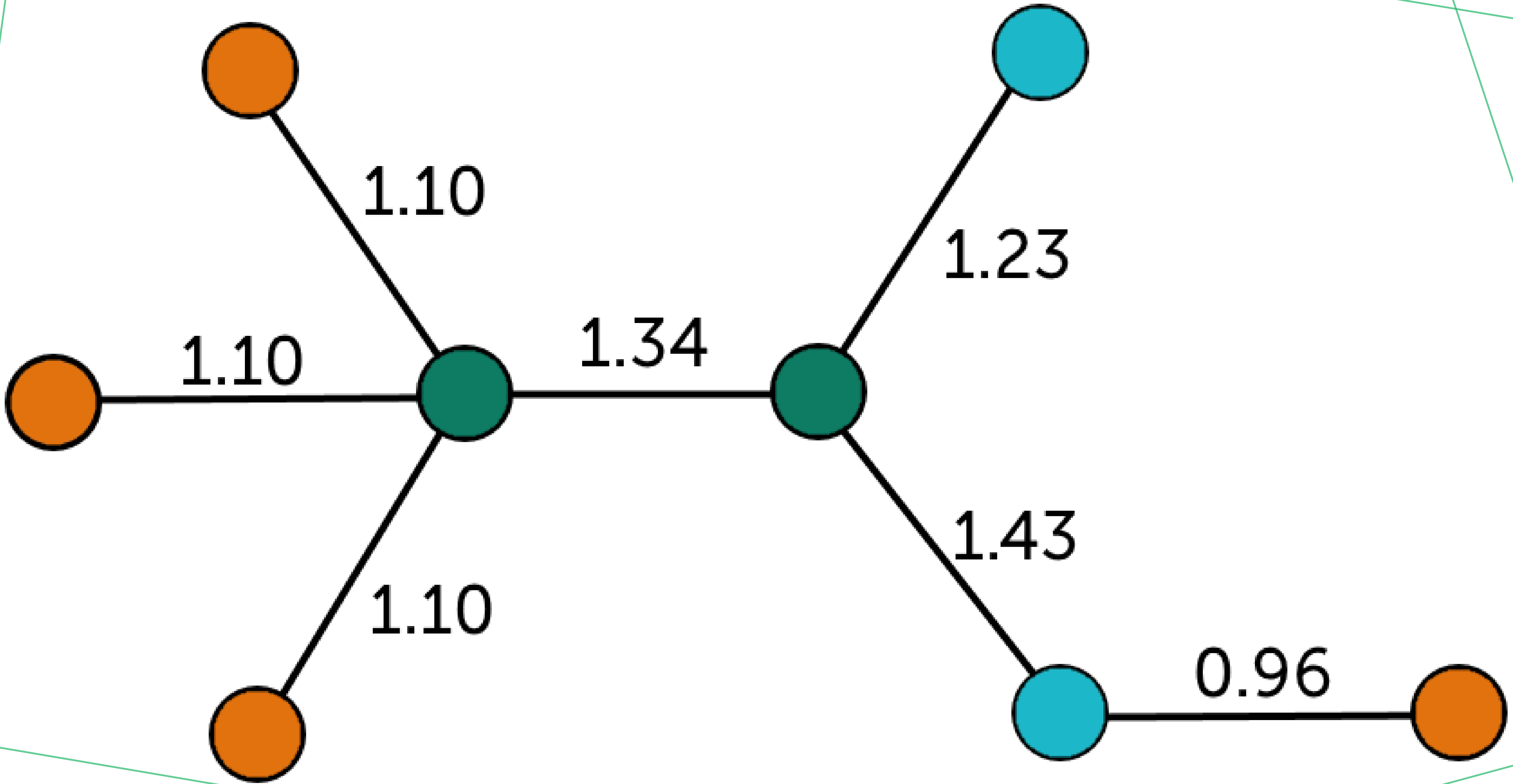
DIRECTED GRAPHS

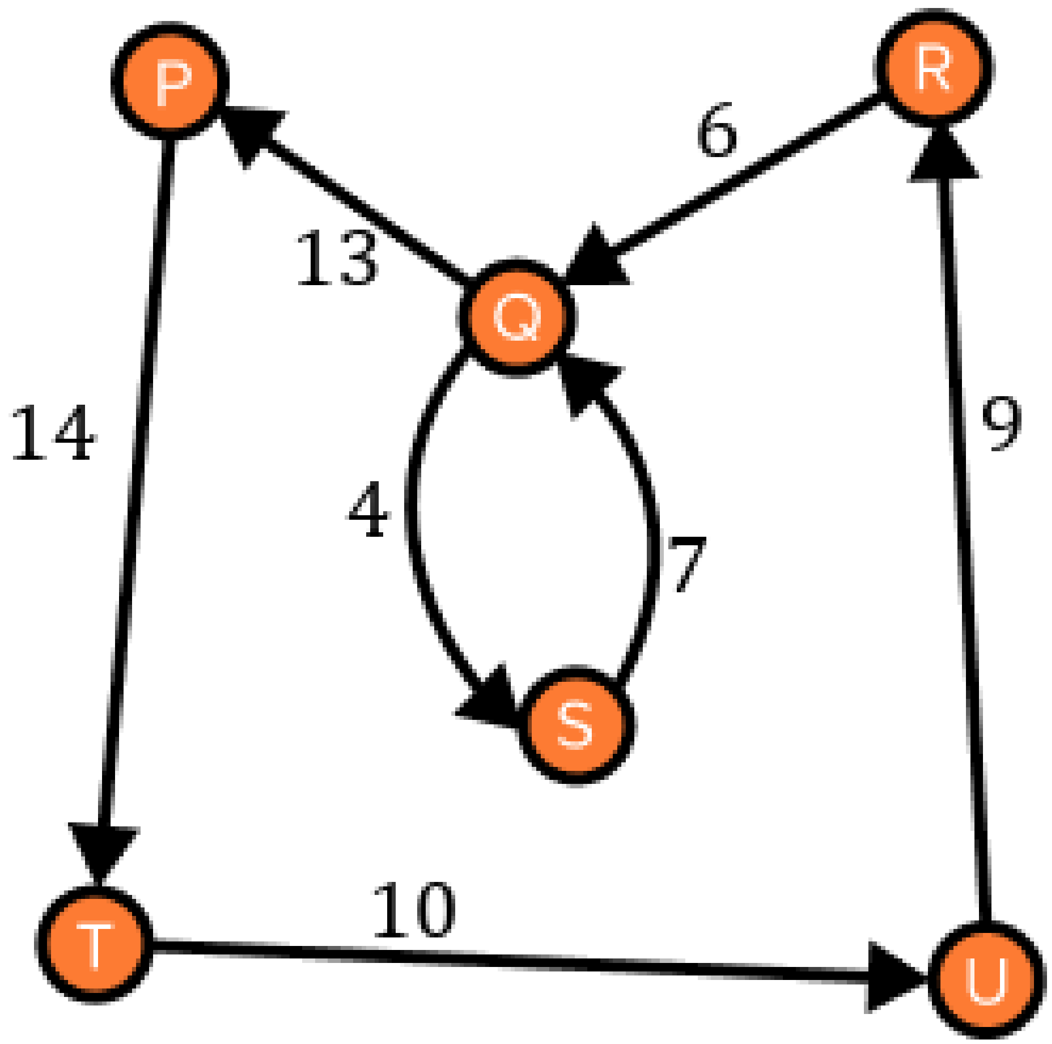
- Directed graphs, also known as digraphs, have edges with a specific direction.
- Each edge points from one vertex to another, indicating a one-way relationship.
- essential when the direction of the relationship matters, such as in web page links or organizational hierarchies.

- Directed (also called arcs, links)
- ! A -> B
- ! A likes B, A gave a gift to B, A is B's child

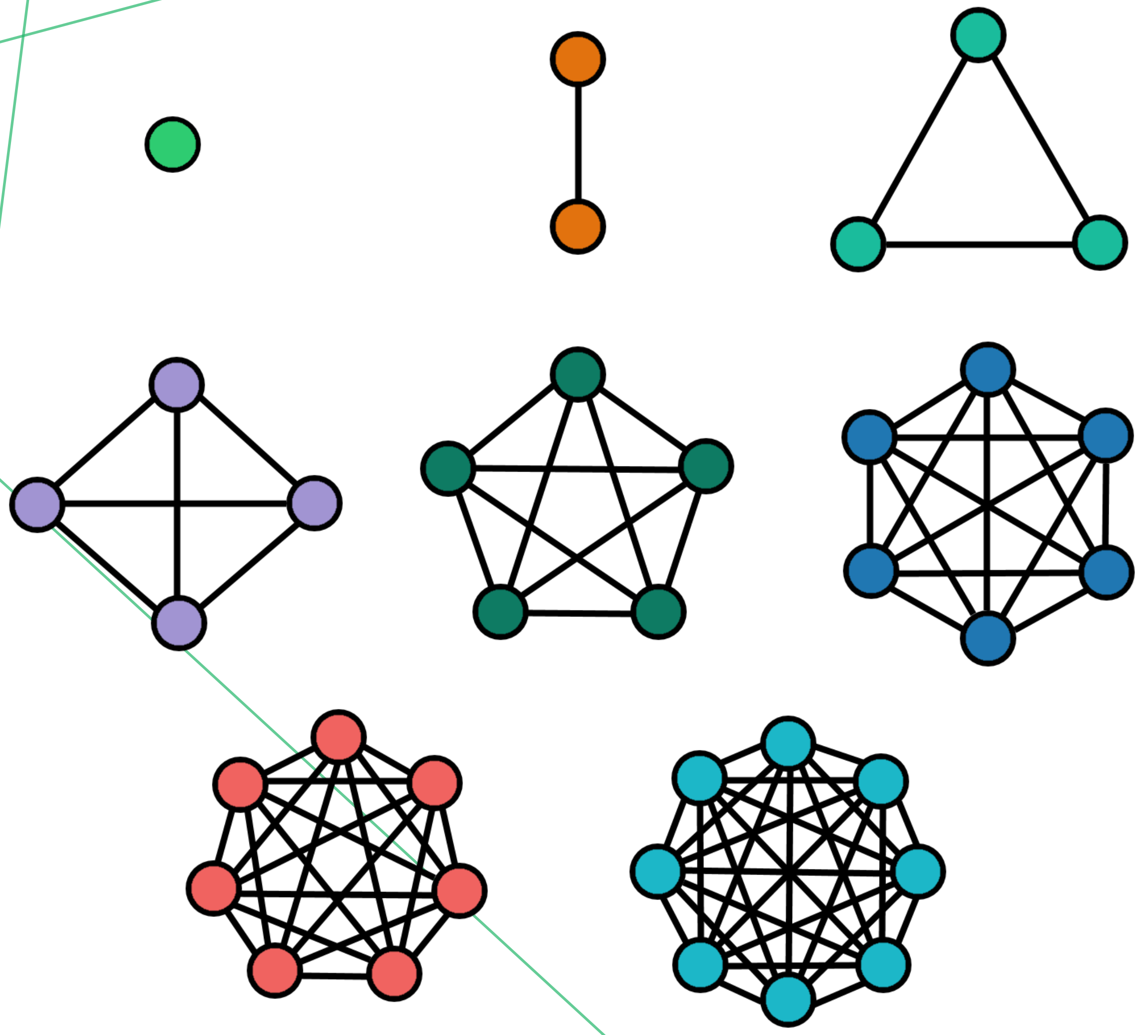
WEIGHTED GRAPHS

- Weighted graphs assign a weight or value to each edge. These weights can represent various metrics, such as distances, costs, or capacities.
- useful for problems where the strength or capacity of connections needs to be considered, such as finding the shortest path in a road network or optimizing network flow.
- the weight of an edge is a numerical value that represents a property such as distance.
- The weight of a graph is the sum of the weights of all the edges.


1.10
1.10
1.34
1.23
1.10
1.43
0.96



- What is the weight of the edge from S to Q?
- What is the weight of the edge from S to T?
- What is the weight of the entire network?

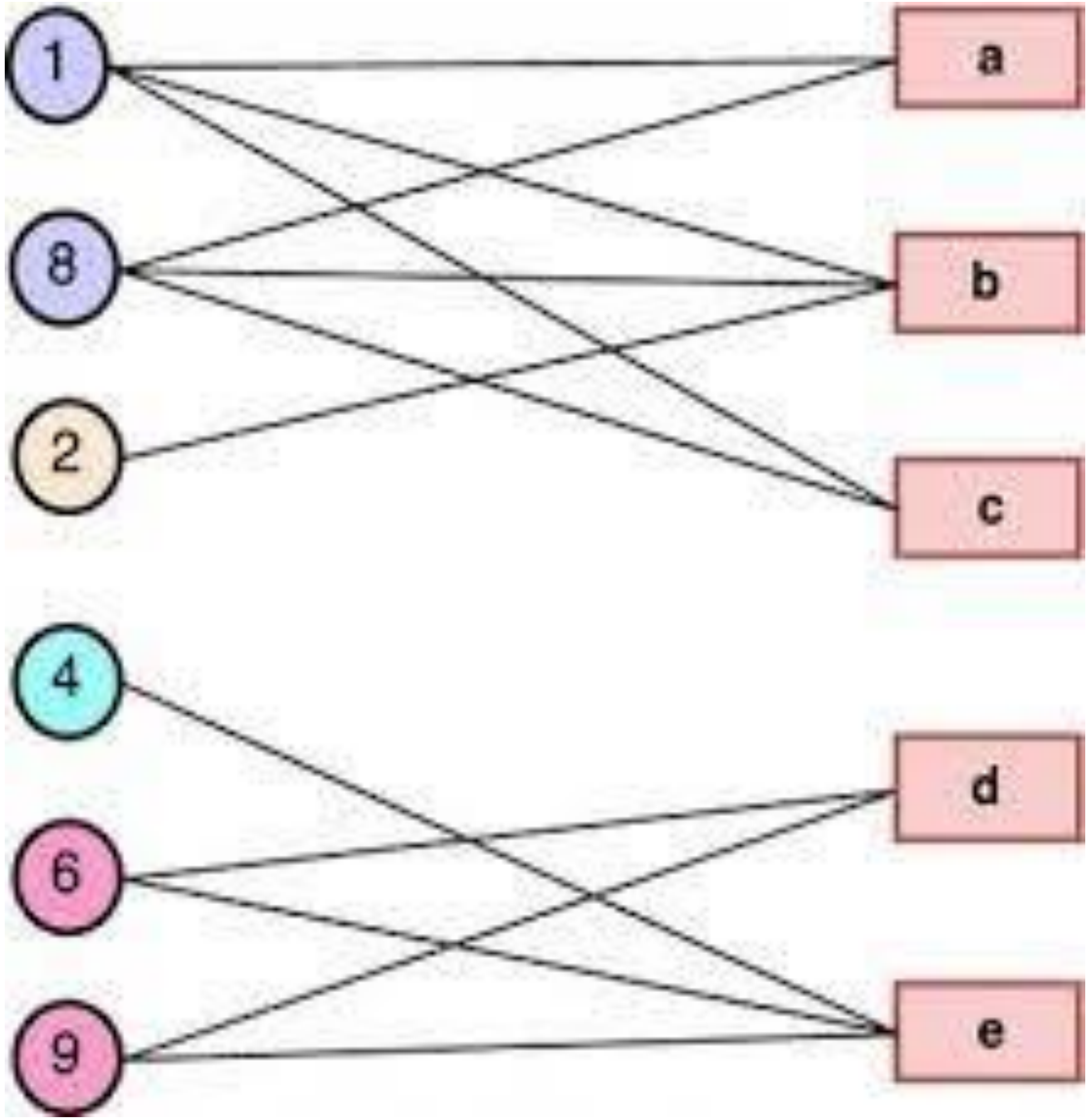


TYPES OF GRAPHS

- **Complete graph**
- We call a graph on n vertices complete if every vertex is connected to every other vertex. There is exactly one complete graph for each value of n.

BIPARTITE GRAPHS

- Bipartite graphs have their vertices divided into two disjoint sets, with edges only connecting vertices from different sets. This type of graph is useful in scenarios where two distinct groups interact.
- Bipartite graphs are also used in modeling relationships in databases, such as linking users to their preferences or products to their categories.


1
8
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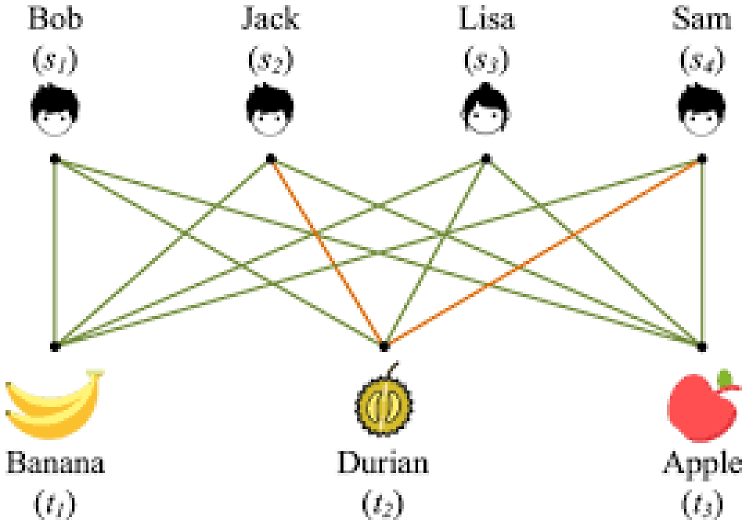
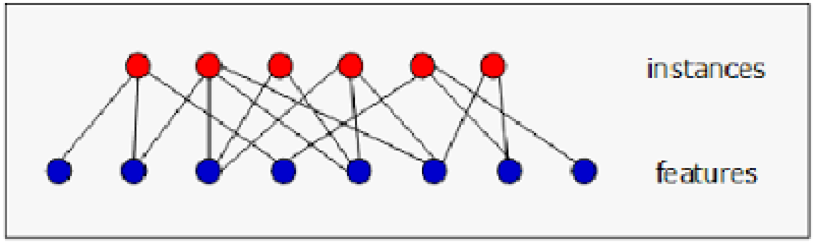
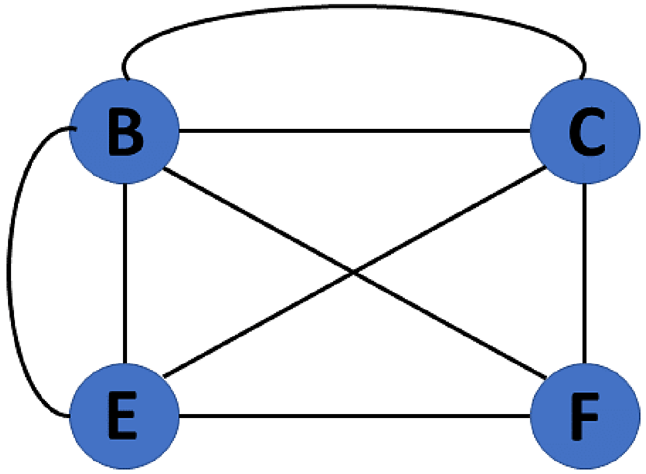

Bob
(s_1)
Jack
(s_2)
Lisa
(s_3)
Sam
(s_4)
Banana
(t_1)
Durian
(t_2)
Apple
(t_3)

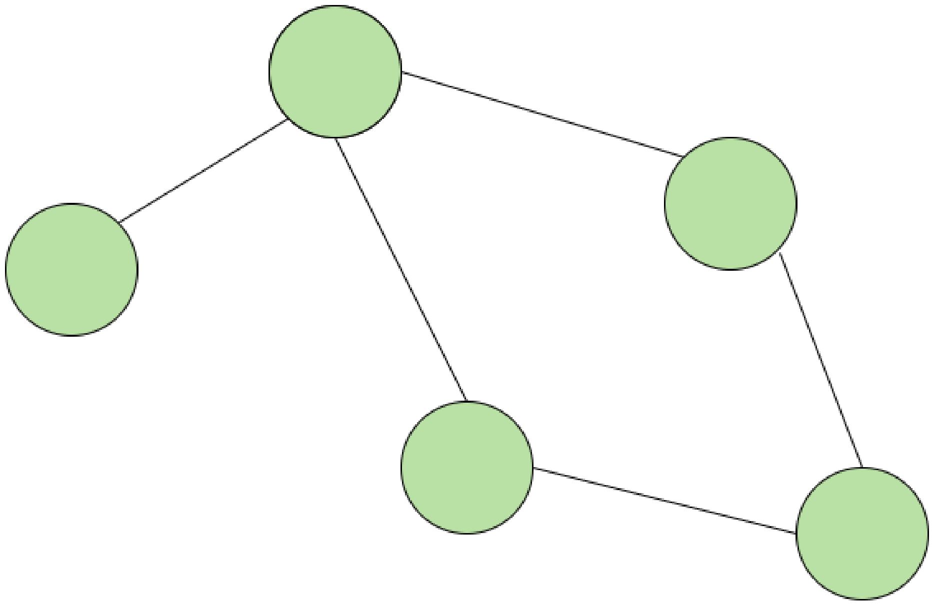

instances
features

MULTI GRAPH

- If there are numerous edges between a pair of vertices in a graph, it is referred to as a multigraph. There are no self-loops in a Multigraph.



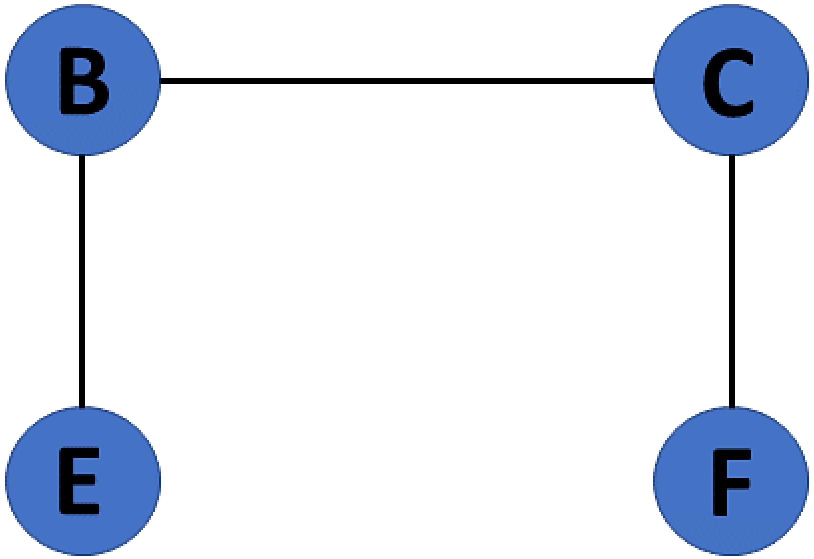
CYCLIC GRAPH

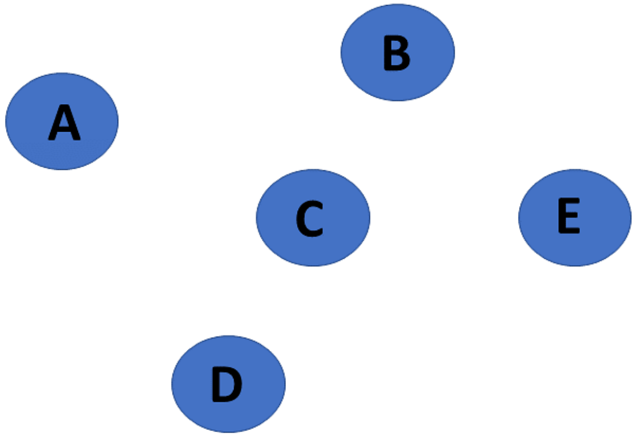


- A cyclic graph is defined as a graph that contains at least one cycle which is a path that begins and ends at the same node, without passing through any other node twice.
- A cyclic graph contains one or more cycles or closed paths, which means that you can traverse the graph and end up where you started.

ACYCLIC GRAPH

- When there are no cycles in a graph, it is called an acyclic graph.



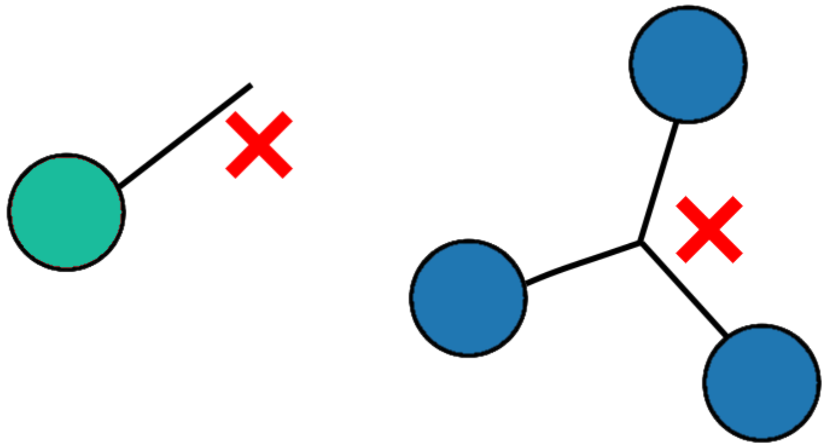


NULL GRAPH

- It's a reworked version of a trivial graph. If several vertices but no edges connect them

EDGES AND RELATIONSHIPS

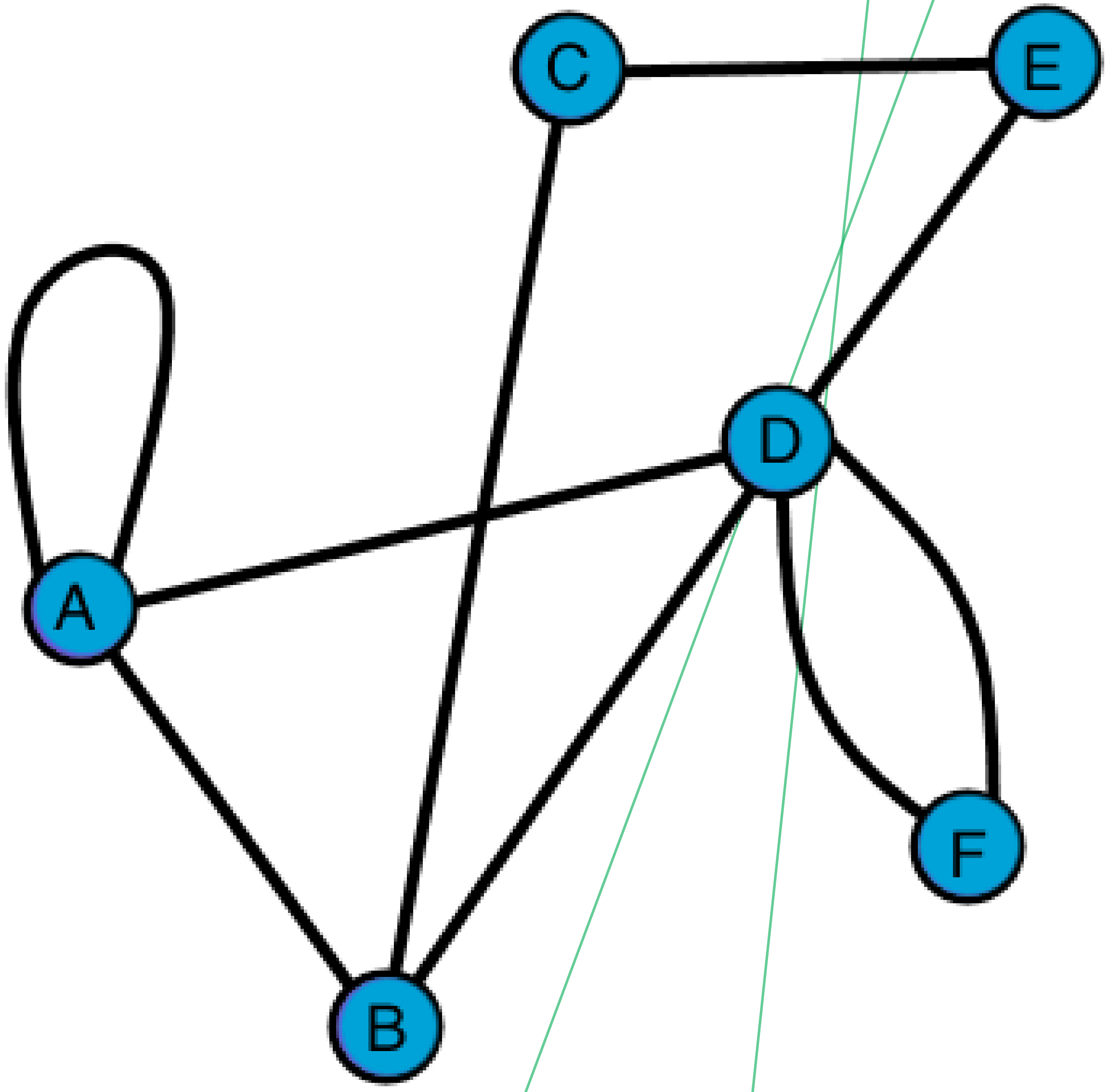
- Edges emphasize the connection itself. They represent the direct link between two nodes. In technical terms, an edge is a fundamental part of the graph structure, focusing on the existence of a link between nodes.
- An edge can’t connect at only one end, and can’t connect more than two vertices together.
- Relationships emphasize the semantic meaning. Relationships add context and meaning to the connections, making it easier to understand the nature of the interactions between nodes.



LOOPS AND MULTIPLE EDGES

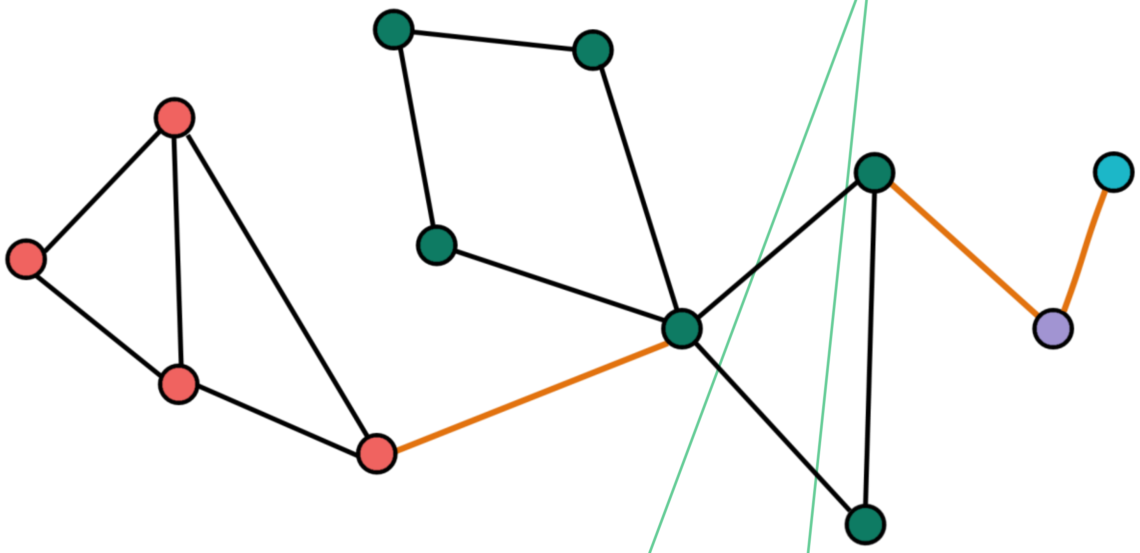
- An edge that starts and ends at the same vertex is called a loop.

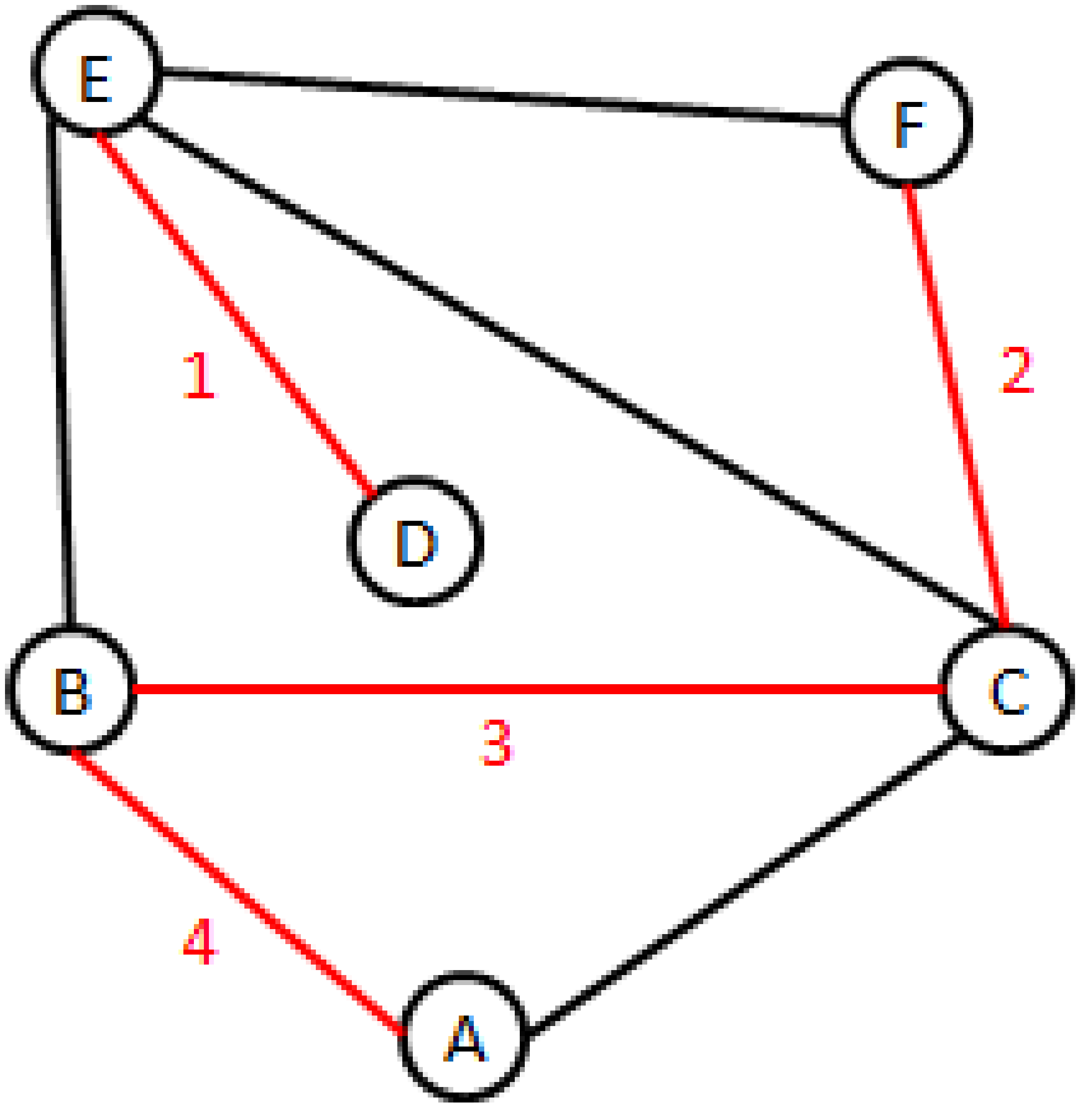
- When there are two or more edges that start at the same vertex and finish at the same vertex, we refer to these as multiple edges



BRIDGES

- If we can remove a single edge such that the graph is broken into two pieces, then we call that edge a bridge.
- Deleting any bridge will break the graph into two parts, with no connection between the parts. If any other edge is deleted, the graph will remain in a single piece.
- An edge is considered as a bridge if and only if removing it leads to the network becoming disconnected.





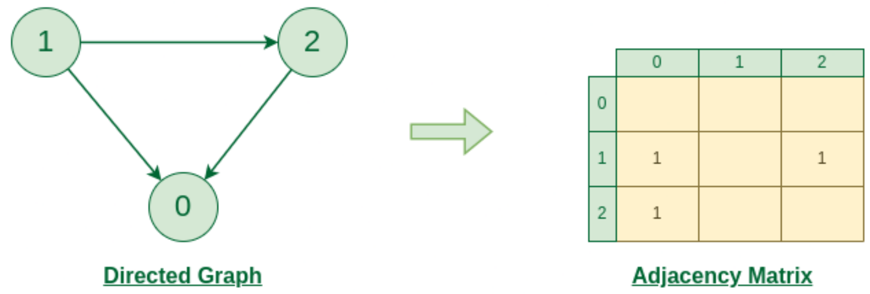
- Which of the highlighted edges in the network is a bridge?

EDGES ATTRIBUTES

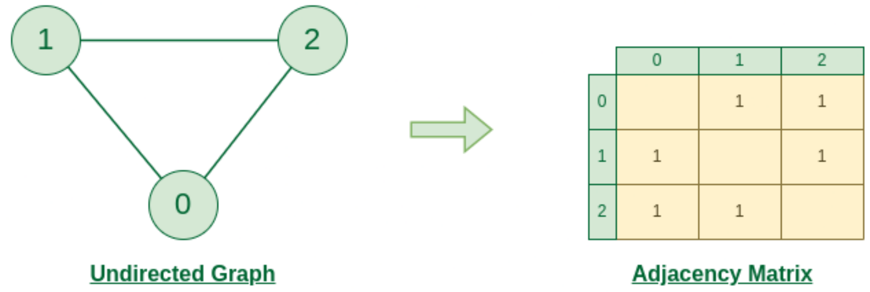
- weight (e.g. frequency of communication)
- ranking (best friend, second best friend…)
- type (friend, relative, co-worker)
- properties depending on the structure of the rest of the graph: e.g. betweenness

ADJACENCY MATRICES

- An adjacency matrix is a square matrix that represents a graph's connections between nodes using 0s and 1s. The matrix's elements indicate whether pairs of vertices are adjacent, or connected, in the graph:
- 0: Indicates no edge
- 1: Indicates an edge



Graph Representation of Directed graph to Adjacency Matrix



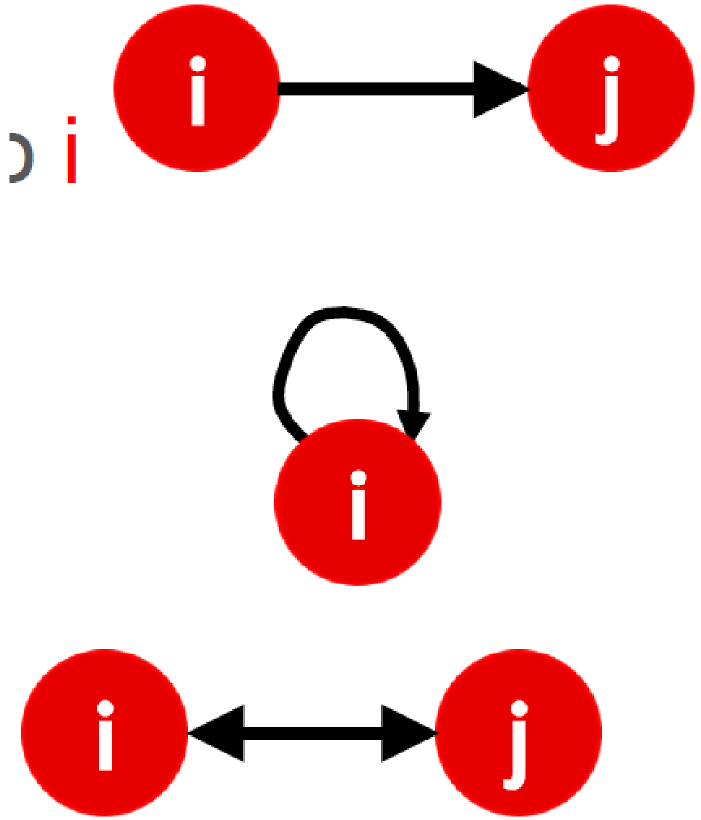
Graph Representation of Undirected graph to Adjacency Matrix

EXAMPLE

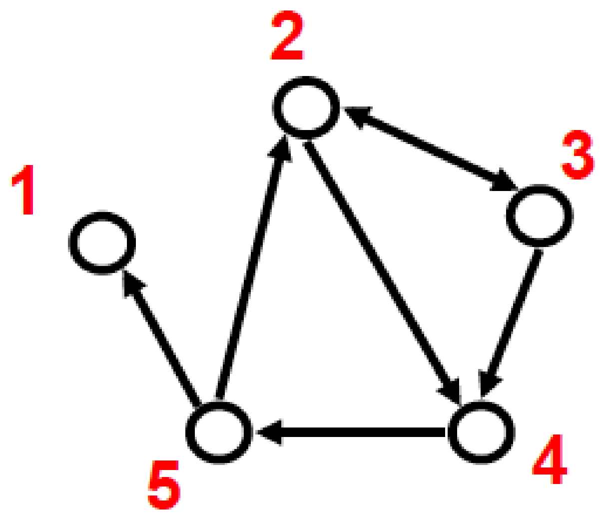
- Representing edges (who is adjacent to whom) as a matrix
- $A_{ij} = 1$ if node j has an edge to node i

  $= 0$ if node j does not have an edge to i
- $A_{ii} = 0$ unless the network has self-loops
- $A_{ij} = A_{ji}$ if the network is undirected,

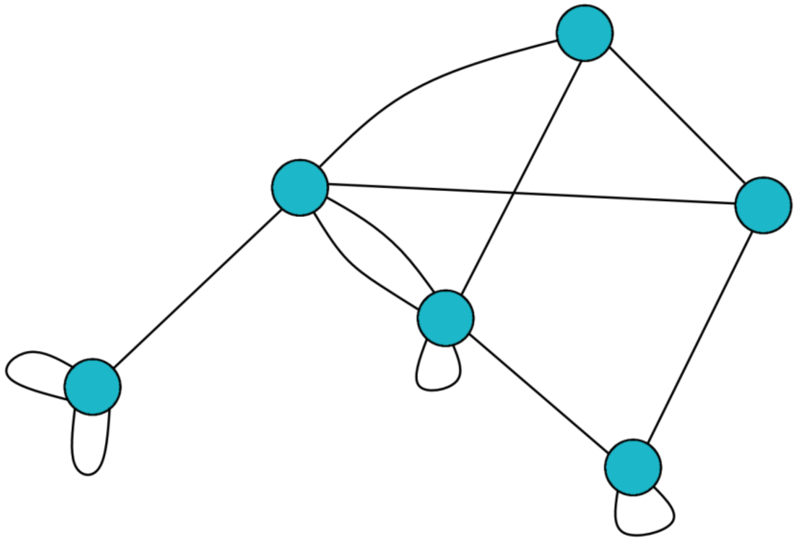
  or if i and j share a reciprocated edge

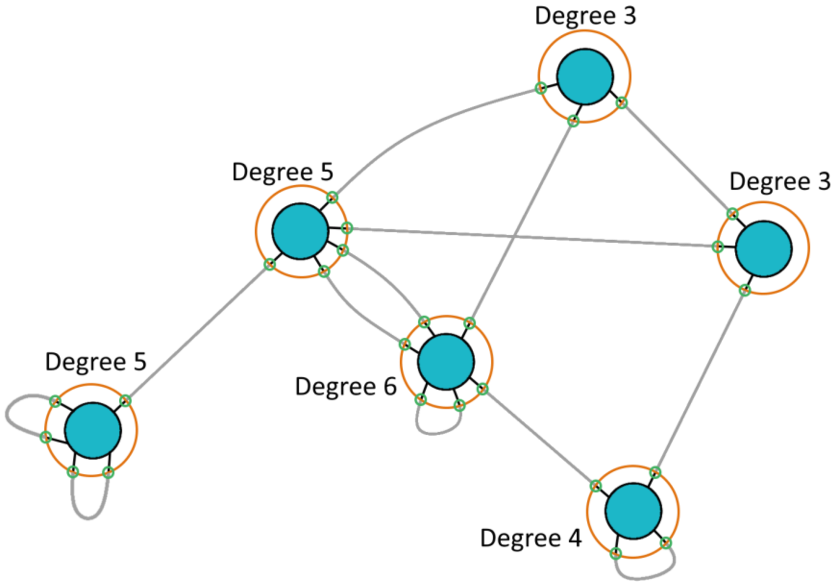


Example adjacency matrix



Result behind this……





DEGREE OF A VERTEX

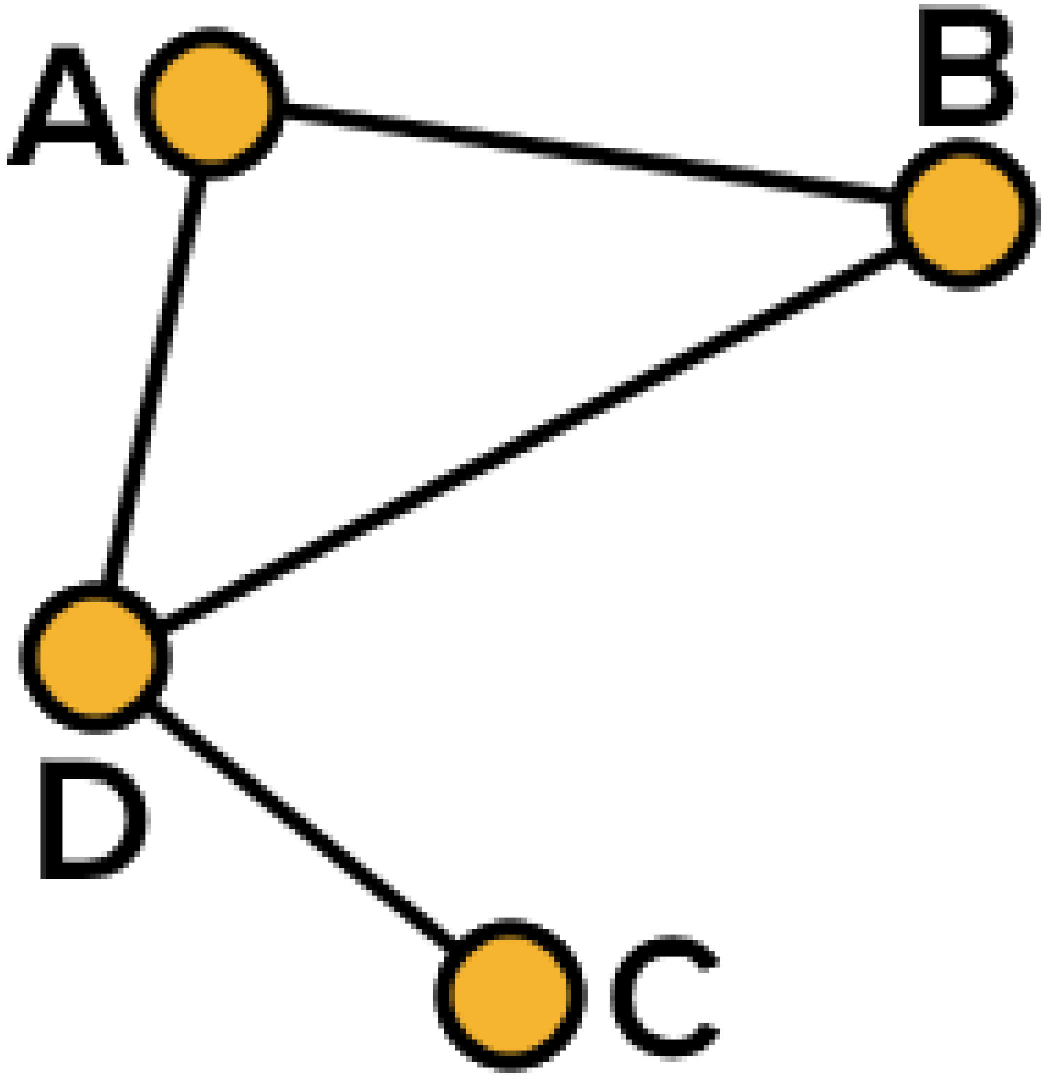
- The degree of a vertex is the number of edges that either go into or out of a vertex, where loops are counted twice. This number tells us how many ways we can move from that vertex to another (or even the same) vertex within the graph.

- A useful trick is to make a ring close around the vertex. Count the number of times that edges cross the ring at a vertex, and we will have the degree.

DEGREE OF A VERTEX

- A vertex is referred to as odd if the degree of the vertex is odd; and referred to as even if the degree of the vertex is even.

- If the degree of a vertex is zero, then there are no edges connected to it (not even a loop), and it is called an isolated vertex.



- What is the degree of vertex C?
- What is the degree of vertex D?
- What is the degree of vertex B?

THANK YOU