BIG DATA STATISTICS FOR BUSINESS

AY 2023-24

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Introduction

- The basic idea of a social network is very simple.
- A social network is a set of actors (or points, or nodes, or vertices) that may have relationships (or edges, or ties) with one another.
- Networks can have few or many actors, and one or more kinds of relations between pairs of actors (e.g. students in a classroom might like or dislike each other, they might play together or not, they might share food or not, ecc.).
- Network data are defined by actors and by relations (or nodes and ties, etc.).
- Network analysis focuses on the relations among actors.

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Graphical techniques

- For the calculation of indexes describing networks, it is most useful to record information as matrices.
- For visualizing patterns, graphs are often useful.
- One reason for using mathematical and graphical techniques in social network analysis is to represent the descriptions of networks compactly and systematically.

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Network data

- «Conventional» data consists of a rectangular matrix.
- The rows of the array are the cases, or subjects, or observations. The columns consist of (numerical or categorical) variables.
- «Network» data (in their purest form) consist of a square matrix of measurements.
- The rows of the matrix are the subjects (or actors or observations).
- The columns of the matrix are the same set of subjects.
- Each cell of the matrix describes a relationship between the subjects.

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Network data

- The major difference between conventional and network data is that conventional data focuses on actors and variables, while network data focuses on actors and relations.

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Example

- Suppose we were describing the structure of close friendship in a group of four people: Bob, Carol, Ted, and Alice.
- We could describe this pattern of liking ties with an actor-by-actor matrix where the rows represent choices by each actor (network matrix).
- We will put in a "1" if an actor likes another and a "0" if he doesn't.

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Example

	Bob	Carol	Ted	Alice
Bob	---	1	1	0
Carol	0	---	1	0
Ted	1	1	---	1
Alice	0	0	1	---

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Graphs

- Network analysis uses (primarily) one kind of graphic display that consists of points (or nodes) to represent actors and lines (or edges) to represent ties or relations.
- These graphic displays are known as «undirected graphs» (undirected network) or «directed graphs» (directed network) according to the indication of the relations.

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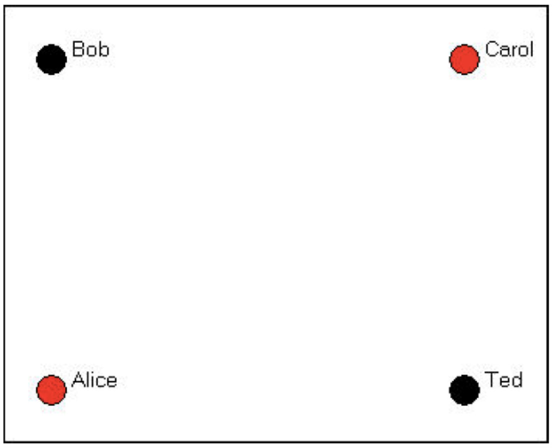

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	Bob	Carol	Ted	Alice
Bob	---	1	1	0
Carol	0	---	1	0
Ted	1	1	---	1
Alice	0	0	1	---

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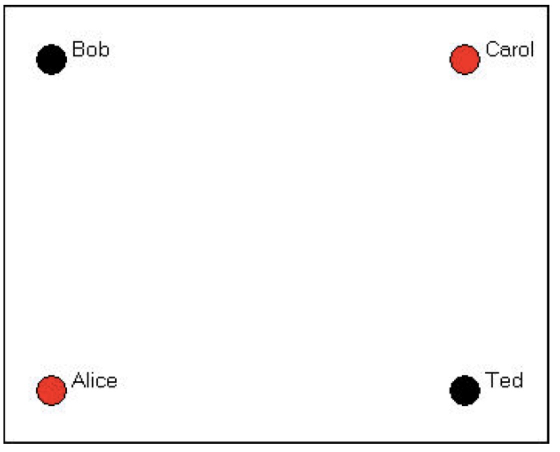
Undirected network



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	Bob	Carol	Ted	Alice
Bob	---	1	1	0
Carol	0	---	1	0
Ted	1	1	---	1
Alice	0	0	1	---

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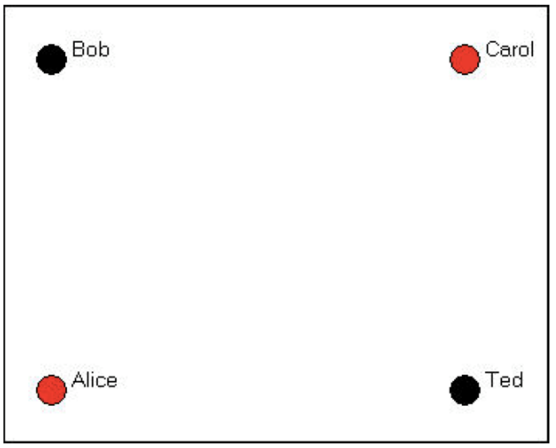
Directed network



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Popularity of the nodes

- If we sum the elements of the column vectors in this example, I would be measuring how "popular" each node was (in terms of how often they were the target of a directed friendship tie).

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	Bob	Carol	Ted	Alice
Bob	---	1	1	0
Carol	0	---	1	0
Ted	1	1	---	1
Alice	0	0	1	---

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Rearranging the matrix

- It is also helpful, sometimes, to rearrange the rows and columns of a matrix so that we can see patterns more clearly.
- Let's rearrange (permute) the matrix so that the two males and the two females are adjacent in the matrix.

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	Bob	Ted	Carol	Alice
Bob	---	1	1	0
Ted	1	---	1	1
Carol	0	1	---	0
Alice	0	1	0	---

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- If we calculate the proportion of all ties within a block that are present, we can create a block density matrix.

	Male	Female
Male	1.00	0.75
Female	0.50	0.00

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Network measures
Degree

- In a network analysis, the **degree** of a node is the number of all its connections.

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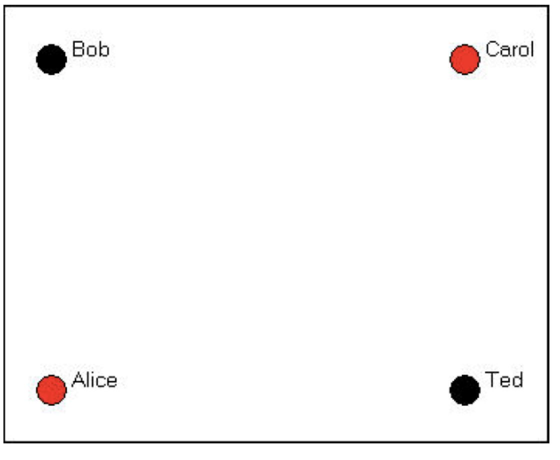

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Network measures
Degree

- In directed network, we can distinguish between in-degree and out-degree: in-degree is a count of the number of ties directed to the node, and out-degree is the number of ties that the node directs to others.

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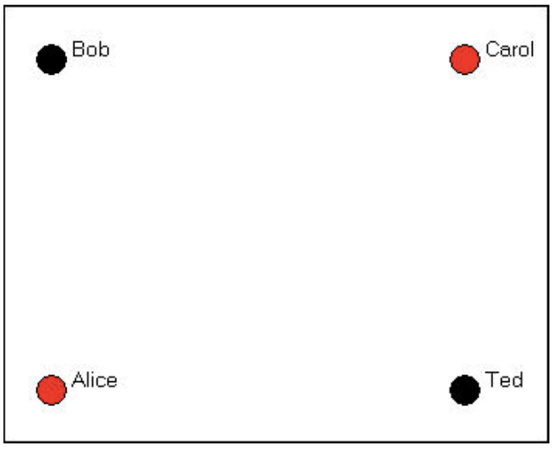

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Network measures
Diameter

- In network analysis the **diameter** of a network is the shortest distance between the two most distant nodes in the network.
- In other words, once the shortest path length from every node to all other nodes is calculated, the diameter is the longest of all the calculated path lengths.

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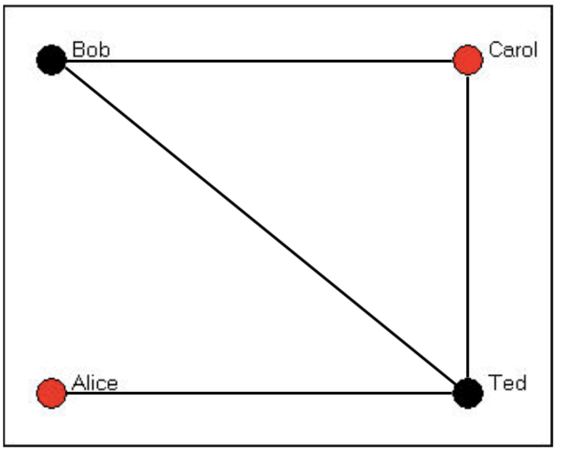

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Network measures
Average distance

- In network analysis the **average distance** calculates the average path length in a graph, by calculating the shortest paths between all pairs of vertices.

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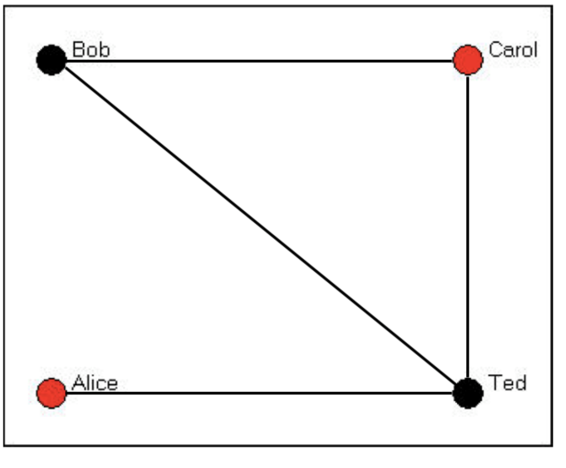

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Network measures
Density

- In network analysis the density is the ratio of the realized edges and the possible edges.

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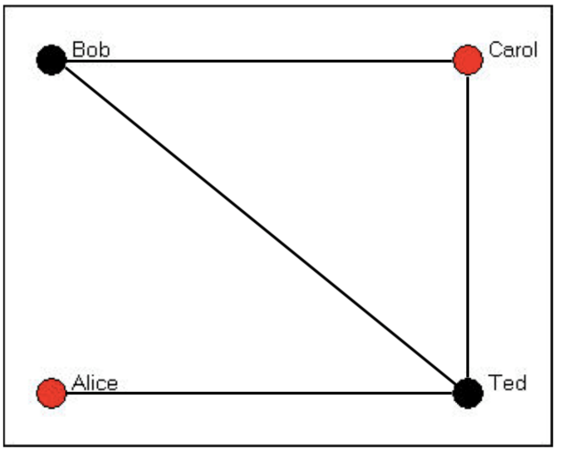

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Network measures
Closeness

- In network analysis with N nodes, **closeness** centrality (or closeness) of a node is a measure of centrality, calculated as (N-1) divided by the sum of the length of the shortest paths between the node and all other nodes in the graph.
- Thus, the more central a node is, the closer it is to all other nodes.

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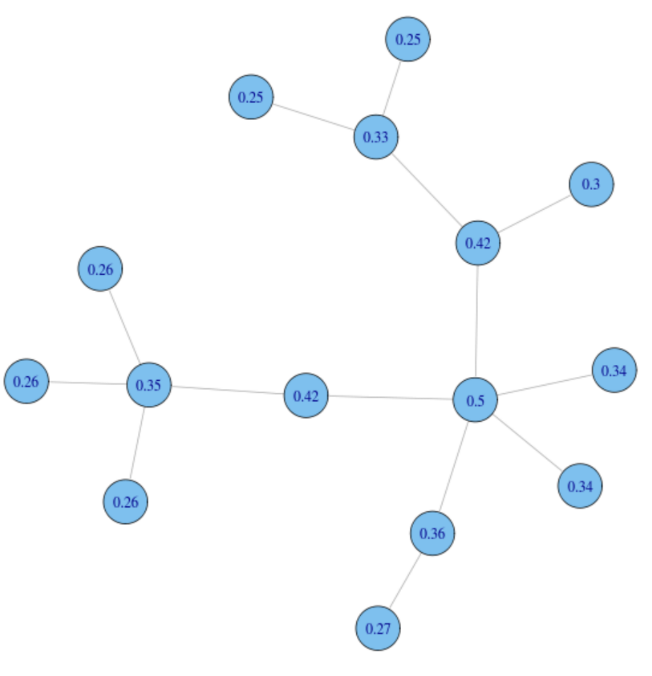

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Betweenness

- In network analysis, **betweenness** centrality (or betweenness) of each node is how often a node is a bridge between other nodes.

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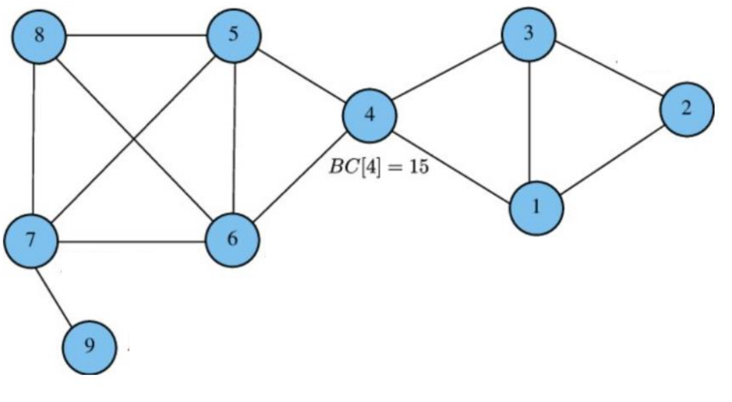

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Weighted network

- A **weighted network** is a network with weighted edges.
- Edge weights are often crucial for network analysis and modeling, and many data sets include edge weights. They often represent the strength of a connection, or distance, or some other quantity.
- In many real-world networks, we can observe that not all ties in a network have the same capacity (in terms of their intensity, or capacity).

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Weighted network

- For example, in social networks, some contacts are friends, whereas others are simply acquaintances.
- Granovetter (1973) argued that the strength of a social tie is a function of its duration, emotional intensity, intimacy, and exchange of services.
- In information networks, variations in the strength of a tie might depend on the flow of information.

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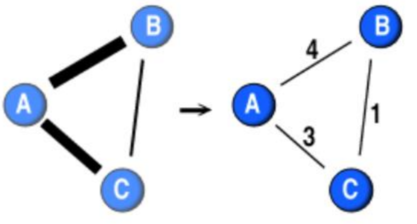

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