



A decorative graphic on the left side of the slide consisting of a network of thin, light blue lines. These lines branch out and connect to small, empty circles, resembling a circuit board or a network diagram. The lines and circles are more densely packed on the left and fade out towards the right.

GRAPHICAL SOCIAL NETWORK ANALYSIS

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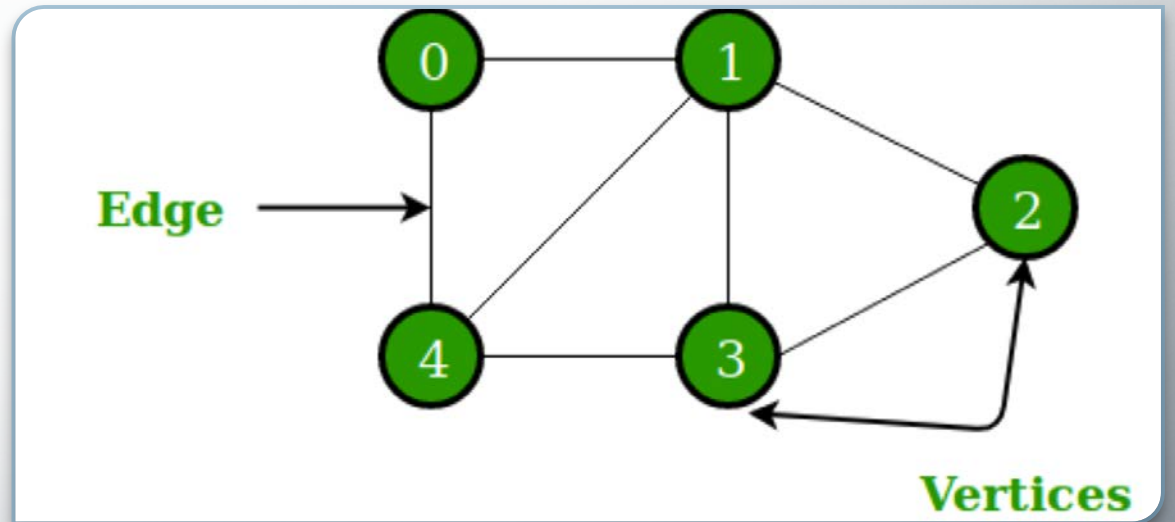


TOPICS TO COVER

- **Background**
 - **Centrality Measures**
 - **Types of Centrality Measures**
 - **Degree Centrality**
 - **Closeness Centrality**
 - **Betweenness Centrality**
 - **Eigenvector Centrality**
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BACKGROUND

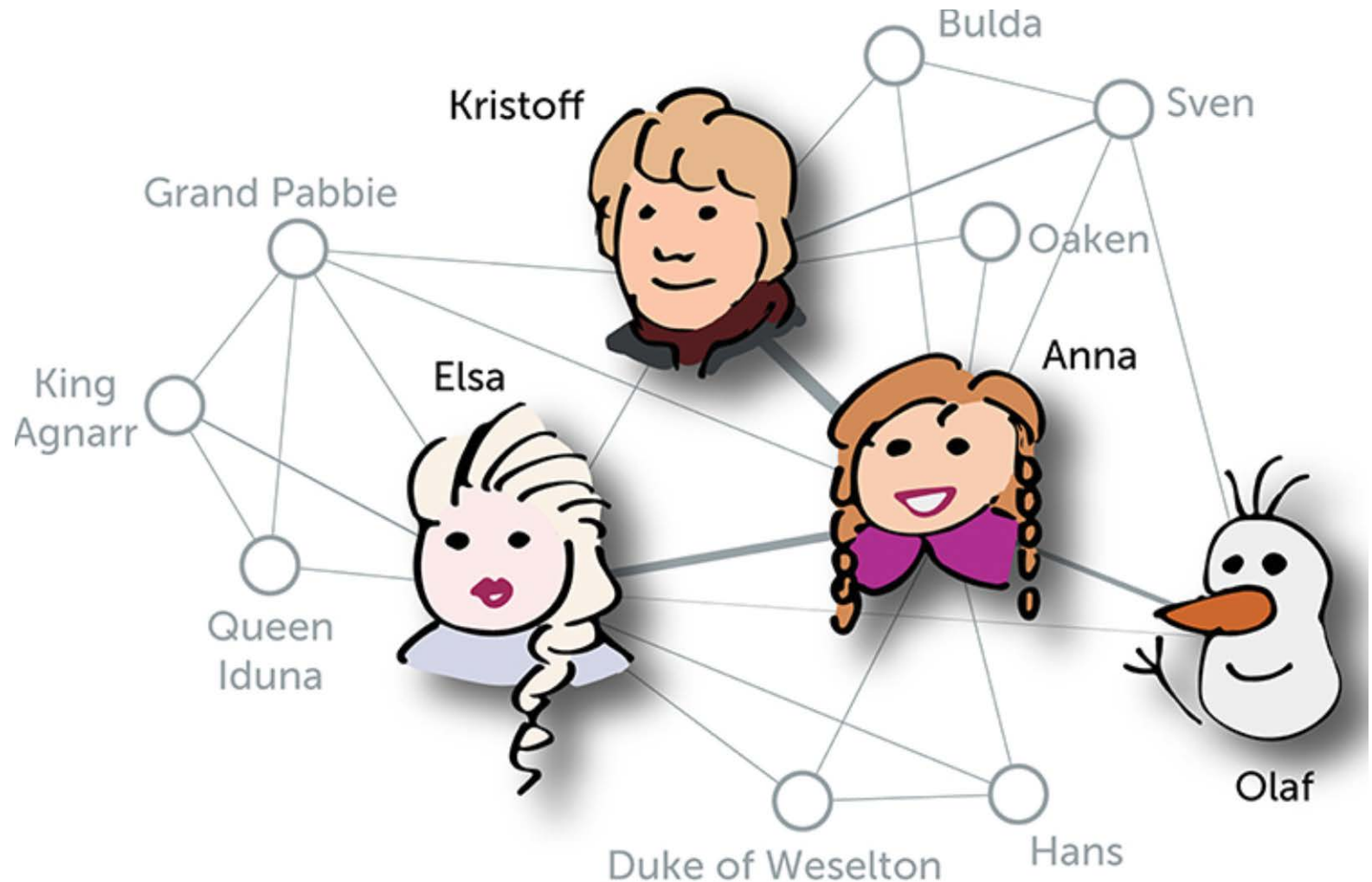
- Recall : vertices or nodes are the units or actors in a network (or a graph or a system).
- Edges are the ties or connections between nodes.



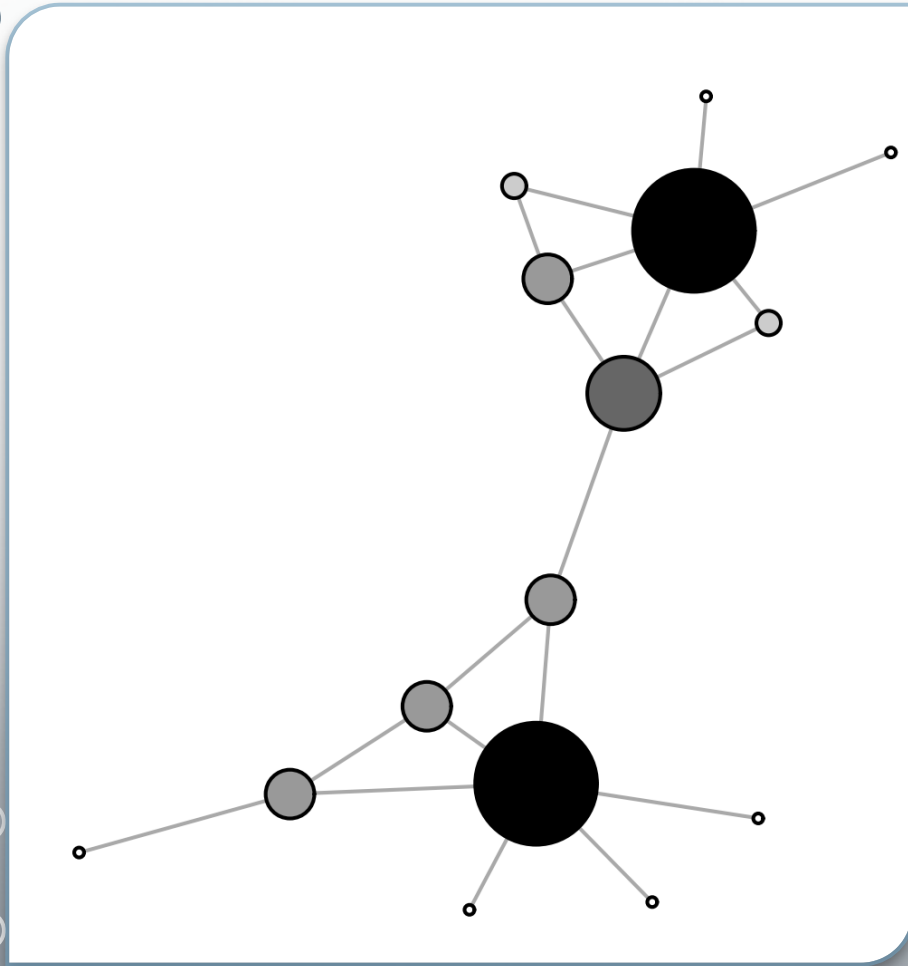
Nodes (vertices) and Edges in an Undirected graph

- It is a measure of how many connections one node has to other nodes.
- It also identifies the most influential person(s) in a social network, key infrastructure nodes in the Internet or urban networks, and super-spreaders of disease.

CENTRALITY MEASURES : WHO IS THE MOST IMPORTANT PERSON IN THIS NETWORK?

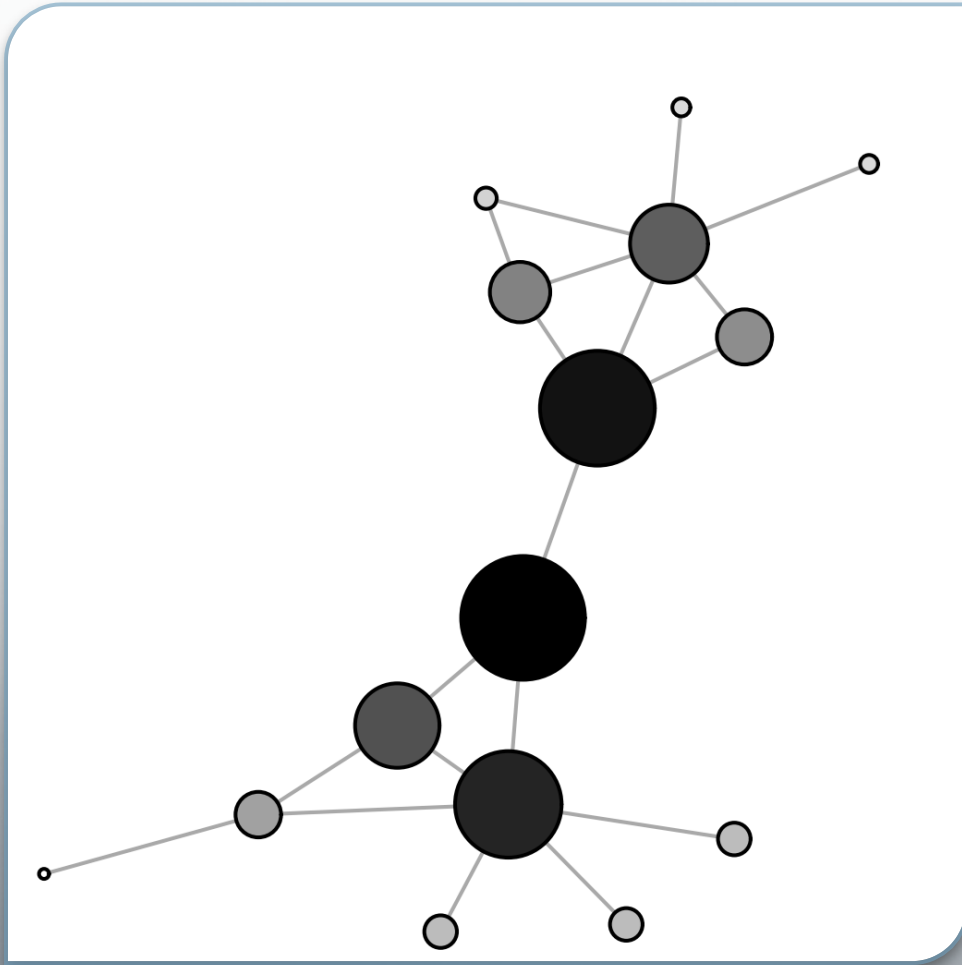


DEGREE CENTRALITY



- Degree centrality for an undirected graph is straightforward— It's the **number of ties** (connections) a node has to other nodes.
- Nodes who have more ties may have multiple alternative ways and resources to reach goals—and thus be relatively advantaged.
- In the case of a directed network (where ties have direction), we usually define two separate measures of degree centrality, namely **indegree** and **outdegree**.
- Accordingly, indegree is a count of the number of ties **directed to the node** and outdegree is the number of ties that the **node directs to others**.

CLOSENESS CENTRALITY

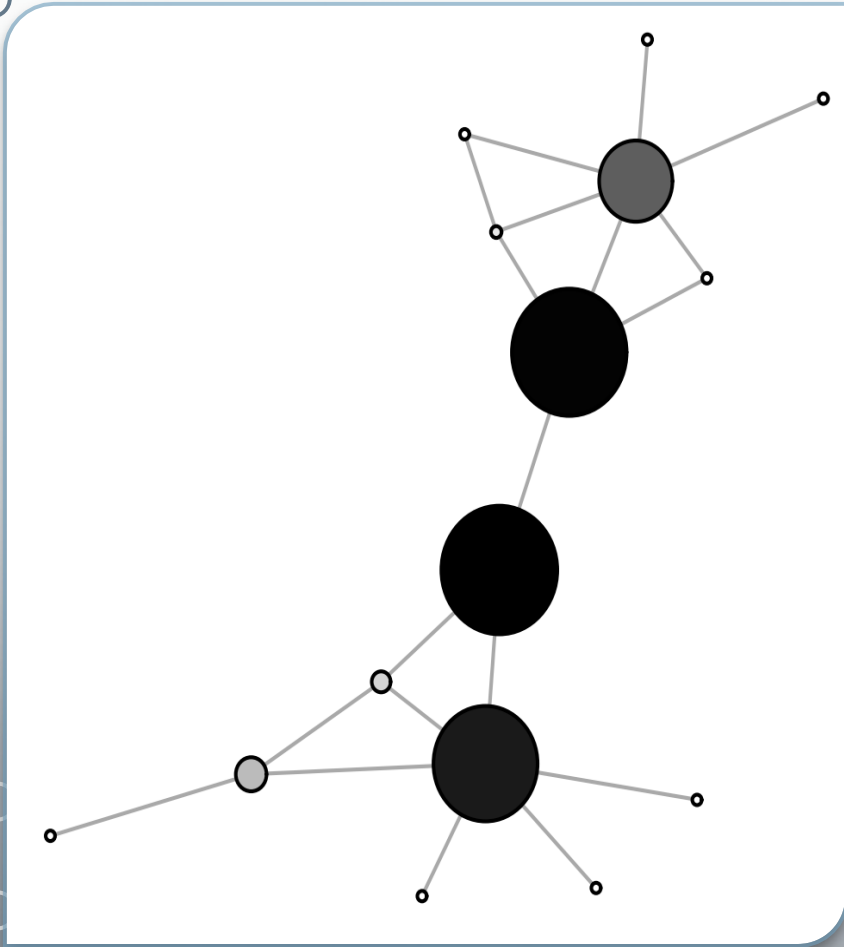


- Closeness centrality of a node is the reciprocal of sum of the length of the shortest paths between the node and all other nodes in the graph.

$$C(x) = \frac{1}{\sum_y d(y, x)}.$$

- $d(y, x)$ is the distance (farness) between vertices x and y
- The more central a node is, the closer (inverse of farther) it is to all other nodes.

BETWEENNESS CENTRALITY

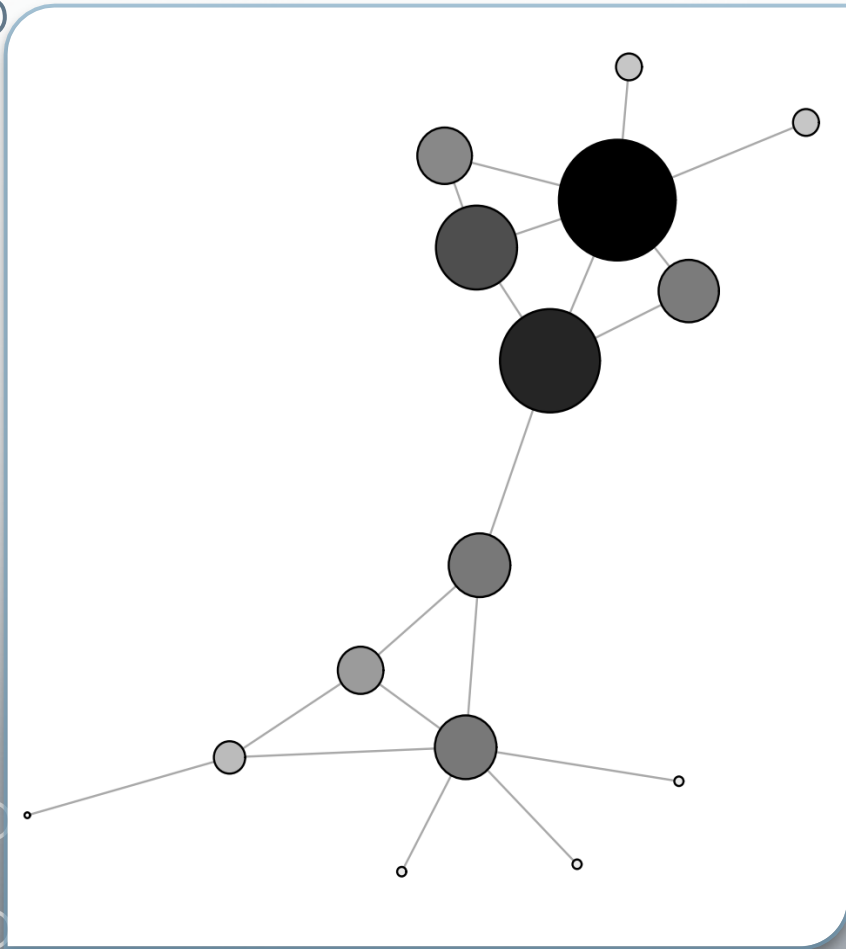


- Betweenness centrality quantifies the number of times a node acts as a **bridge** along the shortest path between two other nodes.

$$C_B(v) = \sum_{s \neq v \neq t \in V} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

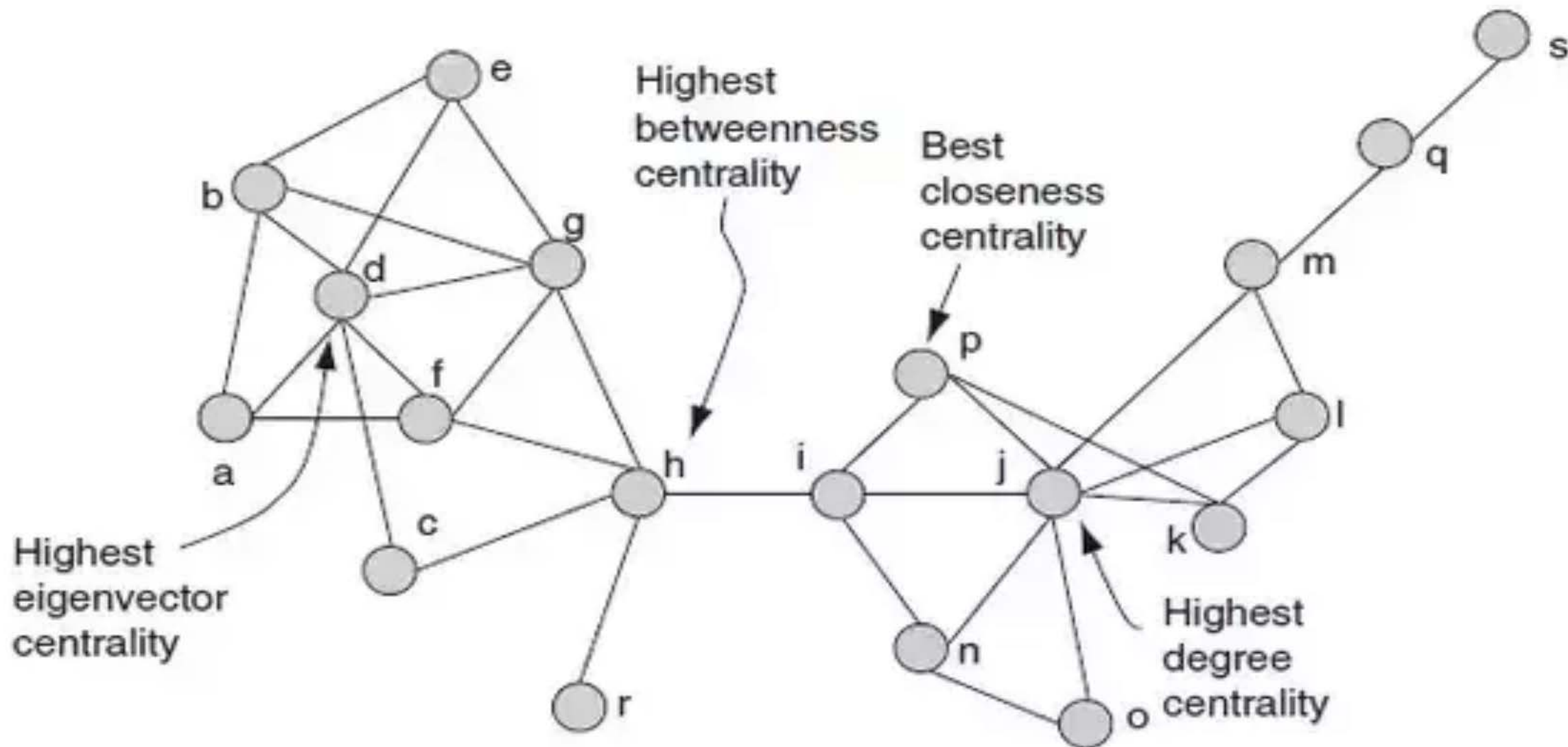
- Where σ_{st} is total number of shortest paths from node s to node t and $\sigma_{st}(v)$ is the number of those paths that pass through v .
- In other words, it measures the extent to which a node is connected to other nodes that are not connected to each other!

EIGENVECTOR CENTRALITY



- Until now we considered centrality based on connections of the node. What about connections of it's neighbors? (- and its neighbors' neighbors?)
- Basic Idea behind eigenvector centrality: A central user is connected to **other central users**.
- By definition, the eigenvector centrality of each vertex is proportional to the sum of the centralities of its neighbors.
- A high eigenvector score means that a node is connected to many nodes who themselves have high scores.
- **Google's PageRank** is a variant of Eigenvector Centrality Measure.

An example of how different Centrality Measures can vary when applied to the same Network





REFERENCES

- [1] Network centrality : An Inrtoduction <https://arxiv.org/pdf/1901.07901.pdf>
 - [2] Centrality Wiki : <https://en.wikipedia.org/wiki/Centrality>
 - [3] Network Basic Concept:
<https://www.lsu.edu/faculty/bratton/networks/closeness.ppt>
 - [4] Eigenvector Centrality : https://en.wikipedia.org/wiki/Eigenvector_centrality
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The image features a light gray gradient background. In the corners, there are decorative elements resembling circuit board traces. The top-left and bottom-left corners have dark blue lines, while the top-right and bottom-right corners have light gray lines. These lines form various geometric shapes, including circles and straight segments, creating a technical or digital aesthetic.

THANK YOU!!!