# GRAPHICAL SOCIAL NETWORK ANALYSIS

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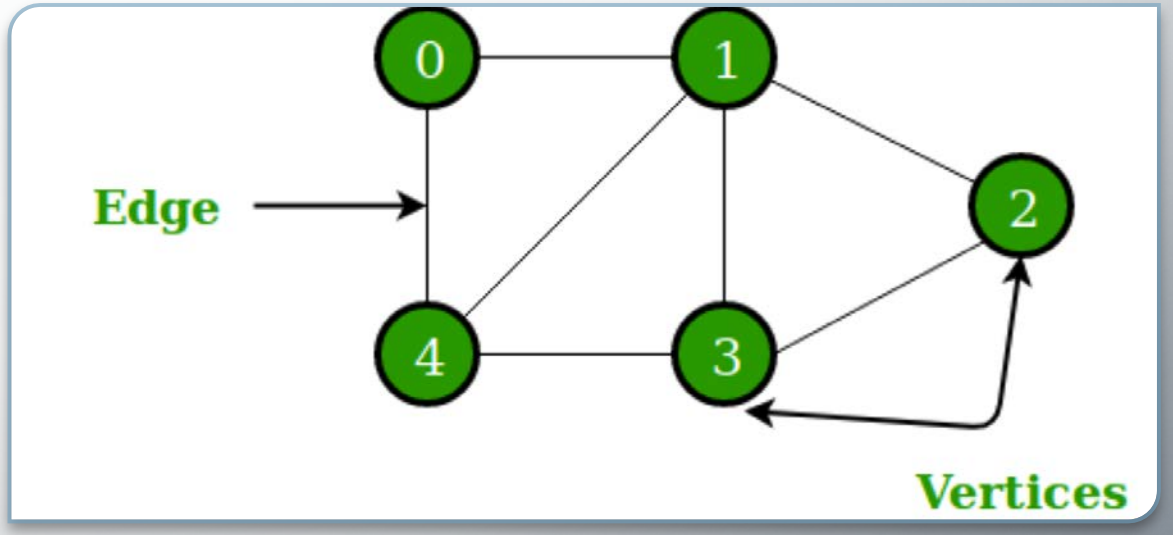
# TOPICS TO COVER

- Background
- Centrality Measures
- Types of Centrality Measures
  - Degree Centrality
  - Closeness Centrality
  - Betweenness Centrality
  - Eighenvector Centrality

# 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.

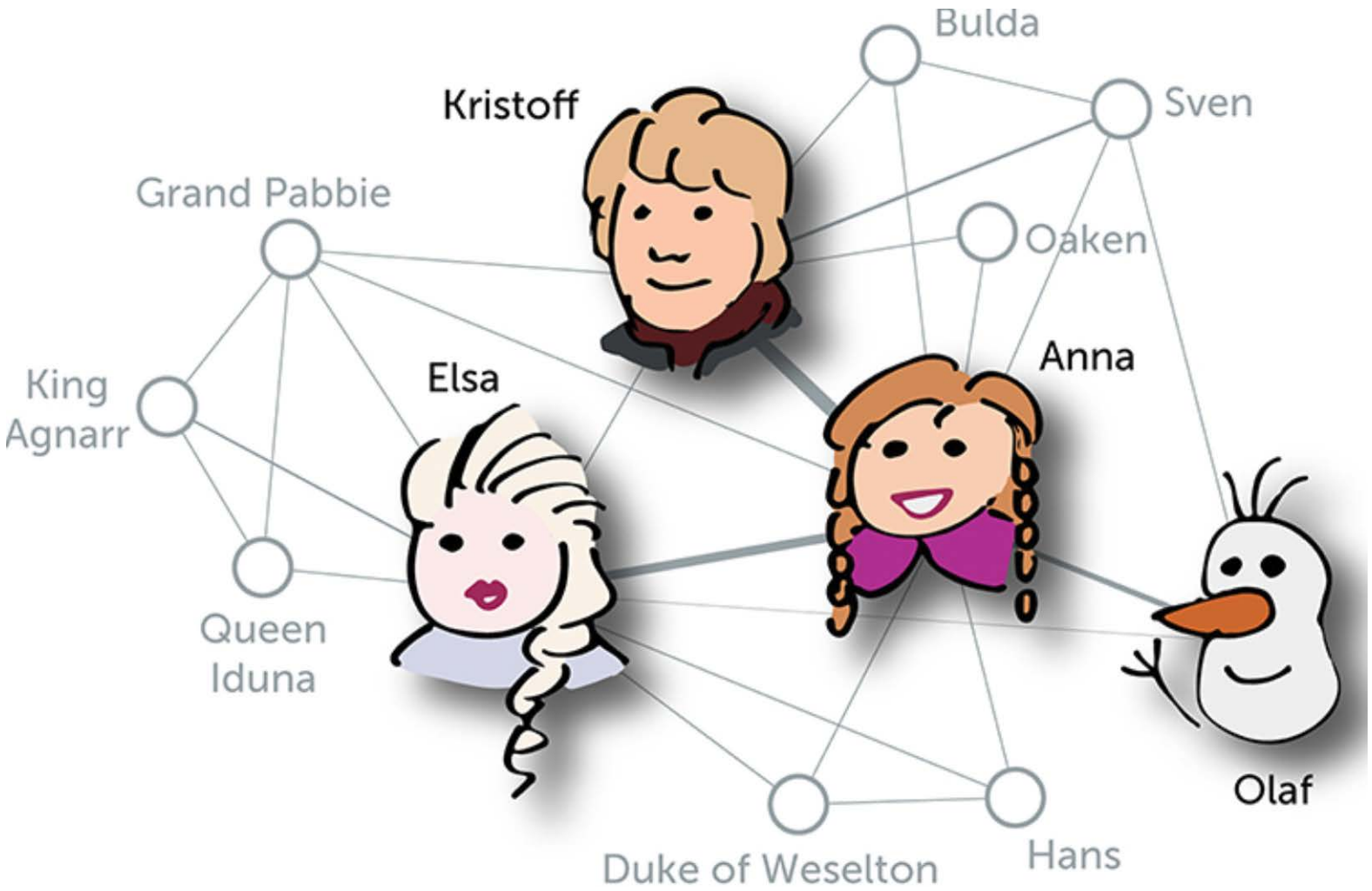



*Nodes (vertices) and Edges in an Undirected graph*

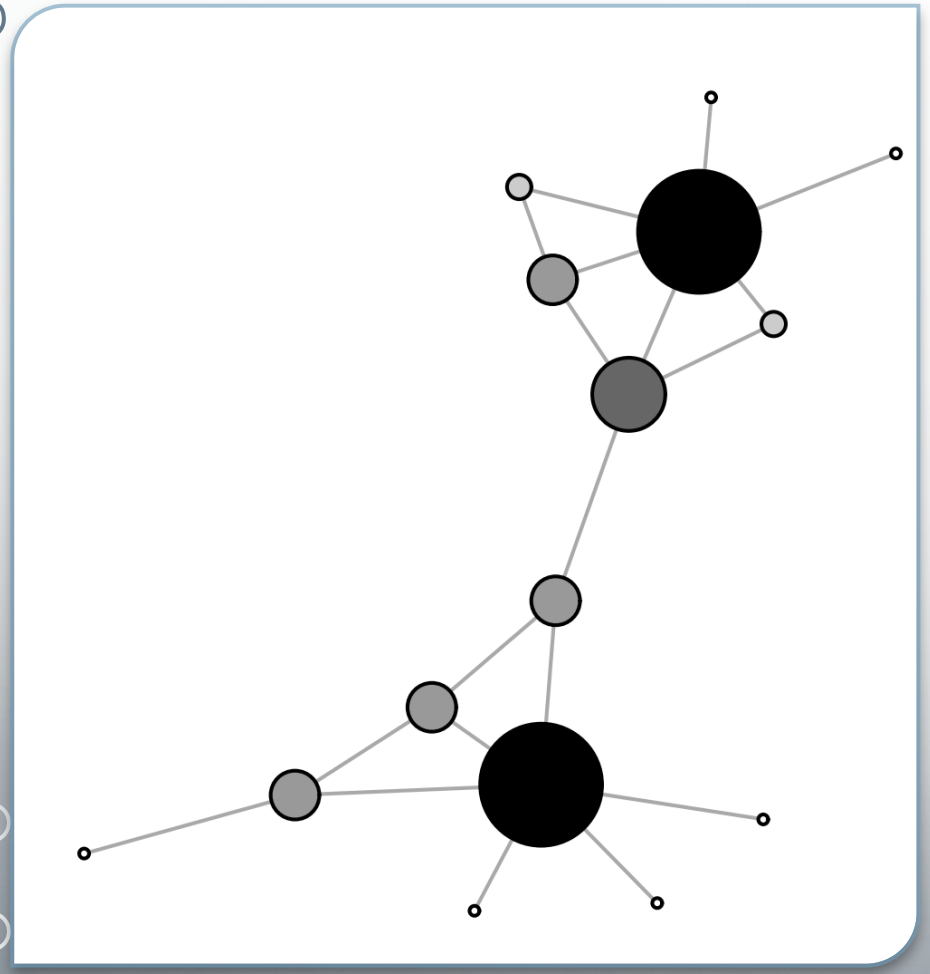
# CENTRALITY MEASURES : WHO IS THE MOST IMPORTANT PERSON IN THIS NETWORK?

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.

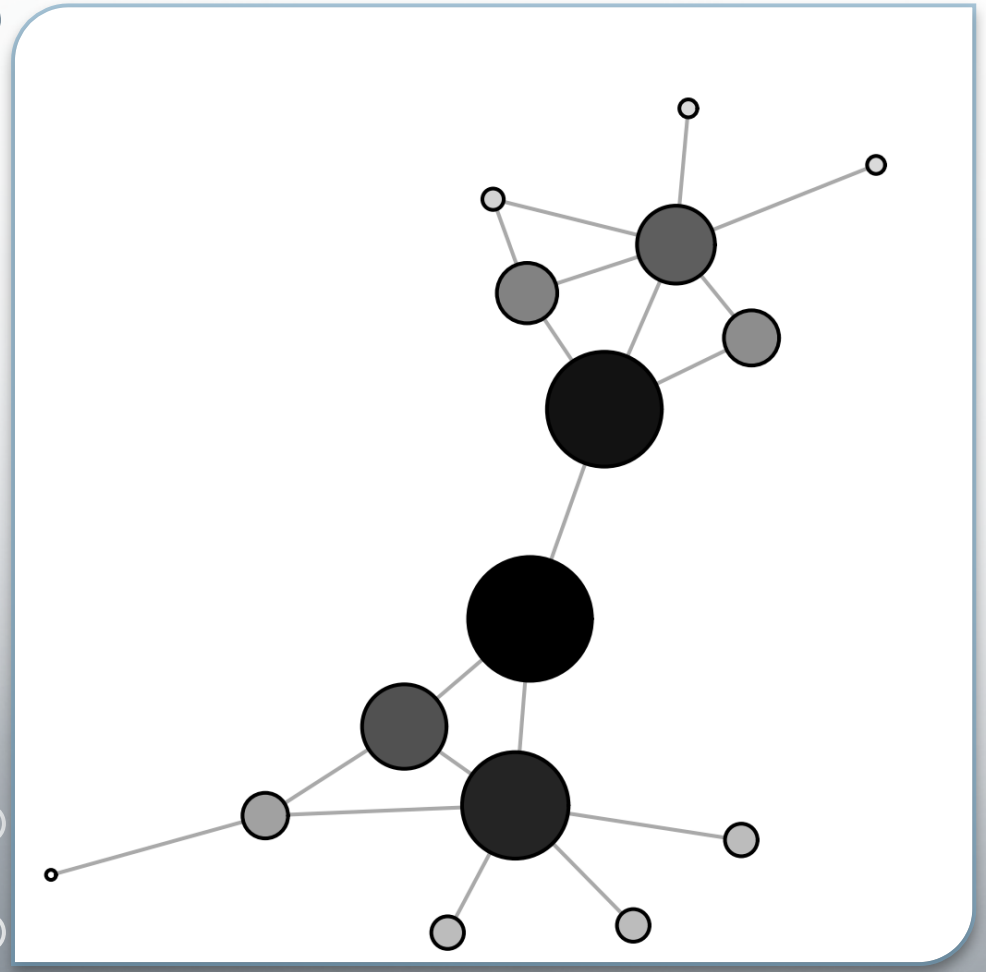


# DEGREE CENTRALITY



- 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

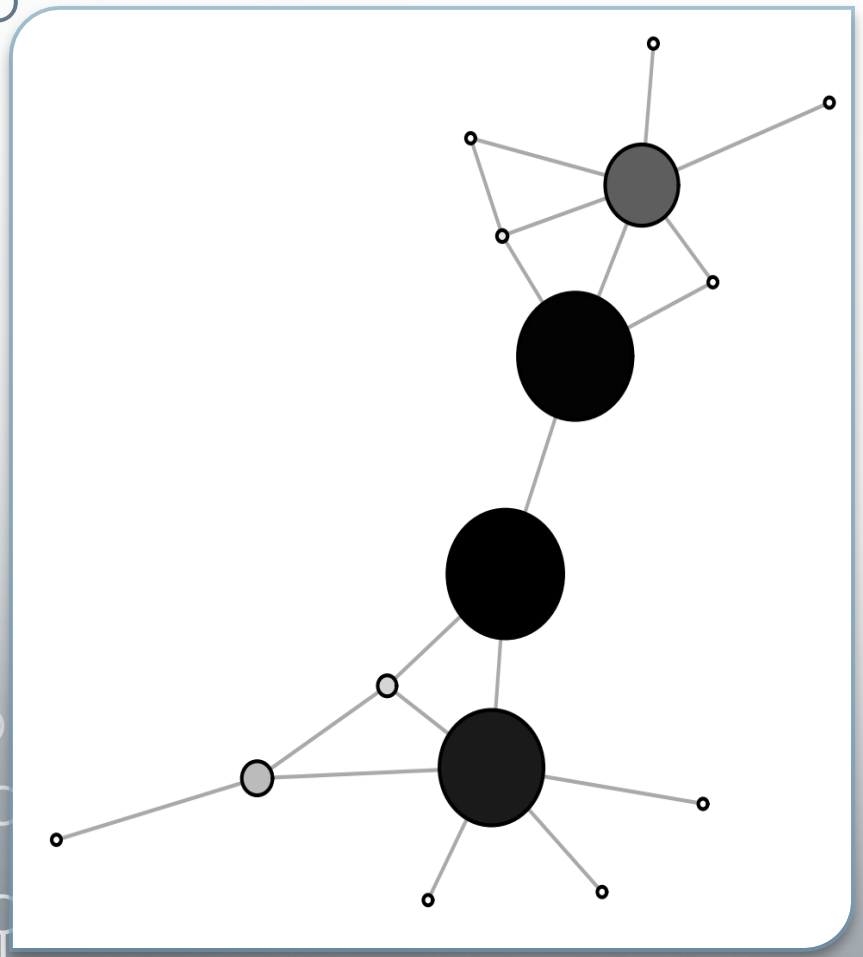


- Closeness centrality of a node is the reciprocal of sum of the length of the shortest paths between the node and all other nodes in the graph.

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

- $d(y,x)$ 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

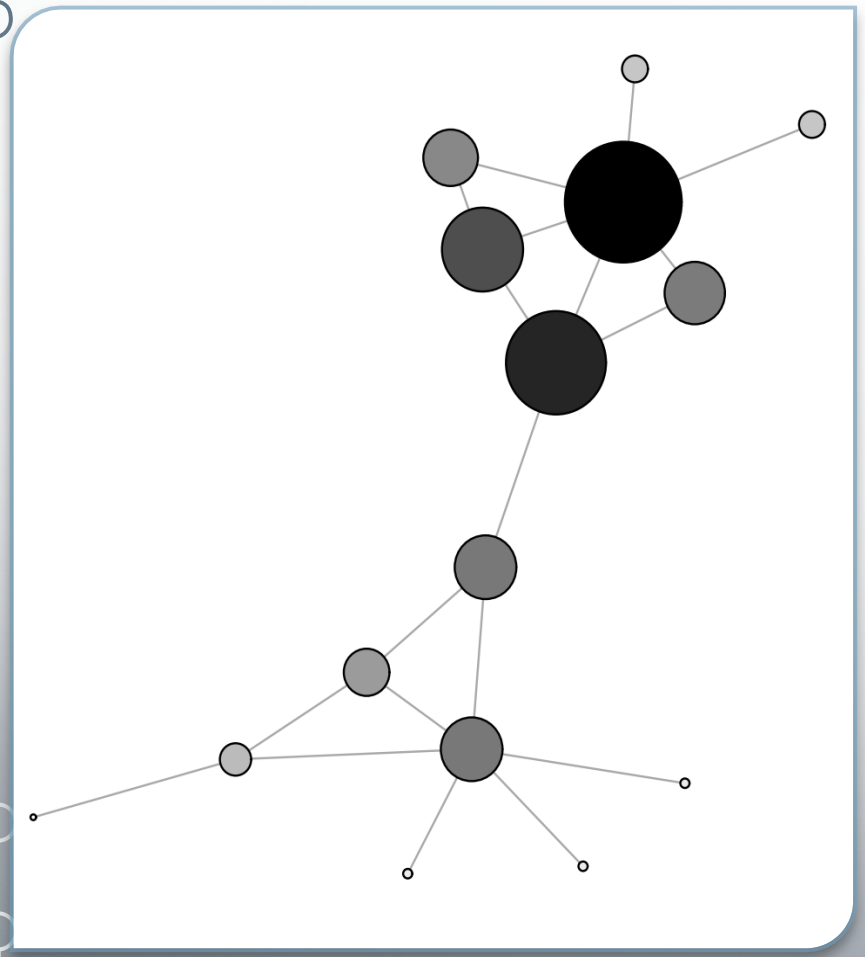


- Betweenness centrality quantifies the number of times a node acts as a **bridge** along the shortest path between two other nodes.

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

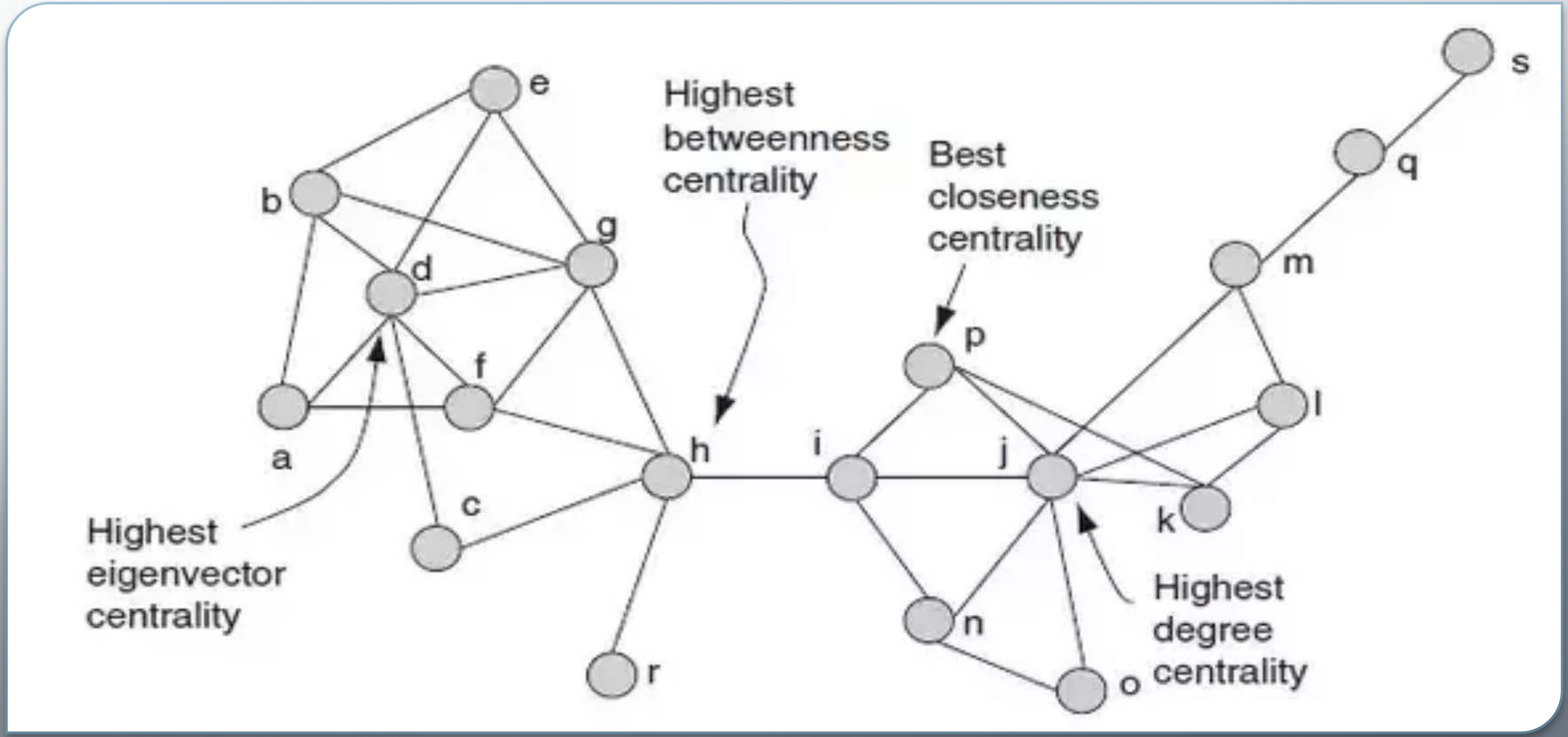
- Where $\sigma_{st}$ is total number of shortest paths from node s to node t and $\sigma_{st}(v)$ is the number of those paths that pass through v.
- In other words, it measures the extent to which a node is connected to other nodes that are not connected to each other!

# 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



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[3] Network Basic Concept: https://www.lsu.edu/faculty/bratton/networks/closeness.ppt

[4] Eigenvector Centrality : https://en.wikipedia.org/wiki/Eigenvector_centrality

# THANK YOU!!!