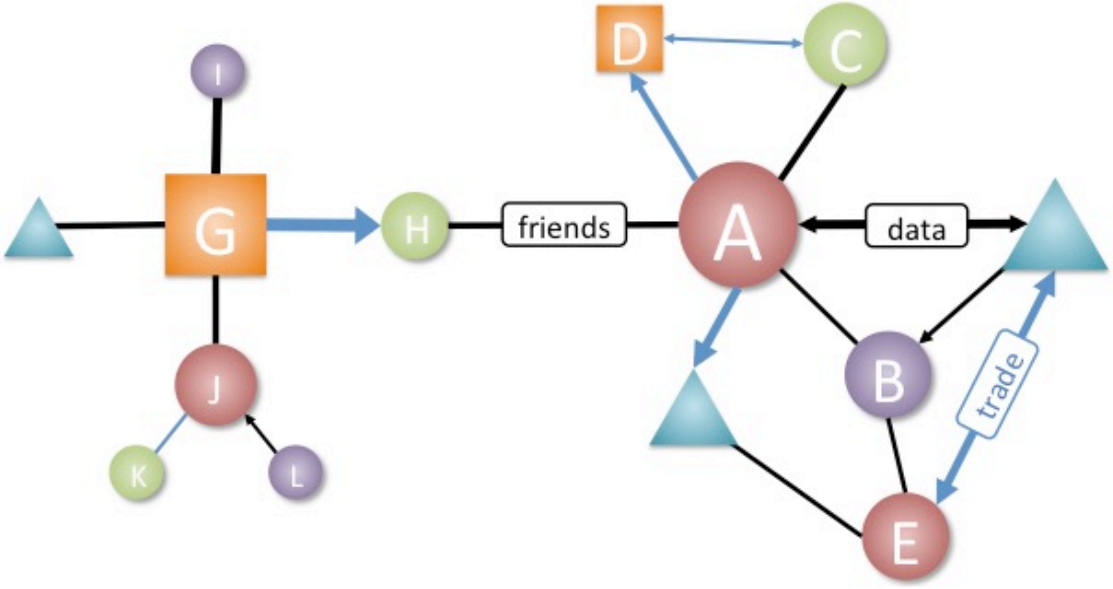
Networks

BBAS 423 Leading Social Change with Systems Thinking



Properties of Nodes:

Nodes are the things that re connected in the network, represented by dots or shapes.

- **Degree:** the number of connections a node has. The node may be drawn at a size proportional to its degree. Nodes with high degrees are called hubs. Node A has a degree of 6 and is a hub in this network. Node G has a degree of 4, and node B has a degree of 3.
- **Centrality:** the number of connections that must go through a node to connect to one another. Node H has high centrality, despite its low degree, because all connections between the right and left sides of the network go through it.
- **Kind:** the type of thing a node is, indicated by the color, shape, or label of the node.

Properties of Connections:

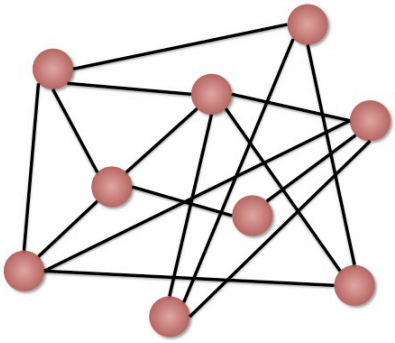
Connections are the links between nodes, represented by lines.

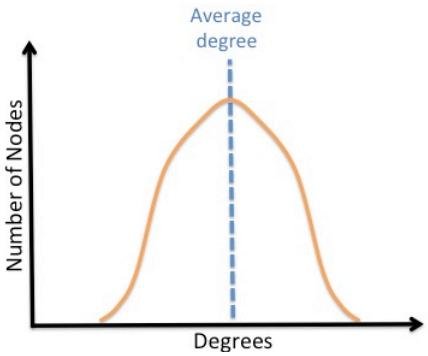
- **Content:** what the connection carries, indicated by the color or labels of the lines.
- **Weight:** the volume, weight, or frequency of a connection, indicated by the thickness of the line.
- **Direction:** which way the connection goes, indicated with arrowheads.
- **Structural hole:** the absence of a direct connection between two nodes, so that they can only connect through an intermediary node (or nodes). There is a structural hole between nodes K and L (bottom left of the diagram), so they must go through node J to connect.

Properties of Whole Networks:

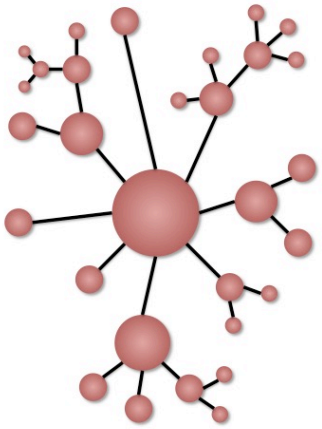
- **Average degree:** networks can be sparsely or densely connected. This is determined by dividing the total number of connections by the total number of nodes. The diagram above is sparsely connected, with an average degree of 1.2 (17 connections ÷ 14 nodes ≈ 1.2 connections per node).
- **Degree distribution:** networks can be homogenous (nodes have more or less the same degree) or heterogeneous (nodes have widely varying degrees). The diagram above is heterogeneous, with node degrees ranging from 1 to 6.

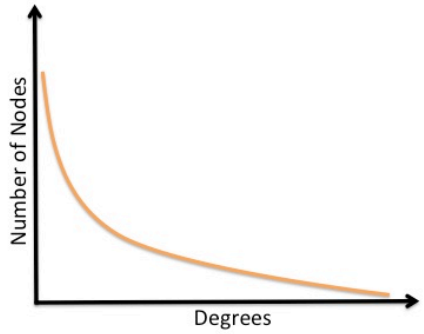
Random Networks: arise when connections are added randomly between nodes. The degree distribution of such networks is homogenous, following a bell-curve centred on the average degree of the network. The average degree represents the characteristic scale of the network.





Scale-Free Networks: have a heterogeneous degree distribution that follows a power law. They have a small number of super-hubs, a few big hubs, some lesser hubs, and many low-degree nodes. With this degree distribution, there is no meaningful average degree, and thus no characteristic scale.





Mechanisms of Network Growth:

Real world networks generally do not grow randomly. Instead, nodes following simple decision rules about which other nodes they connect to produce order and structure in the overall network without central planning or coordination. In this way, networks form through processes of *self-organization*. Two prominent mechanisms of network growth are:

- **Preferential attachment:** nodes connect to nodes that already have many connections (high degree). This mechanism is also known as the Barabási-Albert model, the "popularity is attractive principle," the "rich get richer" phenomenon, and the "Matthew effect." Preferential attachment produces scale-free networks.
- **Homophily:** nodes connect to nodes that are similar in kind, and avoid dissimilar nodes. Homophily creates echo chambers and political polarization in social media networks.

Power in Networks:

Networks feature unique forms of power, including:

- **Popularity:** preferential attachment rewards those who already have many connections with even more connections. This creates an early-comer advantage, path dependence, and inequality in networks (the rich get richer).
- **Gatekeepers/switchers:** are nodes with high centrality that control access from one part of a network to other parts of a network (gatekeepers), or act as a bridge between different networks (switchers).
- **Programmers**: design the platform or protocol by which connections are made in a network. Their designs shape *what* gets transferred, and *to whom* it is transferred.