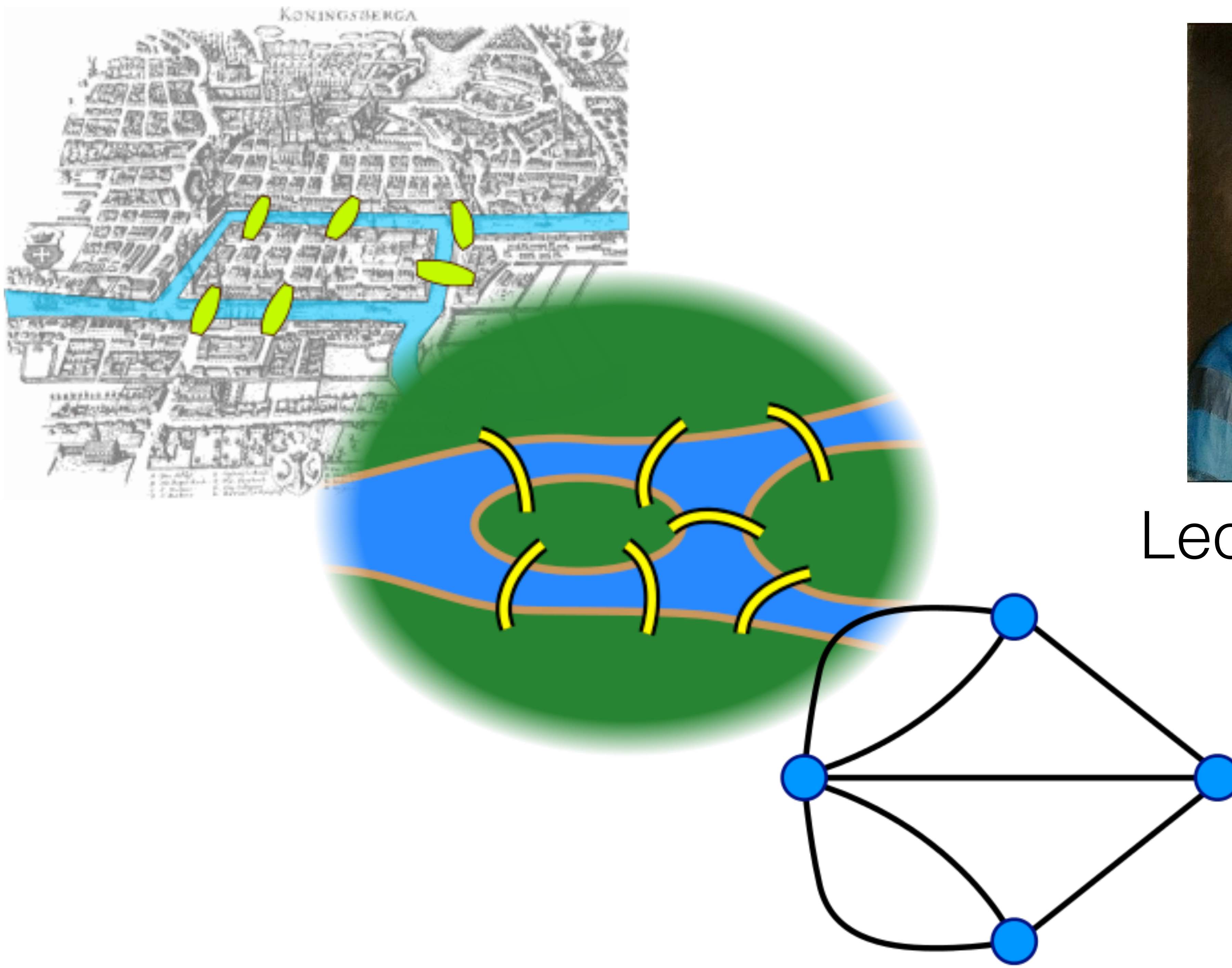
History



Leonhard Euler

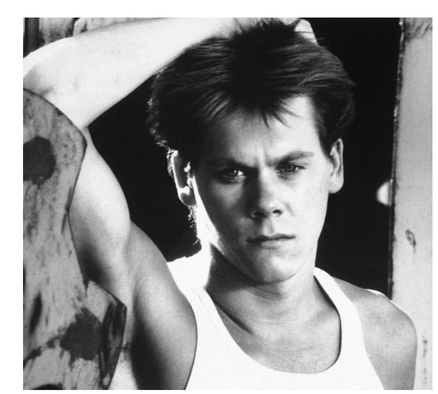
History

- Random network the size of the US (in 1950) would require at most two intermediaries to connect any two people (Kochen)

- Small World Experiments (Miligram)

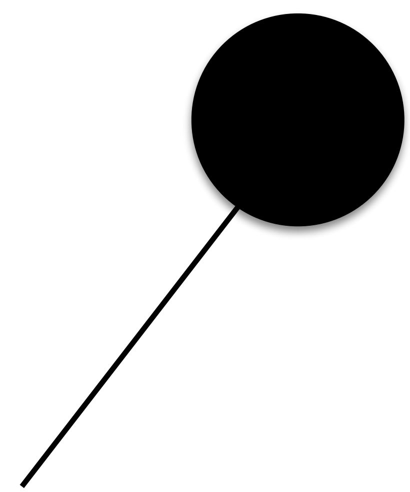
  

  - Postcards sent to random people in Kansas
  - People instructed to send their postcard to a target person in Boston or someone that they think might know that person

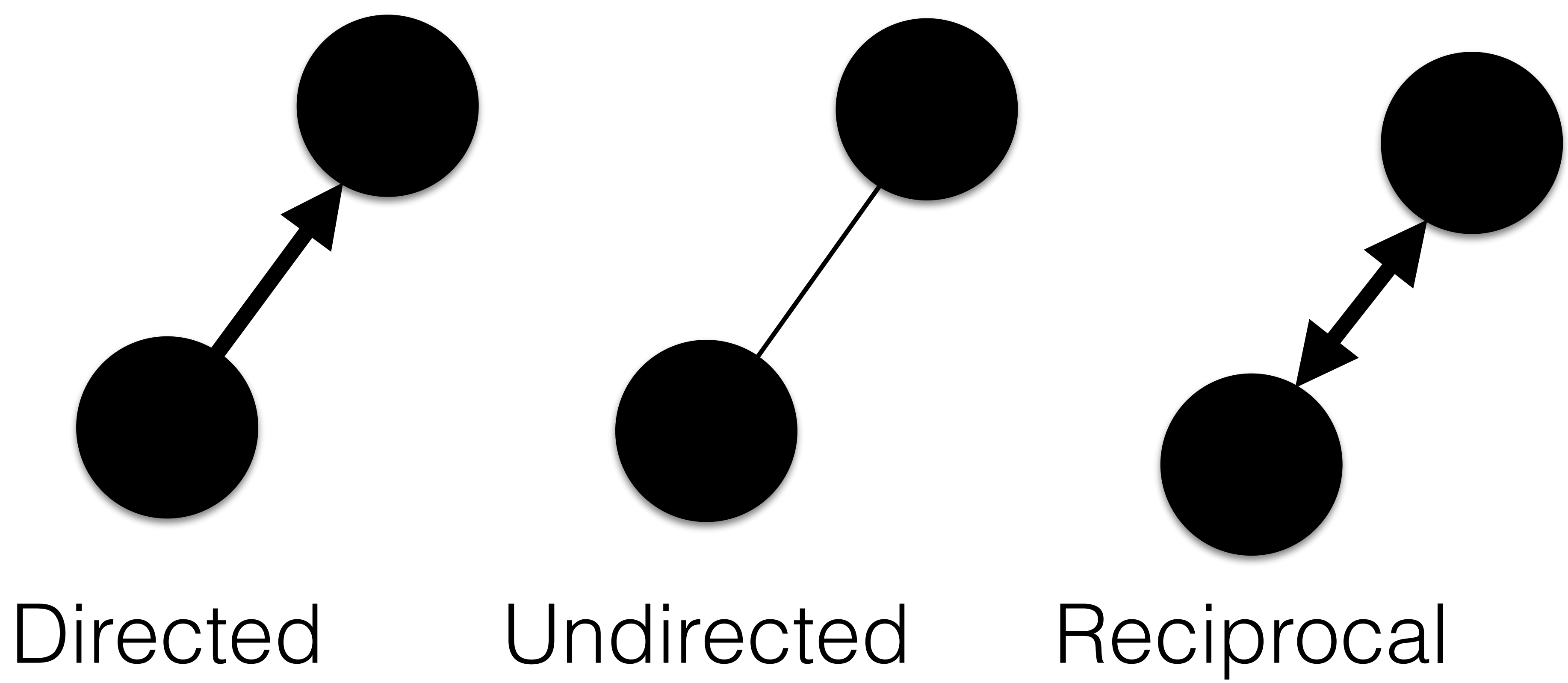


Networks

(Graphs)

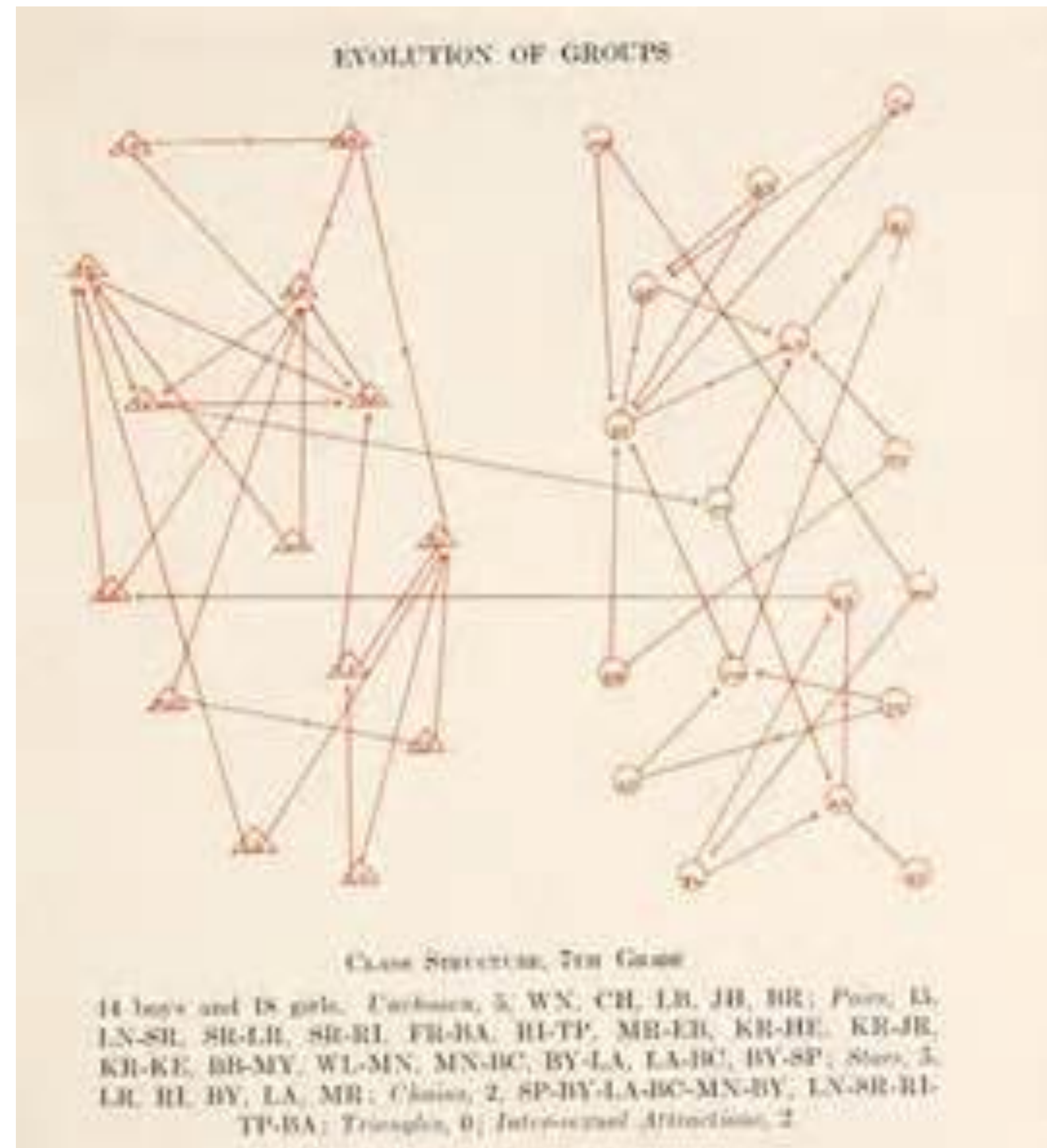


Networks



Use in Education

- Helen Jennings & Jacob Levy Moreno
- Hudson School for Girls (1934)



Use in Education

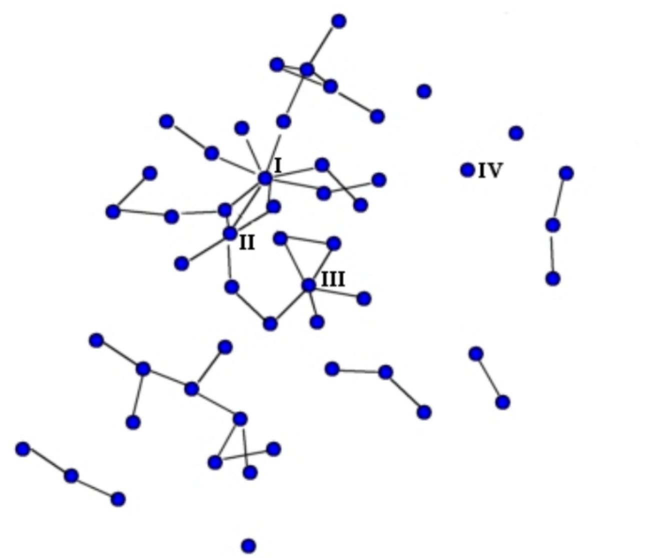
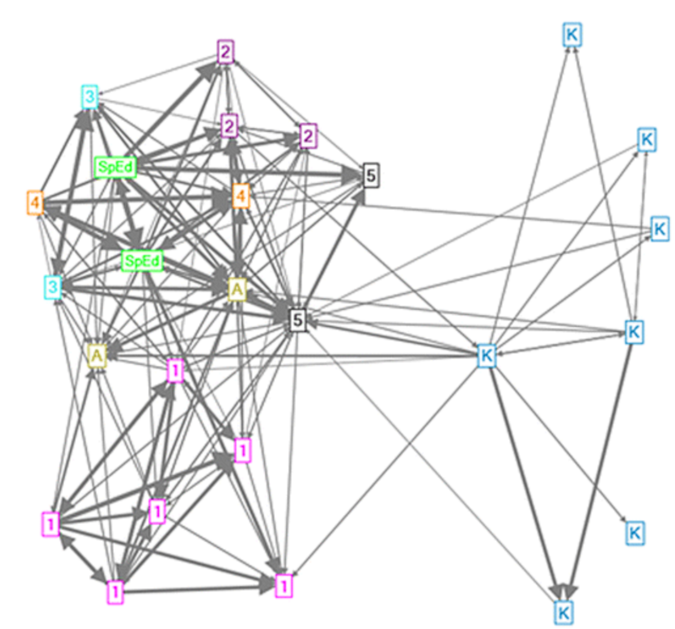


Figure 2. Sociogram of discussion forum interactions

Dawson (2008)

Centrality measures from forum posts correlate to student sense of belonging (mediated by external network)



Smith, Trygstad, Hayes (2016)

SNA can be used to identify influential teachers within their peer group

Activity 1: Brainstorm

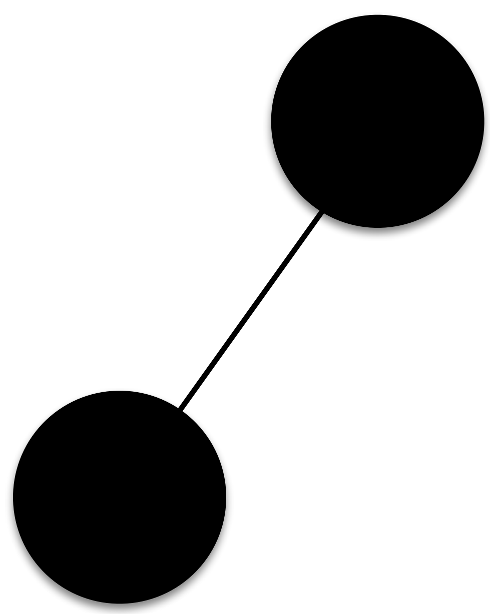
- In your group
- Discuss interactions that might be important between students in a class
  - What does a high value represent? What does a low value represent?
  - What patterns would you expect to see?
- Choose three interactions in which two students can have a maximum of one interaction between each other and see if you can count them amongst the students in your group

Activity 2: Graphing

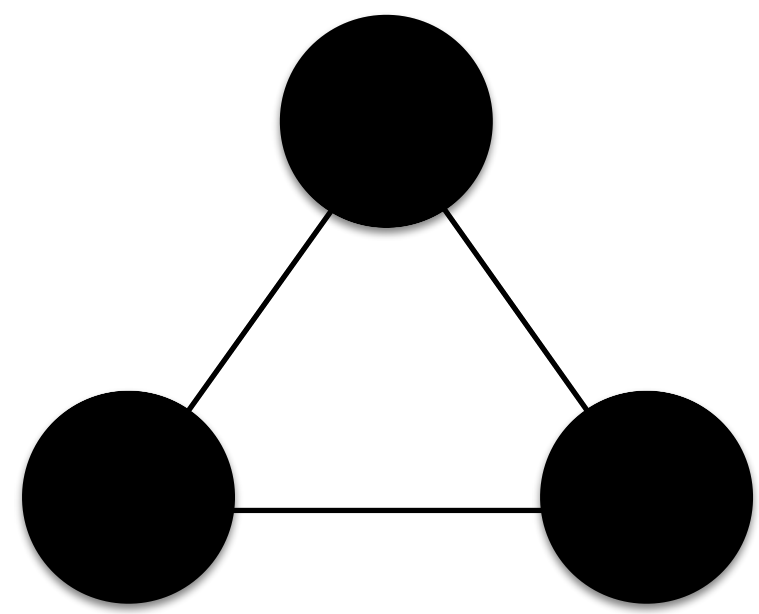
- In your group
- Using the measures you (or another group) devised, draw <u>three</u> networks in a Google Doc/Presentation/Keynote
- What patterns do you observe?
- Can you interpret the patterns?
- <u>Write down your answers</u>

Dyad & Triad (Cycle)

How close is the graph to the maximal number of links



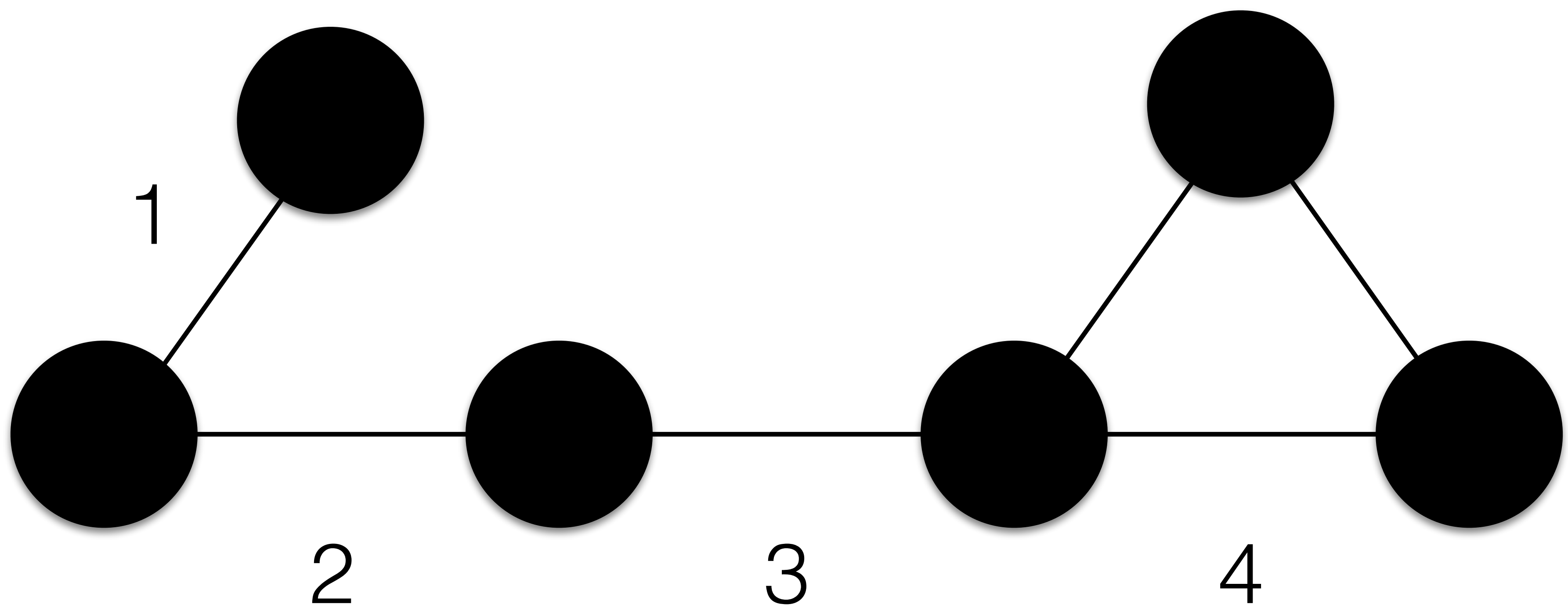
Dyad



Triad

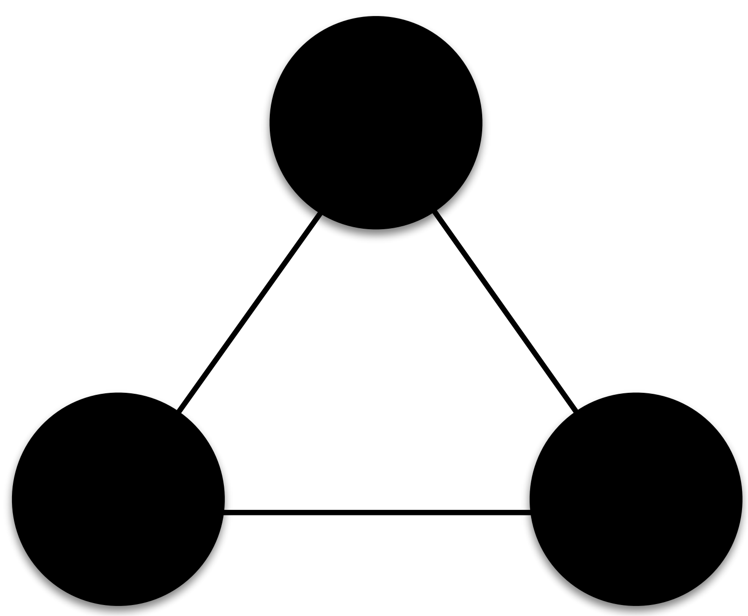
Distance

The length of the shortest path between the most distant nodes of a graph.

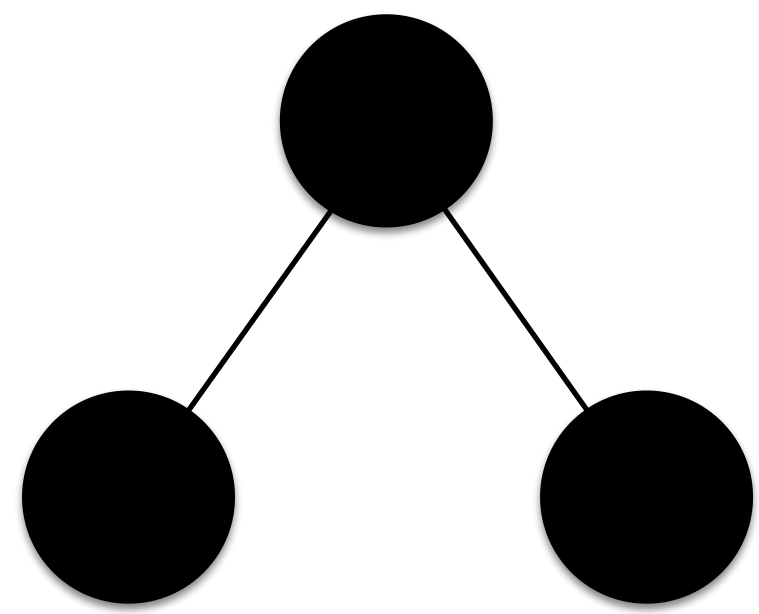


Density

How close is the graph to the maximal number of links



3 actual
3 possible
Density = 1



2 actual
3 possible
Density = 0.67

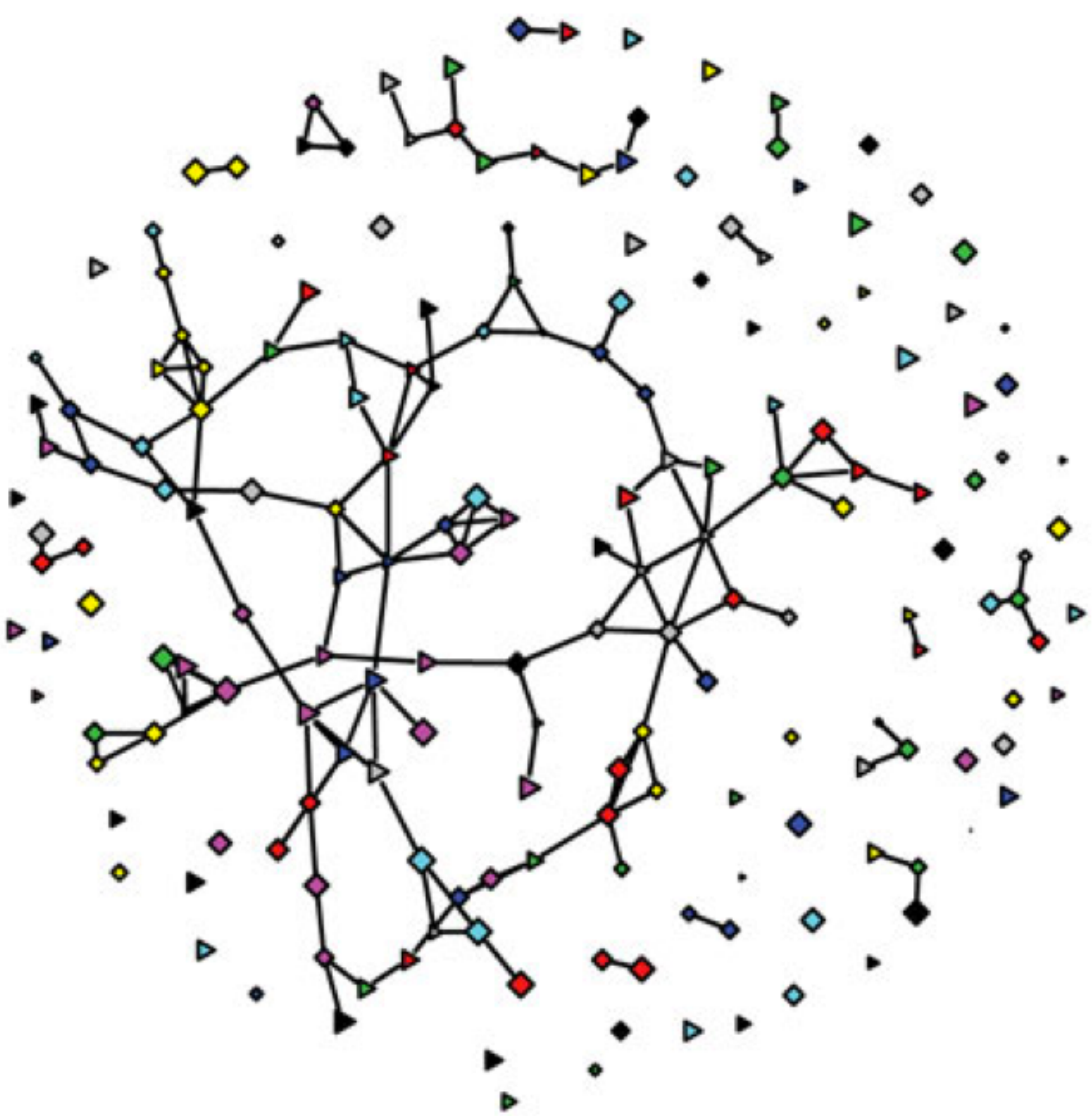
Activity 3: Complexity

- Using the networks you drew:
    - Calculate the number of dyads and triads in your three graphs
    - Calculate the diameter of your three graphs
    - Calculate the density of your three graphs
    - What

Degree

The number of links to other nodes in the network

Undirected



Directed

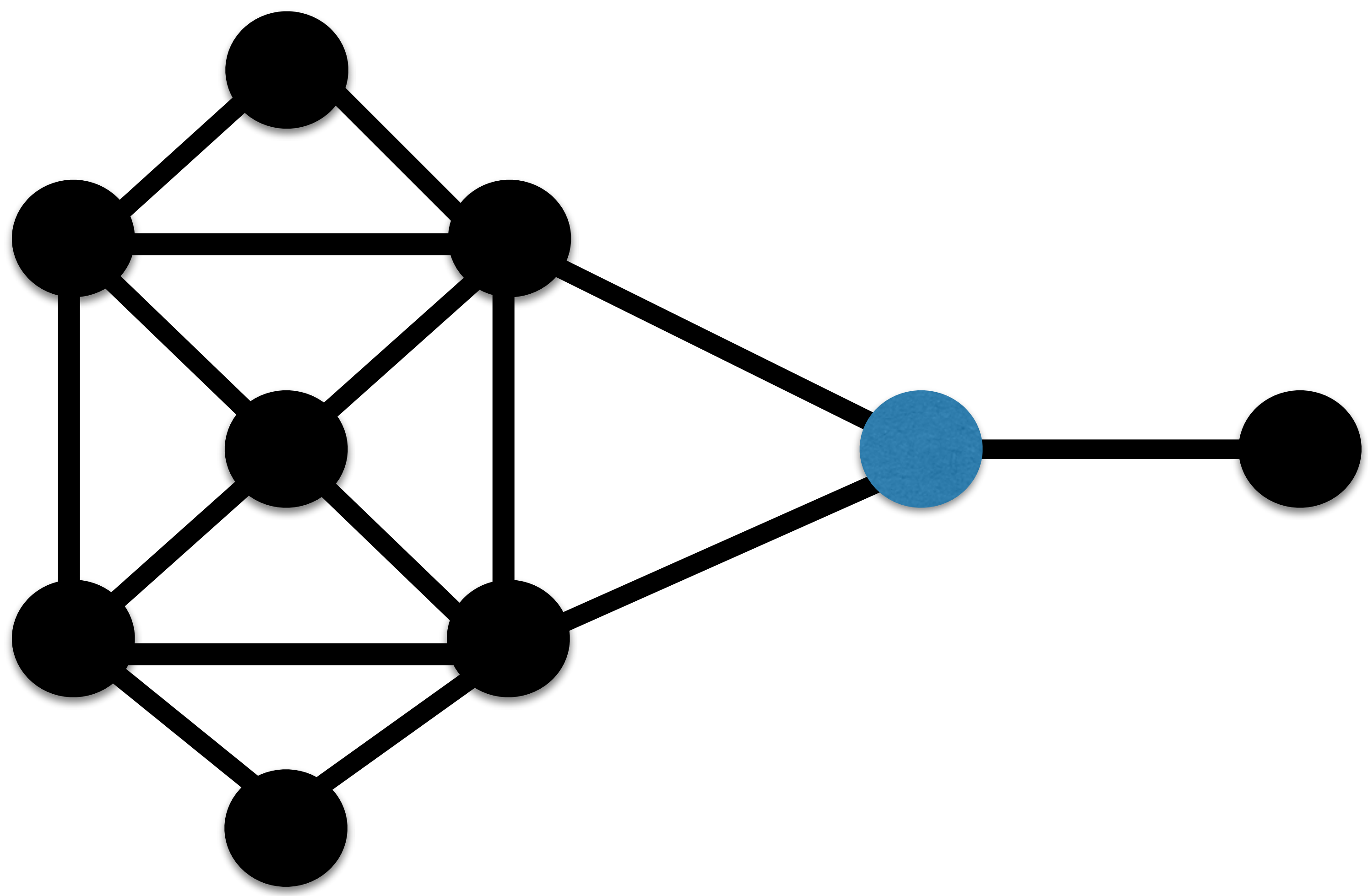
Indegree = Popularity
Outdegree = No shame

Activity 4: Degree

- Using the networks you drew:
  - Are your networks directed or undirected?
  - What is the degree centrality of the whole network?
  - What is the degree centrality of each member of the network?
  - If your network is directed, what is the indegree and outdegree of each member in the network?
  - How do you interpret these metrics?

Betweenness Centrality

The extent to which a node lies between other nodes

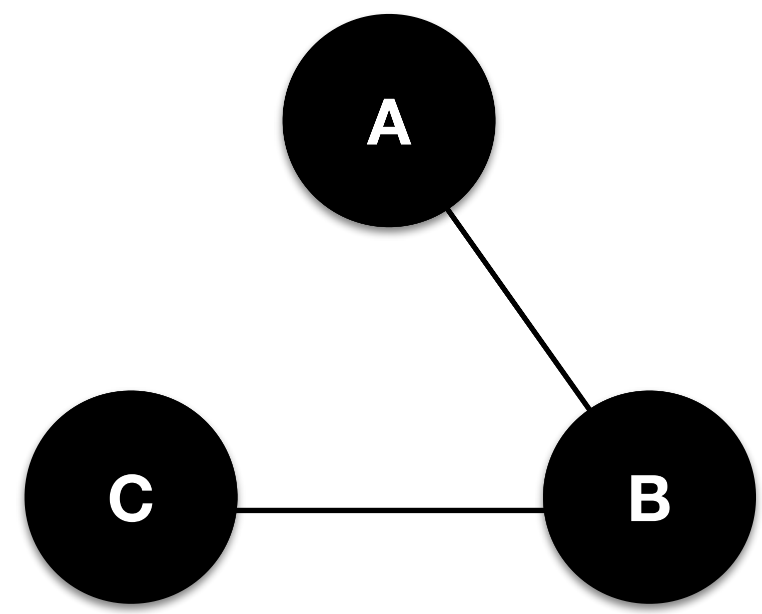


It is equal to the number of shortest paths from all nodes to all others that pass through that node

Adjacency Matrix

Tabular representation of the graph

Nodes	A	B	C
A		1	0
B	1		1
C	0	1	



Modularity

The fraction of the edges that fall within the given groups minus the expected such fraction if edges were distributed at random

$$
\begin{aligned}
Q_S &= \frac{1}{2\bar{w}} \sum_i \sum_j \left(\bar{w}_{ij} - \frac{\bar{w}_i \bar{w}_j}{2\bar{w}} \right) \delta(C_i, C_j) \\
&= \frac{1}{4w} \sum_i \sum_j \left(w_{ij} + w_{ji} - \frac{(w_i^{\text{out}} + w_i^{\text{in}})(w_j^{\text{out}} + w_j^{\text{in}})}{4w} \right) \delta(C_i, C_j) \\
&= \frac{1}{4w} \sum_i \sum_j \left[\left(w_{ij} - \frac{w_i^{\text{out}} w_j^{\text{in}}}{2w} \right) + \left(w_{ji} - \frac{w_i^{\text{in}} w_j^{\text{out}}}{2w} \right) \right] \delta(C_i, C_j) \\
&= -\frac{1}{(4w)^2} \sum_i \sum_j (w_i^{\text{out}} - w_i^{\text{in}})(w_j^{\text{out}} - w_j^{\text{in}}) \delta(C_i, C_j) \\
&= Q_D - \frac{1}{(4w)^2} \sum_i \sum_j (w_i^{\text{out}} - w_i^{\text{in}})(w_j^{\text{out}} - w_j^{\text{in}}) \delta(C_i, C_j).
\end{aligned}
$$

Activity 5: Betweeness & Modularity

- Using the networks you drew:
    - Calculate the betweenness for each node in the network in your three graphs
    - Is anyone in your graph a gatekeeper? How would you interpret this?
    - Convert your three graphs into adjacency matrices in a table in a Google Doc/Powerpoint/etc.
    - Do you think any of your graphs are modular? If not, why not?
    - For any modules you think exist, count the number of edges you believe belong to the modules. What percentage of the total edges is this?
    - Now, create a random adjacency matrix with the same number of edges as your graph where you located the modules. Draw up the adjacency matrix and flip a coin to determine if there is a connection between two nodes: heads = yes, tails = no. Stop when you run out of combinations or you reach the same number of edges as your graph with the modules.
    - Are there any modules in your random graph? If so count the number of edges that are within modules and calculate the percentage of total edges.
    - Subtract the percentage of edges within modules in your random graph from the percentage of edges in your original graph - this is a crude measure of modularity (Q)

Activity 6: Review

- Look back at the answers you wrote in part 2
- Did the different metrics provide additional information or not?