Lecture 2:
Network types and individual properties

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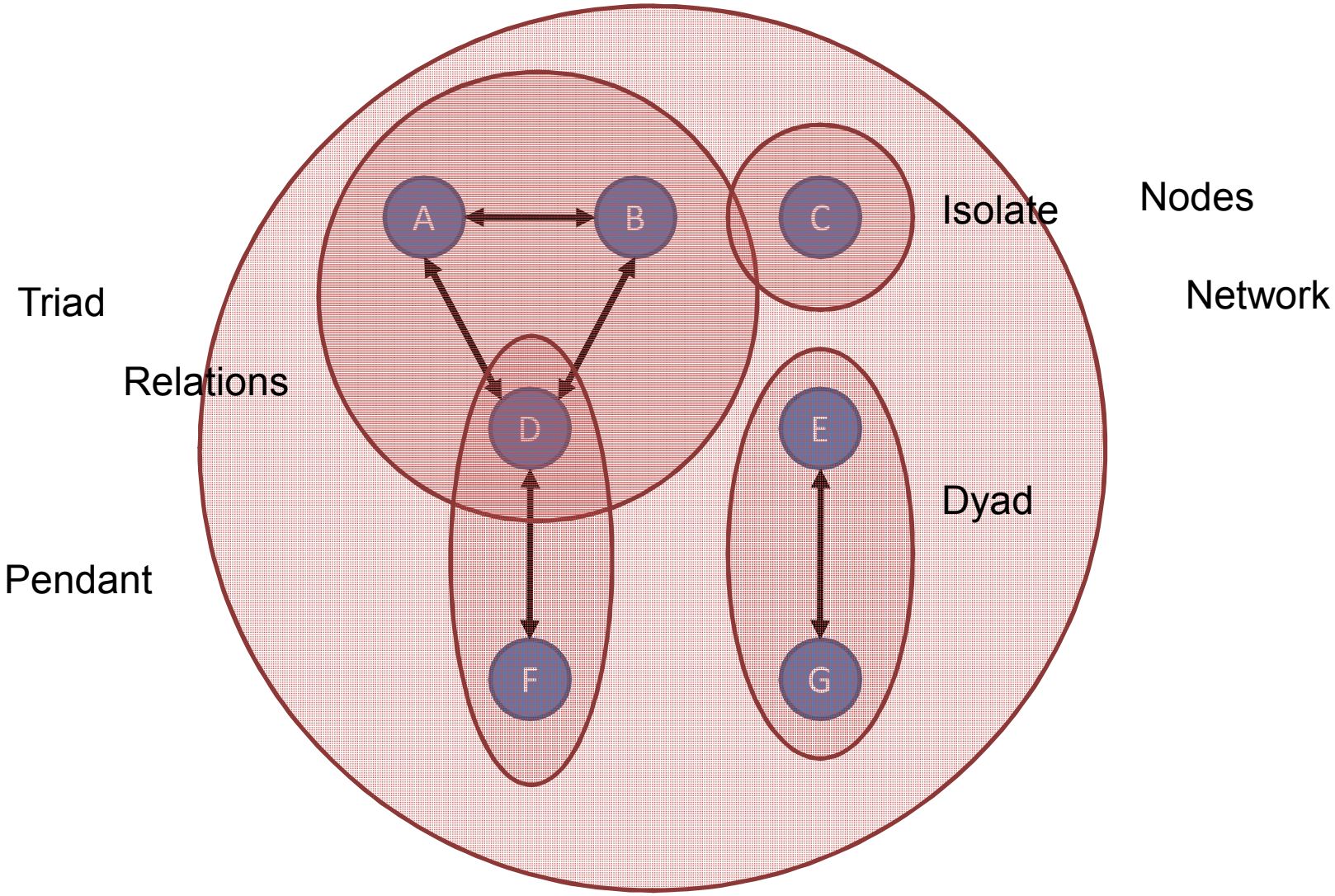
Actors & relations

- Actors (nodes, vertices)
  - People, groups, organizations, communities, nation-states
- Relations (links, ties, edges)
  - Evaluations of one person by another (friendship, liking, ...)
  - Transfers of material resources (lending, donations, ...)
  - Association or affiliation (membership, attendance, …)
  - Behavioral interaction (communication, intercourse, …)
  - Movement between places or statuses (migration, mobility, …)
  - Physical connections (roads, routers, …)
  - Formal relations (authority, supply chain, …)
  - Biological relations (kinship, descent, …)

Groups & components

- A network is a set of nodes and collection of links between these nodes
- Networks do not need to be completely-connected
- **Component**: Connected subset of network nodes and links


Triad
Relations
Pendant
A
B
C
D
E
F
G
Isolate
Dyad
Nodes
Network

Sociomatrix

	A	B	C	D	E	F	G
A	-	1	0	1	0	0	0
B	1	-	0	1	0	0	0
C	0	0	-	0	0	0	0
D	1	1	0	-	0	1	0
E	0	0	0	0	-	0	1
F	0	0	0	1	0	-	0
G	0	0	0	0	1	0	-

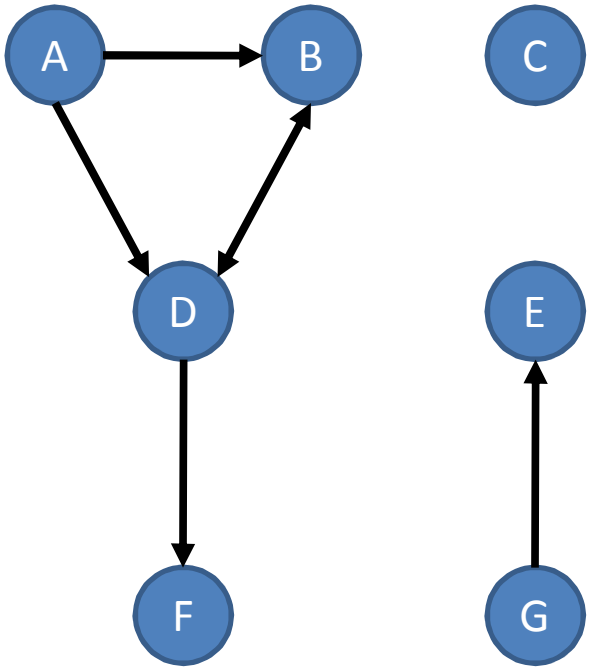
C has **no** relationships with A,B,D,E,F

F has a relationship with D

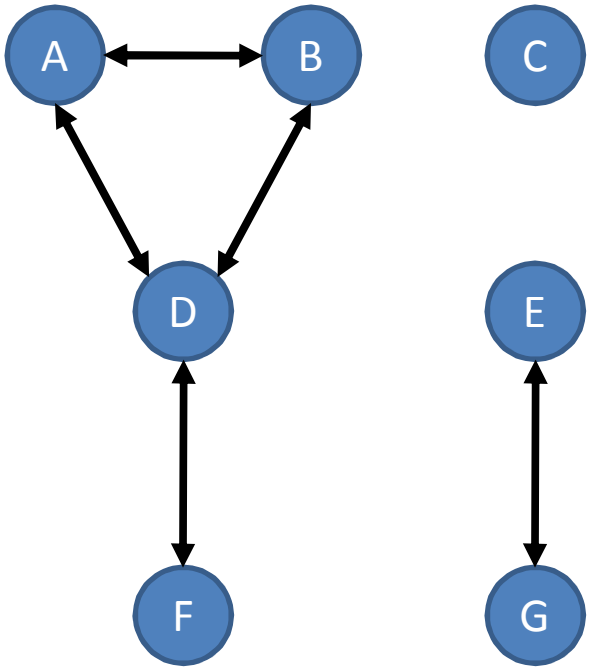
Directed & undirected

- Communication vs. friendship networks

twitter

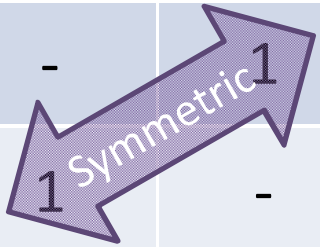


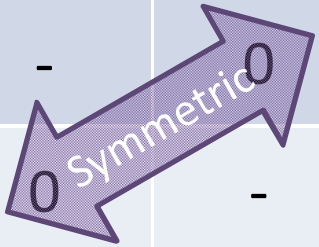
facebook

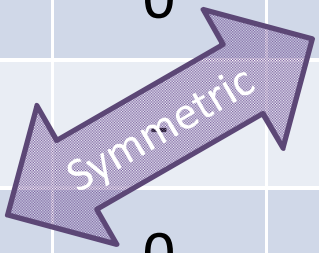


Undirected sociomatrix

	A	B	C	D	E	F	G
A	-	1	0	1	0	0	0
B	1	-	0	1	0	0	0
C	0	0	-	0	0	0	0
D	1	1	0	-	0	1	0
E	0	0	0	0	-	0	1
F	0	0	0	1	0	-	0
G	0	0	0	0	1	0	-







Directed sociomatrix

	A	B	C	D	E	F	G
A	-	1	0	1	0	0	0
B	0	-	0	1	0	0	0
C	0	0	-	0	0	0	0
D	0	1	0	-	0	1	0
E	0	0	0	0	-	0	0
F	0	0	0	0	0	-	0
G	0	0	0	0	1	0	-

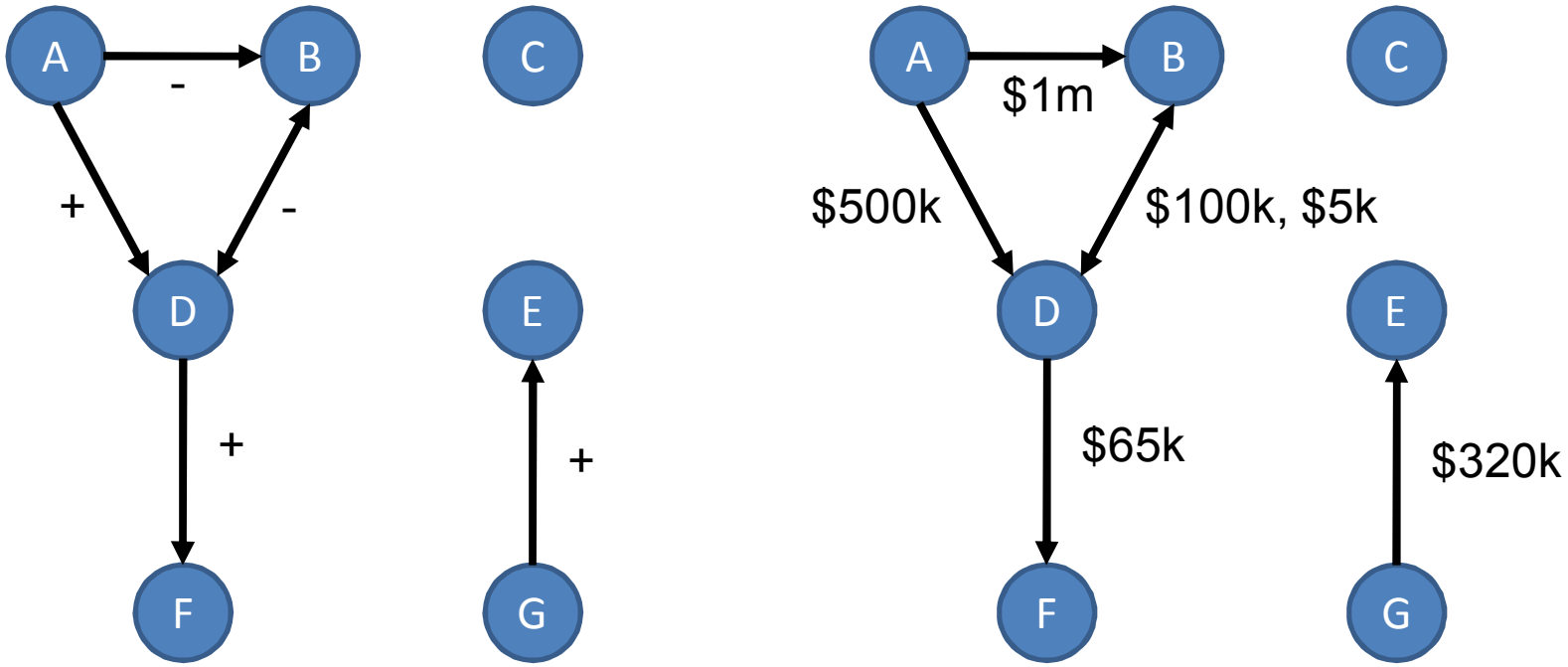
Unsymmetric

Unsymmetric

Unsymmetric

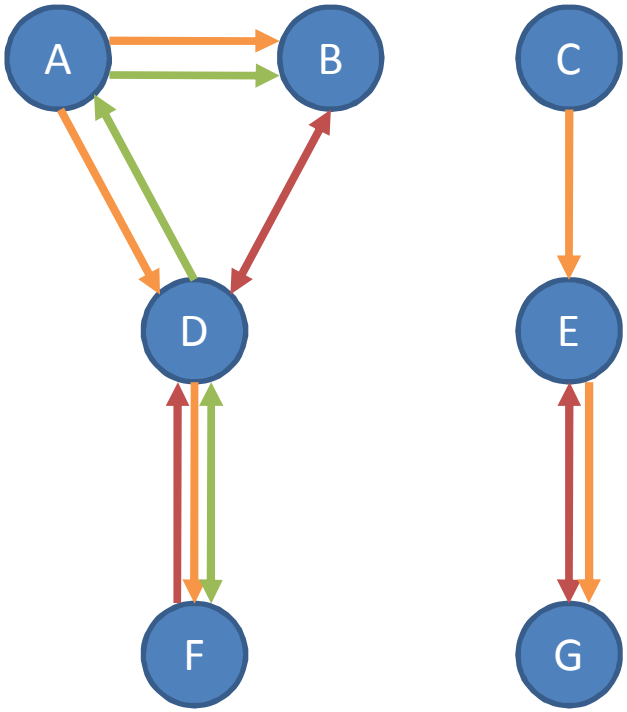
Signed & valued

- Affect in a sorority vs. campaign financing



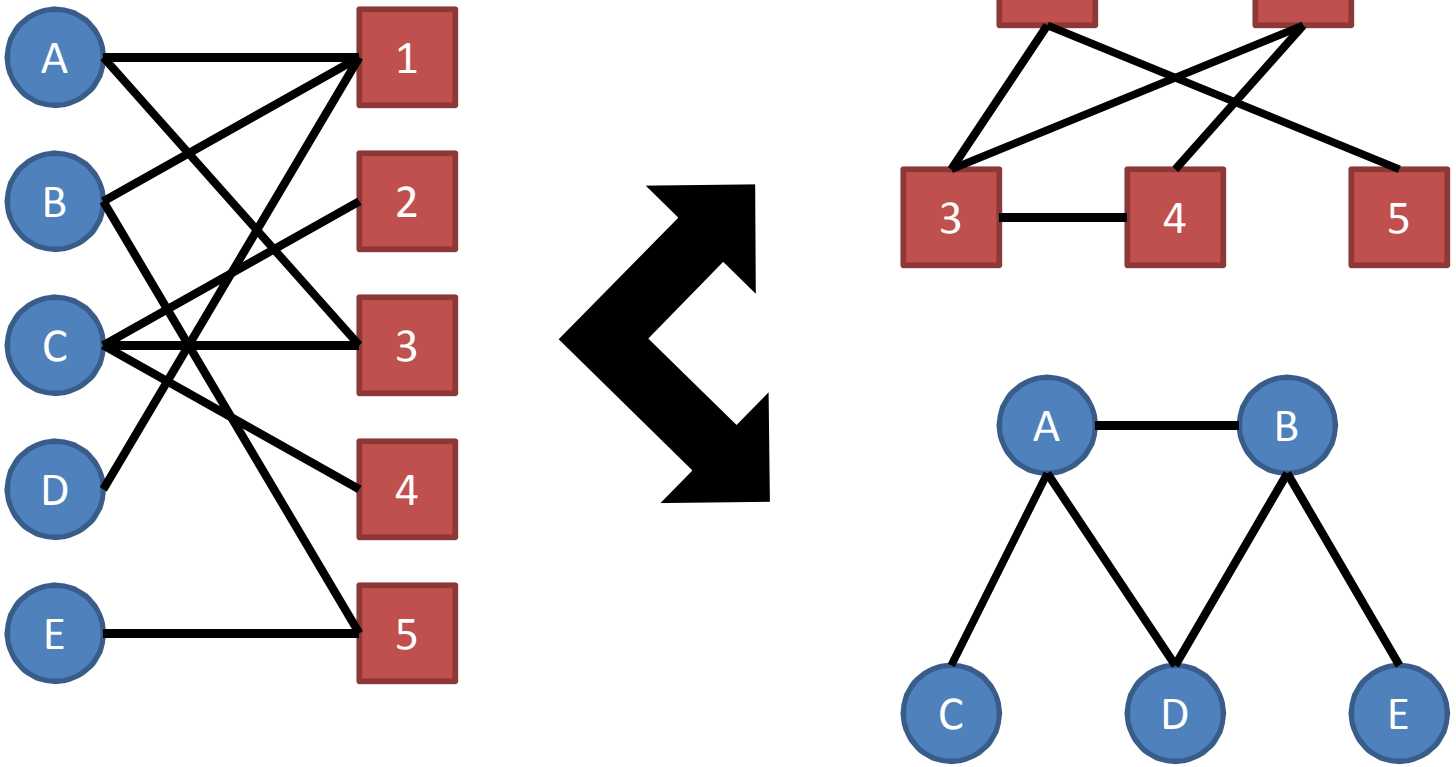
Multi-relational

- Organizations: **authority**, **trust**, & **friendship**



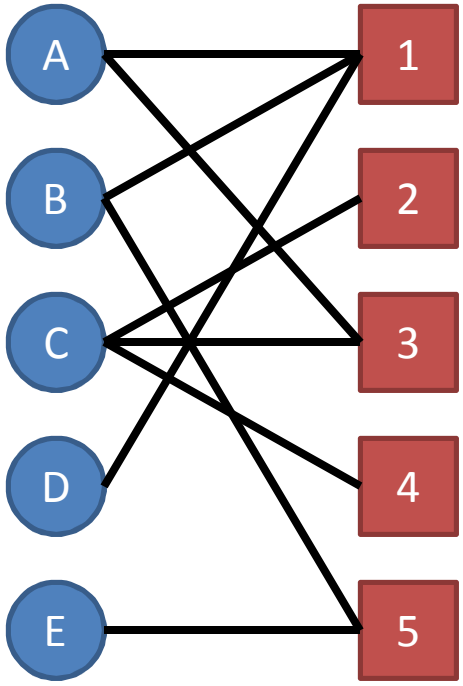
One-mode & two-mode

- Actor-actor & actor-event
- Lobbyist & co-location networks



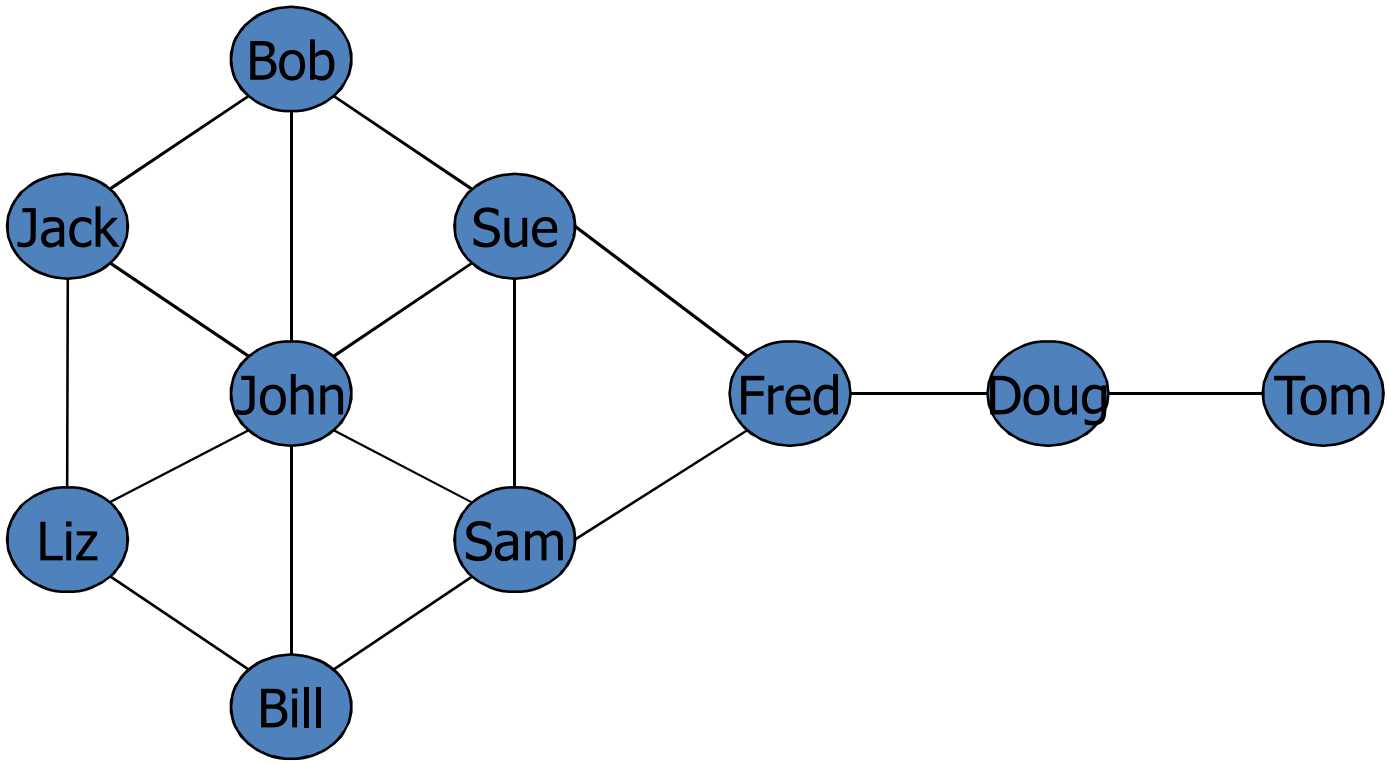
Bipartite sociomatrix

	1	2	3	4	5
A	1	0	1	0	0
B	1	0	0	0	1
C	0	1	1	1	0
D	1	0	0	0	0
E	0	0	0	0	1



The Kite Network

Which actor is the ***most important*** in this network?

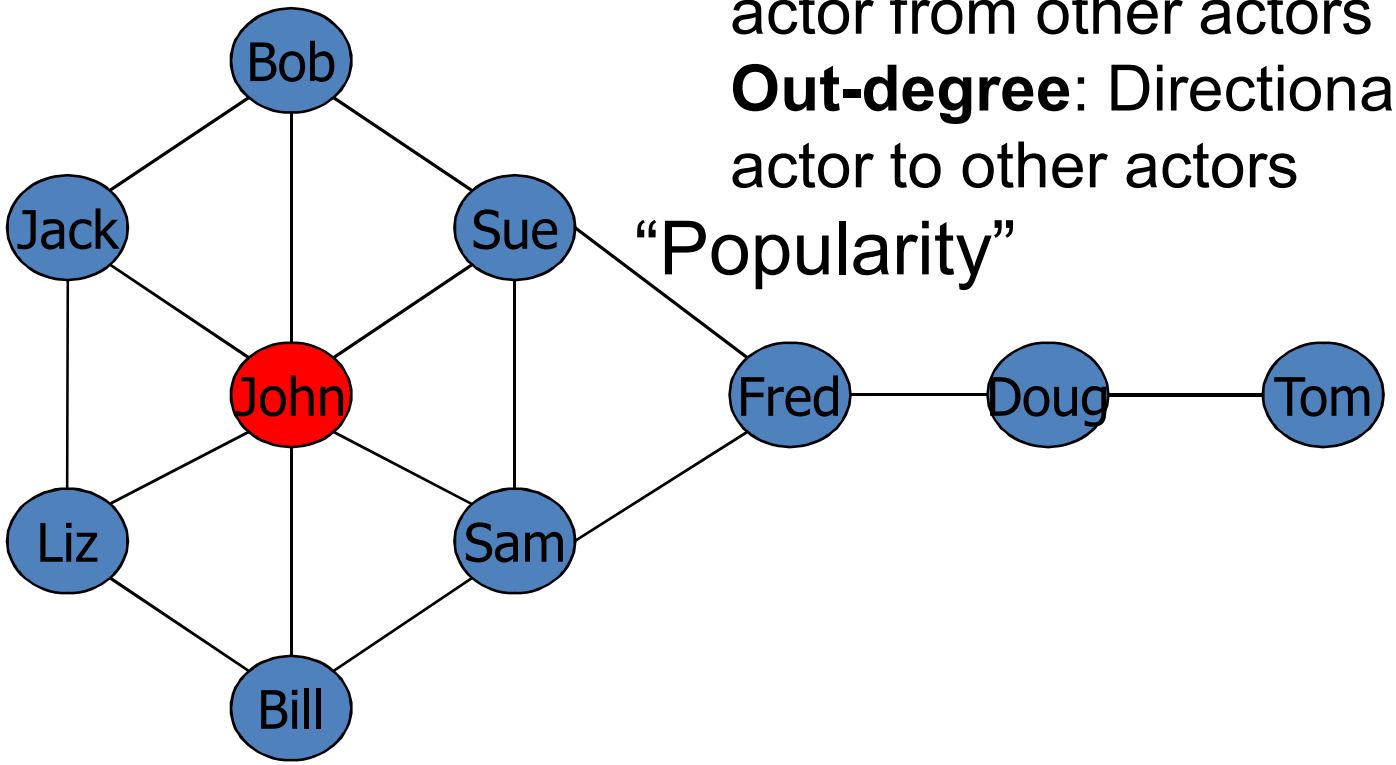


Degree Centrality

Degree: total number of links with other actors

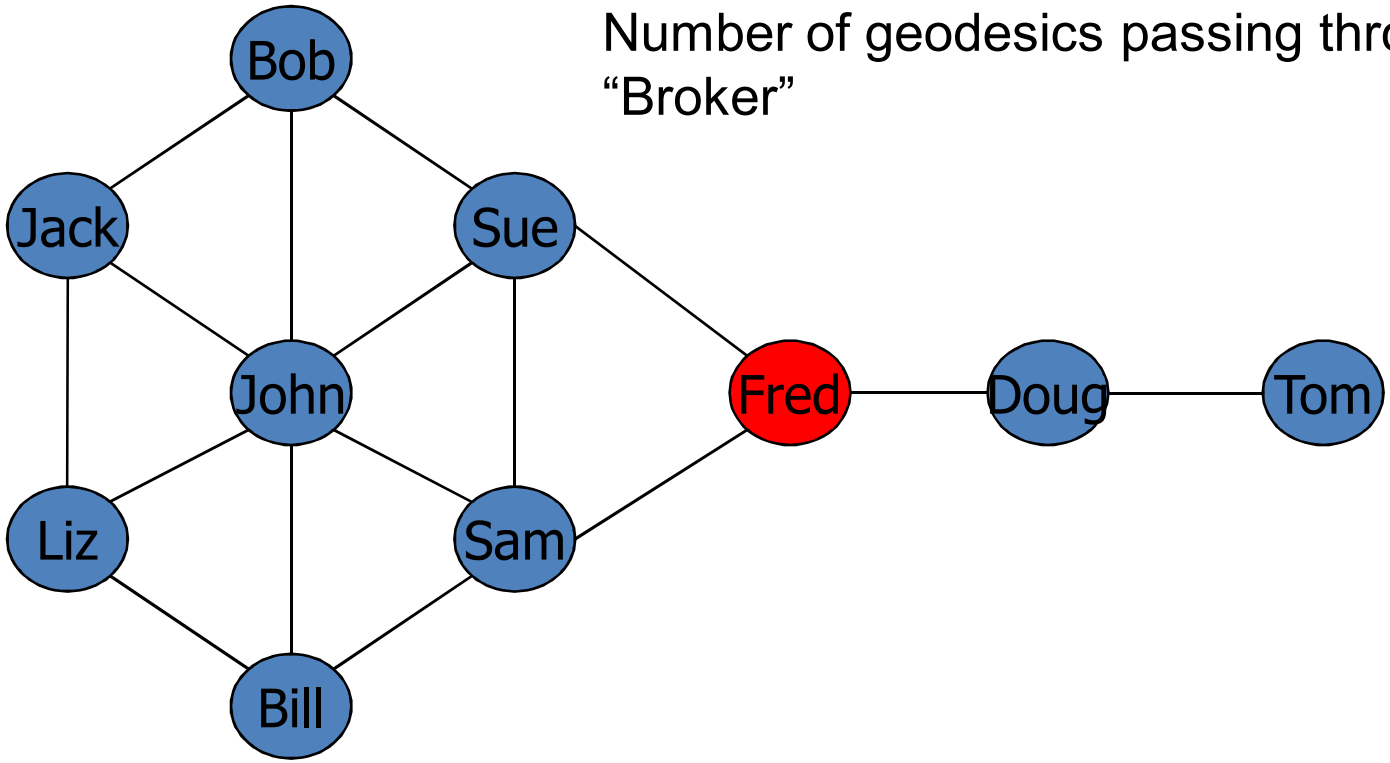
- **In-degree**: Directional links to actor from other actors
- **Out-degree**: Directional links from actor to other actors

"Popularity"



Betweenness Centrality

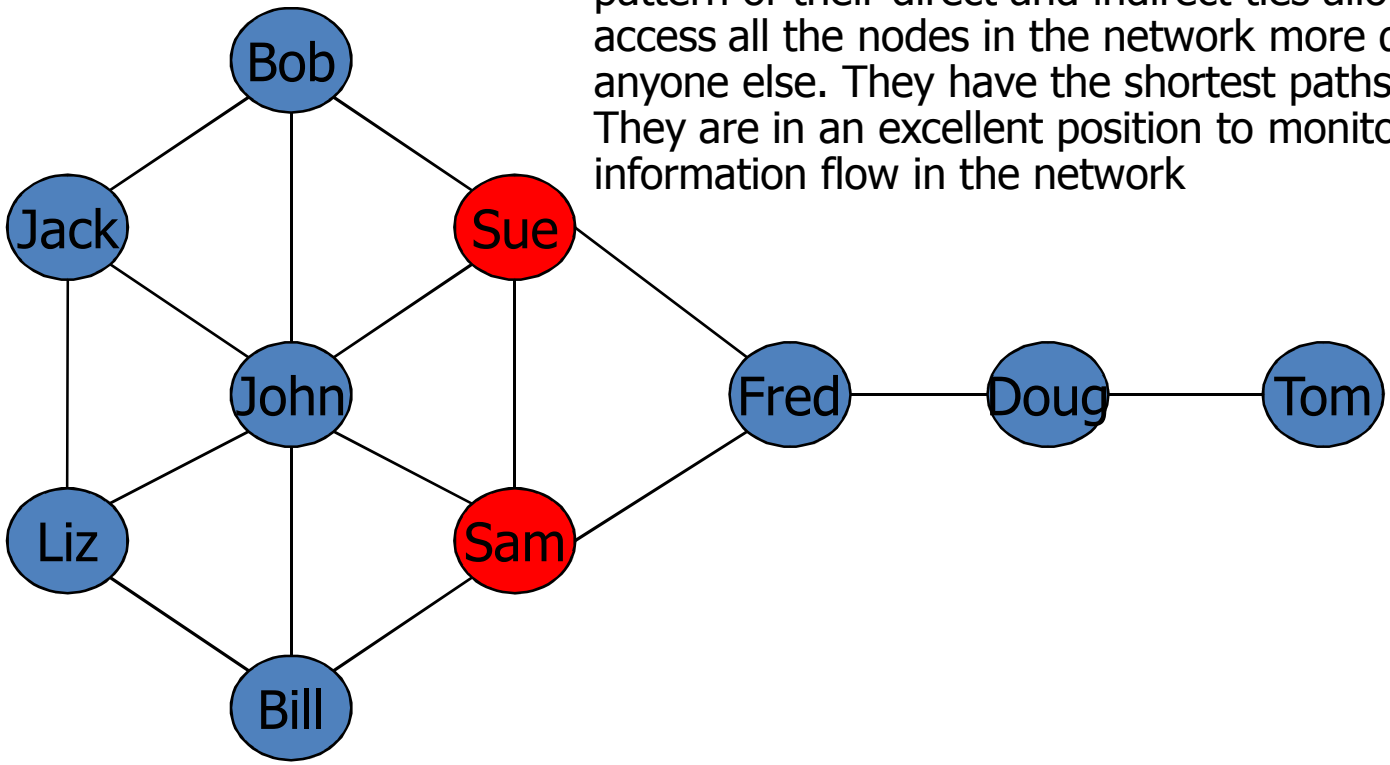
How much an actor lies between distinct groups
Number of geodesics passing through actor
"Broker"



Closeness Centrality

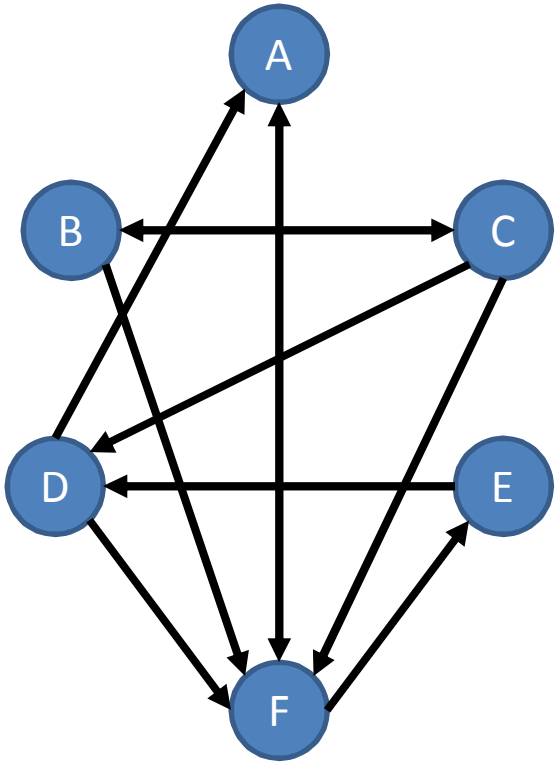
How easily one actor can reach rest of network
Actor with shortest average path length
"Pulse-taker"

Sue and Sam have fewer connections than John, yet the pattern of their direct and indirect ties allow them to access all the nodes in the network more quickly than anyone else. They have the shortest paths to all others They are in an excellent position to monitor the information flow in the network



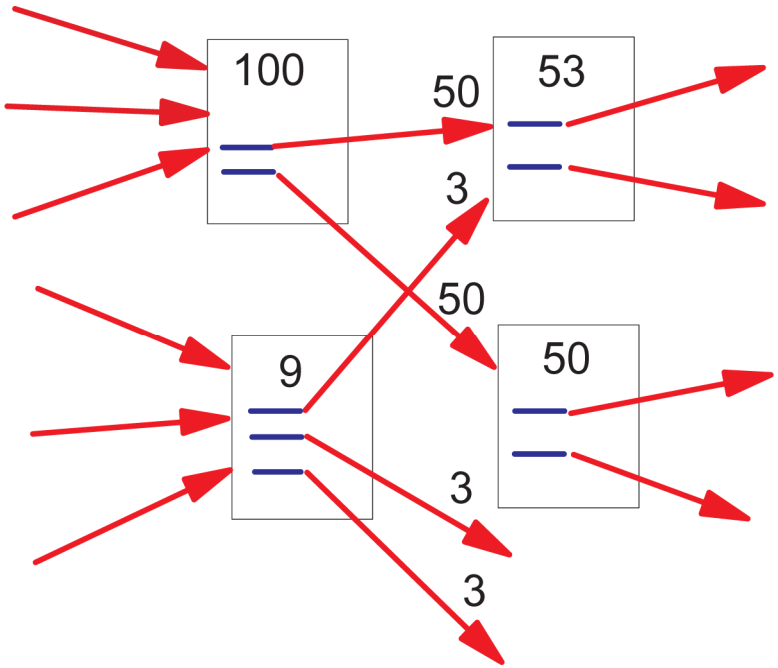
Eigenvector centrality

- A node's centrality is a function of its neighbors' centralities
  - Recompute each node's score as weighted sum of neighbors' centralities
- Highest between and\or degree central actor often have highest eigenvalue central actor, but not always the case with less central actors
  - Nodes B, C, E have equal in-degrees
  - Node E recommended by F, which has high in-degree
  - Nodes B & C only recommended by each other
  - E's eigenvalue > B & C's eigenvalues



1998 Stanford technical paper

"Unlike academic papers which are scrupulously reviewed, web pages proliferate free of quality control or publishing costs… **Generally, highly linked pages are more "important" than pages with few links**… If a web page has a link off the Yahoo home page, it may be just one link but it is a very important one. This page should be ranked higher than many pages with more links but from obscure places… We are able to order search results so that more important and central Web pages are given preference… [using] information external to the Web pages themselves – **backlinks provide a kind of peer review**."



The PageRank Citation Ranking: Bringing Order to the Web

January 29, 1998

Computer Networks and ISDN Systems 30 (1998) 107–117

COMPUTER NETWORKS and ISDN SYSTEMS

The anatomy of a large-scale hypertextual Web search engine [1]

Sergey Brin [2], Lawrence Page [*,2]

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