

Social Network Analysis: Descriptive methods

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Level of measurements

Node level

Dyadic level (all pairs)

Clique/subgroup

Entire network level

Network visualization: MDS and agglomerate clustering

One-mode/bipartite networks

Four different types of graphs/networks

Binary or values of social networks	Direction of social network	
	Undirected	Directed
Binary	Type I Binary undirected social networks	Type II Binary directed social networks
Valued	Type III Valued undirected social networks	Type IV Valued directed social networks

Binary undirected graph

Marriage

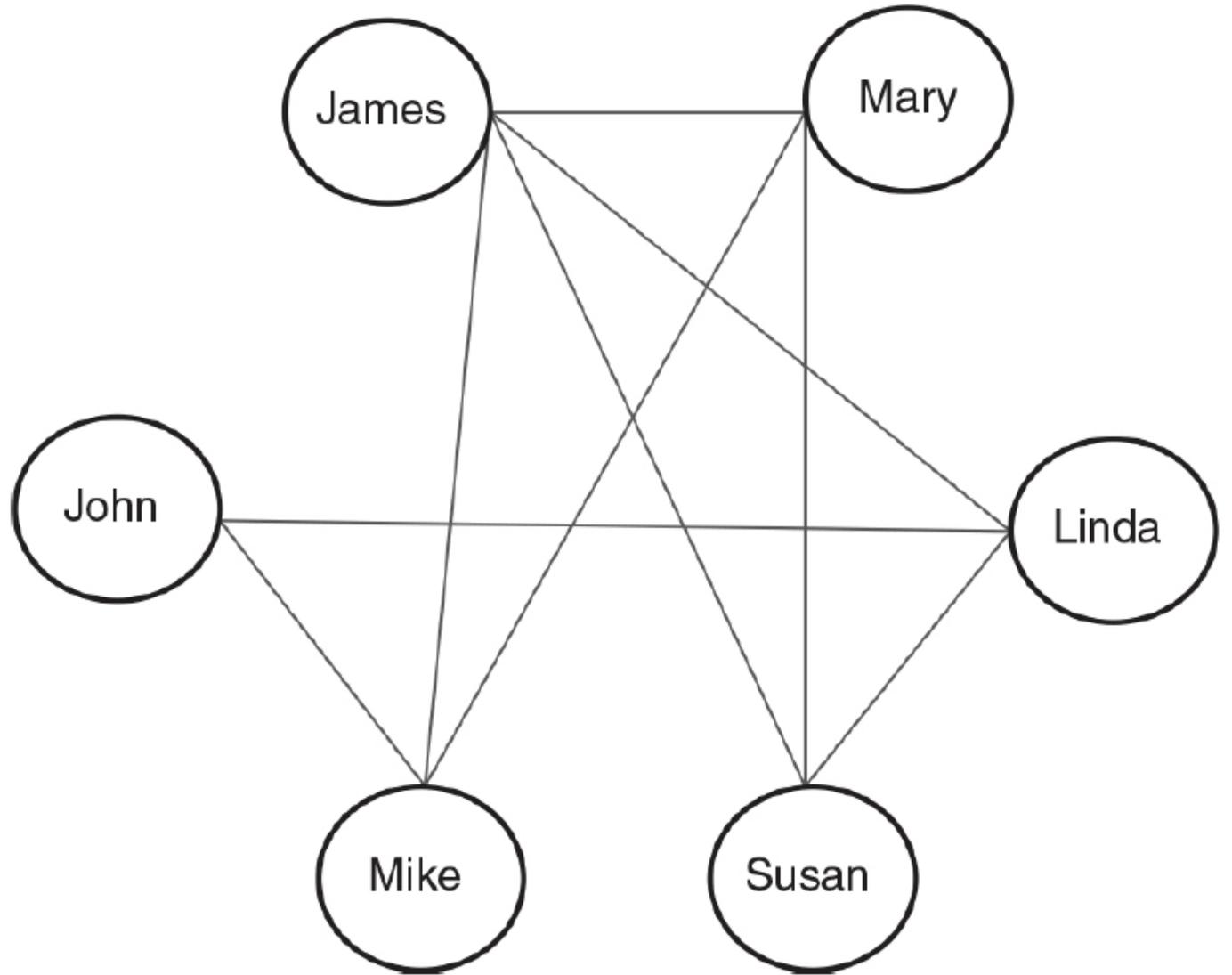
Friends

Roommate network

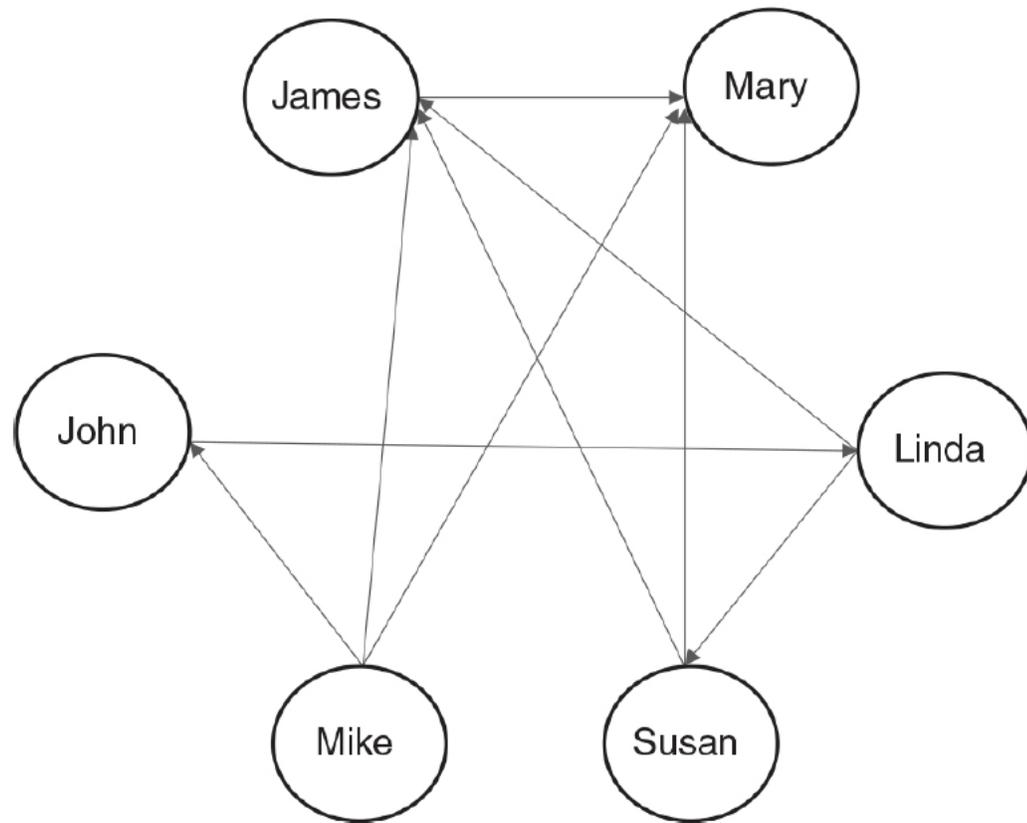
co-author network

Board interlocking

All ties that featured as presence or absence



Binary directed graphs



Reporting network

Emailing

Communication

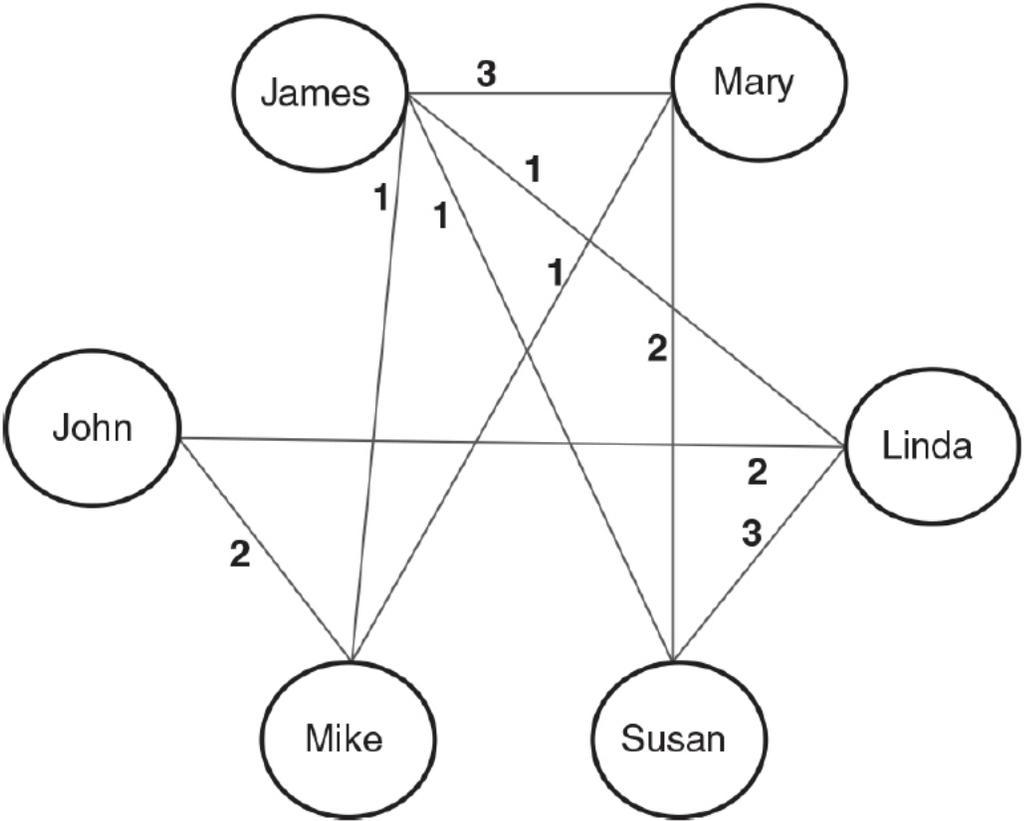
Friendship nomination

Hierarchical relationship

Citation network

Trade relationship

Valued (weighted) undirected graphs



- Face to face interactions
- Intercity traffic network
- Co-authorship network
- Sexual network (intensity measured)
- Trade volume Network

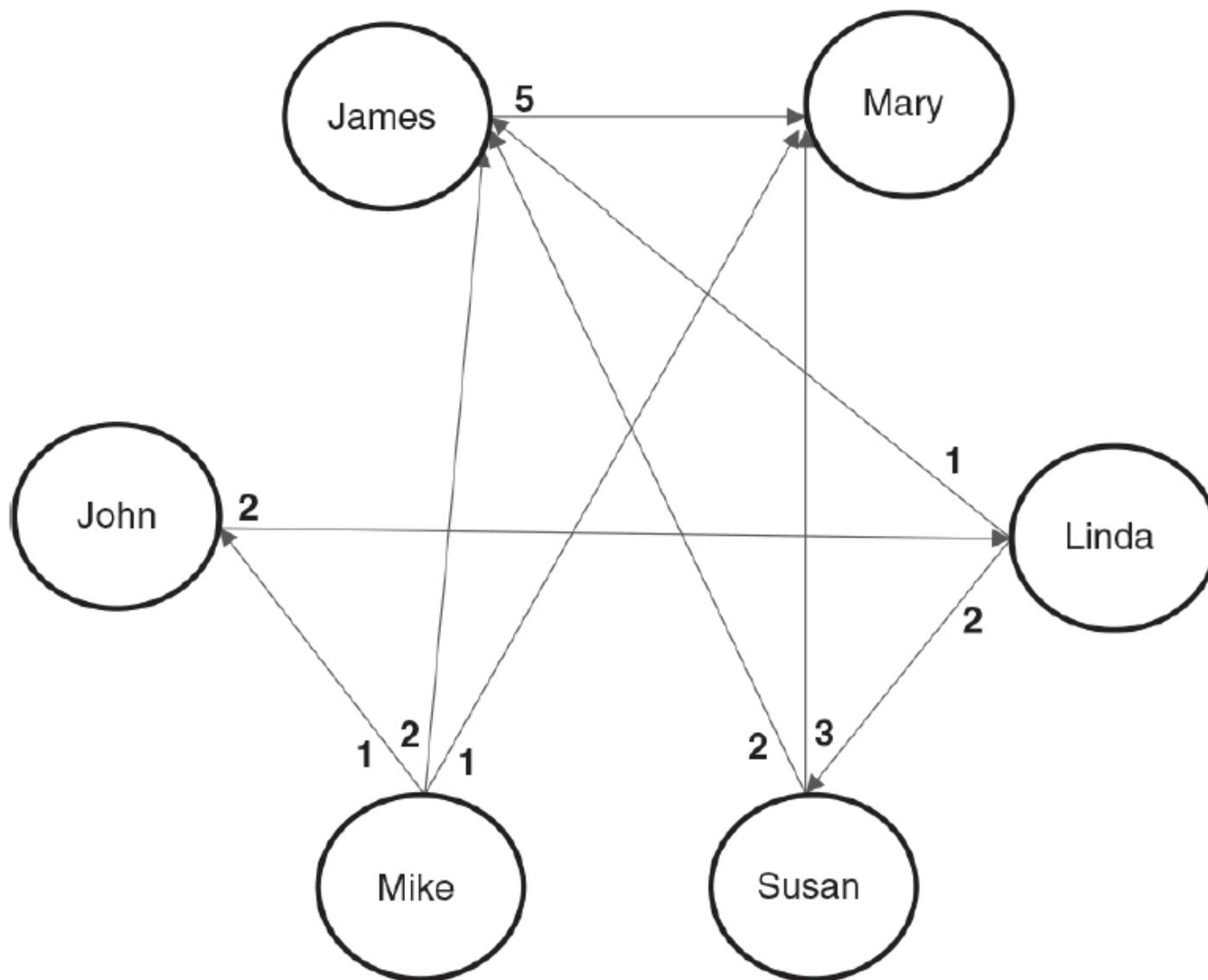
Valued (weighted) directed graphs

Social Media Following
Network

Messages sending/receiving
Friendship nomination (with
intensity measured)

Communication frequency
network

International Trade Network



Node level measurements

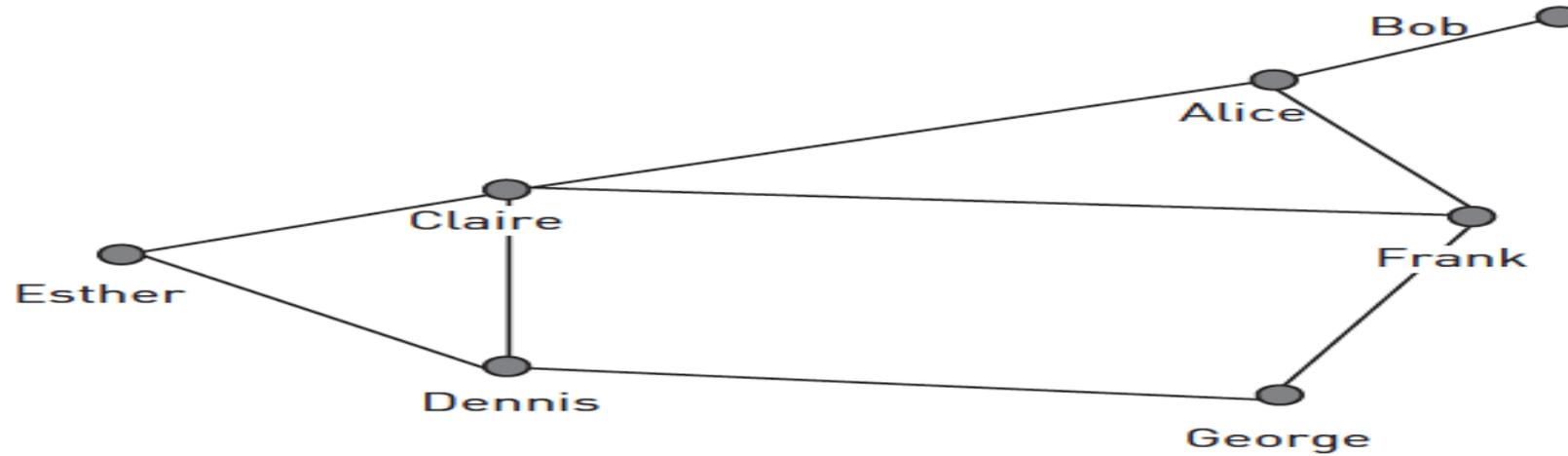
- Centrality:
 - Degree centrality
 - Betweenness centrality
 - Closeness centrality

Degree centrality

$$C_D(N_i) = \sum_{j=1}^g x_{i,j} \quad (i \neq j)$$

- Degree centrality measures to what extent a given node is connected with all other nodes in a network (it only accounts for direct connection)

- It basically is the row margin or column margin of the network matrix

FIGURE 3.1 • Friendship Network Among Seven Individuals**TABLE 3.1 • Adjacency Matrix of Friendship Network Among the Seven Individuals**

	Bob	Alice	Frank	George	Dennis	Claire	Esther	RM
Bob	0	1	0	0	0	0	0	1
Alice	1	0	1	0	0	1	0	3
Frank	0	1	0	1	0	1	0	3
George	0	0	1	0	1	0	0	2
Dennis	0	0	0	1	0	1	1	3
Claire	0	1	1	0	1	0	1	4
Esther	0	0	0	0	1	1	0	2
CM	1	3	3	2	3	4	2	—

Notes: RM: row margin—aggregating cell values within a given row across columns. CM: column margin—aggregating cell values within a given column across rows.

For directed binary graphs, one needs to distinguish between in-degree (CM) and out-degree centrality (RM)

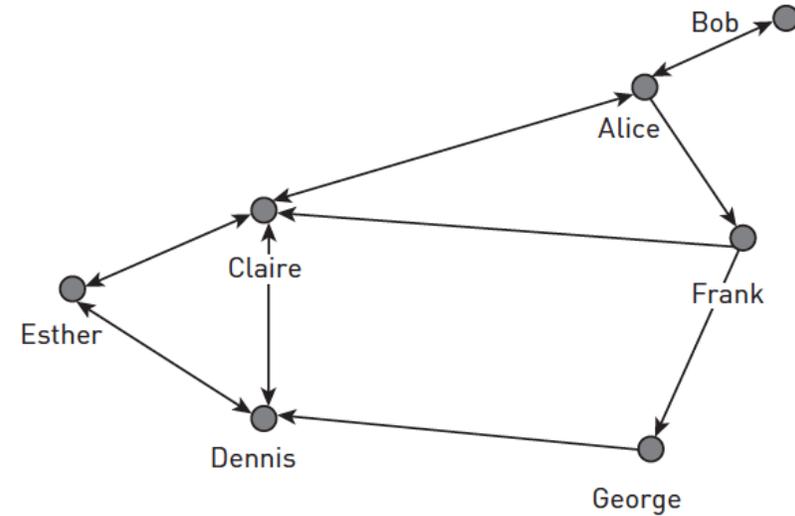


TABLE 3.2 • Binary-Directed Matrix of Friendship Among Seven Individuals

	Bob	Alice	Frank	George	Dennis	Claire	Esther	RM
Bob	0	0	0	0	0	0	0	0
Alice	1	0	1	0	0	1	0	3
Frank	0	0	0	1	0	1	0	2
George	0	0	0	0	1	0	0	1
Dennis	0	0	0	0	0	1	0	1
Claire	0	1	0	0	1	0	1	3
Esther	0	0	0	0	1	1	0	2
CM	1	1	1	1	3	4	1	—

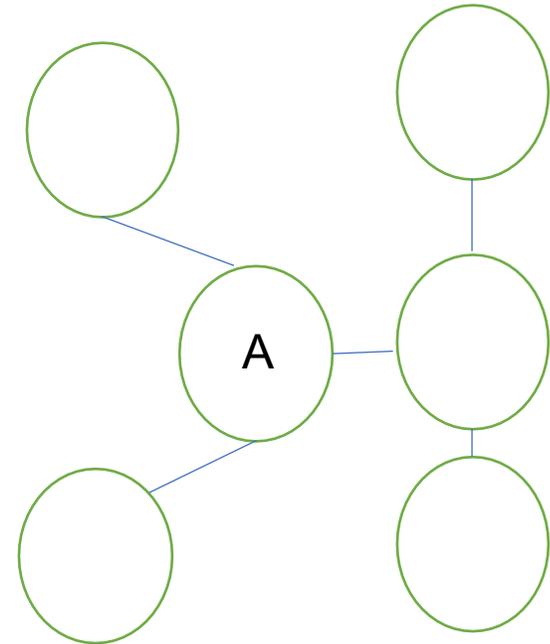
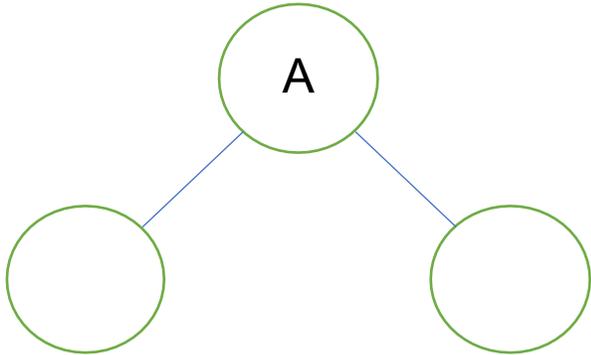
Standard degree centrality

$$C'_D(N_i) = \frac{C_D(N_i)}{g-1}$$

- Degree centrality is very sensitive to the size of network, to compare node's degree centrality across different network, one needs to use standard degree centrality

Comparing node A in the following graphs

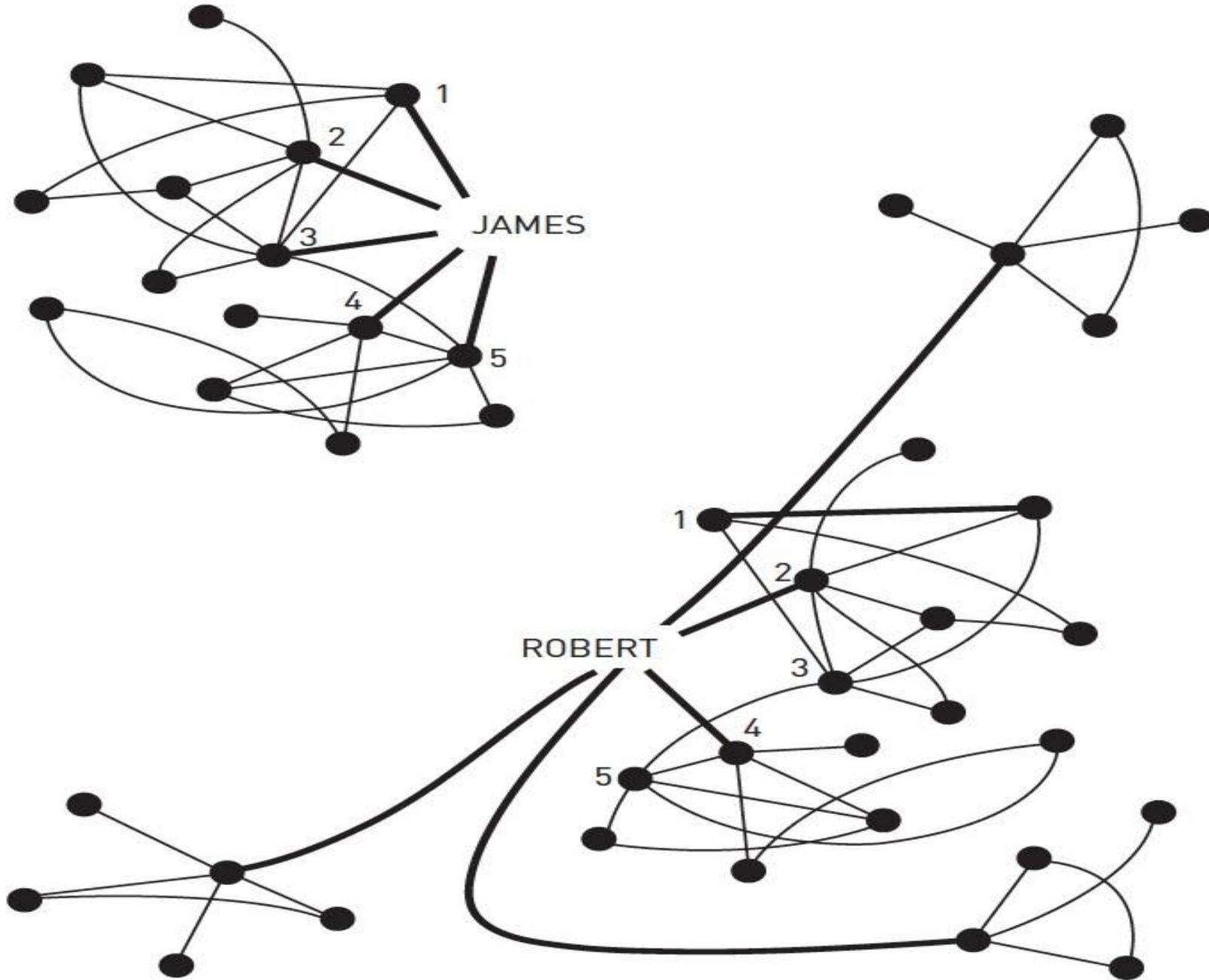
- Two nodes centrality



Betweenness centrality

Betweenness centrality measures to what extent a given node sits on the geodesic path of all other pairs of nodes in a given network

It draws on Burt's famous "structural hole" theory, which states that a node occupies structural hole by connecting with two or more unconnected nodes or clusters of nodes.



*Thick lines represent a manager's direct contacts.

Computing betweenness centrality

- For a given node i ,

$$C_B(N_i) = \sum_{j < k} \frac{g_{j,k}(N_i)}{g_{j,k}}$$

- Standardized betweenness centrality

$$C'_B(N_i) = \frac{C_B N_i \times 2}{(g-1)(g-2)}$$

$$C'_B(N_i) = \frac{C_B N_i}{(g-1)(g-2)}$$

Closeness centrality

$$C_C(N_i) = \frac{1}{\left[\sum_{j=1}^g d(N_i, N_j) \right]} \quad (i \neq j)$$

- Closeness centrality measures the shortest path for a given node to all other nodes in a network
- It is the inverse of the geodesic distance for a given node i and other nodes in the network,
- It does not measure the isolated node as the denominator can not be 0

Standard closeness centrality

$$C'_C(N_i) = (g-1)(C_C(N_i)) = \frac{g-1}{\left[\sum_{j=1}^g d(N_i, N_j) \right]}$$

- Much like degree centrality and betweenness centrality, closeness centrality is very sensitive to the size of network



The three centrality measures

Comparing nodes within the same graph/network, all centrality measures apply, each of which measures different aspects of the nodes (degree – direct connection, betweenness – structural hole, and closeness – geodesic distance or speed)

Comparing nodes across different graph/network, apply the standard version of the three centrality measures
