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

Node level measurements

- Centrality:
  - Degree centrality
  - Betweeneness centrality
  - Closeness centrality

Degree centrality

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

- 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

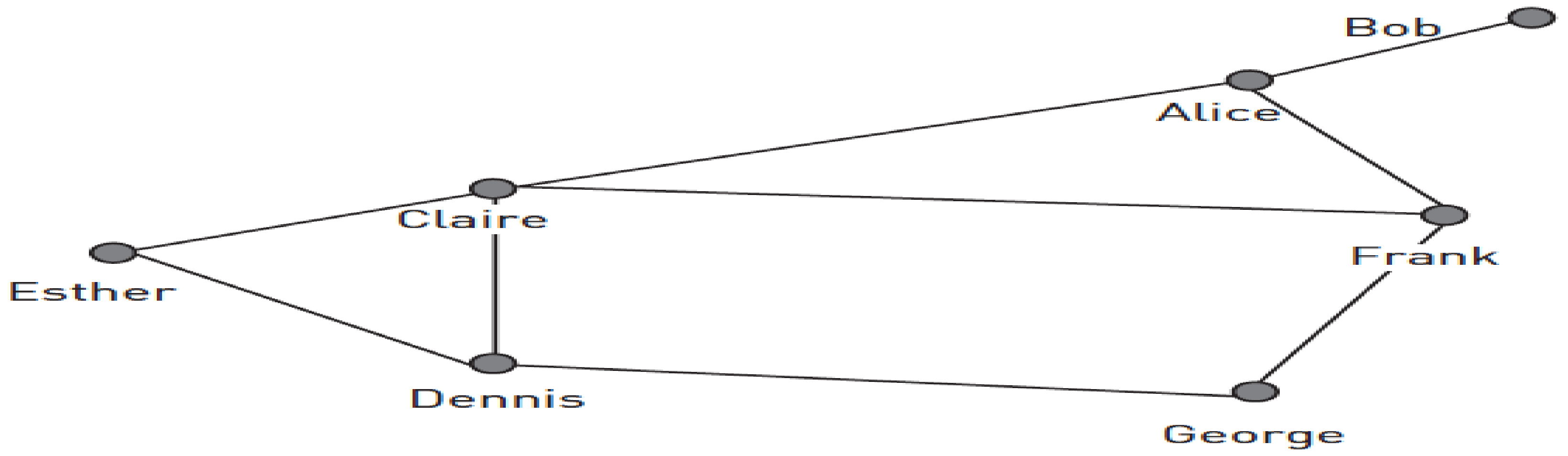


TABLE 3.1 • Adjacency Matrix of Friendship Network Among the Seven Individuals

	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)

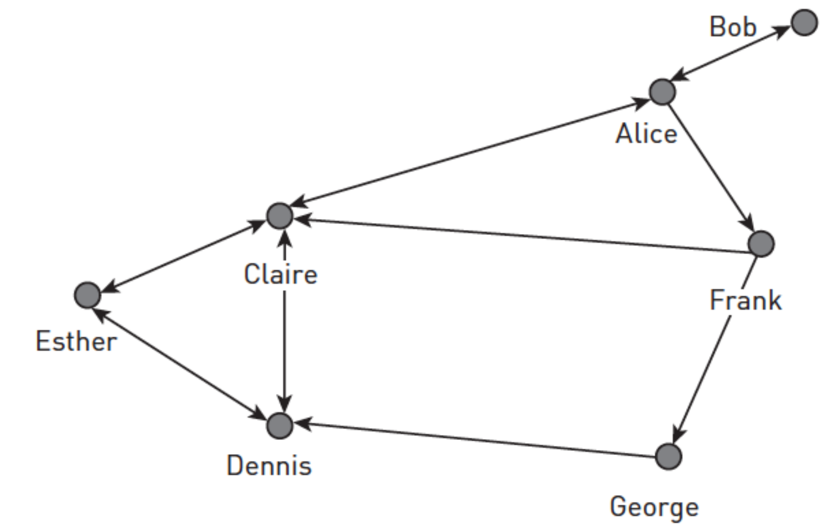


TABLE 3.2 ● Binary-Directed Matrix of Friendship Among Seven Individuals

	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	—

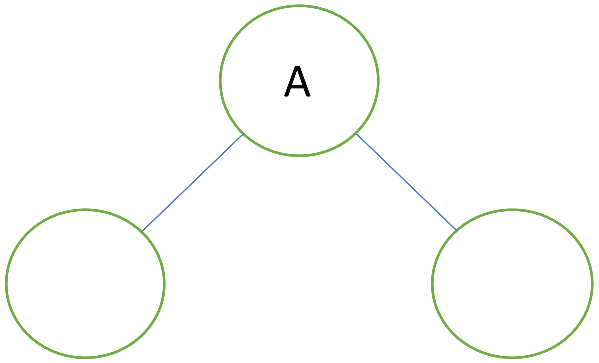
Standard degree centrality

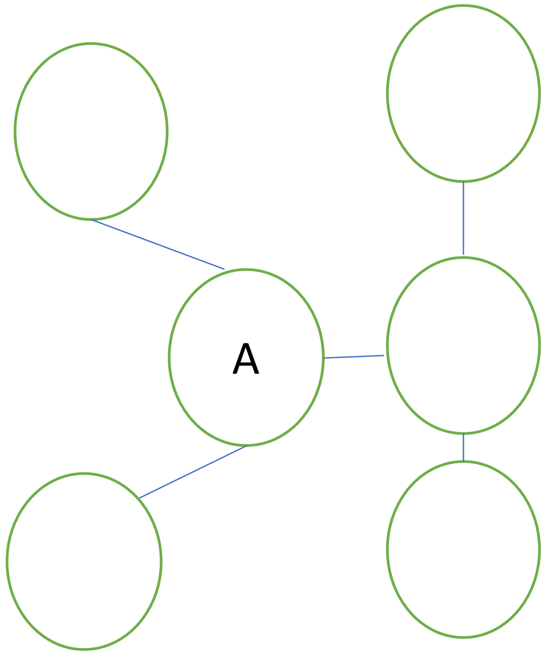
$$C'_D(N_i) = \frac{C_D(N_i)}{g-1}$$

- 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

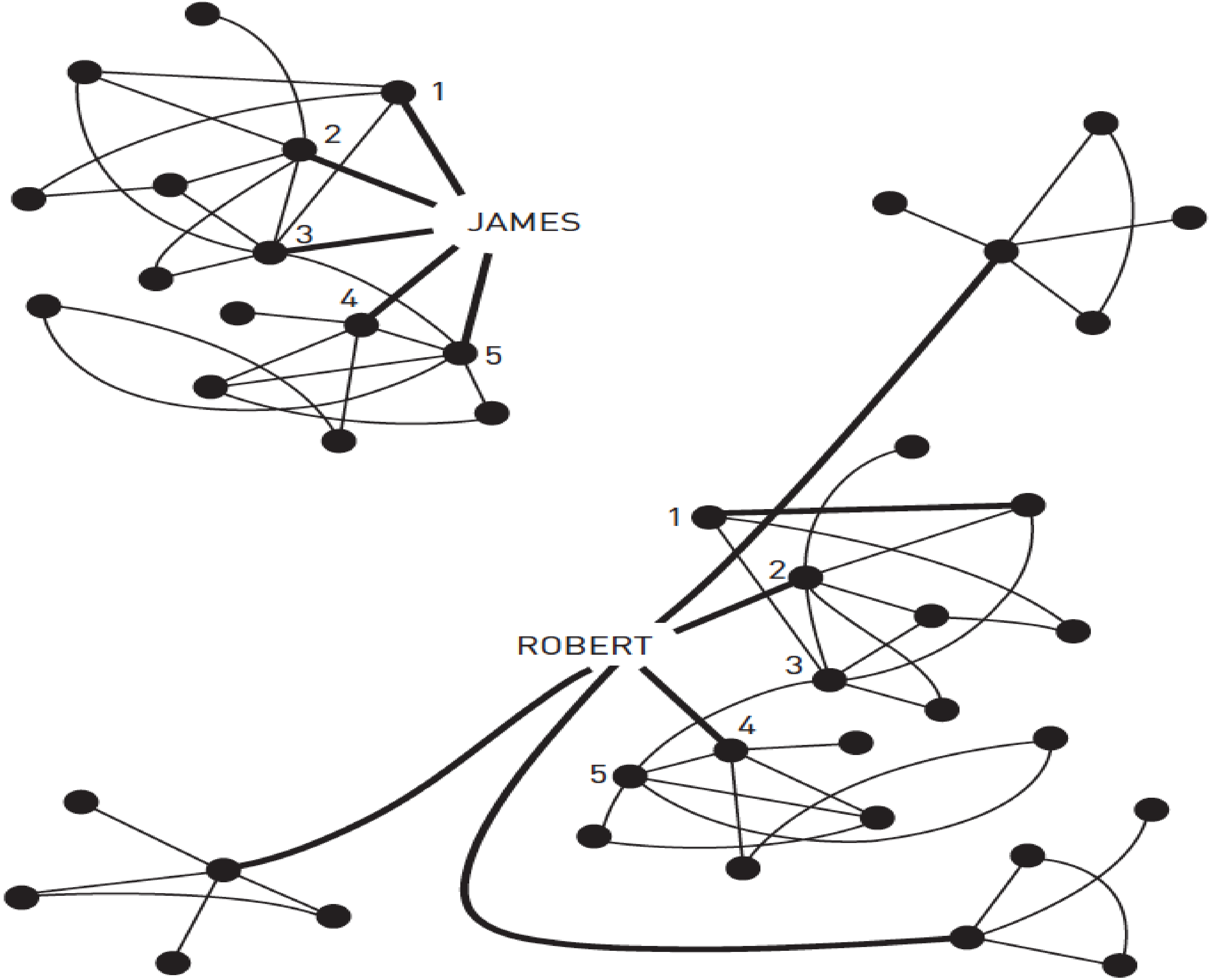




Betweenness centrality

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 occupy 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