Taxonomy of Network Analysis Indicators

Macro, Meso, and Node-Level Measures

SMM638 Network Analytics

Three Levels of Analysis

Network indicators operate at different scales:

Level	Focus	Questions
Macro	Entire network	How big? How centralized? How connected?
Meso	Groups/Communities	Are there clusters of nodes? How modular?
Micro/Node	Individual positions	Who is central? Who bridges groups?

Caution

Key Principle: Different levels reveal different insights

- Macro: Overall structure and properties
- Meso: Subgroup organization
- Micro: Individual advantages and constraints

Macro-Level Indicators

Whole Network Properties

Characterize the overall structure and global patterns

Key Measures:

1. **Network Size**: Number of nodes and edges
2. **Density**: Proportion of possible connections realized
3. **Centralization**: Concentration of connections
4. **Diameter**: Maximum distance between any two nodes
5. **Average Path Length**: Mean distance across all pairs
6. **Fragmentation**: Presence of disconnected components

Purpose: Understand network-wide characteristics and compare across networks

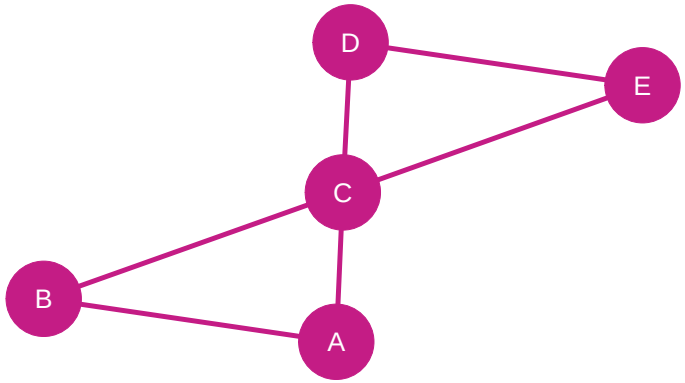
Example: Network Size and Density

Definition: Basic structural properties

- **Node count**: Total number of vertices (n)
- **Edge count**: Total number of connections (m)
- **Possible edges**: $\frac{n(n-1)}{2}$ for undirected networks

Business Example: LinkedIn Network

- **Small startup network** (50 employees)
  - Possible connections: 1,225
  - Observed connections: 245
  - Density: 20%
- **Large corporation network** (5,000 employees)
  - Possible connections: 12,497,500
  - Observed connections: 187,500
  - Density: 1.5%



Network Metrics:

Nodes (n)

5

Edges (m)

6

Possible Edges

10

Density

60.0%

Example: Centralization

Definition: Extent to which connections concentrate around few nodes

- **High centralization**: Star-like, hierarchical structure
- **Low centralization**: Distributed, egalitarian structure

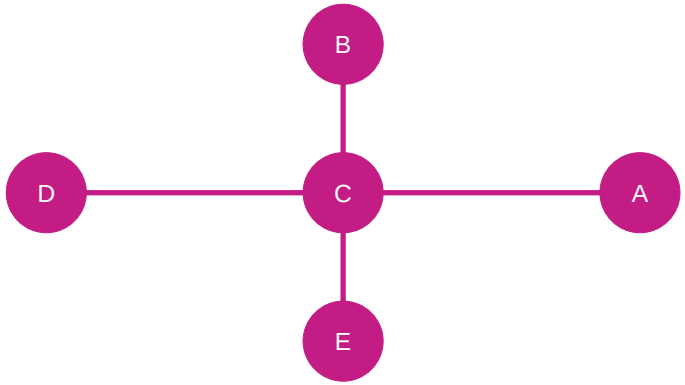
Business Example: Communication Patterns

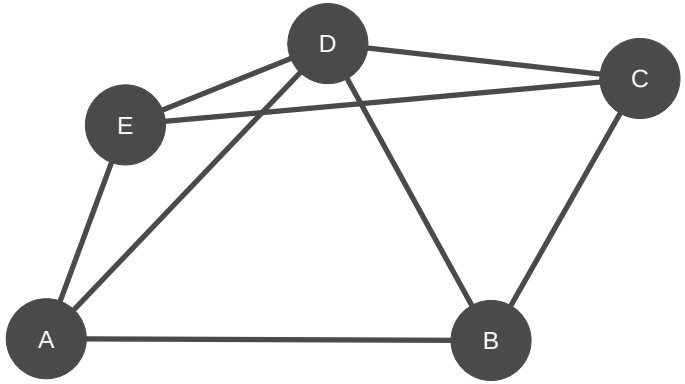
Startup (Low Centralization = 0.25)

- Flat structure with distributed communication
- Multiple people coordinate projects
- Information flows through many channels

Traditional Corporation (High Centralization = 0.78)

- Hub-and-spoke: most communication through managers





Network Metrics:

Network
Size
Density
Higher centralization (top)
5 nodes, 4 edges
40.0%

Meso-Level Indicators

Community and Subgroup Structure

Identify cohesive groups and organizational patterns

Key Measures:

1. **Modularity**: Quality of network partitioning into groups
2. **Community Detection**: Algorithmic identification of clusters
3. **Core-Periphery**: Distinction between dense core and sparse periphery
4. **Structural Holes**: Gaps between groups creating brokerage opportunities
5. **k-cores**: Subgraphs where all nodes have minimum degree k

Purpose: Reveal hidden organizational structure and group boundaries

Example: Network Modularity

Definition: Strength of division into communities

- Measures how well network separates into distinct groups
- Higher values indicate stronger community structure

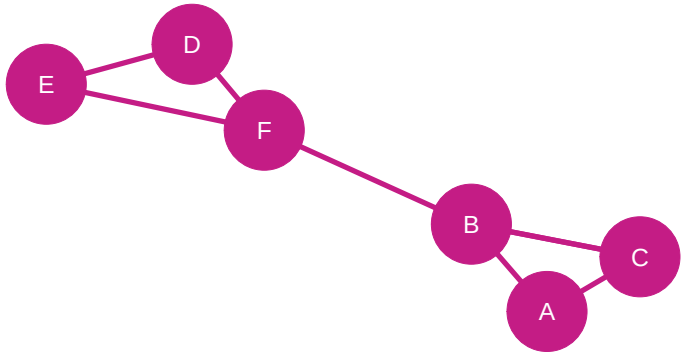
Business Example: Corporate R&D Network

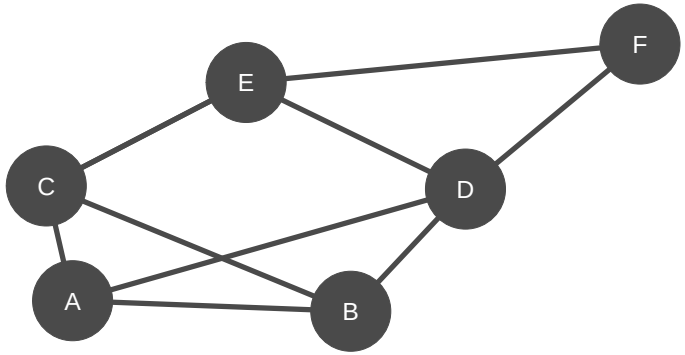
Higher Modularity

- Clear separation: Chemistry, Biology, Engineering teams
- Limited cross-disciplinary collaboration
- Potential for siloed innovation

Lower Modularity

- Extensive cross-team connections
- Interdisciplinary collaboration
- Potential for breakthrough





Note

The top network seems to have two communities ({A, B, C} and {D, E, F} triads)

Node-Level Indicators

Individual Position and Influence

Characterize actor positions within the network

Major Categories:

1. **Centrality Measures**: Various ways to measure importance
   - Degree, Closeness, Betweenness, Eigenvector
2. **Structural Position**: Role in network architecture
   - Bridges, Brokers, Isolates, Cliques
3. **Local Clustering**: Cohesion of immediate neighborhood
4. **Embeddedness**: Integration into network structure

Purpose: Identify influential actors, structural advantages, and vulnerabilities

> **Note**

Summary: Levels in Practice

Integrated Analysis Framework:

Macro Level → Strategic organizational design

- Should we have a centralized or distributed structure?
- How connected is our organization overall?

Meso Level → Team and department dynamics

- Are we too siloed or too integrated?
- Where are the boundaries between groups?

Micro Level → Individual talent management

- Who are our key connectors and influencers?
- Who has structural advantages or disadvantages?

Important

Best Practice: Analyze networks at multiple levels simultaneously for comprehensive insights