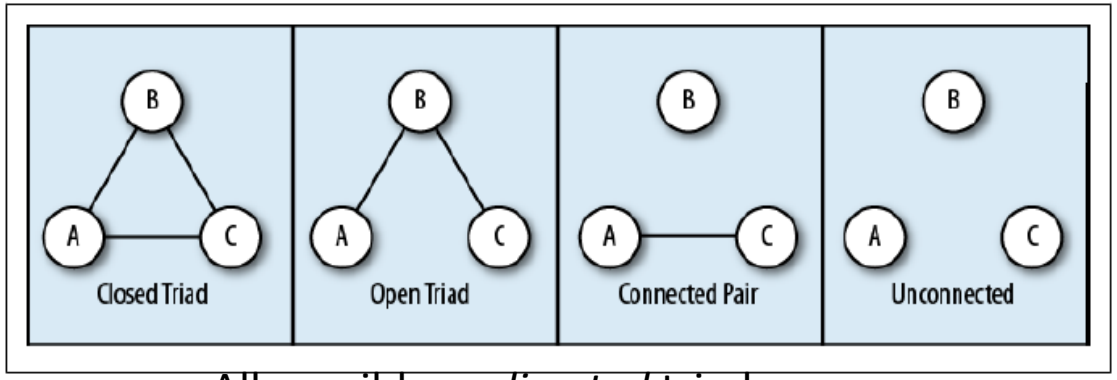
Triads

Dr.V.S.Felix Enigo

Introduction

- A triad is simply three nodes interlinked in some way.



All possible *undirected* triads

```
[alice, bob, carol]
[alice, bob, dave]
[carol, dave, alice]
[carol, dave, bob]
```

- Here closed triad represents a fully connected group: *A*, *B*, and *C* are connected to each other with equivalently strong ties.

Example

- A “nuclear family"—mother (Alice), father (Bob) and a child (Carol).
- These triads can overlap—for example, the same mother and father might have another child (Dan), in which case there is not one triad

Cond…

- In a *triad*, the third individual becomes at a source of balance (providing second opinions and calming nerves)

Findings:

- Asymmetric ties (e.g., “I like you more then you like me”) were the least stable
- Triadic structures were the most stable over time

Triads and Terrorists - Example

- Al Qaeda cells during training in safe houses form a triadic structure
- Everyone embedded in triads with everyone else
- All information from the outside world arrived highly filtered through the cell leader
- the groups generate their own cultural artifacts
- They define their identity as religious extremist and reinforcing their resolve to complete the attack
- Studying Hamburg Cell (responsible for 9/11 attack) shows that most common factor driving them was the social ties within their cell

Forbidden Triads or Structural Holes

- A person pays bank A 5% interest and bank B 7% interest
- Bank A and B never talk with each other but through middleman
- If they interacted, they could agree on *A* loaning money to *C* directly at a rate of 6% and realize that both could benefit by cutting out the middleman
- *Banker B* would be rather upset if that happens
- *Banker's* interests are to make sure that the two ends of their open-triad network never communicate directly
- Such open-ended triads are called Forbidden triads or structural holes or brokerage structure
- It is the number of structural holes to a person's ability to perform as an entrepreneur, a banker, a broker or a real-estate agent.

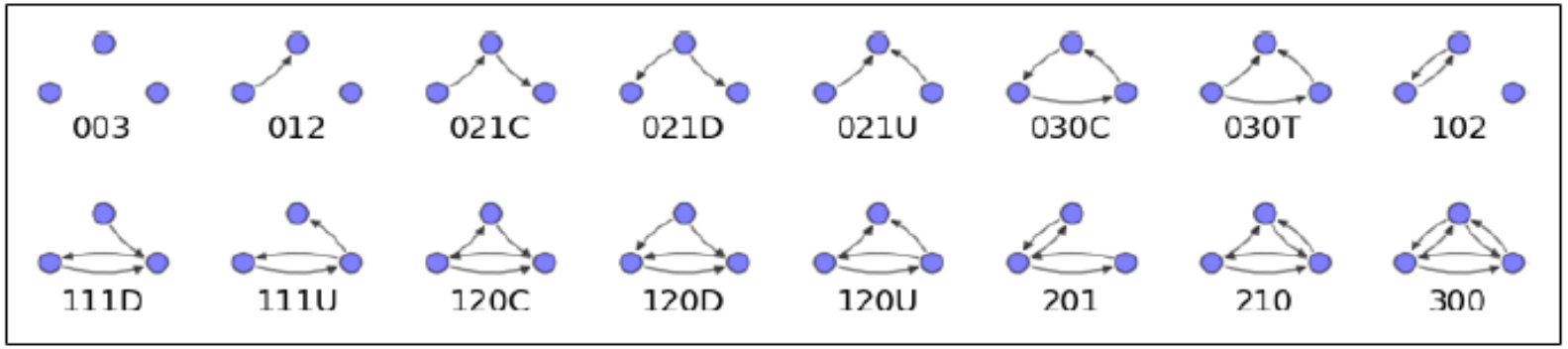
Structural Holes and Boundary Spanners

- Structural holes can span asymmetric information they can also bridge entire communities.

Example : community with scientist and community with musicians, here scientist and musician serve as a boundary spanners

Directed Triads

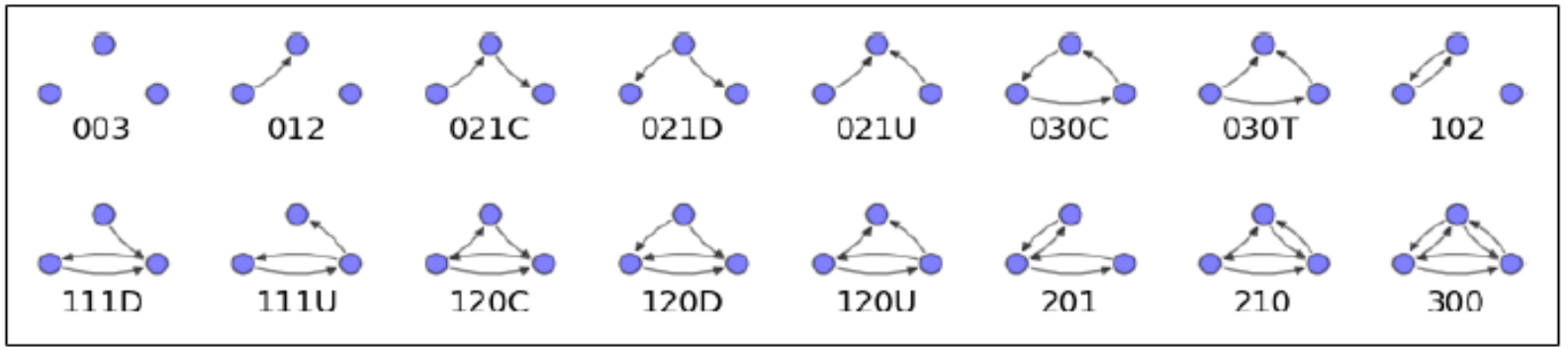
- In a directed triad, both one-way and bidirectional is considered
- So instead of 4 possible triads it has 16 variations



- The first number is the number of bidirectional edges.
- The second number is the number of single edges.
- The third number is the number of “non-existent” edges.
- A letter code to distinguish directed variations of the same triad—U for “up,” D
- for “down,” C for “circle,” and T for “transitive” (i.e., having 2 paths that lead to
- the same endpoint).

Triadic Analysis

- The process of triadic analysis in a real network is called the *triad census*
- In this process, for every node we count occurrences of the 16 types of triads to determine the node's role in the network structure
- For example, a node with many occurrences of triads 4, 7, and 11 (i.e., rich in outgoing links and structural holes) is a *source* of information or possibly a group leader.



Example for Triads and census

- Triadic census lets one make high-level conclusions about the network structure in a macro form
- Triadic census on the 9/11 hijacker’s data shows 300 (all have bidirectional edges, with no non-existence edges) for Mohammed Atta
- Part of Hamburg cell that planned the September 11th attacks, and served as the hijacker-pilot of American Airlines Flight 11, crashing the plane into the North Tower of the World Trade Center

Clique

- Clique in a social network as a cohesive group of people that are tightly connected to each other
- A clique is defined as a *maximal complete subgraph* of a given graph
- Essentially, a clique consists of several overlapping closed triads, and inherits many of properties of closed triads.
- A clique must generate consensus or fall apart
- It is very easy to agree about conflict, and having a common enemy (or a group of common enemies) helps cliques unite

Clusters - Hierarchical Clustering

Algorithm:

1. Starting at the lowest level, every node is assigned its own cluster.
2. Using the distance table, find the closest pair of nodes and merge them into a cluster
3. Recompute the distance table, treating the newly merged cluster as a new node.
4. Repeat steps 2 and 3, until all nodes in the network have been merged into a single large cluster.
5. Choose a useful clustering threshold between the bottom and top levels

Cond…

There are three common methods for merging two clusters:

- *Single-link*: merge two clusters with the smallest *minimum* pairwise distance
- *Average-link*: merge two clusters with the smallest *average* pairwise distance
- *Maximum-link* or *Complete-link*: merge the two clusters with the smallest *maximum* pairwise distance

- The *complete-link* method is considered most sensitive to outliers
- S*ingle-link* method tends to form long chains of
- *Average-link* method is considered a compromise between the two and the most frequently used.

Block Models

- A block model is a simplified network derived from the original network
- All nodes in a cluster are considered a single node, and all relationships between original nodes become aggregated into relationships between blocks
- The below block model shows relationships between the Russia-centric, Western-oriented, and Islamic-oriented clusters (0, 1, and 2)
- Clusters 3 and 4 are small republics that have significant ties with Russia, but almost no ties with anyone else