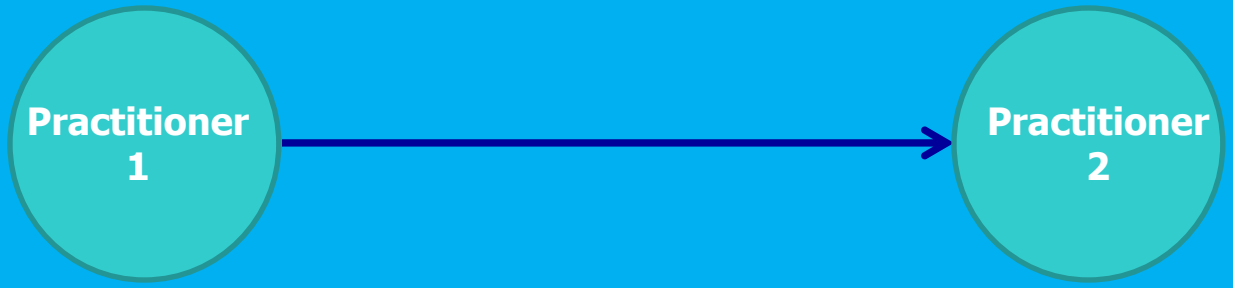
Clustering
Community Detection

Class starts at 5:05

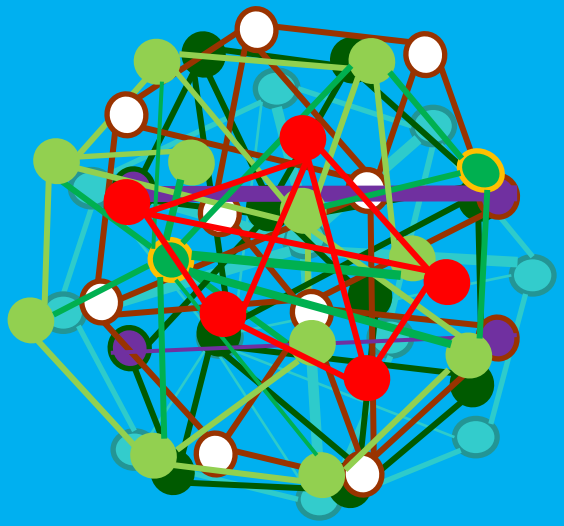
Referral Network – Notations

- Practitioners are represented as nodes/shapes (e.g. Circles, Triangles)
- Practitioner relationships are represented by arrows
- Strength of the relationship is represented by the color and/or thickness of the arrow



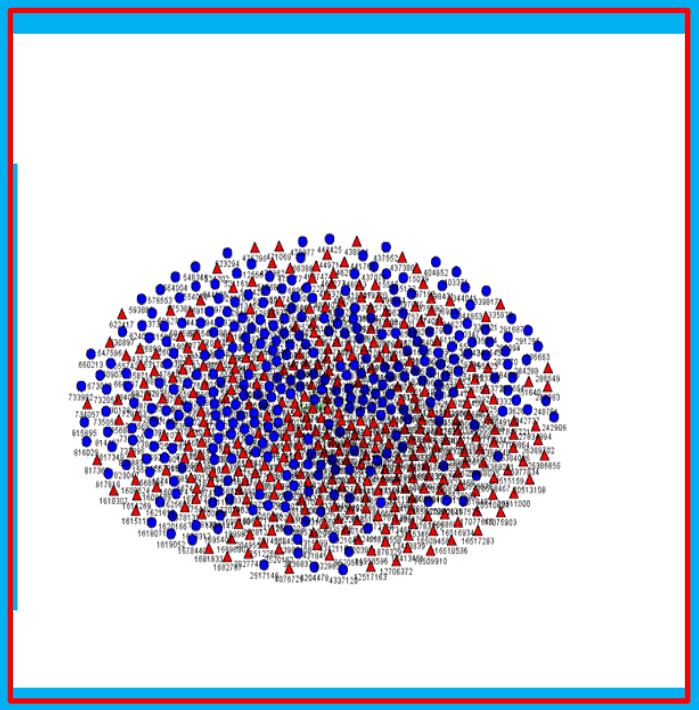
Referral Network/Social Network/Communities

Using these notations and representations, a referral network of practitioners can appear quite complex.



Example: Complex Network Of Oncologists and Radiation Oncologists

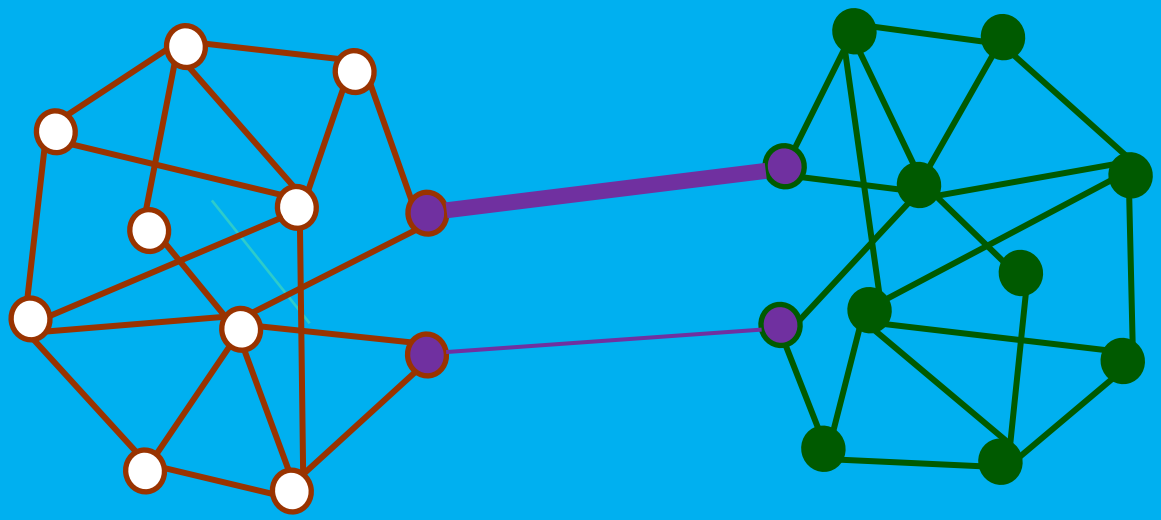
A referral network of roughly 300 Oncologists and Radiation Oncologists treating thyroid cancer.



Referral Network (Thyroid Cancer)

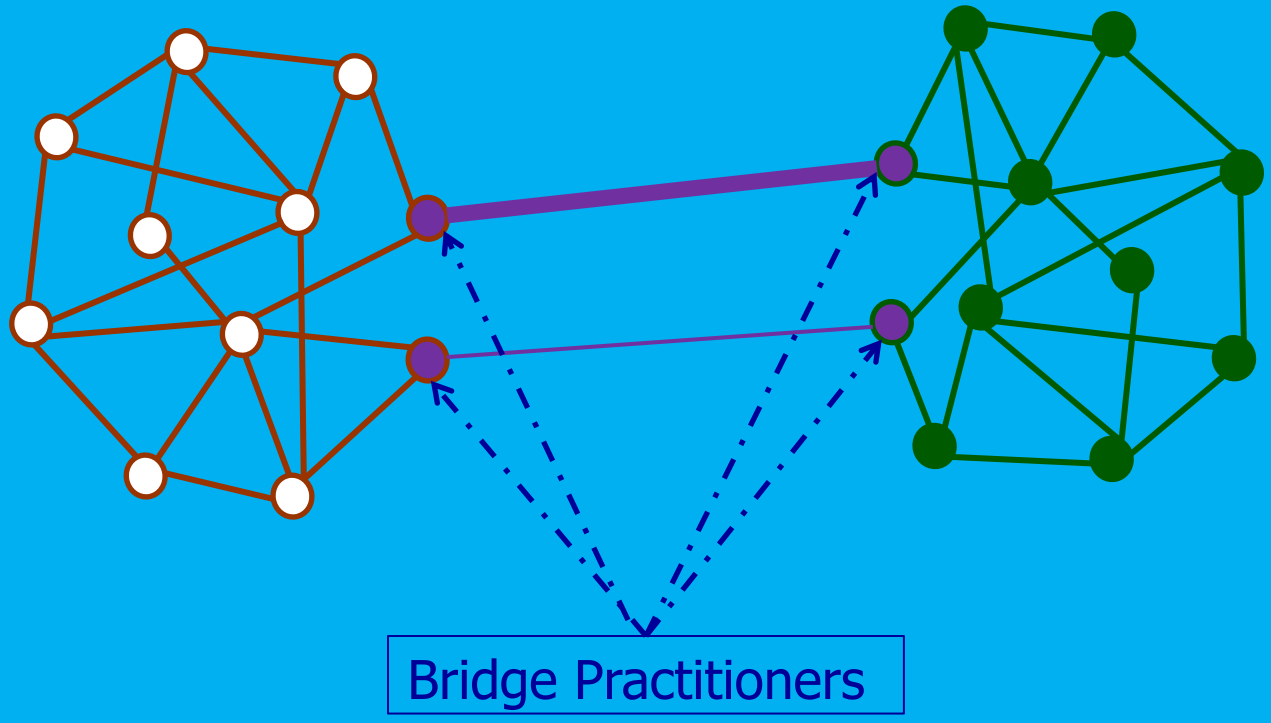
Referral Network/Social Network

"Referral Network Analysis" can decompose the network into distinct sub-networks and measure the importance of each practitioner to the network.



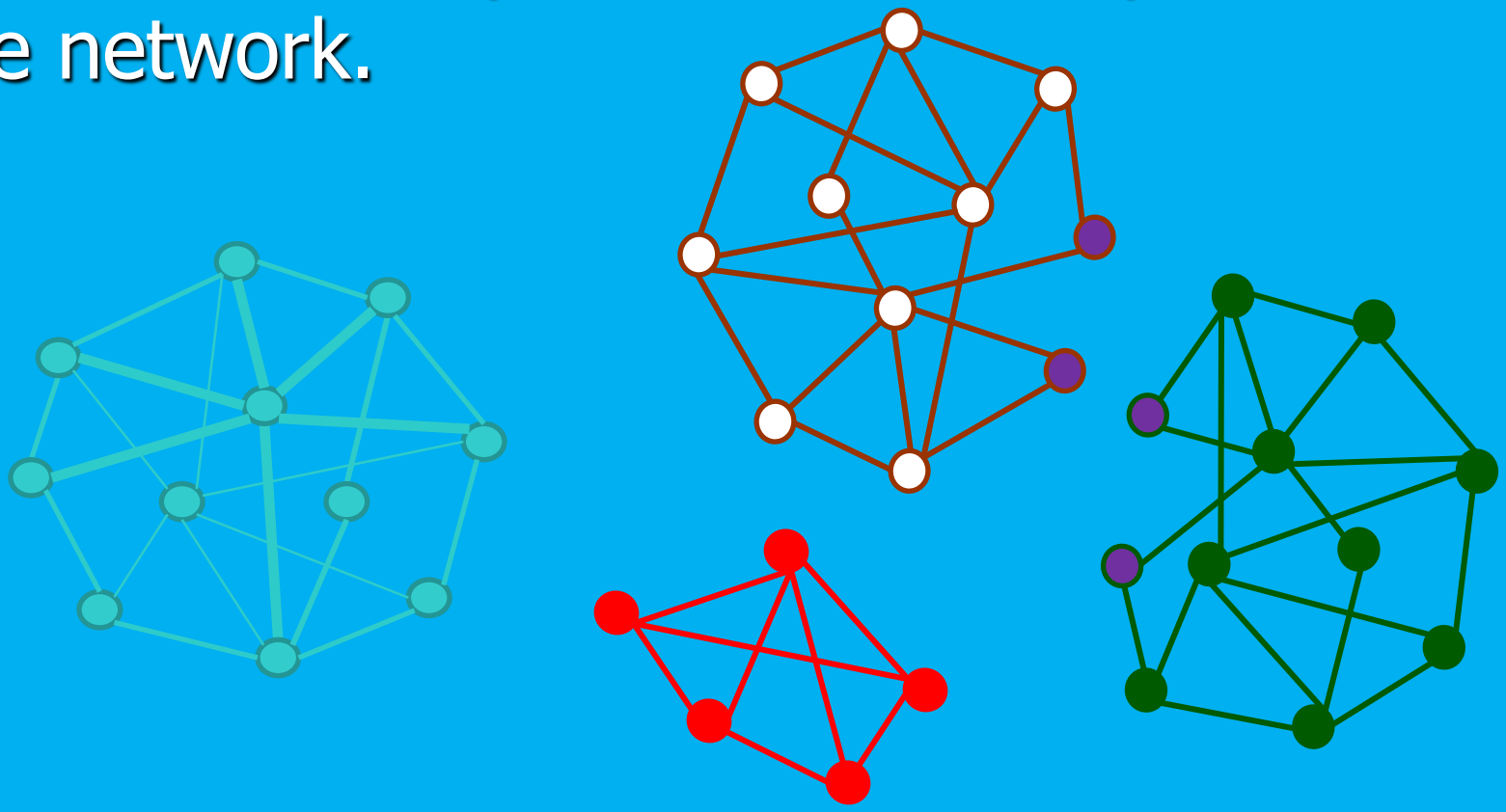
Referral Network/Social Network

The 'Bridge Practitioners' connect two or more Sub-Networks. They might be the best way to extend the influence of the brand.



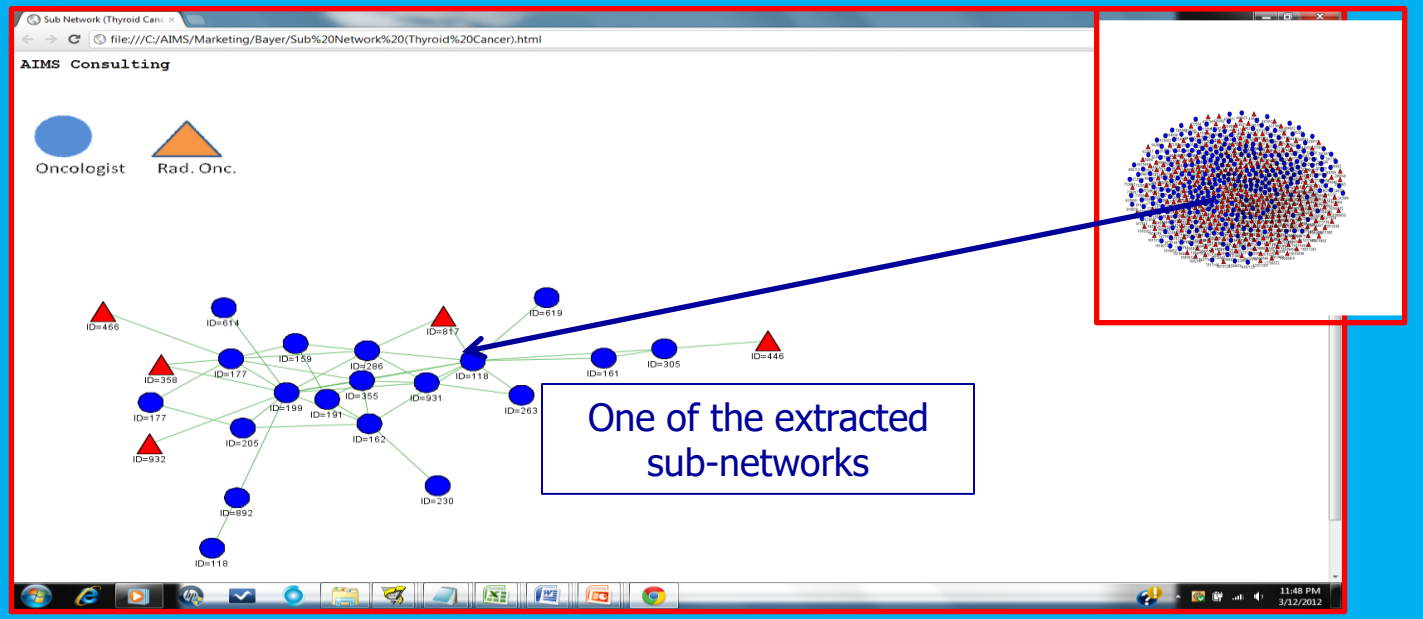
Referral Network/Social Network

"Referral Network Analysis" can decompose the network into distinct sub-networks and measure the importance of each practitioner to the network.



The Power of Referral Network Analysis Example: Extracting a Thyroid Sub-Network

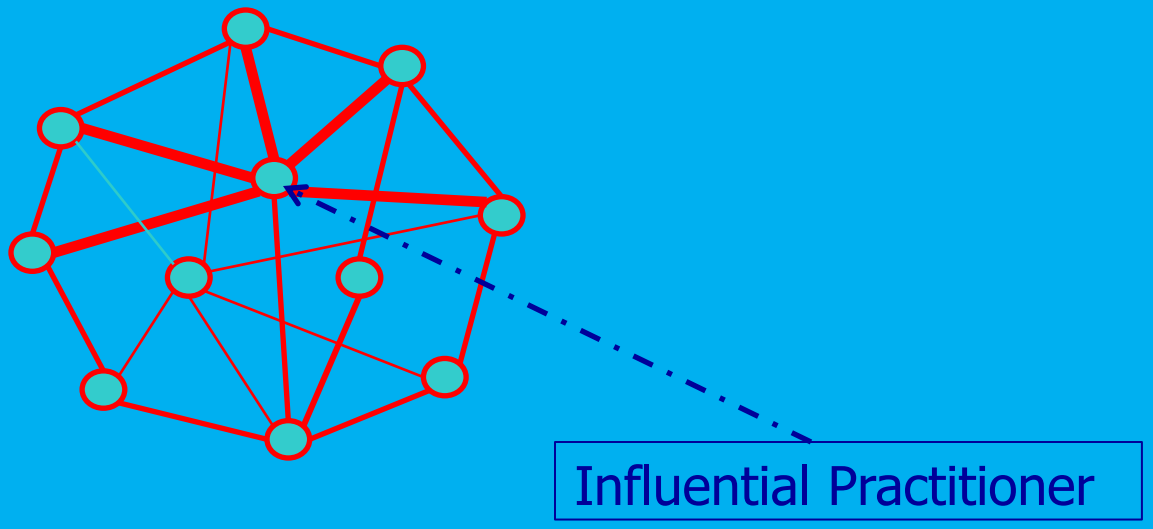
Using "Referral Network Analysis", a sub-network of oncologists, treating thyroid cancer, is extracted



Sub-Network (Thyroid Cancer)

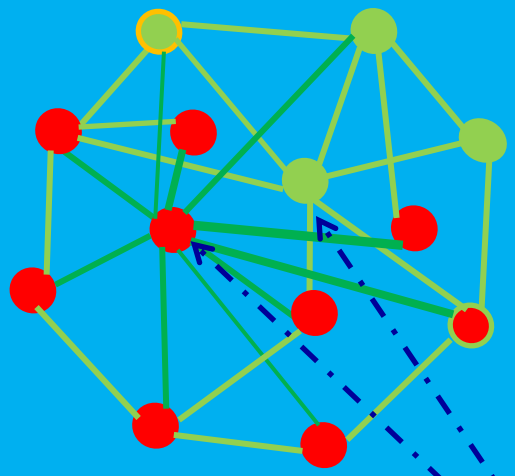
Referral Network/Social Network

Some practitioners are more influential in a social network e.g., Key Opinion Leaders – KOL, and would be prime candidates for Physician Marketing Events - PME and entry points.



Referral Network/Social Network

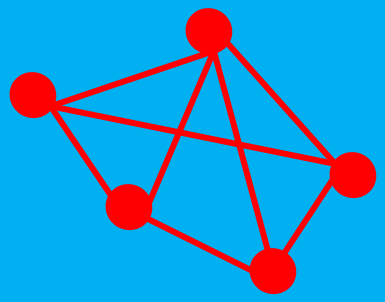
To gain wider brand acceptance, practitioners with the fewest overlapping connections to other practitioners should be targeted more heavily.



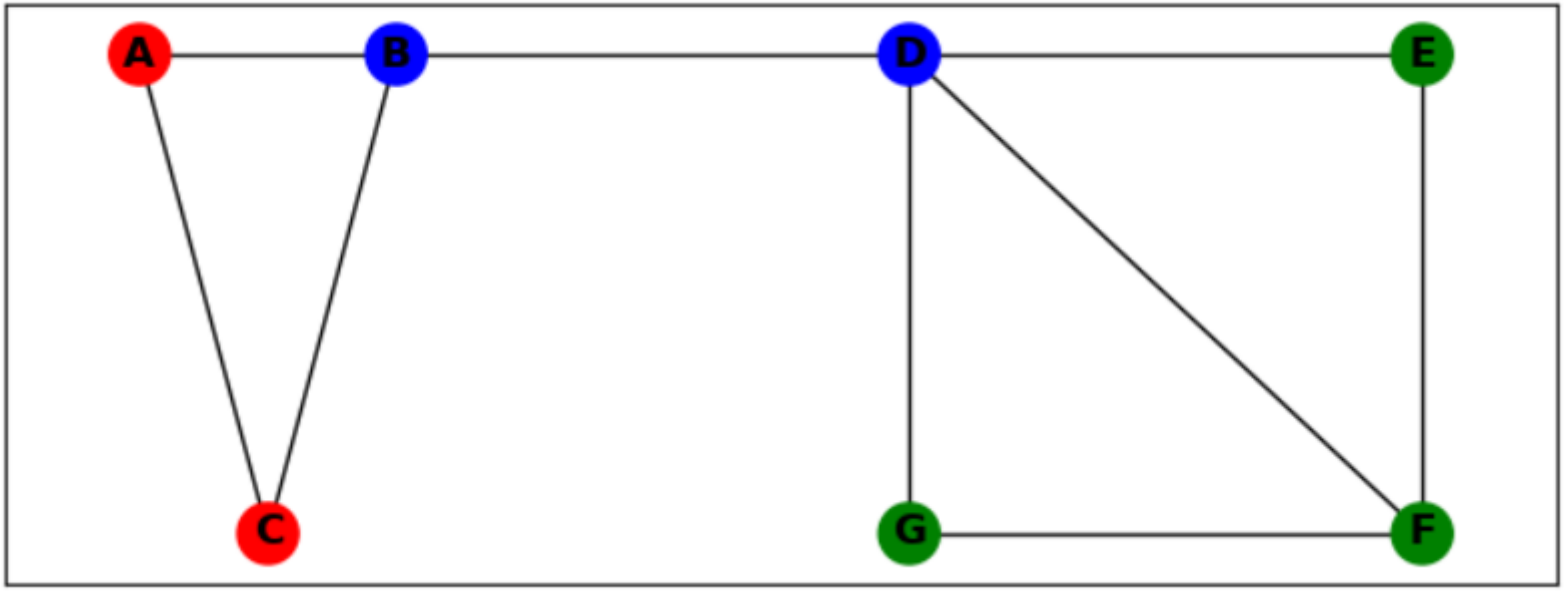
Two Practitioners Influence the Entire Sub-Network

Referral Network/Social Network

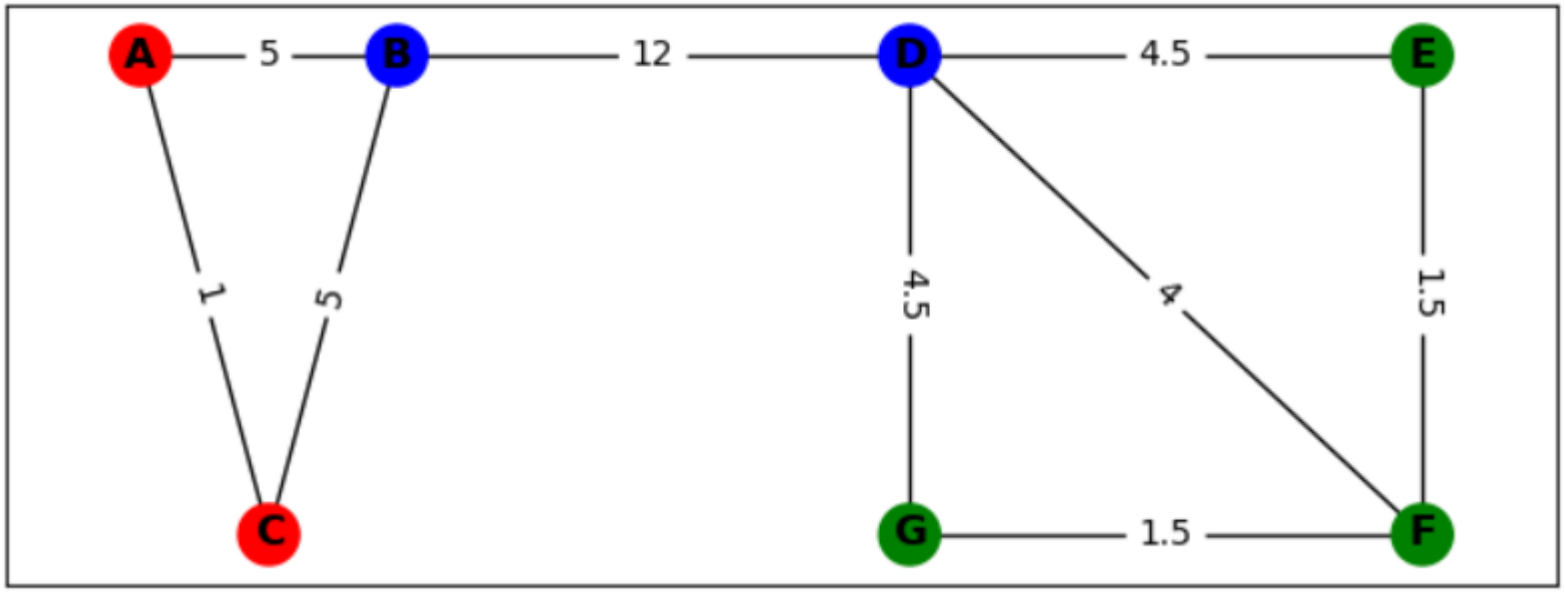
Members in smaller networks should be treated similarly, e.g. receive more consistent messages, and be aligned to the same sales rep.



Referral Network/Identifying Communities



Referral Network/Identifying Communities



Referral Network/Conductance

In graph theory, **conductance** is a measure of how "well connected" a graph is, and it is particularly relevant in analyzing the connectivity of networks and the quality of clusters within them. It is often used in the context of partitioning or clustering a graph.

Formally, for a subset S of vertices in a graph $G = (V, E)$, the conductance $\phi(S)$ is defined as:

$$\phi(S) = \frac{\text{cut}(S, \overline{S})}{\min(\text{vol}(S), \text{vol}(\overline{S}))}$$

Where:

- $\text{cut}(S, \overline{S})$: The total weight of edges that cross between the set S and its complement $\overline{S} = V \setminus S$. In an unweighted graph, this is the number of edges between S and $\overline{S}$.
- $\text{vol}(S)$: The sum of the degrees of all vertices in S, i.e., $\text{vol}(S) = \sum_{v \in S} \deg(v)$.

Referral Network/Graph Density

For an Undirected Graph

If $G = (V, E)$ is an undirected graph with $n = |V|$ vertices and $m = |E|$ edges, the density D is defined as:

$$D = \frac{2m}{n(n-1)}$$

This formula calculates the ratio of the actual number of edges to the maximum possible number of edges in an undirected graph, which is $\binom{n}{2} = \frac{n(n-1)}{2}$.