13/08/21 Friday	UCS 1722 -- Social Network Analysis Continuous Assessment Test - I	Sukeerthi 185001175 CSE - C

Part-B

1. a) Social network emerges as a dense cluster or social groups sparsely connected to each other by a few ties.

Network visualizations based on topographic or physical principles can help understand the group structure of social networks and pinpoint hubs that naturally tend to gravitate toward the center of the visualization.

→ A clique in a graph is maximal complete subgraph of three or more nodes. k-plex is a maximal subgraph in which each node is adjacent to no fewer than gs-k nodes in the subgraph where gs = no. of nodes in subgraph.

→ Cohesive group defined by lambda-set analysis method. which is based on the definition of edge connectivity. which would be the minimum number of lines to be removed in a graph to leave no path between the two vertices

A lambda-set defined for a pair of nodes has a larger edge connectivity than any pair of nodes, when one node is from within the set and the other from outside the set.

Example - Signed network relations with positive affections one subgroup and negative affections in the other.

→ Clustering method focusing on ties connect them rather than focusing on subgroups.

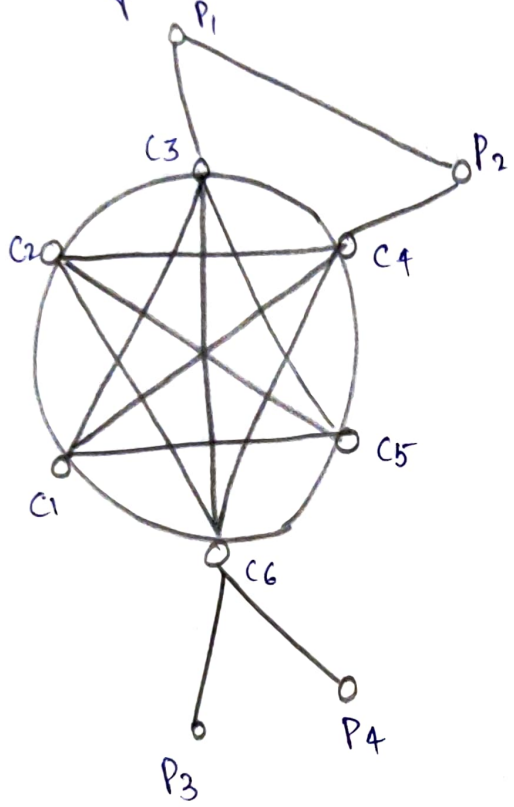
→ Ties between groups are spotted by betweenness

Edge Betweenness = $\frac{\text{Fraction of Edge that contains them}}{\text{set of all shortest paths in the graph.}}$

*A typical pattern that often emerges in social studies is that of a Core-Periphery (C/P) structure. ⟶ nodes can be divided into two distinct subgroups :- nodes in the core are densely connected with each other and the nodes on the periphery while peripherial nodes are not connected with each other but only to the nodes in the core.

* The matrix form of a core periphery structure is a $\begin{pmatrix} 1 & \cdot \\ \cdot & 0 \end{pmatrix}$ matrix. Algorithms for identifying C/p structure and other block models work by dividing the set of nodes in a way that the error between actual image and the 'perfect' image is minimal.

→ The result of the optimization is a classification of nodes as core or periphery and a measure of the error of the solution.



C1	C2	C3	C4	C5	C6	P1	P2	P3	P4
1	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	1	0	0	0
1	1	1	1	1	1	0	1	0	0
1	1	1	1	1	1	0	0	0	0
1	1	1	1	1	1	0	0	1	1
0	0	1	0	0	0	0	1	0	0
0	0	0	1	0	0	1	0	0	0
0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	1	0	0	0	0

In situations where additional information allows us to group our nodes into categories, we already have a division of our network into clusters based on shared interests or affliations. These clusters are overlapping depending on whether a single person is allowed to have multiple interests or affliations.

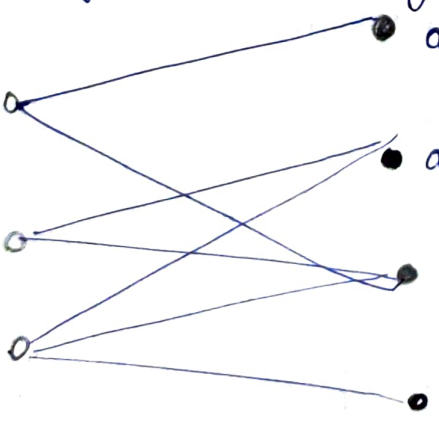
Affiliation networks contain information about the relationships between two set of nodes : a set of subjects and affiliations. An affiliation network can be formally represented as a bipartite graph, known as two-mode network.

An n-partite graph or n-mode network is a graph $G = \langle V, E \rangle$ where there exists a partitioning $V = \bigcup_{i=1}^{n} V_i$ such that $\bigcap_{i=1}^{n} V_i = 0$ and $(V_i \times V_j \cap E = 0)$.

The set of vertices is divided into n disjoint sets and there are no edges between vertices belonging to the same set.

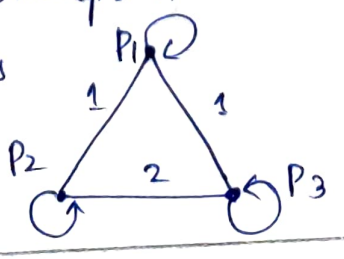
Affiliation Networks are transformed directly to a regular, one-mode network.

Transformation considers the overlaps between the affiliations as a measure of the tie strength b/w actors



	P_1	P_2	P_3	a_1	a_2	a_3	a_4
P_1	0	0	0	1	0	1	0
P_2	0	0	0	0	1	1	0
P_3	0	0	0	0	1	1	1
a_1	1	0	0	0	0	0	0
a_2	0	1	1	0	0	0	0
a_3	1	1	1	0	0	0	0
a_4	0	0	1	0	0	0	0

Eg :- Interlocking Directorates - overlaps in board membership of companies



	P_1	P_2	P_3
P_1	2	1	1
P_2	1	2	2
P_3	1	2	3

1. b) A structural hole occurs in the space that exists between closely clustered communities. It is a gap b/w two individuals or groups that do not know each other or have any relationship.

→ Ronald Burt identified holes in networks significant for many situations

→ People who use this position to act as a broker b/w other people or groups can provide a lot of value and receive many benefits.

→ The broker gains advantage by bridging such holes.

→ Therefore, this measure favours those nodes that connect a significant number of powerful, sparse linked actors with only minimal investment in the strength.

→ Structural holes show information benefits in three forms
  → access to large, disparate parts of the network.
  → timing (receiving information sooner than others)
  → reputation through referrals

2) Structural Dimension of social capital refers to patterns of relationships or positions that provide benefits in accessing networks.

The measure for single node (the ego) in the center is based on its connectivity to other nodes (the alters)

Measures of Structural Dimensions

→ Degree of Centrality

* In graph terms, number of links of a node
* In social network, actor with large link has many ties.
* Often act as third party or broker disconnected from large part of network
* Important measure in a scale free network.

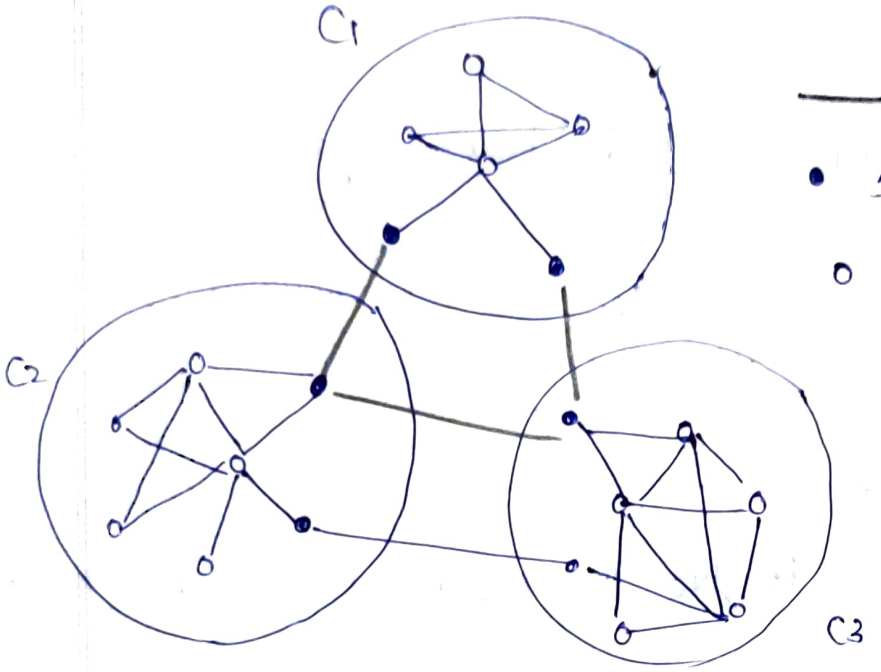
→ Closeness Centrality

* A measure that finds the nodes that are closet to other nodes
* Calculated by finding shortest path between each node, assigns score based on sum of all paths
* Nodes with high closeness value have a lower distance to all other nodes
* They are efficient broadcasters of information

→ Betweenness centrality

* High betweenness centrality node act as 'bridges' b/w other nodes
* They form the shortest path of communication within network
* They are important gatekeepers of information between groups.

Structural Hole - Gap b/w two individuals or groups that do not know each other or have any relationship.



— Cross Edge

• Structural Hole Spanner

o Internal Node.

People who use this position to act as a broker between other people or groups can provide a lot of value and receive many benefits.

Part-C

(i) Eccentricity of node 3

Largest geodesic distance b/w a node and another node in the graph

$[\max(d(3,j)) \; \forall \; j \neq 3]$

Distance between Node 3 and Node 7 is highest, = 5

$\therefore$ Eccentricity of node 3 = 5

(ii) Bridges in the Graph

(i) Node 0 – Node 4

(ii) Node 4 - Node 5

(iii) Node 5 - Node 9

(iii) A Walk, a Trial and two paths between pair of nodes

Nodes :- 4 and 7

Walk : $N_4, N_5, N_6, N_7, N_8, N_7$ Path N_4, N_5, N_8, N_7

Trial - N_4, N_5, N_8, N_7 N_4, N_5, N_6, N_7

(iv) Tour in the Graph :

$N_0, N_1, N_2, N_3, N_0, N_4, N_5, N_6, N_7, N_8, N_5, N_4, N_9, N_{10}, N_{11}, N_9$

$0 \to 1 \to 2 \to 3 \to 0 \to 4 \to 5 \to 6 \to 7 \to 8 \to 5 \to 4 \to 9 \to 10 \to 11 \to 9$

(v) Nodal Degree of all Nodes

	$(d-\bar{d})^2$
N_0 - 3	0.44 Variance Calculation done her
N_1 - 2	~~0.44~~ 0.11
N_2 - 2	~~0~~ 0.11
N_3 - 2	0.11
N_4 - 3	0.44
N_5 - 3	0.44
N_6 - 2	0.11
N_7 - 2	0.11
N_8 - 2	0.11
N_9 - 3	0.44
N_{10} - 2	0.11
N_{11} - 2	0.11

2.64

(vi) Mean Nodal Degree $\Rightarrow \frac{2L}{q}$

$G = 12$

$L = 14$

$\Rightarrow \frac{2 \times 14}{12} \Rightarrow 2.33$

(vii) Variance of Degree

$$S_p^2 = \sum_{i=1}^{q} \frac{(d(n_i) - \bar{d})^2}{q} \Rightarrow \frac{2.64}{12} = 0.22$$

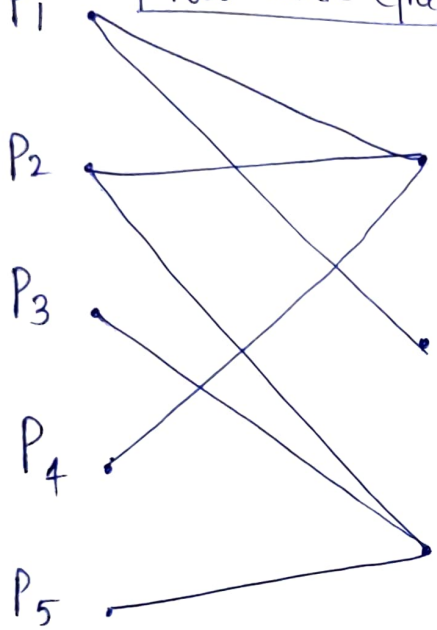
Variance = 0.22

(viii) Density $\Rightarrow \frac{2L}{q(q-1)} \Rightarrow \frac{2 \times 14}{12 \times 11} \Rightarrow 0.212$

Part - B

3) Two Mode Affiliation Network and represent in matrix format.

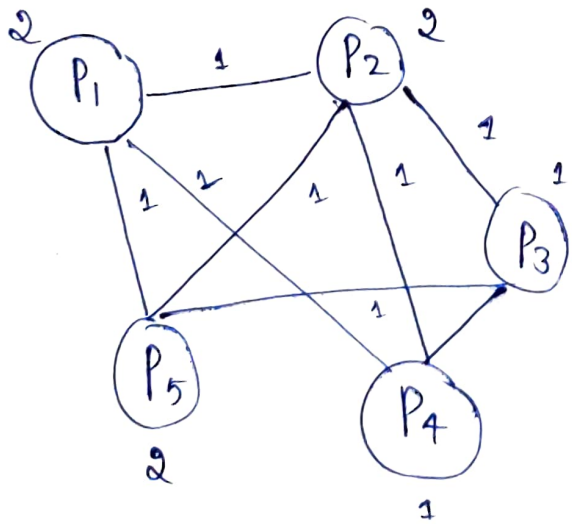
Two Node Graph



Matrix

	P1	P2	P3	P4	P5	F1	F2	F3
P1	0	0	0	0	0	1	1	0
P2	0	0	0	0	0	1	0	1
P3	0	0	0	0	0	0	0	1
P4	0	0	0	0	0	1	0	0
P5	0	0	0	0	0	0	1	1
F1	1	1	0	1	0	0	0	0
F2	1	0	0	0	1	0	0	0
F3	0	1	1	0	1	0	0	0

Transform to one-mode network considering the overlaps as the strength of the tie



	P1	P2	P3	P4	P5
P1	2	1	0	1	1
P2	1	2	1	1	1
P3	0	1	1	0	1
P4	1	1	0	1	0
P5	1	1	1	0	2