Social Network Analysis

Position

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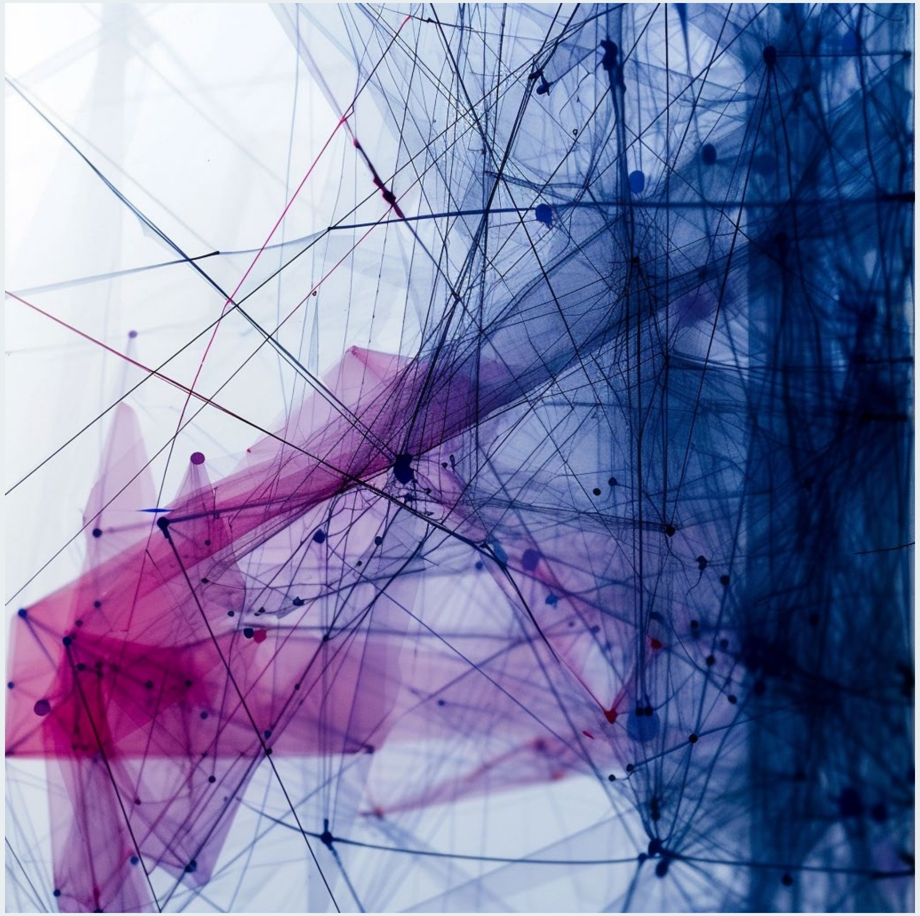
Outline

- Positional and Role Analyses
- Position (social position)
- Role (social role)
- Position Analysis
- Types of Equivalence
- Structural Equivalence
- CONCOR
- Block Modeling
- Position and Social Context
- Paper Reading
- References



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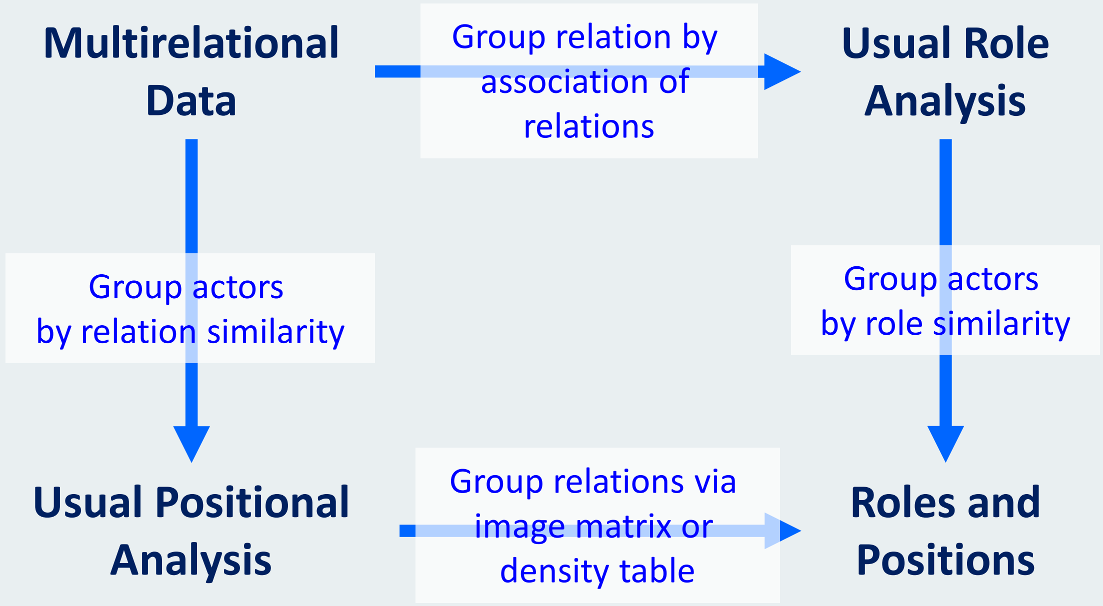
Position and Role Analyses

- **Positional analysis**
- Identifying social positions as collections of similar actors in their ties with others.
- **Role Analysis**
- Modeling social roles as systems of ties between actors or between positions.
- Both are used to characterize the structural similarities and patterns of relations of actors.

Position and Role Analyses

Sailer (1978) and Pattison (1982)

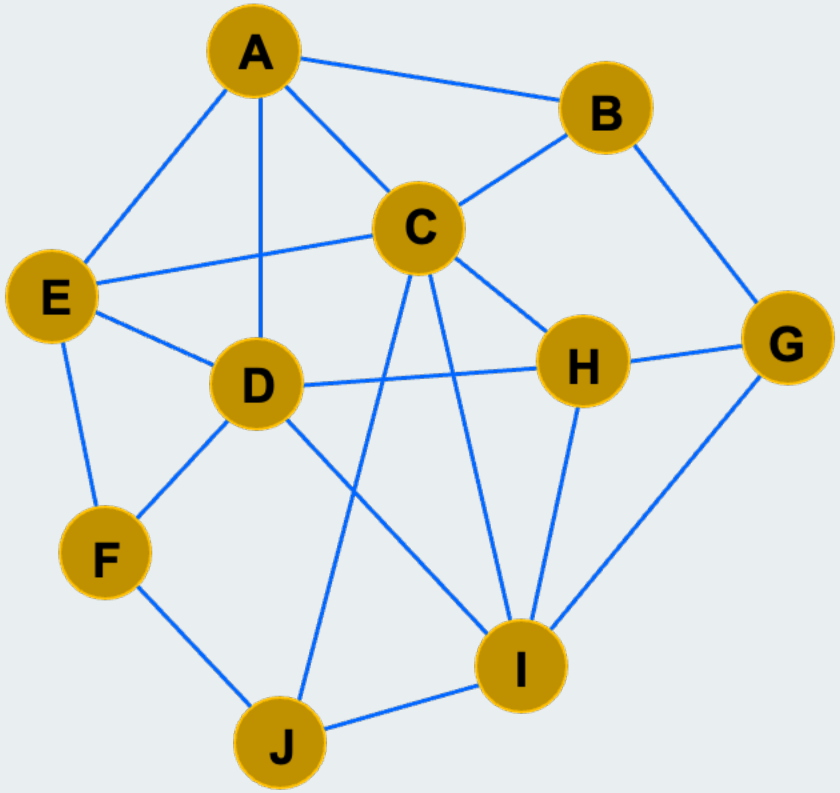
– Beginning with an asset of network data consisting of a collection of relations (a multi-relational data set), the ultimate goals are to “group” actors into positions based on their relational similarity and simultaneously describe the association among relations based on how they link actors or positions.



Position

– A **collection of individuals** similarly embedded in relations networks (e.g., social activities, ties, or intersections concerning actors in other positions).

– Based on the **similarity of ties**.



Social Position

- **Collection of actors similarly embedded in a network**
  - Have **similar sets of ties to other actors**
  - **Not** based on adjacency, proximity, or reachability
- **Example:**
  - Professors and students in a university
  - Each professor has his laboratory and taught courses, and each student has a different study schedule and courses. However, both professors and students play their positions.

Roles

- The underlying foundation of this concept rests on the discernible patterns of interrelationships **between actors or positions**.
- An **association among relations** that link social positions.
- **Collections of relations** and the **associations among relations**.

Social Roles

– The set of **attitudes and characteristic behaviors** expected of an individual who **occupies a specific position or performs a particular function in a social context**, such as being a spouse or acting as a caregiver for an aging parent (APA Dictionary of Psychology).

– For example, a person whose social status of 'parent' may have a set of social roles that include providing care, shelter, and love. Conversely, a student's social role might be to study, learn, and attend class.

– A family has several social roles: husband, wife, brother, sister, mother-in-law, …

Social Roles and Social Positions

- **Position** is a grouping process based on their tie similarity.
- **Role** is to characterize the attitude or behavior of a group.
- For structural analysts, the building blocks of social structure are “social role” and “social positions.”
- These social roles or positions are defined by **regularities in the patterns of relations among actors**, **not attributes** of the actors themselves.
- We identify and study social roles and positions by studying **relations among actors**, **not** by studying **attributes of individual actors**.

Social Roles and Social Positions

– From Nadal's perspective, …

– The composition of roles:
  – The responsibility to other people or other categorical people.
  – A role compliment/ reciprocal role (Linton) is necessary to characterize a role
  – Example: parent ➔ children, doctor ➔ patient

– He emphasized **the importance of the coherence of role systems**.

Social Roles and Social Positions

- White et al. (1976) addressed that each set into which the population is partitioned is a position.
- Burt (1967) considered that a position in a network is the specified set of relations to and from each actor in a system. A position is a collection of ties in which an actor is involved.
- Most studies concentrated on how to find the positions in a network; however, they have yet to discuss analyzing the relations between positions.

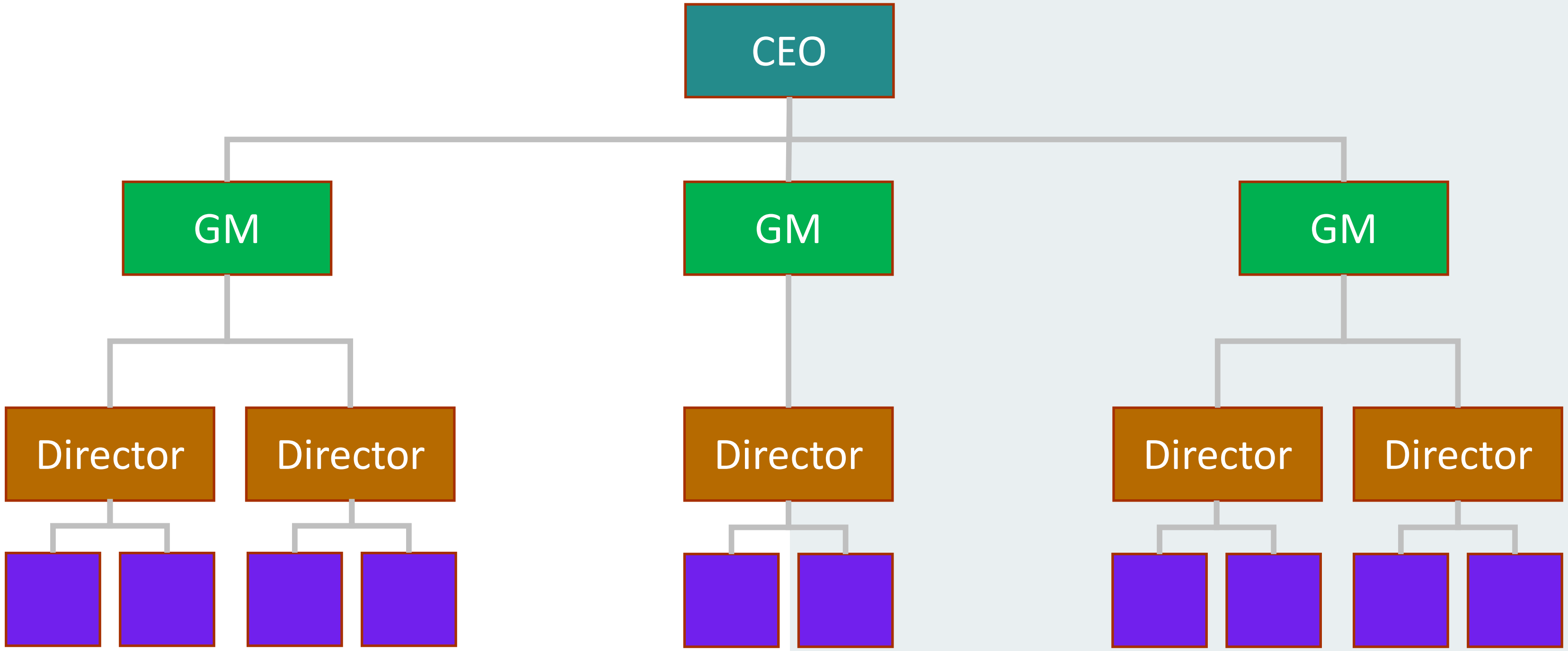
Position Analysis

- **The Definition of Equivalence**
- This refers to an assessment of the extent to which subsets of actors conform to the aforementioned definition within a specified dataset of network relationships.
- This denotes an evaluation of the sufficiency or suitability of the aforementioned portrayal, typically in relation to other actors.

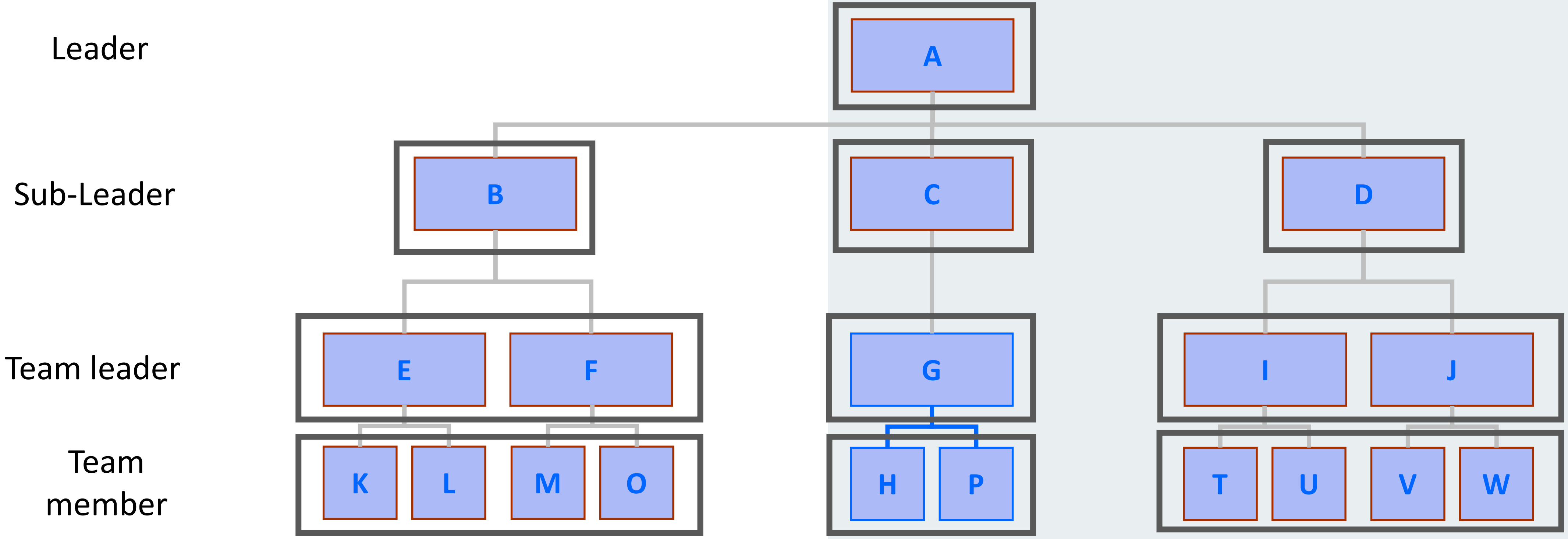
Type of Equivalence

- **Structural equivalence**
  - Two nodes have the **same relationships to all other nodes**.
  - Two actors must be exactly substitutable to be structurally equivalent.
- **Automorphic equivalence**
  - Two nodes have **identical ties** to equivalent actors.
  - Completely interchangeable/ But, it is a less strict definition
- **Regular equivalence**
  - Two nodes have the **same profile of ties with members of other sets of actors** that are also regularly equivalent.

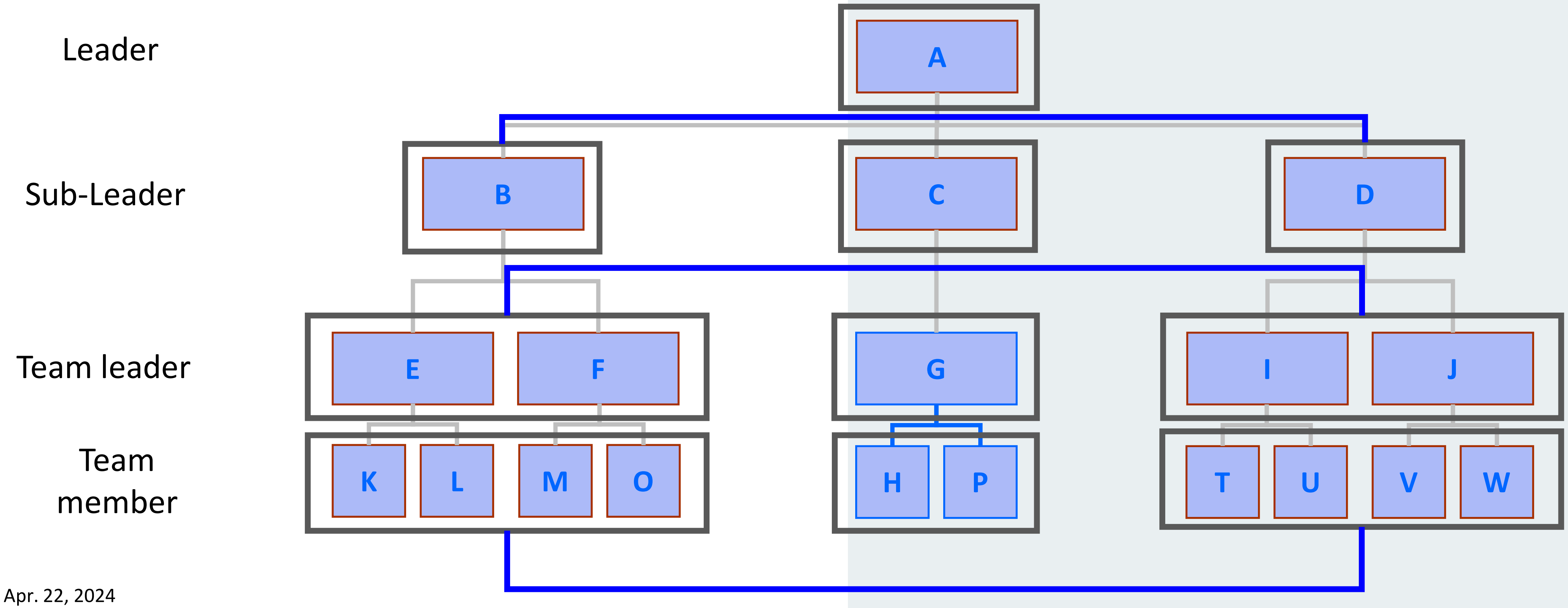
From a Enterprise Organization Framework



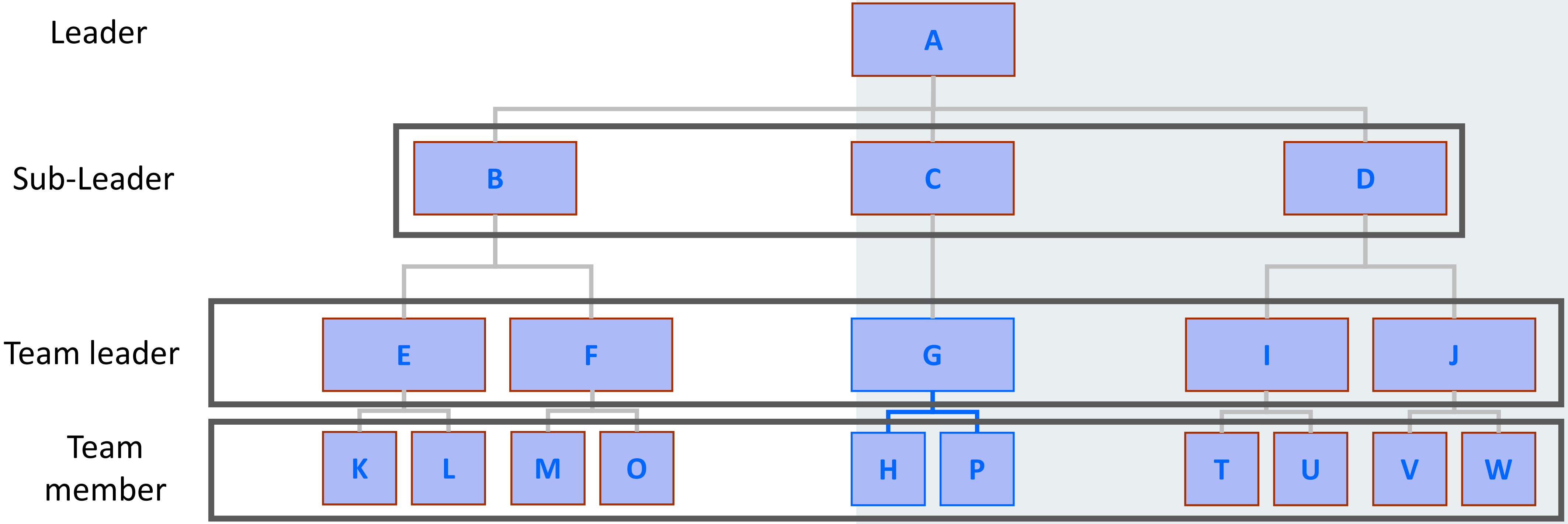
Structural Equivalence



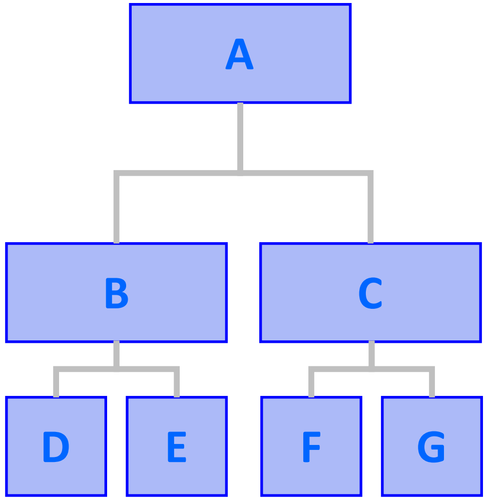
Automorphic equivalence



Regular equivalence



Structural Equivalence



	A	B	C	D	E	F	G
A	0	1	1	0	0	0	0
B	1	0	0	1	1	0	0
C	1	0	0	0	0	1	1
D	0	1	0	0	0	0	0
E	0	1	0	0	0	0	0
F	0	0	1	0	0	0	0
G	0	0	1	0	0	0	0

Actors who are the **structural equivalence** have the **same column and row**.

Thinking about Structural Equivalence

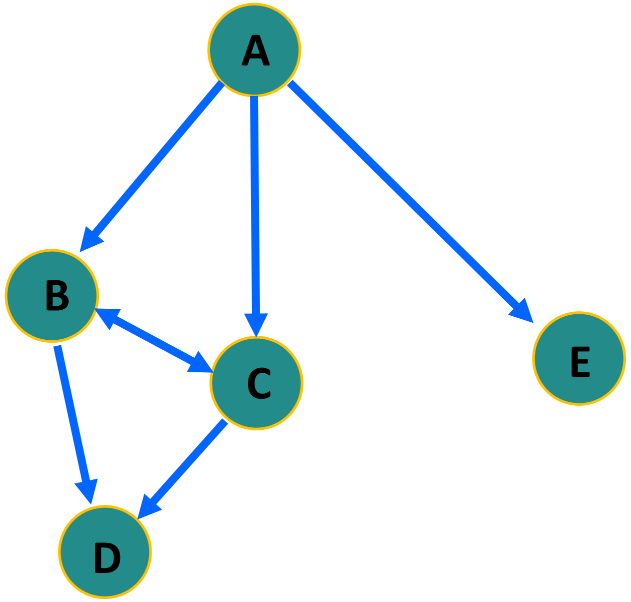
- Structural equivalence is based on **the similarity of nodal connections** in a network.
- Therefore, we need to investigate the dyadic measures of each pair of actors; more specifically, we want to the distance between a certain actor to other actors.
- But, how to define the distance measurement?
  - Euclidean distance, Manhattan distance, …

Euclidean Distance

$$d_{ij} = \sqrt{\sum_{q=1}^{k}\left(z_{iq} - z_{jq}\right)^2 + \sum_{q=1}^{k}\left(z_{qi} - z_{qj}\right)^2}, q \neq i, j$$

$$d_{ij} = \sqrt{\sum_{r=1}^{R}\sum_{q=1}^{k}\left(z_{iqr} - z_{jqr}\right)^2 + \left(z_{qir} - z_{qjr}\right)^2}, q \neq i, j$$

Structural Equivalence: Individual-level



Adjacency matrix

	A	B	C	D	E
A	0	1	1	0	1
B	0	0	1	1	0
C	0	1	0	1	0
D	0	0	0	0	0
E	0	0	0	0	0

Structural Equivalence matrix

	A	B	C	D	E
A				$\sqrt{5}$	
B					
C					
D					
E					

$$d_{AD} = \sqrt{(z_{AB} - z_{DB})^2 + (z_{AC} - z_{DC})^2 + (z_{AE} - z_{DE})^2 + (z_{BA} - z_{BD})^2 + (z_{CA} - z_{CD})^2 + (z_{EA} - z_{ED})^2}$$

$$d_{AD} = \sqrt{(1-0)^2 + (1-0)^2 + (1-0)^2 + (0-1)^2 + (0-1)^2 + (0-0)^2} = \sqrt{5}$$

Please design a python code to complete the structural equivalence matrix.

Structural Equivalence: Network-level

– How do we measure the structural equivalence at the network level?

– Correlation coefficient

$$r_{ij} = \frac{\sum_{q=1}^{k}\left(x_{iq} - \overline{x_{i.}}\right)\left(x_{jq} - \overline{x_{j.}}\right) + \sum_{q=1}^{k}\left(x_{qi} - \overline{x_{.i}}\right) + \left(x_{qj} - \overline{x_{.j}}\right)}{\sqrt{\sum_{q=1}^{k}\left(x_{iq} - \overline{x_{i.}}\right)^2 + \sum_{q=1}^{k}\left(x_{jq} - \overline{x_{j.}}\right)^2}\sqrt{\sum_{q=1}^{k}\left(x_{qi} - \overline{x_{.i}}\right)^2 + \sum_{q=1}^{k}\left(x_{qj} - \overline{x_{.j}}\right)^2}}$$

Structural Equivalence: Network-level

$$Z = \begin{bmatrix} z_{11} & z_{12} & z_{13} & \cdots & z_{1k} \\ z_{21} & z_{22} & z_{23} & \cdots & z_{2k} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ z_{k1} & z_{k2} & \cdots & \cdots & z_{kk} \end{bmatrix}$$

1 to others (q)

2 to others (q)

$$r_{12} = \begin{bmatrix} z_{13} & z_{23} \\ z_{14} & z_{24} \\ z_{15} & z_{25} \\ \vdots & \vdots \\ z_{1k} & z_{2k} \\ z_{31} & z_{32} \\ z_{41} & z_{42} \\ \vdots & \vdots \\ z_{k1} & z_{k2} \end{bmatrix}$$

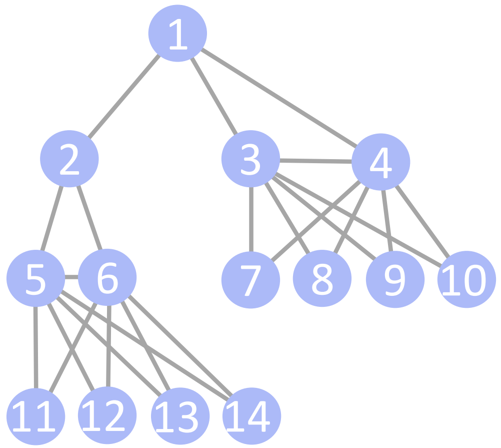
Others (q) to 1

Others (q) to 2

CONCOR

- **Step 1:** compute the correlation coefficient of row (column) and row (column)
  - $If\ r_{12} = 0.8,\ then\ Cell_{12} = 0.8$
  - The diagonal values in the computed matrix will be symmetric matrix with all one diagonal.
  - Determine whether the tie relation of Actor 1 and actor 2 is similar
- **Step 2:** repeat step until all values in the matrix belong to 1 or -1.
- **Step 3:** partition the matrix into 2 or 2n blocks based 1 and -1.

CONCOR



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	.	1	1	1	0	0	0	0	0	0	0	0	0	0
2	1	.	0	0	1	1	0	0	0	0	0	0	0	0
3	1	0	.	1	0	0	1	1	1	1	0	0	0	0
4	1	0	1	.	0	0	1	1	1	1	0	0	0	0
5	0	1	0	0	.	1	0	0	0	0	1	1	1	1
6	0	1	0	0	1	.	0	0	0	0	1	1	1	1
7	0	0	1	1	0	0	.	0	0	0	0	0	0	0
8	0	0	1	1	0	0	0	.	0	0	0	0	0	0
9	0	0	1	1	0	0	0	0	.	0	0	0	0	0
10	0	0	1	1	0	0	0	0	0	.	0	0	0	0
11	0	0	0	0	1	1	0	0	0	0	.	0	0	0
12	0	0	0	0	1	1	0	0	0	0	0	.	0	0
13	0	0	0	0	1	1	0	0	0	0	0	0	.	0
14	0	0	0	0	1	1	0	0	0	0	0	0	0	.

3	4
1	1
0	0
0	0
0	0
1	1
1	1
1	1
1	1
0	0
0	0
0	0
0	0

1			1	1	0	0	0	0	0	0	0	0	0	0
2			0	0	1	1	0	0	0	0	0	0	0	0

Pearson Correlation Coefficient: -0.2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.00	**-0.20**	0.08	0.08	-0.19	-0.19	0.77	0.77	0.77	0.77	-0.26	-0.26	-0.26	-0.26
2	**-0.20**	1.00	-0.19	-0.19	0.08	0.08	-0.26	-0.26	-0.26	-0.26	0.77	0.77	0.77	0.77
3	0.08	-0.19	1.00	1.00	-1.00	-1.00	0.36	0.36	0.36	0.36	-0.45	-0.45	-0.45	-0.45
4	0.08	-0.19	1.00	1.00	-1.00	-1.00	0.36	0.36	0.36	0.36	-0.45	-0.45	-0.45	-0.45
5	-0.19	0.08	-1.00	-1.00	1.00	1.00	-0.45	-0.45	-0.45	-0.45	0.36	0.36	0.36	0.36
6	-0.19	0.08	-1.00	-1.00	1.00	1.00	-0.45	-0.45	-0.45	-0.45	0.36	0.36	0.36	0.36
7	0.77	-0.26	0.36	0.36	-0.45	-0.45	1.00	1.00	1.00	1.00	-0.20	-0.20	-0.20	-0.20
8	0.77	-0.26	0.36	0.36	-0.45	-0.45	1.00	1.00	1.00	1.00	-0.20	-0.20	-0.20	-0.20
9	0.77	-0.26	0.36	0.36	-0.45	-0.45	1.00	1.00	1.00	1.00	-0.20	-0.20	-0.20	-0.20
10	0.77	-0.26	0.36	0.36	-0.45	-0.45	1.00	1.00	1.00	1.00	-0.20	-0.20	-0.20	-0.20
11	-0.26	0.77	-0.45	-0.45	0.36	0.36	-0.20	-0.20	-0.20	-0.20	1.00	1.00	1.00	1.00
12	-0.26	0.77	-0.45	-0.45	0.36	0.36	-0.20	-0.20	-0.20	-0.20	1.00	1.00	1.00	1.00
13	-0.26	0.77	-0.45	-0.45	0.36	0.36	-0.20	-0.20	-0.20	-0.20	1.00	1.00	1.00	1.00
14	-0.26	0.77	-0.45	-0.45	0.36	0.36	-0.20	-0.20	-0.20	-0.20	1.00	1.00	1.00	1.00

CONCOR :: Iteration 1

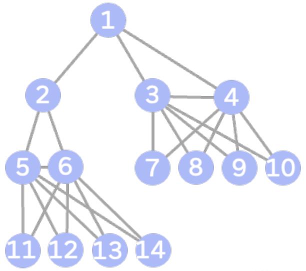
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.00	-0.77	0.55	0.55	-0.57	-0.57	0.95	0.95	0.95	0.95	-0.75	-0.75	-0.75	-0.75
2	-0.77	1.00	-0.57	-0.57	0.55	0.55	-0.75	-0.75	-0.75	-0.75	0.95	0.95	0.95	0.95
3	0.55	-0.57	1.00	1.00	-1.00	-1.00	0.73	0.73	0.73	0.73	-0.75	-0.75	-0.75	-0.75
4	0.55	-0.57	1.00	1.00	-1.00	-1.00	0.73	0.73	0.73	0.73	-0.75	-0.75	-0.75	-0.75
5	-0.57	0.55	-1.00	-1.00	1.00	1.00	-0.75	-0.75	-0.75	-0.75	0.73	0.73	0.73	0.73
6	-0.57	0.55	-1.00	-1.00	1.00	1.00	-0.75	-0.75	-0.75	-0.75	0.73	0.73	0.73	0.73
7	0.95	-0.75	0.73	0.73	-0.75	-0.75	1.00	1.00	1.00	1.00	-0.77	-0.77	-0.77	-0.77
8	0.95	-0.75	0.73	0.73	-0.75	-0.75	1.00	1.00	1.00	1.00	-0.77	-0.77	-0.77	-0.77
9	0.95	-0.75	0.73	0.73	-0.75	-0.75	1.00	1.00	1.00	1.00	-0.77	-0.77	-0.77	-0.77
10	0.95	-0.75	0.73	0.73	-0.75	-0.75	1.00	1.00	1.00	1.00	-0.77	-0.77	-0.77	-0.77
11	-0.75	0.95	-0.75	-0.75	0.73	0.73	-0.77	-0.77	-0.77	-0.77	1.00	1.00	1.00	1.00
12	-0.75	0.95	-0.75	-0.75	0.73	0.73	-0.77	-0.77	-0.77	-0.77	1.00	1.00	1.00	1.00
13	-0.75	0.95	-0.75	-0.75	0.73	0.73	-0.77	-0.77	-0.77	-0.77	1.00	1.00	1.00	1.00
14	-0.75	0.95	-0.75	-0.75	0.73	0.73	-0.77	-0.77	-0.77	-0.77	1.00	1.00	1.00	1.00

CONCOR :: Iteration 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.00	-0.99	0.94	0.94	-0.94	-0.94	0.99	0.99	0.99	0.99	-0.99	-0.99	-0.99	-0.99
2	-0.99	1.00	-0.94	-0.94	0.94	0.94	-0.99	-0.99	-0.99	-0.99	0.99	0.99	0.99	0.99
3	0.94	-0.94	1.00	1.00	-1.00	-1.00	0.97	0.97	0.97	0.97	-0.97	-0.97	-0.97	-0.97
4	0.94	-0.94	1.00	1.00	-1.00	-1.00	0.97	0.97	0.97	0.97	-0.97	-0.97	-0.97	-0.97
5	-0.94	0.94	-1.00	-1.00	1.00	1.00	-0.97	-0.97	-0.97	-0.97	0.97	0.97	0.97	0.97
6	-0.94	0.94	-1.00	-1.00	1.00	1.00	-0.97	-0.97	-0.97	-0.97	0.97	0.97	0.97	0.97
7	0.99	-0.99	0.97	0.97	-0.97	-0.97	1.00	1.00	1.00	1.00	-0.99	-0.99	-0.99	-0.99
8	0.99	-0.99	0.97	0.97	-0.97	-0.97	1.00	1.00	1.00	1.00	-0.99	-0.99	-0.99	-0.99
9	0.99	-0.99	0.97	0.97	-0.97	-0.97	1.00	1.00	1.00	1.00	-0.99	-0.99	-0.99	-0.99
10	0.99	-0.99	0.97	0.97	-0.97	-0.97	1.00	1.00	1.00	1.00	-0.99	-0.99	-0.99	-0.99
11	-0.99	0.99	-0.97	-0.97	0.97	0.97	-0.99	-0.99	-0.99	-0.99	1.00	1.00	1.00	1.00
12	-0.99	0.99	-0.97	-0.97	0.97	0.97	-0.99	-0.99	-0.99	-0.99	1.00	1.00	1.00	1.00
13	-0.99	0.99	-0.97	-0.97	0.97	0.97	-0.99	-0.99	-0.99	-0.99	1.00	1.00	1.00	1.00
14	-0.99	0.99	-0.97	-0.97	0.97	0.97	-0.99	-0.99	-0.99	-0.99	1.00	1.00	1.00	1.00

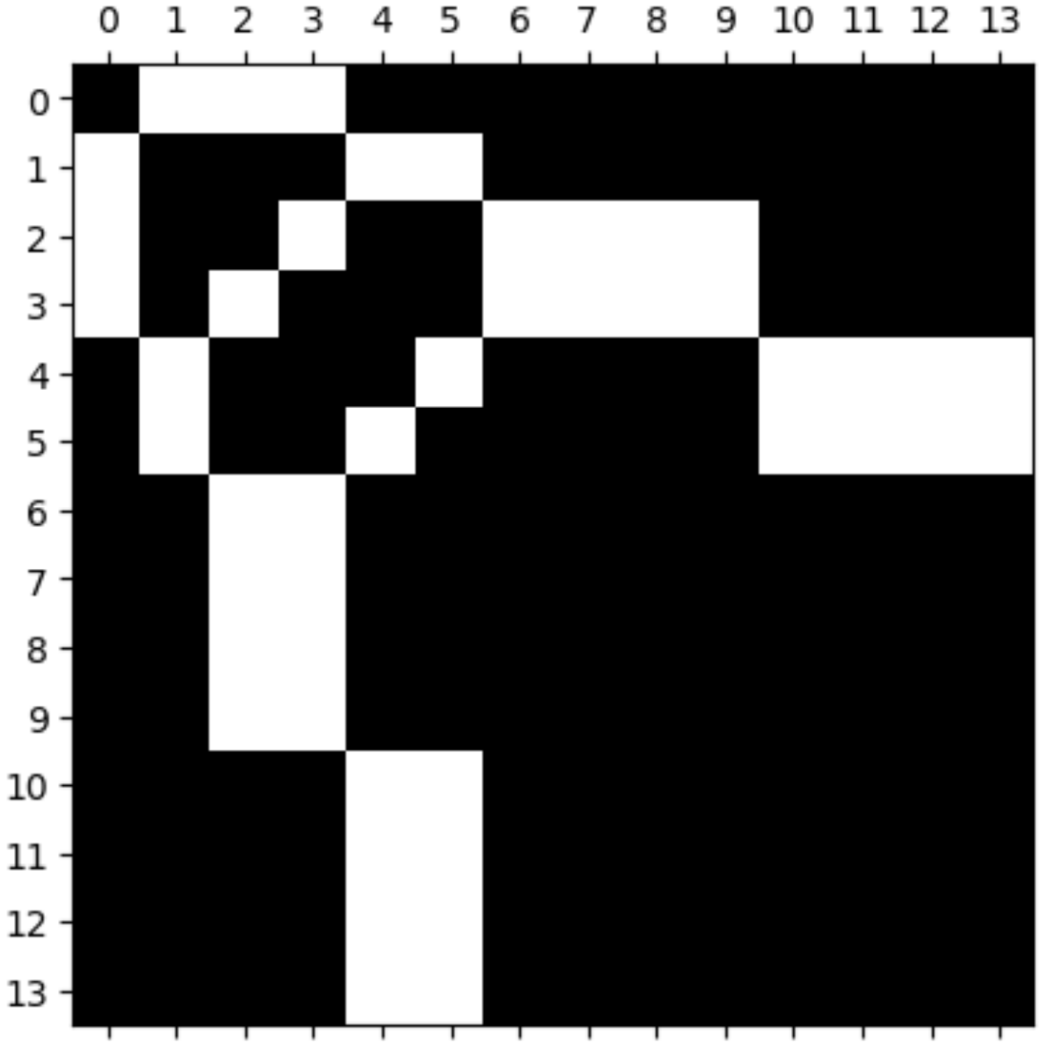
CONCOR :: Iteration 3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
2	-1.00	1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00
3	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
4	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
5	-1.00	1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00
6	-1.00	1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00
7	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
8	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
9	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
10	1.00	-1.00	1.00	1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00
11	-1.00	-1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00
12	-1.00	-1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00
13	-1.00	-1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00
14	-1.00	-1.00	-1.00	-1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00

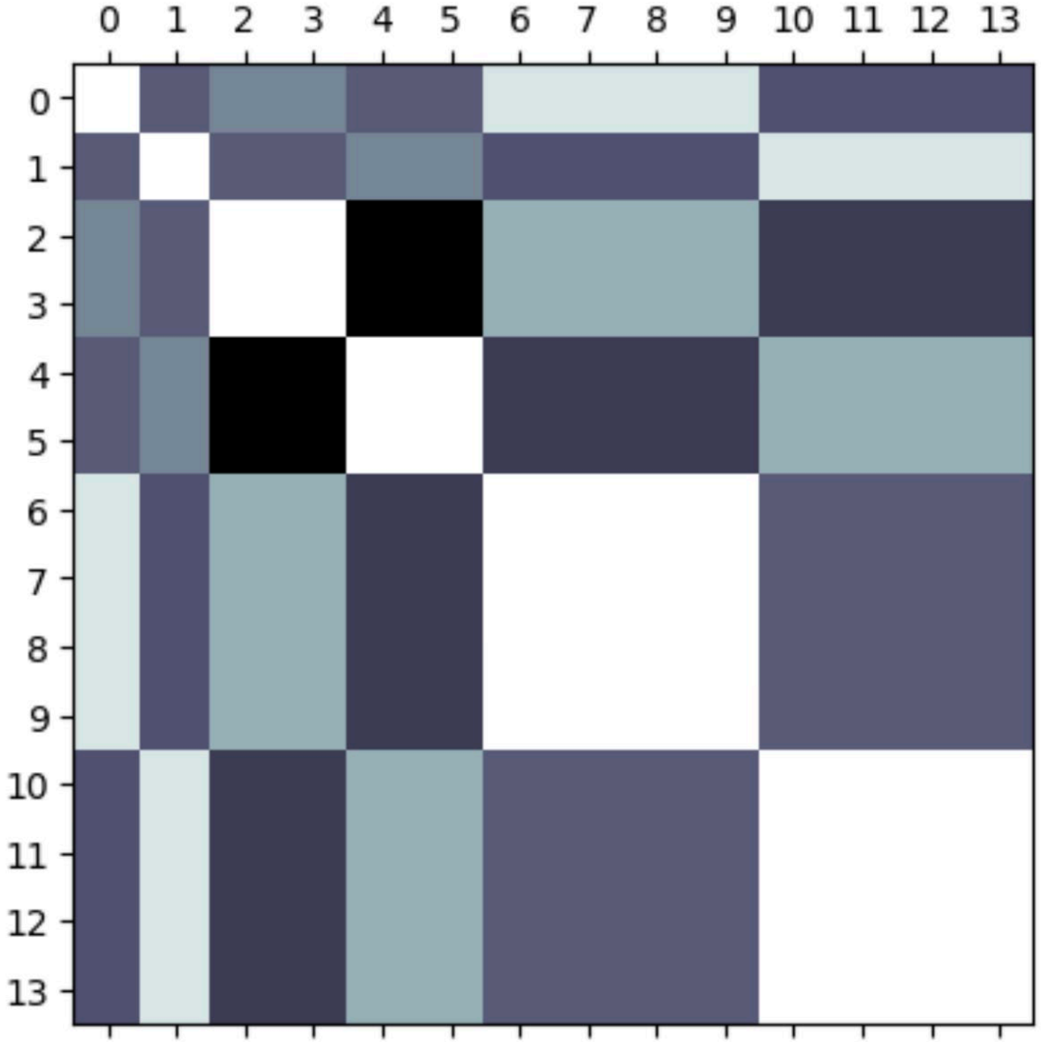


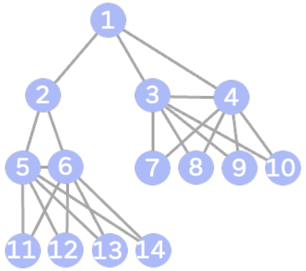
[redacted]

Initial: adjacent matrix

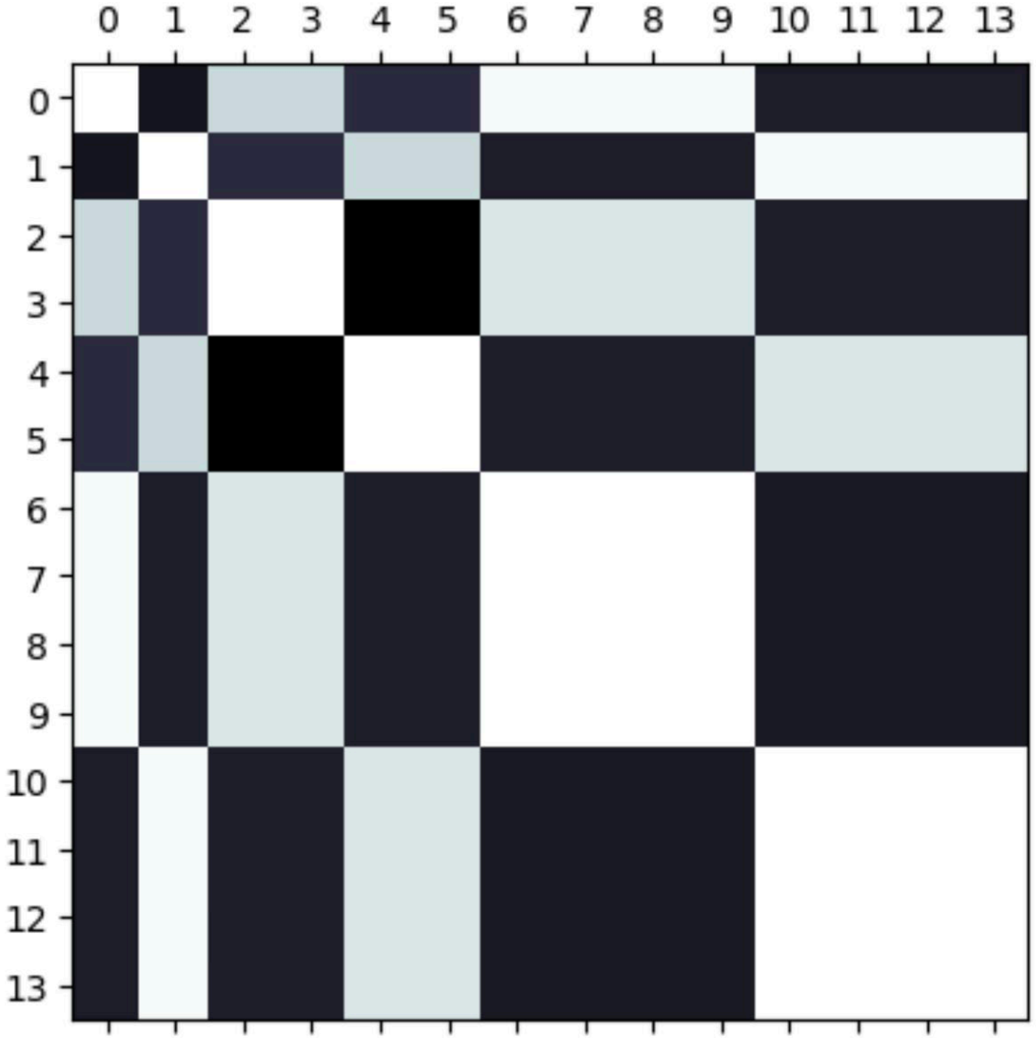


Run 1 - Results

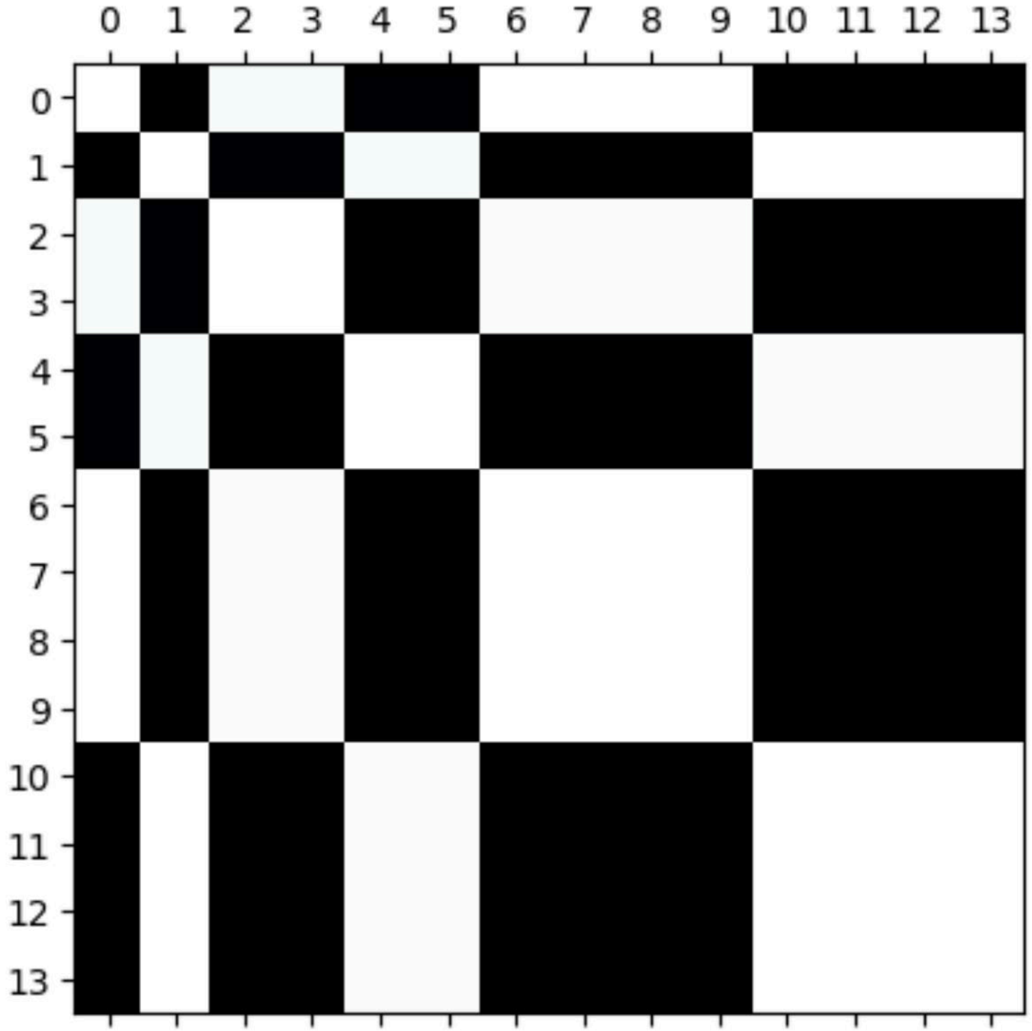




Run 2 - Results



Run 3 - Results



CONCOR :: Re-Organization

	1	3	4	7	8	9	10	2	5	6	11	12	13	14
1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
4	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
2	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
11	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
12	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
13	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
14	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

BlockModeling

– Blockmodeling is the process of identifying different types of positions by using a block in the adjacency matrix.

	1	2	3	4	5	6	7	8	9
1	-	0	0	1	0	0	0	0	1
2	0	-	0	0	1	0	1	0	0
3	0	1	-	0	1	1	1	1	0
4	1	0	0	-	0	0	0	0	1
5	0	1	0	0	-	0	1	0	0
6	0	1	1	0	1	-	1	1	0
7	0	1	0	0	1	0	-	0	0
8	0	1	1	0	1	1	1	-	0
9	1	0	0	1	0	0	0	0	-

Adjacency matrix

	6	3	8	4	1	9	2	5	7
6		1	1	0	0	0	1	1	1
3	1		1	0	0	0	1	1	1
8	1	1		0	0	0	1	1	1
4	0	0	0		1	1	0	0	0
1	0	0	0	1		1	0	0	0
9	0	0	0	1	1		0	0	0
2	0	0	0	0	0	0		1	1
5	0	0	0	0	0	0	1		1
7	0	0	0	0	0	0	1	1	

Permuted and partitioned matrix

BlockModeling

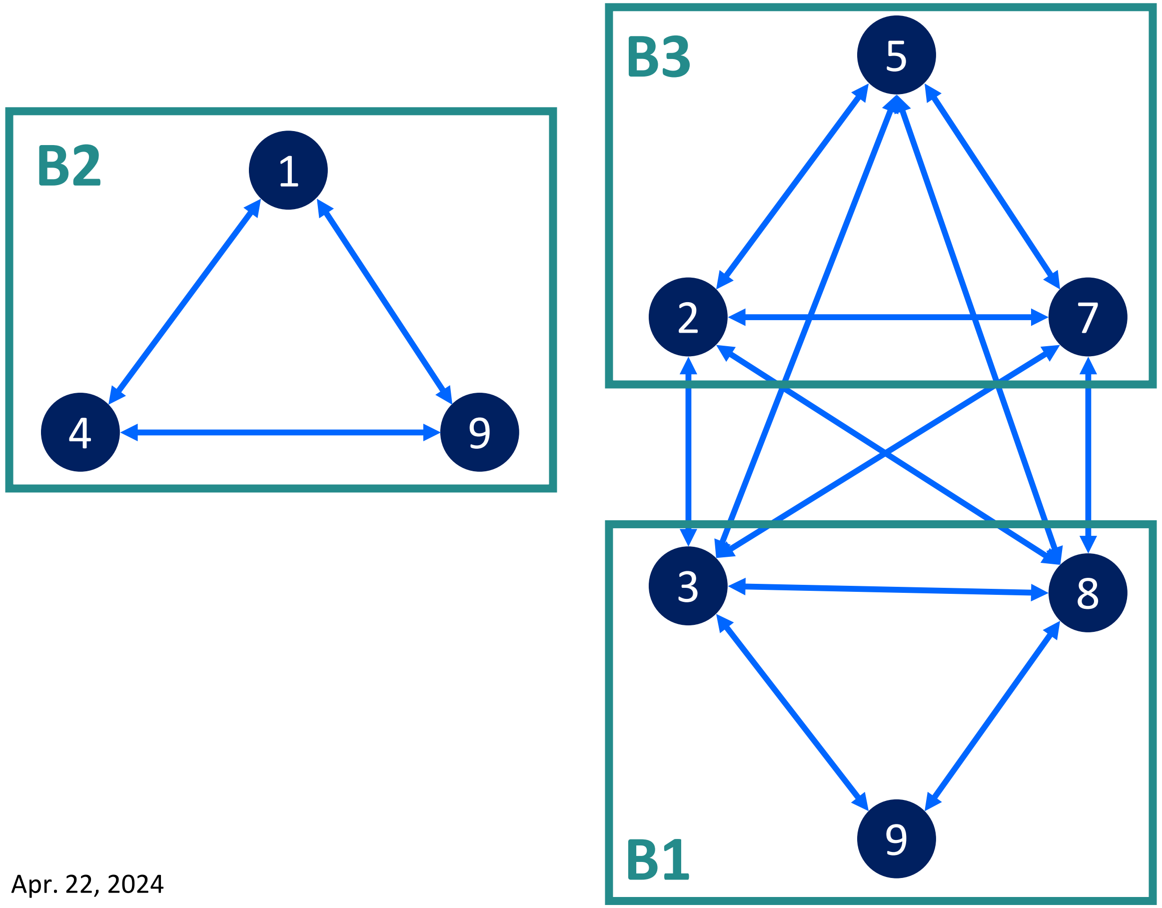
	6	3	8	4	1	9	2	5	7
6		1	1	0	0	0	1	1	1
3	1		1	0	0	0	1	1	1
8	1	1		0	0	0	1	1	1
4	0	0	0		1	1	0	0	0
1	0	0	0	1		1	0	0	0
9	0	0	0	1	1		0	0	0
2	0	0	0	0	0	0		1	1
5	0	0	0	0	0	0	1		1
7	0	0	0	0	0	0	1	1	

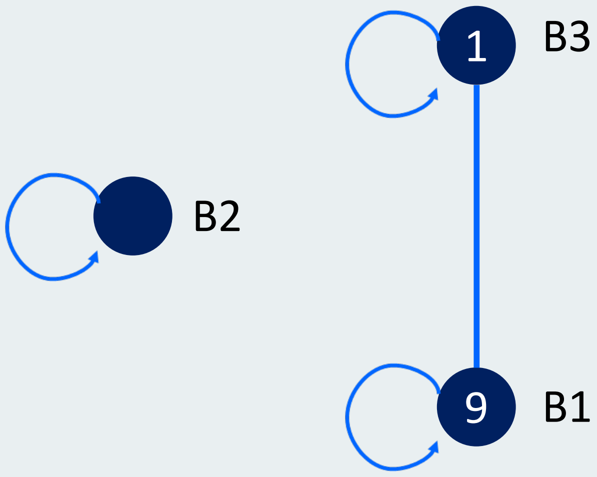
Permuted and partitioned matrix

Image matrix

	B1	B2	B3
B1	1	0	1
B2	0	1	0
B3	0	0	1

Position Analysis





Position Analysis

Within Block	Among Blocks	Type
Few	Many	Brokers
Few	Few	Sycophants
Many	Few	Isolation
Many	Many	Primary

Burt, 1976

Position and Social Context

– Structural equivalence only indicates that these actors have the same/ similar ties with others; therefore, it does not imply that they always interact together.

– Actors with structural equivalence will have the same/ similar social status or behavior.

1) The competition among actors with structural equivalence still exists
2) The actors with structural equivalence are affected by the co-connected actors
3) The actors with structural equivalence have certain attributes and characteristics that affect their behavior, which non-structurally equivalent actors cannot achieve

Paper Reading

ELSEVIER

Cities

Volume 104, September 2020, 102809

Measuring megaregional structure in the Pearl River Delta by mobile phone signaling data: A complex network approach

Wenjia Zhang [a b], Chenyu Fang [c d], Lin Zhou [b e], Jiancheng Zhu [b]

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Highlights

Zhang, W., Fang, C., Zhou, L., & Zhu, J. (2020). Measuring megaregional structure in the Pearl River Delta by mobile phone signaling data: A complex network approach. Cities, 104, 102809.

Questions:

1. What is the objective of this paper?
2. How did the authors formulate the transportation network and quantify the transportation characteristics with nodal indicators?
3. What are the findings of this study?
4. If you want to achieve the same objective, how do you formulate the network?

References

- Wasserman, S., & Faust, K. (1994). Social network analysis: Methods and applications.
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- Hanneman, R. A., & Riddle, M. (2005). Introduction to social network methods.
- https://en.wikipedia.org/wiki/Social_network

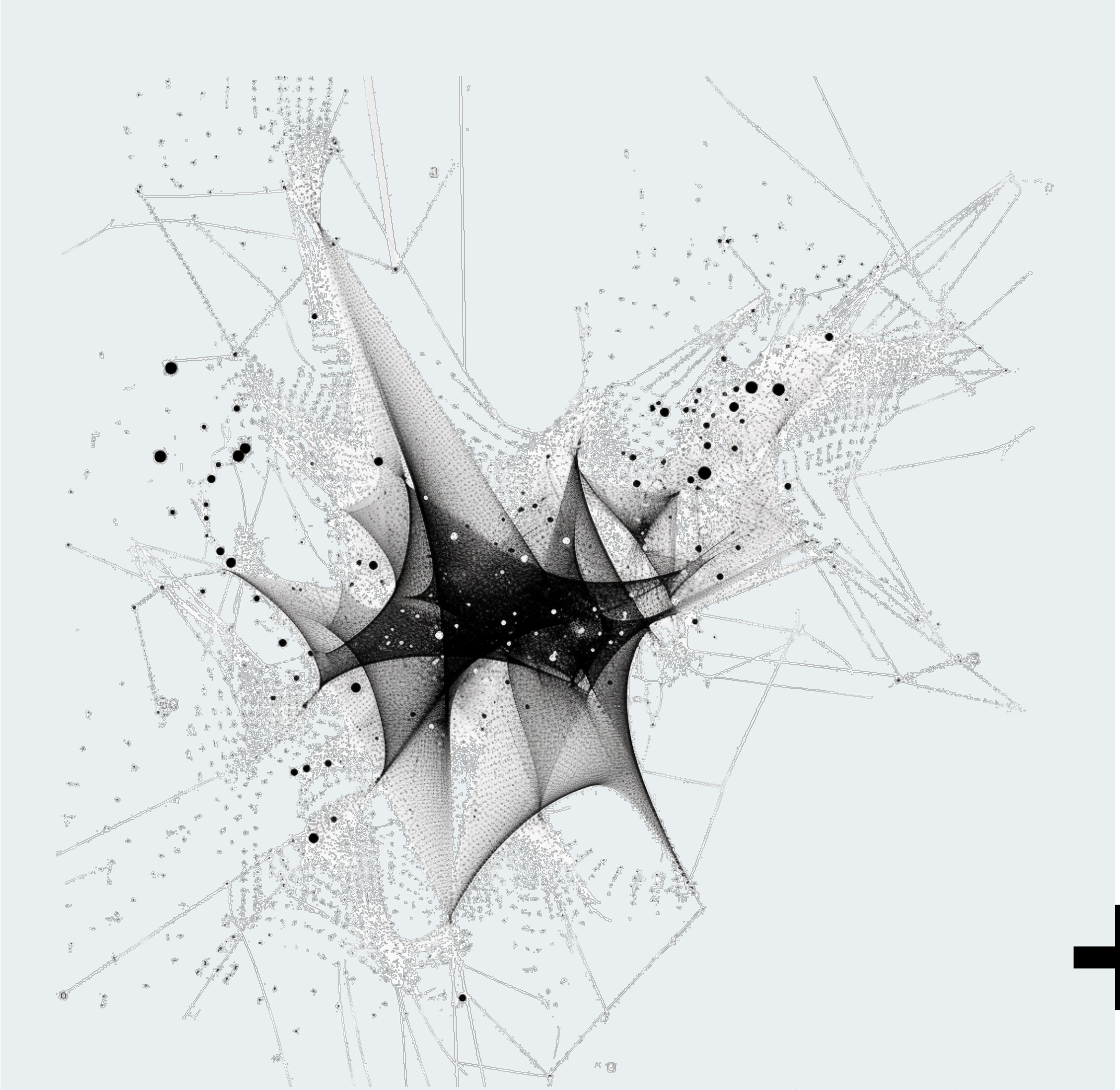

Photo credit: midjourney

The End

Thank you for your attention!

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Website: toodou.github.io

Photo credit: midjourney