COGNITIVE SOCIAL STRUCTURES

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Agenda

- Introduction
- Definition of Cognitive Social Structure
- Aggregations
- An Empirical Example
- Conclusion

Introduction

- Bernard, Killworth and Sailer (BKS)
  - Informants are inaccurate; memory does decay exponentially with time… And on top of all this there appears to be systematic distortion in how informants recall just about everything. (1984: 509)

- Freeman and Romney
  - The recollections people have may represent enduring patterns of interaction more accurately than individual instances of behavior.

Introduction

- The premise behind all of these arguments

  -- "Accuracy"

- Two alternative ways of eliminating the BKS's "problem" and opening new avenues for approaching the study of networks.
  1. Relating people's perceptions to objective reality (behavior, in this case)
  2. Focusing on the cognitive reconstructions themselves

Definition of Cognitive Social Structure

- Social Structure
  - R_{NXN} – a set of relational statements between all pairs of actors in the system, where $R_{i,j}$ represent the relationship between i and j
    - i – the "sender" of the relation
    - j – the "receiver"

$$R_{i,j} \begin{cases} = 1 & \text{if i is related to j} \\ = 0 & \text{otherwise} \end{cases}$$

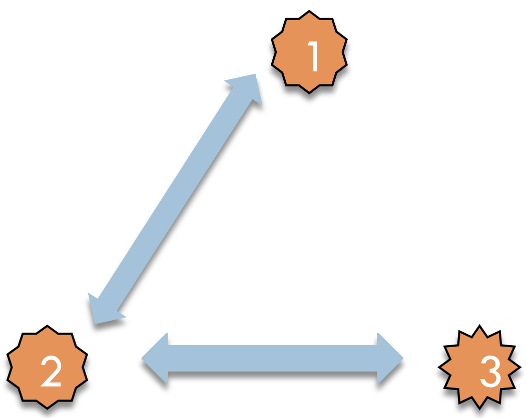
ex. $R_{3,12}=1$: Person 3 approaches Person 12 for help and advice.

Definition of Cognitive Social Structure

- Cognitive Social Structure (CSS)
  - R_{NXNXN}
  - $R_{i,j,k}$, where k is the "perceiver"
    - $R_{3,12,8}$ =1: Person 8 thinks that person 3 approaches person 12 for help and advice.
  - 2 Characteristics of CSS
    1. The amount of information in a CSS far exceeds that in a traditional social structure. (use small networks: $N < 50$)
    2. There is no implication in the definition that any "objective" relation in an (i, j) dyad has any correlation to the various k perceptions of that same dyad.

Aggregations

- Social Structure: $N = 3$, *for all* $i \neq j$



$$R_{i,j} = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

Aggregations

- Cognitive Social Structure: $N = 3$, *for all* $i \neq j$

Perspective:

$$1\ (R_{i,j,1}) \qquad 2\ (R_{i,j,2}) \qquad 3\ (R_{i,j,3})$$

$$\underbrace{\underbrace{\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}}_{\text{Slice}} \qquad \begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix} \qquad \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}}_{\text{Locally aggregated Structures}}$$

Aggregations

- Slices
  - "slice" is from the three-dimensional matrix, holding constant the "perceiver" dimension:

    $R'_{i,j} = R_{i,j,K}$,   where K = a constant.
- Locally Aggregated Structures (LAS)

LAS from Intersection Rule: $\mathscr{R}'_{i,j} = \{\mathscr{R}_{i,j,i} \cap \mathscr{R}_{i,j,j}\}$,

LAS from Union Rule: $\mathscr{R}'_{i,j} = \{\mathscr{R}_{i,j,i} \cup \mathscr{R}_{i,j,j}\}$.

Aggregations

- Consensus Structures (CS)

$$\mathcal{R}'_{i,j} = f\left(\mathcal{R}_{i,j,k_1},\ \mathcal{R}_{i,j,k_2}, \ldots, \mathcal{R}_{i,j,k_n}\right).$$

  - Threshold function:

$$\mathcal{R}'_{i,j} = \begin{cases} 1 & \text{if } \frac{1}{N}\Sigma_k \mathcal{R}_{i,j,k} \geq \text{Threshold}, \\ 0 & \text{otherwise}, \end{cases}$$

    - A Threshold of 0.5 would be interpreted as meaning that a relation exists from *i* to *j* if and only if a majority of the members of the network perceive that it exists.

An Empirical Example

- To demonstrate these aggregations and illustrate their differences, we collected data from a small manufacturing organization on the west coast.
- Employ: 100 people, 21 managers
- Collecting data from this management team:
  - N = 21
- Completed the questionnaire:
  - "Who would Steve Boise go to for help or advice at work?"
  - Listed each of the other 20 managers below the question.
  - Mark a check beside the names of all the people that Steve Boise is likely to go to.
- There are 21 slices, 1 Locally Aggregated Structure (intersection), 1 Consensus Structure.

$$\mathscr{R}'_{i,j} = \begin{cases} 1 & \text{if } \frac{1}{21}\sum_{k=1}^{21}\mathscr{R}_{i,j,k} \geq 0.5, \\ 0 & \text{otherwise.} \end{cases}$$

An Empirical Example

- Locally Aggregated Structure

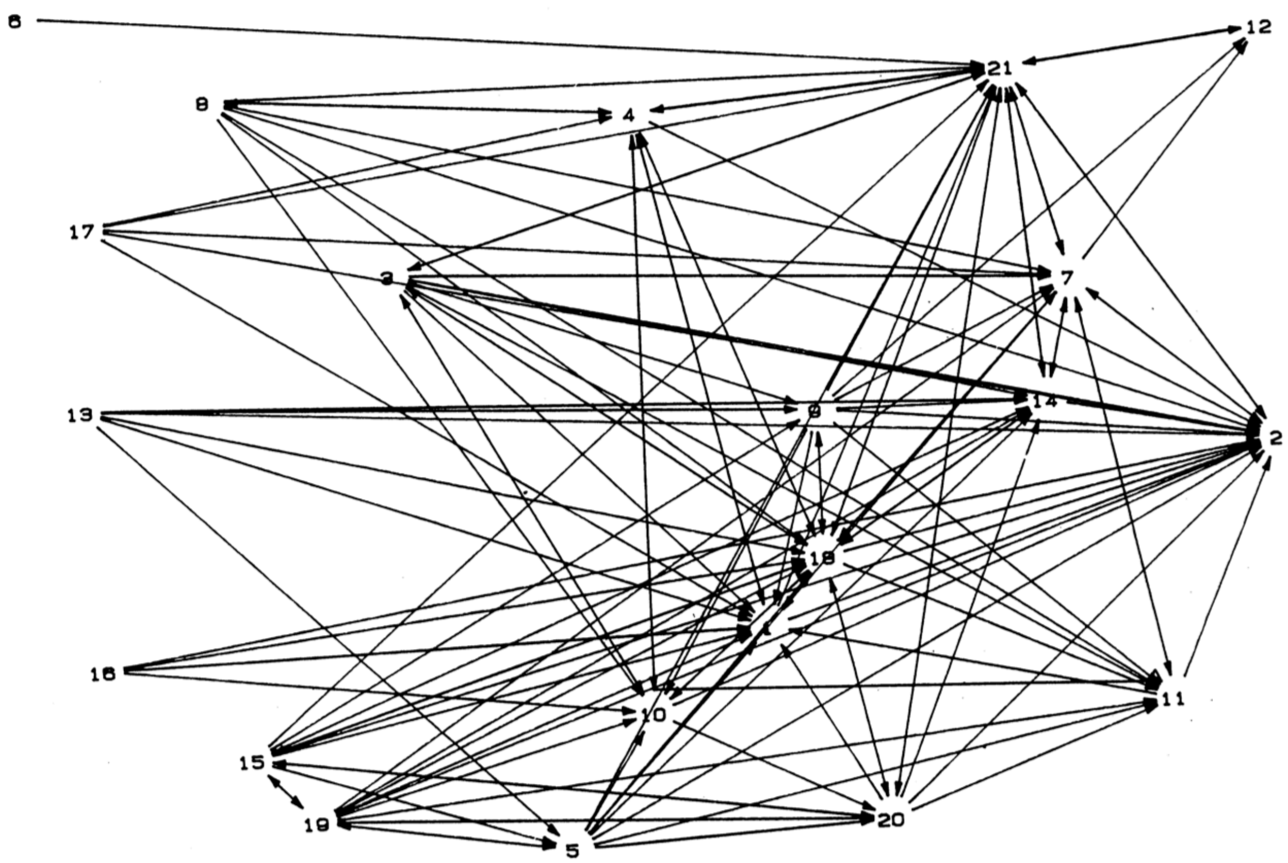


Fig. 1. Sociogram of locally aggregated structure.

An Empirical Example

- Person 15's slice:

$$
15 = \begin{pmatrix}
010000000010001001000 \\
100010100000011001100 \\
010000100000011001000 \\
010000010000000000001 \\
010000100010011001110 \\
000010100000011010101 \\
010000000000010000001 \\
000000000000000000001 \\
000000000000011000000 \\
000000000000000001000 \\
010010100000011001100 \\
000001000000000000001 \\
000010001000011000100 \\
011010101000001001111 \\
111111111111110111111 \\
010000000000000000000 \\
000001000000000000001 \\
000000100010011010000 \\
000010000000011000000 \\
000000000000011000000 \\
010000100000010000000
\end{pmatrix}
$$

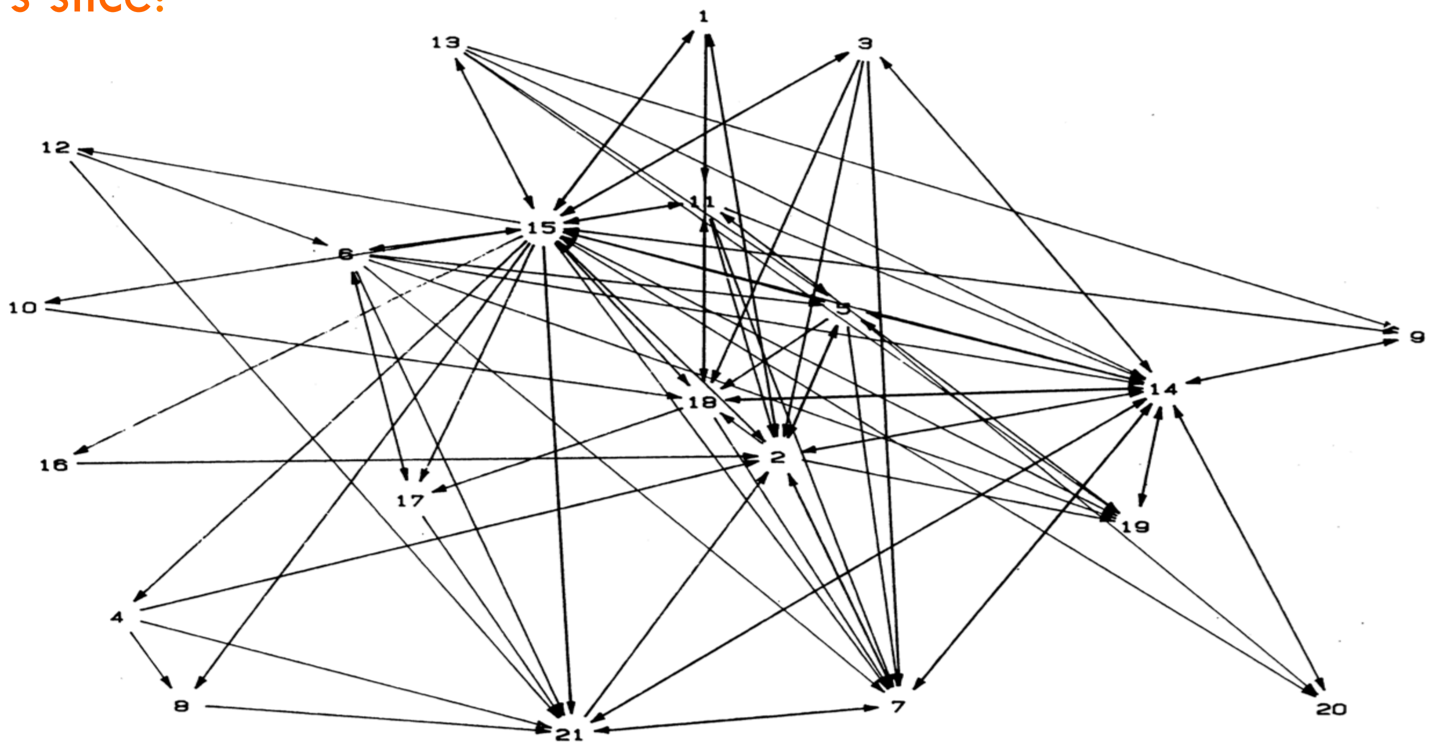


Fig. 3. Sociogram of person 15's slice.

An Empirical Example

- To formalize these qualitative observations, centrality measures were calculated for each individual in each the three aggregations: their own Slice, the LAS and the CS.
- The centrality measures computed were: indegrees, outdegrees, and betweenness.
- The difference in patterns from one person to the next across the aggregations.
  - Person 15:

k	*k*'s Slice			Locally Aggr			Consensus		
	Indg	Outdg	Betw	Indg	Outdg	Betw	Indg	Outdg	Betw
15	12	20	$\boxed{81.15}$	3	9	$\boxed{0.70}$	0	5	$\boxed{0.00}$

An Empirical Example

Table 1
Centrality scores (indegree, outdegree, and betweeness) for each individual (k) based on the three separate aggregations

k	k's Slice			Locally Aggr			Consensus		
	Indg	Outdg	Betw	Indg	Outdg	Betw	Indg	Outdg	Betw
1	18	6	2.81	12	4	10.97	1	5	0.67
2	20	3	43.67	18	2	18.23	18	5	56.66
3	12	15	11.06	3	9	1.29	0	5	0.00
4	12	12	2.71	6	7	2.07	4	4	3.09
5	9	15	6.36	3	10	3.69	3	5	0.78
6	2	1	0.33	0	1	0.00	3	4	4.43
7	13	8	5.01	11	6	8.80	10	5	12.09
8	1	8	2.29	1	7	0.87	1	4	0.63
9	10	13	26.17	4	9	8.76	2	5	0.00
10	13	14	19.42	8	5	4.53	2	1	0.00
11	14	3	40.78	9	3	3.15	7	4	3.07
12	8	2	0.93	3	1	0.00	2	2	0.00
13	0	6	9.38	0	6	0.20	0	7	0.17
14	19	4	17.01	10	4	2.76	12	5	10.32
15	12	20	81.15	3	9	0.70	0	5	0.00
16	0	4	2.83	0	4	0.11	1	5	3.00
17	1	5	14.63	0	5	0.28	0	5	4.43
18	17	17	19.64	15	12	13.95	16	5	38.26
19	4	11	12.22	2	10	1.44	3	6	2.07
20	12	12	65.35	6	7	1.60	2	4	0.42
21	18	11	7.86	15	8	31.59	8	4	14.53

An Empirical Example

- Does the position of the individual in the network affect his/her perception of the network?
  - Position: central, or periphery
- Obviously, there is a relationship between *k*'s centrality and the network from *k*'s point of view.

Conclusion

- Depend on the results of empirical research, we can conclude that: “Perceptions are real in their consequences, even if they do not map one-to-one onto observed behaviors”.
- And the author also recommend that, the future research should not focus on comparing the importance of behaviors and cognitions. We need to show the consequences of each behavior and cognition.