NetSciX2026: International School and Conference on Network Science
February 17^{th}-20^{th}, 2026 - Auckland, New Zealand

Estimating latent structure in perceptions of social networks with multilayer Aggregated Relational Data

Keywords: Aggregated Relational Data, Cognitive Social Structures, multilayer networks, network sampling, survey methods

Extended Abstract

The study of social networks often concerns itself with the notion of a *true* network. For a given relationship type, the true network is typically defined by what is captured when asking each individual about their own relationships. The study of cognitive social structures (CSSs) [1] made a radical departure from these approaches by proposing that individuals' *perceptions* provide valuable information about the network, and through them, multiple notions of the network exist. CSSs capture information present, but usually ignored, in our social networks: our (varied) perceptions of the social structure.

Traditional analyses of CSSs have focused on identifying individuals' accurate (or inaccurate) perceptions of their network. If the scope of a research question is to compare misperceptions, collecting data is arduous. In a complete CSS survey, each person in a population is asked to report on not only their own connections in the population, but also on their *perceptions* of *everyone's* connections. In a community of n people, this necessitates asking each person about $n(n-1)$ different relationships *(do you think i and j are friends?)*. To weigh the infeasibility of this survey task, consider that for even a small community of 20 individuals, each person is asked to report on a total of 380 possible connections. As such, the few available CSS datasets are small or have structured missingness [e.g., 1–3].

However, when people are asked to perceive their social networks, theoretical and empirical work tells us that they rely on heuristics, to do so [4–6]. Recent CSS work departs from the emphasis on studying *accuracy* in social perceptions towards the aim of identifying *structure* in the perceptions of a social network [7, 8]. Finding structure amongst these perceptions reveals how individuals categorize which traits of their peers are meaningful in defining friendships, and how they rely on *relational schema* [4]—assumptions about how the characteristics of others determines relationships between them—in perceiving their social networks.

If finding statistically significant structure in network perceptions is the main goal of studying a population, the limited available CSS datasets are insufficient in two glaring respects: (i) with such a small population, any method which relies on a statistical test is unreliable, and (ii) the populations are likely too small for a person necessarily rely on heuristics to cognitively store and navigate the network. In such cases, it is thus necessary to have perceived social network data for much larger populations.

In this work, we propose a novel approach for circumventing a complete CSS survey by extending the method of collecting aggregated relational data (ARD)—which consists of asking respondents to estimate the number of connections they have to people with a particular trait—to the setting where we aim to collect multiple perceptions of relationships across given traits.

To extend the approach of ARD for collecting perceived network data, we consider data of the form *"What proportion of i's connections do you think are to people with trait m?"* (see Figure 1). To identify latent structure using this data, we propose an adaptation of the SBM algorithm in [9] to consistently estimate latent structure across these perceptions. The proposed algorithm identifies C *cognitive communities* which describe the latent structure of the varied perceptions—individuals in the same cognitive community rely on the same relational schema in their perceptions. Within each perception cluster c, we invoke the algorithm from [9] to identify K_c *social communities* which describe how individuals are categorizing the socially relevant

traits of others in their community. The remaining SBM parameters for the cth perception cluster can be estimated using the equations from [9]. More specificially, our proposed algorithm consistently identifies C different SBMs which concisely describe the latent structure of the n different perceptions of the network, thereby identifying the strata multilayer SBM from [10].

Considering data collection in this way not only allows for much larger perceptual networks to be collected than historically possible, but also for the flexibility to collect perceptual networks of acquaintances, hard-to-reach populations, or of a general (perceived) population. Furthermore, if the purpose of collecting a perceptual network is not to identify particular discrepancies across perceptions, but rather to identify *latent structure* in how people are assuming and perceiving connections within their social network, collecting data in this way has potential to invoke these assumptions and schema much more concretely.

References

[1] David Krackhardt. "Cognitive social structures". In: *Social networks* (1987).

[2] David Krackhardt. "Assessing the political landscape: Structure, cognition, and power in organizations". In: *Administrative science quarterly* (1990).

[3] Eric Feltham, Laura Forastiere, and Nicholas A Christakis. "Cognitive representations of social networks in isolated villages". In: *Nature Human Behaviour* (2025).

[4] Mark W Baldwin. "Relational schemas and the processing of social information." In: *Psychological bulletin* (1992).

[5] Judith A Howard. "A social cognitive conception of social structure". In: *Social Psychology Quarterly* (1994).

[6] Matthew E Brashears. "Humans use compression heuristics to improve the recall of social networks". In: *Scientific reports* (2013).

[7] Juan Sosa and Abel Rodríguez. "A latent space model for cognitive social structures data". In: *Social Networks* 65 (2021).

[8] Izabel Aguiar and Johan Ugander. "The latent cognitive structures of social networks". In: *Network Science* 12.3 (2024).

[9] Emily Breza et al. "Consistently estimating network statistics using aggregated relational data". In: *Proceedings of the National Academy of Sciences* 120.21 (2023).

[10] Natalie Stanley et al. "Clustering network layers with the strata multilayer stochastic block model". In: *IEEE TNSE* (2016).

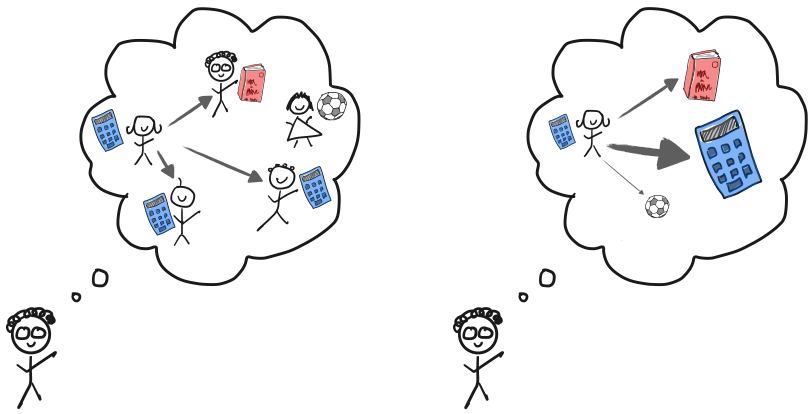

Figure 1: CSS data requires asking each person in a population for their perception of each person's possible relationships (left). We adapt ARD to estimate latent structure across perceptions using individuals' perceptions of the proportion of others' friendships across people with different traits (right).