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Community formation at IC^{2}S^2 2017

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Extended Abstract

During the 3^{rd} International Conference on Computational Social Science IC^{2}S^2, July 10-13, 2017, Cologne, Germany, face-to-face interactions were recorded using sociometric badges of the SocioPatterns platform. These badges record an interaction when two persons face each other within a distance of 1.5 meters. The data has recently been made publicly available [Génois et al., 2022]. The stated goal of IC^{2}S^2 2017 was "to create a broad and interdisciplinary community of researchers, including academics, tech industry workers, open data activists, government agency workers, and think tank analysts, who are committed to advancing social science knowledge through computational methods." [IC^{2}S^2, 2017] Can a process of community formation be observed during the event?

We operationalize community formation as the emergence of a pattern in face-to-face interaction network structure. A pattern emerges (a) when conference attendees increasingly achieve a *consensus* on the pattern they observe and (b) when there is increasing pattern *reproduction*, that is, when the similarity of patterns at times t and $t+1$ increases with t [Flack, 2017]. There are many ways to measure patterns. Community detection is a possibility, but it fails at detecting core/periphery structure where the network periphery can be a latent community of conference attendees with equivalent network positions. Here, we use the Bayesian Stochastic Blockmodel (SBM) because it allows for detecting core/periphery structure in addition to community structure [Peixoto, 2019]. Using the SBM in the context of emergence means that we assume that blockmodeling is an order-creating mechanism. Since the SBM is a stochastic model, the inferred node partition will differ for model runs. This allows us to measure the pattern consensus among conference attendees as the partition similarity of independent SBM runs where the latter are assumed to represent individual observations. Pattern reproduction is then the similarity of consensus partitions over time.

The SocioPatterns badges record face-to-face interactions in 20 seconds intervals. **Figure A** shows that there was activity in more than 5000 such intervals and that activity is much higher during breaks than during talks. This prevents us from using clock time to aggregate network snapshots which are to be blockmodeled. Instead, we build on percolation theory to construct snapshots with variable duration. The criterion to stop aggregation is when the largest connected component contains about half of the nodes. **Figure B** depicts the durations of the snapshots and the average attendee degrees in those snapshots. The dashed horizontal lines mark the average degree k_c per conference day (the shaded area marks two standard deviations). k_c decreases day by day, that is, it takes fewer interactions with other attendees, on average, for the largest connected component to form. This is the first sign of community formation. **Figure C** shows that consensus increases over normalized time. Each data point represents a network snaphot, and the positive and significant slope indicates that conference attendees are increasingly agreeing on the pattern they observe. **Figure D** shows that reproduction also increases significantly. That means, the consensus pattern in a network snapshot is increasingly predictive of the subsequent pattern. We conclude that these are early signs of community formation at IC^{2}S^2 2017.

References

Jessica C. Flack. Coarse-graining as a downward causation mechanism. *Philosophical Transactions of the Royal Society A*, 375(2109):20160338, 2017. doi: 10.1098/rsta.2016.0338.

Mathieu Génois, Johann Schaible, Maria Zens, Marcos Oliveira, and Markus Strohmaier. SocioPatterns conferences dataset - Contact data. *SowiDataNet | datorium*, 2022. doi: 10.7802/2351. Version 1.0.0.

IC^{2}S^2. Call for papers. `https://easychair.org/cfp/IC2S2-2017`, 2017.

Tiago P. Peixoto. Bayesian Stochastic Blockmodeling. In Patrick Doreian, Vladimir Batagelj, and Anuška Ferligoj, editors, *Advances in Network Clustering and Blockmodeling*, pages 289–332. Wiley, 2019. doi: 10.1002/9781119483298.ch11.

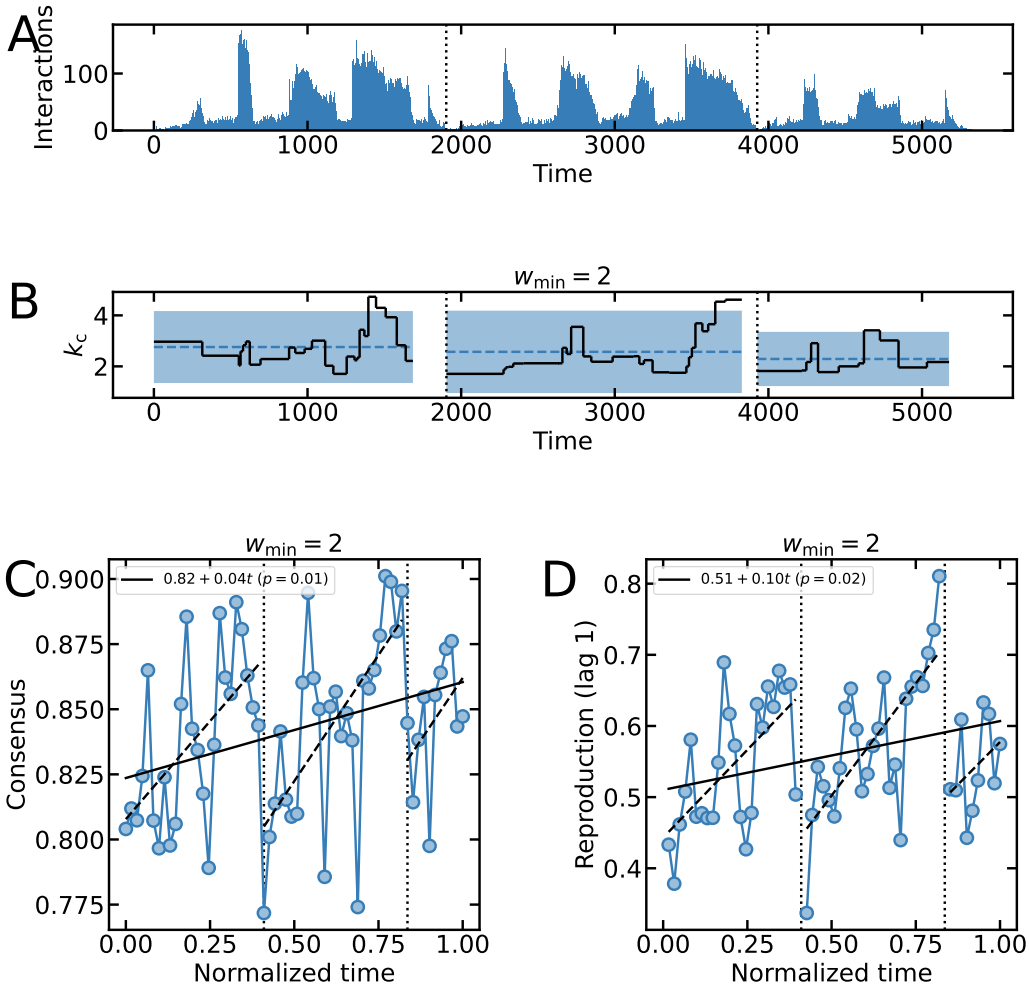

Figure 1: Snapshot construction and community formation at IC^{2}S^2 2017