Assembly in Populations of Social Networks

Abigail Z. Jacobs
University of California, Berkeley
Berkeley, CA 94720, USA
azjacobs@berkeley.edu

Abstract
In-depth studies of sociotechnical systems are largely limited to single instances. Network surveys are expensive, and platforms vary in important ways, from interface design, to social norms, to historical contingencies. With single examples, we cannot in general know how much of observed network structure is explained by historical accidents, random noise, or meaningful social processes, nor can we claim that network structure predicts outcomes, such as organization success or ecosystem health. Here, I show how we can adopt a comparative approach for settings where we have, or can cleverly construct, multiple instances of a network to estimate the natural variability in social systems. The comparative approach makes previously untested theories testable. Drawing on examples from the social networks literature, I discuss emerging directions in the study of populations of sociotechnical systems using insights from organization theory and ecology.

Author Keywords
social networks; organizational ecology; populations of organizations; social network assembly

ACM Classification Keywords
H.5.3 [Information interfaces and presentation (e.g., HCI)]; Group and Organization Interfaces; J.4 [Social and Behavioral Sciences]
In the late 1960s, the ecologist E.O. Wilson led an experiment: he and collaborators fumigated six small islands, destroying all fauna. This experiment built off his 1967 text *The Theory of Island Biogeography*, which emphasized the opportunity of studying *islands as microcosms* of large, complex ecological systems [14]. Islands across comparable environmental conditions act as a sensible unit of observation with well-defined boundaries: for Wilson, observing the cleared islands revealed the empirical similarities and variation in the assembly of new ecological communities. Contemporaneously, sociologist Peter Blau argued for “the systematic comparison of a fairly large number of organizations in order to establish relationships between their characteristics” [3]. However, major comparative studies remain a challenge in both fields. Now, complex sociotechnical ecosystems characterize our homes, social lives, and workplaces, making this challenge as relevant as ever. With the promise of newly available sources of data, we can explore how complex, interrelated underlying social processes shape the structure of these systems. Focusing on network structure, we are left with the same challenge confronted fifty years ago: with single examples of social systems, we can not in general know the degree to which observed network structure is explained by historical accidents, random noise, or meaningful social processes. Nor can we claim that network structure predicts outcomes, such as organization success or ecosystem health.

Why populations of networks? How do we show that how the structure of sociotechnical systems meaningfully varies with social and organizational properties? Analysis across multiple platforms is undoubtedly useful; however across instances of different platforms, ruling out variation due to platform differences or historical idiosyncrasies is nontrivial. In contrast, among sociotechnical systems of comparable origin or generating process, we can take a population-level approach, where we can characterize variation across a population of social systems. Uncontroversially, evidence for specific empirical social phenomena is more compelling when shown across multiple instances of comparable social systems. Hill and Shaw persuasively argue for the population-level study of communities across a single medium, and we follow in their steps here [9].

**Social network assembly** We draw on the ecological notion of *community assembly*, which reflects the complex, overlapping processes contributing to community formation [21]. These processes have direct analogs in sociotechnical systems: composition of the current community; ordering effects (which group arrives earliest may set constraints on who may join, or set norms for behavior); competition within and between systems; and natural limits on growth (due to local or global resources) [13]. Just as islands were necessary to study community assembly, here, I show how

---

For example, high school is as bad as you thought: status predicts social structure in a population of 100 high school social networks [1]. In that setting, as here, the focus is on “finite populations,” drawn from comparable generating processes (100 schools, one name generator), not multiple draws from the same process (e.g., 100 observations of one school).

Paraphrasing Hill and Shaw, they highlight the benefits of such a perspective: generalizability of results across online communities; the ability to study community- or organization-level attributes and outcomes; insight into diffusion between communities, e.g., across platforms; insight into ecological dynamics, extending the organizational ecology approach to online systems; and insight into multilevel processes, merging individual-level dynamics with understanding of meso- and macro-level processes [9].

---

Borrowing from Blau: “the comparative method, in the broadest sense of the term, underlies all scientific and scholarly theorizing” [3].
we can adopt a comparative approach for settings where we have, or can cleverly construct, multiple instances of a network (Fig. 1). This approach allows us to estimate natural variability in social systems and tease apart the social processes underlying network assembly.

Boundaries of sociotechnical systems To empirically study populations of social systems, we must define inclusion criteria for a set of users. These criteria determine the boundary of or within a sociotechnical system. For example, we might consider all registered users of a platform, or all eligible individuals—e.g., all individuals with a harvard.edu email address in 2004 (see panel). These properties can be defined exogenously from the platform, for example, platform members with a shared offline affiliation, such as an alma mater, team, or employer [12, 13, 17, 22]. These properties can also be endogenous to the platform, such as Reddit communities or Facebook groups. In both settings, the onus is on the researcher to empirically or experimentally defend the degree to which interaction between communities affects interactions within the community. We can then study network assembly—processes such as product adoption or the emergence of norms—by looking at interactions within our bounded populations.

Empirical assembly and diversity We can exploit these boundaries to empirically explore assembly. For example, university affiliations reveal that Facebook adoption rates reflected students’ shared geography [13]. Across a population of peer production systems, norms are set and entrenched by early settlers of wiki governance arms [18, 19]. Organizational ecology also seeks to understand the diversity and sources of heterogeneity across and within organizations [2]. Even among organizations of similar types—firms within the same industry, or gaming systems with shared plug-ins—recent work reveals a wide diversity across organizational forms [6, 12] (see panel, next page). It is impossible to fully characterize organizational diversity without studying systems that fail; fortunately, these settings can be cleverly empirically designed [6, 8, 19]. To understand diversity within organizations, we can characterize communities with overlap in properties, goals, and membership as belonging to the same niche [22]. Within the same niche, communities must either compete for members or resources, or otherwise some mechanism must allow them to coexist. In online settings, similar groups suffer competition from sharing members [20]; moreover, competition is more intense among communities with users with shared offline affiliations [22]. Turmoil within a community can drive migration [16]; sufficiently diverse platforms, however, can support the emergence of new niches—for example counterpublics of non-dominant but cohesive communities [10].

Discussion The comparative perspective enables us to quantify effects of policies on platforms, how norms emerge, how organizational structure reflects their environments, and how structure reinforces desirable (or undesirable) outcomes for individuals, organizations, and systems of platforms. While experiments across networks are usually limited to virtual lab settings (e.g., [4, 15]) and observational data reveal a noisy, incomplete representation of a system [7], future work will progress by developing empirical strategies for observational data. Despite a plethora of enterprise communication and task-based systems and multi-community online platforms such as Reddit, Wikia and StackExchange, this area remains underdeveloped. Organizational ecology provides novel opportunities to understand populations of sociotechnical systems. While still rare, this is a compelling area for future research.
Acknowledgments

The author thanks Kristen Altenburger, Aaron Clauset, Aaron Shaw, Johan Ugander, and Duncan Watts for helpful conversations during the development of this work.

References

[1] B Ball and MEJ Newman. 2013. Friendship networks and social status. Network Science 1, 1 (2013).
[2] JA Baum and Andrew V Shipilov. 2006. Ecological Approaches to Organizations. In The Sage Handbook of Organization Studies. Sage, Chapter 2, 55.
[3] Peter M Blau. 1965. The comparative study of organizations. ILR Review 18, 3 (1965), 323–338.
[4] D Centola and A Baronchelli. 2015. The spontaneous emergence of conventions: An experimental study of cultural evolution. PNAS 112, 7 (2015), 1989–94.
[5] AK Fahimipour and AM Hein. 2014. The dynamics of assembling food webs. Ecol. Lett. 17, 5 (2014).
[6] S Frey and RW Sumner. 2018. Emergence of complex institutions in a large population of self-governing communities. arXiv:1804.10312 (2018).
[7] D Gaffney and JN Matias. 2018. Caveat Emptor, Computational Social Science: Large-Scale Missing Data in a Widely-Published Reddit Corpus. arXiv:1803.05046.
[8] BM Hill. 2013. Almost Wikipedia: What Eight Early Online Collaborative Encyclopedia Projects Reveal about the Mechanisms of Collective Action. In Essays on Volunteer Mobilization in Peer Production. Ph.D. Dissertation. MIT.
[9] BM Hill and A Shaw. 2017. Studying Populations of Online Organizations. Oxford U. Press.
[10] SJ Jackson and B Foucault Welles. 2015. Hijacking#myNYPD: Social media dissent and networked countercultures. J. Comm. 65, 6 (2015), 932–952.
[11] AZ Jacobs. 2017. Comparative, Population-Level Analysis of Social Networks in Organizations. Ph.D. Dissertation. University of Colorado Boulder.
[12] AZ Jacobs and D Watts. 2018. When do networks matter? A comparative study of informal social networks in firms. Preprint (2018).
[13] AZ Jacobs, SF Way, J Ugander, and A Clauset. 2015. Assembling thefacebook: Using Heterogeneity to Understand Online Social Network Assembly. Proc. ACM WebSci (2015).
[14] RH MacArthur and EO Wilson. 1967/2001. The Theory of Island Biogeography. Princeton Univ. Press.
[15] A Mao, W Mason, S Suri, and D Watts. 2016. An experimental study of team size and performance on a complex task. PloS one 11, 4 (2016), e0153048.
[16] E Newell, D Jurgens, HM Saleem, H Vala, J Sassine, C Armstrong, and D Ruths. 2016. User Migration in Online Social Networks: A Case Study on Reddit During a Period of Community Unrest. In ICWSM.
[17] Tuan Q Phan and Edo M Airoldi. 2015. A natural experiment of social network formation and dynamics. PNAS 112, 21 (2015), 6595–6600.
[18] A Shaw and BM Hill. 2014. Laboratories of oligarchy? How the iron law extends to peer production. J. Comm 64, 2 (2014), 215–238.
[19] N TeBlunthuis, A Shaw, and BM Hill. 2018. Revisiting The Rise and Decline in a Population of Peer Production Projects. In CHI. ACM, 355.
[20] X Wang, BS Butler, and Y Ren. 2013. The impact of membership overlap on growth: An ecological competition view of online groups. Org. Sci. 24, 2 (2013).
[21] BH Warren, D Simberloff, RE Ricklefs, and others. 2015. Islands as model systems in ecology and evolution: Prospects fifty years after MacArthur-Wilson. Ecol. Lett. 18, 2 (2015), 200–217.
[22] H Zhu, J Chen, T Matthews, A Pal, H Badenes, and RE Kraut. 2014. Selecting an effective niche: an ecological view of the success of online communities. In Proc. CHI. ACM, 301–310.