
Article

Studying Networks in Complex Problem Domains: Advancing Methods in Boundary Specification

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ABSTRACT

The application of network perspectives and methods to study complex problem and policy domains has proliferated in the public management literature. Network metrics are highly sensitive to boundary decisions as findings are a direct reflection of who and what was considered to be part of the network. The more complex the problem domain, the messier the network and the more challenging it is for researchers to determine network boundaries. Laumann, Marsden, and Prensky's seminal (1989) article on network bounding highlighted the theoretical and methodological significance associated with determinations of network boundaries in social network research. However, despite an expansion of network scholarship, the advancement of frameworks aimed at assisting scholars in thinking through the relative advantages and disadvantages of different boundary determinations has received limited attention. This article addresses this gap. Drawing insights from three network studies, we argue that problem domain characteristics and concerns such as formal structures, isolates, disconnected subgroups and/or the duration of the ties will be differentially emphasized with different boundary approaches. We leverage these insights to advance a framework for aiding network scholars working in complex problem domains to consider the strengths and limitations of varied bounding approaches in relation to the question at hand.

Introduction

Imagine a situation in which two public management researchers share a common interest in network structures that promote effectiveness in managing complex problem domains. Unbeknownst to each other, they both carry out a network study on a mid-sized community in the Midwest which has received national acclaim for its achievements in reducing homelessness. Both researchers are interested in mapping the structure of the coordination patterns underlying the community homelessness response network. However, neither researcher is from the area and has limited a priori knowledge of the community.

The first researcher learns about a collaborative network convened by the Governor's Task Force to End Homelessness comprised of representatives from 23 different organizations and agencies. Asking each of the representatives in this group to indicate whom of the 22 other members they coordinate with directly, this network scholar suggests, based on their findings that effective network governance is facilitated by network centralization around a network administrative organization. The second researcher, unaware of the Governor's Task Force group, spends time identifying representatives of prominent organizations and agencies engaged in homelessness prevention work. Using

an initial list of 10, the second researcher conducts interviews asking informants to identify others with whom they coordinate directly resulting in the identification of 47 organizations. Based on their findings, researcher two suggests that effective networks are relatively decentralized and densely connected. Thus, two researchers interested in the same question in the same community, each using network methodologies that have precedence in the existing literature, create data on coordination patterns that support contradictory conclusions. Is this possible, you ask? Absolutely. In this article, we describe the challenges and consequences of boundary determinations when applying network perspectives to gain insight into complex problem domains. We do this with an eye toward offering a framework to aid scholars in critically considering the features of the domain to both inform and justify their boundary decisions.

Social network theory, constructs, and methods provide a valuable toolkit for understanding the social structure and processes that underlie human responses to complex problem domains (Borgatti, Everett, and Johnson 2013; Hennig et al. 2012; Wasserman and Faust 1994). Post-modern theorists remind us that all scholarship is interpretive and what one “finds” in scholarly enterprise is a function of how one asks the question, the methods one uses to answer it, and the lens one uses to interpret the resulting findings. Network science, in particular, requires significant interpretive decisions in design, analysis, and interpretation. However, the field has given limited attention to considering how different network methods may emphasize certain features of social structure while systematically obscuring others. This is especially relevant in terms of our knowledge about how we bound networks for the purposes of quantitative network analysis. Given the proliferation of network research in the field of public management, it is timely that we critically reflect upon the ways in which we bound networks in studying institutional responses within complex problem domains and how design choices may influence our understanding of those domains.

Many public management scholars have embraced a narrow use of the term “network,” referring specifically to a formal, multi-organizational entity with presumably clear boundaries (e.g., Provan and Kenis 2008). However, a network perspective is far more versatile and can be usefully applied to aid in understanding a broad range of social phenomenon among a group of interdependent actors, even when network boundaries are fuzzy and dynamic (Brass et al. 2004). Across many fields in the social, health, and environmental sciences, there is increasing recognition that many significant public issues facing local communities are in fact interconnected sets of

problems (Trist 1983), which collectively form problem domains (Ackoff 1999; Arias et al. 2000; Lasker and Weiss 2003). Problem domains are influenced by the actions and decisions of numerous interdependent actors seeking to manage the domain (Rethemeyer and Hatmaker 2008).

A key challenge in the study of formal and informal responses within complex problem domains is that they are, by definition, ill-defined, leaving it up to the scholar to make determinations concerning who is and is not to be considered part of the network when using network methods. To further complicate boundary specifications, networks are social constructions that may look and be evaluated differently depending on whose perspective is being privileged (Nowell et al. 2016; Mandell and Keast 2008). For example, network actors may differ from each other in their understanding of who belongs to or within the network. Further, scholars may differ in their perspectives about a network relative to those actors involved in the network (Mandell and Keast 2008; Turrini et al. 2010). Finally, two scholars may study the same social phenomenon yet draw the boundaries of the network differently. Consequently, challenges relating to network boundary determinations are endemic to all network research. They are particularly germane when applying a network perspective to gain insight about social structure that undergirds complex problem domains (Weber and Khademian 2008).

The solution for researchers (and reviewers) is to be clear about the relative advantages and disadvantages of a given boundary decision. Transparency, deliberate consideration of boundary consequences, and evidence of informed choices are all reasonable responses to the challenges of dealing with boundary specification with messy networks in complex problem domains. In 1989, Laumann et al. warned scholars of the methodological and theoretical significance associated with boundary determinations in network research. Despite this, decisions concerning how network boundaries are determined are rarely discussed or critically examined and the extant literature provides little advice to guide a scholar's decision or to consider the consequences of their design choices.

The goal of this article is two-fold. First, we consider the methodological strengths and limitations of Laumann et al.'s (1989) three bounding approaches when applying a network perspective to the study of messy problem domains. Second, we offer a decision framework to aid researchers and reviewers in critically assessing the appropriateness of any given boundary approach based on key characteristics of the research context and focal research question. To ground this discussion in real world application, we review Laumann et al.'s. (1989) framework as it

corresponds to three whole network studies drawn from our own research, allowing us the opportunity to reflect upon the research team's thought processes that guided each study's design, how network boundary and problem domain characteristics are linked, and the consequences of these linkages on the interpretation of findings. We do this with an eye toward offering a framework for aiding researchers in considering strengths and limitations of different approaches under different contexts.

NETWORK BOUNDING

The topic of network boundaries is situated in the literature within the larger conversation around social network analysis. To date, the attention to network boundary considerations has been largely descriptive (Crona and Bodin 2011; Ernstson 2011; Isaac and Dawoe 2011; Prell, Reed, and Hubacek 2011; Ramirez-Sanchez 2011; Sandström 2011; Tindall, Harshaw, and Taylor 2011), with some attention to the challenges and complexities associated with establishing network boundaries (Bodin and Prell 2011; Borgatti et al. 2013; Frank 2011; Marsden 2005; Zuckerman 2003). Frank (2011) characterizes network boundary definitions as a key potential pitfall of social network analysis. He emphasizes this is a function of the analytic practices rather than from a data characteristic perspective (Frank 2011, 18). Sandström (2011) acknowledges the necessity of empirically based network boundary definitions. She points out that although empirical approaches are needed, governance networks pose complexities stemming from possible incongruences among formal hierarchical networks and informal "real-world networks of governance" (Sandström 2011, 239). Bodin and Prell developed a classification system to help "organize one's thinking about defining appropriate system boundaries" (Bodin and Prell 2011, 354). This classification scheme is designed with natural resource governance networks in mind and uses a network characteristic, the extent to which the system is open or closed, to aid the researcher in thinking about relevant actors and ties within that system.

Barnes discussed boundary definition as the problem of "where to set the limits in the analysis of social networks that in reality do not have any obvious limits at all" (Barnes 1979, 414). Wasserman and Faust underscore this, explaining, "to study a network, we must be able to enumerate a finite set of actors to study," (Wasserman and Faust 1994, 32). This is critically important as the way researchers bound networks has implications for their findings. For example, popular network metrics such as density and centrality are only interpretable in reference to a clearly delineated network boundary. Further, most network metrics

are highly sensitive to changes in network boundaries (Provan, Fish, and Sydow 2007). For example, a central actor in a network as conceptualized using one set of bounding criteria may be a peripheral actor under different boundary criteria (Wasserman and Faust 1994). This requires a network researcher interested in whole networks to make a significant interpretive move in designing their research, drawing a line around who is and is not considered.

Consequently, network researchers literally give shape to the phenomena they seek to study through the boundary choices they make. Methods and theory for approaching networks in complex problem domains cannot be separated; they are inherently linked in how researchers think about a network, how they bound it, and study it. This linkage also affects the data researchers analyze and the conclusions they can draw.

Bounding Approaches

In 1989, Laumann and colleagues published a conference paper that has become one of the foremost-cited pieces of literature for scholars seeking to characterize their research methods related to network boundary decisions in whole network studies. In this article, the authors offer three methodological alternatives for identifying who is considered "in" and who is "out" of a focal network of interest. These three approaches are: (1) actor characteristics, (2) relations, or (3) events/activities. Used independently, or in combination, the application of these approaches provides the methodological decision rules for defining a network as an entity worthy of investigation.

Real world case examples can offer valuable insights into the capabilities and limitations of these different approaches to bounding to advance a discussion of the methods for and consequences of different approaches to bounding. Here, we consider case examples of three whole network studies from our own research portfolios and describe how each was bound by the researcher or research team. Each example study employs a different boundary approach to identify a network of interest within a complex problem domain. The first example primarily leverages an actor-characteristic bounding approach among individuals involved in community health initiatives. The second example uses a variant of an actor relations approach to conceptualize a policy network associated with the regulation of genetically modified organisms (GMO). Our final example applies an event/activity approach to study interactions within a disaster response network. In the section below, we briefly summarize each network bounding approach as outlined by Laumann and colleagues (1989) followed by a methodological description and critical reflection of this approach as it was used to define the network of

interest in the corresponding example case. Our goal is to illustrate different methodological approaches to bounding based on previous research rather than creating de novo research.

An Investigation of Networks in Community Health Promotion: Actor Characteristics Approach

Network boundaries based on actor characteristics identify network members based on some a priori attribute or affiliation. For example, actors may be identified because they all went to a given university, are members of a fraternity, or are known leaders within a given community. In this approach, there is no a priori assumption of any particular interpersonal or inter-organizational linkage among network members. Rather, the network is defined purely as actors who share a common characteristic and allows the researcher to investigate where linkages exist among this set of actors. Laumann and colleagues further delineated two common methods to defining actor characteristics: (1) positional and (2) reputational. The positional approach is based on formal membership criteria, often associated with employment by an organization (Krackhardt 1990). The reputational approach relies on judgments of knowledgeable informants to determine if a participant actor fits a specific attribute (Laumann et al. 1989).

In our first example case, the research team studied membership interlocks among collaborative multi-organizational groups organized around health promotion working in the same community. These collaborative groups were defined as three or more organizations or agencies who self-identified as having a mission to improve health and wellness within a single county (Nowell, Yang, and Hano 2013). The network of interest was composed of organizations that participated in these groups within a specific county. Therefore, a *positional actor characteristic* sampling approach was used.

To establish the list of network members, the researchers started with the membership list from a large, cross-cutting collaborative group that served as a hub for identifying and coordinating efforts around health priorities within the county. Next, the team employed a snowball approach to identify other health-oriented collaborative groups within the community (Borgatti et al. 2013, 34–5). The team then contacted each group and obtained their membership list. The snowball sampling continued with each newly identified health collaborative until no new collaborative groups were identified. To supplement the snowball sampling, the research team conducted web searches to identify potential isolates, actors or subgroups that were disconnected from other network actors but fit the definition of a health collaborative

established above. In all, a total of 34 health-oriented collaborative groups were identified within the county.

Confirmed membership lists from each collaborative were then entered into a relational database and cross-referenced to identify organizations that shared common memberships across two or more collaborative groups. A two-mode network was then constructed which represented connections between organizations and collaborative groups via shared memberships, revealing a macro structure of health-oriented collaboration within the county (Nowell, Hano, and Albrecht 2017).

The resulting two mode network revealed a wide array of organizations engaged in health oriented collaborative groups within the county. They were connected through their membership to one or more of 34 different groups. If our research team had bounded the health service delivery network using a relational approach (see below), it would have created a more traditional study of “who collaborates with whom” at the dyadic level. This might have allowed the researchers to consider collaboration occurring strictly between two organizations, a structural feature not considered in our study. However, it would have also meant that the researchers would have missed understanding the broader institutional structures within which much of health-oriented collaboration took place. The advantage of sampling based on the positional actor characteristics in a health-oriented collaborative group was that those actors central to collaborative health-related activity in the county were captured as were those isolates and subgroups who had limited connection. Isolates are network nodes disconnected from the other nodes on the modeled relationship of interest. Further, it allowed the researchers to identify groups that had a high degree of overlapping memberships with other collaboratives and those that appeared to operate in complete isolation from the broader network.

This approach also provided representation of macro community structure as long as all health collaborative actors were involved in some type of health-related collaborative group. However, if important actors who shape health efforts within the county did not share this inclusionary attribute, the researchers’ understanding of this community system would be incomplete and potentially skewed. For example, the researchers noted that elected officials and funders were generally not members of these collaboratives. Therefore, this approach may obscure certain key elements in a community. In summary, the positional actor approach has the advantage of revealing the formal institutions and structures and inclusion of isolates and subgroups based on the actor characteristics, but will limit the ability to see a broader system or network that extends beyond these actor characteristics.

GMO Policy Coalition—A Relational Approach

Network bounding based on *actor relations* uses an a priori specified type of dyadic relationship to identify who is considered in the network. For example, a network researcher may choose to bound a service delivery network based on referral patterns such that an agency is included in the network if it refers to, or receives referrals from, another agency in the county. Sampling in this approach is generally based on a snowball design initiated by identifying the referral ties associated with an initial actor or set of actors and would continue until no new actors were identified in any referral ties associated with any actor.

The aim of our second case example was to describe the origins and evolution, structure and governance, and the management and leadership of a policy coalition opposed to various aspects of the United States' regulatory policy for GMO. Over the last 14 years, organizations and individuals within this network have engaged in various judicial and legal actions against the US federal government in an attempt to alter GMO regulatory policy. The organizations and individuals forming this policy coalition advocate a more precautionary regulatory approach to GMOs than the current US regulatory policy. A network perspective was deemed advantageous for understanding the structure of this group of individuals and organizations, and sought to identify whether the network was characterized by significant closure in terms of who cooperated with whom.

The actors in this setting did not self-identify as a network or formal group of any kind. Consequently, the network was bound based on an actor *relational approach* of cooperation as co-litigants on lawsuits related to GMOs or co-signatories on citizen petitions to regulatory agencies. The policy issue focus was limited to specific GMOs or release events where a GMO would be introduced to a new environment. To identify potential network participants, the researcher reviewed two types of legal documents, court filings and citizen petitions, from 2001 to 2014. The documents were downloaded from the Center for Food Safety (CFS) Web site. The court filings included complaints, motions, orders, injunctions, amicus briefs, and Supreme Court Opinions from lawsuits filed against the federal government. The court filings were reviewed to identify the list of organizational and individual plaintiffs involved in the lawsuit, all of which were considered actors in this network. The citizen petitions were submitted to various US agencies including the Federal Drug Administration, US Department of Agriculture, and US Fish and Wildlife Services requesting specific types of regulatory guidelines and actions. Citizen petitions were reviewed for organizations or individuals that signed the petition, and all signatories

were considered actors in the network. This bounding methodology identified a policy coalition of 152 organizations and 24 non-affiliated individuals that utilized legal actions to advocate for a more precautionary stance to the regulation of GMOs. As the CFS was the initial actor from which most others were identified, this actor was common to all legal proceedings investigated. Internet searches were performed to identify other US-specific GMO legal actions where the CFS was not involved, but this search did not reveal additional lawsuits.

The GMO policy network study revealed a picture of a policy coalition highly centralized around the CFS. The snowball sample of cooperative ties in the litigation was focused around CFS. Therefore, this sampling approach carried with it the risk that the resulting network was not a representation of the national GMO policy network but rather captured only a sub-set represented by the extended ego network of the CFS. A confirmatory alternative sampling strategy was used to mitigate for this risk. Internet searches were used to identify US-specific GMO legal actions where CFS was not involved, which is a modification of an event-based sampling strategy. None were identified which provided additional confidence that CFS is, in reality, a highly central actor in this network. However, the risk remained that independent GMO-related litigation efforts were occurring in isolation of the core policy network. In network terminology, these actors would be referred to as isolates or potentially disconnected sub-groups. In addition, the GMO policy network based on cooperative relationships related to legal actions meant that organizations or individuals active in the policy network, but not involved in litigation, were excluded from consideration. For example, organizations who engaged in the national GMO debate solely via public awareness and advocacy efforts were excluded from consideration.

In summary, network bounding based on our example revealed that there were challenges to identifying formal institutions and structures due to the relational approach that centered on the CFS, but it did provide insight into the informal institutions and structures of the policy coalition. A relational approach also provided opportunities to explore network relationships over time and how they might evolve and change. Nonetheless, there were risks associated with missing isolates and disconnected subgroups, but these were mitigated by utilizing a second sampling strategy that emphasized an event based approach. Compensating for these relative weaknesses, the relational approach does provide a greater degree of confidence that those with clear relational ties to CFS were identified comprehensively.

Disaster Response Networks During a Large-Scale Wildfire—An Event Based Approach

In our third case example, organizations involved in transboundary disaster responses were studied using an event based approach. Transboundary disasters necessitate quick response in uncertain and dynamic conditions by a myriad of agencies representing multiple jurisdictions and operational areas (Ansell, Boin, and Keller 2010). Disaster response networks have been defined as “the collection of individuals, organizations, and agencies that have sustained involvement during the event who aim to serve the community in minimizing and coping with damages brought on by the disaster” (Nowell and Steelman 2012, 235). These networks are not static; as a whole, they must be able to maintain their ability to respond to an event while undergoing transformations as organizations and agencies become more central, decrease in centrality, or enter or exit the network. In this study, the goal was to understand communication patterns among actors within a disaster response network during a large-scale wildfire disaster.

To bound the network in this study, the research team utilized an *event based* sampling strategy. Building on a previously developed methodology used in other incidents (Stelman et al. 2014), any organization or informal group who became operationally engaged during an incident response was considered part of the network. This research developed an initial roster of incident responders based on operational areas of responsibility (i.e., evacuation, road closures, fire operations), then refined this roster based on who actually responded during a specific incident. Incident specific information about responders was collected and verified via interviews with Incident Management Team (IMT) members and emergency managers.

To define specific incident response networks, the researchers first contacted the Incident Commander from IMT responding to the wildfire event to confirm affected jurisdictions and host agencies involved. Researchers then contacted the Liaison Officer or equivalent position for the IMT and asked them to identify agencies and personnel engaged in responding to the fire. Members of the IMT Command and General Staff were also identified during this process. Personnel from host units and select county agencies were then contacted to confirm participation in the incident response network. Through this process, responders were identified and then surveyed about communication, coordination, and performance on the incident.

The wildfire response network was bounded based on participation in response to a specific wildfire event. This strategy provided researchers with a robust methodology for capturing the whole network, or full range

of actors involved, regardless of institutional affiliation or whether they engaged with the rest of the network. The ability to capture isolates and disconnected subgroups is a key strength of event based network sampling. This was deemed an appropriate approach in this case because in a disaster event, identifying isolates is important as they can be indicative of a coordination failure. However, because participation in the event is the criterion for inclusion, the resulting network failed to represent those who did not engage, but perhaps should have. Therefore, event participation sampling can be problematic if researchers want to situate findings to the broadest set of actors that *may* or *should* be engaged at different points in time within the complex problem domain. In these cases, positional actor characteristics or relational sampling would need to be used to augment research findings. Further, an event-based approach requires the authors to temporally bound what constitutes the beginning and the end of the event. The case of the disaster response networks, this was not so simple as the response phase of the incident often transitions organically into recovery and mitigation types of activities. This requires the researcher to make an additional interpretive move of deciding when the “response” event ends even though activities related to the incident may be on-going for months if not years to come. In our case, we used 65%–75% containment of the wildfire as our indication that the response phase of the incident was drawing to a close.

In summary, event based sampling is not a strong approach for identifying formal or informal institutions and structures or for covering phenomena that are considered more permanent. Because of the episodic nature of these events, exploring longer term network relationships or the duration of relationships over time is not ideal. It is a strong approach for capturing isolates and subgroups and useful in cases where the events themselves are of theoretical relevance. Caution should be used, however, in extrapolating findings from event based networks which are episodic to permanent networks. Further, scholars should carefully consider and be able to justify the temporal boundaries that will be used to constitute “the event”.

Costs and Considerations of Different Bounding Approaches

Each of the three approaches to bounding described here have distinct implications for determining which actors are included in the analysis, and which are excluded from consideration. Clearly, one approach is inherently no better than another. Laumann et al. noted these methods can be, and often are, used in combination. Although it may be tempting to consider automatically using all three approaches concurrently to avoid missing actors, this is likely to be

unrealistic. First, many complex problem domains do not have networks that conform to all three bounding approaches (e.g., lack of theoretically interesting events), so researchers would be in the position of shaping questions to fit bounding decisions, which is backward. Further, each of these methods carry a high-response burden on the part of participants. Collecting network data using all three methods separately would both create undue burden on study participants, meaning it would be unlikely to receive approval from a research institution and would suffer from very low response rates.

We identified distinct differences when we considered specific types of actors that were excluded from each of the networks described. Boundary determinations based on positional actor characteristics have strengths in overcoming the issue of capturing isolates and disconnected sub-groups. This is because sampling in this approach is done based on a characteristic of the node—not a characteristic of the relationship between two nodes, which is more typical of the relational approach. Therefore, there is no assumption in this method that there is any relationship between any actor and any other actor in the network. This approach also has the advantage of homogenizing the network based on whatever positional actor characteristic is the basis of sampling which can aid in comparison for the purposes of theory building.

However, a key limitation of a positional actor characteristic approach is that it may conflate institutional effects and social dynamics. This is because the very basis upon which network membership is determined is often based on some institutional membership. For instance, people who work for a certain agency, or belong to certain groups or positions may result in an institutional bias. Consequently, any network data collected among this group of actors is likely to reflect as much about the institution that defined network membership as it does about the interpersonal dynamics of the people within the institution. Disentangling institutional from interpersonal effects can be challenging.

Bounding based on the relational approach has particular strengths compared to the positional actor characteristic and event based in it allows the researcher to identify organic networks that result from formation of dyadic relationship ties. This is easily understood in the context of the GMO policy network, because this type of network is not associated with institutional boundaries. Therefore, relational bounding does not suffer the same limitations of other approaches that may miss critical network effects and structures because the researcher limited their consideration to affiliation within specific organizations or group designations or events. This is particularly relevant in the field of public management where the intersection of

formal organizational boundaries and informal social connections is often of interest. However, relational approaches to studying networks impose other kinds of blind spots. In particular, isolates—actors who are disconnected from other network actors—are generally excluded from consideration when using an actor relations approach. This is because the sampling strategy generally entails identifying a focal actor or set of actors and then tracing patterns of relationships from those actors using a snowball type of approach. Isolates or disconnected sub-groups would be excluded in such an approach, which may obscure the researcher's understanding of key network dynamics—particularly in loosely coupled (sparse) networks.

Defining network boundaries based on participation in an event, as in the wildfire study, also has trade-offs. Unlike the relational approach, this approach will easily capture isolates and disconnected sub-groups. Further, unlike positional actor characteristics, the participation approach is not limited in any way by institutional boundaries. Therefore, it can be a powerful method for capturing interactions of loosely coupled individuals representing numerous institutions as is often seen in emergent networks such as those involved in responding to disasters. However, this approach is arguably also the narrowest of all the approaches. It limits the network to actors who were at a specific event, which may be limited in temporal and spatial scale. Therefore, the event becomes the sole domain of consideration and may limit generalizability of findings beyond that event. It may be difficult to understand how actors associated with a given event relate to other events over time, and measures like duration and embeddedness would be difficult to capture. It is important to remember that the network associated with one event may not be the same as the networks associated with similar events at different points in time, even if the location or circumstances of the events are very similar.

ADVANCING A NETWORK BOUNDING DECISION FRAMEWORK

When deciding how to bound a network, a researcher must first determine the network features that are of primary interest to their research question. Consideration of the network features that are relevant to the research question informs the decision criteria for sampling, which in turn directly reflects the network bounding approach and the conclusions one can draw from the research.

As networks are socially constructed and there is not a single “true” network that can be identified, networks are defined through the proper boundary specification based on researchers' objectives and the context

of interest. There is no one correct way to bound a given network, but there are wrong ways of bounding if researchers inadvertently choose a boundary definition that excludes actors who are arguably central to understanding how the network behaves or includes actors who are not.

Abstracted beyond the networks examined here, our comparison findings suggest that depending upon the network attributes and features of interest, one method of network bounding may be more fruitful than another (Table 1). Our goal for writing this article is to focus the attention of network scholars on the process of considering which bounding approach to employ. To that end, we offer the network bounding decision-making framework shown in Table 1, which can be used as a tool to assist researchers make strategic decisions related to how the networks in their research studies are bound.

Institutional norms and formal structures are often important considerations of network studies in the

public and nonprofit literature. These features represent the organizational and interpersonal rules, processes, and norms that guide the social and relational interactions of network members. As within organizations, networks can form formal and informal norms and structures over time. One example of emergent, informal structures are the latent power structures that exist between and among actors. If informal power is a focal interest to the research question, then sampling based on a relational approach may be fruitful because informal power is inherently interpersonal and may transcend position or any one event. However, if one is interested in more formalized, existing institutional norms and decision spaces, and the corresponding flow of power within them, sampling on events or actor characteristics may be appropriate.

Isolates and disconnected subgroups (also called cliques or factions) are additional features of interest in some network studies. These actors or sub-groups have no direct relational or formal connections with

Table 1. Key Consideration When Determining a Network Bounding Approach

Network Feature Important to Research Context	Description	Cues to Aid in the Determination of a Bounding Approach	Recommended Bounding Approach		
			Relational	Positional or Reputational Actor Characteristics	Event Participation
Institutional norms and structures	Informal or formal rules and processes that emerge as patterns because they are ingrained in the fabric of the network and ties among actors	Does the research question (RQ) have a primary focus on <i>informal</i> ties between actors or <i>informal power</i> structures? Does the RQ focus on understanding formal ties and processes among actors?	✓	✓	
Isolates	Actors who have no direct relational ties	Does the RQ address questions related to the presence of <i>all</i> actors important to the domain, regardless of their connections to others?		✓	✓
Disconnected subgroups	Cliques or factions within the network that do not share relational ties with other parts of the network	Does the RQ seek to identify the existence or roles of cliques or factions within the network that do not share relational ties with other parts of the network?		✓	✓
Duration	Permanence of ties between actors over time	Does the RQ explore a network characterized by enduring relationships over time?	✓	✓	

other actors in the network. Entirely relational based approaches to identifying networks are not justified if isolates are likely present in the problem domain. Such an approach can dramatically skew the overall degree of connectivity that actually exists within the domain when isolates are ignored. In contrast, an actor characteristic or event based approach to bounding will allow the researcher to identify and include individuals or groups who are relevant to the research question but who have no network ties to anyone else.

Some network studies are particularly interested in certain types of networks based on the duration of the relationships among actors. Research interested in network duration, meaning the permanence of ties between actors over time, may be aimed at understanding long-term enduring relationships among actors, or have a primary interest on short-term relationships. If network duration is a key network feature important to the research context, and the network of interest is characterized by enduring relationships over time, then positional actor characteristics and/or a relational approach might be more appropriate. Event participation is unsuitable for bounding such a network as that approach may reflect only temporary networks that emerge due to the specific event.

There are additional network features that are not addressed in Table 1 based on their ubiquity. For instance, all three bounding methods are appropriate for researching measures of embeddedness (multiplexity), centrality, span, density, and connectivity. These measures can be applied to any network data regardless of bounding; however, the measures themselves are affected by the type of bounding used. For instance, the span of a network bounded by the event based approach will likely not mirror the span of a similar network bounded by the relational approach, and so forth. There are also implications for data structure and analytical decisions, which should flow from each method of bounding.

CONCLUSION

In this article, we have identified that network boundary decisions are endemic to all network research but become even more critical when applying a whole network perspective to the consideration of complex problem domains with fuzzy boundaries, as are typical in public administration research. However, despite its theoretical and methodological importance, discussion around how networks are bounded and the explicit trade-offs inherent in the method chosen continues to be under developed. As network scholarship continues to grow, the consequences of how networks are bounded should be treated more seriously given the consequence they can have on findings. In this article,

we offer some guidance to network researchers in how to think about selecting an appropriate strategy for defining network boundaries. Although there is no perfect solution for how a network can be bounded, there are informed tradeoffs that researchers should choose knowingly while justifying the relative advantages and disadvantages a given approach offers. Based on our review of three whole network studies, each embracing a different approach, we conclude that each of three approaches proposed by Laumann et al. (1989) has strengths and limitations including: (1) their ability to reveal formal and informal institutional norms and structures; (2) their ability to capture isolates and disconnected sub-groups, and (3) their ability to represent social relations over time. Through recognizing these strengths and associated limitations, researchers are better informed to choose the most appropriate strategy. Insights like the ones provided through our research will help strengthen the overall use of network approaches in research to provide greater clarity into network dynamics.

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