Ch. 8 – Affiliations and Overlapping Subgroups, Stanley Wasserman and Katherine Faust

This chapter outlines methods for analyzing affiliation networks, which are two-mode networks representing the patterns of connections between actors and “social occasions”, also called events. This method has roots in sociology theories stating that an individual's social identity is defined by the intersection of affiliations that s/he has. In practice, this means that two individuals are connected by a shared affiliation, while two events are connected by a shared member. This concept is referred to as duality.

Affiliation networks can be represented using bipartite graphs, sociomatrices, or hypergraphs (see pp. 301-305). They can also be simplified to one-mode networks using a traditional symmetrical sociomatrix, recording a relationship when actors have co-membership or events overlap. These one-mode networks have certain properties, including density, which is a function of the number of events or the size of attendance. One can also analyze reachability, connectedness, and diameter. These attributes are unique in affiliation networks, because there are no paths between actors or between events with a length of 1. All connections happen between the different modes.

Cohesive subgroups occur when groups of events share the same attendees, or when groups of actors attend the same events. In a clique at level 3, all actors in the subgroup would share at least 3 memberships, or vice-versa if studying event cliques. Subgroups can also be defined by actors or events connected by some minimum reachability level.

Recent affiliation network analysis uses techniques such as Galois Lattices to study actors and events simultaneously. This is a visualization technique in which each point represents both a subset of actors and a subset of events. It focuses on subsets and may help identify patterns in relationships between actors and events, though quickly becomes complex in large networks.
Correspondence analysis is another technique for simultaneous analysis of actors and events. It uses mathematical methods to determine a correlation score between the two modes. One can then assign scores to each actor/event. An actor’s score is based on the scores of the events they attend. This allows for objective visual representations of the relationship between the modes.

**Network analysis of 2-mode data, Borgatti & Everett**

Borgatti and Everett start by defining traditional social science as the study of individual attributes, and network analysis as the study of attributes of pairs of individuals, or dyadic attributes. Because of this difference, traditional methods utilize a person-by-attribute matrix, while network analysis uses a person-by-person matrix. However, there are techniques for analyzing 2-mode data with network techniques, blurring the lines between traditional methods and network methods.

Even non-network data like opinion polls can be studied as network data. Using the dualistic methods described in the previous readings, one can determine relationships between individuals by shared opinions, and relationships between opinions by co-members. If converting 2-mode to 1-mode data, one can use traditional network techniques. However, to study 2-mode data, new visualization techniques are needed, such as correspondence analysis and bipartite graphing techniques (see 247-250).

2-mode data requires some modifications to 1-mode network attributes, although many of the same attributes are useful. One can calculate density, although the denominator will change because there can be no connections within one mode. Similarly, one can determine degree, closeness, betweeneness or eigenvector centrality (see 254-258 for formulas). Centralization, or the degree to which a network has a central actor, is also important in two-mode networks.
Because of the dual nature of the data, one can study how actors and events are centralized around a particular actor/event, or how actors are centralized around a particular actor (one- or two-mode approaches).

Finally, one can study cohesive subgroups such as cliques, clubs and clans; however mathematical definitions must be altered, because the distance between any two actors will be at least 2, rather than 1. In two-mode datasets, these groups are called $n$-bicliques, $n$-biclubs, and $n$-biclans. Additional subgroup identification is possible with blockmodeling and clustering techniques.

**The Duality of Persons and Groups, Ronald L. Breiger**

Like Wasserman and Faust, Breiger begins with the sociological theory that individuality is at least partially determined by the intersection of an individual's affiliations. Based on this concept, one can use shared affiliations (and shared membership) as an indicator of connections between actors/events. One can then build two sociomatrices and sociographs, (one for each mode), as well as a binary adjancy matrix of connections between actors and events.

Goffman noted that individuals are connected “to collectivities through memberships and to other individuals through social relationships” (183). While Breiger does not exclude relationships between individuals through co-membership, he does acknowledge the distinction between membership and social relations connections. In one-mode approaches, all nodes are actors, and all lines are ties, or relationships. However, in two-mode networks, an actor can be both a node and a tie, because events are linked through actors.

Breiger also addresses identifying subgroups, and suggests that events with zero member overlap may be most likely to separate actors into “socially meaningful subgroups” (185). He goes on to explain a proof connecting person-to-person ties with group-to-group ties.
An affiliation network consists of a set of actors and a collection of subsets of actors called events (frequently joint participation in social activities or membership in collectivities). Examples of this type of network include interlocking boards of directors or membership in voluntary organizations. These networks can be represented co-membership matrices, event overlap matrices or bipartite graphs. Centrality has frequently been used to study these types of networks, but such analyses often ignored key properties such as the presence of two modes, the duality of actors and events, and the non-dyadic affiliation relation.

Faust presents four key ideas that inform centralities in affiliation networks, the first of which is centralities should exist for both actors and events, and there should be a clear relationship between them. She then states that centralities also exist for subsets of actors and/or subsets of events, and the centrality of an actor is a function of the events to which it belongs, and the centrality of an event is a function of the centrality of its members. Additionally, the article describes the importance of linkages created by actors and events, which creates a type of betweenness centrality, as an actor is central if it creates ties between events and an event is central if it creates ties between actors. It finally describes the importance of subset-superset relationships in actors’ affiliations and events’ memberships, an example of which is the idea that secondary actors are more likely to participate in events when primary actors are also present, and unlikely to participate on their own, but primary actors participate in events regardless of whether secondary actors are present.

Multiple types of centrality can be assessed in affiliation networks. Degree centrality for actors is determined by their number of events, where actors with a high number of events considered central, and degree centrality for events is determined by their number of members,
with a large number of members marking the event as central. However this type of centrality doesn’t consider the centrality of adjacent nodes, therefore eigenvector centrality is frequently assessed as well. In this measure, the centrality of a node is proportional to the centrality of the nodes to which it is adjacent, weighted by the value of the tie between the nodes. Again, an actor’s centrality is determined by the centralities of the events they belong to, and an event’s centrality is a function of the centralities of its members. This measure accounts for the duality between actor and event centralities.

Degree centrality and eigenvector centrality have been studied extensively in affiliation networks, but there are also measures that haven’t been fully explored. Closeness centrality can also be calculated. For actors, it is a function of the minimum distance to its events, and for events it’s a function of minimum distances to its actors. Betweenness centrality is also useful to look at; an event gains betweenness centrality if pairs of its members only belong to that event, and if its members belong to no other events. Finally flow betweenness centrality can be explored. This is an extension of betweenness centrality that considers all paths between nodes, instead of only geodesics, and can be used for both graphs and valued graphs where larger values indicate stronger ties. Finally both galois lattice and graph covers can be used to represent subset-superset relationships among actors and events.

**Introductory Overview, Lauman & Knoke**

Lauman & Knoke use two mode networks as a theoretical framework to explore state/elite decision making. Their analysis looks the relationship between a set of actors (who have interests in a range of issues, relevant mobilizing resources, and are embedded in an exchange network) and various decision making events. Their approach differs in many ways from other state-policy making approaches, such as Marxism, elite structures, pluralist political
science and corporatism. Their framework instead takes a managerial-elite perspective, which views the state, defined as a collection of political arenas incorporating both governmental and private actors, as an autonomous social formation, and uses the state as the unit of analysis rather than individual actors.

Their model for analysis has two major assumptions: corporate entities are key state policy-domain actors, and the use of a social perspective, which assumes the structural arrangements among the corporate entities must be taken into account when explaining event participation. For their purposes a policy domain is a set of actors whose preferences and actions must be taken into account on policy events by other domain participants. Generally members of a national policy domain are complex formal organizations, but only certain components, such as executives participate. Three relationships are significant in the social structure of these policy domains, information transmission, resource transactions and boundary penetration.

The authors lay out four levels of analysis, Individual Actors-Individual Events, which looks at why an individual participates in a particular event, Individual Actors-Relational or Systemic Events, which examines the behavior of individual actors in response to institutional structures, Relational or Systemic Actors-Individual Events, which looks at how interconnections among actors affects a specific event, and Relational/Systemic Actors-Relational/Systemic Events, which relates systems of actors to systems of events. Regardless of the method, all analyses must look at the relationship between each actor and event, as well as the interrelationships among events and the interrelationships among actors.

For the purposes of their analysis, an event occurs when a concrete proposal for an authoritative action is placed before a decision making body. Their framework for the analysis of policy decisions therefore seeks to connect consequential organizational actors with a set of
temporally arrayed policy events. This analysis of policy decisions represents a Relational/Systemic Actors-Relational/Systemic Events framework, as neither policy actors nor policy events exist in isolation. Actors must fully understand the structure of the event in order to best influence policy decisions, which requires their understanding of the antecedent, concurrent and impending events, not just the specific policy decision being considered. This supports their argument that the characteristic of the event itself must be included in the analysis, rather than focusing on the actors.

_The Structure of Class Cohesion: The Corporate Network and Its Dual, James Bearden & Beth Mintz_

The purpose of this study was to assess the relationship between class and corporations in American capitalism. It first looked at the function of different types of directors in uniting a corporate network. This used the corporation as the unit of analysis and asked what types of individuals were most crucial in organizing the business world. This analysis worked to establish interlockers, directors on the board of multiple corporations, to assess ties among corporations created by shared board membership. The study then changed the unit of analysis, looking at a network of corporate directors, and investigated the role of individuals in creating system unity by analyzing individual ties created by shared board membership. Data was collected from 200 of the largest nonfinancial firms and the 50 largest financial institutions in the US.

While the analysis found that 90% of the companies are directly tied to at least one other firm, 84% share just one director, and 64% of directors sit on only two boards. However, corporations are strongly interconnected through outsiders, generally business men and women without full-time affiliations to the corporations under study. These outsiders are generally drawn from individuals affiliated with very large, but not the largest corporations, or retired executives. These individuals draw many of their elite connections from membership in social clubs and external business connections like seats on the boards of commercial banks. These
results indicate that corporations are a major location for the intersection of class and institutional interests, and that either institutional position or elite social background can serve as a vehicle for decision-making participation.

Analysis of the person-by-person network of directors found a strong regional component; the network contains a national grouping, a semi-national grouping, and a number of geographically defined subsets. The study indicates that these components represent the difference between a national ruling class and important local elites. Evidence suggests that regionally organized directors maintain strong ties within their local and that members of the national component serve a bridging role in uniting the regions. When comparing component members to non-component members, the study found that non-component members were more likely to have elite status, have more than three board positions and participate in policy planning. This indicates that component membership may function as an alternative mechanism for cohesion formation. The authors of the study believe that ties created by shared boardships produce relationships among directors which help bridge the differences between class and institutional interests.