Social Network Analysis

NOTATIONS FOR SOCIAL NETWORK DATA

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Social Network Analysis

- Social network data can be represented mathematically in different ways

- Three different notational schemes

- Based on its appropriateness, clarity, or efficiency any one is used

- Graph theoretic
- Sociometric
- Algebraic

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Graph theoretic notation

It is most useful for centrality and prestige methods, cohesive subgroup ideas and as dyadic and triadic methods

Sociometric notation

It is often used for the study of structural equivalence and block models.

Algebraic notation

It is most appropriate for role and positional analyses and relational algebras.

$N = \{n_1, n_2, n_3 \dots n_g$

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Graph Notations

It is viewed as an elementary way to represent actors and relations

It views is as a graph, consisting of nodes joined by lines $N = \{n_1, n_2, n_3 \dots n_g\}$

Set N contains g actors

Example:

$$N = \{Alex, George, Alan, Bob, michael, Harris\}$$

$$Here\ we\ infer,\ \ n_1 = Alex, n2 = George, n3 = Alan \dots$$

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Single Relation

Single relation records whether each actor in *N* relates to every other actor on this relation

The relation be dichotomous and directional

If a tie is present between pair of actors $n_i \; and \; n_j$ then the ordered pair belongs to set *L*

Maximum element in the L is g (g-1) and the minimum can be 0

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If the ordered pair $< n_i, n_j >$ has tie between them it is represented by $n_i \rightarrow n_j$

$L = \{l_1, l_2, l_3 \ldots l_l\}$, here each l represents ordered pairs

L can be represented graphically by drawing line from first actor in the element to second actor

The graph is called as directed graph and directed lines are called arcs

Graph g consists of set of nodes **N** and set of lines **L**, mathematically represented as (N, L)

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In some relation, individual actor don't relate to itself, here self choices are not considered

In non – directional no distinguish between the line n_i *and* n_j *and* n_j *and* n_i

Example: set of actors live near each other

L *contains* $\frac{g(g-1)}{2}$ *pairs for undirected graph*

L *can be* $l1 =< Ross, Alan >, l2 =< Alex, michael >, \ldots . l8 =< Sarah, Drew >$

Here friendship is not reciprocal, so it can be $n_i \nrightarrow n_j$

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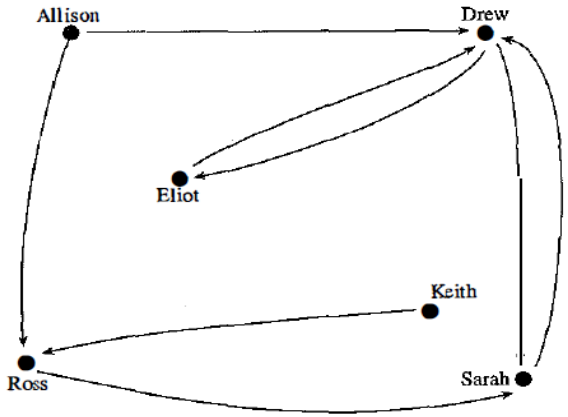
A graph represented as diagram where, nodes are represented as points in 2D space and arcs are represented by directed arrows between points

Location of points in two-dimensional space is irrelevant

Example:



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Multirelational

Graph theoretic notation can be generalized to multirelatiorial networks

It could include both directional and nondirectional relations

Example:

Between 2 persons, two types of relationship: friendship and marital tie

Each relation has a corresponding set of arcs L_r, in $\mathbf{L_r}$ which contains ordered pairs of actors as elements

Where *r* ranges from 1 to R, the total number of relations

each relation is defined on the same set of nodes, but each has a different set of arcs
Example: relation1: friendship, relation2: classmate, relation3: neighborhood

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For each relations, the directed graphs can be viewed in one or more figures

each relation is defined on the same set of nodes, but each has a different set of arcs

Example: relation1: friendship, relation2: classmate, relation3: neighborhood

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Single Relation

single relation measured on one set of gactors in

Define x_{ij} as the value of the tie from the i^{th} actor to the j^{th} actor on the single relation

Place these measurements into a sociomatrix

Rows and columns of this sociomatrix index the individual actors.

Since there are g actors, the matrix is of size g x g

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Sociometric notation uses such matrices to denote measurements on ties

For the relation *X,* we define **X**as the associated sociomatrix. The entries are defined as:

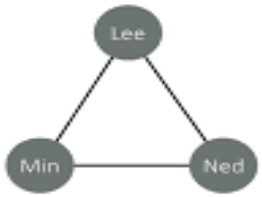
$$X_{ij} = \textit{the value of tie from } n_i \textit{ to } n_j \textit{where } i \textit{ and } j\ (i \neq j) \textit{range over all integers from } 1 \textit{ to } g$$

$$\textit{pairs listing same actor twice } (n_i, n_i), i = 1,2, \ldots g \textit{ are called self choices}$$

Self choices are usually undefined, lie along diagonal of sociomatrix

Sociomatrix

	Lee	Min	Ned
Lee	0	1	1
Min	1	0	1
Ned	1	1	0



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The possible values of the relation C, if it is dichotomous C=2 or if relation is valued and discrete can take no. of different values

Example, if the relation can take on the values -1, 0, 1,

Then map - 1 to 0,0to 1, and +1 to 2 (so that C=3)

Single relation is just a special ease of the multirelational

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Multiple relations

Suppose R relations $X_1, X_2, X_3, \ldots\ldots$ measured on a single set of actors where $r = 1,2,3, \ldots R$.

Relations are valued and come from the set $\{0,1,2, \ldots\ldots C-1\}$

$$X_{ijr} \text{ is the strength of the tie from ith actor to jth actor on rth relation}$$

It is placed in the collection of sociomatrices, one for each relation

Example:

Friendship at Beginning of Year

	Allison	Drew	Eliot	Keith	Ross	Sarah
Allison	-	1	0	0	1	0
Drew	0	-	1	0	0	1
Eliot	0	1	-	0	0	0
Keith	0	0	0	-	1	0
Ross	0	0	0	0	-	1
Sarah	0	1	0	0	0	-

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There are R, g x g sociomatrices, one for each relation defined for the actors in N

R sociomatrices viewed as the layers in a three-dimensional matrix of size g x g x R

The rows index the sending actors, the columns index the receiving actors, and the layers index the relations

Also referred to as a **super sociomatrix** as represents information in a multirelational network.

Example:

Consider of a collection of g = 6 children and R =. 3 relations:

1) Friendship at beginning of the school year
2) Friendship at end of the school year
3) Lives near

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Friendship at Beginning of Year

	Allison	Drew	Eliot	Keith	Ross	Sarah
Allison	-	1	0	0	1	0
Drew	0	-	1	0	0	1
Eliot	0	1	-	0	0	0
Keith	0	0	0	-	1	0
Ross	0	0	0	0	-	1
Sarah	0	1	0	0	0	-

Friendship at End of Year

	Allison	Drew	Eliot	Keith	Ross	Sarah
Allison	-	1	0	0	1	0
Drew	0	-	1	0	1	1
Eliot	0	0	-	0	1	0
Keith	0	1	0	-	1	0
Ross	0	0	0	1	-	1
Sarah	0	1	0	0	0	-

Lives Near

	Allison	Drew	Eliot	Keith	Ross	Sarah
Allison	-	0	0	0	1	1
Drew	0	-	1	0	0	0
Eliot	0	1	-	0	0	0
Keith	0	0	0	-	1	1
Ross	1	0	0	1	-	1
Sarah	1	0	0	1	1	-

$X_{121} = the\ value\ of\ tie\ from\ n_1\ to\ n_2\ on\ the\ relation\ X_1$

$X_{211} = 0\ , no\ friendship\ between\ two$

Social Network Analysis

Summary

- Social network data can be represented mathematically in 3 notations

- Graph theoretic
- Sociometric
- Algebraic

- Graph theoretic notation used in centrality and prestige methods, subgroups

- Sociometric notation used in structural equivalence and block models

- Algebraic notation used in role and positional analyses and relational algebras