Part I: Course Logistics
Paper proposal due in two weeks (February 29)
Jeongyoon’s office hour: Mon (10am-11:30am)

Part II: Student summary of centrality readings
Presentation (Jennie)
Discussion
  Specifics on various measures of centrality
  Relationship between concepts and measures
  How is this concept used?
  How might you wish to use this concept?
  Brass: thinking about his use of correlations/regressions

Break (7:35-7:50)
Part III: Interpreting centrality findings in two networks – small group exercise (if possible, room 302)

Data collected from a group of people who have been assigned to a large ad-hoc work group.

The work groups are engaged in a coordination and design project.
- The task is to design a new, interdisciplinary degree program for a university.
- They are responsible for marketing the program within the university & getting funding.

We will have four Project Groups. Discussion to think about the centrality findings and answer the questions in the class notes.
CENTRALITY AND POWER DEPENDENCE

JENNIE LAW
ROCKEFELLER COLLEGE
PAD 637 SPRING 2012
INTRODUCTION

Centrality and Prestige, Chapter 5 in Wasserman and Faust

Centrality in Social Networks a Conceptual Clarification by Linton C. Freeman

Power Dependence Relations by Richard Emerson

The Distribution of Power In Exchange Networks
CENTRALITY AND PRESTIGE: AN OVERVIEW

• Centrality and Prestige
• Non-directional Relations
• Directional Relations
CENTRALITY AND PRESTIGE

• Prominence

• Further specified into the concepts of:
  • CENTRALITY:
  • PRESTIGE:
ACTOR CENTRALITY

• Levels of involvement: Bavelas (1948) Study of communication networks defined centrality

• C denotes a specific centrality notion which is a function of $n_i$
ACTOR PRESTIGE

• Actors prestige is measured by examining the ties an actor receives

• Used as a measure when directionality is available

• Other aliases include status, rank, deference and popularity

• $P$ denotes a particular prestige measure as a function of $n_i$
GROUP CENTRALIZATION AND GROUP PRESTIGE

- Group level research is mostly restricted to centralization measures
- These look at combinations of actor measures
- Periphery
- Freeman (1979) mathematical definition for group level centralization is the sum of the differences from the largest value and the other values p 176
- *Dispersion and Compactness*
- Group level prestige measures are messy to calculate so often we rely on variance measurements
NONDIRECTIONAL RELATIONS

- Theoretical Bases for Analysis are:
  - Maximum degree
  - Betweeneness
  - Closeness
  - Information
NONDIRECTIONAL RELATIONS

- Most active actors are at the “center” of a network

TIME FOR AN EXAMPLE... VOLUNTEERS?
DEGREE OF CENTRALITY

• Most simple definition, based on degree distinctions
• Star formation versus circle formation implications
• Equation available on p 179
• High Centrality versus periphery

• Ego Density and Span
GROUP LEVEL: DEGREE OF CENTRALITY

- Mathematical equation available p 180, using Freeman’s index with a denominator of \((g-1)(g-2)\)

- Snijders (1981a, 1981b) recommends calculation variance, formula p 180

- The problems of density
CLOSENESS CENTRALITY

- Uses measures of closeness, based on communications studies
- Star graph versus circle graph revisited
- Hakimi (1965) and Sabidussi (1966) define as “minimum steps”
- Examine the Geodesics
- *Jordan Center and Centroid*
GROUP CLOSENESS CENTRALIZATION

• Equations available p 186 and p 187

• It is important to look at variance for group closeness measures

• This generally reports on average closeness and variances
Betweenness examines the roles of intermediaries.

Count the number of geodesics linking actor a and b and see how many include actor c.

This “intermediary” function is also called stress, this particular stress is defined as betweenness.
ACTOR BETWEENNESS CENTRALITY

• Actor betweenness index is the sum of the estimated probabilities that a certain pair will be used instead of all other pairs of actors excluding the one under consideration.

• Minimum and maximum
GROUP BETWEENNESS CENTRALITY

- This measure allows researchers to compare different networks

- *Unity—the star graph*

- Freeman’s index is once again used, p 191
INFORMATION CENTRALITY

Uses betweenness as a foundation

Recognizes betweenness treats all geodesics as equally likely to occur

Why might this be wrong?

Stephenson and Zola (1989) offer a weighted index that assigns weight

Difficult to do for group analysis, use instead the variance of information equation.
A QUICK RECAP

• So far we’ve examined centrality as it relates to
  • DEGREE
  • CLOSENESS
  • BETWEENESS
  • INFORMATION

• All defined with equations for non-directed relations...now let's look at the same indices plus prestige with directional relations.
WHY DIRECTION MATTERS

• “Choices made” versus “Choices received”

• Centrality indices examine choices that are made

• Prestige indices examine choices that are received

• Why might this be more interesting to study?
DIRECTIONAL CENTRALITY

• Degree indices are meaningful if no restrictions are placed on the choices made by actors.

• Calculated in the same manner as non-directional indices except that the out-degree of each actor is substituted for the degree.

• Properties are the same as non-directional.
CLOSENESS

• Calculated by taking the sum of row $I$ of the distance matrix to find the total distance from all the other actors and dividing the minimum possible distance ($g-1$).

• Formula is exactly the same as nondirected
BETWEENESS AND CLOSENESS

- Difficult to calculate using directionality because the original algorithms were designed specifically for non-directional information.
PRESTIGE

• We are mostly concerned with actor level prestige

• Degree prestige: the indegree of each actor (Brad Pitt) Formula available p 203

• Proximity Prestige: adjacency of actors, Freeman’s index is generalized by considering the influence domain

• Status or rank prestige: measure prestige given status within a set of actors, lots of mathematical justifications given p 206-210
CLOSING

- Many theoretical foundations and frameworks

What does this mean?

Let’s move onto Freeman to find out!
The problems of centrality:

- First introduced Bavelas (1948) in examining communication networks
- Initial results that centrality is related to group efficiency in problem solving, perceptions of leadership, and satisfaction of participants

Burgess (1968) stated centrality research had not produced consistent results
OVERVIEW

• Examine the conceptual and measurement problems of centrality

• Examine centrality as it applies to positions or points in networks

• Examine centrality as it is applied to whole networks
POINT CENTRALITY

• Three structural properties are held by the maximally central graph, or the star graph
  • Maximum possible degrees (degree)
  • Maximal number of geodesics (betweeness)
  • Maximally close to all other actors (closeness)
BETWEENESS

- Defined as the frequency at which the point falls between pairs of other points on the shortest geodesic path

- Person of influence who can distort information...or not

- Geodesics are expressed as probabilities
CLOSENESS

- Also related to control, but focus is on independence. That is, the most central actors are the ones who do not have to rely on others to get their message across.

- Used to determine optimum efficiency in communication networks.

- Sabidussi weighted index
GRAPH CENTRALITY

• Examining the relationship between the compactness of graphs and centrality.

• Measures of graph centralization should be based on differences in point centrality

• Ideal indices should
  • Index the differential between the most central points and all others
  • Be expressed in a ratio of the excess to its maximum potential
GRAPH CENTRALITY

- Degree based measures reflect the relative dominance of a single point.
- Betweenness measures the importance of geodesics in the control of information.
- Closeness measures the importance of proximity in independence related to information transmission.
• We specified nine centrality measures founded on three conceptual bases.

• Three are based on point degree and communication indices

• Three are based on point betweenness and indices of the control potential

• Three are based on closeness and indices of independence or efficiency
• These are competing theories that all hold up!
POWER DEPENDENCE RELATIONS
RICHARD M. EMERSON

- Proposes that power is a property of a network, not an attribute of an actor

- Social relations entail ties of mutual dependence

- Power is not always observable in relations

- The one that the power is exerted over has choices, there choices vary as network complexity increases.
CHOICES

• Reactionary choices to the exertion of power include mechanisms of
  • WITHDRAWAL
  • EXTENSION OF THE POWER NETWORK
  • COALITION FORMATION
  • EMERGENCE OF STATUS
FINDINGS

I. Conformity varies directly with the motivational investment in the group
II. Conformity varies inversely with acceptance in alternative groups
III. Conformity is high at both status extremes in groups with member turnover
IV. Highly valued members of groups are strong conformers only if they are valued by other groups as well
V. Coalitions form among the week to control the strong
VI. The greatest rewards among the coalition are given to the less dependent members of the coalition.
TENSION

• Discuss compliance/conformity versus alternatives in power-dependence relationships as ascribed by Emerson.
This article seeks to synthesize concepts of centrality discussed by Wasserman and Faust and detailed by Linman with the Power-Dependency theory illustrated in the Emerson reading.
A theoretical gap exists between network theory and applications, specifically power dynamics.

Based on a review of sociological and anthropological literature.

Seeks to give more substantive meaning to network theory analysis.
EXCHANGE NETWORKS

- Defines exchange networks as
  - A set of actors
  - A distribution of valued resources
  - Exchange opportunities with other actors in the networks
  - Exchange relations between actors in the networks
  - A set of network connections linking exchange relations into a single social network

- EMERSON (1972)
NEGATIVE, POSITIVE, AND MIXED

• Negative elements arise with the presence of alternatives ie dating and friendship networks

• Positive elements arise in the absence of alternatives

• Mixed networks are more likely given the rarity of purely positive exchange networks
CENTRALITY AND POWER IN NEGATIVELY CONNECTED EXCHANGE NETWORKS

- Power is a function of position within a network.
- Point centrality theory holds weakness given the examination of direct relationships.
- Indirect relationships are important.
- Power and influence seem to be a function of centrality.
THE SIMPLE EXPERIMENT

- Subjects recruited from undergraduate cohort with financial incentives
- Placed in private rooms with a computer attached to a mini terminal that allowed researchers control over the network
- Subjects engaged in profit points exchange blind to the total sum, sent offers and counter offers until a trade occurred
- Subjects unable to compare their points with the total sum or the points of any other subject
- Researchers expected to see the emergence of power use over time
As the exchange process proceeds through time, occupants of E will display more power use than F and D in two forms, an increase over time for position E and as a result the greater absolute level of exchange benefit.

The differential power use of E over F will be displayed before the power use of E over D.

In the final phase actor E will exert equal power over actors F and D.
PARTIALLY CONFIRMED

- The effects implied in hypothesis 2, 3, and 4 will be more pronounced under conditions of high exchange incentive than low exchange incentive.
ADD COMPLEXITY

- Researchers ran a more complex computer based simulation and achieved similar results.

- This confirmed the hypothesis of power dependence in negatively connected exchange networks.
QUESTION

• To what extent exchanges depend on the power of the actor?
POINT VULNERABILITY

• Implications of point vulnerability on power dynamics

• Vulnerability locates points of minimum dependence who have limited exchange opportunities and can be removed with little to no disruption in exchange networks.
THANK YOU!
BONACICH CENTRALITY

• Which centralities did Jennie talk about?

• “One’s status is a function of the status of those one is connected to (p.1181)”

• E.g., Karl and I (Jeongyoon) have 5 friends in Rockefeller college. While Karl’s friends have lots of friends, Jeongyoon’s friends are very isolated & poor PhD students… …
  Who is more powerful???

• Conventional centralities focus on friends
• BUT, Bonacich focused on friends’ friends.
POWER CENTRALITY

- Developed Bonacich measure of centrality in terms of $c(\alpha, \beta)$

$$\sum_{k=1}^{\infty} \beta^{k-1} R^k 1 = \sum_{k=0}^{\infty} \beta^k R^{k+1} 1 = c(1, \beta),$$

- Parameter $\beta$
  - Reflects the degree to which an individual’s status is a function of the statuses of those to whom he or she is connected (p.1170)

- Understanding $\beta$ is important
  - Let’s talk about the sign of $\beta$
UNDERSTANDING $\beta$

- Different signs of $\beta$ capture different meaning of Bonacich power centrality:
  - When $\beta > 0$ : Bonacich centrality increases if one’s connections have many connections
  - When $\beta = 0$ : considering direct connections
  - When $\beta < 0$ : Bonacich centrality increases if one’s connections have few connections (because one’s connections are more likely to depend on me)

- It’s important to understand the different sign of $\beta$ because ... ...
In Problem Set #1,

- Calculating Bonacich Power Centrality based on different signs of $\beta$
- These is one rule to follow when you set up the value of $\beta$
  (see p.7 in PS#1)
- $-(1/\text{the largest degree measure in the network}) < \beta < +(1/\text{the largest degree measure in the network})$
  
  E.g., let’s say that there is a network with 8 of the largest degree measure
  Here, $-(1/8) < \beta < +(1/8)$

- Let’s see the Bonacich Power measures in UCINET ...
UNDERSTANDING Β

Problem Set #1
Calculating Power based on different sign of β
Beta Centrality / Bonacich Power

Datasets:
- Input Network Dataset: [Field]
- Output Power Dataset: BonacichPower-Exact

Parameters and Methods:
- Computational Method:
  - Exact (slow for large networks)
  - Iterative (for large networks)
- Beta coefficient: 0
- Maximum Walk Length (longer is more accurate): 10

Normalization method:
- none
- eucl. norm = n
- ssq = n
- If more negative scores than positive, multiply all scores by -1

[Options] [OK] [Cancel] [Help]
Here, We have GOOD News from Steven Borgatti!!
Also, We learned “Various measures of centrality”
Q: What are they?
We learned “Various measures of centrality”
Degree centrality
Betweenness Centrality
Closeness Centrality
Bonacich Power Centrality
We learned “Various measures of centrality”
Degree centrality
Betweenness Centrality
Closeness Centrality
Bonacich Power Centrality

Q: Relationship between concepts and measures?
   How is this concept used?
   Conceptually, how different are they?
We learned “Various measures of centrality”

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Degree</th>
<th>Betweenness</th>
<th>Closeness</th>
<th>Bonacich</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Indegree: actor's</td>
<td>Brokerage position</td>
<td>Shortest paths</td>
<td>B &gt; 0 : My friends have many connections =&gt; increasing my power</td>
</tr>
<tr>
<td></td>
<td>attractiveness</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Outdegree: actor's</td>
<td>Controlling the</td>
<td>Ability of my</td>
<td>B &lt; 0 : My friends have few connections =&gt; increasing my power</td>
</tr>
<tr>
<td></td>
<td>sociality</td>
<td>information flow</td>
<td>independence</td>
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</table>
We learned “Various measures of centrality”
Different concepts derived from Different approach

<table>
<thead>
<tr>
<th>Approach</th>
<th>Degree</th>
<th>Betweenness</th>
<th>Closeness</th>
<th>Bonacich</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>My Structural status</td>
<td></td>
<td></td>
<td>My friends' structural status</td>
</tr>
<tr>
<td>In/direct</td>
<td>Direct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of connections</td>
<td>Local</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Controlled by focal node</td>
<td>Yes (only outdegree)</td>
<td></td>
<td></td>
<td>No (We don’t know the rest of our whole networks)</td>
</tr>
</tbody>
</table>
Again, We learned the difference between “Centrality” and “Centralization”

<table>
<thead>
<tr>
<th>Centrality</th>
<th>Centralization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actor level measures</td>
<td>Group level measures</td>
</tr>
<tr>
<td>Focus on “Within” the networks</td>
<td>Focus on “Across” the networks</td>
</tr>
<tr>
<td>Normalization does not matter!</td>
<td>Normalization matters!</td>
</tr>
</tbody>
</table>
APPLIED RESEARCH

BEING IN THE RIGHT PLACE: A STRUCTURAL ANALYSIS OF INDIVIDUAL INFLUENCE IN AN ORGANIZATION.

BRASS, DANIEL J. (1984)
OBJECTIVE

• To apply a structural perspective to the study of individual influence

• His research idea comes from two:
  • One, structure defines individual opportunities and constraints in their immediate environment
  • Two, influence is reflected as power: Power of A over B is the extent of B’s dependency on A (Emerson, 1962)

• Basically, this research attempts to identify the relationship between structural characteristics and influence (Power)
INDIVIDUAL POWER IN ORGANIZATION

- Power is a multi-level concept:
  - Individual: Power arising from personality traits (Strauss, 1973; Allen and Porter, 1959)
  - Organizational: Structural sources of power (Hinningset al, 1974; Salancik and Pfeffer, 1974)
  - Mixed: Individual gains from position due to personality, relevant exposure and opportunities (Pfeffer, 1981; see McCall, 1979)
HYPOTHESES

- **H1**: Individuals at organizational boundaries will be more powerful than those inside.
- **H2**: Individuals in a workflow position with many transaction alternatives will have more potential influence than those with fewer transaction alternatives.
- **H3**: Individual centrality in workflow will be positively associated to their distance from organization’s boundary.
- **H4**: Centrality in communication network is directly related to individual power.
- **H5**: Centrality in friendship network gives more influence than a peripheral position.
- **H6**: Centrality in dominant coalition will be extremely important in acquiring influence.
- **H7**: Individual power increases with the membership in a dominant coalition.
METHODS: SOCIAL NETWORK ANALYSIS (SNA)

• Since power is operationalized in terms of social relationships, SNA is the perfect tool.

• Study locates structural positions of non-supervisory employees within 3 social networks (based on Tichy, Tushman and Fombrun, 1979):
  - Workflow network
  - Communication network
  - Friendship network

• Data: from a newspaper publishing company with 140 full-time, non-supervisory staff.
MEASURING POWER

• Let’s see how to measure... ...
• As Dependent Variable (DV): Power measured as reputation by supervisory ratings, non-supervisory listing and promotion to supervisory position
• Conditions of possession of power (IV):
  • 1. Actor must possess resource that others depend on (increase dependency of others)
  • 2. Actor must not depend on others (reduced dependency on others)
MEASURING CENTRALITY

• Measures of centrality (Freeman, 1979):
  • Degree: number of contacts – measure of activity
    \[ \Sigma \text{ (distance between i and } \Sigma \text{ j)} \]
  • Proximity: minimum distance to others in a group – measure of independence/access (condition 2)
    \[ \Sigma \text{ shortest paths from i to } \Sigma \text{ j} \]
  • Betweenness: presence on shortest path between points – measure of control (condition 1)
    Number of times i exists between \( \Sigma \text{ j} \) and \( \Sigma \text{k} \) geodesics
OTHER MEASURES

- **Criticality:**
  - number of available routes for work-flow after replacing individual

- **Transaction Alternatives:**
  - alternate workflow positions available to an individual for acquisition/distribution of the same input/output

- **Department Membership:**
  - dummy to identify individual’s association to the 5 dept within org.

- **Distance from Organizational boundary:**
  - number of workflow links on the shortest path between an employee and a person outside the organization pursued for inputs / outputs

- **Contacts beyond Workflow:**
  - number of direct relationship with members of other groups
### Relationships between Structural Measures and Measures of Influence

<table>
<thead>
<tr>
<th>Structural measures</th>
<th>Supervisors' ratings of influence</th>
<th>Nonsupervisors' listings</th>
<th>Promotion</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>$r$</td>
<td>Beta</td>
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<tr>
<td><strong>Workflow</strong></td>
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<td>Criticality</td>
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<td>Transaction alternatives</td>
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<td>Access</td>
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<td>Control</td>
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<td>-04</td>
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<td><strong>Distance from organizational boundary</strong></td>
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<td><strong>Communication</strong></td>
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<td>Access</td>
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<td><strong>Organization</strong></td>
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<td>Access</td>
<td>46</td>
<td>(.261)</td>
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<td>Control</td>
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<td><strong>Contacts beyond workflow</strong></td>
<td>24</td>
<td>(-.011)</td>
<td>21</td>
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<td><strong>Department membership</strong></td>
<td>46</td>
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<td>26</td>
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</tbody>
</table>

Adjusted $R^2$

- $p \leq .05$; **$p \leq .01$**

*Represents a multiple correlation.
HOMOPHILY AND DIFFERENTIAL RETURNS

OBJECTIVE

• To clarify the ways and extent to which men and women networks differ

• To clarify the potential consequences of observed differences between networks
APPROACH

• Evaluate sex differences in network structure and access in five interaction networks within one organization:
  • Communication
  • Advice
  • Support
  • Influence
  • Friendship
HYPOTHESES

• **H1**: Controlling for availability, women will tend to choose women as *expressive network contacts* but will choose men as *instrumental network contacts*. Men will predominantly choose men across multiple networks.

• **H2**: Men will have more multiplex network ties, in total, than women, as well as more multiplex ties to men than women have to women.

• **H3**: Men will hold more central network positions than women in workplace interaction networks.

• **H4**: Sex differences in centrality will be higher in instrumental networks than in expressive networks.

• **H5**: Men will receive greater network returns on their individual and positional resources than women.
METHODS & MEASURES

• Data: from an advertising and PR agency in New England with 94 full time employees.
  • Here, most female employees at the lower levels in the hierarchy

• 5 Networks:
  • Communication: “With whom you discuss what is going on in the org.?”
  • Advice
  • Support
  • Influence
  • Friendship

• Centrality:
  • Measured by “aggregate prominence”

• Homophily:
  • Measured proportion of times a respondent cited same sex individuals in proportion to total cites.

• Multiplexity:
  • Measured number of times the same alter was chosen by an ego across the five networks

• Also, used Individual level control variables
H1: GREATER HOMOPHILY FOR MEN THAN WOMEN

<table>
<thead>
<tr>
<th>Homophily indices</th>
<th>Women (N = 45)</th>
<th>Men (N = 34)</th>
<th>T-value</th>
<th>d.f.</th>
<th>Unstandardized regression coefficients (N = 79)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>HComm</td>
<td>−.03 (.49)</td>
<td>.21 (.78)</td>
<td>−6.90***</td>
<td>77</td>
<td>.39*** (.06)</td>
</tr>
<tr>
<td>HAdvice</td>
<td>−.05 (.42)</td>
<td>.22 (.86)</td>
<td>−8.43***</td>
<td>77</td>
<td>.40*** (.05)</td>
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<tr>
<td>HSupport</td>
<td>−.003 (.55)</td>
<td>.17 (.71)</td>
<td>−5.65***</td>
<td>76</td>
<td>.19*** (.05)</td>
</tr>
<tr>
<td>HInfluence</td>
<td>−.09 (.33)</td>
<td>.22 (.90)</td>
<td>−10.90***</td>
<td>73</td>
<td>.39*** (.04)</td>
</tr>
<tr>
<td>HFriend</td>
<td>.06 (.76)</td>
<td>.14 (.73)</td>
<td>−2.57*</td>
<td>58</td>
<td>.17*** (.04)</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p ≤ .001.

* Values in bold in parentheses are cites to same-sex others, as a proportion of total ties, unadjusted for availability.
† Unstandardized regression coefficients are reported for gender with homophily indices as dependent variables. All control variables (i.e., education, tenure, professional activity, prestige, department, rank) are included in the regression models; standard errors are in parentheses.
H2: OVERALL NUMBER OF MULTIPLEX RELATIONS WERE NOT DIFFERENT, BUT MEN HAD GREATER DISTRIBUTION OF THEIR TIES ACROSS FIVE NETWORKS

<table>
<thead>
<tr>
<th>Multiplexity indices</th>
<th>Means</th>
<th>T-value</th>
<th>Unstandardized regression coefficients</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women (N = 45)</td>
<td>Men (N = 34)</td>
<td>d.f. = 70</td>
<td></td>
</tr>
<tr>
<td>Total multiplexity</td>
<td>2.15</td>
<td>2.23</td>
<td>-.63</td>
<td></td>
</tr>
<tr>
<td>Multiplexity of ties to same sex</td>
<td>2.02</td>
<td>2.42</td>
<td>-.42</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05; **p < .01.

* Unstandardized coefficients are reported for gender with multiplexity indices as dependent variables. All control variables (i.e., education, tenure, professional activity, prestige, department, rank) are included in the regression model; standard errors are in parentheses.
H3 & H4: DIFFERENCES IN MEAN CENTRALITY SCORE FOR MEN AND WOMEN

<table>
<thead>
<tr>
<th>Centrality indices</th>
<th>Means*</th>
<th>T-value (d.f. = 70)</th>
<th>Unstandardized regression coefficients (N = 79)†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women (N = 45)</td>
<td>Men (N = 34)</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>.26 (3.9)</td>
<td>.55 (8.7)</td>
<td>-4.63***</td>
</tr>
<tr>
<td>Advice</td>
<td>.10 (2.0)</td>
<td>.45 (6.8)</td>
<td>-6.11***</td>
</tr>
<tr>
<td>Support</td>
<td>.35 (3.9)</td>
<td>.59 (7.5)</td>
<td>-4.69***</td>
</tr>
<tr>
<td>Influence</td>
<td>.02 (1.2)</td>
<td>.21 (6.2)</td>
<td>-3.53***</td>
</tr>
<tr>
<td>Friendship</td>
<td>.32 (2.3)</td>
<td>.56 (3.9)</td>
<td>-3.38***</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p ≤ .001.

* Degree centrality scores, i.e., the raw number of nominations, are reported in parentheses.

† Unstandardized regression coefficients are reported for gender with centrality indices as dependent variables. All control variables (i.e., education, tenure, professional activity, prestige, department, rank) are included in the regression model; standard errors are in parentheses.
**H5: MEN CAPITALIZE THEIR NETWORK MORE EFFECTIVELY**

### Regression of Centrality on Independent Variables within Sex Groups*

| Independent variables | Women (N = 45) | | | | | | Men (N = 34) | | | |
|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
|                       | Communication | Advice | Support | Friend | Communication | Advice | Support | Friend |
| Professional activity | .05           | .07     | -.01    | .02    | .11**          | .13**   | .03     | .11    |
| Prestige              | -.01          | .03     | .09     | .20    | .09            | .02     | .06     | .08    |
| Tenure                | .004          | .01     | .02*    | .003   | .01            | -.01    | .001    | -.02   |
| Education             | -.00          | .03     | .07*    | .09    | .03            | .02     | .01     | .22**  |
| DEPT2                 | .17**         | .03     | .05     | .09    | .27***         | .21*    | .12     | .43**  |
| DEPT3                 | .14           | .01     | .14*    | .15    | .20**          | -.01    | .12     | .33**  |
| Rank                  | .14****       | .11**** | .08**** | .05    | .24****        | .26**** | .19**   | .11    |
| $R^2$                 | .55****       | .48**** | .47**** | .19    | .76****        | .72**** | .59**** | .36*   |
| Adjusted $R^2$        | .46           | .37     | .37     | .03    | .68            | .64     | .49     | .19    |
| AVHomophily           | -.10*         | -.62    | -1.22** | -1.87* | .76**          | .52     | .38     | .74    |
| Multiplexity          | .06           | .05     | .04     | .15    | -.07           | -.07    | -.02    | -.03   |
| to same sex           | (.05)         | (.05)   | (.04)   | (.08)  | (.35)          | (.43)   | (.38)   | (.68)  |
| $R^2$                 | .61****       | .51**** | .60**** | .30    | .80****        | .74**** | .61**** | .39*   |
| $\Delta R^2$          | .06*          | .03     | .13**   | .11*   | .04*           | .02     | .02     | .03    |
| Adjusted $R^2$        | .50           | .37     | .49     | .11    | .73            | .65     | .47     | .17    |

* $p < .10$; **$p < .05$; ***$p < .01$; ****$p \leq .001$.

* Unstandardized regression coefficients; standard errors are in parentheses.

(1925-1982)
Department of Sociology at University of Washington, Seattle
WILLER, DAVID. (1992). —PREDICTING POWER IN EXCHANGE NETWORKS. 
SOCIAL NETWORKS, 14, 187-211

Department of Sociology 
University of South Carolina, Columbia

Cook, Karen S
Department of Sociology, Stanford University, Stanford, CA
Degree centrality: Freeman's approach

- Degree centrality (outdegree and indegree)
- Betweenness Centrality
- Closeness Centrality

Department of Sociology and Institute for Mathematical Behavioral Sciences
School of Social Sciences, University of California, Irvine, CA

Bonacich's power centrality approach

Department of Sociology, UCLA, CA

Main Developer of UCINET

Department of Management
Gatton College of Business & Economics
University of Kentucky

1989 Ph.D. Mathematical Social Science, University of California, Irvine. (Chair: Linton C. Freeman)

Department of Management
Gatton College of Business & Economics
University of Kentucky
BORGATTI, STEPHEN P. AND BRASS, DANIEL J

The LINKS Center for Social Network Analysis, University of Kentucky
IBARRA, HERMINIA. (1992). —HOMOPHILY AND DIFFERENTIAL RETURNS: SEX DIFFERENCES IN NETWORK STRUCTURE AND ACCESS IN AN ADVERTISING FIRM.‖
ADMINISTRATIVE SCIENCE QUARTERLY, 37(3), 422-447.

Organizational Behavior at INSEAD, Paris, France
The Cora Chaired Professor of Leadership and Learning
Chair, Organizational Behavior Area

Ibarra: Gender and Career Development Networks
(1960s-70s) Exchange theory & Power (Relations)
(1960s-70s) Exchange theory & Power (Relations)

(1980s) Diverse Centrality Measures

Freeman

Bonacich

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Degree ...

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Freeman Betweenness
(1960s-70s) Exchange theory & Power (Relations)

(1980s) Diverse Centrality Measures

(1990s-2000s) Centrality and Networks: New research area

Ansell: Collaboration in the public sector

Ibarra: Gender and Career Development

Freeman

Borgatti

Bonacich

Padgett: Network data development of Renaissance Florence

Brass
THANK YOU!
SMALL GROUP EXERCISE

- Which actors are most central? Are the measures the same? What do the different measures suggest conceptually or practically for the work of the committee?
- Do the centrality findings suggest any process issues that the group should address if they need to work collaboratively?
- What other contextual data would you like to have in order to interpret the findings?
- What do the Bonacich power findings imply? Do the selected betas make sense?
SMALL GROUP EXERCISE

Key to network graph:
- Size: Academic rank – four levels
  - Junior assistant (smallest)
  - Senior assistant
  - Associate
  - Full (largest)
- Color: Red = male; blue = female
- Shape: School
  - Circle = Arts & Sciences
  - Diamond = Business
  - Square = Public Affairs
  - Triangle = Social Work
- Line = Know each other.
- Placement: Modified 2D MDS output (made easier to read). Closer together = more similar in network connections.
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- Size: Academic rank – four levels
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Placement: Modified 2D MDS output (made easier to read). Closer together = more similar in network connections.
ASSIGNMENT

• Readings per the syllabus. Be sure to read W & F 7, Borgatti & Everett (both), Frank, Moore; and Caldeira; if interested, see the Rethemeyer manuscript, which uses core-periphery ideas.

• Be prepared to discuss Problem Set #1 next week