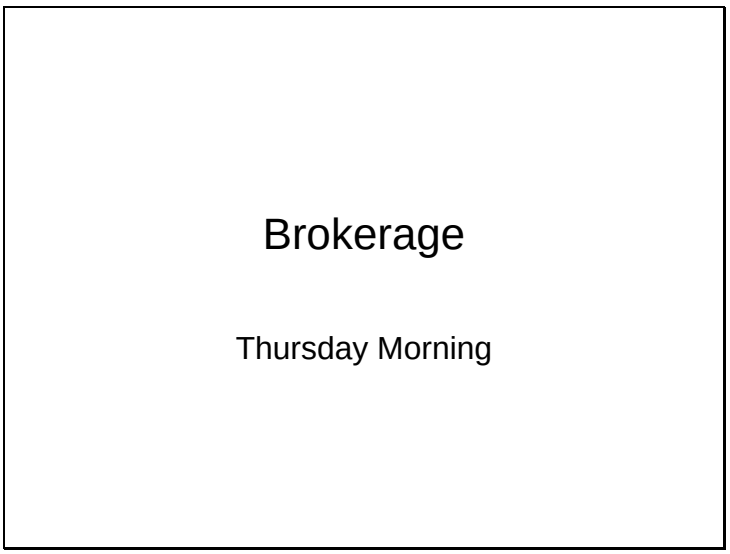
Slide 1



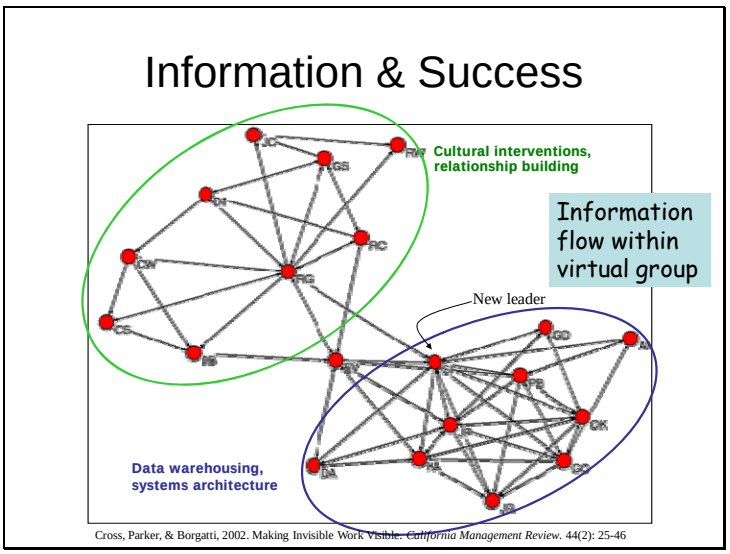
Social Capital, generally speaking, deals with identifying how various network properties can be beneficial, either to the networks themselves or to specific actors in the network. While there is considerable interest in social capital, there are several different and even conflicting views of how social capital works.

Objectives:

After this section, you should be able to:

- Describe the concept of social capital
- Differentiate between the various views of social capital
- Name at least two measures associated with structural holes
- Explain the E-I index and the concept of heterogeneity
- Use UCINET to:
    - Calculate measures of structural holes
    - Calculate transitivity
    - Calculate reciprocity
    - Calculate E-I index
    - Calculate an ego network's strength based on an attribute
- Use NetDraw to:
    - Visualize structural hole measures in NetDraw
    - Visualize reciprocal ties in NetDraw

Slide 2


Information & Success
Cultural interventions, relationship building
Information flow within virtual group
New leader
Data warehousing, systems architecture
Cross, Parker, & Borgatti, 2002. Making Invisible Work Visible. California Management Review. 44(2): 25-46

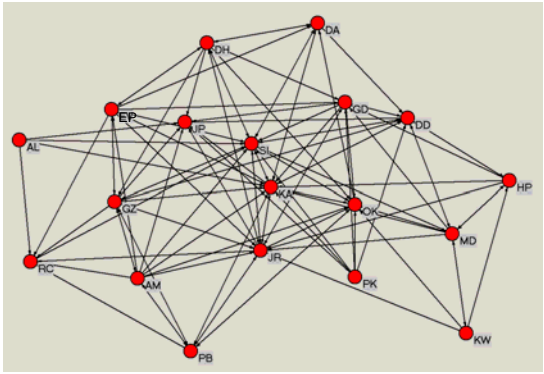
Slide 3

Changes Made

- Cross-staffed new internal projects
  - white papers, database development
- Established cross-selling sales goals
  - managers accountable for selling projects with both kinds of expertise
- New communication vehicles
  - project tracking db; weekly email update
- Personnel changes

Slide 4

9 Months Later



Cross, Parker, & Borgatti, 2002. Making Invisible Work Visible. *California Management Review*. 44(2): 25-46

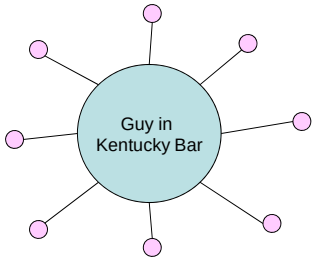
Slide 5

Approaches to Social Capital

- Topological (shape-based)
  - Burt
  - Coleman
- Connectionist (attribute-based)
  - Lin
- Combination of shape-based and attribute-based
  - Gould & Fernandez

Slide 6

Structural Holes

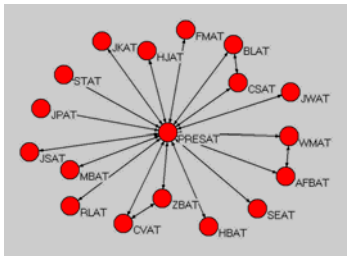


- Basic idea: Lack of ties among alters may benefit ego
- Benefits
  - Autonomy
  - Control
  - Information

Slide 7

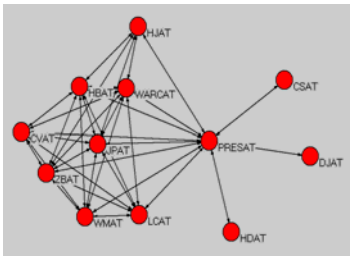
Control Benefits of Structural Holes

White House Diary Data, Carter Presidency



Year 1

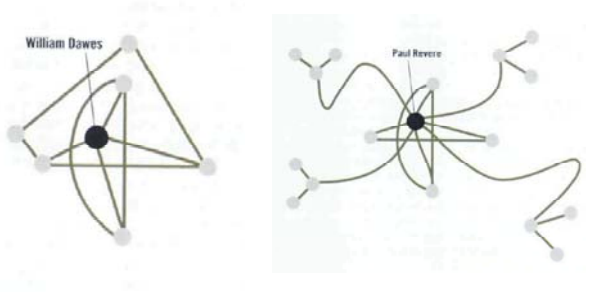
Data courtesy of Michael Link



Year 4

Slide 8

Information Benefits of Structural Holes

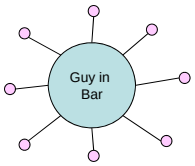


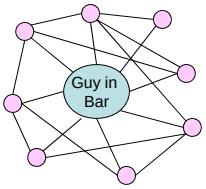
From Uzzi (2005)

Slide 9

Measures of Structural Holes

- Burt's effective size
- Burt's constraint





Slide 10

Effective Size

m_{jq} = j's interaction with q divided by j's strongest relation with anyone
p_{iq} = proportion of i's energy invested in relation with q

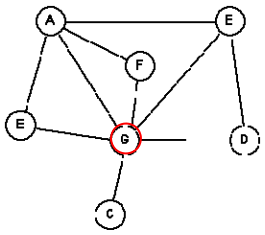
$$ES_i = \sum_j \left[1 - \sum_q p_{iq} m_{jq} \right], \quad q \neq i, j$$

$$ES_i = \sum_j 1 - \sum_j \sum_q p_{iq} m_{jq}, \quad q \neq i, j$$

- Effective size is network size (N) minus redundancy in network

Slide 11

Effective Size



Adapted from Burt (1995:56)

Node "G" is EGO	A	B	C	D	E	F	Total
Redundancy with EGO's other Alters:	3/6	2/6	0/6	1/6	1/6	1/6	1.33

Effective Size of G = Number of G's Alters – Sum of Redundancy of G's alters
= 6 – 1.33 4.67

Slide 12

Effective Size in 1/0 Data

- M_{jq} = j's interaction with q divided by j's strongest tie with anyone
  - So this is always 1 if j has tie to q and 0 otherwise
- P_{iq} = proportion of i's energy invested in relationship with q
  - So this is a constant 1/N where N is ego's network size

$$ES_i = \sum_j \left[1 - \sum_q p_{iq} m_{jq} \right], \quad q \neq i, j$$

$$ES_i = \sum_j \left[1 - \frac{1}{n} \sum_q m_{jq} \right], \quad q \neq i, j$$

$$ES_i = \sum_j 1 - \sum_j \frac{1}{n} \sum_q m_{jq}, \quad q \neq i, j$$

$$ES_i = n - \frac{1}{n} \sum_j \sum_q m_{jq}, \quad q \neq i, j$$

Slide 13

Constraint

Mjq= j's interaction with q divided by j's strongest relationship with anyone
So this is always 1 if j has tie to q and 0 otherwise

P_{iq} = proportion of i's energy invested in relationship with q
So this is a constant 1/N where N is network size

$$c_{ij} = p_{ij} + \sum_{q} p_{iq} m_{qj}, \quad q \neq i, j$$

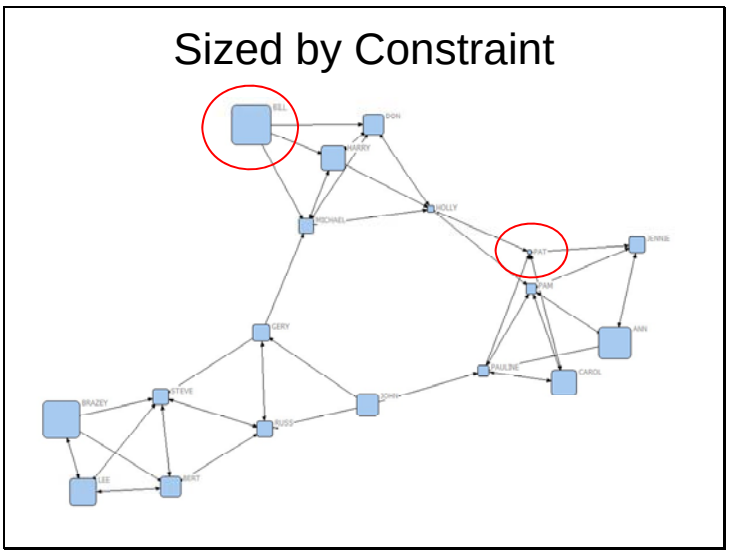
- Alter j constrains i to the extent that
  - i has invested in j
  - i has invested in people (q) who have invested heavily in j. That is, i's investment in q leads back to j.
- Even if i withdraws from j, everyone else in i's network is still invested in j

Slide 14

Constraint: The Basic Idea

- Constraint is a summary measure that taps the extent to which ego's connections are to others who are connected to one another.
- If ego's potential trading partners all have one another as potential trading partners, ego is highly constrained. If ego's partners do not have other alternatives in the neighborhood, they cannot constrain ego's behavior. (Hanneman & Riddle, 2005)

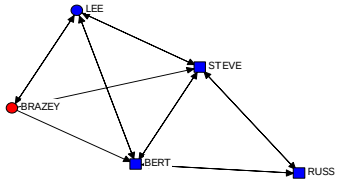
Slide 15



Slide 16

Social Capital: Lin

- Lin's view
  - It is the attributes of those you are connected to that matters. (e.g., position generator)



•We can look at the composition of an ego-net in terms of heterogeneity

Slide 17

E-I Index

- Krackhardt and Stern

$$\frac{E-I}{E+I}$$

- E is number of ties between groups, I is number of ties within groups
- Varies between -1 (homophily) and +1 (heterophily)

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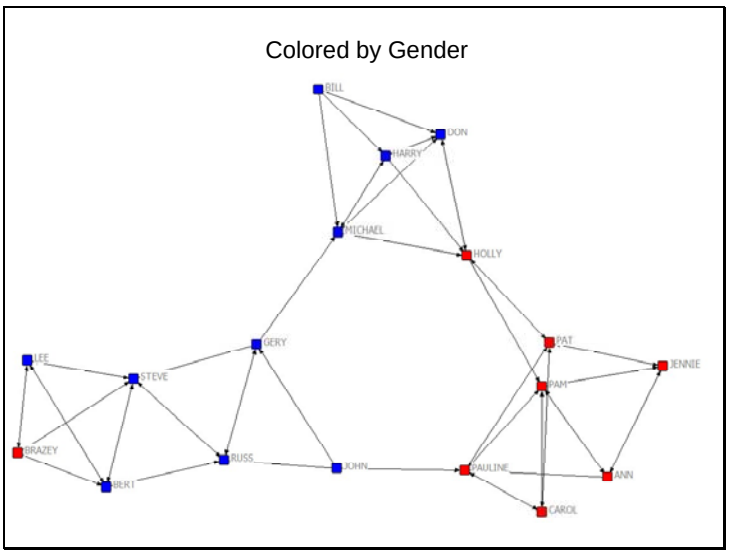

Colored by Gender
BILL
DON
HARRY
MICHAEL
HOLLY
PAT
JENNIE
PAM
GERY
LEE
STEVE
BRAZEY
BERT
RUSS
JOHN
PAULINE
ANN
CAROL

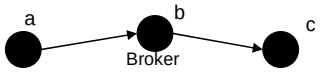
Slide 19

$$\text{E-I Index} = \frac{E - I}{E + I}$$

	External	Internal	EI	
HOLLY	3	2	0.2	
BRAZEY	3	0	1	⇦ Perfect heterophily
CAROL	0	3	-1	
PAM	0	4	-1	
PAT	0	3	-1	
JENNIE	0	3	-1	
PAULINE	1	4	-0.6	
ANN	0	3	-1	
MICHAEL	1	4	-0.6	
BILL	0	3	-1	
LEE	1	2	-0.333	
DON	1	3	-0.5	
JOHN	1	2	-0.333	
HARRY	1	3	-0.5	
GERY	0	4	-1	
STEVE	1	4	-0.6	
BERT	1	3	-0.5	
RUSS	0	4	-1	⇦ perfect homophily

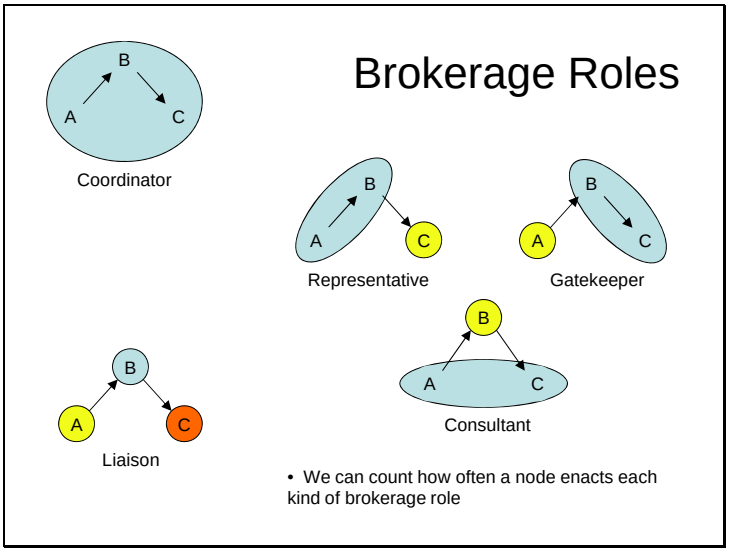
Slide 20

Brokerage Roles

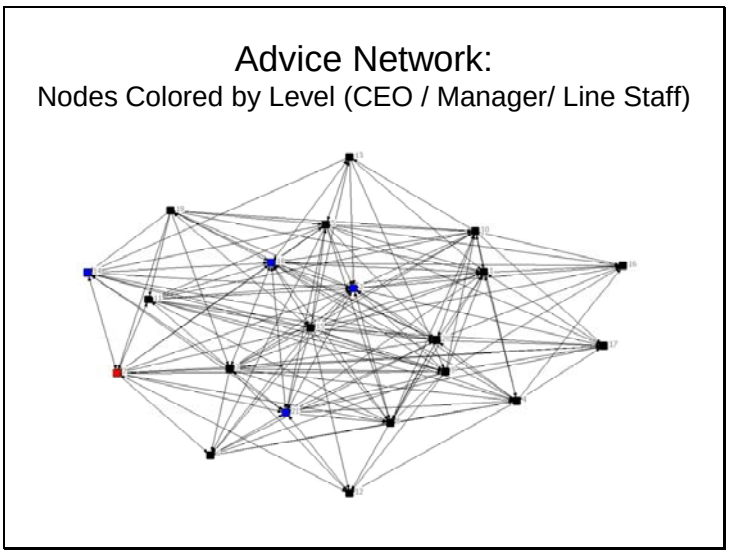


- Gould & Fernandez
- Broker is middle node of directed triad (note: a is NOT connected to c)
- What if nodes belong to different organizations?

Slide 21


Brokerage Roles
B
A
C
Coordinator
B
A
C
Representative
B
A
C
Gatekeeper
B
A
C
Consultant
B
A
C
Liaison
• We can count how often a node enacts each kind of brokerage role

Slide 22

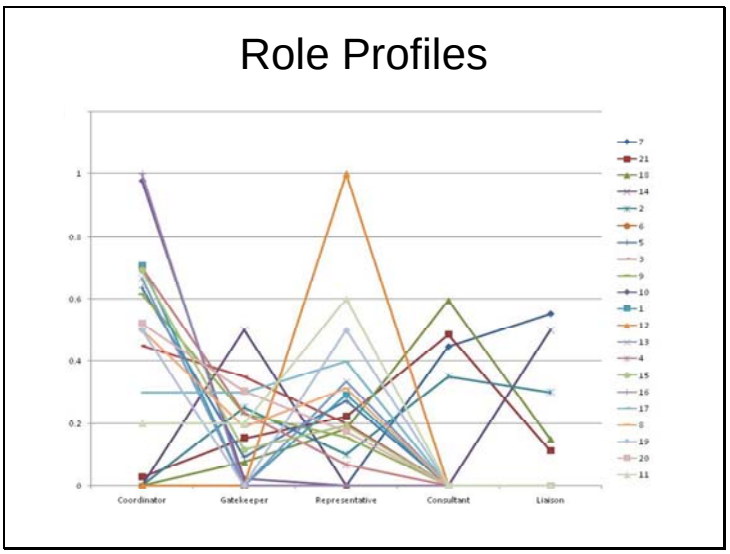

Advice Network:
Nodes Colored by Level (CEO / Manager/ Line Staff)

Slide 23

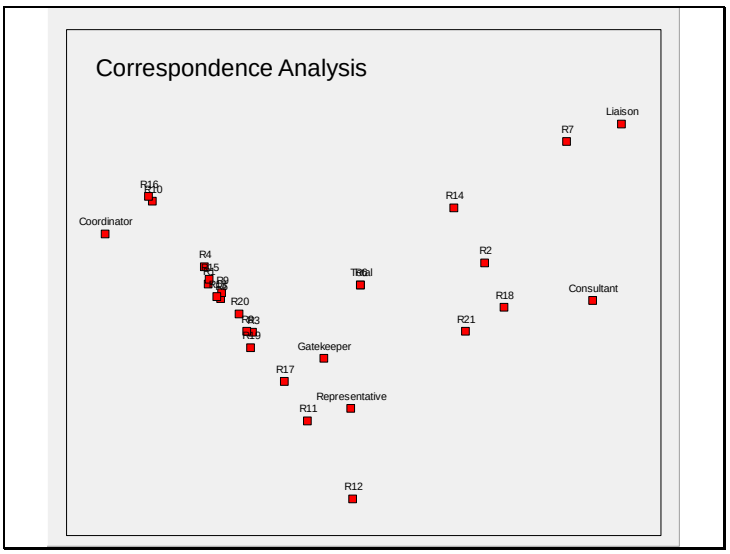
Counting of Role Structures

ID	Coordinator	Gatekeeper	Representative	Consultant	Liaison
7 (CEO)	0	0	0	17	21
21(Mgr)	2	11	16	35	8
18(Mgr)	0	9	22	72	18
14(Mgr)	0	2	0	0	2
2	0	5	2	7	6
6	0	0	0	0	0
5	14	2	6	0	0
3	9	7	4	0	0
9	8	3	2	0	0
10	44	1	0	0	0
1	17	0	7	0	0
12	0	0	2	0	0
13	2	0	1	0	0
4	21	7	2	0	0
15	18	3	5	0	0
16	2	0	0	0	0
17	3	3	4	0	0
8	8	3	5	0	0
19	2	0	2	0	0
20	12	7	4	0	0
11	1	1	3	0	0

Slide 24


Role Profiles
1
0.8
0.6
0.4
0.2
0
Coordinator
Gatekeeper
Representative
Consultant
Liaison
7
21
18
14
2
6
5
3
9
10
1
12
13
4
15
16
17
8
19
20
11

Slide 25

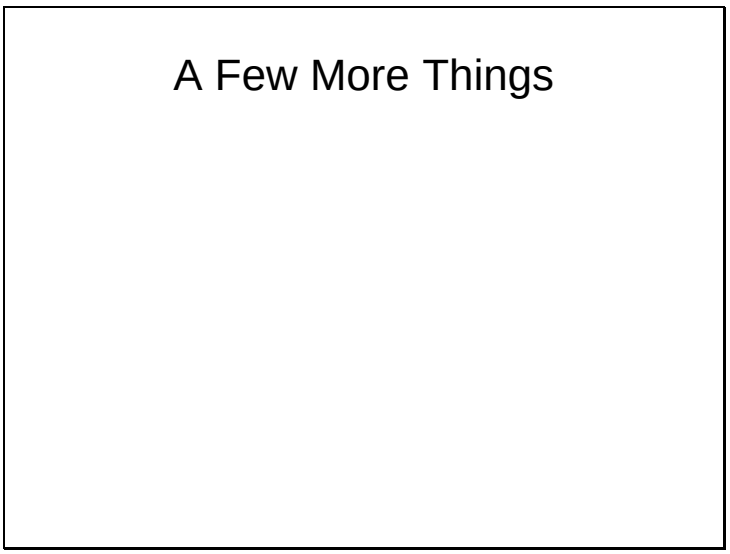

Correspondence Analysis
Liaison
R7
R16
R14
Coordinator
R2
R4
R18
Consultant
R20
R21
Gatekeeper
R17
Representative
R11
R12

Slide 26

SUMMARY

Name:	Description:	Relation to Social Capital:
Effective Size (Burt, 1992)	The number of alters, weighted by strength of tie, that an ego is directly connected to, minus a "redundancy" factor.	Positive. The more different regions of the network an actor has ties with, the greater the potential information and control benefits.
Constraint (Burt,1992)	The extent to which all of ego's relational investments directly or indirectly involve a single alter	Negative. The more constrained the actor, the fewer opportunities for action.
Compositional Quality (e.g., Lin)	The number of alters with high levels of needed characteristics (e.g., total wealth or power or expertise or generosity of alters)	Positive. The more connected to useful others, the more social capital.
Heterogeneity (e.g., Burt, 1983)	The variety of alters with respect to relevant dimensions (e.g., sex, age, race, occupation, talents).	Positive (except when it conflicts with compositional quality)
Brokerage Roles (Gould & Fernandez, 1989)	There are different roles that ego can play depending on network structure and composition	Depends on the situation

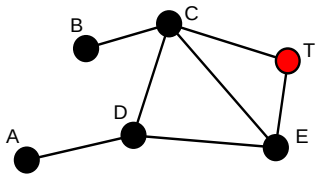
Slide 27



Slide 28

Transitivity

- Proportion of triples with 3 ties as a proportion of triples with 2 or more ties
  - Aka the weighted clustering coefficient

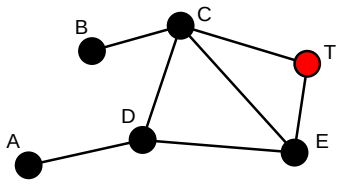


{C,T,E} is a transitive triple, but {B,C,D} is not. {A,D,T} is not counted at all.

Slide 29

Simmelian Ties

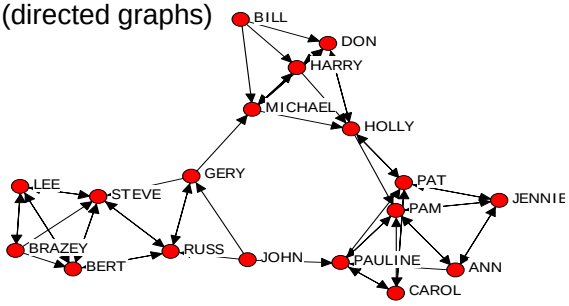
- These are the ties that make up transitivity
  - CD,DE,EC is one set of simmelian ties
  - CT,TE,EC is another set
  - All other sets are not simmelian



Slide 30

Reciprocity

- Basically, are ties mutual?
  - So, obviously, it only applies to digraphs (directed graphs)



Social Capital & Brokerage Lab

For this lab we will use only one dataset:

KRACK-HIGH-TECH (KHT) & HIGH-TEC-ATTRIBUTES (HTA)

This is a dataset collected by David Krackhardt from managers of a high tech company. KRACK-HIGH-TEC is a stacked dataset containing three directed, dichotomous matrices which represent ADVICE, FRIENDSHIP, and REPORTS_TO ties among 21 managers within the company. HIGH-TEC-ATTRIBUTES contains four attributes for each of the 21 actors, including each manager's age (in years), tenure with company, level in corporate hierarchy, and department.

EXERCISES:

1) Structural Holes using UCINET and NetDraw with **KHT** and **HTA**

    a. If you have not already, unpack (Data | Unpack) the KHT dataset to get the three adjacency matrices **FRIENDSHIP, REPORTS_TO, ADVICE.**

    b. Run Network | Ego Networks | Structural Holes on the **FRIENDSHIP** data. From the output, who appears to have the largest Effective Size?

    c. Load the data in NetDraw to visualize it.

    d. When you ran structural holes in UCINET it automatically saved the output in a dataset called "StructuralHoles" (unless you changed the name). Load **STRUCTURALHOLES** as an attribute file in NetDraw and use the effective size attribute (EffSize) to size the nodes on the graph. What information does this convey in the graph?

    e. In NetDraw, run Analysis | Structural Holes. This allows you to do structural hole analysis directly in NetDraw. It also created a new attribute called Density (which refers to the density of each actors Ego-Net). Using the "Nodes" tab in the control region, select this attribute and click on the "size" checkbox to resize the nodes based on Density. What happened? Why? What is the relationship between density and effective size?

2) Transitivity and Clustering in UCINET using **KHT**

    a. Run Network | Cohesion | Clustering Coefficient on the **FRIENDSHIP** data.

    b. By default, this procedure creates a file called **ClusteringCoefficients**. Open that file in the UCINET spreadsheet (click on the grid icon to bring up the UCINET spreadsheet). Select the data and label from the column labeled "Clus Coef" and copy it. Now, open the **StructuralHoles** dataset created in step 1. Increase the number of columns by 1 by changing then value in the box under "Cols:" in the "Dimensions" section of the window, click in the empty label cell for the new column and paste the data you just copied. Save this dataset with a new name (e.g., **HolesAndClusters**) using File | Save As.

c. Now run Tools | Similarities on this new dataset to find correlations between the variables. Which of Burt's structural holes measures is the most like and the most opposite clustering coefficient?

d. Run Network | Cohesion | Transitivity on the **KHT (KRACK-HIGH-TEC)** stacked dataset. What does this tell you? Given that transitivity is about "Closure" (or lack of structural holes), which of the three relations has the most and the least closure?

3) E-I Index with UCINET using **KHT & HTA**

a. Run Network | Cohesion | E-I Index on the **FRIENDSHIP** data, partitioning the data based on department (which is in column 4 of the **HIGH-TEC-ATTRIBUTES** dataset). Looking at the individual E-I index statistics, who has the most homophilous ties (more concentrated within the same department), and who has the most heterophilous (most concentrated outside department) ones?

b. Rerun E-I index using the same partitioning, but instead of using the FRIENDSHIP dataset, use the stacked **KHT (KRACK-HIGH-TEC)** dataset. What do you think these results tell you?

c. Display (using the "D" icon) the **KHT** stacked dataset. Rerun the E-I index on the individual dataset that is displayed first from this command and compare the results to the results from step b. Is this what you thought was happening?

4) Brokerage with UCINET using **KHT & HTA**

a. Run Network | Ego Networks | G& F Brokerage Roles on the same data, again using the department attribute (Column 4 of **HTA**) for your partition vector.

b. Open **KRACK-HIGH-TEC** in NetDraw and, using the "Rels" tab in the control region, display only the **FRIENDSHIP** relation. Compare this visualization with the results from step a. It may help to color or shape the nodes by department. Can you find at least one example of each kind of brokerage for Actor 5? Remember, direction counts in brokerage, so make sure you have the arrows on. It might help to only display the Ego Net for Actor 5 by clicking on the Ego button on the icon bar, clearing (using the Clr button) all the selections, and then selecting just Actor 5.

c. Running G&F Brokerage Roles automatically created two datasets, one called **BROKERAGE** which is a two-mode matrix of actors by brokerage roles. Run Tools | 2-Mode Scaling | Correspondence on the **BROKERAGE** dataset. Interpret the picture you get.

d. Rerun the G&F Brokerage routine using the **REPORTS_TO** data instead of the FRIENDSHIP data, still partitioning based on the department attribute. Thinking about the relationships, what can you tell about the actors based on this output.

e. Re-run the G&F Brokerage routine on the **REPORTS_TO** data, but this time use the Level attribute (Column 3) to partition that data. How does this data compare to the previous

output? Why is it different?

5) Reciprocal ties with NetDraw using **KHT**

   a. Back in NetDraw, ensure you are displaying the **FRIENDSHIP** relation from **KRACK-HIGH-TEC**.

   b. Select Analysis | Reciprocal Ties and complete the dialog box (the defaults are probably sufficient, but feel free to change them if you would like.) Once you click okay the graph will change. Is there any more information on this graph than there was before you used it? Does it convey information more clearly?

   c. To undo the effects of this command, rerun reciprocal ties, but specify both to have black with a size of one.

6) Ego-Net Strength with UCINET and NetDraw using **KHT**

   a. Run Network | Ego Networks | Egonet Composition| Continuous Alter Attributes variable specifying the **ADVICE** dataset you previously unpacked from **KHT** for the Input Network Dataset. For the Input Attribute dataset, specify **HIGH-TEC-ATTRIBUTES** and select the column labeled "Tenure."

   b. This procedure gives information about each actor's egonet with respect to their alters' "Tenure". For example, if we say that getting advice from people who have worked for the company longer is more likely to lead to success, which people are most likely to succeed based on these results?

   c. Go back to NetDraw, load **KHT** and ensure that the **ADVICE** relation is being displayed.

   d. Now load the dataset just created (by default was called **ADVICE-EgoStrength**) as an Attribute file in NetDraw. Size the nodes based on both the "Sum" and the "Avg" (Average) values calculated. How do the results differ? Which do you think is more likely to lead to success?