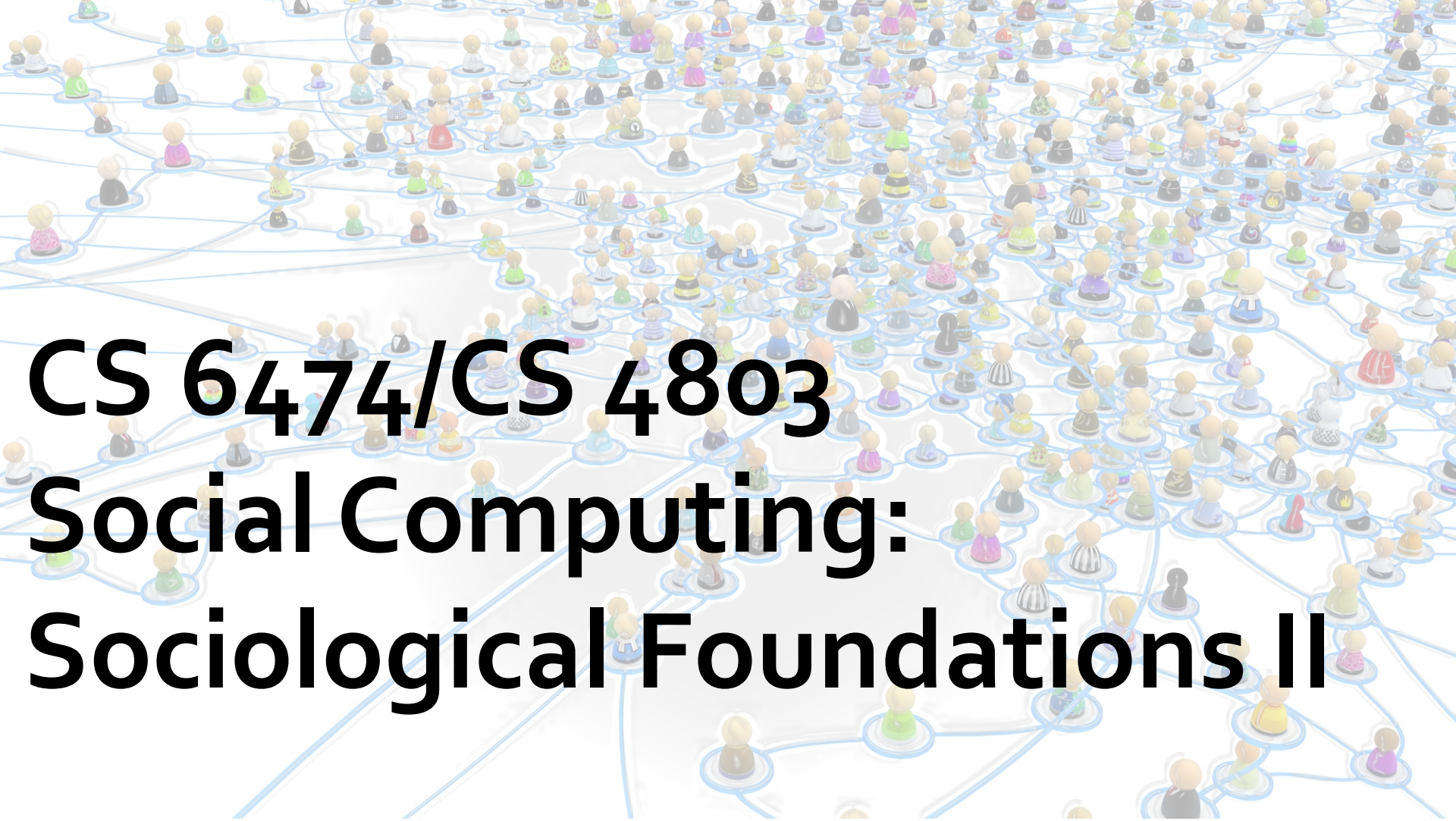

CS 6474/CS 4803 Social Computing: Sociological Foundations II

Munmun De Choudhury

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Week 3 | January 26, 2021

Last class: *human social networks have unique characteristic structures*

Formalist Approach

- Concerned primarily with describing the mathematical form of social networks
- Study the effects of forms, insofar as they are effects on the form itself, and the causes of these forms
  - E.g. Watts and Strogatz's small world network formulation
  - E.g., Barabasi's preferential attachment models

Structuralist Approach

- Concerned with how patterns of relations can shed light on substantive topics within their disciplines.
- Structuralists study such diverse subjects as
  - health (Lin and Ensel, 1989; Pescosolido, 1992; Cohen et al., 1997; S. Cohen et al., 2001),
  - work (Burt, 1992; Podolny and Baron, 1997; Ibarra, 1993),
  - community (Fischer, 1982a; Wellman and Wortley, 1990)

Structuralist Approach

A collection of human beings does not become a society because each of them has an objectively determined or subjectively impelling life-content. It becomes a society only when the vitality of these contents attains the form of reciprocal influence; only when one individual has an effect, immediate or mediate, upon another, is mere spatial aggregation or temporal succession transformed into society. (Simmel, 1908 [1971], pp. 24-25)

Georg Simmel

Georg Simmel

Born	1 March 1858 Berlin, Kingdom of Prussia
Died	26 September 1918 (aged 60) Strassburg, German Empire
Nationality	German
Alma mater	University of Berlin
Era	19th-century philosophy
Region	Western philosophy
School	Neo-Kantianism *Lebensphilosophie*[1]
Institutions	University of Berlin University of Strasbourg
Notable students	György Lukács
Main interests	Philosophy, sociology
Notable ideas	Formal sociology, social forms and contents, the tragedy of culture,[2] web of group affiliation

Structuralist Approach

- Defining Key Concepts in Network Terms

- Testing an Existing Theory

Structuralist Approach

- Looking at network causes of phenomenon of interest
  - Today
- Looking at network effects of phenomenon of interest
  - Next class

This class: *not just your distance from Paul Erdos or Kevin Bacon, but your network position also matters!*

Social structures, creativity, and innovation

Structural Holes and Good Ideas

Summary

- Role of social network structure on access to social resources
- Burt's observations:
  - Opinions and thoughts within groups are homogenous
  - People who extend themselves across the 'structural holes' between groups are exposed to diverse ways of thinking

- Brokerage across structural holes between groups can lead to greater accumulation of "social capital" – quantitatively defining the *network constraint* measure, that uses the size, density, and hierarchy measures of an individual's egonetwork
  - Hypothesis is tested with a case study of the network structure of managers in a supply chain company

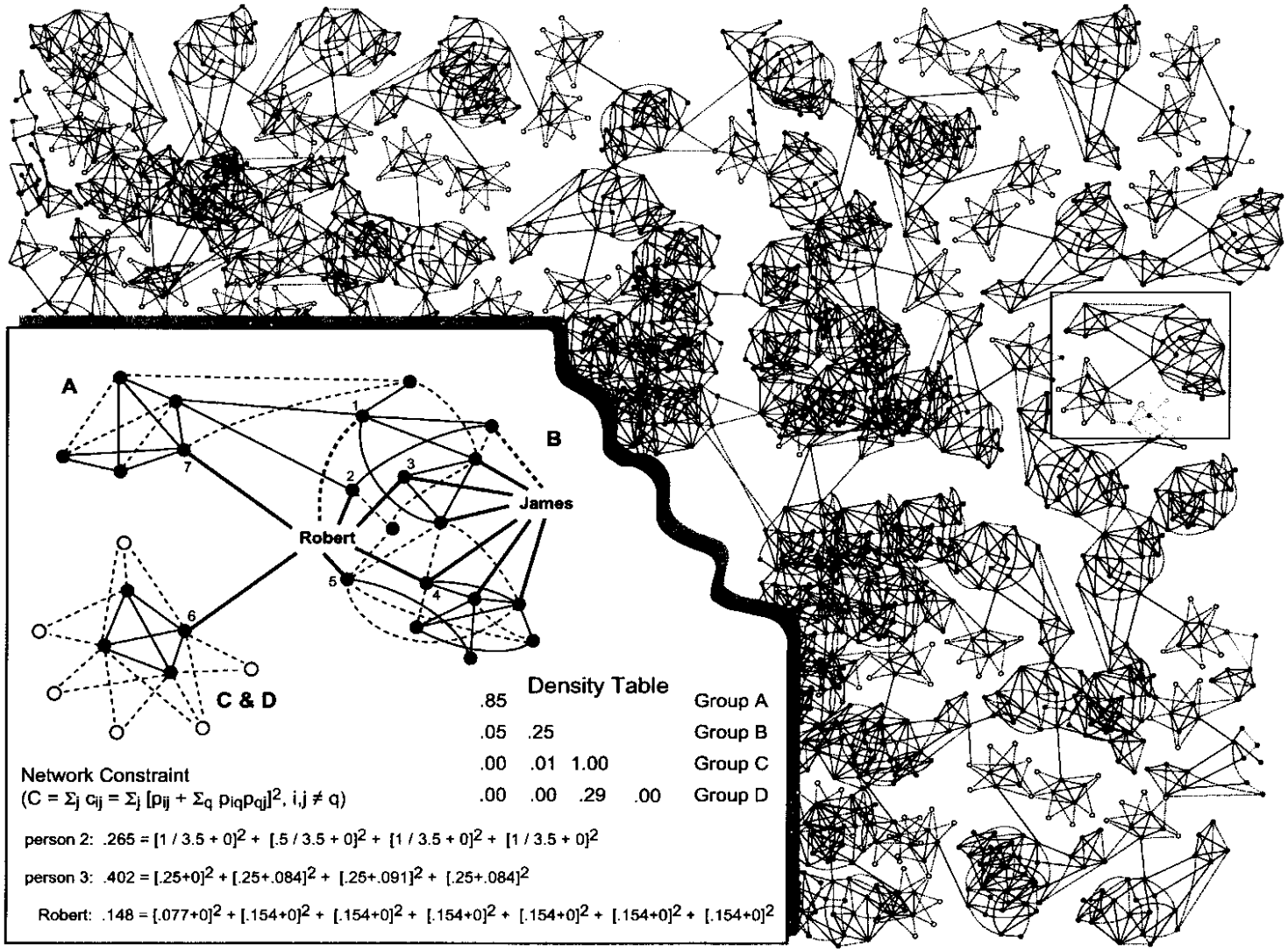
Summary

- Managers asked to come up with an idea to improve the supply chain
- Then asked:
  - whom did you discuss the idea with?
  - whom do you discuss supply-chain issues with in general
  - do those contacts discuss ideas with one another?

- 673 managers (455 (68%) completed the survey)
- ~ 4000 relationships (edges)

Structural Holes

(Figure 1 from Burt 2004)



The results show a strong effect of network constraint on salary, evaluation and promotion, independent of the job/age characteristics related to human capital explanations.

TABLE 1

PREDICTING PERFORMANCE

	1 Salary		2 Salary		3 Evaluation		4 Promotion	
Manager 1	−31,099**	(2,882)	−35,707**	(3,498)	−.973	(.678)	.689	(.670)
Manager 2	−16,652**	(2,745)	−19,892**	(3,479)	−.863	(.631)	1.165	(.648)
Manager 3 (reference)	. . .		. . .		. . .		. . .	
Sr. manager	19,638**	(3,782)	15,484**	(4,143)	.116	(.843)	−.635	(.885)
Executive	65,394**	(4,522)	61,930**	(4,835)	.423	(1.01)	.221	(1.08)
Purchasing	754	(1,351)	1,811	(1,884)	.410	(.313)	.478	(.345)
Age	338**	(52)	300**	(71)	−.085**	(.013)	−.084**	(.013)
Bachelor	1,610	(1,003)	200	(1,401)	−.211	(.237)	.118	(.240)
Graduate	734	(864)	−451	(1,155)	−.208	(.203)	.182	(.204)
Hightech	3,516**	(880)	3,150*	(1,189)	.087	(.209)	.162	(.210)
Lowtech	−6,927**	(1,481)	−6,607*	(2,375)	−.351	(.342)	−.409	(.378)
Urban 1	3,613**	(1,046)	3,947**	(1,456)	.423	(.247)	−.152	(.252)
Urban 2	5,049**	(1,010)	5,585*	(1,427)	−.564	(.238)	−.052	(.243)
Network constraint	−7	(25)	−1	(38)	−.014**	(.004)	−.022**	(.006)
Mgr2 × constraint	−19	(35)	−47	(58)	.004	(.008)	−.008	(.009)
Mgr3 × constraint	−47	(38)	−159*	(59)	−.007	(.009)	.003	(.009)
SrMgr × constraint	−214*	(75)	−216*	(84)	−.005	(.017)	.010	(.019)
Executive × constraint	−681**	(124)	−697**	(132)	−.011	(.028)	.024	(.030)
N	673		398		673		638	

NOTE.—Coefficients in models 1 and 2 are change in salary dollars with a unit increase in row variable (respectively .80 and .83 squared multiple correlations; network effect plotted in fig. 4). Coefficients in model 3 predict three levels of evaluation for an ordinal logit model (114.8 χ^2 with 17 *df*; network effects are plotted in fig. 4 holding age constant). Coefficients in model 4 are for a logit model predicting whether the employee was promoted in the year after the network survey or received an above average raise (100.5 χ^2 with 17 *df*; network effect is plotted in fig. 4 holding age constant). SEs are given in parentheses.

* $P < .05$.

** $P < .001$.

Four levels of brokerage

- Level 1
  - Make people on both sides aware of the interests and difficulties in the other
- Level 2
  - Transferring best practices from one group to another
- Level 3
  - Draw analogies between groups ostensibly irrelevant to one another (difficult for people who have spent a long time in a group because they use differences to justify continuing their behavior on the basis that the other group is a different context)
- Level 4
  - Synthesis

- A setting dependent on formal chains of command for communication is a setting rich in opportunities to coordinate directly across the formal chains

Network Constraint

- Measure of the extent to which the people a respondent knows are tied to each other
- High constraint means the network is redundant and recycles information
- Low constraint = bridging between groups = good ideas

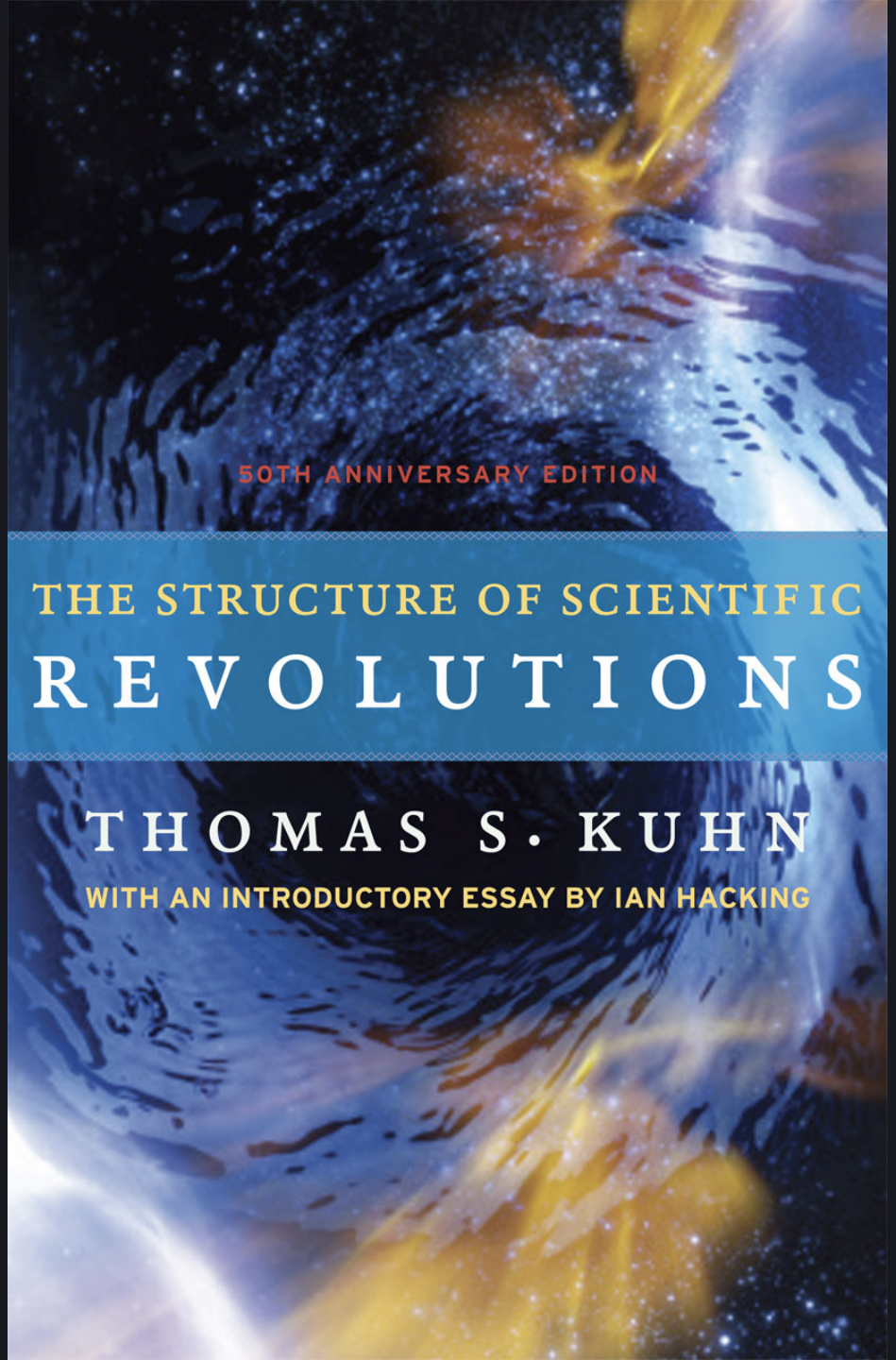
Summary

- Main finding – interconnected groups give rise to "better ideas" compared to densely intra-connected groups
- Other findings –
  - 1) organizations that collaborate with partner firms show greater financial growth;
  - 2) higher ranked, high tech, and managers in urban settings came up with better ideas;
  - 3) managers who brokered connections across structural holes were rewarded for brokerage in terms of compensation, performance evaluations, and promotions

To what extent are the findings on the importance of brokerage and structural holes affected by the case studies considered?

What are some of the variables that should have been considered/controlled for in the study?

Can a structure (and related structural holes) be too large or small to realize the benefit of brokerage?


50TH ANNIVERSARY EDITION
THE STRUCTURE OF SCIENTIFIC
REVOLUTIONS
THOMAS S. KUHN
WITH AN INTRODUCTORY ESSAY BY IAN HACKING

"Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change. And perhaps that point need not have been made explicit, for obviously these are the men who, being little committed by prior practice to the traditional rules of normal science, are particularly likely to see that those rules no longer define a playable game and to conceive another set that can replace them."

—*Thomas S. Kuhn, The Structure of Scientific Revolutions*

"Why should a change of paradigm be called a revolution? In the face of the vast and essential differences between political and scientific development, what parallelism can justify the metaphor that finds revolutions in both?

One aspect of the parallelism must already be apparent. Political revolutions are inaugurated by a growing sense, often restricted to a segment of the political community, that existing institutions have ceased adequately to meet the problems posed by an environment that they have in part created. In much the same way, scientific revolutions are inaugurated by a growing sense, again often restricted to a narrow subdivision of the scientific community, that an existing paradigm has ceased to function adequately in the exploration of an aspect of nature to which that paradigm itself had previously led the way. In both political and scientific development the sense of malfunction that can lead to crisis is prerequisite to revolution."

—Thomas S. Kuhn, The Structure of Scientific Revolutions

THINK TANK; Where to Get a Good Idea: Steal It Outside Your Group

By MICHAEL ERARD MAY 22, 2004

Got a good idea? Now think for a moment where you got it. A sudden spark of inspiration? A memory? A dream?

Most likely, says Ronald S. Burt, a sociologist at the University of Chicago, it came from someone else who hadn't realized how to use it.

"The usual image of creativity is that it's some sort of genetic gift, some heroic act," Mr. Burt said. "But creativity is an import-export game. It's not a creation game."

Mr. Burt has spent most of his career studying how creative, competitive people relate to the rest of the world, and how ideas move from place to place. Often the value of a good idea, he has found, is not in its origin but in its delivery. His observation will undoubtedly resonate with overlooked novelists, garage inventors and forgotten geniuses who pride themselves on their new ideas but aren't successful in getting them noticed. "Tracing the origin of an idea is an interesting academic exercise, but it's largely irrelevant," Mr. Burt said. "The trick is, can you get an idea which is mundane and well known in one place to another place where people would get value out of it."

Mr. Burt, whose latest findings will appear in the American Journal of Sociology this fall, studied managers in the supply chain of Raytheon, the large electronics company and military contractor based in Waltham, Mass., where he worked until last year. Mr. Burt asked managers to write down their best ideas about how to improve business operations and then had two executives at the company rate their quality. It turned out that the highest-ranked ideas came from managers who had contacts outside their immediate work group. The reason, Mr. Burt said, is that their contacts span what he calls "structural holes," the gaps between discrete groups of people.

Class Exercise I

Burt says: ""Good" will take on specific meaning with empirical data, but for the moment, a good idea broadly will be understood to be one that people praise and value."

What would be some examples of good ideas beyond ones discussed in the paper, where you expect structural holes and network positions to play a role? How do you define/operationalize "good"?

Structural Holes help? Well it depends

New Contract Revenue — **Coefficients[a]**

	Unstandardized Coefficients			
	B	Std. Error	Adj. R^2	Sig. F Δ
(Base Model)			0.40	
Size Struct. Holes	13770***	4647	0.52	.006
Betweenness	1297*	773	0.47	.040

a. Dependent Variable: **Bookings02**
b. Base Model: YRS_EXP, PARTDUM, %_CEO_SRCH, SECTOR(dummies), %_SOLO.

Contract Execution Revenue — **Coefficients[a]**

	Unstandardized Coefficients			
	B	Std. Error	Adj. R^2	Sig. F Δ
(Base Model)			0.19	
Size Struct. Holes	7890*	4656	0.24	.100
Betweenness	1696**	697	0.30	.021

a. Dependent Variable: **Billings02**
b. N=39. *** p<.01, ** p<.05, * p<.1

Bridging diverse communities is more significant for *landing* new contracts.

Being in the thick of information flows is more significant for contract *execution*.

Source: M. van Alstyne, S. Aral. Networks, Information & Social Capital (formerly titled 'Network Structure & Information Advantage'), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=958158

Structural Holes help? Well it depends

New Contract Revenue — **Coefficients[a]**

	Unstandardized Coefficients			
	B	Std. Error	Adj. R^2	Sig. F Δ
(Base Model)			0.40	
Best structural pred.	12604.0***	4454.0	0.52	.006
Ave. E-Mail Size	-10.7**	4.9	0.56	.042
Colleagues' Ave. Response Time	-198947.0	168968.0	0.56	.248

a. Dependent Variable: **Bookings02**
b. Base Model: YRS_EXP, PARTDUM, %_CEO_SRCH, SECTOR(dummies), %_SOLO.

Contract Execution Revenue — **Coefficients[a]**

	Unstandardized Coefficients			
	B	Std. Error	Adj. R^2	Sig. F Δ
(Base Model)			0.19	
Best structural pred.	1544.0**	639.0	0.30	.021
Ave. E-Mail Size	-9.3*	4.7	0.34	.095
Colleagues' Ave. Response Time	-368924.0**	157789.0	0.42	.026

a. Dependent Variable: **Billings02**
b. N=39. *** p<.01, ** p<.05, * p<.1

Sending *shorter* e-mail is positively related to both new contracts and contract execution.

Faster response from colleagues is positively related to contract execution revenues.

Source: M. van Alstyne, S. Aral. Networks, Information & Social Capital (formerly titled 'Network Structure & Information Advantage'), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=958158

Structural Holes help? Well it depends

	Revenue $	$ for completed searches	Completed searches	Multitasking	Duration	Duration controlling for multitasking
Size of rolodex (Q50)	-10.2 (60.3)	-22.9 (32.6)	0.000 (0.001)	0.000 (0.001)	-0.013 (0.021)	-0.013 (0.016)

*** p < 0.10, ** p < 0.05, *** p < 0.01, Standard err in paren.**

Instead, a larger private rolodex is associated with:

- Less information sharing
- Less DB proficiency
- Lower % of e-mail read
- Less learning from others
- Less perceived credit for ideas given to colleagues
- More dissembling on the phone

Recruiters with larger personal rolodexes generate no more or less output

Source: M. van Alstyne, S. Aral. Networks, Information & Social Capital (formerly titled 'Network Structure & Information Advantage'), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=958158

Structural Holes help? Well it depends

Bookings Coefficients[a]

	Unstandardized Coefficients			
	B	Std. Error	t	Sig.
(Constant)	-227802	185001	-1.23	.223
Size of Structural Holes	12795**	5705	2.243	.032
Partner Dummy	148887*	74581	1.996	.054
Num External E-Mail Sent (per day)	-3316	9132	-.363	.719
Concentration Internal Sent	565088	735771	.768	.448

a. Dependent Variable: **BOOKINGS**

b. Adjusted R^2 = .45 with controls for SECTOR, %_CEO, YRS_EXP.

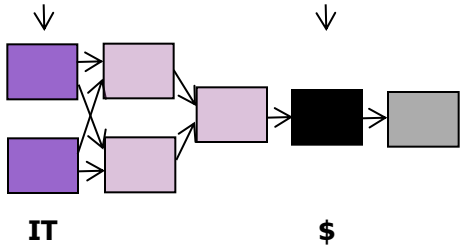
Billings Coefficients[a]

	Unstandardized Coefficients			
	B	Std. Error	t	Sig.
(Constant)	523237***	121745	4.30	.000
Size of Structural Holes	-6988*	3988	-1.75	.089
Partner Dummy	-87118*	51235	-1.70	.098
Num External E-Mail Sent (per day)	17137***	5856	2.93	.006
Concentration Internal Sent	-455568	475974	-.95	.345

a. Dependent Variable: **BILLINGS**

b. Adjusted R^2 = .51 with controls for SECTOR,CEO, and EXP.

- Larger structural holes helps generate business but can hurt job execution.
- Sending more email helps job execution but has no measurable effect on generating business.

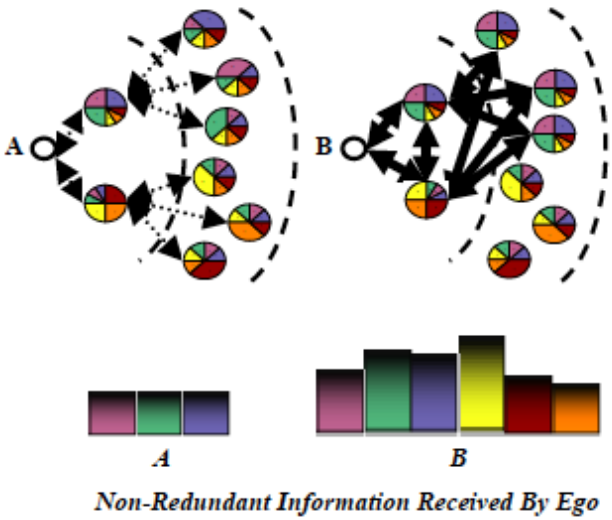


Social Networks have different effects depending on job role

Source: M. van Alstyne, S. Aral. Networks, Information & Social Capital (formerly titled 'Network Structure & Information Advantage'), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=958158

Networks of higher degrees drive performance by providing access to novel information

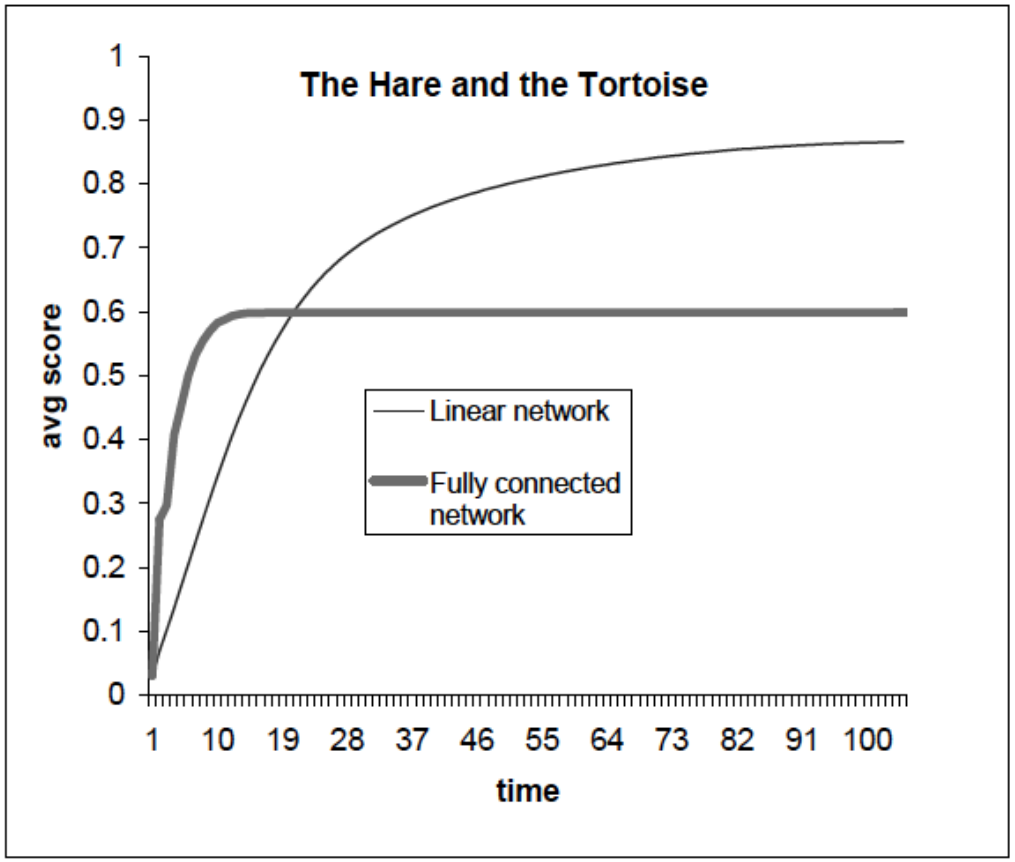
- network structure (having high degree) correlates with receiving novel information sooner (as deduced from hashed versions of their email)
- getting information sooner correlates with $$ brought in
  - controlling for # of years worked
  - job level
  - ….



Source: M. van Alstyne, S. Aral. Networks, Information & Social Capital, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=958158

Networks and innovation

- fully connected network converges more quickly on a solution, but if there are lots of local maxima in the solution space, it may get stuck without finding optimum.
- linear network (fewer edges) arrives at better solution eventually because individuals innovate longer



source: Lazer, David and Friedman, Allan,The Parable of the Hare and the Tortoise: Small Worlds, Diversity, and System Performance: http://ssrn.com/abstract=832627

Class Exercise II

Brokerage led to promotions, salary hikes, and positive performance evaluations of managers. If brokerage improves "performance" in an online setting, what form of "performance" can it be? On a related note, what would it mean to replicate Burt's findings in online social networks?

Cite a case example where the structural hole phenomenon can explain a specific characteristic of online social networks.

Extras

György Pólya
PÓLYA PROCESS
MATHEMATICIAN

George Kinsley Zipf
WEALTH DISTRIBUTION
ECONOMIST

Herbert Alexander Simon
MASTER EQUATION
POLITICAL SCIENTIST

Robert Merton
MATTHEW EFFECT
SOCIOLOGIST

Albert-László Barabási & Réka Albert
PREFERENTIAL ATTACHMENT
NETWORK SCIENTISTS

George Udmy Yule
YULE PROCESS
STATISTICIAN

Robert Gibrat
PROPORTIONAL GROWTH
ECONOMIST

Derek de Solla Price
CUMULATIVE ADVANTAGE
PHYSICIST

MILESTONES

PUBLICATION DATE

1923 1925 1931 1935 1941 1945 1950 1955 1960 1968 1970 1976 1980 1985 1990 1995 1999 XXI 2000 2005 2010

György Pólya (1887-1985)
Preferential attachment made its first appearance in 1923 in the celebrated urn model of the Hungarian mathematician György Pólya [2]. Hence, in mathematics preferential attachment is often called a **Pólya process**.

George Udmy Yule (1871-1951)
used preferential attachment to explain the power-law distribution of the number of species per genus of flowering plants [3]. Hence, in statistics preferential attachment is often called a **Yule process**.

Robert Gibrat (1904-1980)
proposed that the size and the growth rate of a firm are independent. Hence, larger firms grow faster [4]. Called **proportional growth**, this is a form of preferential attachment.

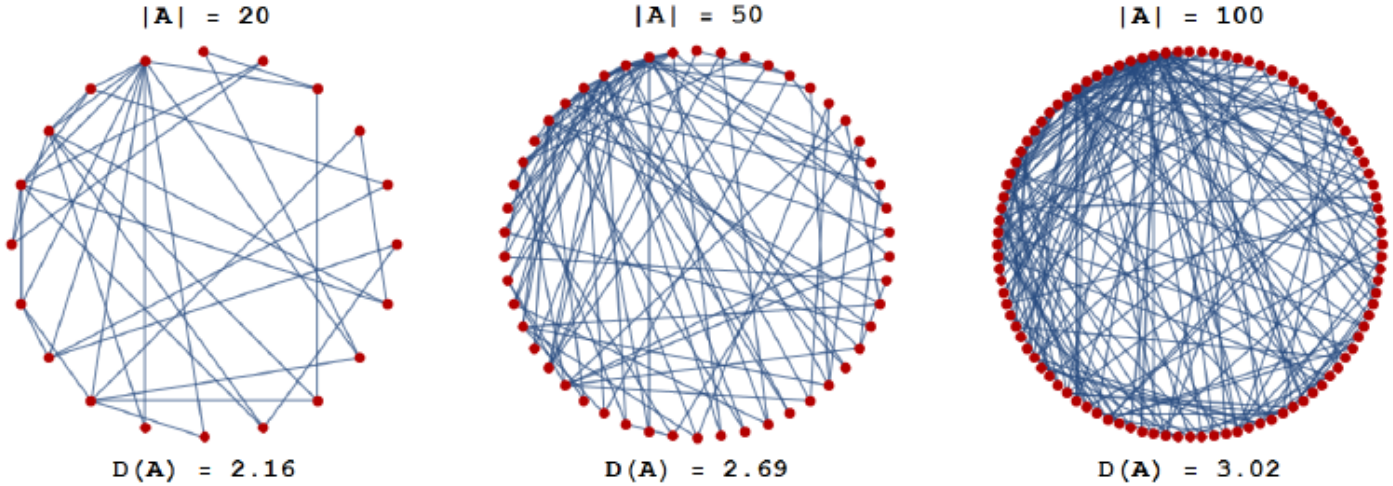
George Kinsley Zipf (1902-1950)
used preferential attachment to explain the fat tailed distribution of wealth in the society [5].

Herbert Alexander Simon (1916-2001)
used preferential attachment to explain the fat-tailed nature of the distributions describing city sizes, word frequencies, or the number of papers published by scientists [6].

Derek de Solla Price (1922-1983)
used preferential attachment to explain the citation statistics of scientific publications, calling it **cumulative advantage** [7].

Robert Merton (1910-2003)
In sociology preferential attachment is often called the **Matthew effect**, named by Merton [8] after a passage in the Gospel of Matthew.

Barabási (1967) & **Albert** (1972)
introduce the term **preferential attachment** to explain the origin of scale-free networks [1].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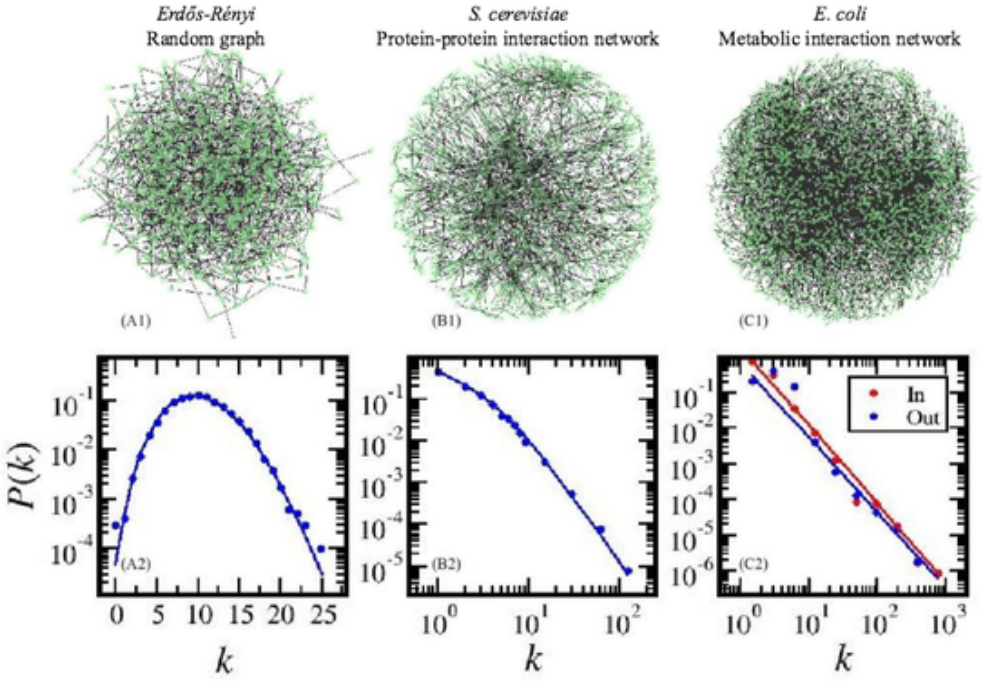
Erdős-Rényi
Random graph
S. cerevisiae
Protein-protein interaction network
E. coli
Metabolic interaction network
(A1)
(B1)
(C1)
P(k)
(A2)
(B2)
(C2)
In
Out
k
k
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