Co-Institutional Collaboration Network on U.S. University Patents 1975-2004

Paper Prepared for the 2008
International Workshop and Conference on Network Science

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June 27, 2008
Norwich BioSciences Institute
Norwich, UK

Objectives

❖To investigate the landscape of institutional collaborations on patents issued to U.S. universities between 1975 and 2004

❖To explore the concentration, connection and diffusion of university patenting activities between institutions

❖To study the evolution of the U.S. university patenting network over this thirty year time-frame

❖To make visible a normally transparent aspect of power as it pertains to ideas as property

❖To make a base map of institutional collaborations on which other values and relationships can be connected

Background

- 1980 Bayh-Dole Act
- U.S. university patents now represent 5% of all U.S. owned patents
- Patents are concentrated at the top 50 institutions in terms of all academic R&D expenditures
- Many countries are emulating the U.S. system of technology transfer
- Some argue that academic patenting promotes knowledge diffusion
- Others argue that academic patenting hinders knowledge diffusion
- Is there evidence that diffusion is being promed through collaboration?

Data Sources

- United States Patent and Trademark Office PATSIC, CONAME and INVENTOR files
- Scrape of the United States Patent and Trademark online data server for 2nd, 3rd, 4th … assignee information
- Scrape of the United States Patent and Trademark online data server for citations to U.S. University originated patents
- The World Wide Web to verify institutional and inventor data reduction
- Communications with individual inventors and institutions to clean data

- Data Extractions: 1975-2004
- 44,394 Patents issued to U.S. Universities involving
- 47,556 Unique Inventors
- 108468 instances of inventorship
- 1048 Unique Institutions
  - ✓326 U.S. Universities
  - ✓657 U.S. Collaborators
  - ✓65 International Collaborators

Methodology

Undirected Network Analysis

Study of relationships between institutions to explore structure of social actions

Node = Institution

Edge = Undirected connection between two institutions

Graph = Plotting of nodes and edges

Diameter = how far apart are two farthest points on graph

Clustering Coefficient= Watts-Strogatz (1998): the averaged probabilities that two neighbors of a node are connected; divided by the total number of nodes in the graph. This network shows an initial highly unconnected graph which grows to a scale free graph with most nodes depicted small connections but some depicting many more

Average Degree=the number of edges that are incident to node divided by the number of nodes. Nodes with small degrees indicate infrequent collaborations

Scale-Free Networks

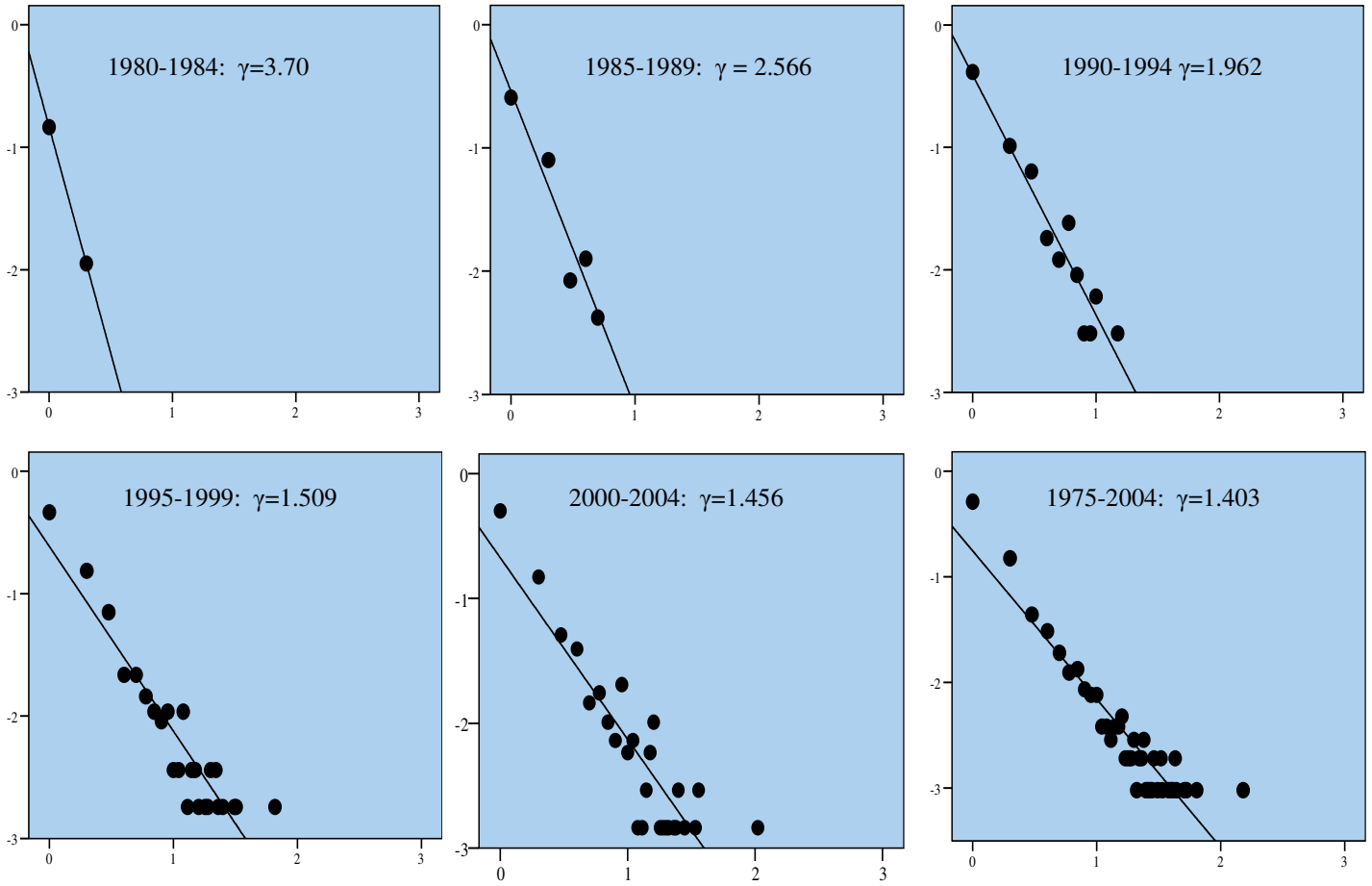
- Are governed by preferential attachment
- This affects both internal and external links
- Random networks, by contrast, have decreasing node degree and increasing node separation
- This evolving network of institutional collaborations is described by increasing node degree and decreasing node separation

Table 1. Co-Institution Network of U.S. University Patent Collaborations 1975-2004

	75-79	*80-84*	*85-89*	*90-94*	*95-99*	*00-04*	*1975-2004*
Network Type	Tree	Tree	Scale Free	Scale Free	Scale Free	Scale Free	Scale Free
# of Nodes	154	178	238	330	553	686	1048
# of Nodes with Edges	12	28	86	217	456	595	908
# of Edges	7	15	61	216	667	917	1581
Average Degree	.091	.1685	.5126	1.3091	2.4123	2.6435	3.0172
Average Shortest Path	1.300	1.118	1.821	5.644	4.106	3.953	3.724
Diameter of Network	2	2	5	12	10	10	9
Density	.0006	.0010	.0022	.0040	.0044	.0039	.0029
Weakly Connected Graph?	Yes	No	No	No	No	No	No
Clustering Coefficient (Strogatz)	0	0	.1733	0.2481	0.3741	0.3997	0.4244
No. of Connected Components	147	163	179	140	112	113	161
Nodes in Largest Connected Component	4	3	8	152	423	547	863

Data Analysis

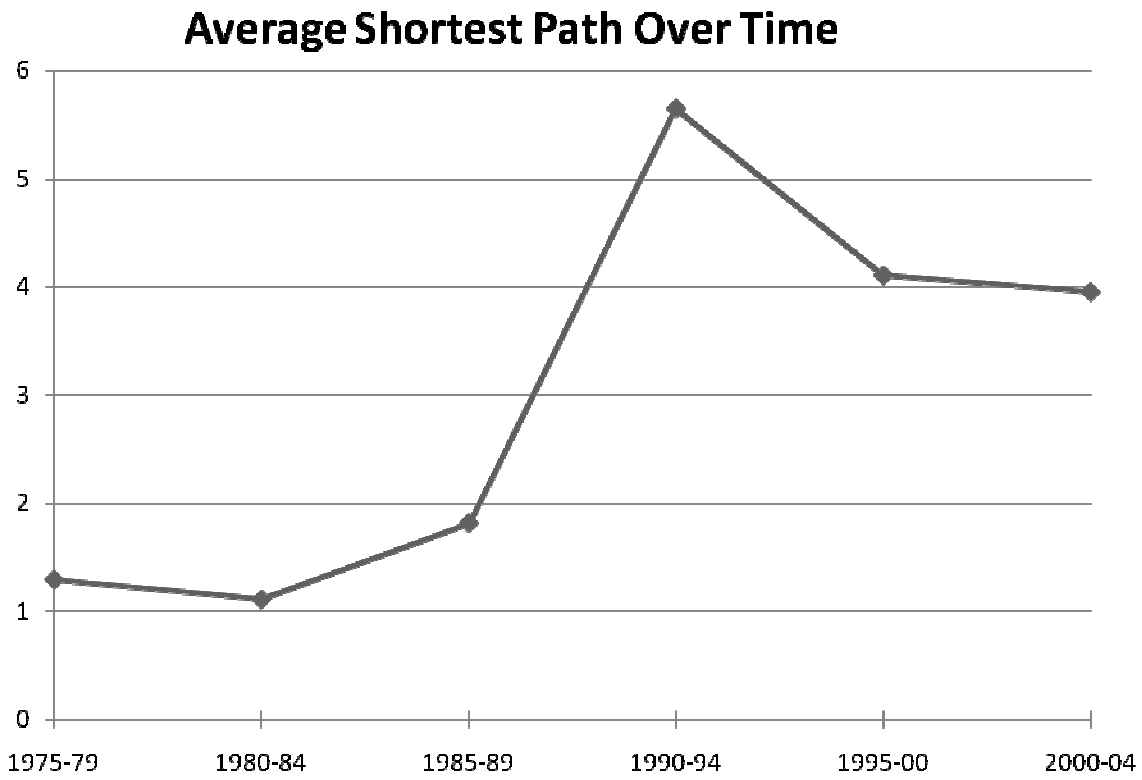
- Degree Distribution begins as a tree and then evolves into a scale-free network following a power law distribution


1980-1984: γ=3.70
1985-1989: γ = 2.566
1990-1994 γ=1.962
1995-1999: γ=1.509
2000-2004: γ=1.456
1975-2004: γ=1.403

Average Shortest Path

- The ability of two nodes to communicate depends on the length of the shortest path between them.

- Average shortest path begins to decrease as more nodes are added to the network


Average Shortest Path Over Time
6
5
4
3
2
1
0
1975-79
1980-84
1985-89
1990-94
1995-00
2000-04

Data Analysis

- Relative size of the largest cluster increases from 4 (.026 of network) to 863 (involving .82of network) over time
- The network is defined by preferential attachment

Table 2. Co-Institution Collaborations on U.S. University Patents

	1975-79	*1980-84*	*1985-89*	*1990-94*	*1995-00*	*2000-04*	*1975-04*
Total Patents Issued	1674	2269	4118	7474	12978	15881	44394
1 assignee	1666	2249	4337	7196	12104	14769	42321
2 assignees	8	20	81	277	875	1112	2373
3 assignees	--	--	2	22	98	105	227
4 assignees	--	--		1	6	11	18
5 assignees	--	--	--	--	--	3	3
6 assignees	--	--	--	--	--	2	2
7 assignees	--	--	--	--	--	2	2
International first Inventor	15	15	73	122	309	401	935
International institutions	4	0	8	24	106	162	304

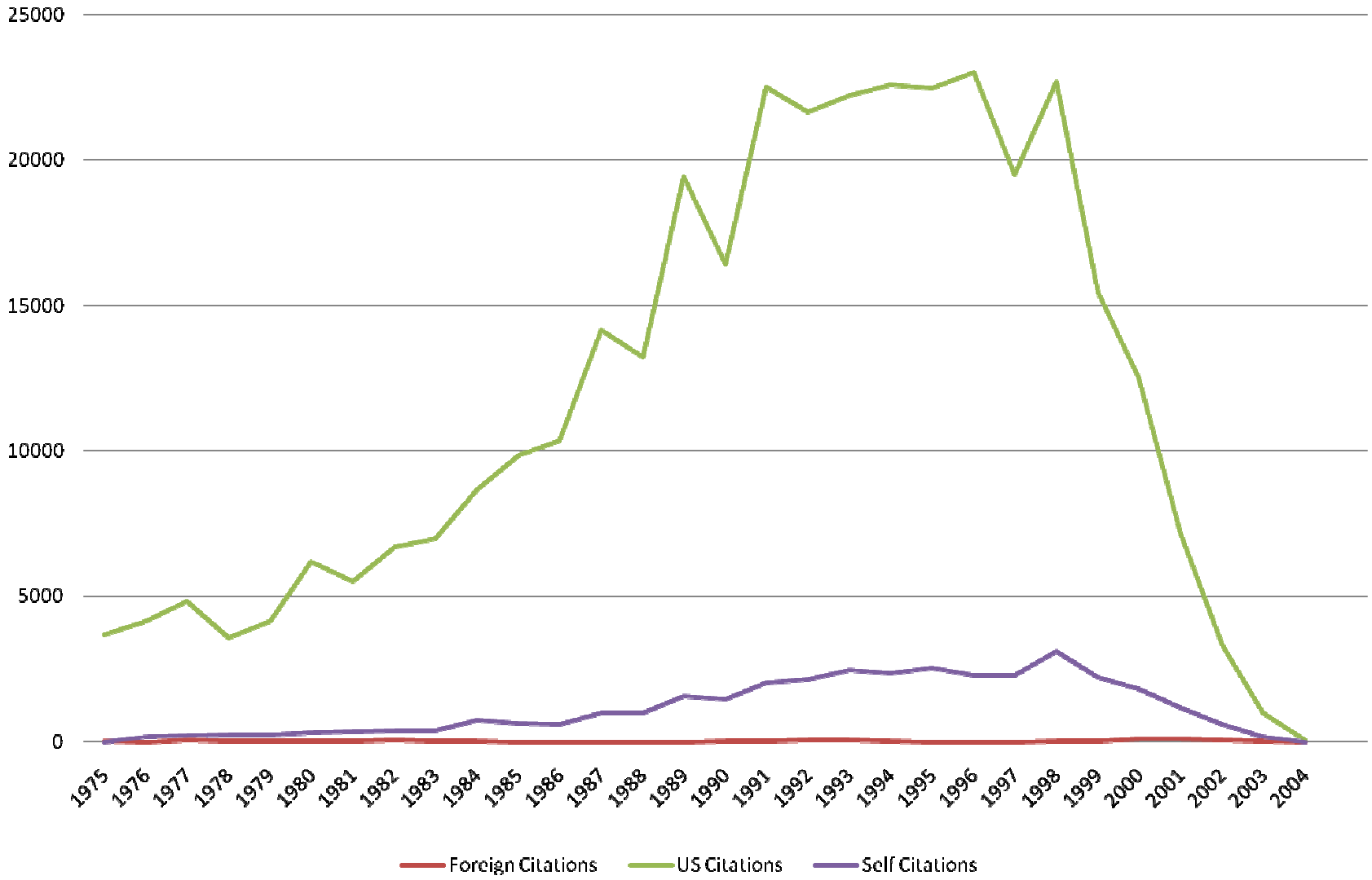
Table 3. Unique Co-Institution Collaborators on U.S. University Patents

	1975-79	*1980-84*	*1985-89*	*1990-94*	*1995-00*	*2000-04*	*1975-04*
Total Patents Issued	1674	2269	4118	7474	12978	15881	44394
Universities	147	47	45	26	27	34	326
U.S. Collaborators	6	12	29	93	236	281	657
International Collaborators	1	1	4	19	20	20	65

Top 50 Institutions by Average Citation Strength of Cited Patents

Med Institute, Inc.	208
Houston Advanced Research Center	158
Nova Pharmaceutical Corporation	104
Wang; Jin-Shan	103
Johnson and Johnson	100
California and Alsius Corporation	96
Target Therapeutics, Inc.	94
McMaster University	89
FGN, Inc.	88
TASC, Inc.	85
Symyx Technologies, Inc.	84
Candela Laser Corp.	81
Atrionix, Inc.	78
Sematech, Inc.	72
Vaughn College of Aeronautics	*63*
Hoechst Roussel Pharmaceuticals Inc.	60
Xerox Corporation	60
Intec Systems, Inc.	59
Intel Corporation	50
Ultratech Stepper, Inc.	57
Nellcor Puritan Bennett	55
Vical Incorporated	51
Protein Technologies International, Inc.	49
Toshiba Corporation	49
Bell Telephone Laboratories, Inc.	47
Strohtech, Inc.	46
Twin City Surgical, Inc.	44
SBC Technology Resources, Inc.	42
Riverside Research Institute	41
Brookhaven Science Associates	*41*
American Telephone and Telegraph Company	40
PharmaGenics, Inc.	40
Envirco Corp.	36
John Innes Institute	35
Microelectronics Center of North Carolina	34
Albany International, Corp.	33
Instituto Trentino di Cultura	32
J.A. Woollam Co. Inc.	32
National Research Council of Canada	31
American Gas Association	31
Kent State U.	*28*
Children's Medical Center Corporation	28
Florida State U.	*27*
Stereotaxis, Inc.	27
Fordham U.	*26*
Alkermes	26
Cold Spring Harbor Laboratory	26
Hoffmann-La Roche, Inc.	25
MiniMed Inc.	25
U.S. Secretary of the Air Force	25
U. Of West Florida	*25*

Citations to Patents Issued to US Universities: 1975-2004

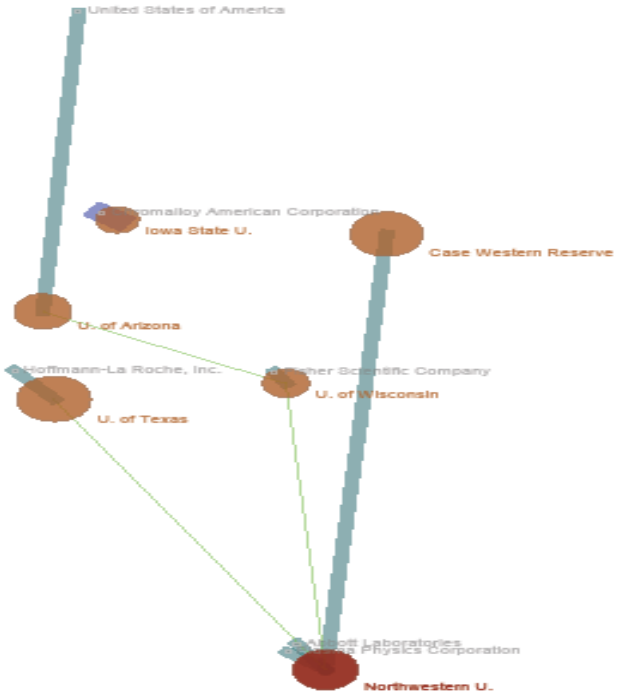


Some Significantly Correlated Findings

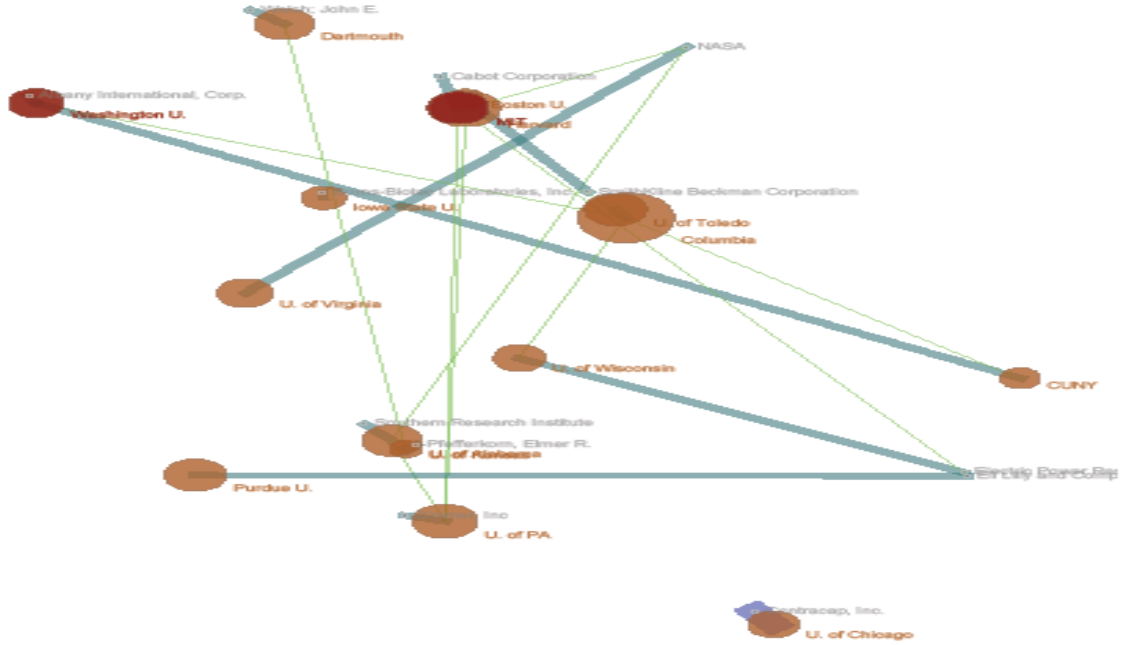
959 Collaborations with 959 Total Citations	.497**
004 Collaborations with 004 total citations	.697**
75-04 Collaborations with 75-04 Total Citations	.961
75-04 Total Citations with Total Number of Patents	.410**
75-04 Total Citations with Total Collaborations	.423**
75-04 Total Citations with Total Collaborative Diversity	.12*

**significant at .01 level (2-tailed)
*significant at .05 level (2-tailed)

1975-1979 Co-Institution Network

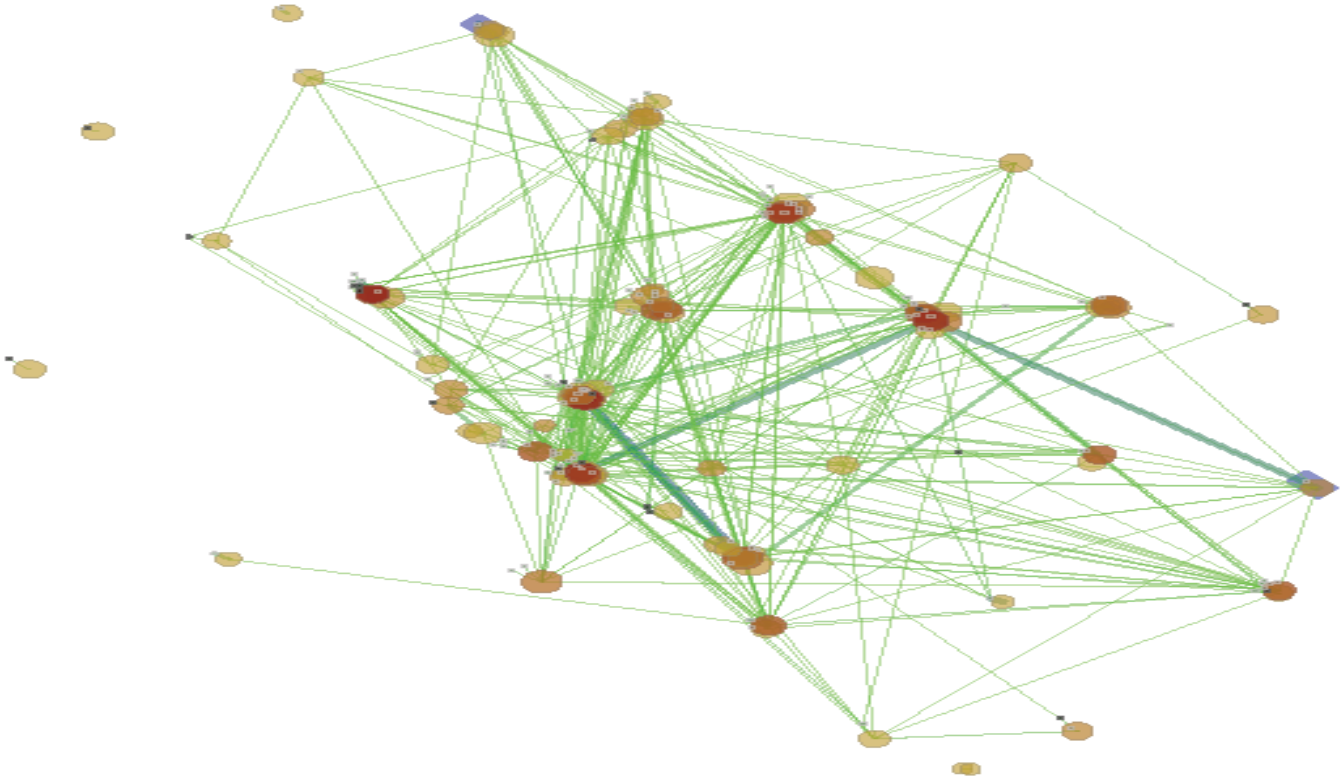


1980-1984 Co-Institution Network

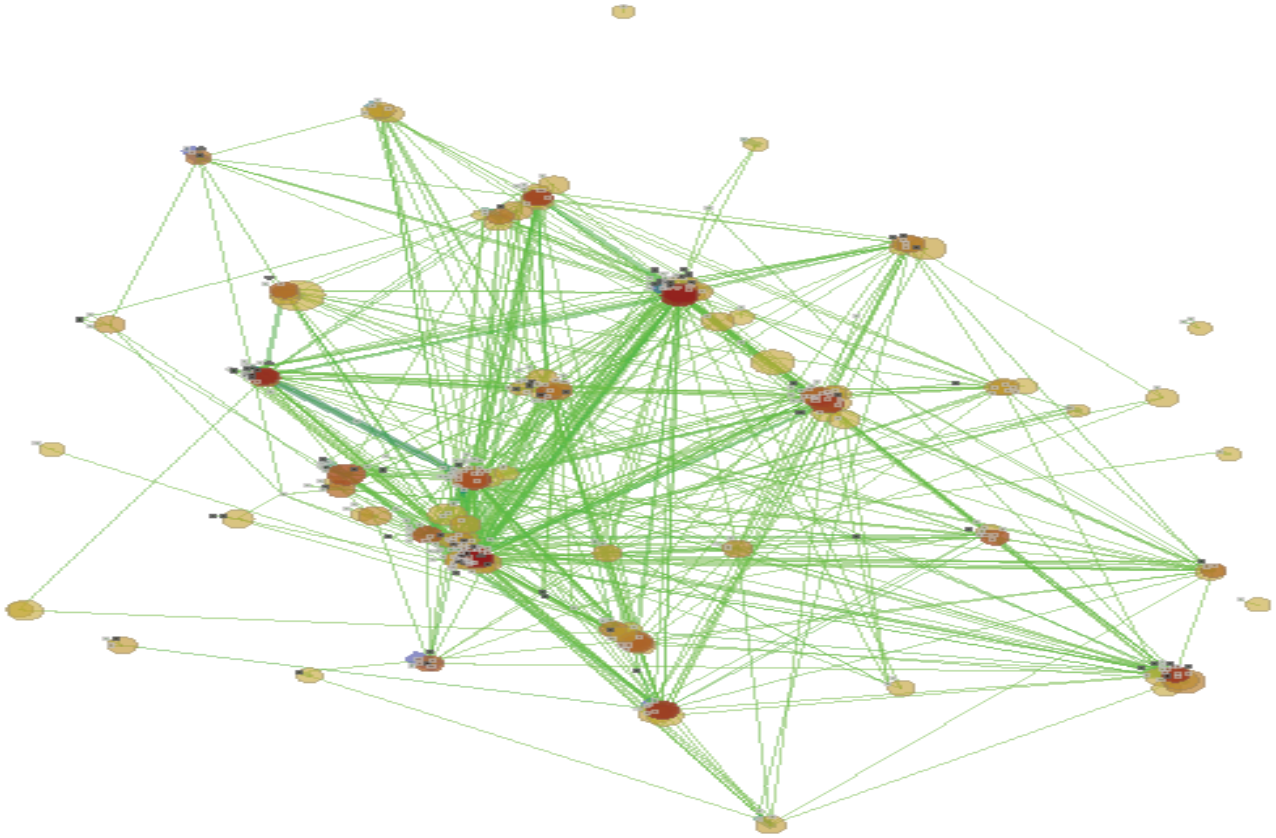


1985-1989 Co-Institution Network

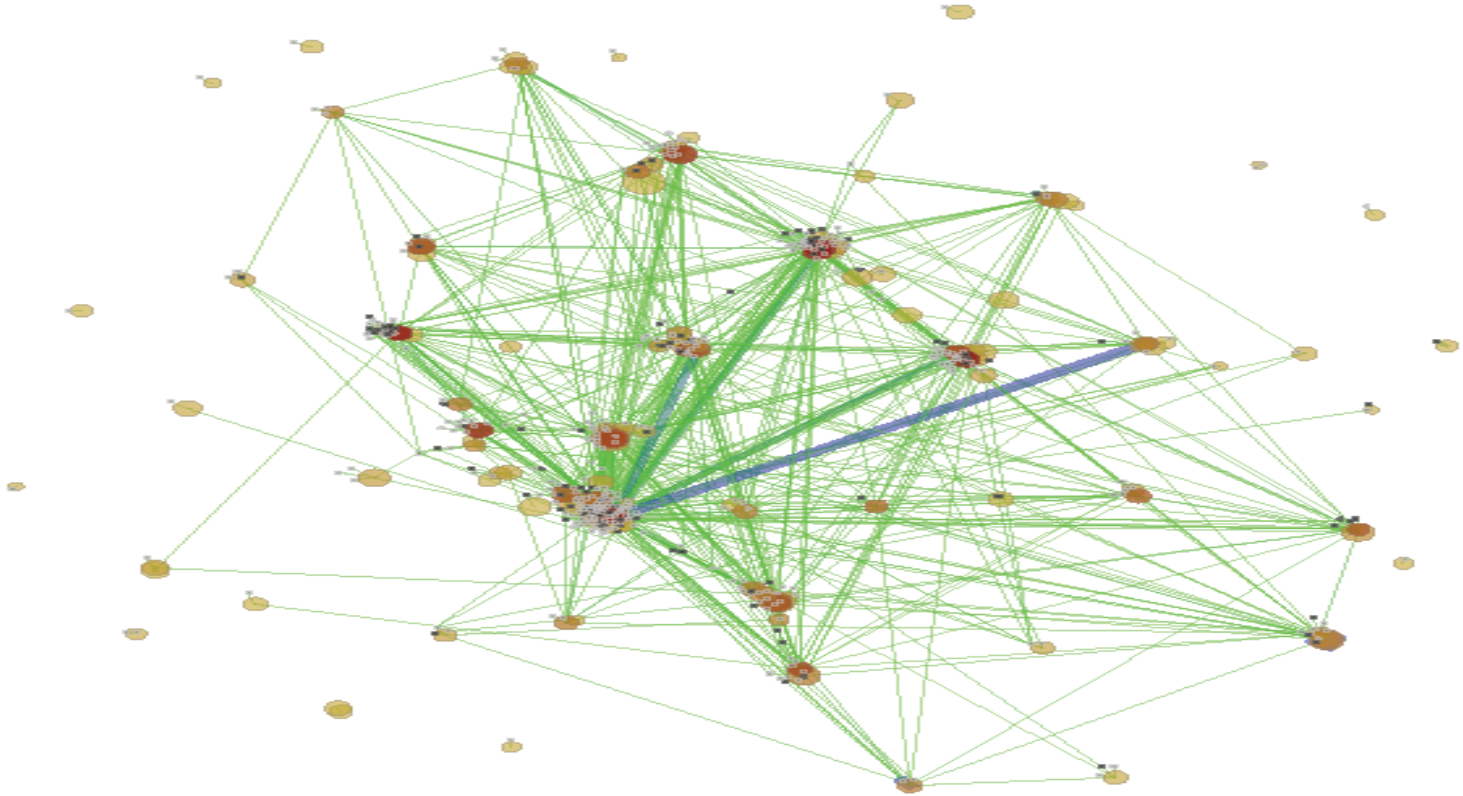
1990-1994 Co-Institution Network



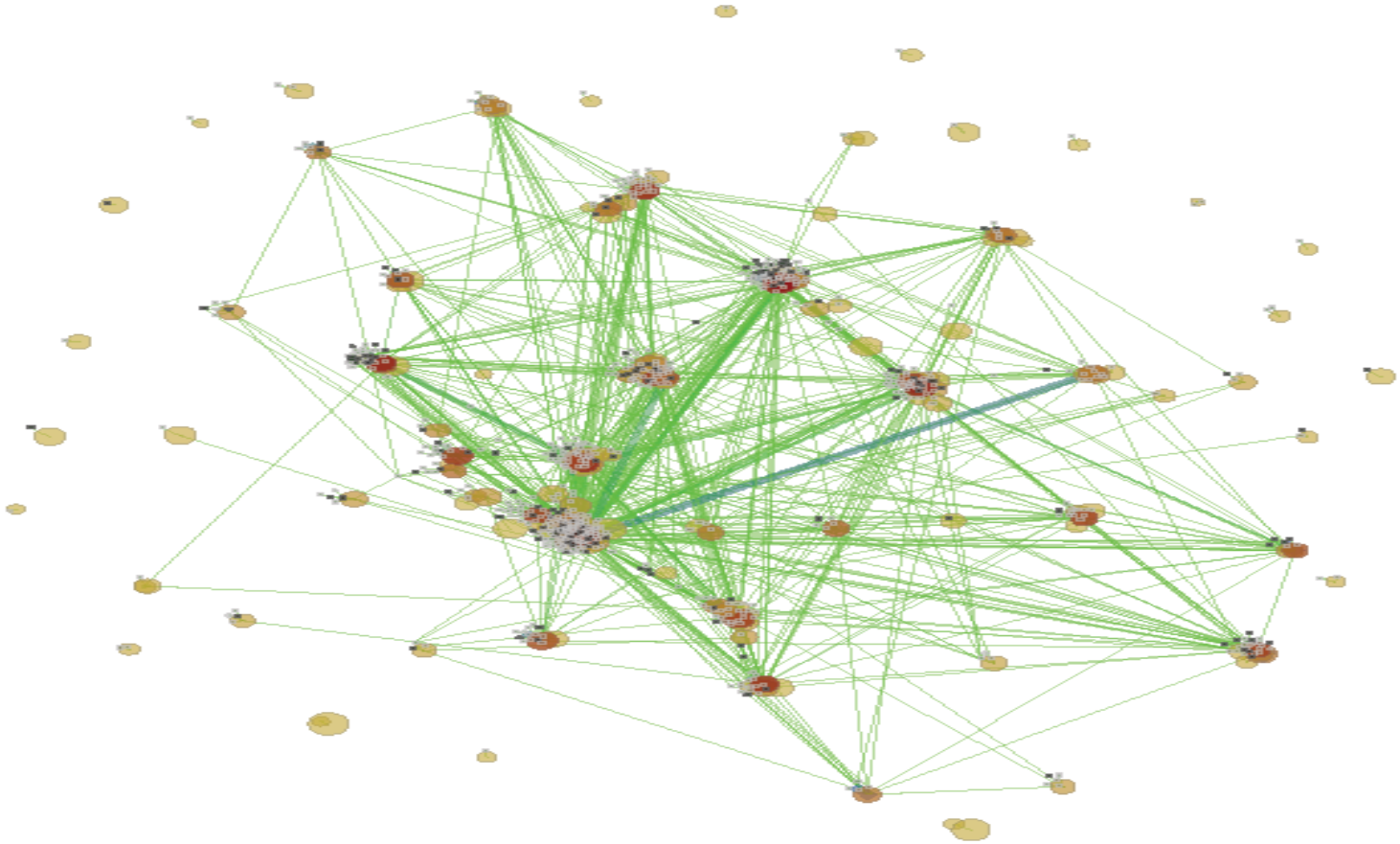
1995-1999 Co-Institution Network



2000-2004 Co-Institution Network



1975-2004 Overall Co-Institution Network



Conclusions

- The Co-Institution networks of university patenting have evolved into scale-free, non random networks of affiliation
- These networks are self-selective and governed by affiliation through affinity
- As more institutions enter the network, there is a correlation between collaboration and diffusion

Conclusions

- Co-Inventor Networks resemble Co-Author networks of scientific journals in their non-random growth dynamics
- Collaborations are positively related to the importance of the patent as defined by citation strength

Conclusions

- U.S. Universities are benefitting from external domestic and international collaborations
- Collaborative diversity is increasing
- Collaborations on Academic Patenting should be encouraged

Acknowledgements

This work has been influenced by Dr. Katy Borner's initiatives at Indiana University to map the world of science, Dr. Kevin Boyack's work at Sandia National Laboratories, Bruce Herr who helped with the visualizations, and Paul Harrison at the USPTO for providing me with data and contexts for the data.

I would also like to acknowledge the network bench tool for network analysis which is described in: Designing Highly Flexible and Usable Cyberinfrastructures for Convergence (in press). William S. Bainbridge (Ed.) Progress in Convergence. Annals of the New York Academy of Sciences. http://cishell.org/papers/06-cishell.pdf