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Gender and the Social Structure of Collaboration

Kjersten Bunker Whittington
Reed College

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Reed College

whittington@reed.edu

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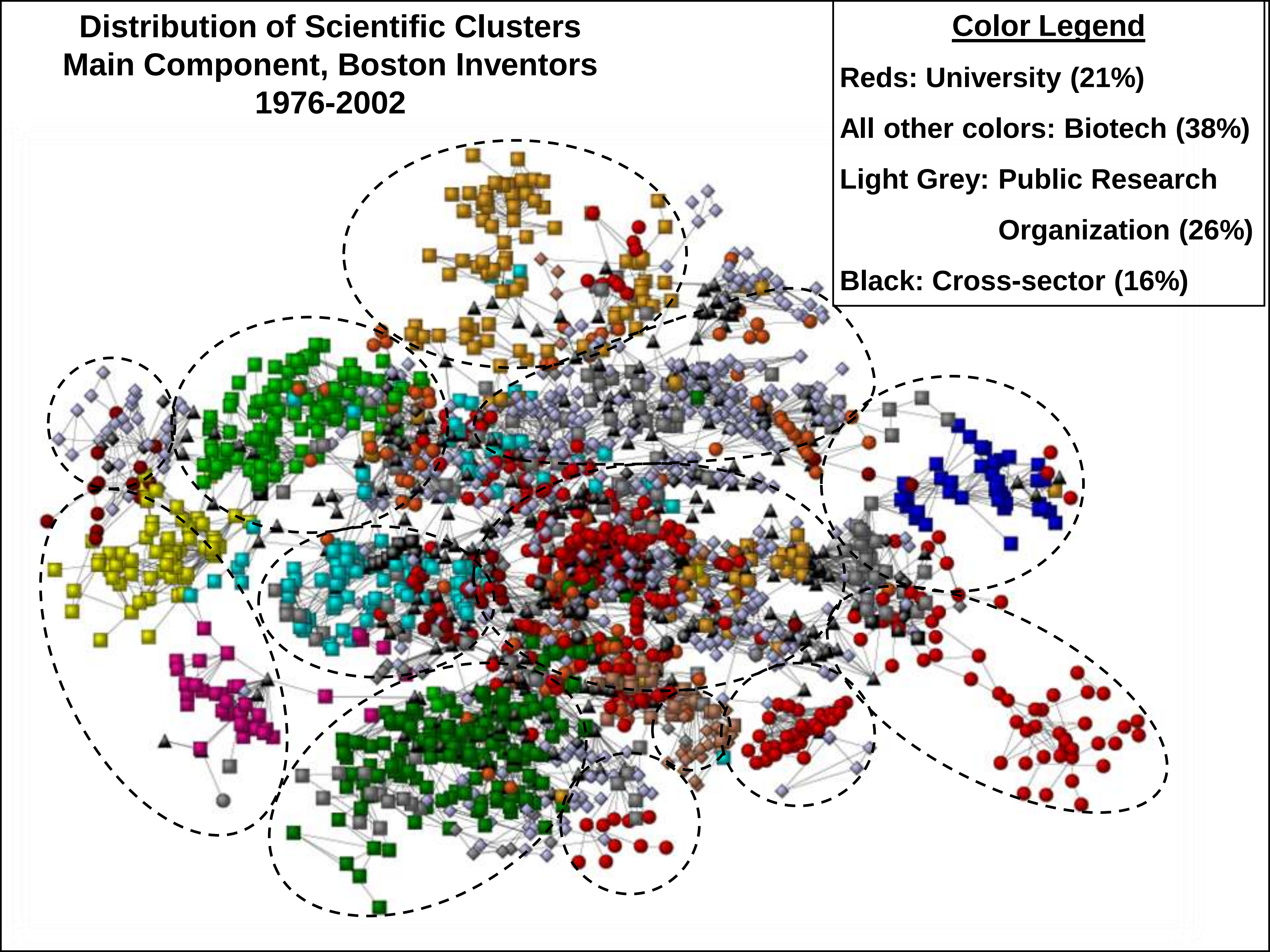
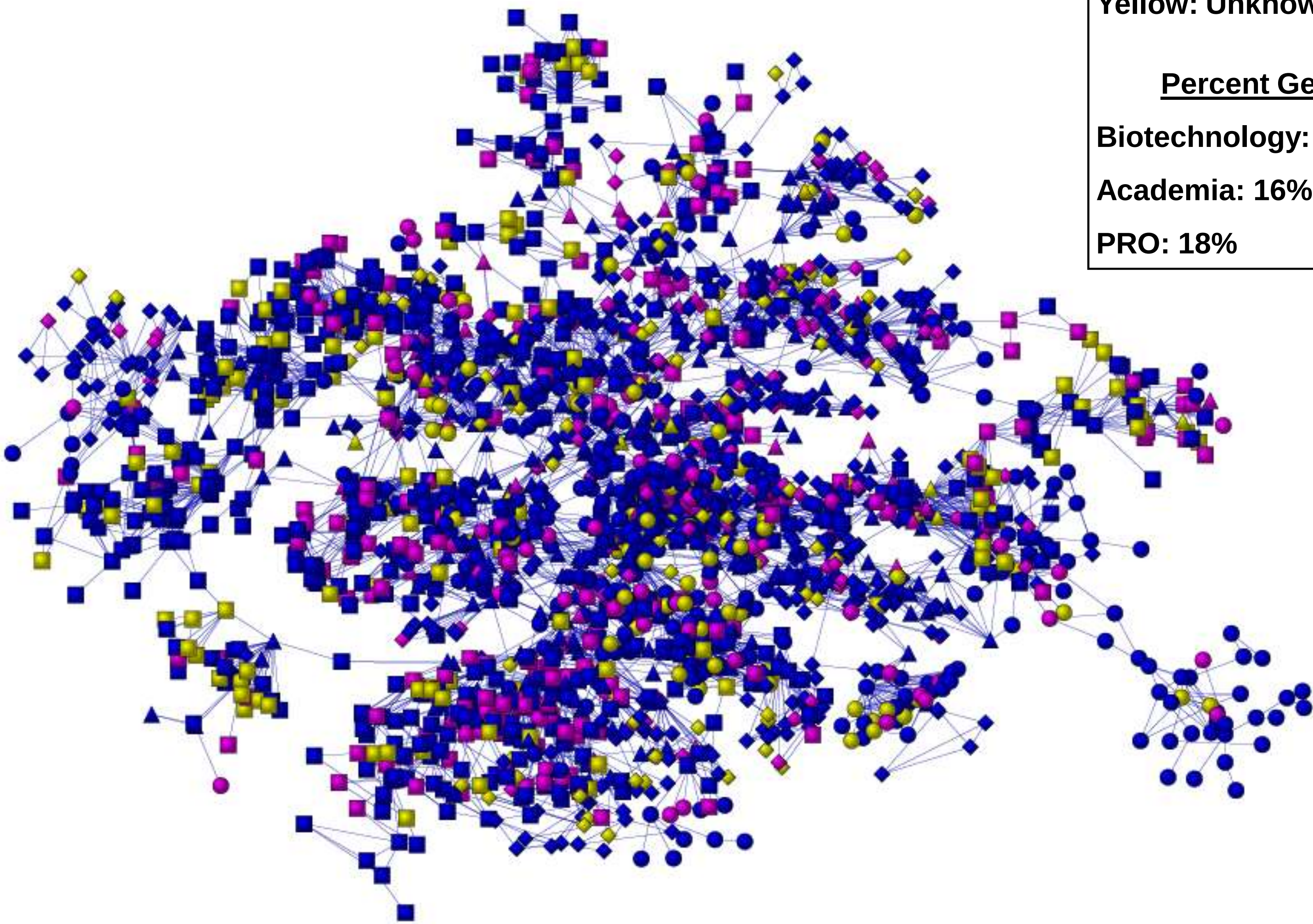
Focal Issues

- Broadly: Public Science, Private Science
- Science as an institution exists in the face of great gender inequality
- Intersection of gender and commercial science relatively unaddressed.
- Changing occupational and professional structure in academia and industry.

Academic Commercial "Pipeline":
Patenting → Licensing → Industry Consulting → Involvement with a Company → Firm Founding


Distribution of Scientific Clusters
Main Component, Boston Inventors
1976-2002
Color Legend
Reds: University (21%)
All other colors: Biotech (38%)
Light Grey: Public Research Organization (26%)
Black: Cross-sector (16%)

Distribution of Male and Female Scientists
Main Component, Boston Inventors
1976-2002



Node Color

Blue: Male (69%)

Magenta: Female (18%)

Yellow: Unknown (13%)

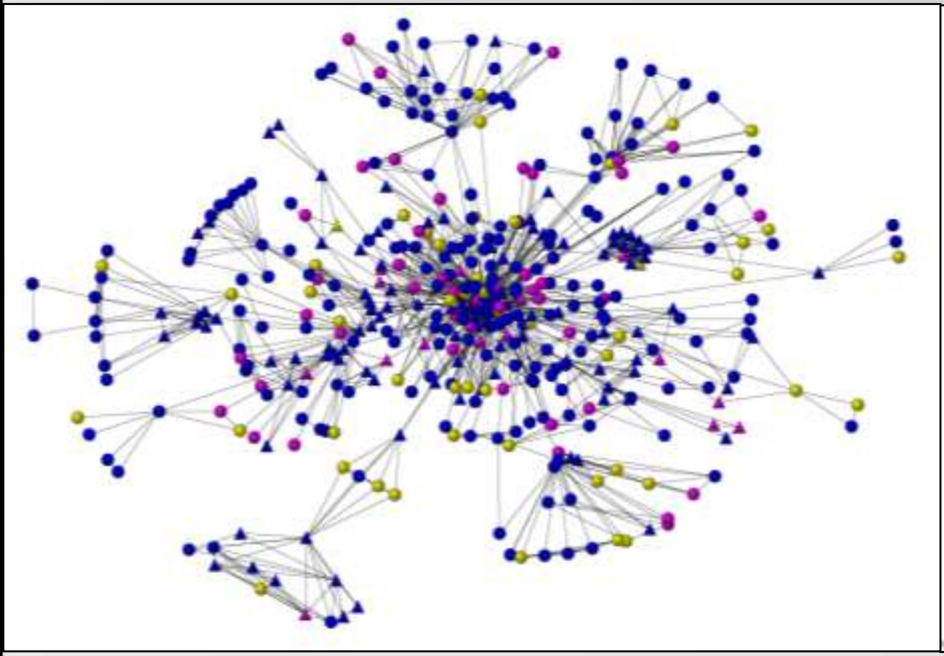
Percent Gender:

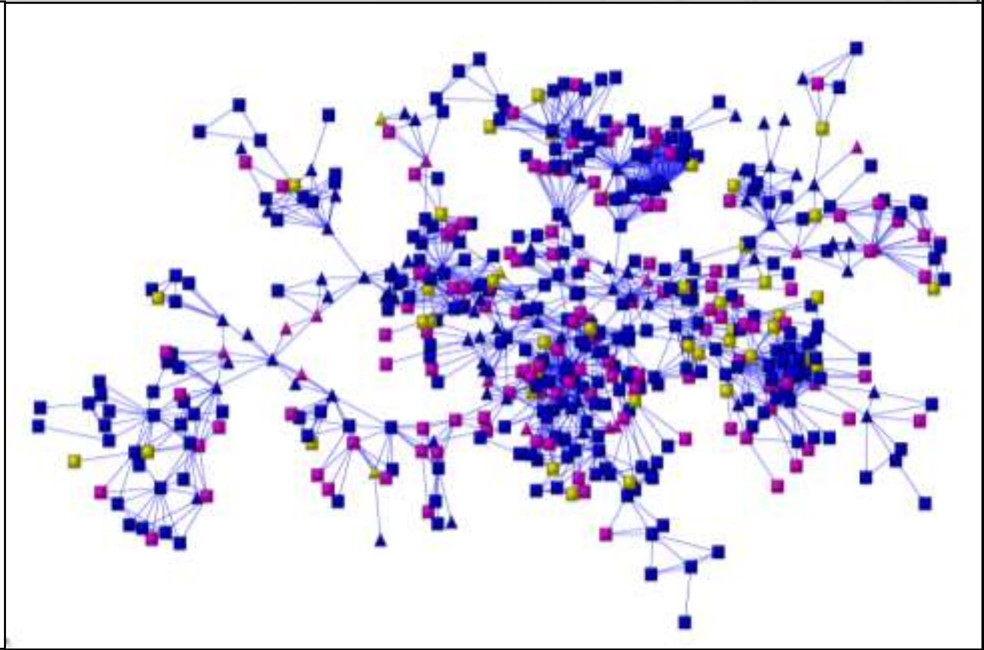
Biotechnology: 21%

Academia: 16%

PRO: 18%

The social structure of academia and industry





Academic Science

Largest Academic Component (all years)

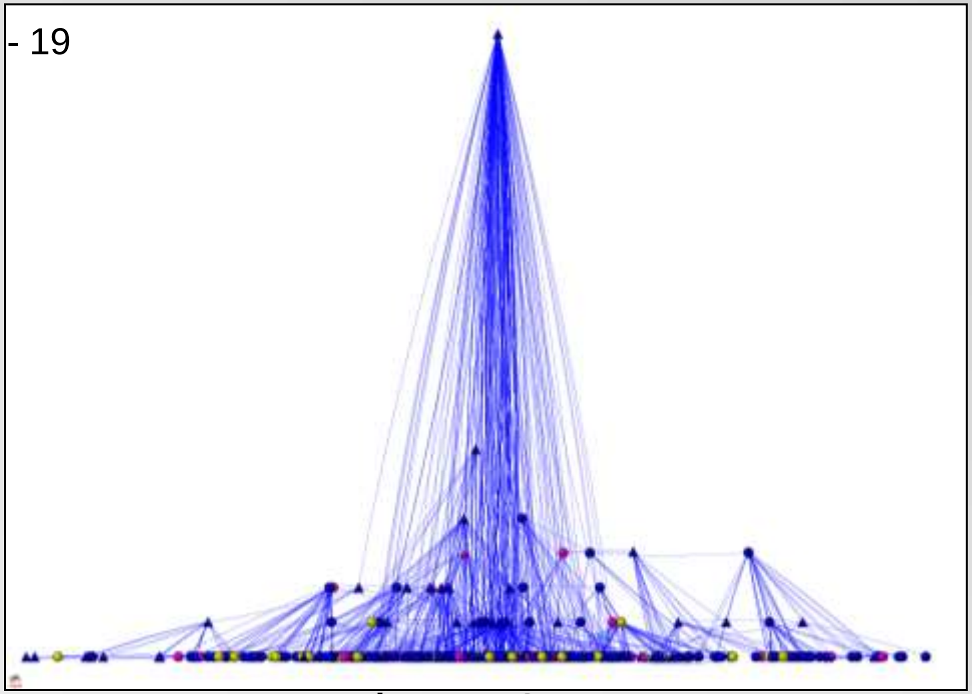
Male (Blue) = 73%
Female (Magenta) = 14%
Unknown (Yellow) = 12%
Overall Centralization (0-1 range): .28

Industrial Science

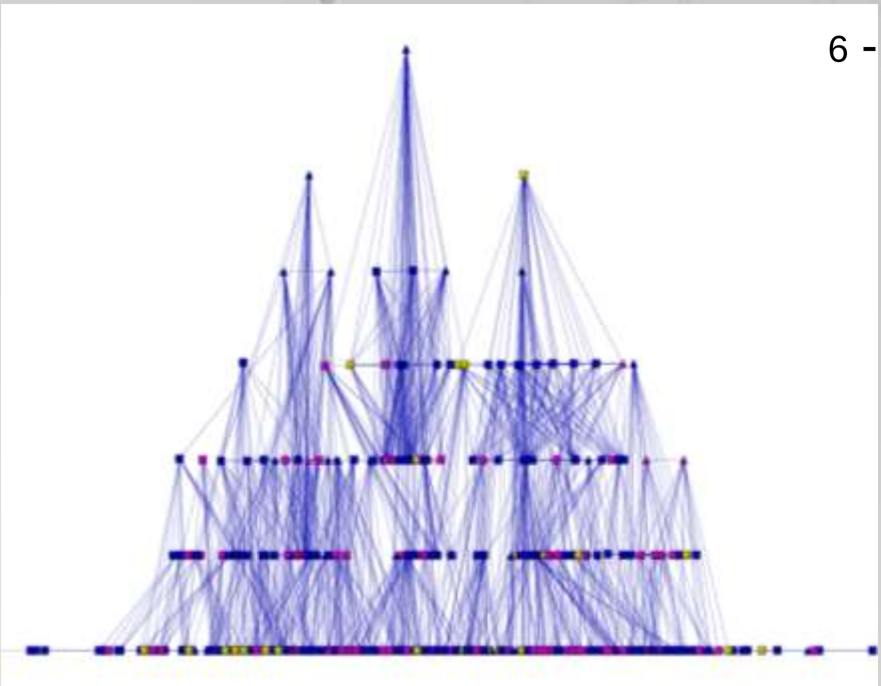
Largest Industry Component (all years)

Male (Blue) = 66%
Female (Magenta) = 25%
Unknown (Yellow) = 8%
Overall Centralization (0-1 range): 0.07

These same networks inverted hierarchically:



Academic Science



Industrial Science

Degree Distribution
Largest Academic Component

Bottom Level (avg.): 5.25
Subsequent Levels (std. dev): 6.93
Overall Centralization (0-1 range): .28

Degree Distribution
Largest Industry Component

Bottom Level (avg): 6.45
Subsequent Levels (std. dev): 5.31
Overall Centralization (0-1 range): 0.07

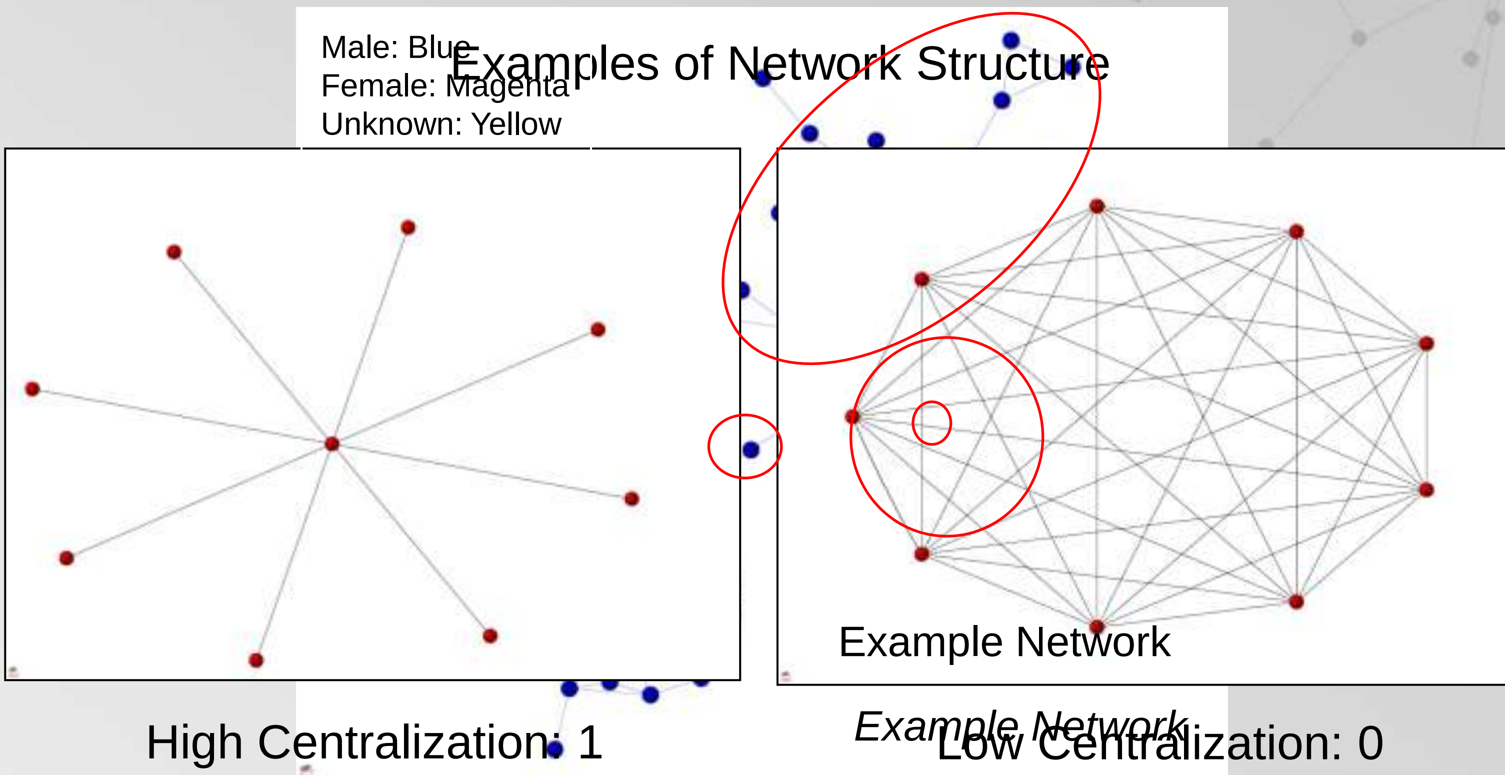
The Importance of Networks and Network Structure

- Those situated in particularly central or strategic positions accrue benefits from these positions, be they for promotion, tangible outcomes, likelihood of retention, etc.

- Positioning in surrounding social structure influences the extent of output and performance. At the level of:
  - **Scientists**
  - Science **Organizations**
  - Science and Technology **Regions**

Collaboration Network Mechanics

Examples of Network Structure



Example Network

High Centralization: 1

Low Centralization: 0

Network Analysis Can Reveal:

- Differences among individual positions
- Overarching structure of collaboration

Networks and Gender

- Situation of underrepresented groups may complicate taken for granted network relationships – status, legitimacy, and marginality influence the flow of information and resources.
- Both structural and status mechanisms are speculated to play a role in defining where women are located in work and productivity networks.
- The need for “borrowed social capital” may be a need for women in workplaces where issues of status and legitimacy are prevalent (Burt).

Gender, Networks, and Work Setting

- The necessary connections needed to establish successful innovative outputs may vary for women by location in academia or industry.

- In industry (specifically in horizontally organized firms) collective work environments may result in women assuming more central collaborative locations than in academic settings.

- Those with decreased access or exposure to potential collaborators may benefit more from dense ties than sparse ones.

  - Academic women may see more innovative return from network positions that foster close ties than those high in brokerage opportunities.
  - DBF women (and men) may see return from brokerage opportunities.

Data

I construct patenting collaboration networks of life science inventors in the Boston region.

- Global population, 1976-2005.
- Total N = 215,639, Total(Boston) = 6,988
- Scientific Affiliations:
  - 5% Dedicated biotechnology firms (DBF)
  - 12% University
  - 5% Public research organizations (PRO)
  - 67% Pharmaceutical firms
  - 4% Other biotechnology firms
  - 7% Multiple firm-type inventors
- 21% Female

Measures and Methodology

Individual Fixed Effects Models, 1980-2000 (inventor-years)

Dependent Variable: Patenting involvement (0/1, Logit)
Patenting productivity (Count, NBCM)

Independent Variables: Degree centrality, normalized
Brokerage (0/1)

Control Variables: Betweenness centrality, normalized
Main component membership (yearly)
Current patenting activity

Directions of Network Effects on Increasing Centrality Measures

Centrality Measure	Involvement in Patenting or Number of Patents			
Independent Variables	Academic Men	Academic Women	Firm Men	Firm Women
Degree Centrality	+	+	+	+*
Brokerage Role (at least one instance)	+		+	+
Betweenness Centrality (normalized)	+			
Main Component				

Notes: Signs indicate statistically significant coefficients (p<.05). Models control for previous patent activity and individual fixed effects.

Blank cells indicate neither a positive or negative effect of the measure on patenting.

* Coefficient not significant in models predicting involvement in patenting.

Implications and Conclusion

- Patenting as a non-required activity in the academy may also be influencing women's involvement in patenting.
- Lack of influence for various network measures may suggest that other types of ties and linkages may be more salient for women.
- The models suggest that organizational form mediates the effects of centrality for women.
- Underrepresented groups may be more constrained in conditions of hierarchy versus more horizontal arrangements.