Network Models of Dissemination in Public Health

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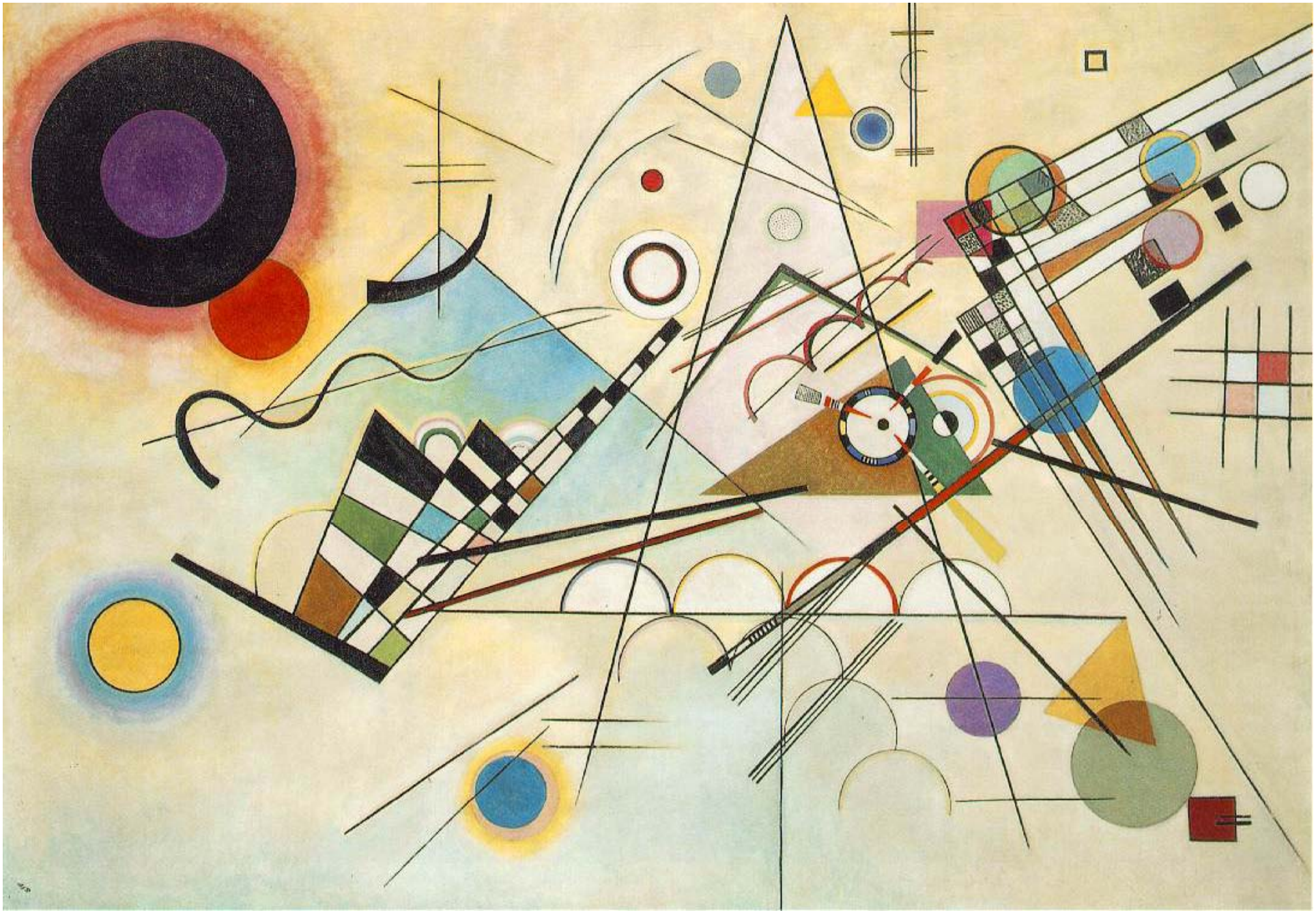
Washington University in St. Louis

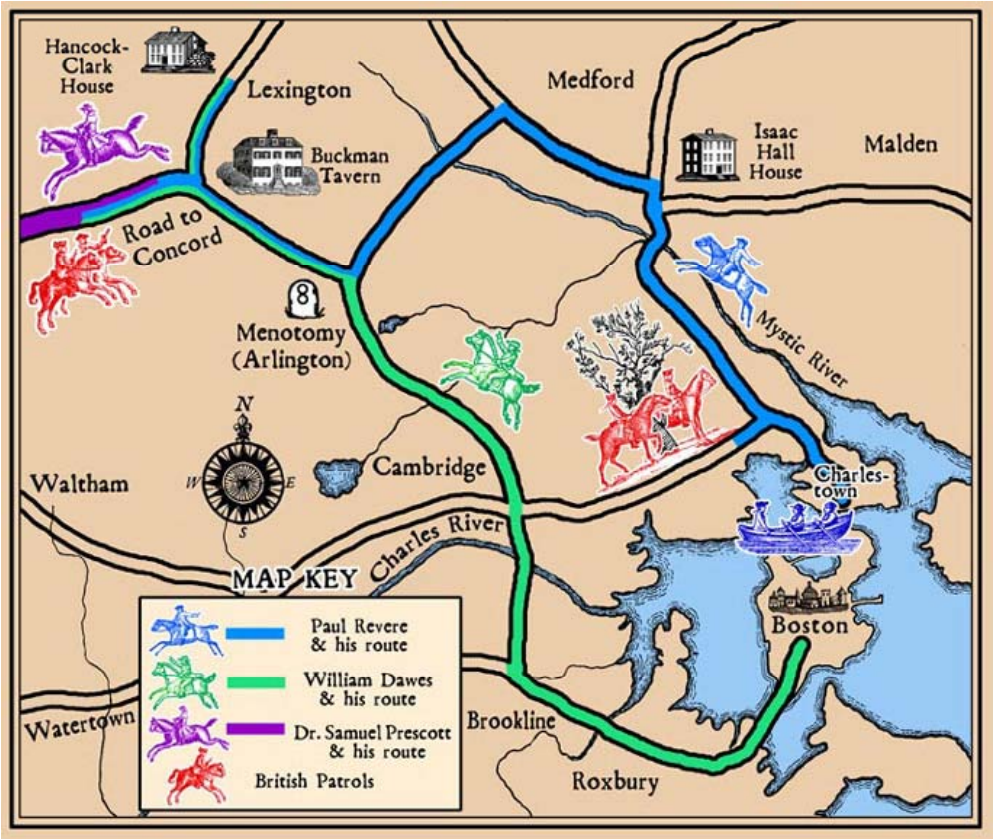
GEORGE WARREN BROWN SCHOOL of Social Work



Overview

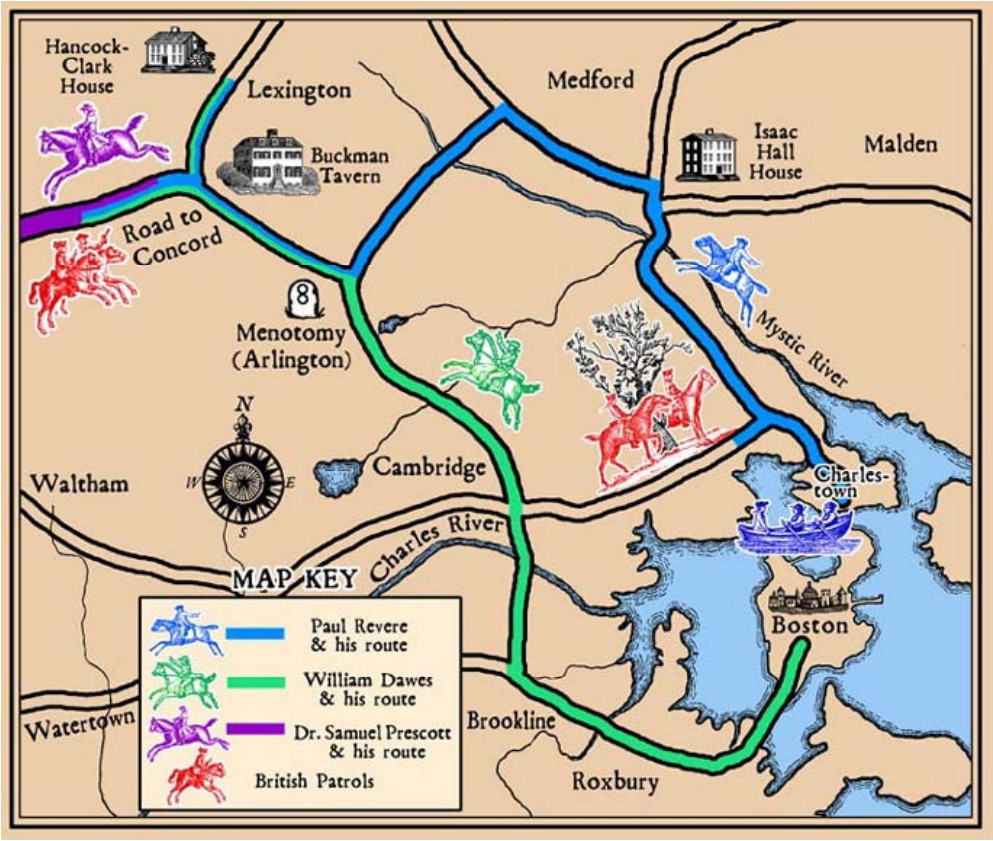
- Dissemination as a networked process
- Existing theoretical approaches to dissemination
- The need for networks
- What research questions can be answered using network dissemination models?
- Examples
  - Identifying dissemination *gaps*
  - Exploring how broader communication networks drive and constrain dissemination processes

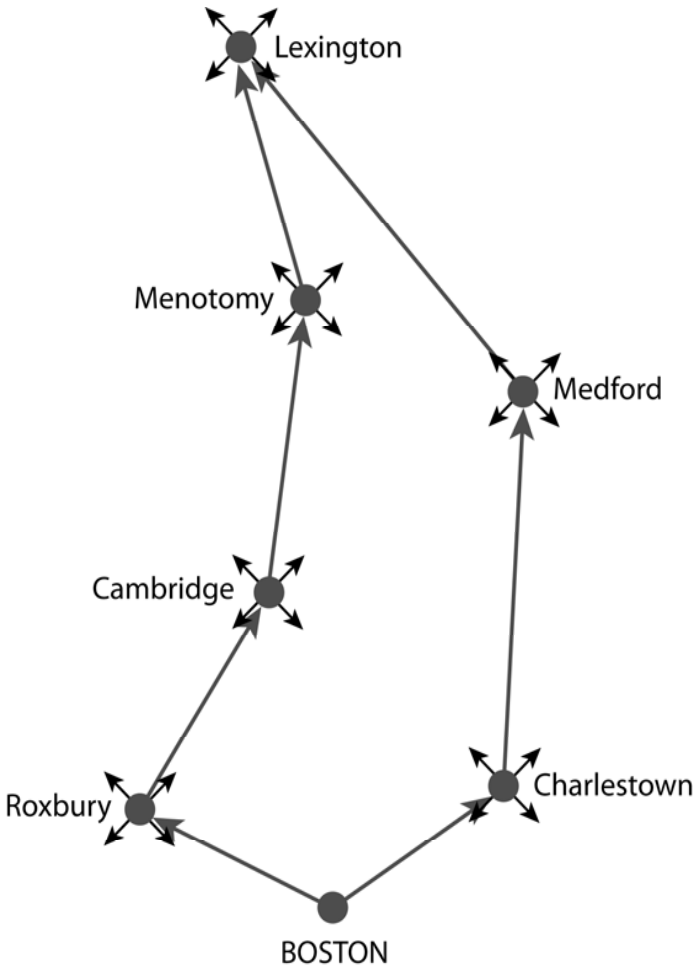
Paul Revere – Dissemination specialist?



From www.paulreverehouse.org

Paul Revere – Or network analyst?





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Where has network analysis been used in public health?

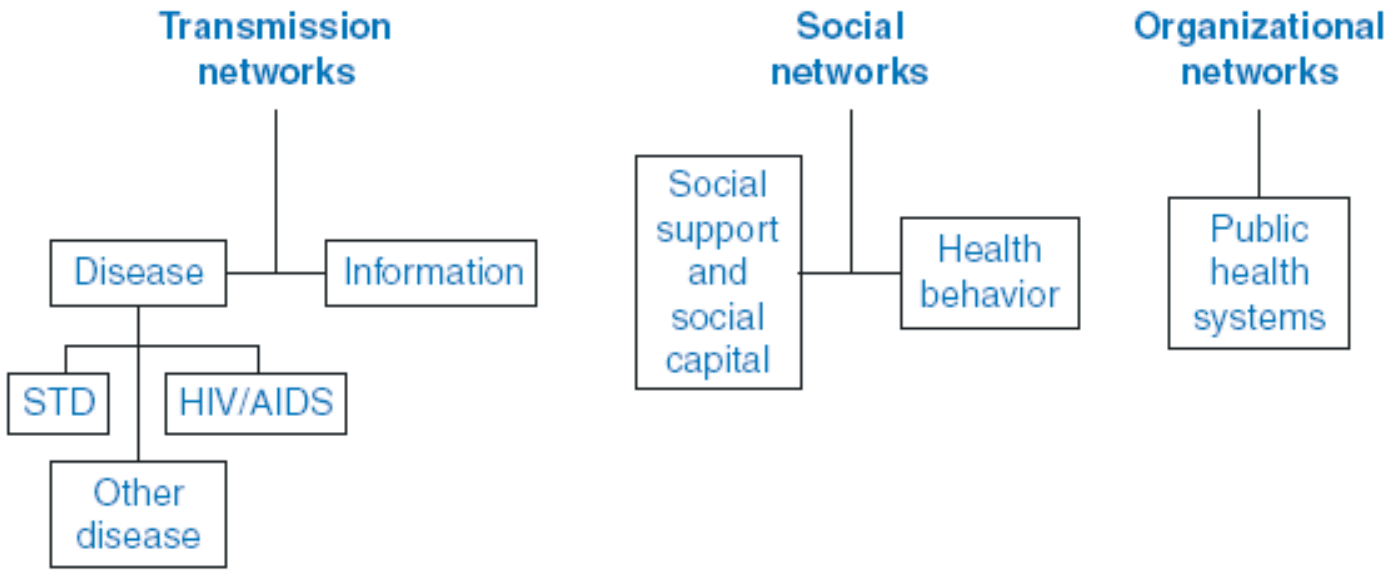


Figure 5

Categorization of network analysis applications in public health.

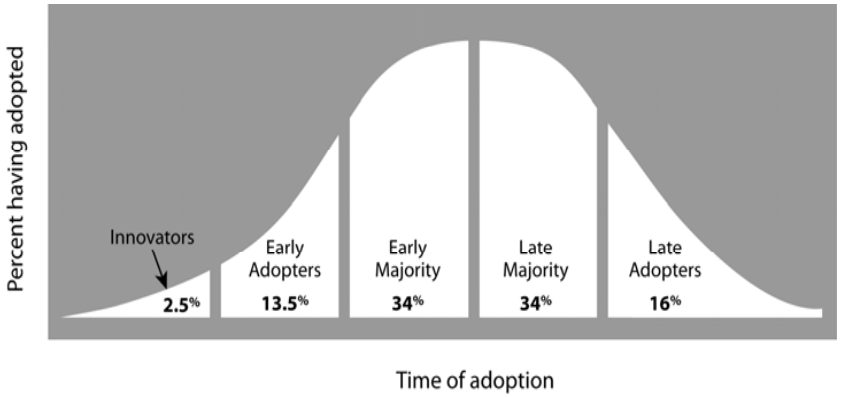
From Luke & Harris (2007)

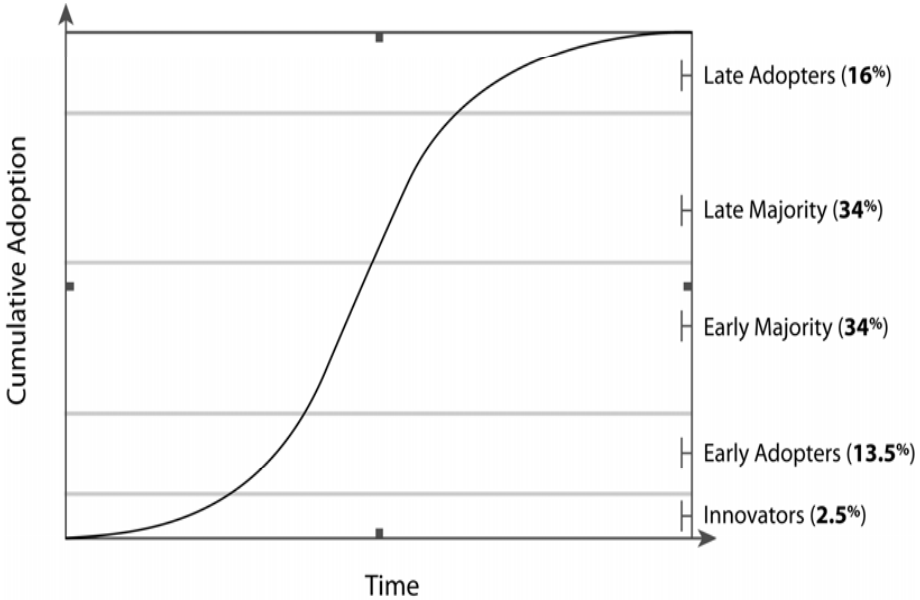
Theoretical models

- Many dissemination models
  - Diffusion of innovations (Rogers)
  - Persuasive communication (McGuire)
  - Social marketing (Kotler & Zaltman)
  - Two-communities theory (Caplan)
- These theories tend to emphasize:
  - Characteristics of the innovation
  - Characteristics of the actors
  - Characteristics of the communication channels
  - Characteristics of the environment
    - (See review articles by Green and Wejnert)

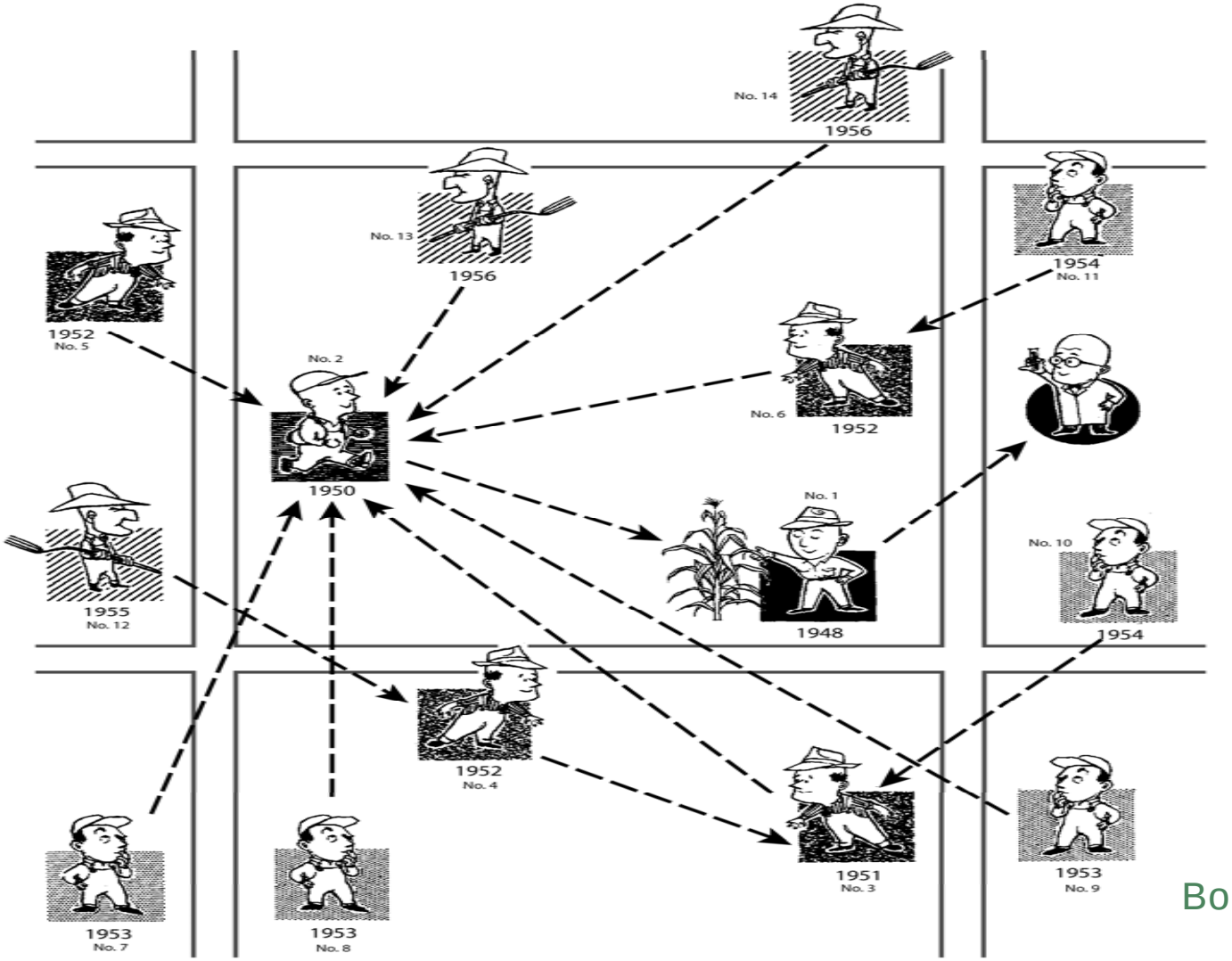
Diffusion of Innovations

- Most influential theory guiding dissemination science
  - Early development emphasized temporal patterns and actor characteristics
  - Not particularly relational, until Valente's work



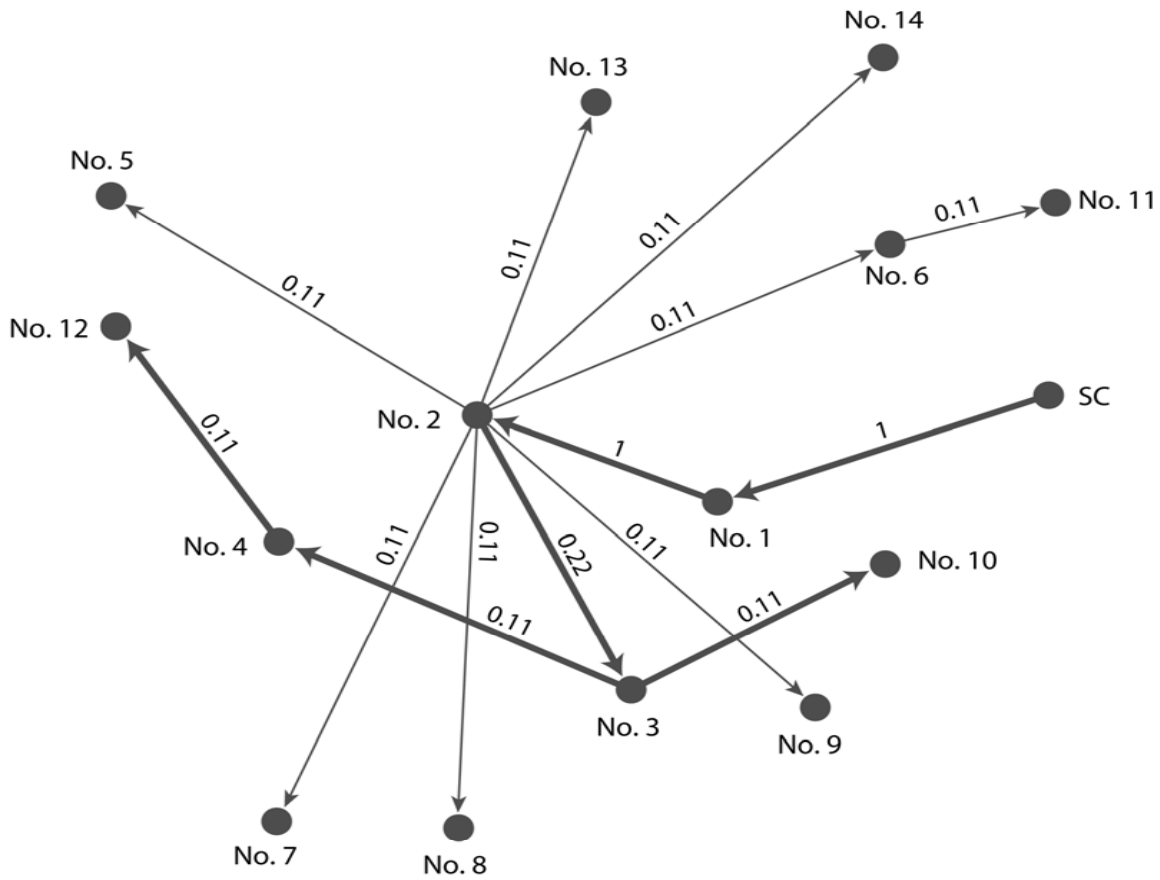


Diffusion of hybrid seed corn



Bohlen, 1962

Diffusion & dissemination as a network analysis problem



Two propositions

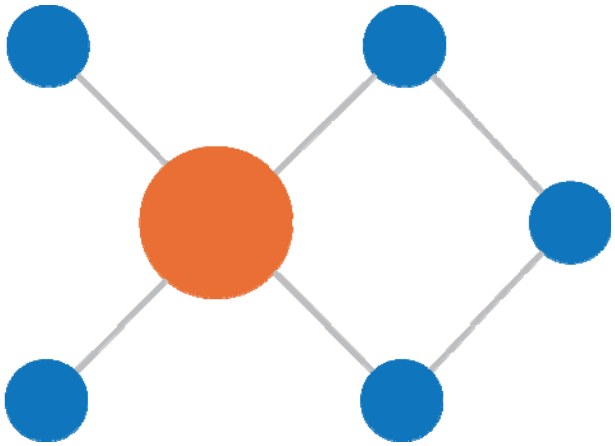
- Theoretical proposition:
  - Dissemination occurs within specific organizational and social systems
- Design proposition
  - Network study designs and network analytic approaches are ideal for studying how these systems shape dissemination processes and influence dissemination outcomes

Developing a network model of dissemination

- Dissemination flows through, and is structured by the set of relationships between multiple actors in a social system
- Multilevel ‘map’ of potential research questions
  - Local network characteristics
  - Global network characteristics
  - Multiple types of relationships in a single network
  - Internetwork relationships

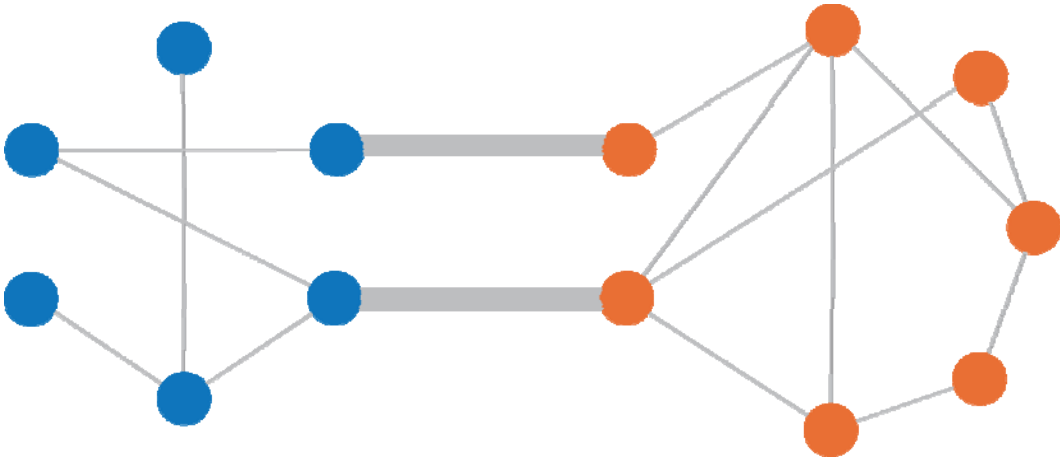
1) Local network characteristics

- Focus – local
- Example dissemination research questions
  - How do prominent actors in a network control the dissemination process?
  - What are the local network characteristics of opinion leaders?



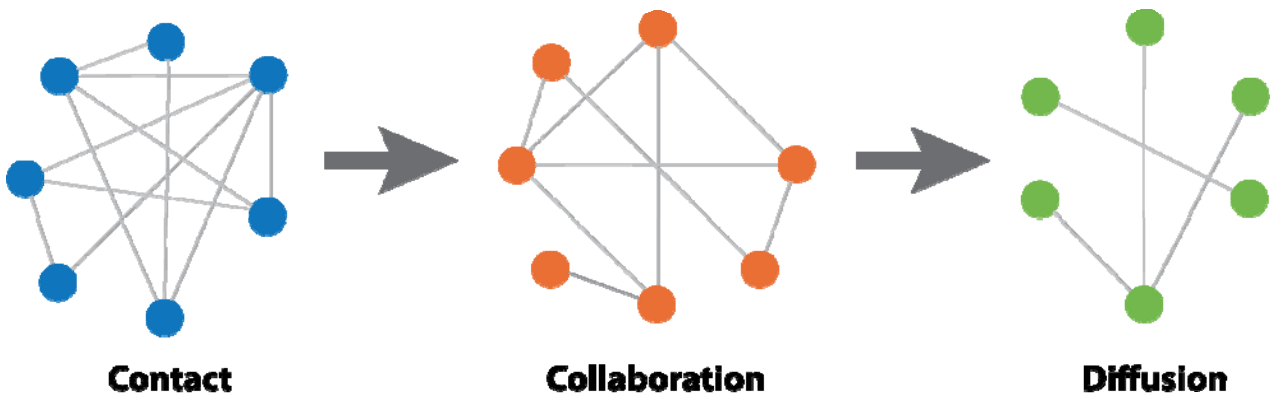
2) Global network characteristics

- Focus – entire network
- Dissemination research questions
  - How do various network structures affect ‘bottom-up’ and ‘top-down’ dissemination strategies?
  - Can filling network gaps speed up the dissemination process?



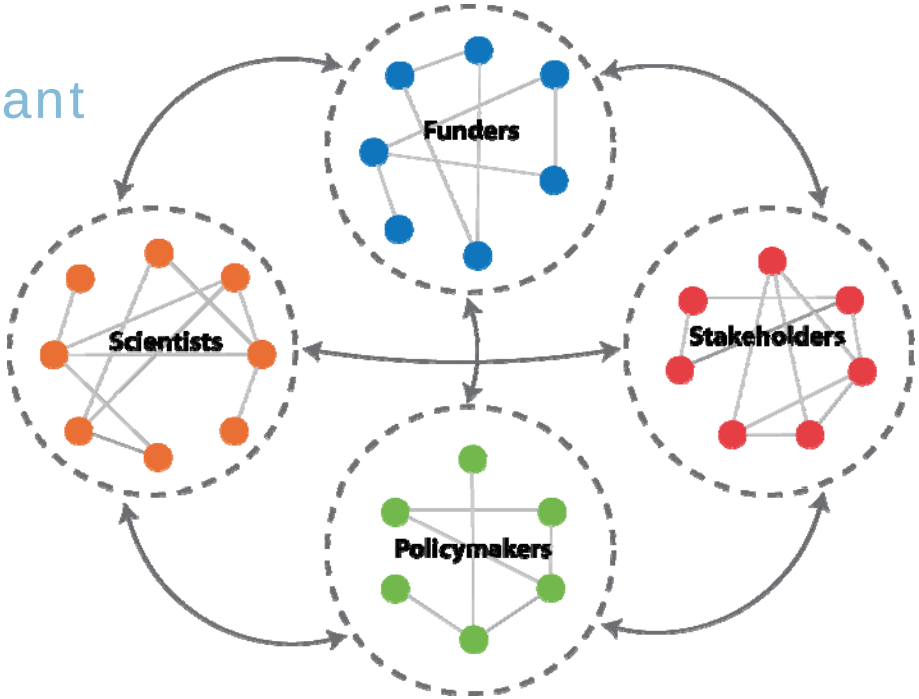
3) Multiple network relations

- Focus – how different types of network relations influence each other
- Dissemination research questions
  - Does dissemination of evidence-based guidelines take advantage of previously established collaborative relationships?



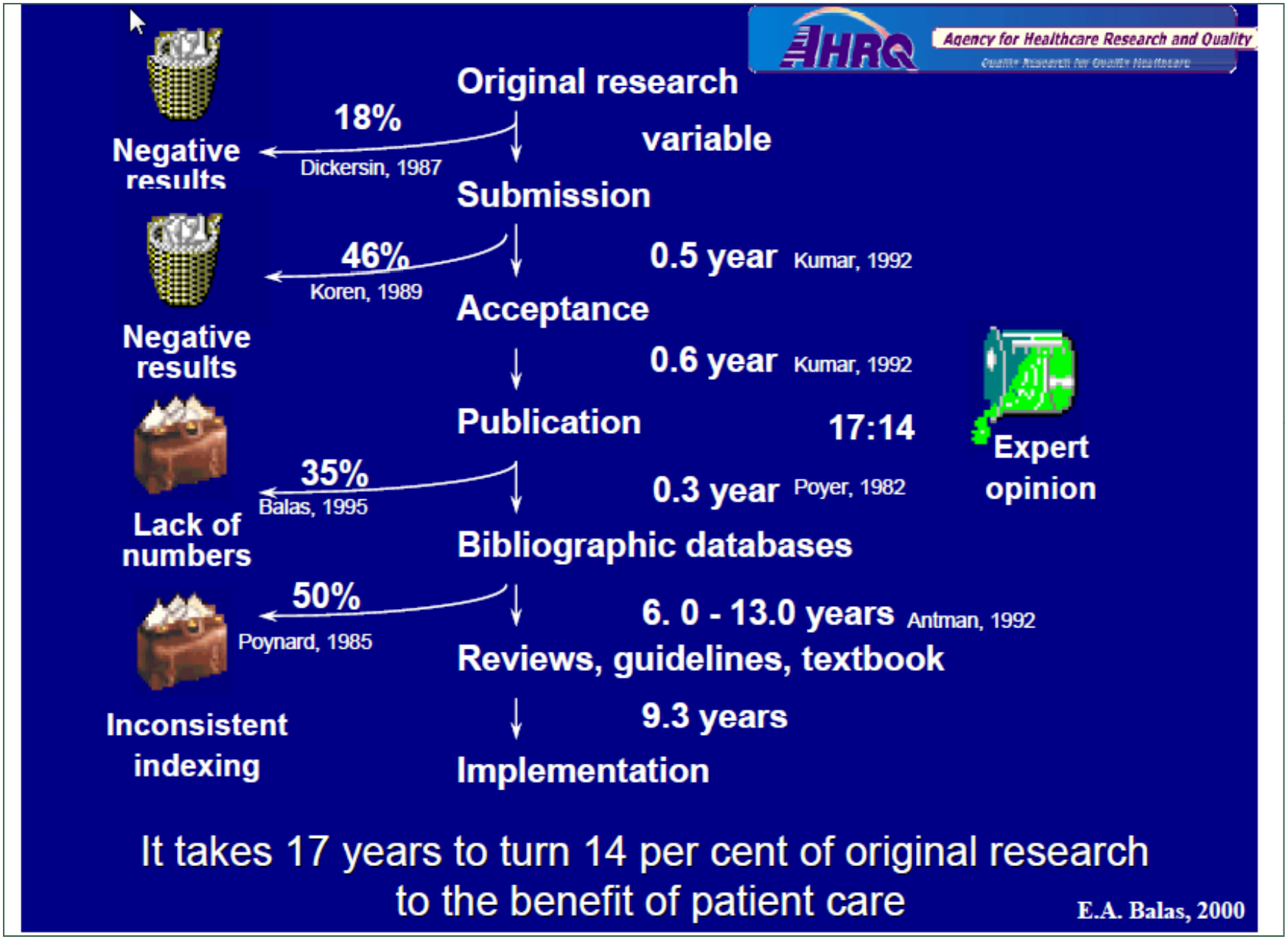
4) Multiple networks

- Focus – internetwork relationships
- Dissemination research question
  - What are the translational challenges as new discoveries flow through various types of networks?
  - How can we identify important 'bridgers' in these complex internetwork systems?



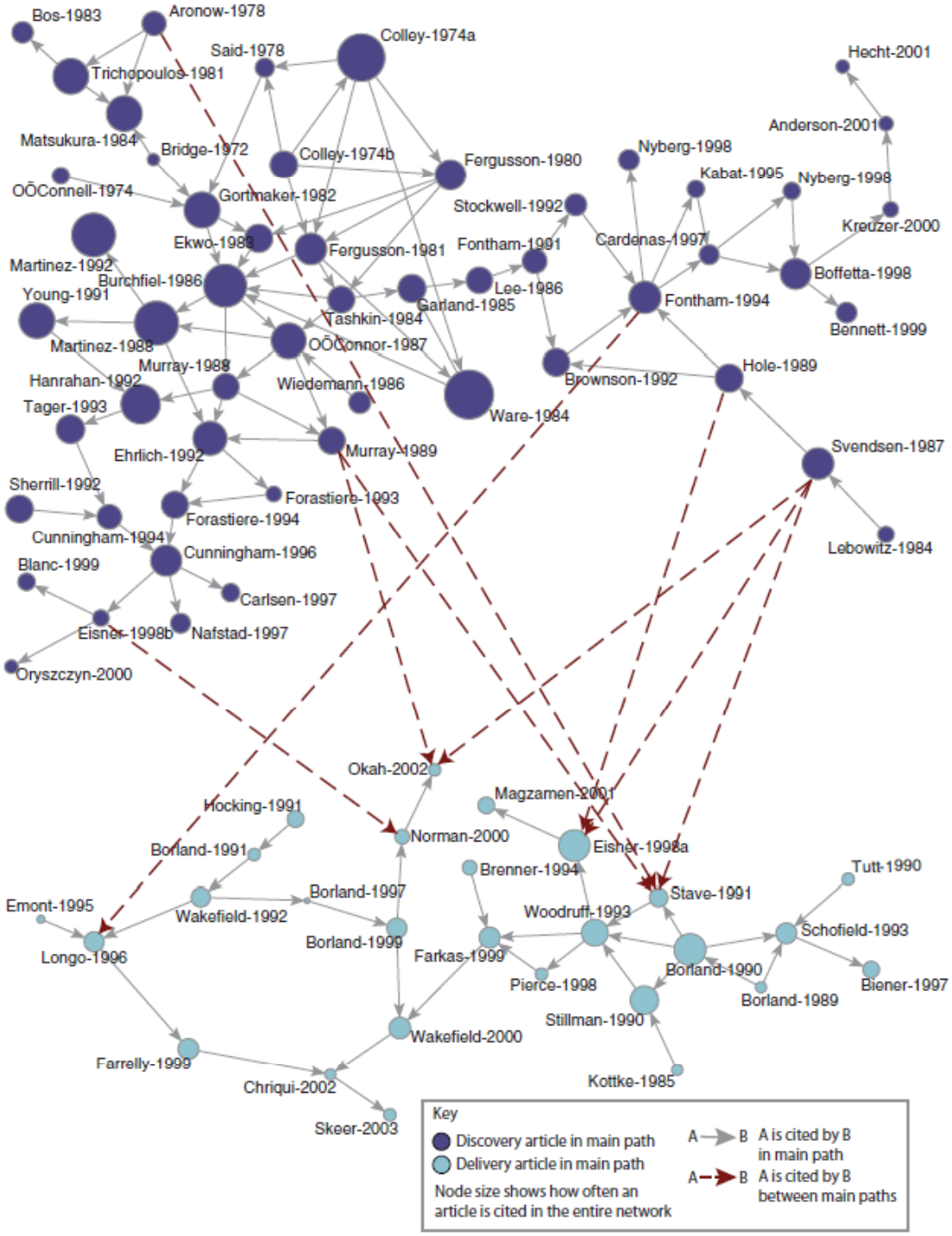
Example 1

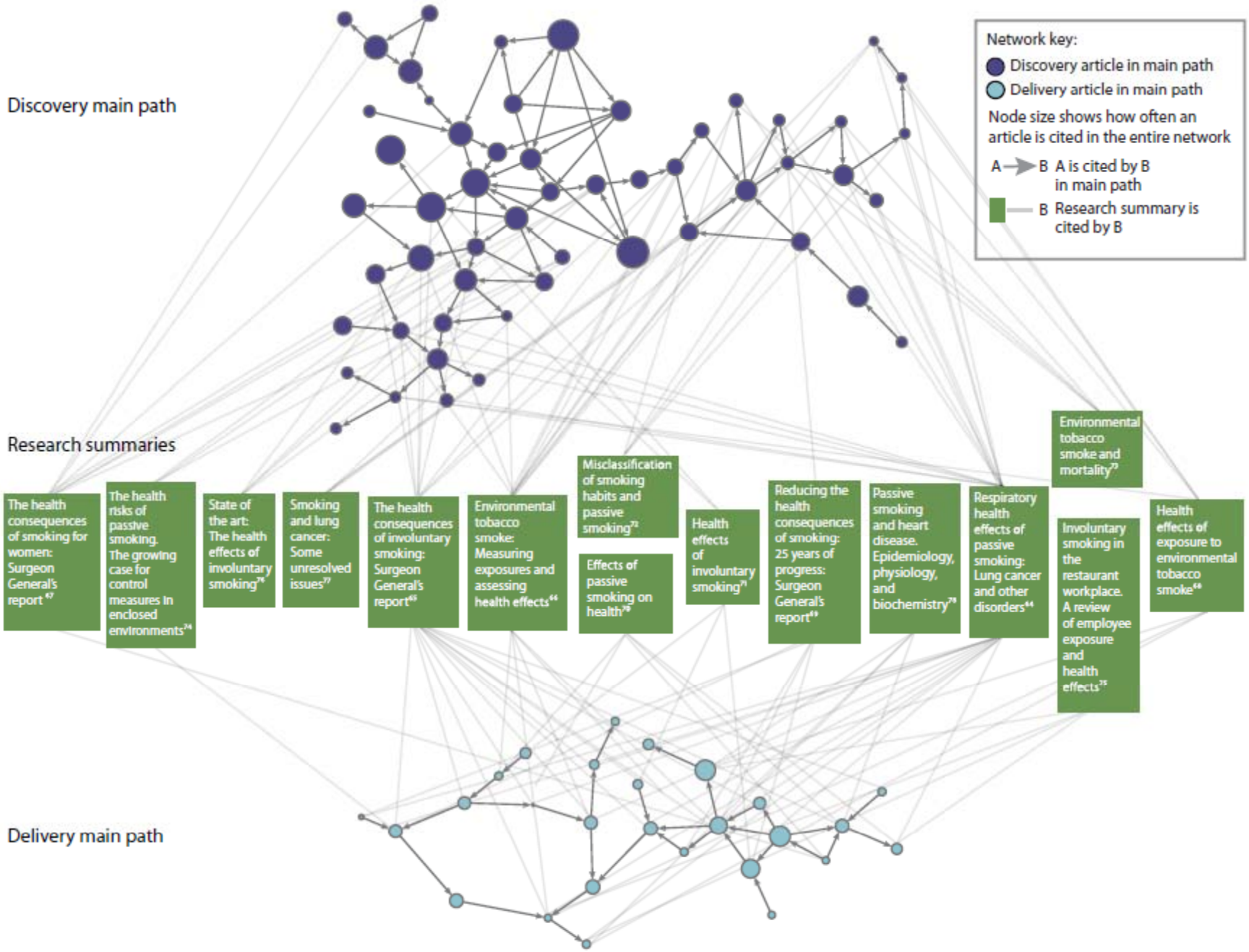
- Identification of a gap in the dissemination of secondhand smoke science
  - Example of level 2 in our network map: focusing on global properties of a network
- Study examined citation patterns among 1,877 secondhand smoke scientific studies
  - 40 years of basic science (discovery) and policy/intervention (delivery) studies
    - Harris, Luke, Zuckerman, & Shelton (2009). Forty years of secondhand smoke research: The gap between discovery and delivery. *American Journal of Preventive Medicine, 36,* 538-548.



From Palmer (2006). Turning Research to Action. AHRQ.

- Citation network analysis identifies gap between basic science and policy/prevention science
  - Only 9 direct citations from delivery to discovery




Discovery main path
Research summaries
Delivery main path
Network key:
Discovery article in main path
Delivery article in main path
Node size shows how often an article is cited in the entire network
A B A is cited by B in main path
B Research summary is cited by B
The health consequences of smoking for women: Surgeon General's report 47
The health risks of passive smoking. The growing case for control measures in enclosed environments 74
State of the art: The health effects of involuntary smoking 76
Smoking and lung cancer: Some unresolved issues 77
The health consequences of involuntary smoking: Surgeon General's report 65
Environmental tobacco smoke: Measuring exposures and assessing health effects 66
Misclassification of smoking habits and passive smoking 72
Effects of passive smoking on health 79
Health effects of involuntary smoking 71
Reducing the health consequences of smoking: 25 years of progress: Surgeon General's report 69
Passive smoking and heart disease. Epidemiology, physiology, and biochemistry 78
Respiratory health effects of passive smoking: Lung cancer and other disorders 64
Environmental tobacco smoke and mortality 73
Involuntary smoking in the restaurant workplace. A review of employee exposure and health effects 75
Health effects of exposure to environmental tobacco smoke 68

Dissemination gap is real

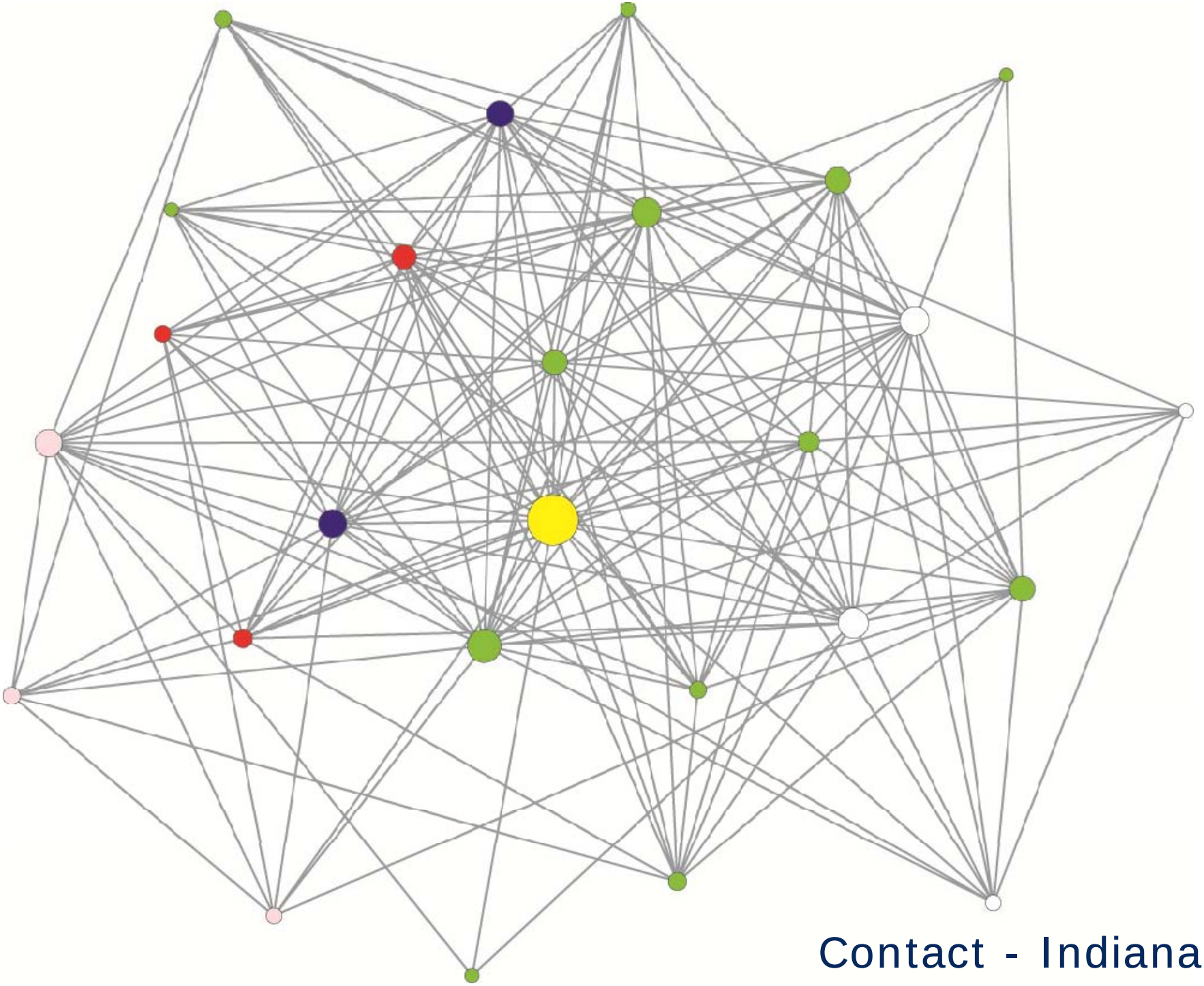
Table 5. Logit model predicting citation linkages among articles in the entire SHS citation network (N=1877)

	Model 1				Model 2			
Coefficient	**Logit**	**SE**	**OR**	**95% CI**	**Logit**	**SE**	**OR**	**95% CI**
Edges/arcs	−5.27	0.10	0.005	0.004–0.006	−5.14	0.10	0.006	0.005–0.007
Year citation patterns								
Cites articles by year (indegree)	−0.10	0.001	0.905	0.903–0.907	−0.10	0.001	0.905	0.903–0.907
Cited by year (outdegree)	0.04	0.002	1.041	1.037–1.045	0.04	0.002	1.041	1.037–1.045
JOURNAL CITATION PATTERN								
Cites articles (indegree)								
Impact factor <3	ref	—	—	—	ref	—	—	—
Impact factor 3–5	0.79	0.03	2.203	2.077–2.336	0.80	0.03	2.226	2.098–2.360
Impact factor >5	1.58	0.03	4.855	4.578–5.149	1.61	0.03	5.003	4.717–5.306
Cited (outdegree)								
Impact factor <3	ref	—	—	—	ref	—	—	—
Impact factor 3–5	0.23	0.03	1.259	1.187–1.335	0.22	0.03	1.246	1.176–1.322
Impact factor >5	0.32	0.04	1.377	1.273–1.489	0.31	0.04	1.363	1.261–1.475
Subfield citation patterns								
Discovery cites discovery					ref	—	—	—
Discovery cites delivery					−1.80	0.09	0.165	0.139–0.197
Delivery cites discovery					−1.03	0.04	0.357	0.330–0.386
Delivery cites delivery					1.47	0.04	4.349	4.021–4.704
Model fit	−2LL	AIC		df	−2LL	AIC		df
	98,520	98,533		7	95,587	95,607		10

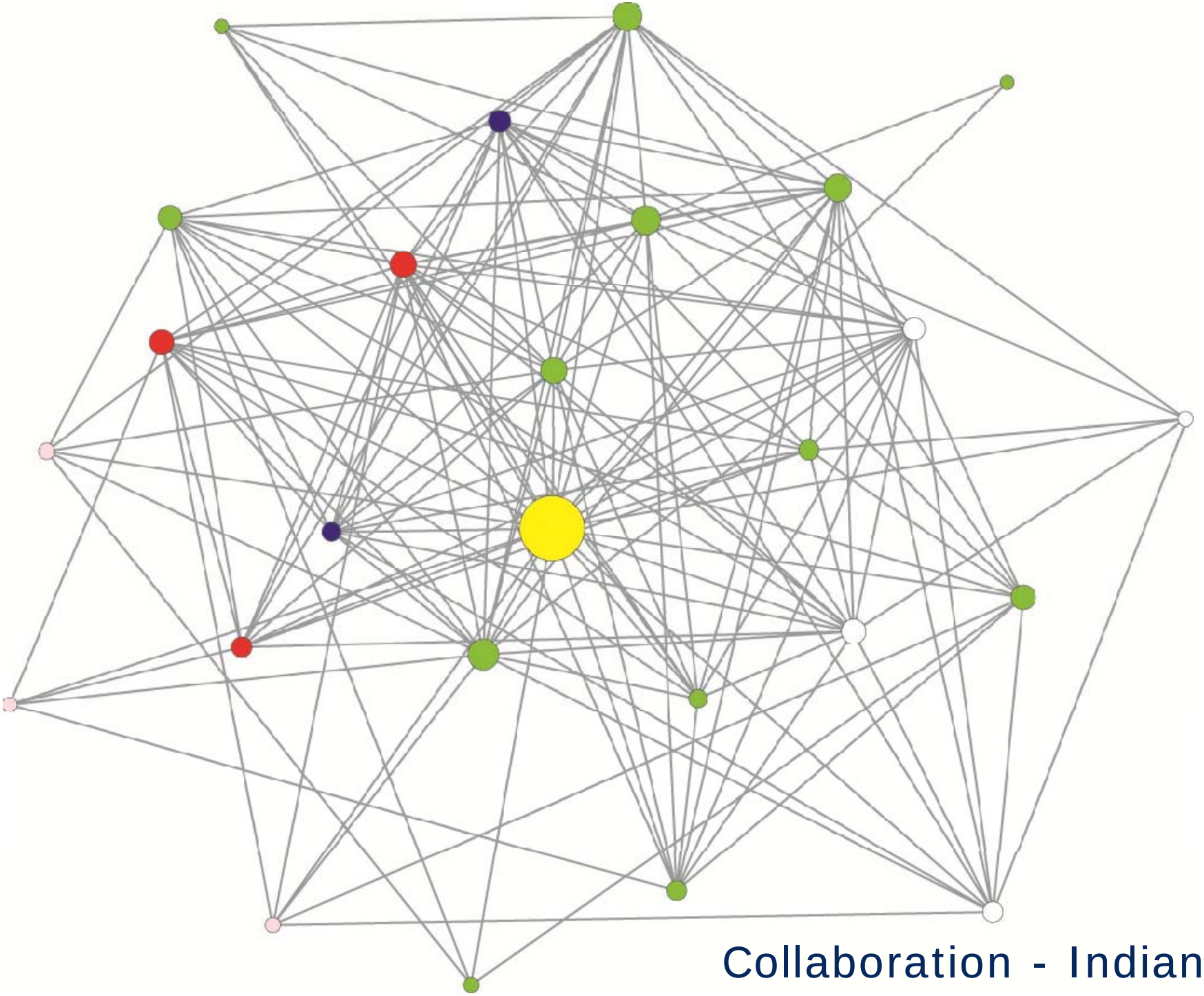
AIC, Akaike Information Criterion; −2LL, −2 times the log-likelihood

Example 2

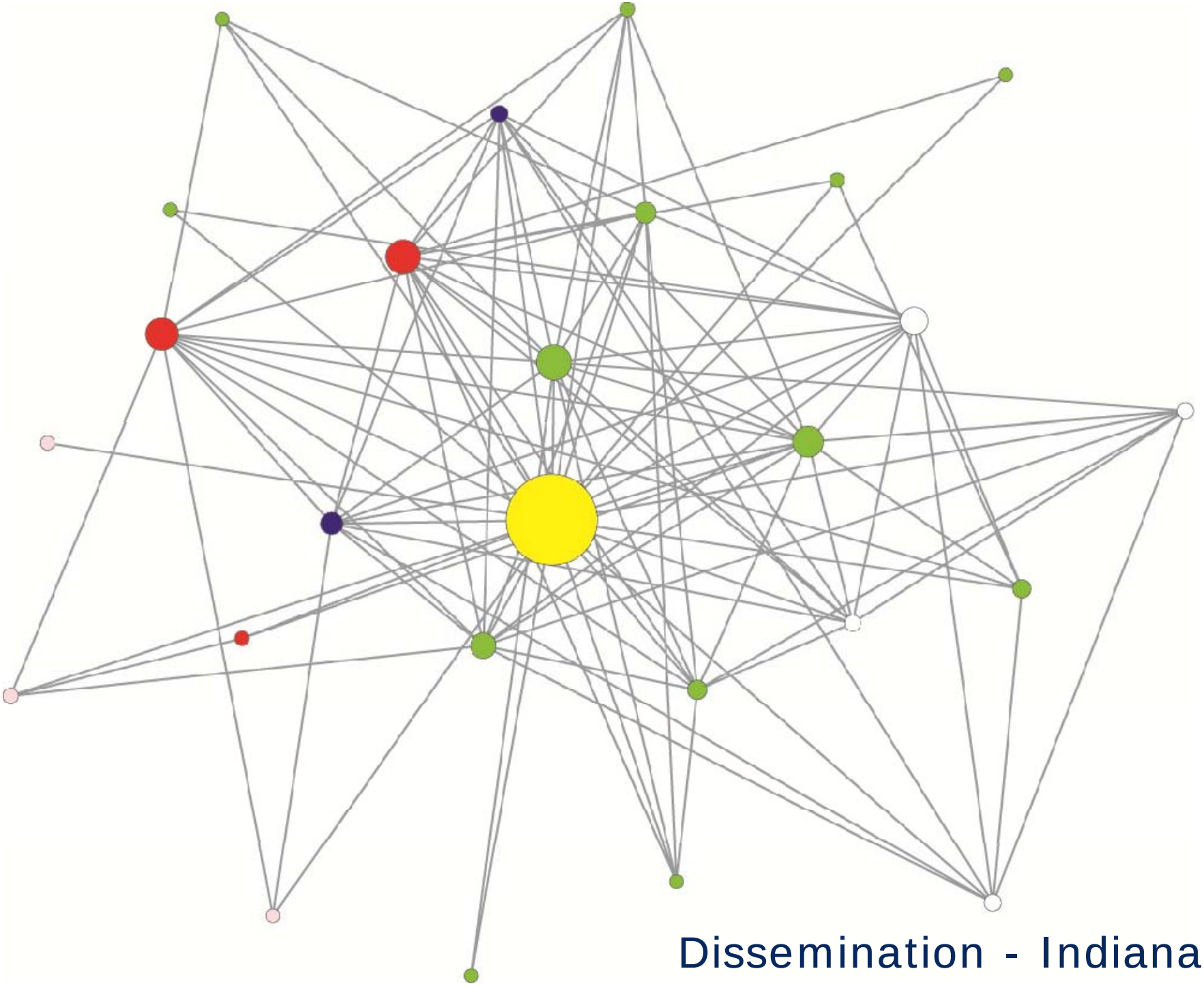
- Identifying predictors of dissemination of evidence-based guidelines in statewide tobacco control programs
  - Example of level 3 in our network map: Examining multiple relations in a single network
- Part of a CDC-funded evaluation project of state tobacco control programs
  - Examining how states are disseminating and implementing the evidence-based *Best Practices* guidelines



Contact - Indiana

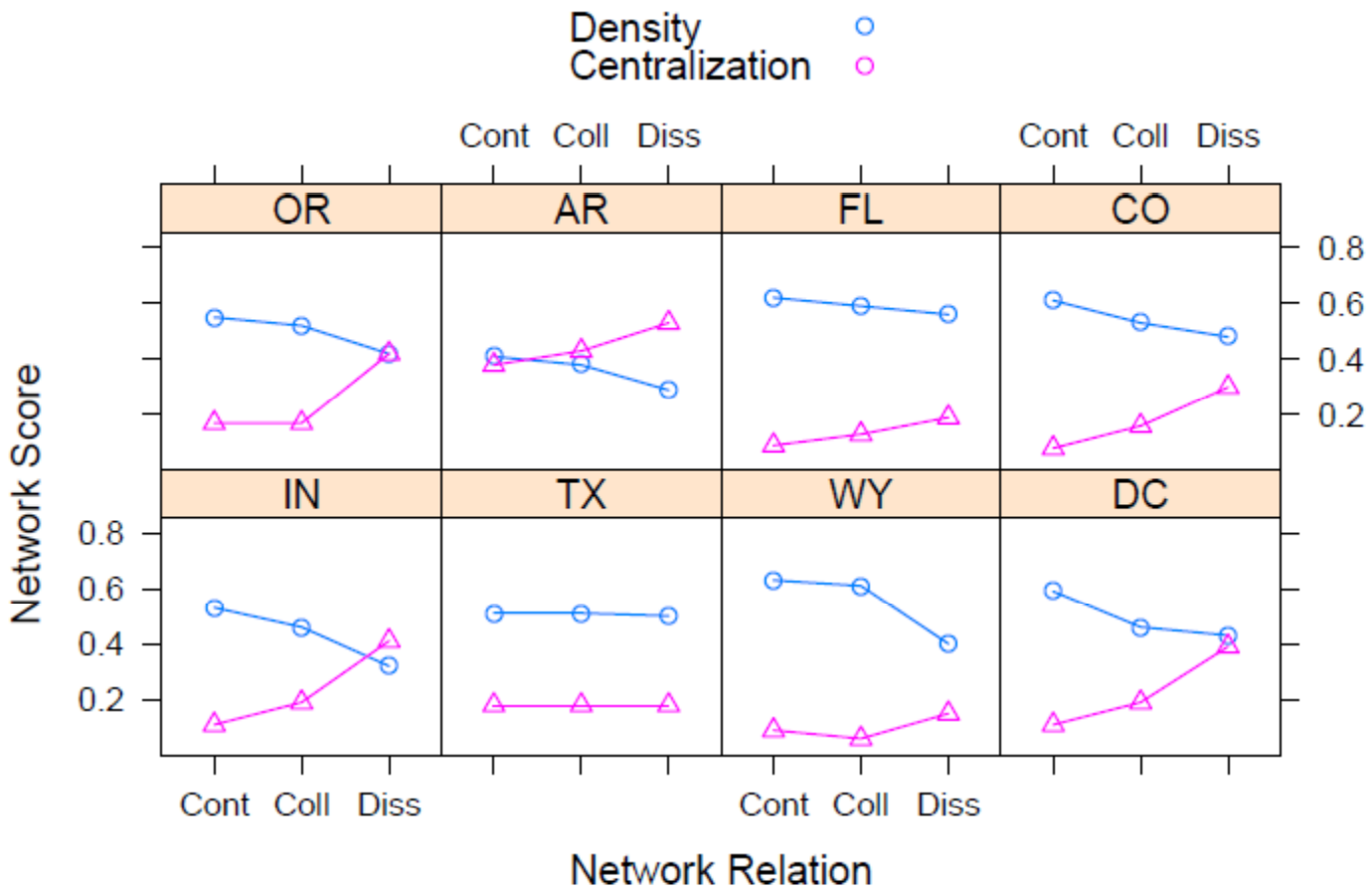


Collaboration - Indiana



Dissemination - Indiana

Network characteristics across 3 types of relationships: Contact, Collaboration, Dissemination



Prediction of EBG dissemination

	Indiana (g=26)			Texas (g=20)			Wyoming (g=20)			DC (g=19)		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Parameters												
Edges	-2.63	-4.21	-4.05	-0.16	-0.97	-0.93	-1.05	-1.87	-2.23	-2.32	-4.37	-5.43
TC Experience	0.11 (.02)*	0.10 (.02)*	0.08 (.02)*	0.03 (.02)	0.02 (.03)	0.01 (.03)	0.09 (.03)*	0.07 (.03)*	0.07 (.03)*	0.18 (.04)*	0.16 (.04)*	0.20 (.05)*
Agency Level (Homophily)	0.59 (.08)*	0.61 (.10)*	0.32 (.10)*	0.83 (.10)*	0.85 (.10)*	0.78 (.11)*	-0.22 (.11)	-0.46 (.10)*	-0.45 (.10)*	0.17 (.10)	.02 (.12)	0.58 (.13)*
Agency Distance	.000 (.000)	.000 (.000)	.000 (.000)	-.001 (.000)*	-.001 (.000)*	-.001 (.000)*	-.000 (.000)	-.001 (.000)*	-.000 (.000)	-.001 (.00)*	-.001 (.00)*	-.000 (.00)
Degree (GWDegree)	2.82 (1.39)*	2.87 (1.63)	4.53 (1.79)*	200.6 (7.3)*	296.4 (7.6)*	302.3 (7.6)*	-4.58 (.44)*	-3.33 (.55)*	-3.41 (.54)*	3.54 (1.44)*	3.32 (1.75)	1.97 (1.70)
Network Contact(OR) (95% CI)		2.69 (2.54-2.85)	2.01 (1.90-2.14)		2.05 (1.90-2.22)	1.73 (1.63-1.84)		2.03 (1.92-2.16)	1.68 (1.59-1.78)		3.63 (3.36-3.93)	1.86 (1.69-2.05)
Network Collaboration(OR) (95% CI)			1.65 (1.55-1.75)			1.32 (1.25-1.40)			1.38 (1.30-1.46)			2.83 (2.57-3.12)
Model Fit												
AIC	372.2	285.4	272.2	272.1	237.5	236.1	212.1	187.55	186.8	203.0	137.3	120.0
p	.000	.000	.000	.000	.000	.066	.000	.000	.096	.000	.000	.000
GOF (%)	.74	.84	.92	.85	.93	.88	.74	.75	.78	.82	.90	.93

Contact and collaboration predict dissemination

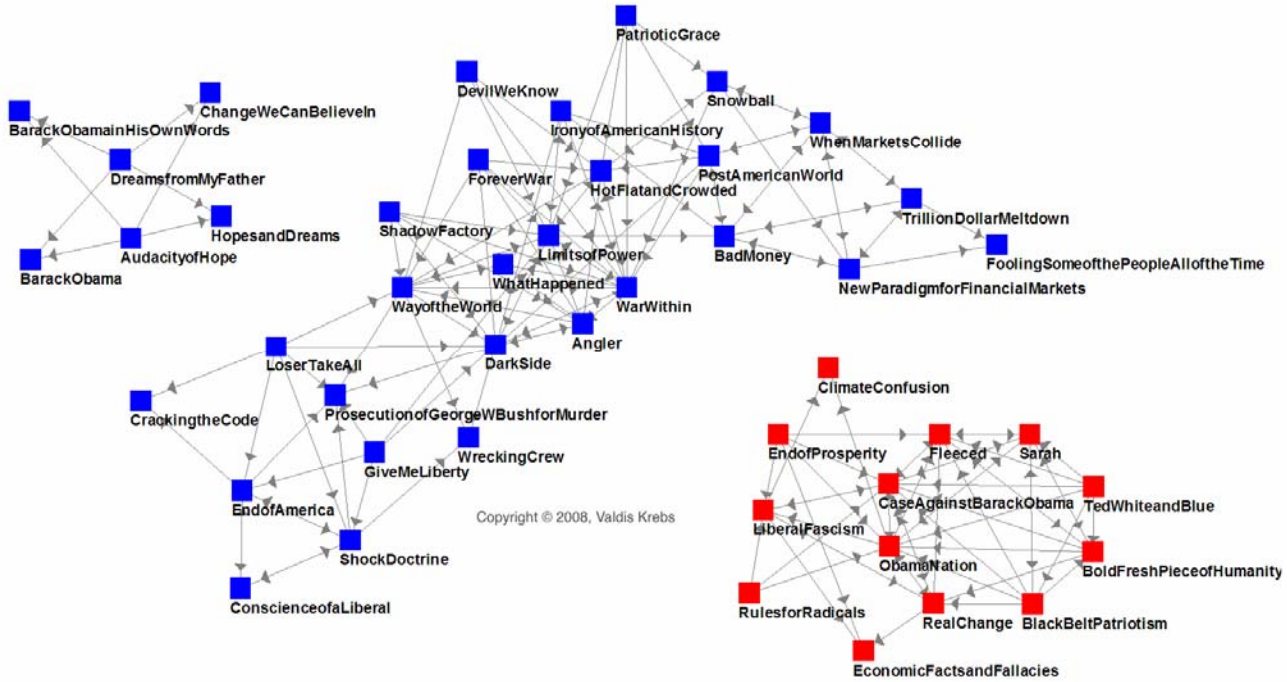
	Indiana (g=26)		Texas (g=20)		Wyoming (g=20)		DC (g=19)	
	M2	M3	M2	M3	M2	M3	M2	M3
Network *Contact* (OR)	2.69	2.01	2.05	1.73	2.03	1.68	3.63	1.86
(95% CI)	(2.54-2.85)	(1.90-2.14)	(1.90-2.22)	(1.63-1.84)	(1.92-2.16)	(1.59-1.78)	(3.36-3.93)	(1.69-2.05)
Network *Collaboration* (OR)		1.65		1.32		1.38		2.83
(95% CI)		(1.55-1.75)		(1.25-1.40)		(1.30-1.46)		(2.57-3.12)

	Oregon (g=17)		Arkansas (g=17)		Florida (g=16)		Colorado (g=15)	
	M2	M3	M2	M3	M2	M3	M2	M3
Network *Contact* (OR)	2.92	1.45	5.00	2.64	4.53	3.56	3.53	2.92
(95% CI)	(2.7-3.15)	(1.31-1.60)	(4.45-5.63)	(2.26-3.09)	(4.02-5.09)	(3.17-4.01)	(3.13-3.97)	(2.59-3.28)
Network *Collaboration* (OR)		3.46		2.89		1.35		1.35
(95% CI)		(3.13-3.81)		(2.52-3.31)		(1.20-1.52)		(1.20-1.52)

Wrapping up

- Dissemination is a networked process
- Using network theory and analysis can
  - enrich theories of dissemination
  - help us understand dissemination better
  - lead to more effective dissemination
- Need to start using more sophisticated network approaches
  - Multiple relations
  - Multiple networks
  - Dynamic networks
  - Statistical modeling of networks

Political Books – 2008



(Krebs, orgnet.com)