Visualization

Center for Public Health Systems Science
Brown School
Washington University in St. Louis

Goals

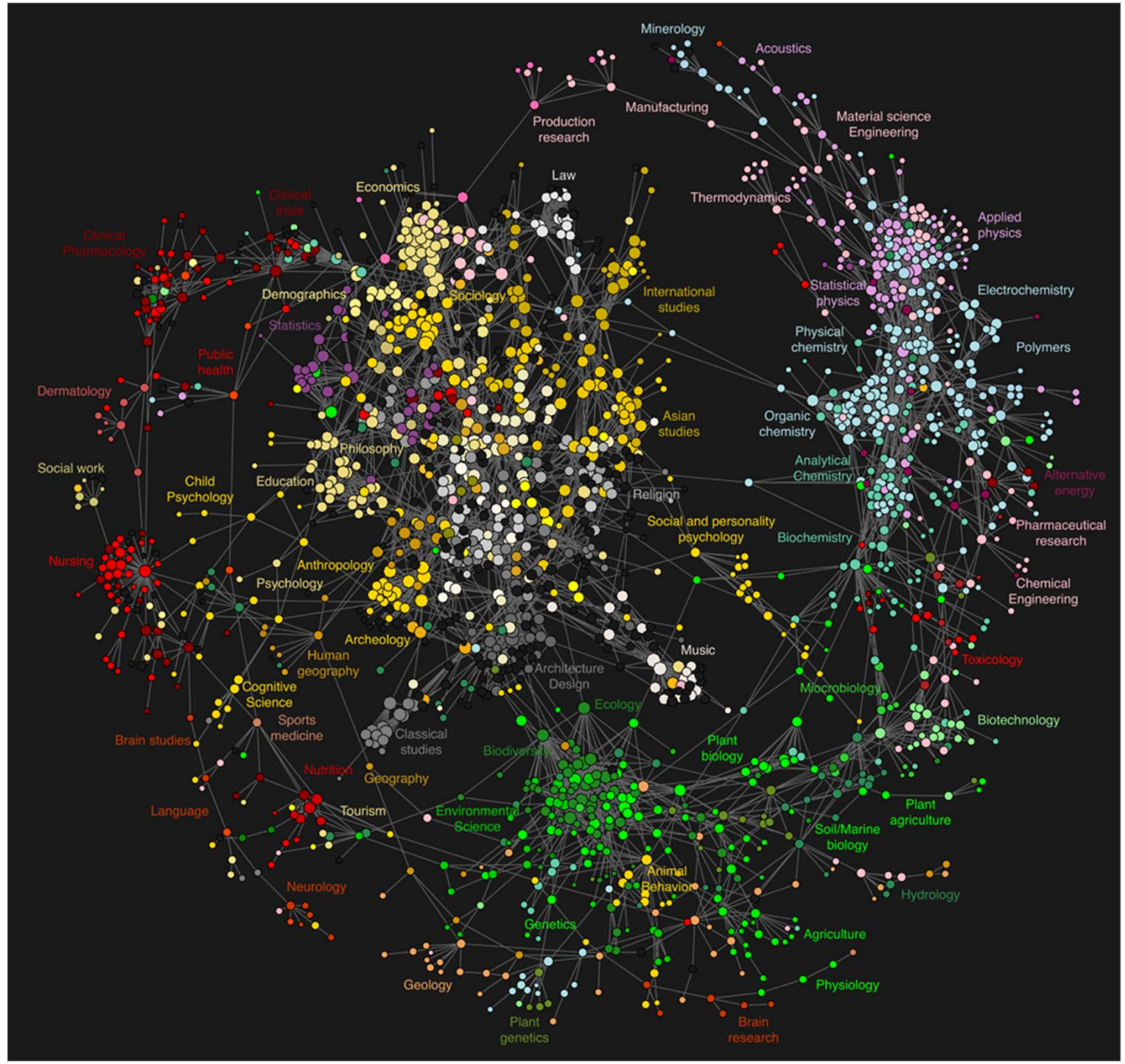
- Discuss basic principles of network visualization
- Explore a few important visualization algorithms
- Present tips for effective network graphics

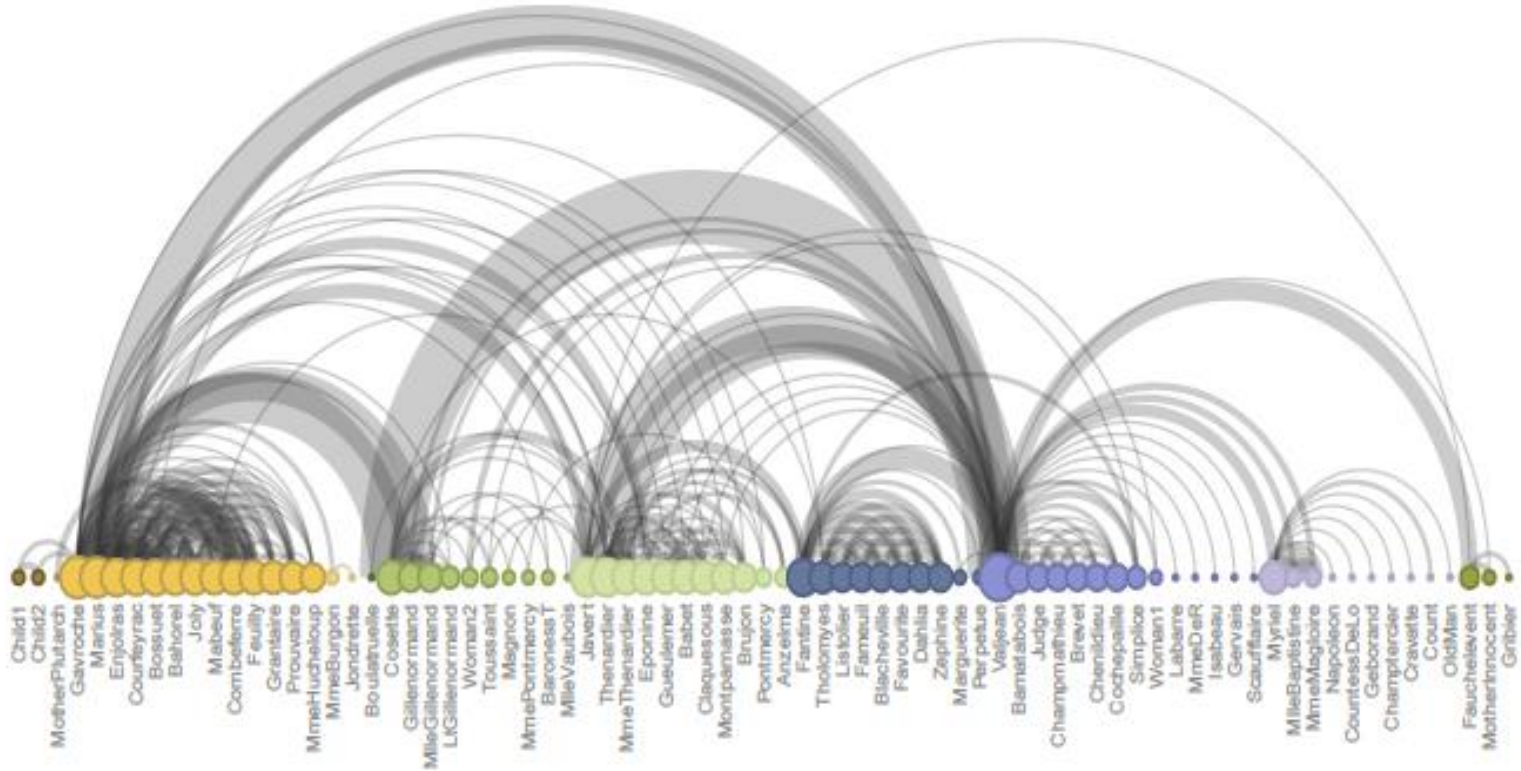
Importance & challenge

Visualization as a core element of network analysis

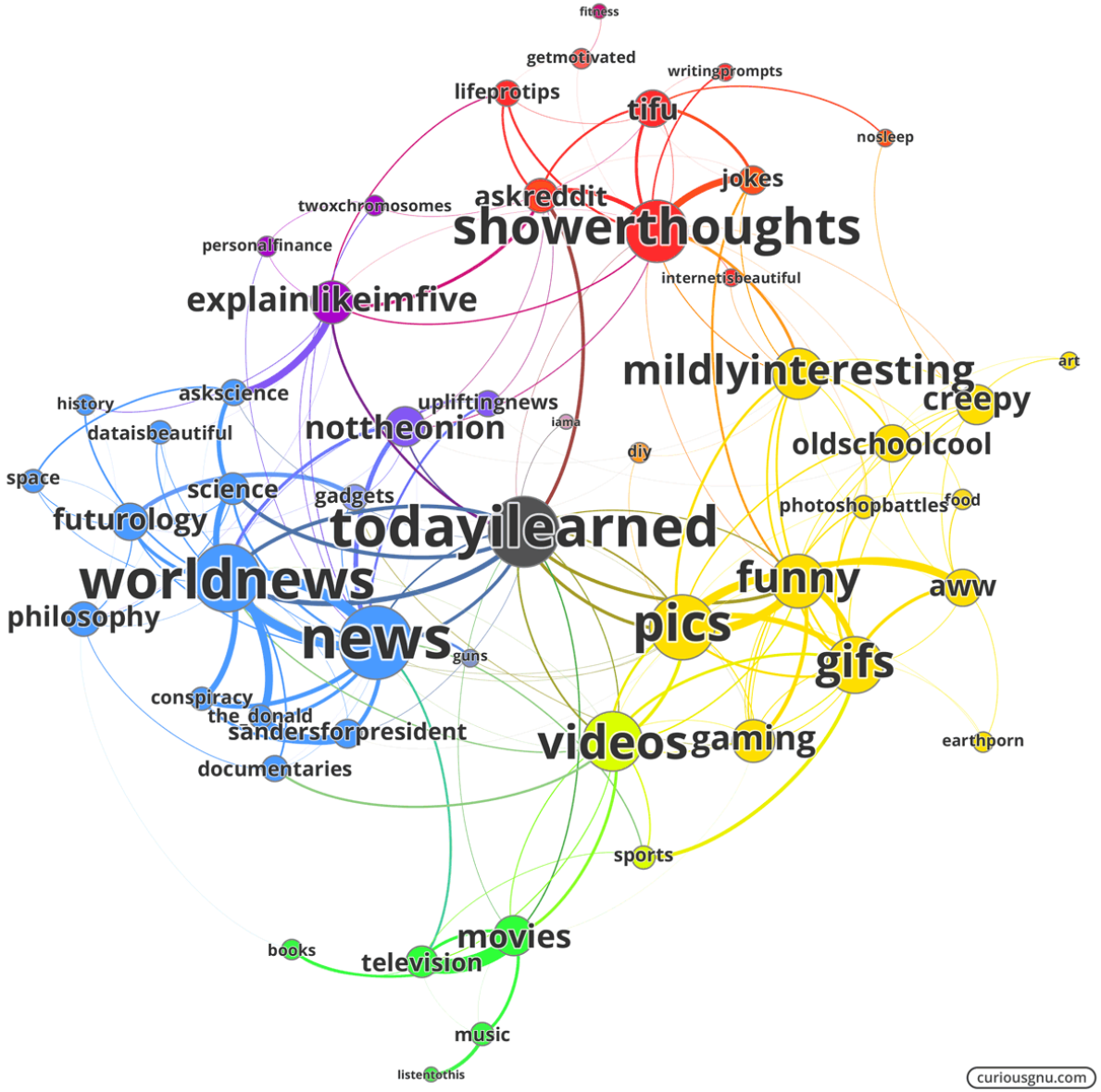
Visualization as fundamental network activity

- Importance
- Challenges
  - Scalability
  - Dimensionality
  - Speed
  - Dynamics
  - Multidimensionality of information
  - Macro-Micro views
  - Negative information: gaps, weak ties

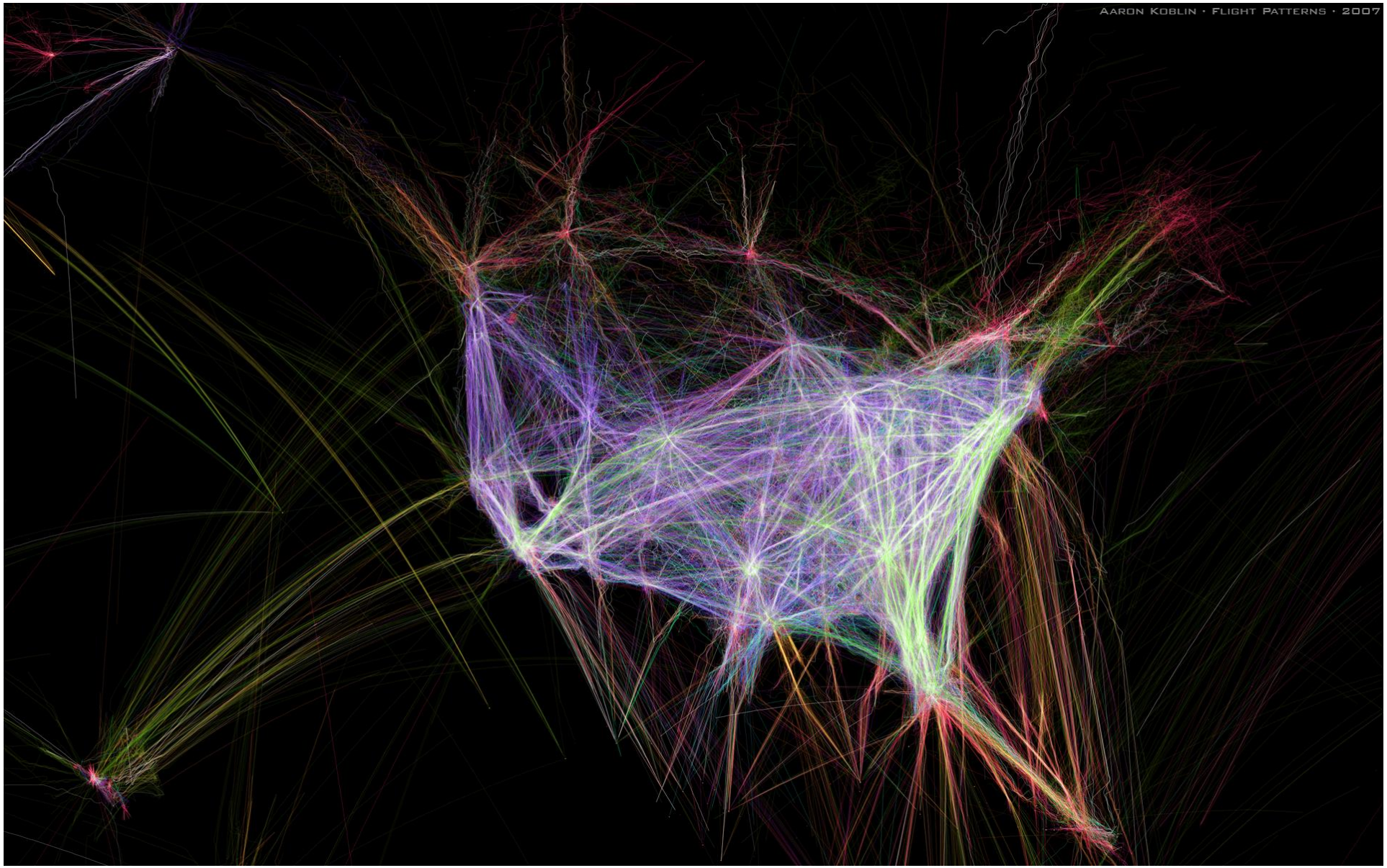

Minerology
Acoustics
Manufacturing
Production research
Material science Engineering
Thermodynamics
Applied physics
Law
Economics
Clinical trials
Clinical Pharmacology
Demographics
Sociology
International studies
Statistical physics
Electrochemistry
Statistics
Physical chemistry
Polymers
Public health
Dermatology
Asian studies
Organic chemistry
Philosophy
Analytical Chemistry
Alternative energy
Social work
Child Psychology
Education
Religion
Social and personality psychology
Biochemistry
Pharmaceutical research
Nursing
Anthropology
Psychology
Chemical Engineering
Archeology
Music
Toxicology
Human geography
Architecture
Design
Cognitive Science
Ecology
Microbiology
Biotechnology
Sports medicine
Brain studies
Classical studies
Plant biology
Biodiversity
Nutrition
Geography
Tourism
Language
Environmental Science
Plant agriculture
Soil/Marine biology
Animal Behavior
Neurology
Hydrology
Genetics
Agriculture
Geology
Physiology
Plant genetics
Brain research



http://www.r-bloggers.com/arc-diagrams-in-r-les-miserables/



https://www.curiousgnu.com/assets/images/rd-comments/rd_comments_net_hd.png



http://www.coolinfographics.com/blog/2007/10/6/flight-patterns.html

Visualization principles

Best practices for layouts of network graphs

Aesthetic Criteria

- Network graphics are easier to understand if they follow these aesthetic guidelines:
  - Symmetry
  - Evenly distributed nodes
  - Uniform edge lengths
  - Minimize edge crossings

Minimizing edge crossings

- Reduces clutter
- Eases interpretation
- Example
  - www.planarity.net

Algorithms

- Eades Spring-embedded model
  - Tied nodes connected by a spring
  - Incorporates attractive and repulsive forces
  - Results in display that tends to result in uniform edge lengths and symmetry
- Modified by Kamada & Kawai
  - Iteratively repositions nodes one at a time
  - Desirable distance between nodes based on shortest path

Algorithms

- Fruchterman & Reingold
  - Fast force-directed placement
  - Results in evenly distributed nodes, uniform edge lengths, minimizes line crossings
  - Moves nodes all at once
- Davidson & Harel simulated annealing
  - Particularly emphasizes aesthetic qualities
  - Allows for temporary worsening of the solution to escape local minima
  - Can be slow

Examples of layout algorithms

- Examples
  - http://blog.ivank.net/force-based-graph-drawing-in-as3.html
  - https://www.youtube.com/watch?v=_Oidv5M-fuw
  - https://homes.cs.washington.edu/~jheer/files/zoo/
    - See network section
  - http://www.anchormodeling.com/modeler/latest/
    - (very cool)

Tips & tricks

Some design guidance for network graphics

How to Plan a Network Graphic

- What is the purpose of the graphic?
  - What story are you trying to tell?
- Content and form
  - What content (information) are you communicating?
  - What form supports the greatest clarity and efficiency of that communication?
- What design elements do you have available?

Design Elements

- Nodes
  - Size, shape, color
- Lines
  - Thickness, type, color
- Labels
  - Size, font, orientation
- Legend
- Title, subtitle

Climate Change - the Existing Network - A Snaphot View from the Web

Tips

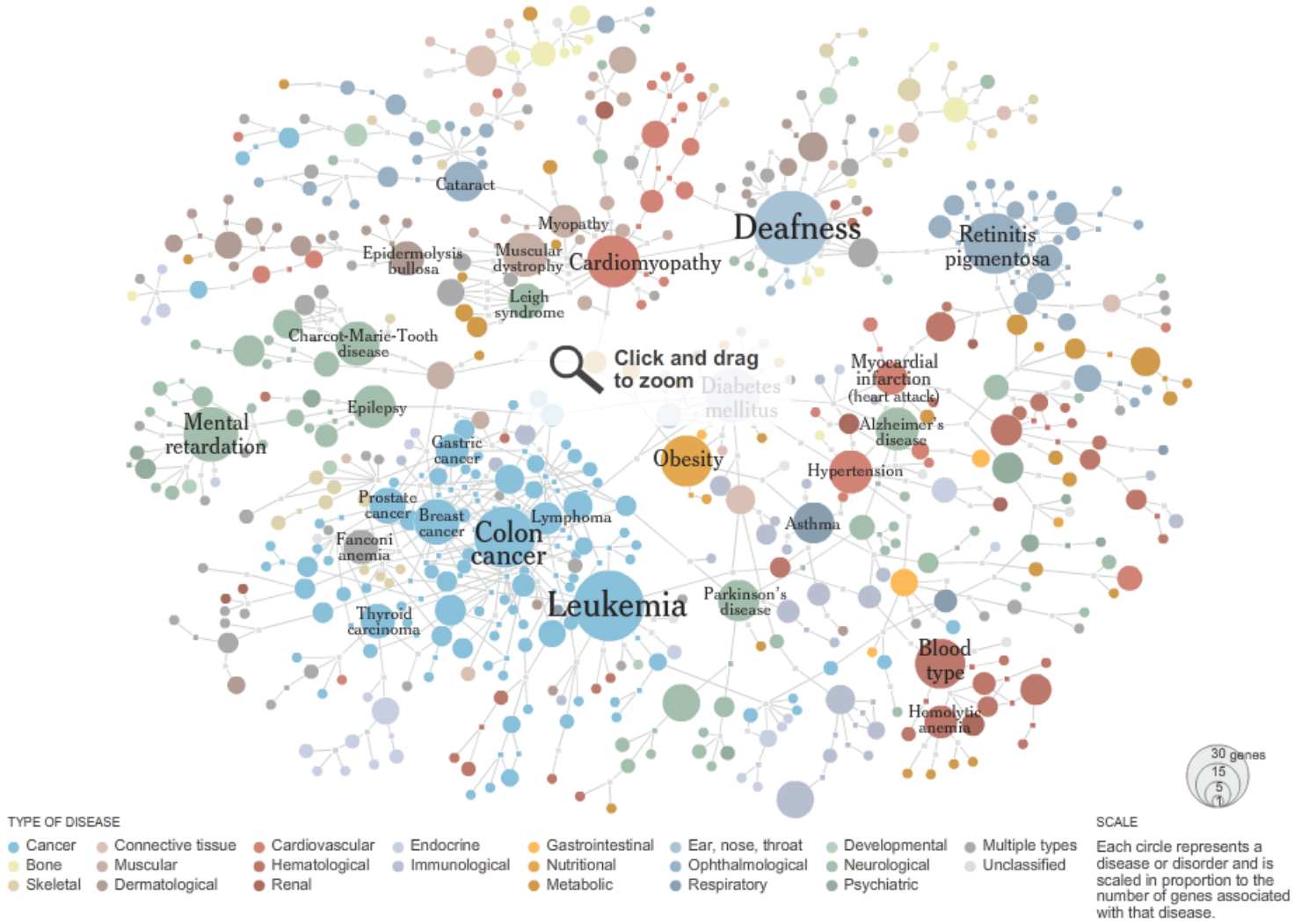
- Start with some form of spring-embedded algorithm
- For small networks, manually adjust network display to achieve desired informational results
- Use color of nodes to represent some important node *classification*
- Use size of nodes to represent some locational or node attribute (e.g. degree, centrality, age, etc.)

Tips

- Decide whether audience needs to know who the nodes are. Only use labels when they are informative, and for small networks
- De-emphasize lines for highly dense networks
- When showing multiple network graphs, try to maintain the same node/line orientation between figures
- Be careful with line widths, arrows. They often obscure the network structure
- As networks get larger, emphasize subgroups or regions of the network

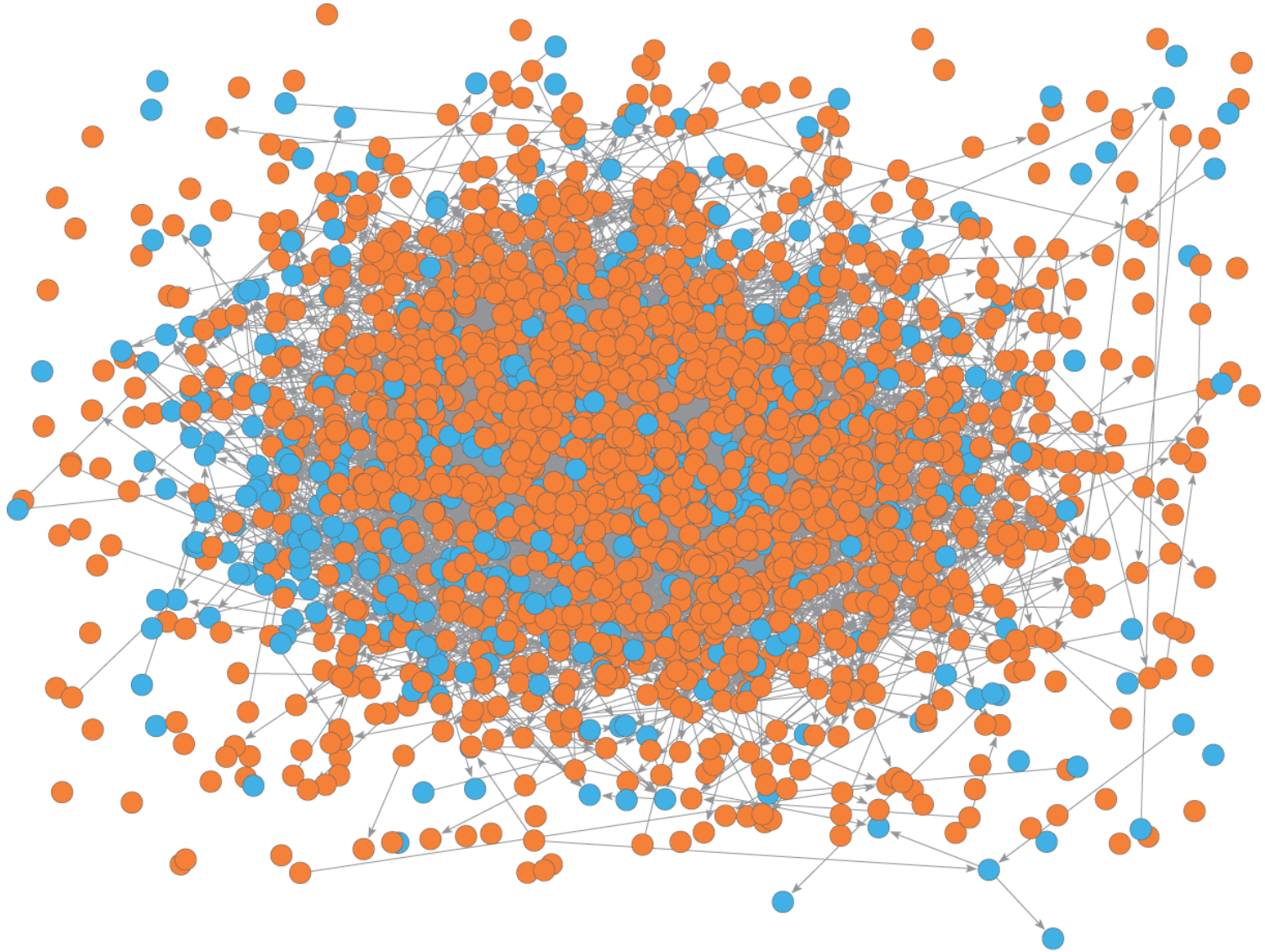
Examples

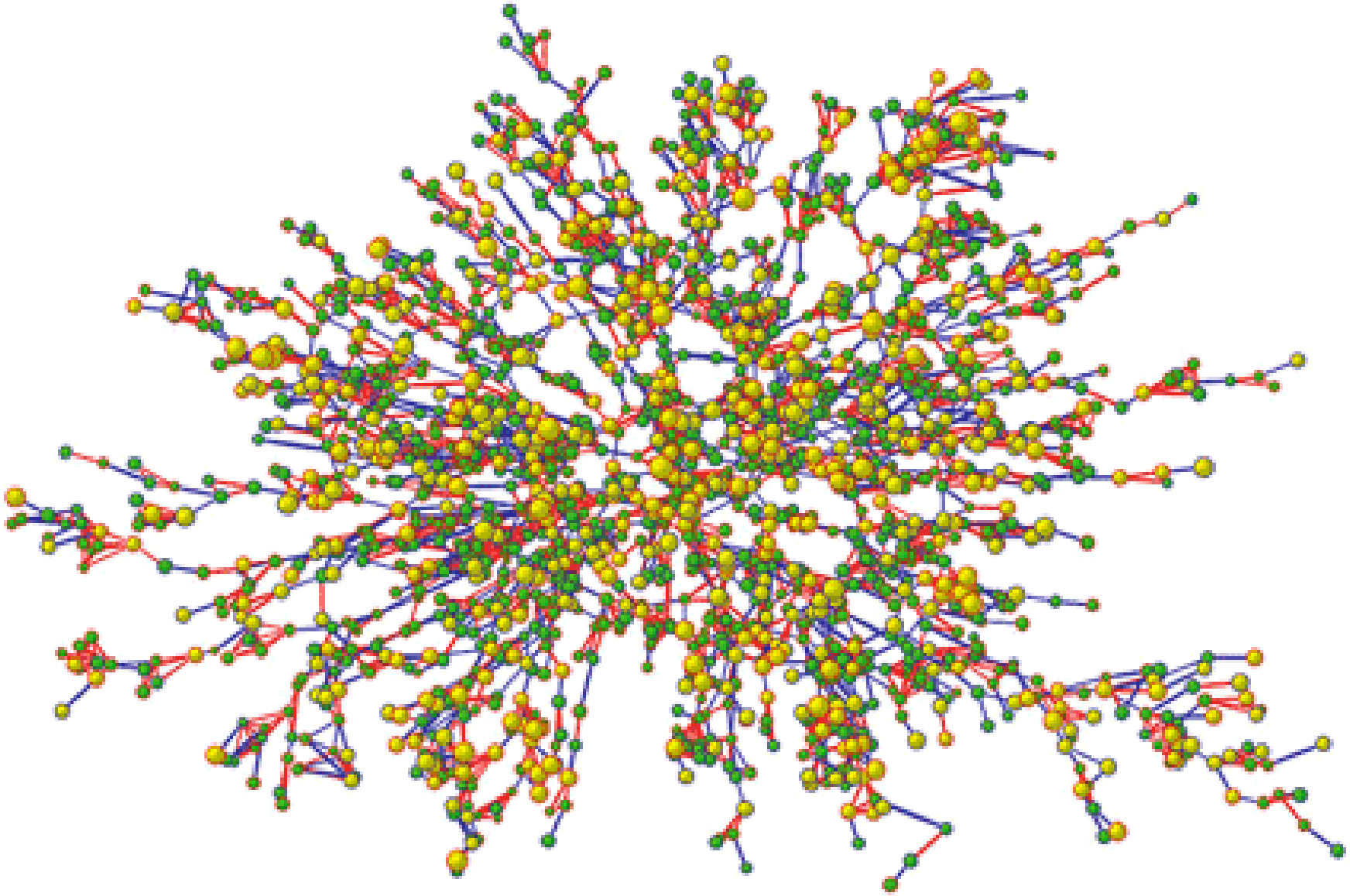
Mapping Human ‘Diseasome’



https://archive.nytimes.com/www.nytimes.com/interactive/2008/05/05/science/20080506_DISEASE.html

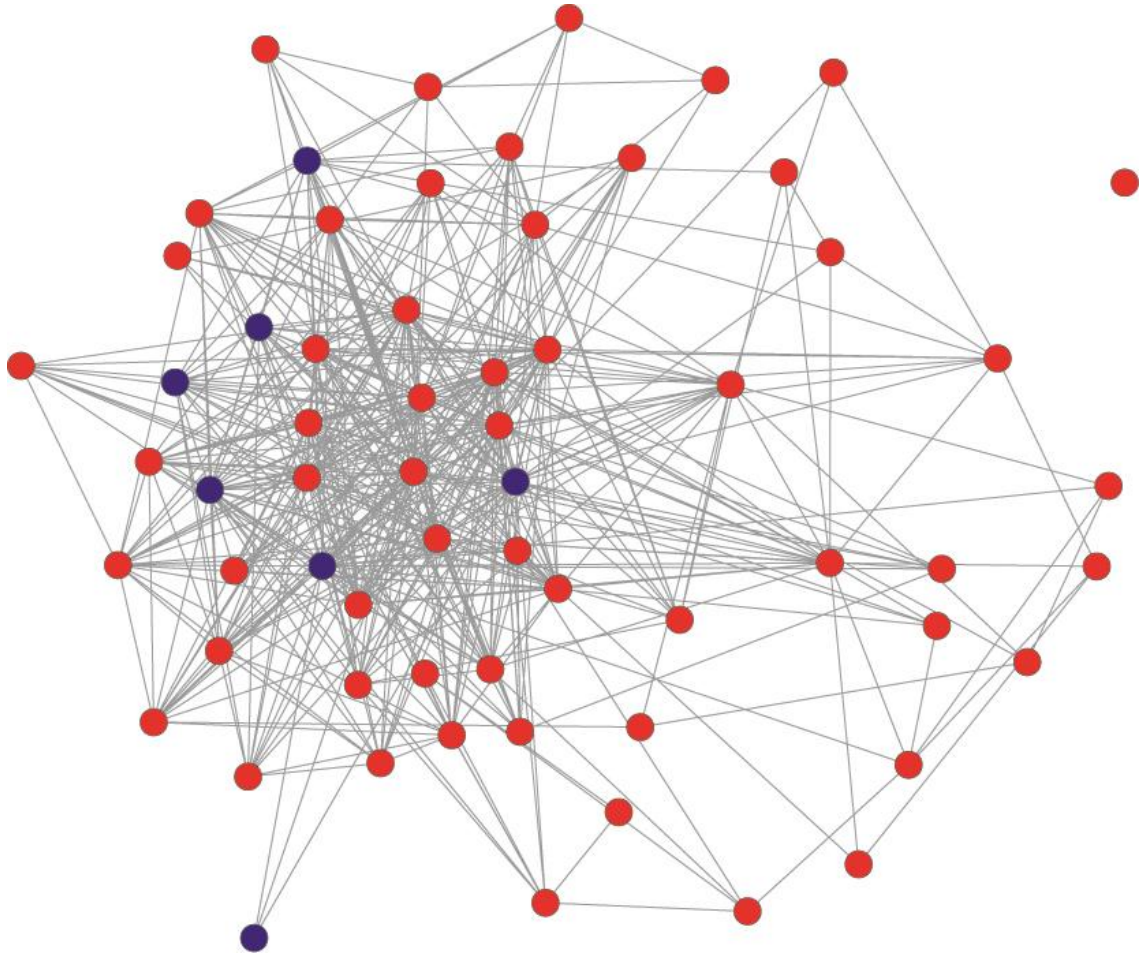
Bad spaghetti graph – Secondhand smoke citation network



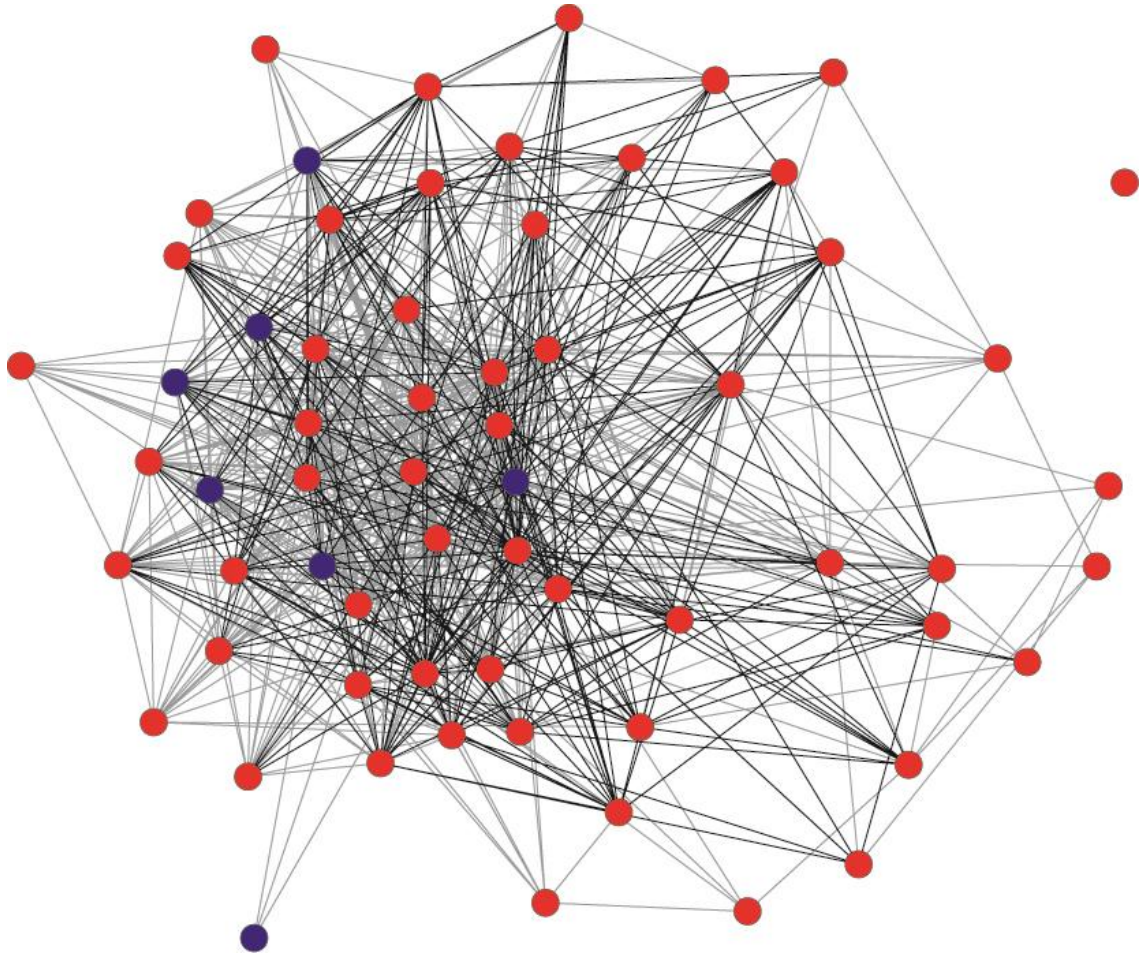


Clustering of obesity (yellow circles) in a social network
(Christakis & Fowler, 2007)

Tobacco Control Agency Knowledge – Pre-Institute



Tobacco Control Agency Knowledge – Post-Institute



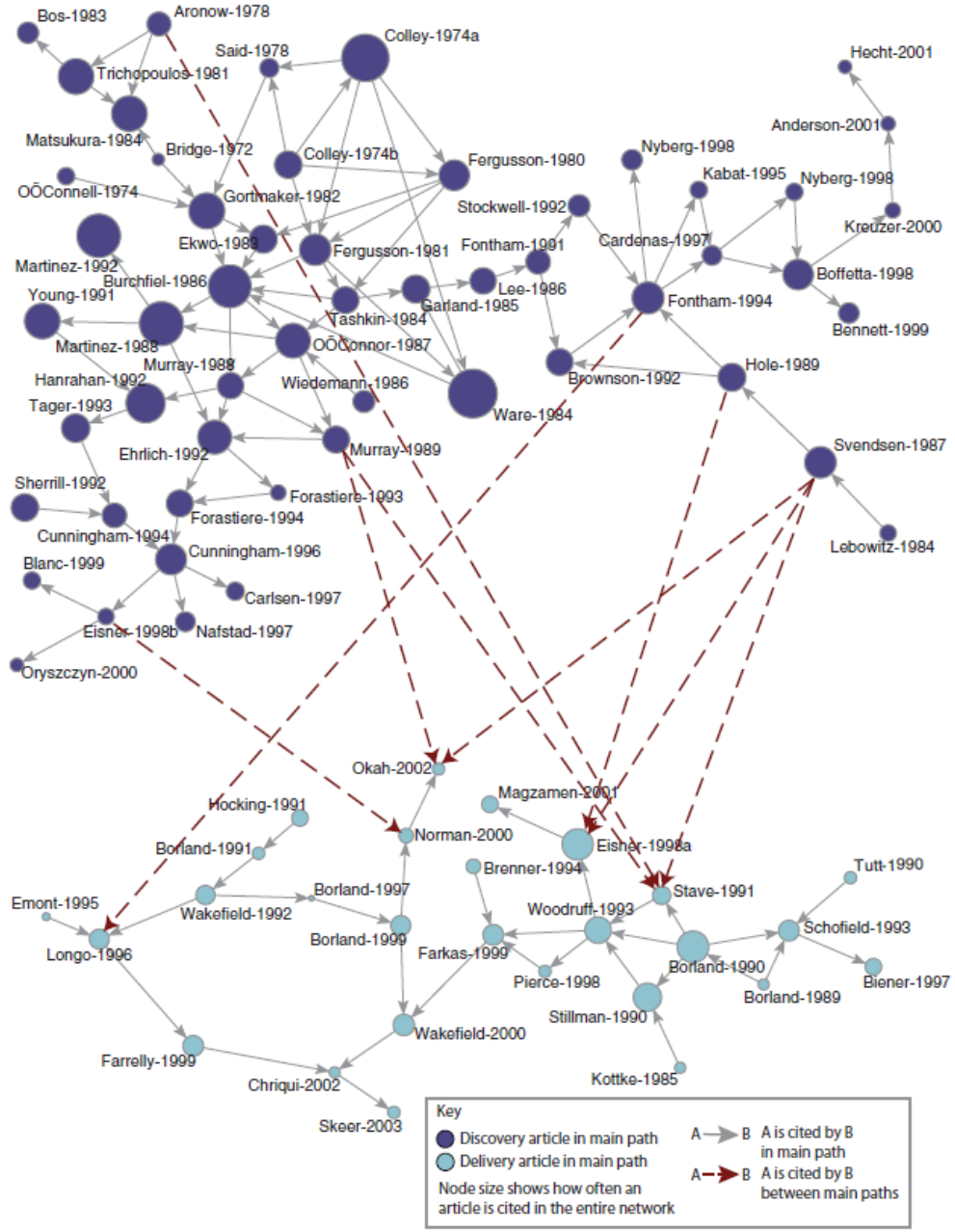
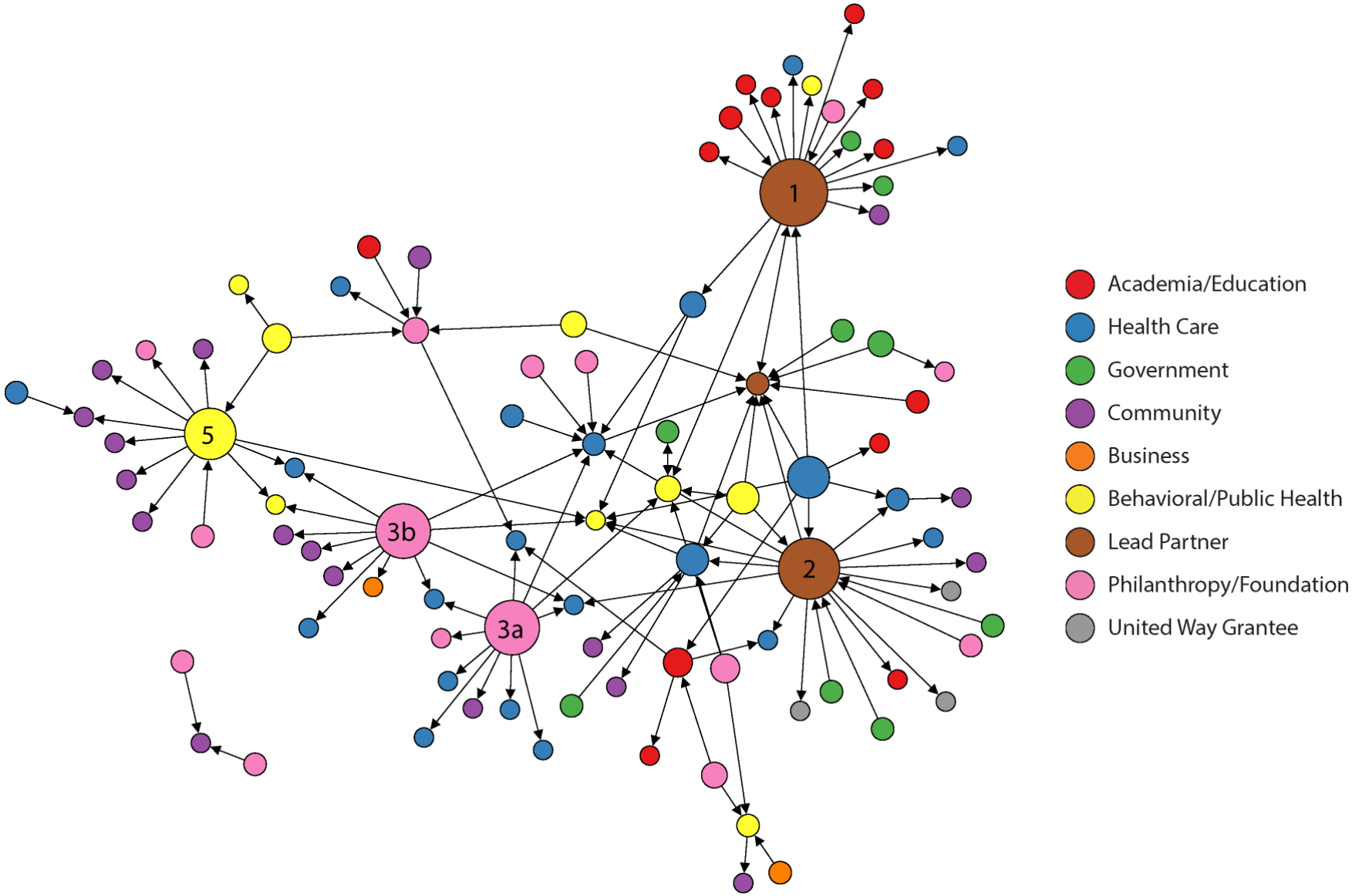


Figure 1. Main citation paths through discovery (top; n=54) and delivery (bottom; n=27) research articles related to SHS exposure, and citation links between the two paths; see Appendix C, available online at www.ajpm-online.net, for list of articles.


1
2
3a
3b
5
Academia/Education
Health Care
Government
Community
Business
Behavioral/Public Health
Lead Partner
Philanthropy/Foundation
United Way Grantee

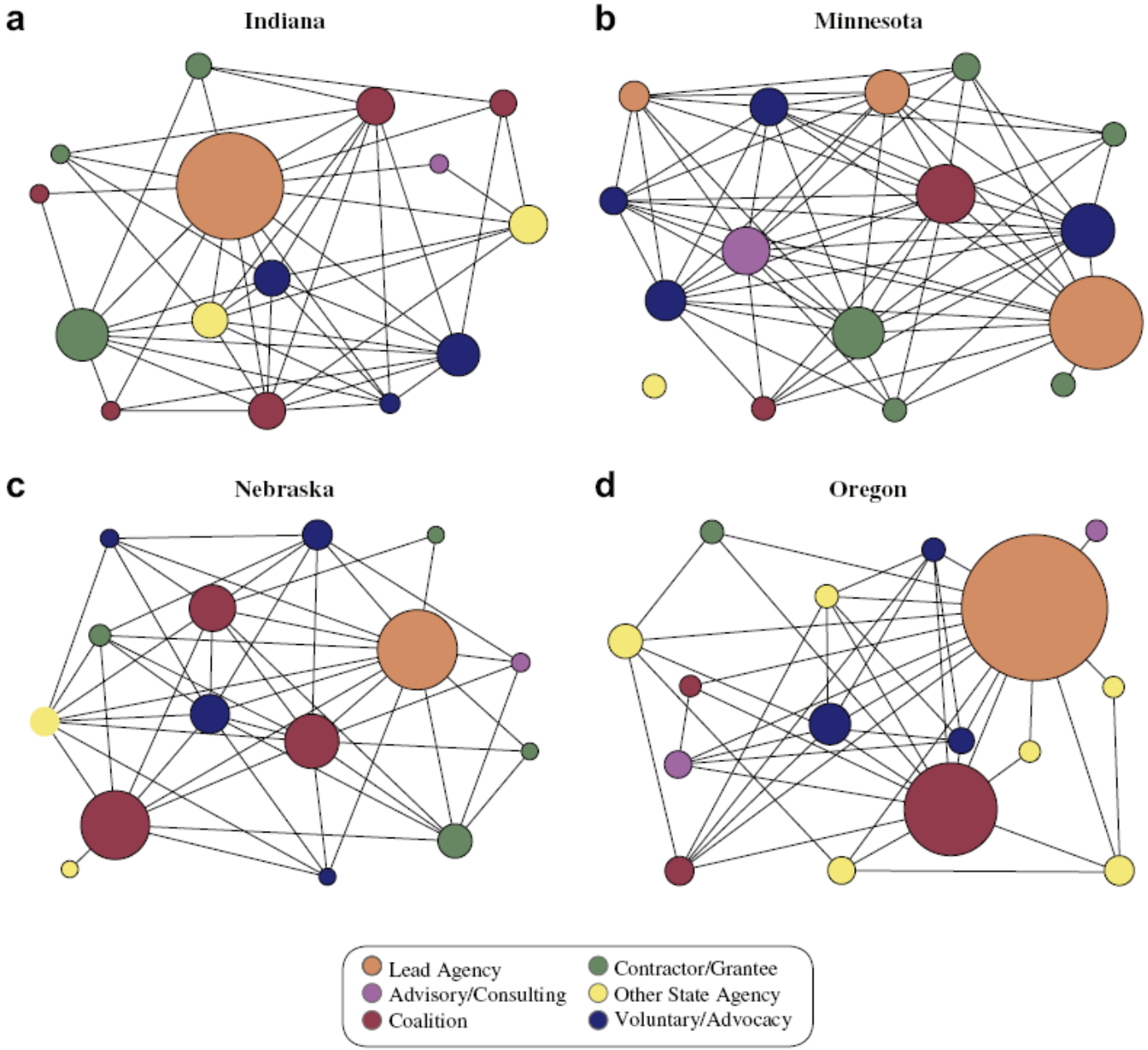
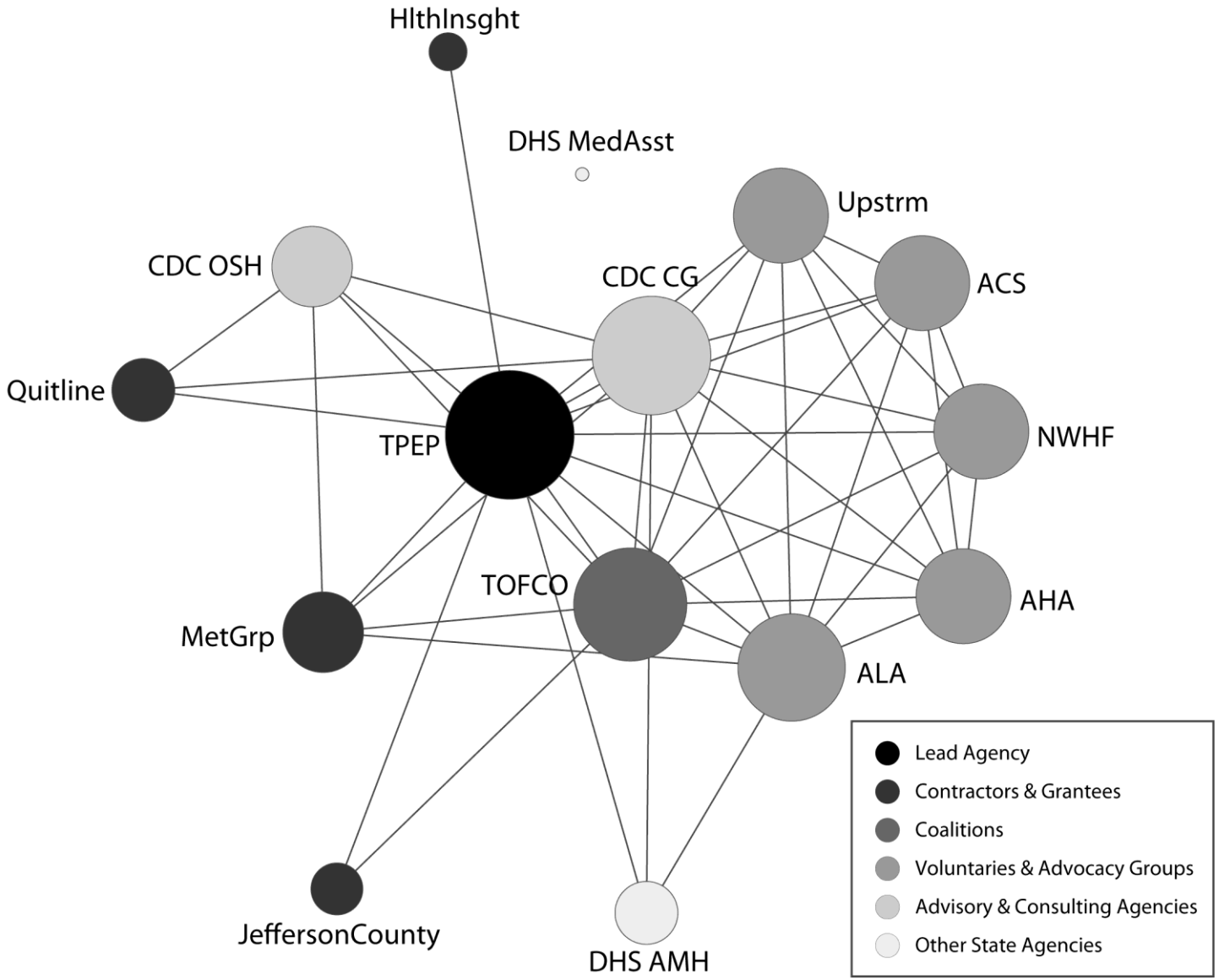
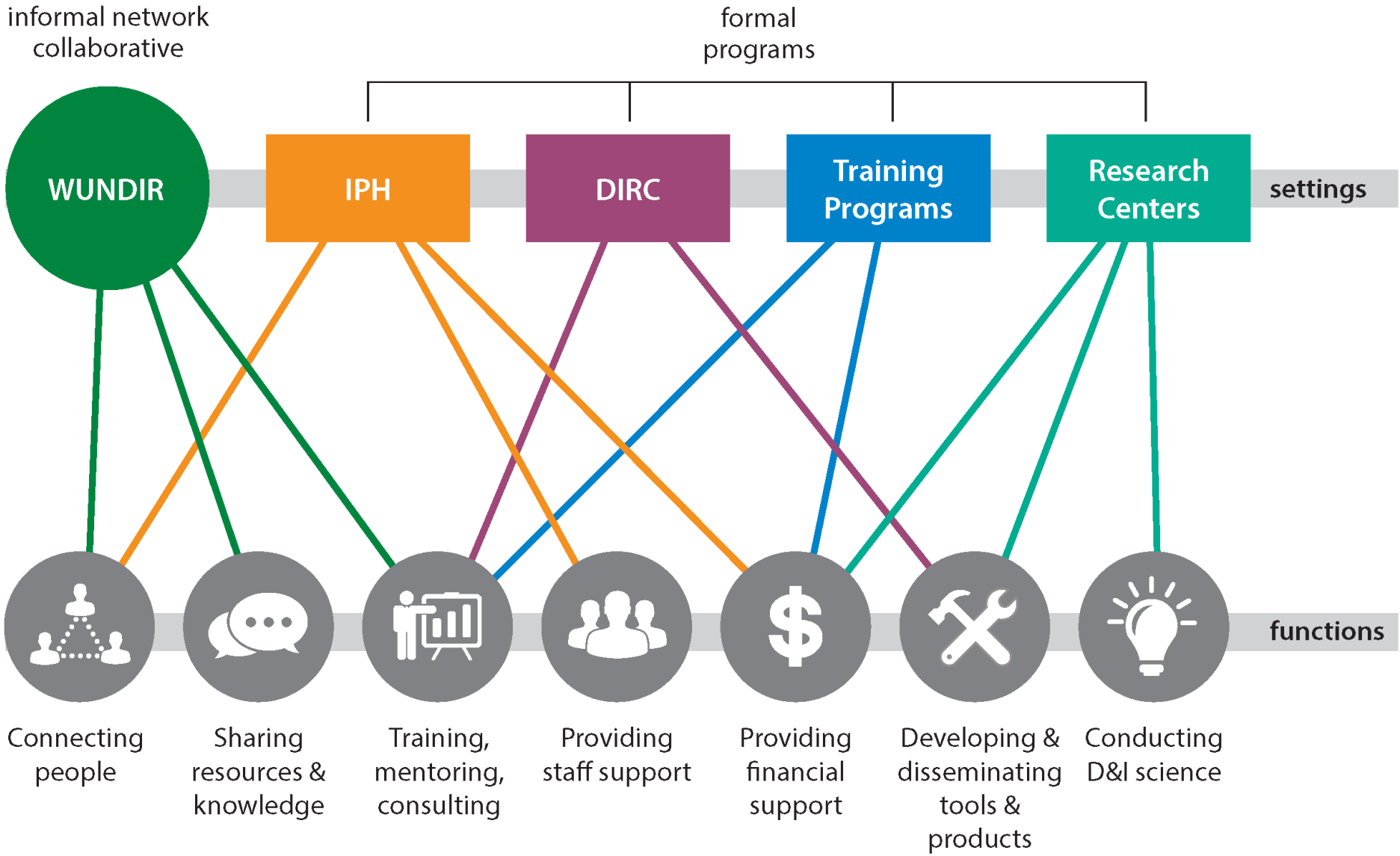


Fig. 1. Networks depicting contact frequency among key agencies in four state tobacco control programs.


HlthInsght
DHS MedAsst
Upstrm
CDC OSH
CDC CG
ACS
Quitline
TPEP
NWHF
TOFCO
AHA
MetGrp
ALA
JeffersonCounty
DHS AMH
Lead Agency
Contractors & Grantees
Coalitions
Voluntaries & Advocacy Groups
Advisory & Consulting Agencies
Other State Agencies


informal network collaborative
formal programs
WUNDIR
IPH
DIRC
Training Programs
Research Centers
settings
functions
Connecting people
Sharing resources & knowledge
Training, mentoring, consulting
Providing staff support
Providing financial support
Developing & disseminating tools & products
Conducting D&I science

Also see:

- Best online network visualization tutorial
  - https://kateto.net/network-visualization