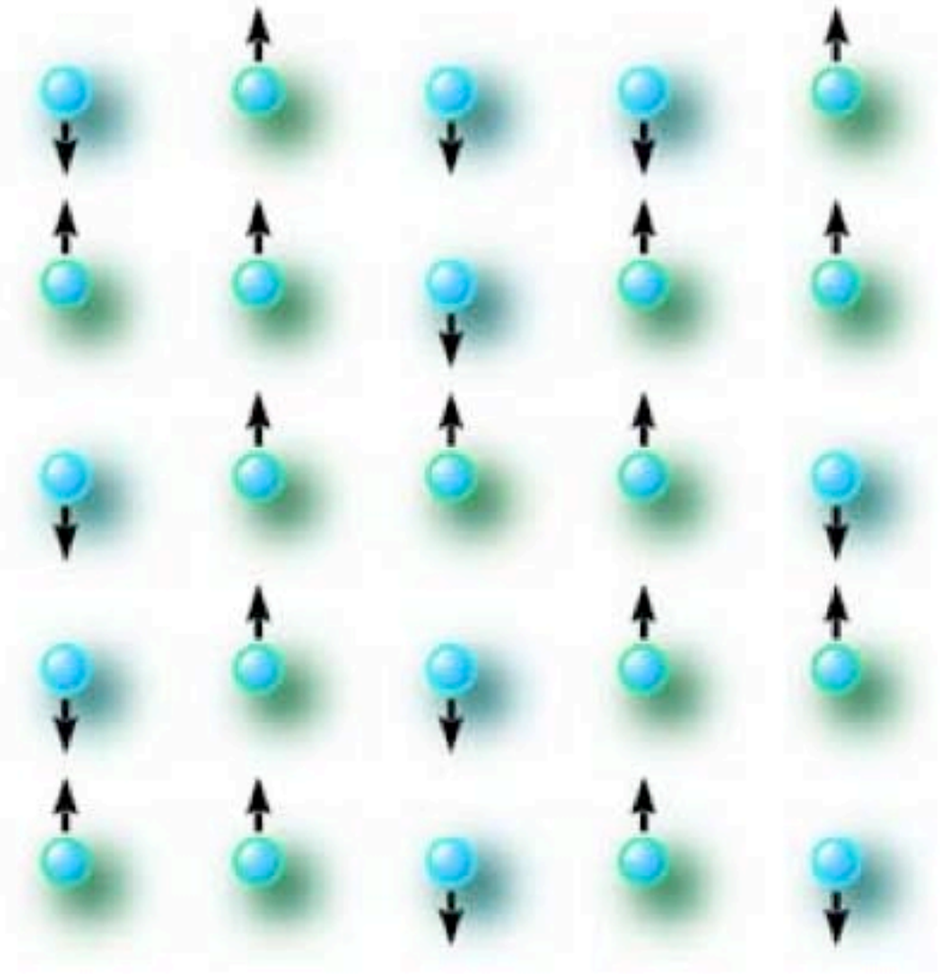
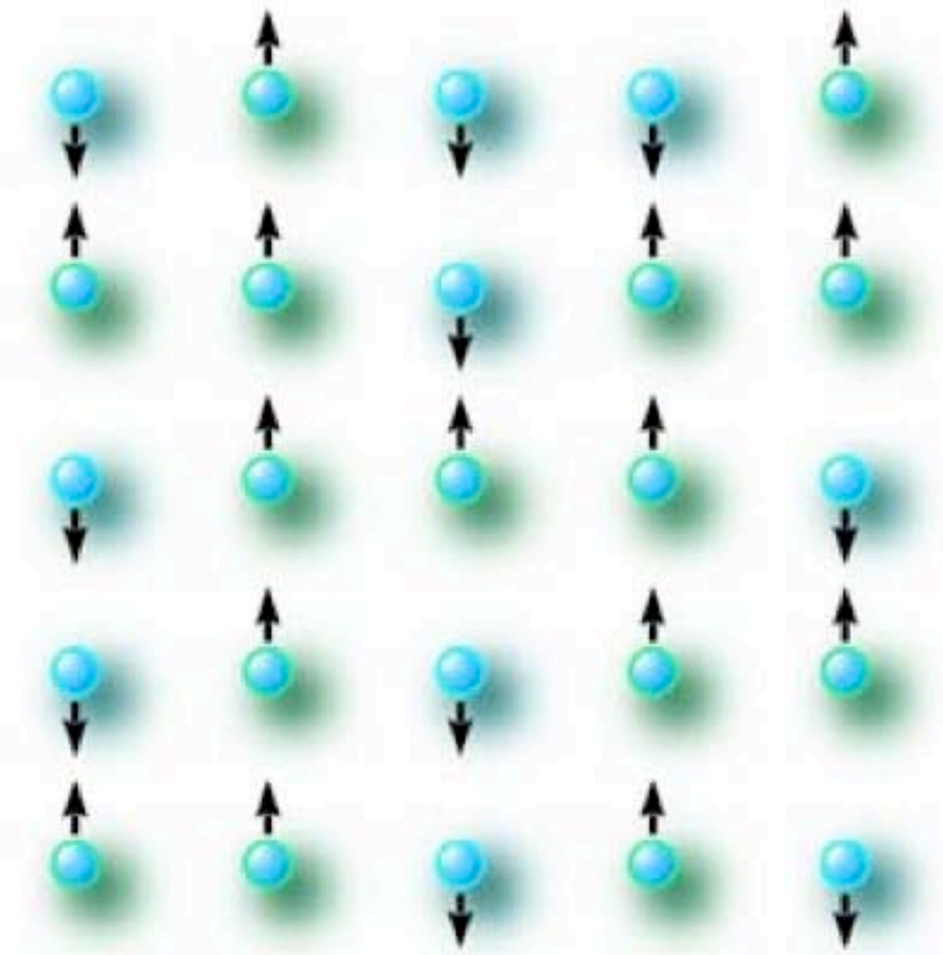
What is creativity?

Science is all about the flow of ideas

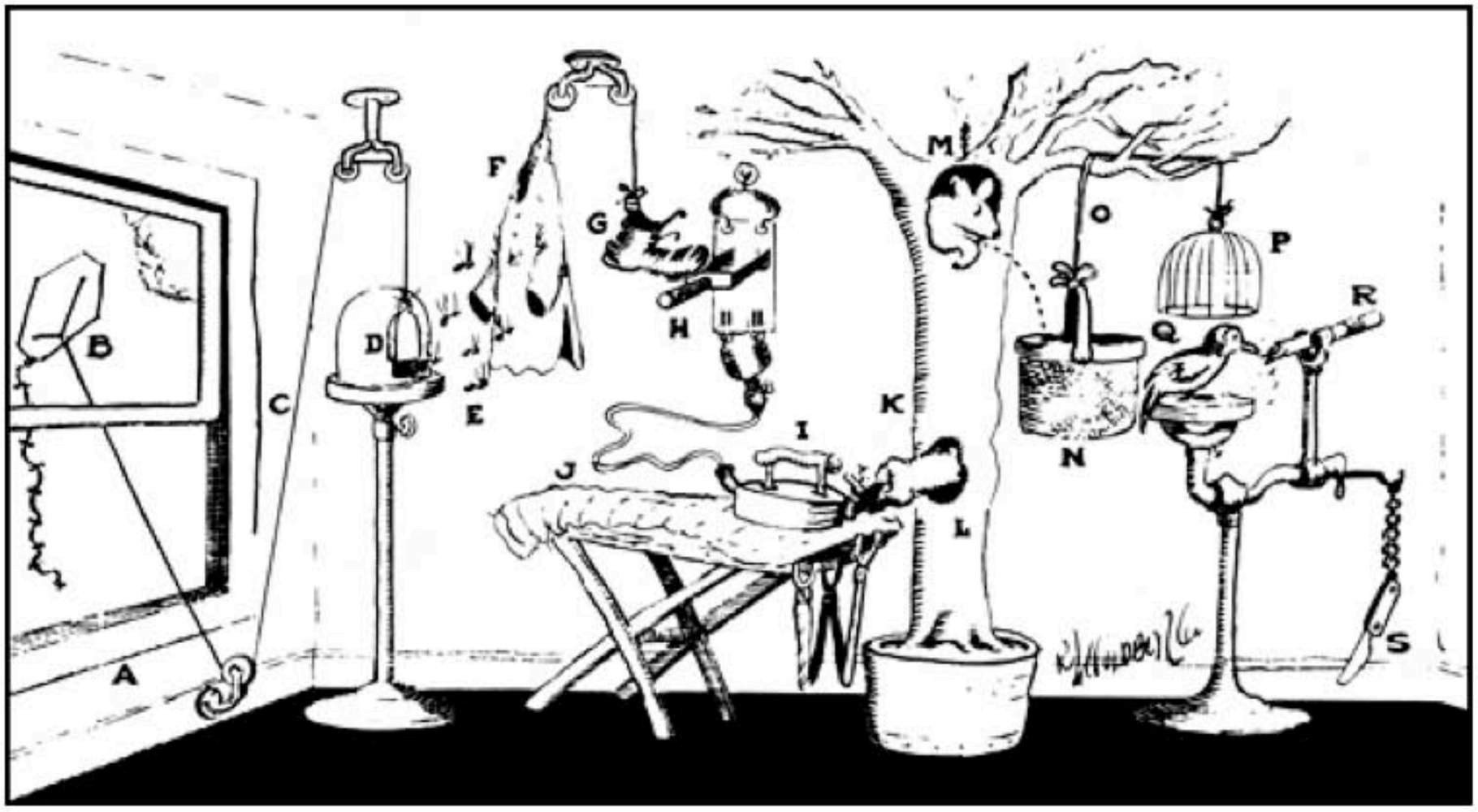
Interchangeable components





Regular structure

出所 : http://www.flickr.com/photos/victoriapeckham/164175205



Rube Goldberg, "A simplified pencil sharpener"

Pairwise

Sequential

Purposeful

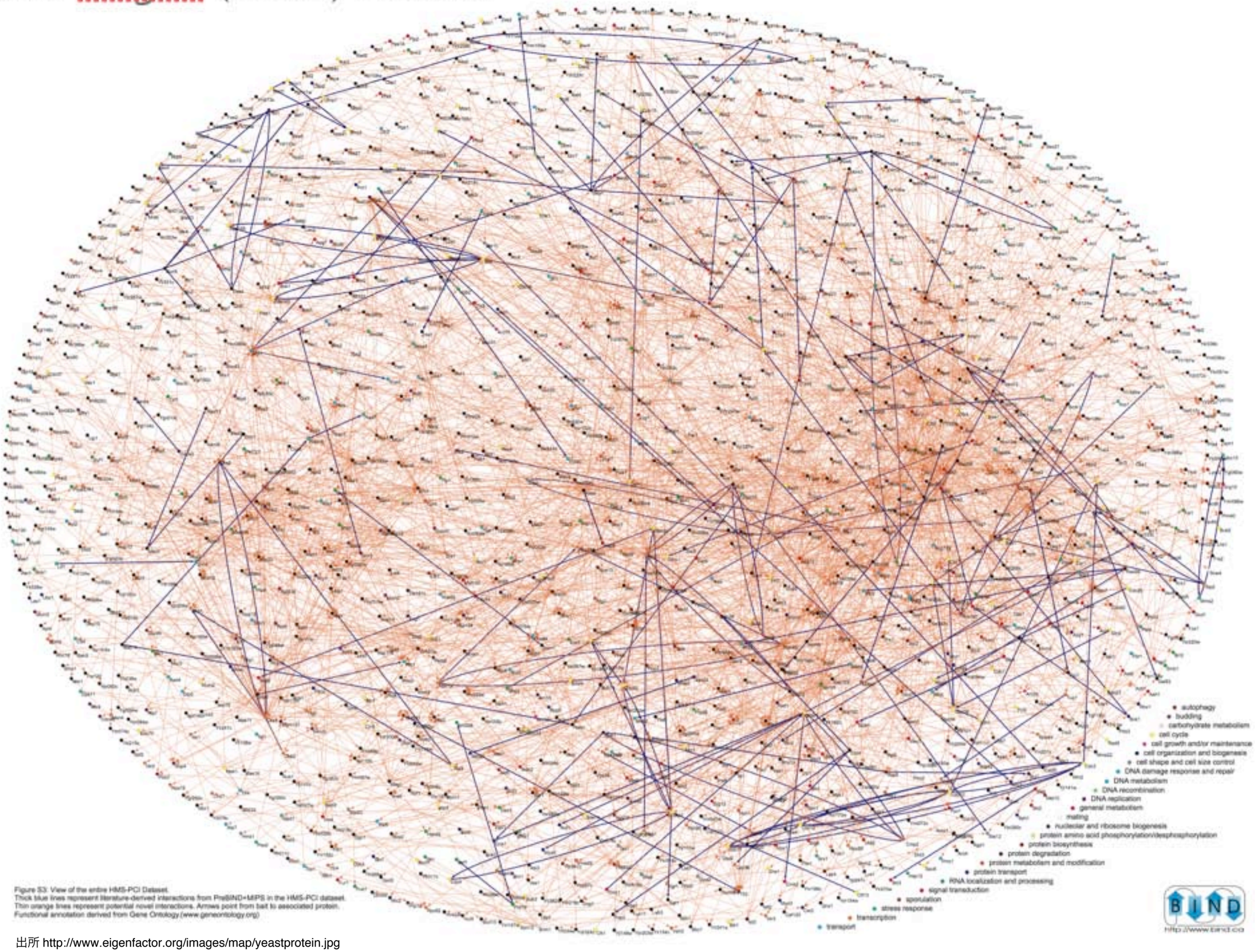
differentiated
multipartite
integrated
dynamic

出所 : http://www.flickr.com/photos/bbsc30/248132475/

Networks.

Yeast protein interaction network

Bader and Hogue (2002) Nature



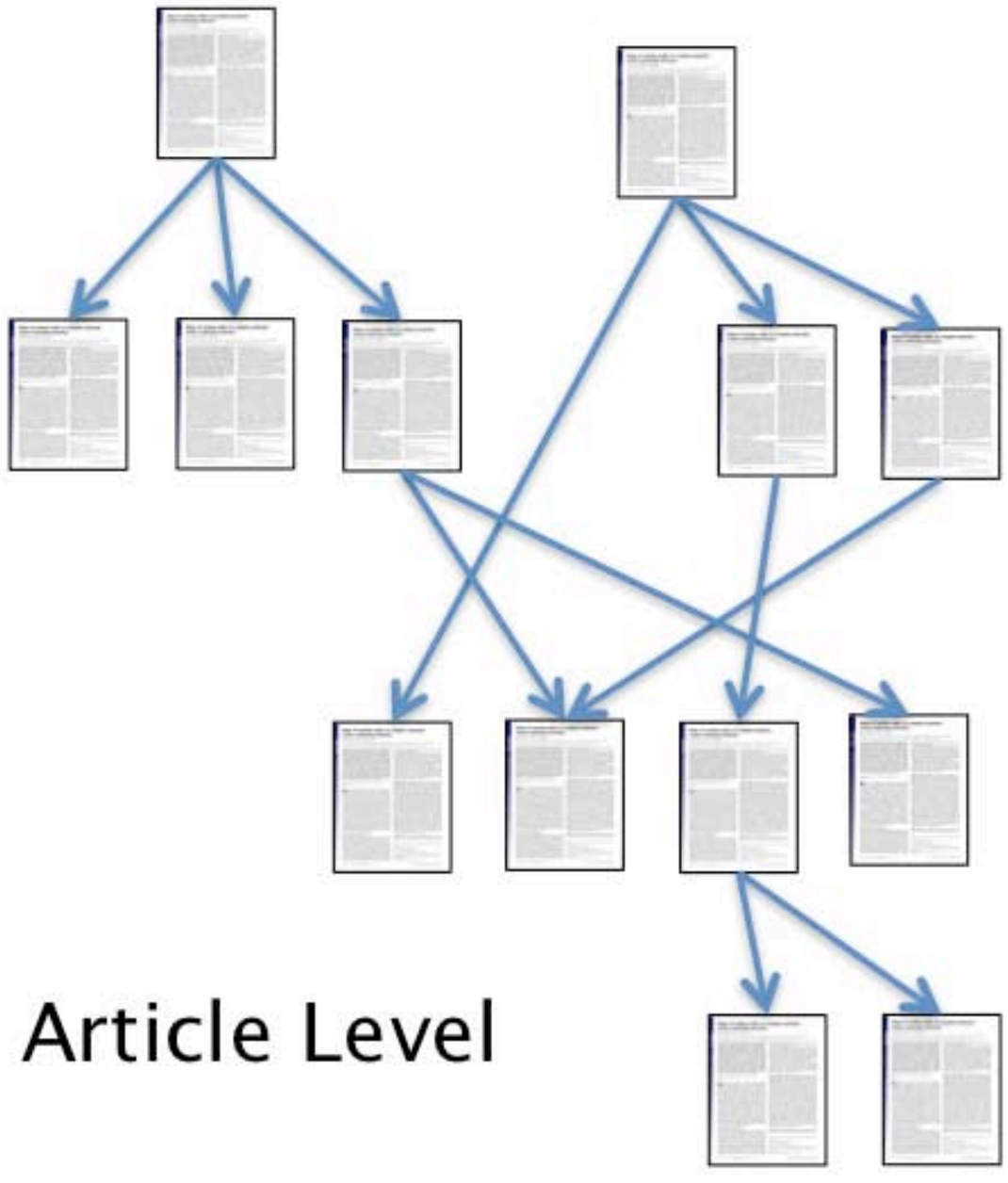
出所 http://www.eigenfactor.org/images/map/yeastprotein.jpg

出所：http://maps.google.com/

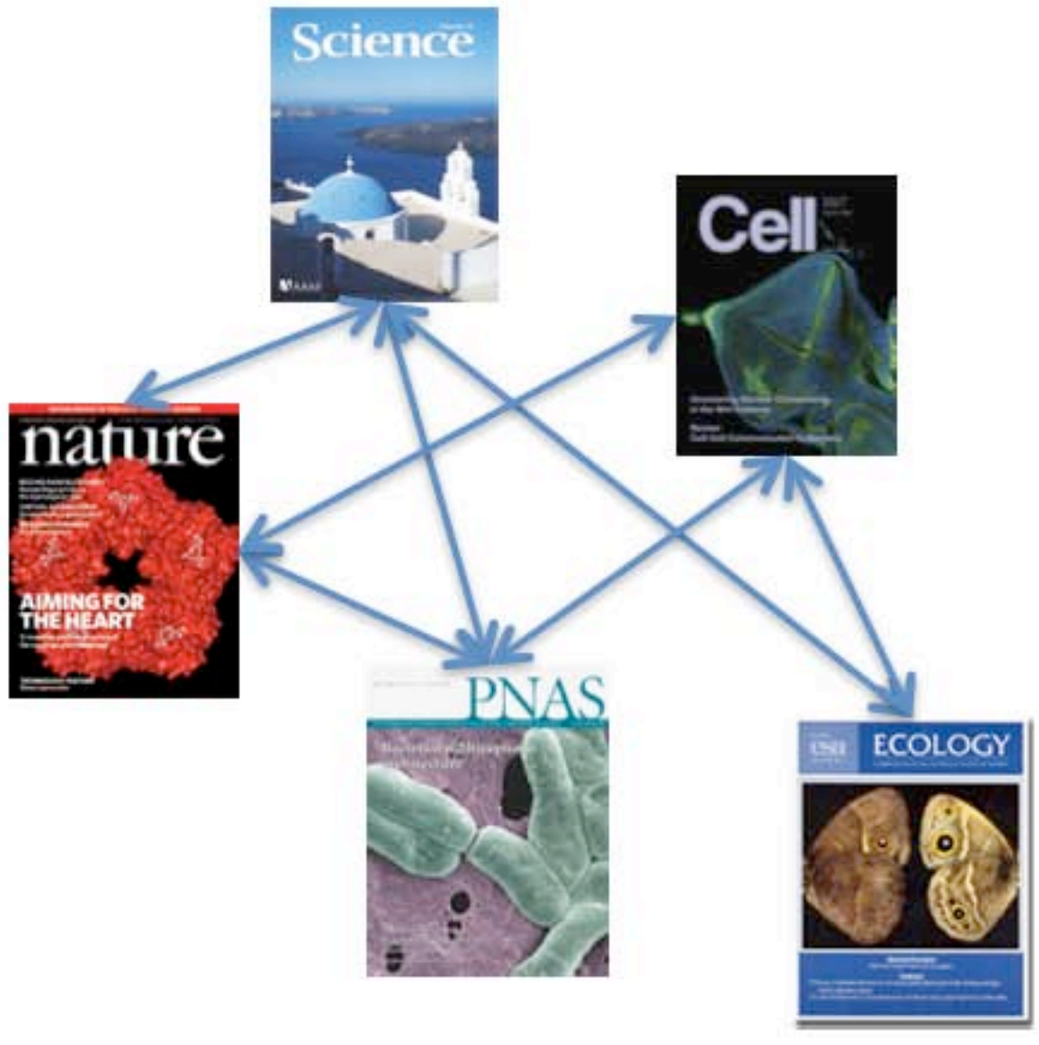
ALEWIFE
DAVIS
PORTER
HARVARD
CENTRAL
KENDALL
CHARLES
OAK GROVE
MALDEN CENTER
WELLINGTON
SULLIVAN SQUARE
COMMUNITY COLLEGE
NORTH STATION
HAYMARKET
PARK STREET
WASHINGTON
SOUTH STATION
BROADWAY
ANDREW
NORTH QUINCY
WOLLASTON
QUINCY CENTER
QUINCY ADAMS
BRAINTREE
LECHMERE
SCIENCE PARK
NORTH STATION
HAYMARKET
BOWDOIN
GOVERNMENT CTR
STATE
ESSEX
DOVER
NORTHAMPTON
DUDLEY
EGLESTON
GREEN
FOREST HILLS
WONDERLAND
REVERE BEACH
BEACHMONT
SUFFOLK DOWNS
ORIENT HEIGHTS
WOOD ISLAND
AIRPORT
MAVERICK
AQUARIUM
COLUMBIA
SAVIN HILL
FIELDS CORNER
SHAWMUT
ASHMONT
MATTAPAN
BOYLSTON
ARLINGTON
COPLEY
AUDITORIUM
KENMORE
PRUDENTIAL
SYMPHONY
NORTHEASTERN
BRIGHAM CIRCLE
HEATH
ARBORWAY
E
RESERVOIR
BOSTON COLLEGE
B
CLEVELAND CIRCLE
C
RIVERSIDE
D

simplify

Citation Networks



Article Level



Journal Level

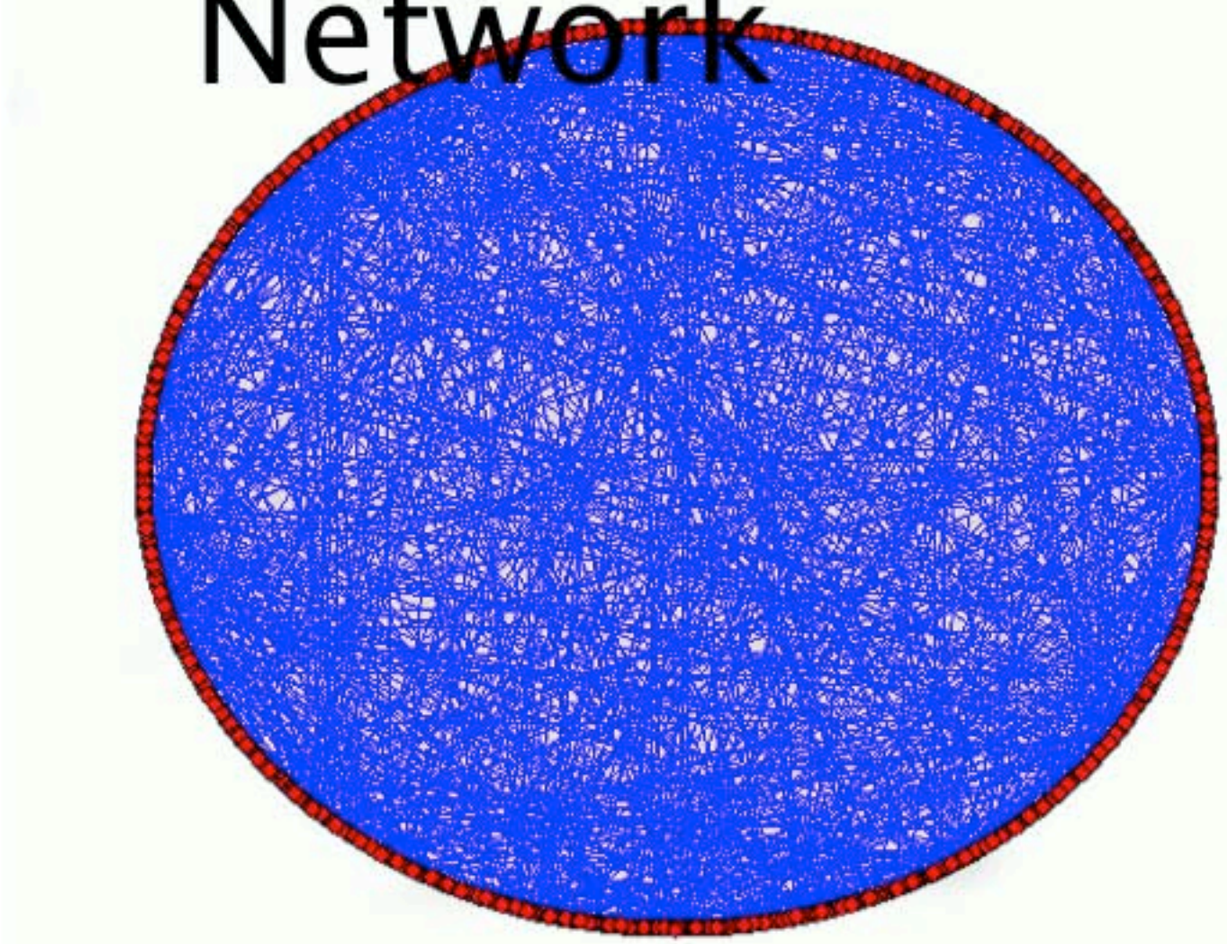
出所 http://www.nature.com/
http://www.cell.com/
http://www.sciencemag.org/
http://www.pnas.org/
http://esapubs.org/

Thomson Scientific Journal Citation Reports 2004

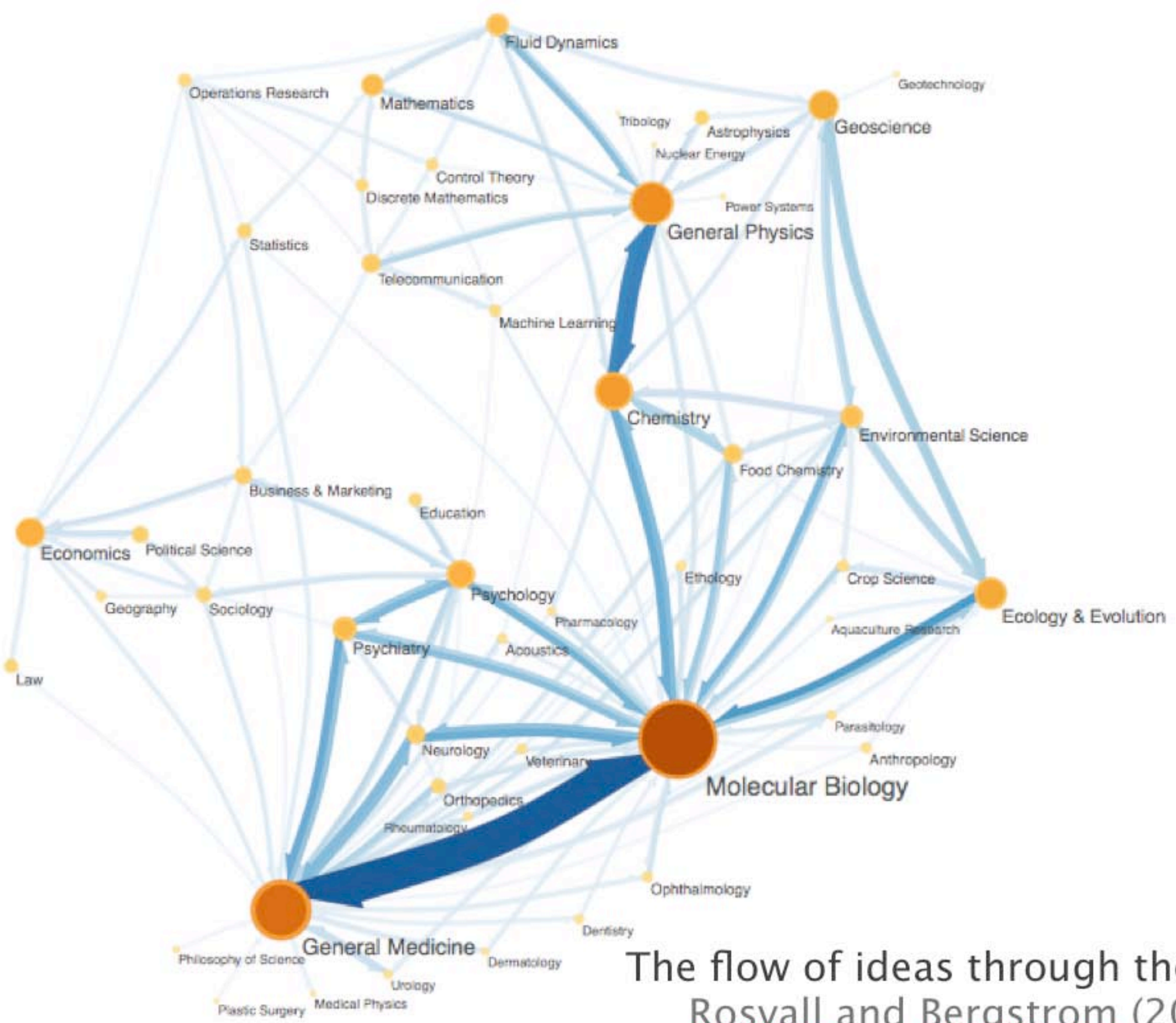
~ 7,000 journals

> 6,000,000 citations

Citation Network

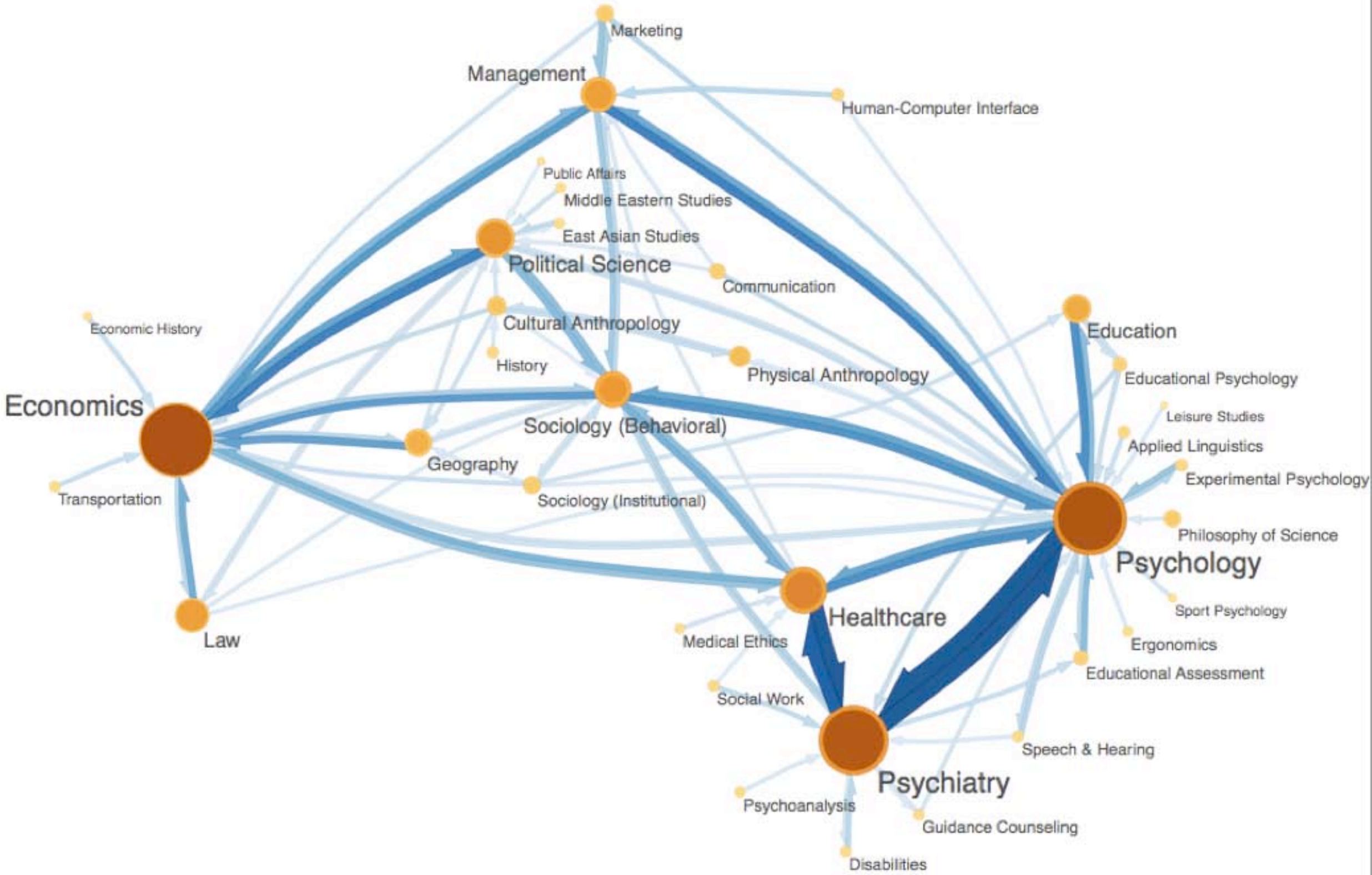


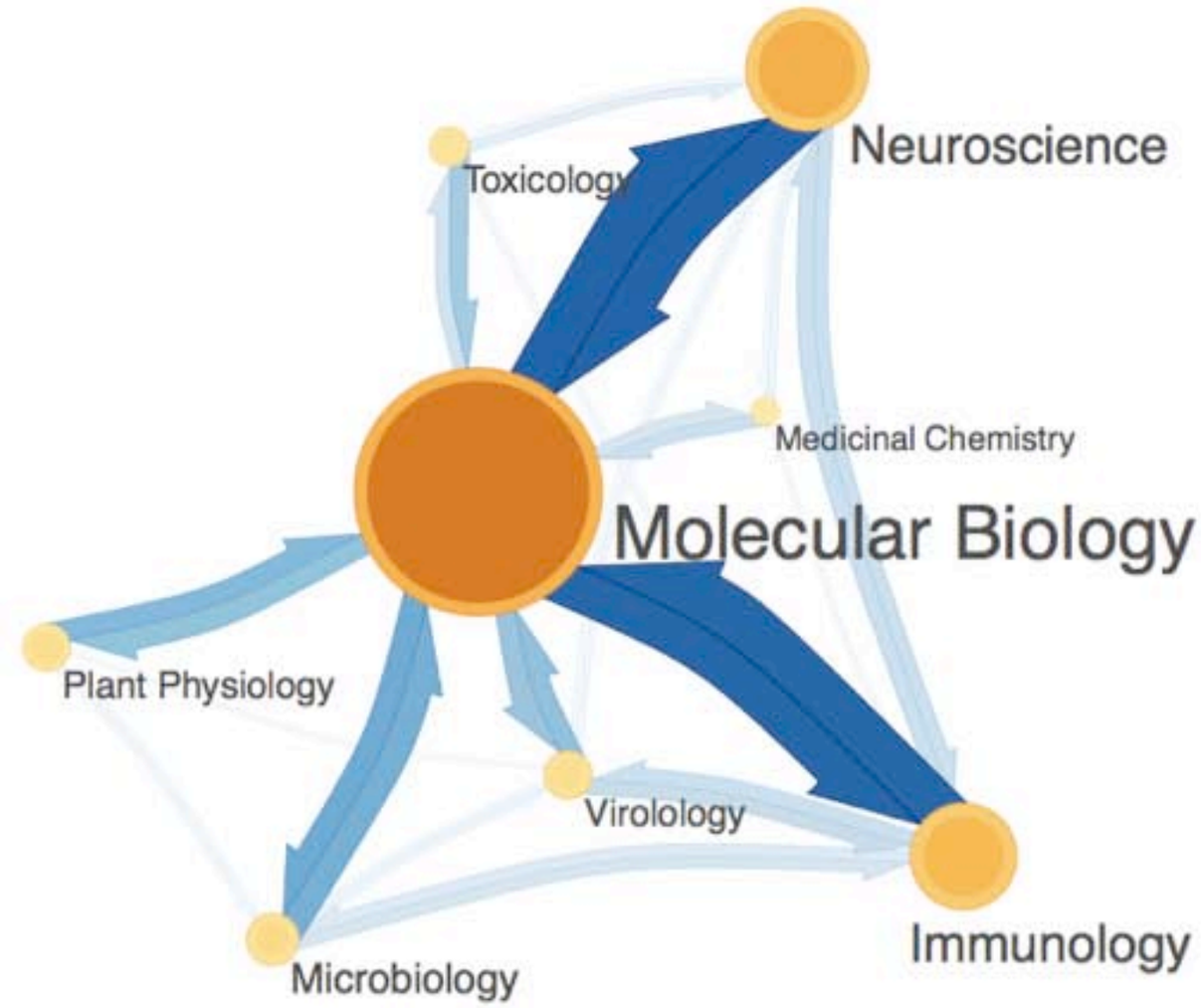
$$L(M) = q_{\curvearrowright} H(Q) + \sum_{i=1}^{m} p^{i}_{\circlearrowright} H(P^{i}).$$



The flow of ideas through the sciences

Rosvall and Bergstrom (2007) PNAS


Marketing
Management
Human-Computer Interface
Public Affairs
Middle Eastern Studies
East Asian Studies
Political Science
Communication
Economic History
Cultural Anthropology
History
Physical Anthropology
Education
Economics
Sociology (Behavioral)
Educational Psychology
Leisure Studies
Applied Linguistics
Geography
Experimental Psychology
Transportation
Sociology (Institutional)
Philosophy of Science
Psychology
Sport Psychology
Healthcare
Medical Ethics
Ergonomics
Educational Assessment
Law
Social Work
Speech & Hearing
Psychiatry
Psychoanalysis
Guidance Counseling
Disabilities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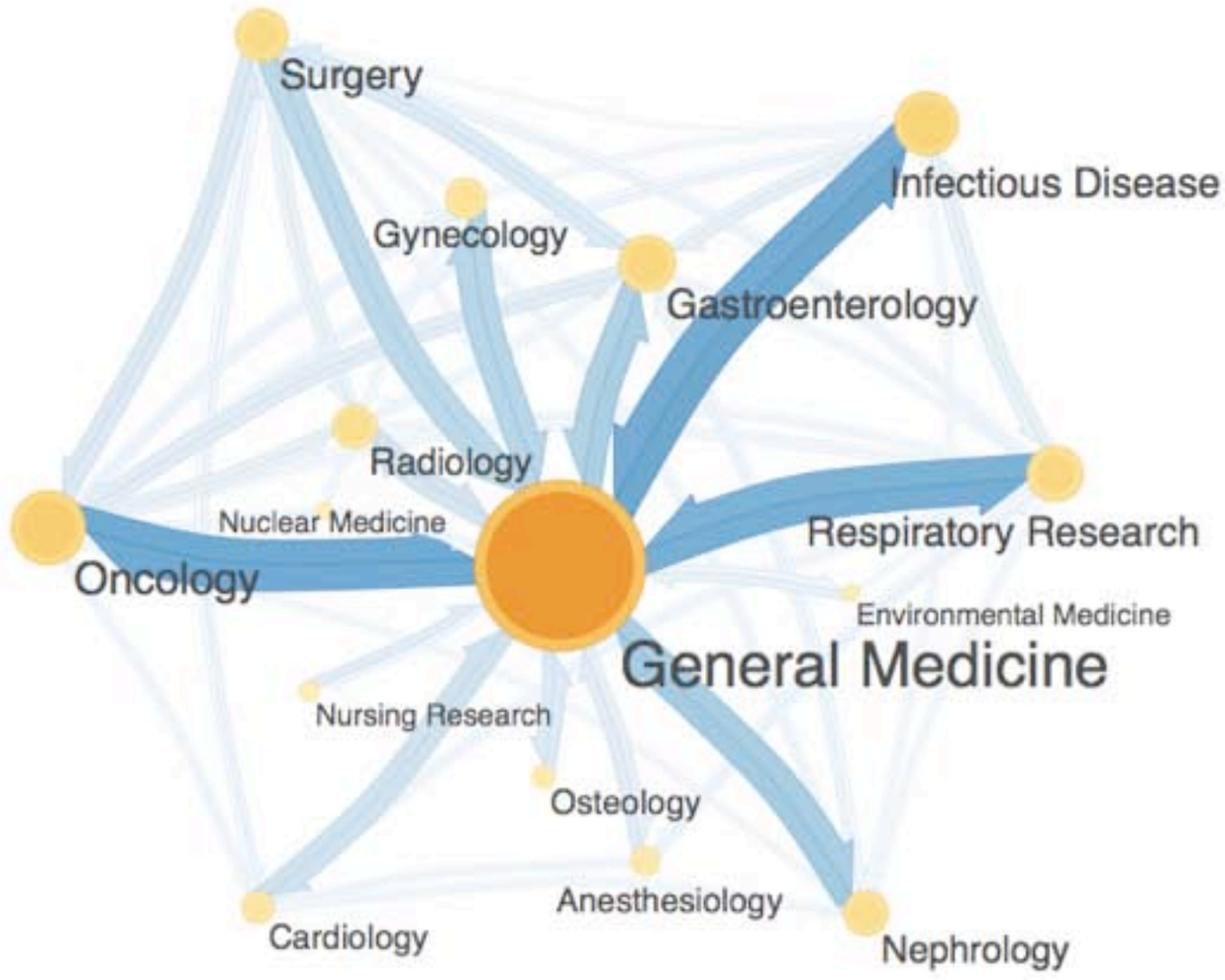
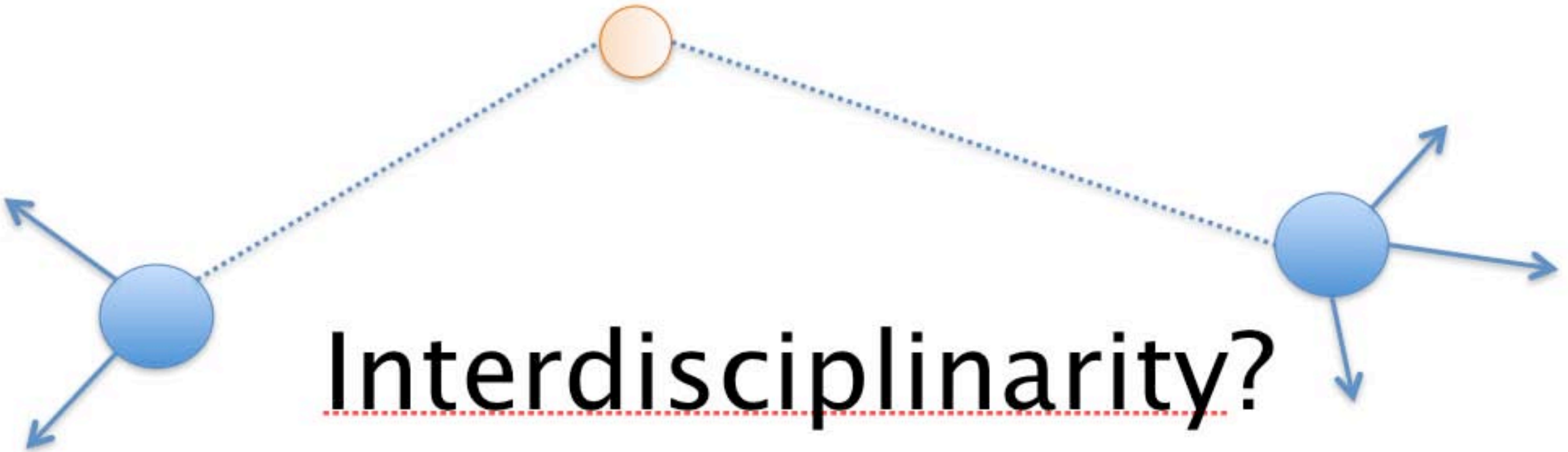
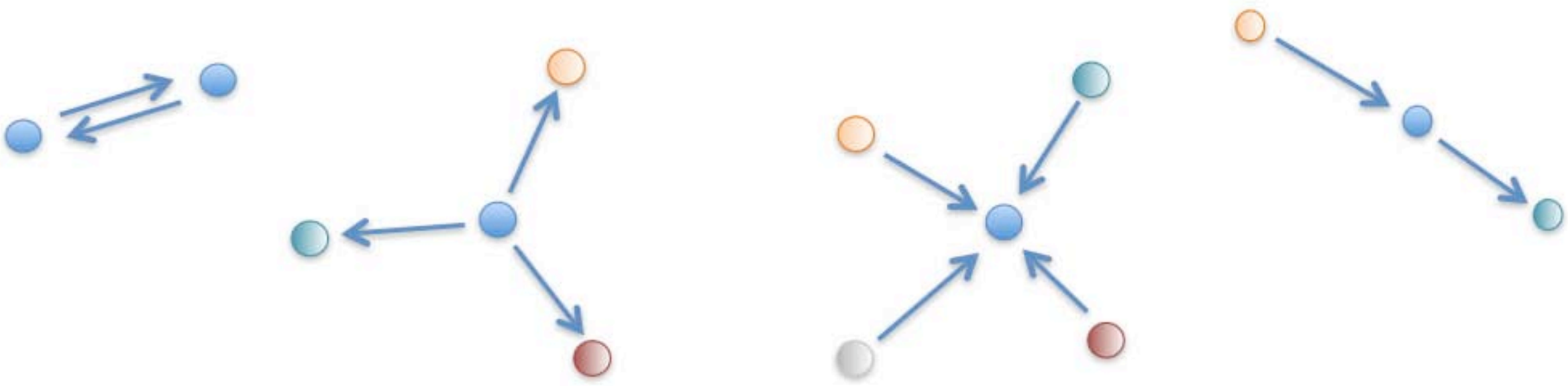
Toxicology
Medicinal Chemistry
Molecular Biology
Plant Physiology
Virolology
Immunology
Microbiology

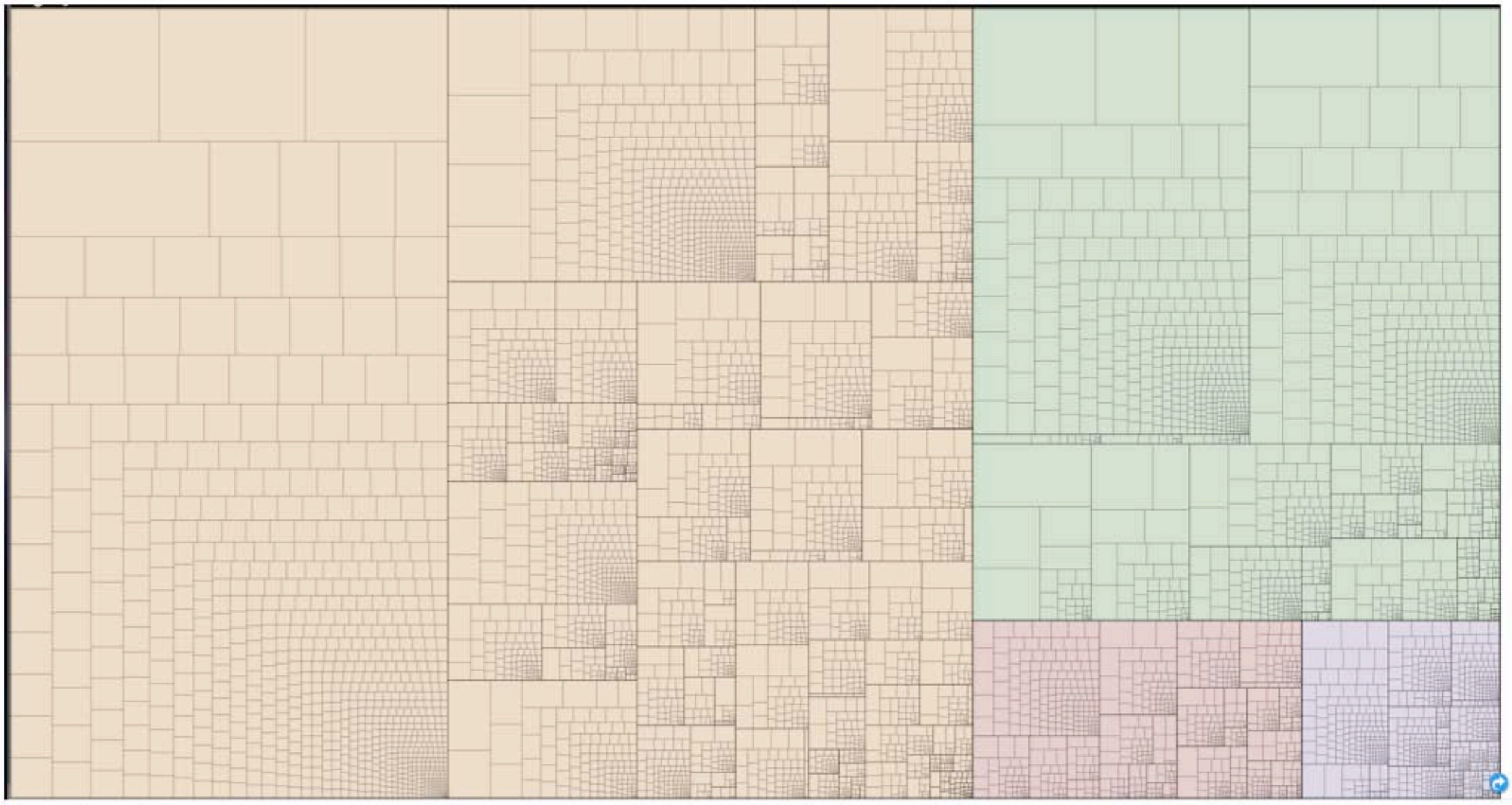

Surgery
Infectious Disease
Gynecology
Gastroenterology
Radiology
Nuclear Medicine
Respiratory Research
Oncology
Environmental Medicine
General Medicine
Nursing Research
Osteology
Anesthesiology
Cardiology
Nephrology

Science Browser
Chemistry
Corrosion
Wood Products
Energy
Environmental Science
Pharmacology & Biomaterials
Chemistry
Fluid Dynamics
Molecular Biology
Geoscience
Food Chemistry
General Medicine
General Physics
Field name
Chemistry
Field size
342 journals and
6.0 percent of all traffic
Highest traffic
1. J Am Chem Soc
2. J Chem Phys
3. J Phys Chem B
4. Angew Chem Int Edit
5. Langmuir
6. Macromolecules
7. Chem Commun
8. Chem Phys Lett
9. J Phys Chem A
10. J Org Chem
based on Moritz Stefaner's Relation Browser



Interdisciplinarity?





Moritz (2008)

Summary

- Scholarly literature forms a vast network
- Develop tools to mine the wealth of information in this network (e.g., mapping–simplifying and highlighting the important structures)
- Ask questions (e.g., Where are the epicenters of creativity in science? Has science developed an institution

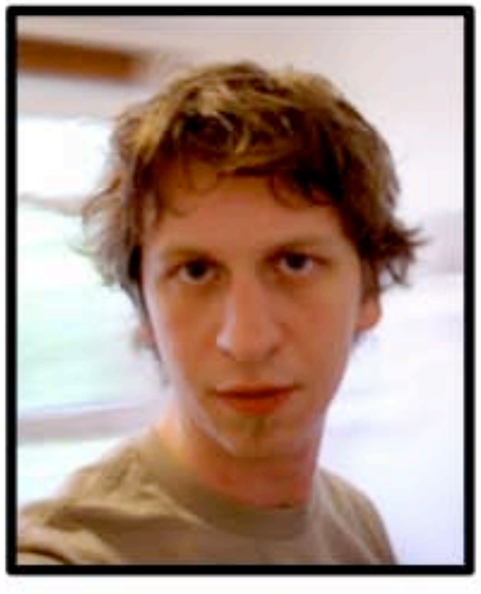
eigenFACTOR.org

RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

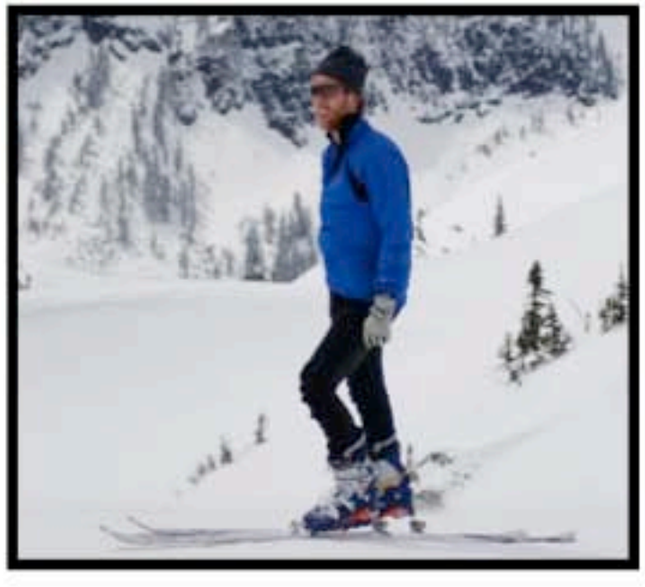
Carl
Bergstrom

Ted
Bergstrom

Ben
Althouse



Moritz
Stefaner



Martin
Rosvall