

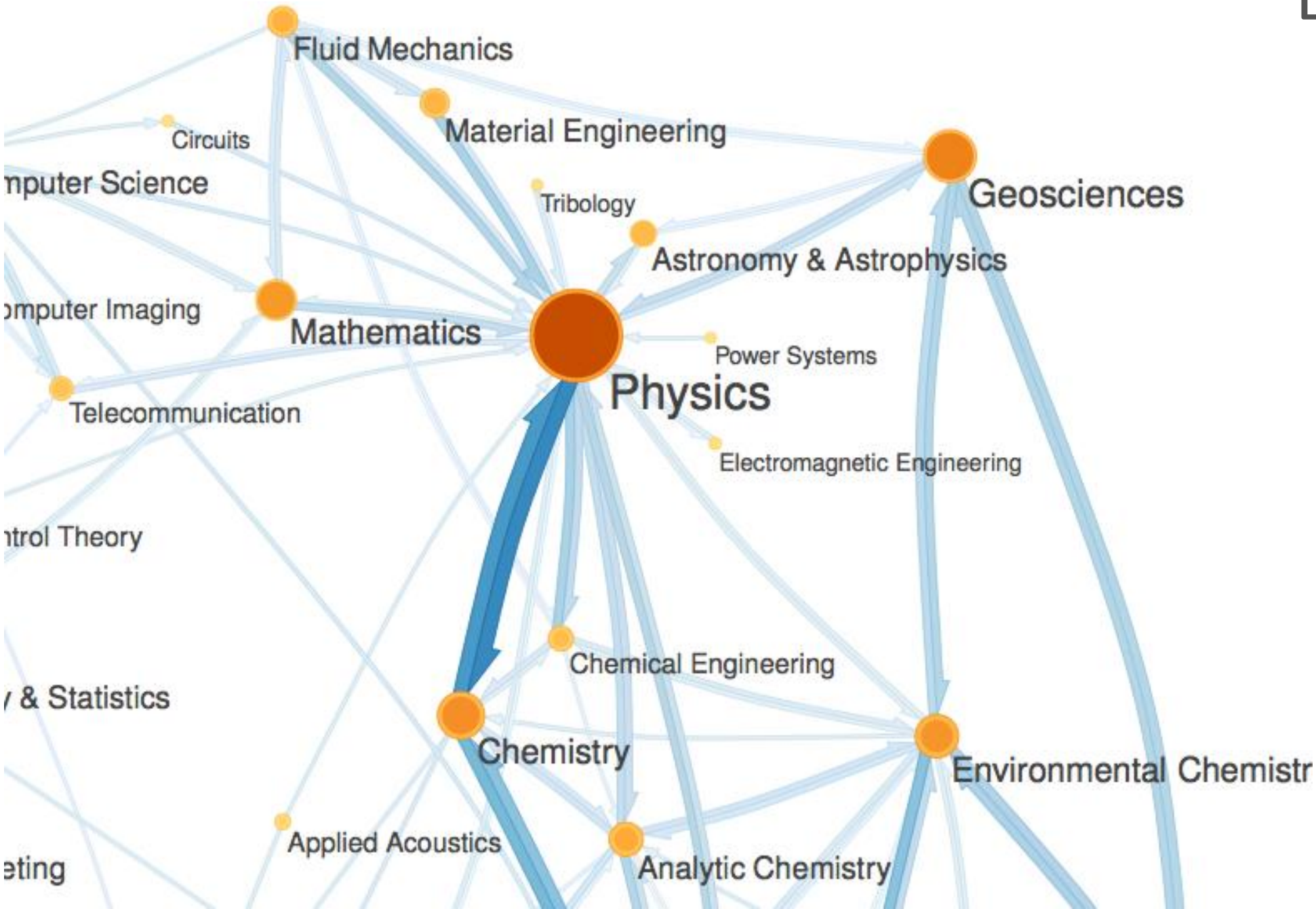
Microsoft® Research

Faculty Summit

10
YEAR ANNIVERSARY

The Eigenfactor Project

Exploring the network structure of science



Carl T. Bergstrom
Univ. Washington

Ranking

Mapping

Discovering

1927



Not enough money.

Which journals should we buy?

Count citations

1955



Impact factor

Cites in 2008 to articles in 2007 or 2006

Articles published in 2007 and 2006

2009

Impact factor drives...



Hiring decisions



Library subscriptions



Promotion and tenure



Ad placement

Research funding



rae2008
Research Assessment Exercise

University Rankings



And as a result...

Scientists obsess.

Editors *scheme*.

Publishers negotiate.

Journals pander.

Librarians fret.

Administrators nag.

Everyone suffers.

Impact factor
was supposed to serve
science

But scientists
end up serving
impact factor



How can we better evaluate
the scholarly literature?

Read it.

Who has time for that?

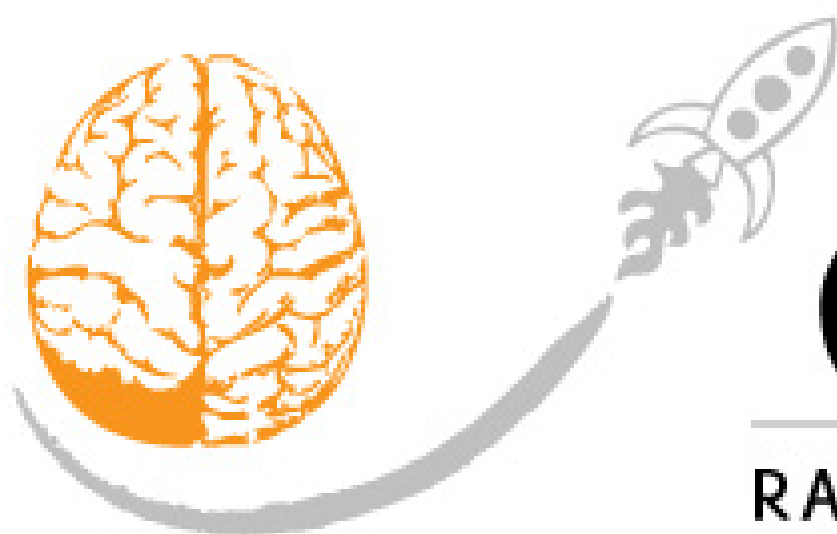
A legitimate need for
quantitative measures

“What is the value of
a full volume of *Science*?”

“How often do biologists cite
economics papers?”

“Which publishers provide the best value per dollar?”

“Which publishers provide the best value per dollar?”



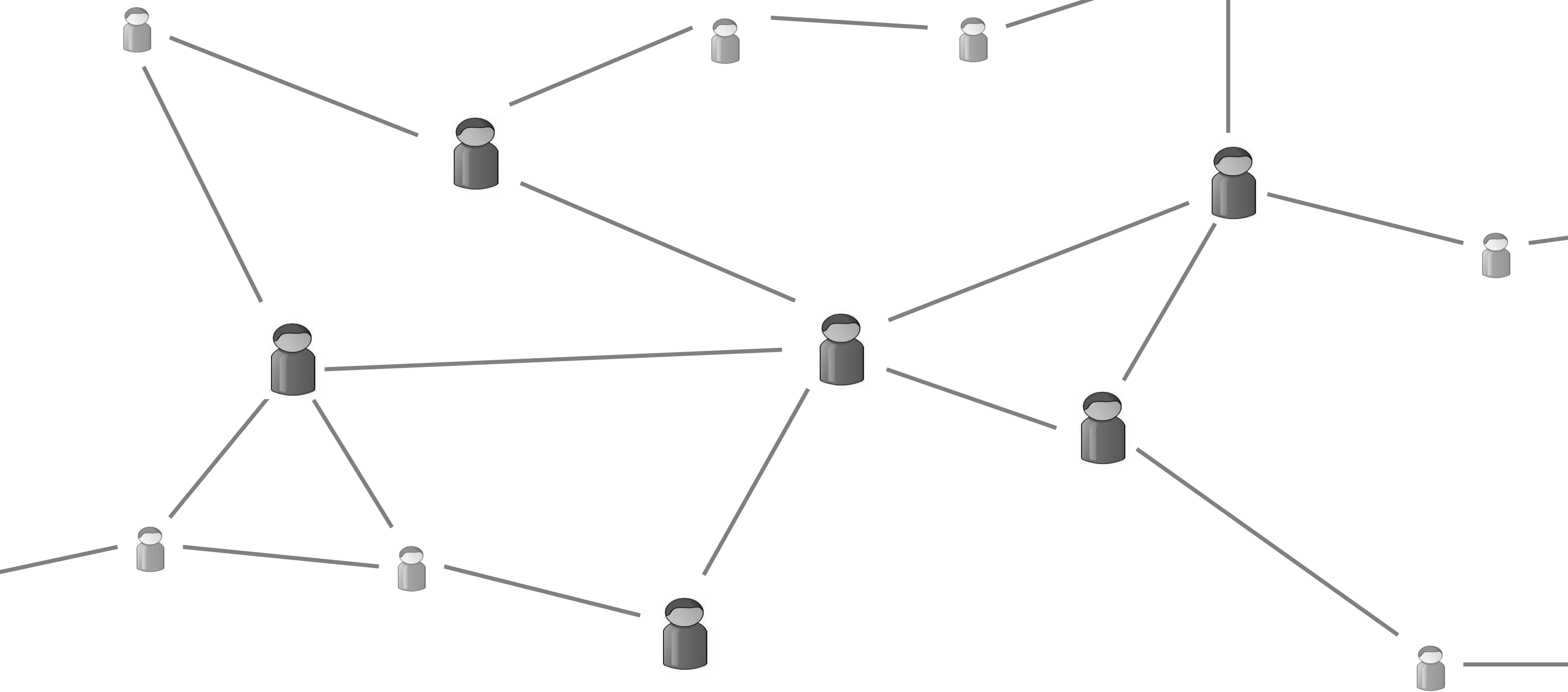
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RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

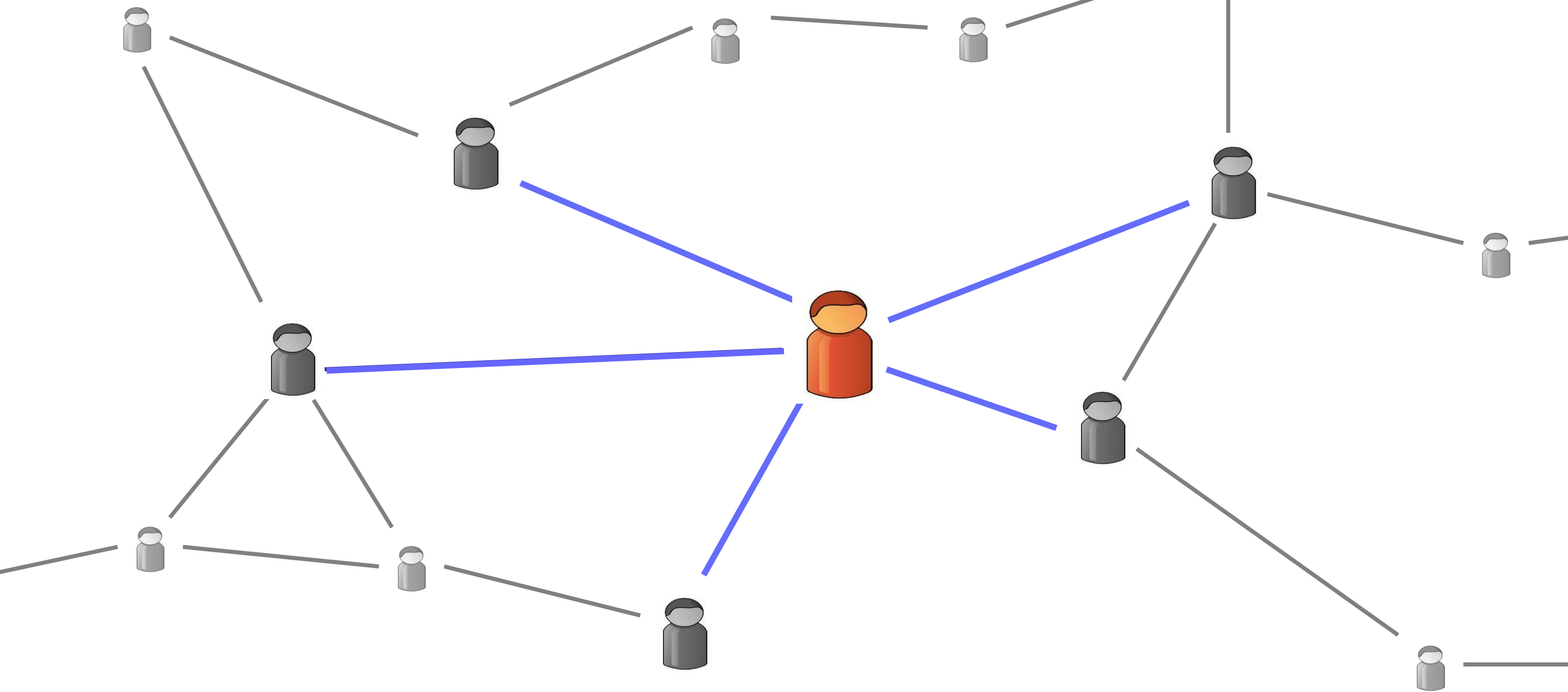
Scholarship is all about
the flow of ideas

Networks are all about
the **flow** of information

Eigenvector centrality

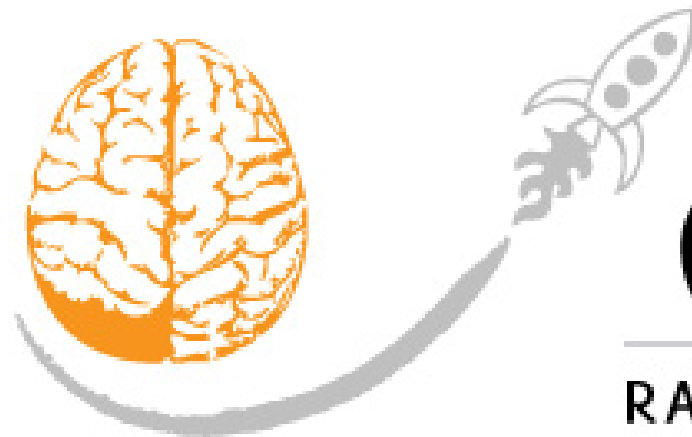


Who is important?



Important **people** have important **friends**

Important websites
are linked to by
important websites



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RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

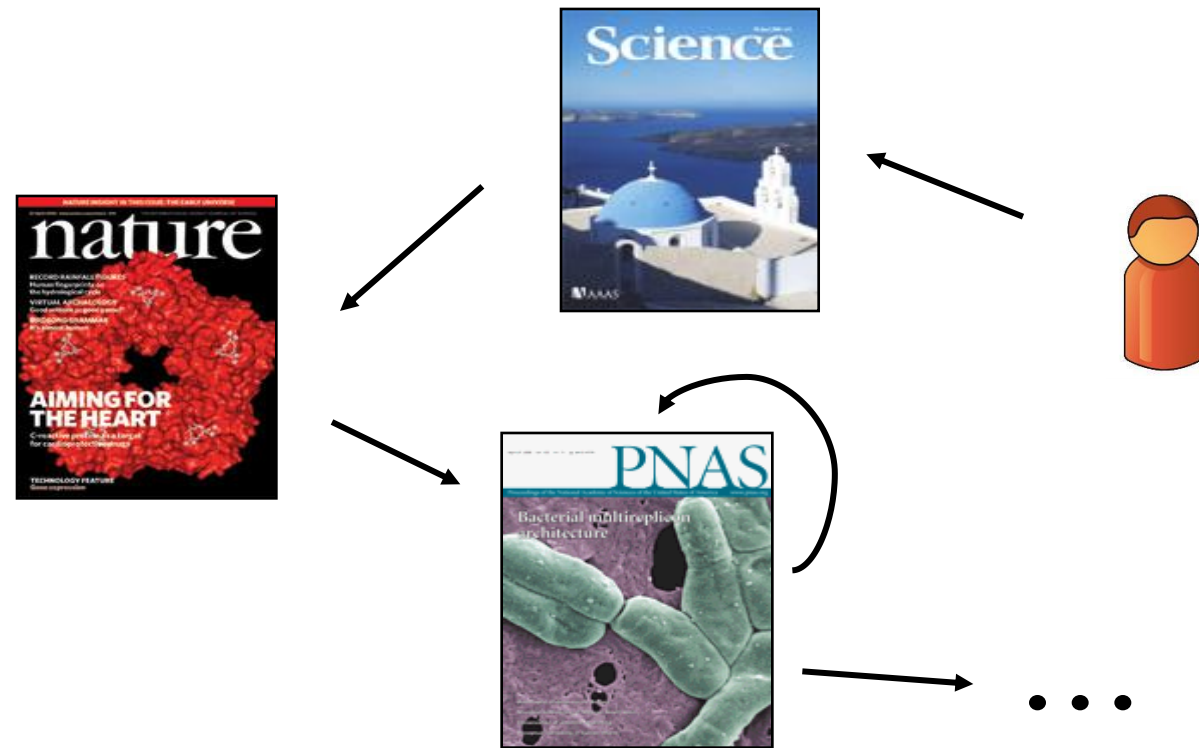
Important journals
are cited by
important journals

Citations from
good journals
are worth more


Citations from
non-review journals
are worth more

Citations from
“frugal” fields
are worth more

A model of citation-driven research





Where does our researcher  spend his time in the long-run?

Eigenfactor Score is a
measure of total value

Journal	Eigenfactor™ Score
Nature	2.0%
Science	1.9%
J. Biol. Chem.	1.8%
Proc. Nat. Acad. Sci.	1.8%
Phys. Rev. Let.	1.4%
J. Am Chem. Soc	1.0%
Phys. Rev. B	0.9%
Appl. Phys. Let	0.7%
New Engl. J. Med.	0.7%
Astrophys. Let.	0.7%

Article Influence is a
measure of prestige

Article Influence

Eigenfactor

Articles

Journal

Article Influence™ Score

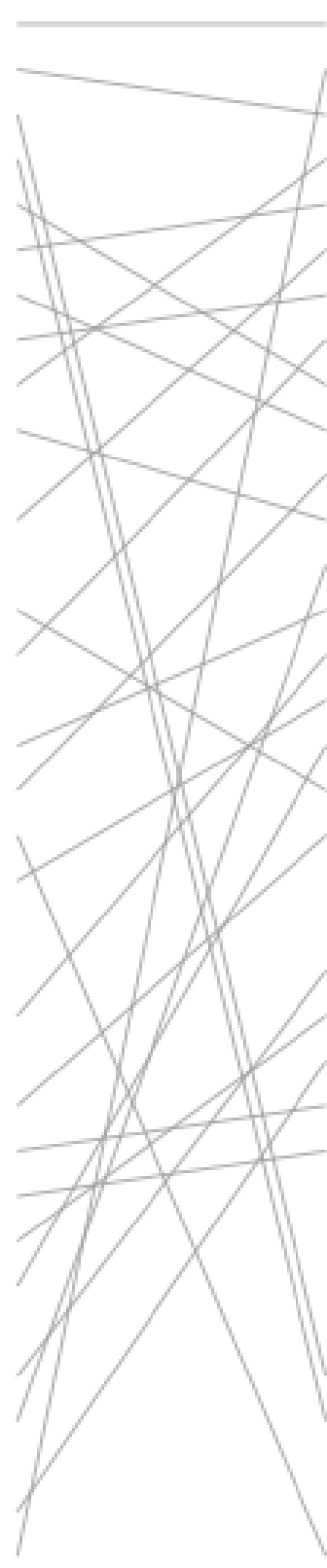
Science	18.3
Nature	17.6
Cell	17.0
New Engl. J. Med.	16.8
Nature Immunology	14.8
Quart. J. Economics	14.7
Cancer CA	13.9
Nature Medicine	13.6
Nature Genetics	13.3
Nature Materials	11.6

Impact Factor

Q J ECON
 J ECON LIT
 J ECON GEOGR
 J HEALTH ECON
 J ECON PERSPECT
 ECONOMETRICA
 J ECON GROWTH
 J FINANC ECON
 J POLIT ECON
 BROOKINGS PAP ECO AC
 J RISK UNCERTAINTY
 REV ECON STUD
 HEALTH ECON
 J ACCOUNT ECON
 AM ECON REV
 ECON GEOGR
 J INT ECON
 J MONETARY ECON
 J LAW ECON
 J ECONOMETRICS
 RESOUR ENERGY ECON
 J ENVIRON ECON MANAG
 REV ECON STAT
 WORLD DEV
 ECON J
 MATH FINANC
 INT ECON REV
 J LABOR ECON
 WORLD BANK ECON REV
 J LAW ECON ORGAN
 ECON POLICY
 RAND J ECON
 ECOL ECON
 IND CORP CHANGE
 NBER MACROECON ANN

Article Influence

Q J ECON 12.57
 NBER MACROECON ANN 9.345
 J ECON LIT 9.282
 J POLIT ECON 7.236
 ECONOMETRICA 7.042
 REV ECON STUD 6.329
 J FINANC ECON 5.701
 AM ECON REV 4.872
 J ECON PERSPECT 4.795
 J ECON GROWTH 4.276
 J MONETARY ECON 3.644
 BROOKINGS PAP ECO AC 3.245
 RAND J ECON 3.12
 J INT ECON 3.008
 REV ECON STAT 2.993
 J ECONOMETRICS 2.949
 WORLD BANK ECON REV 2.949
 J ACCOUNT ECON 2.900
 ECON J 2.835
 J BUS ECON STAT 2.661
 J ECON THEORY 2.584
 ECON POLICY 2.573
 J LABOR ECON 2.536
 IND CORP CHANGE 2.251
 MATH FINANC 2.206
 INT ECON REV 2.152
 J FINANC QUANT ANAL 2.075
 EUR ECON REV 1.960
 ENERG J 1.958
 J APPL ECONOM 1.936
 J ECON GEOGR 1.921
 J HEALTH ECON 1.907
 J MONEY CREDIT BANK 1.879
 J PUBLIC ECON 1.835
 J LAW ECON 1.811





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EIGENFACTOR™ METRICS IN JCR WEB



THOMSON REUTERS™

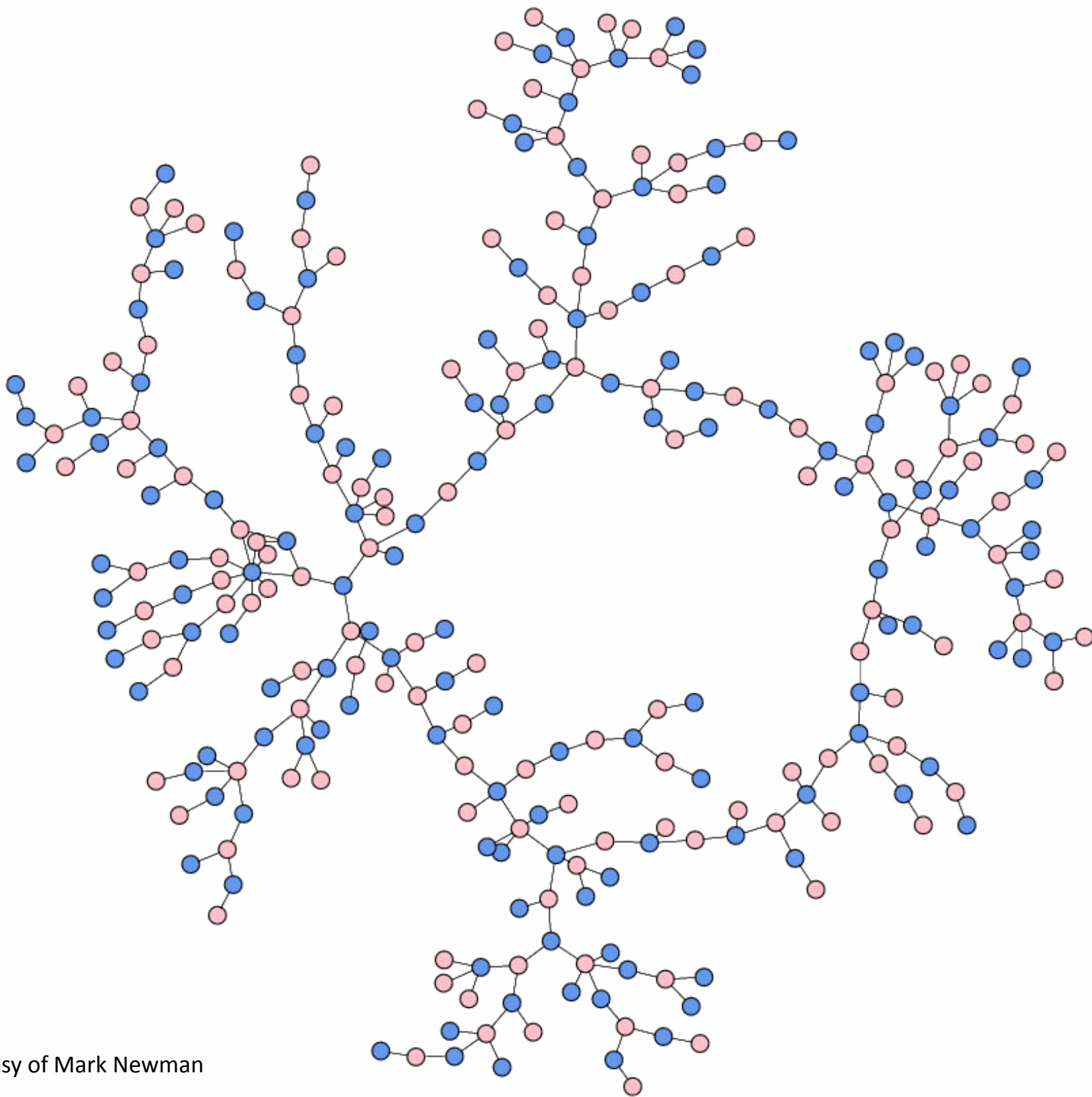
Ranking

Mapping

Discovering

Networks tell stories

High school dating network



Courtesy of Mark Newman

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

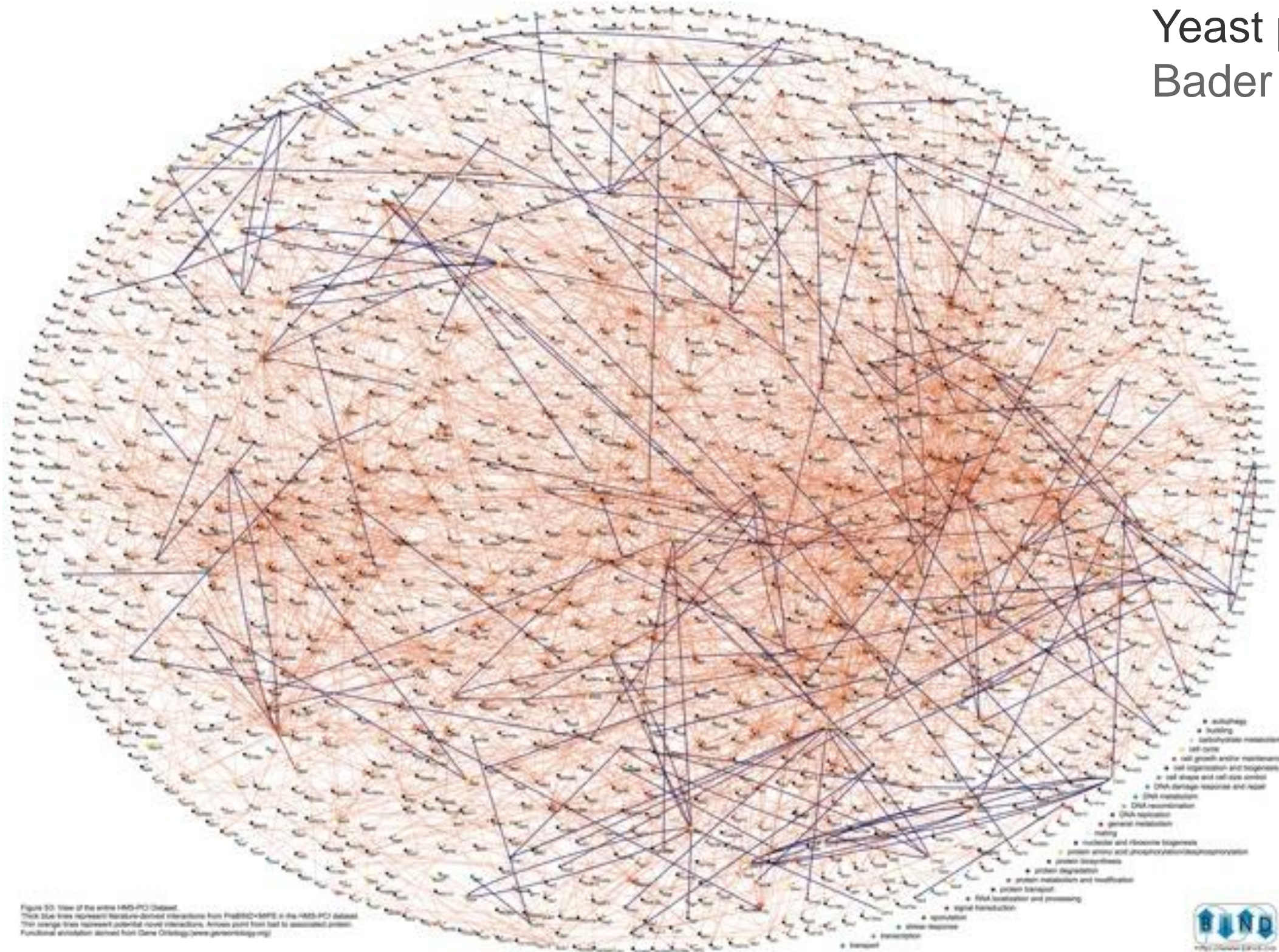
How does this approach **scale up**?

Social Science Journals

Loet Leydesdorff (2004)

Yeast protein interaction network

Bader and Hogue (2002) *Nature*





good maps **simplify**
and **highlight**
relevant structures



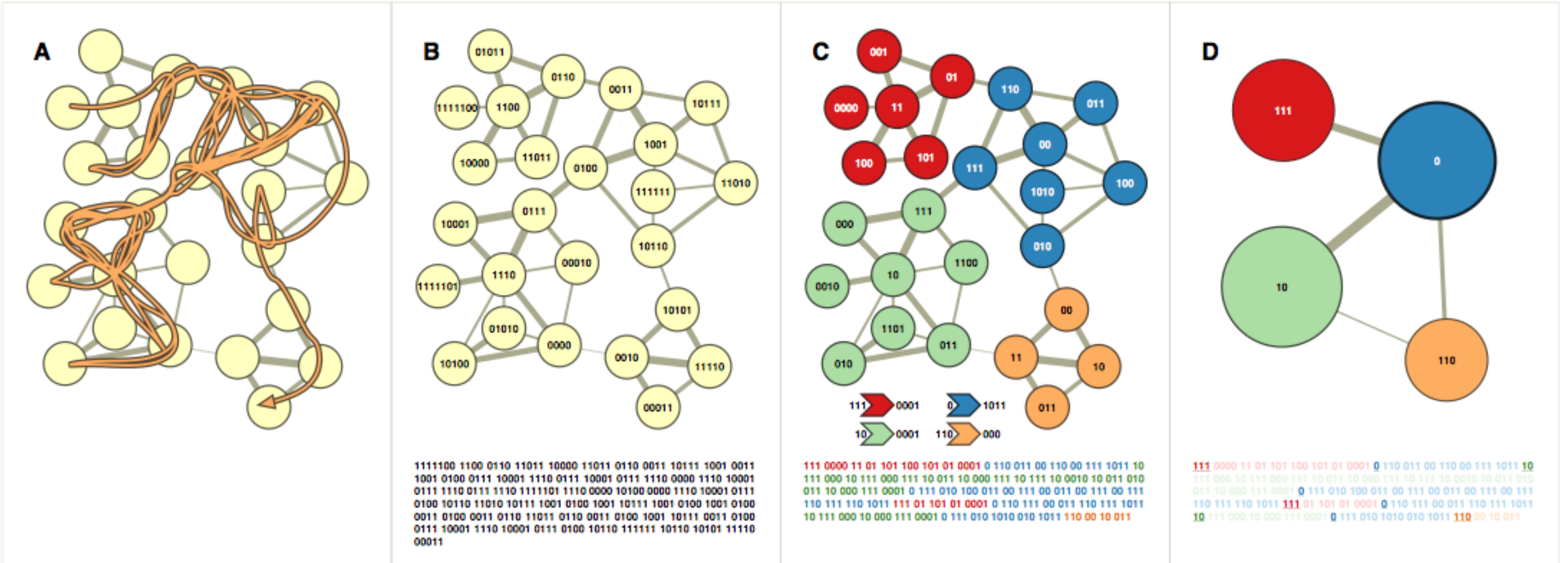
maps are **useful** **compressions**

maps are **useful** **compressions**

Literally.

Compress a path
resulting from
dynamics on a network

Find the important
structural features
of the network



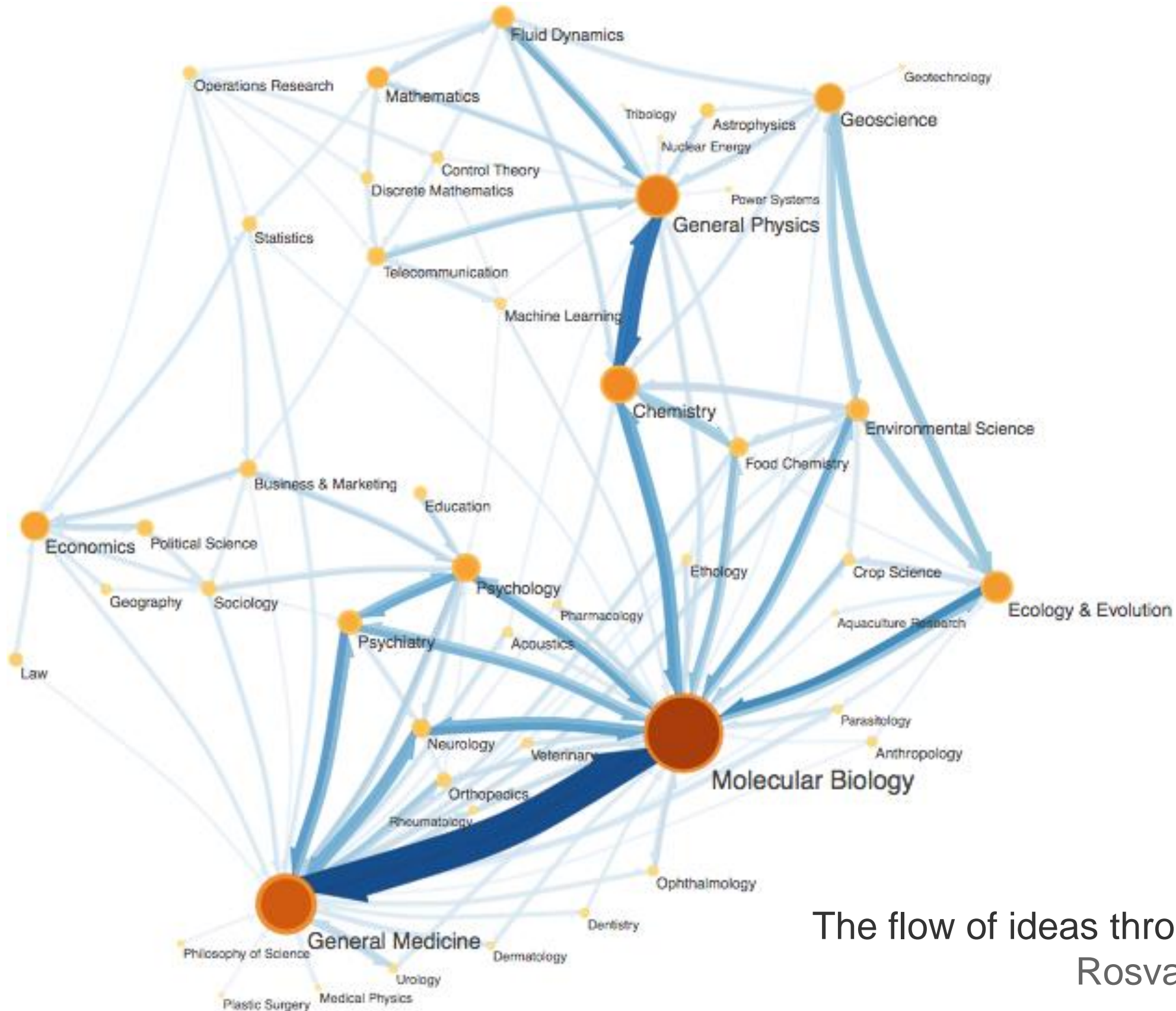
The map equation

Rosvall and Bergstrom 2008 PNAS

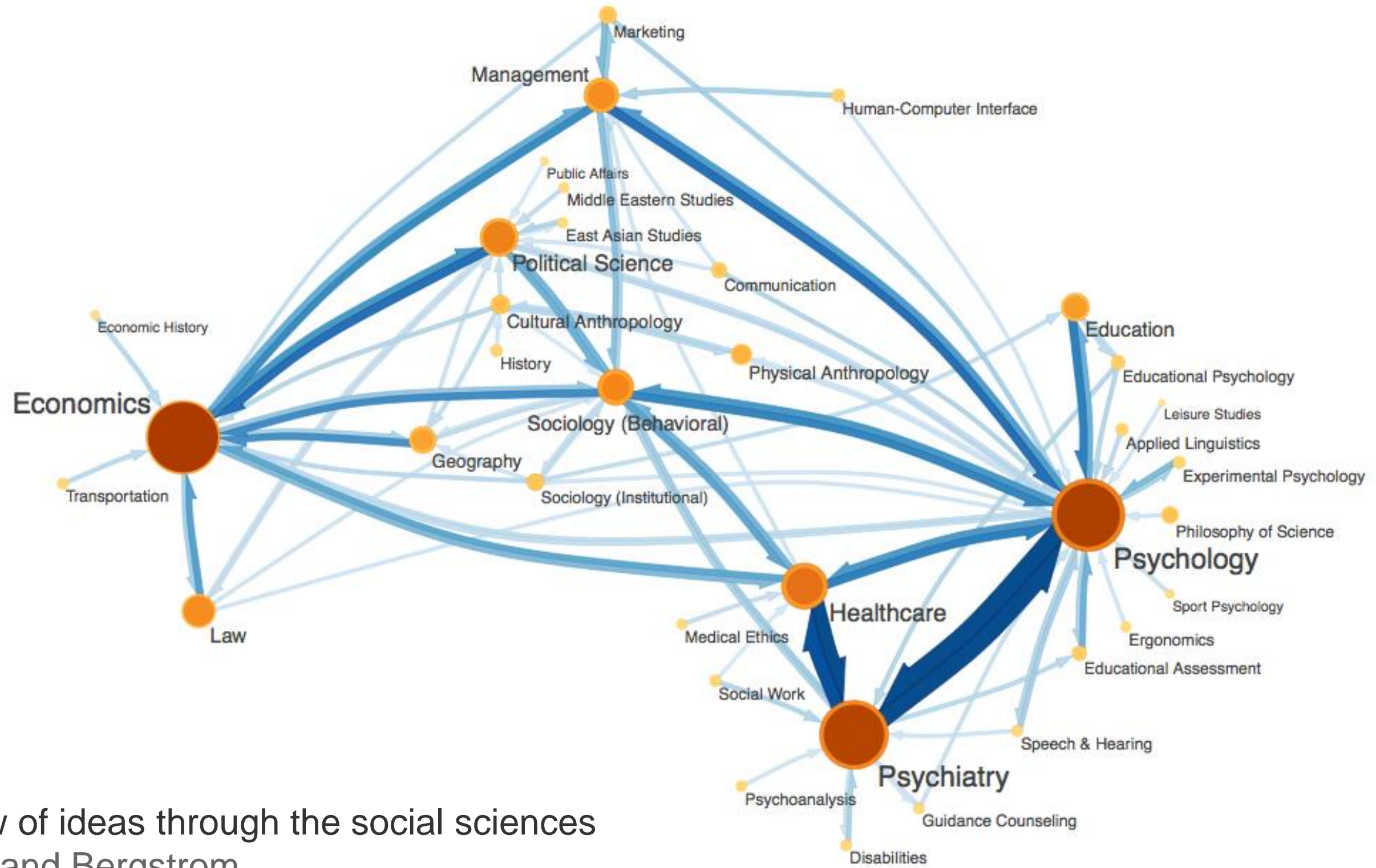
$$L(M) = q_{\curvearrowright} H(\mathcal{Q}) + \sum_{i=1}^m p_{\circlearrowleft}^i H(\mathcal{P}^i)$$

The map equation

Rosvall and Bergstrom 2008 PNAS

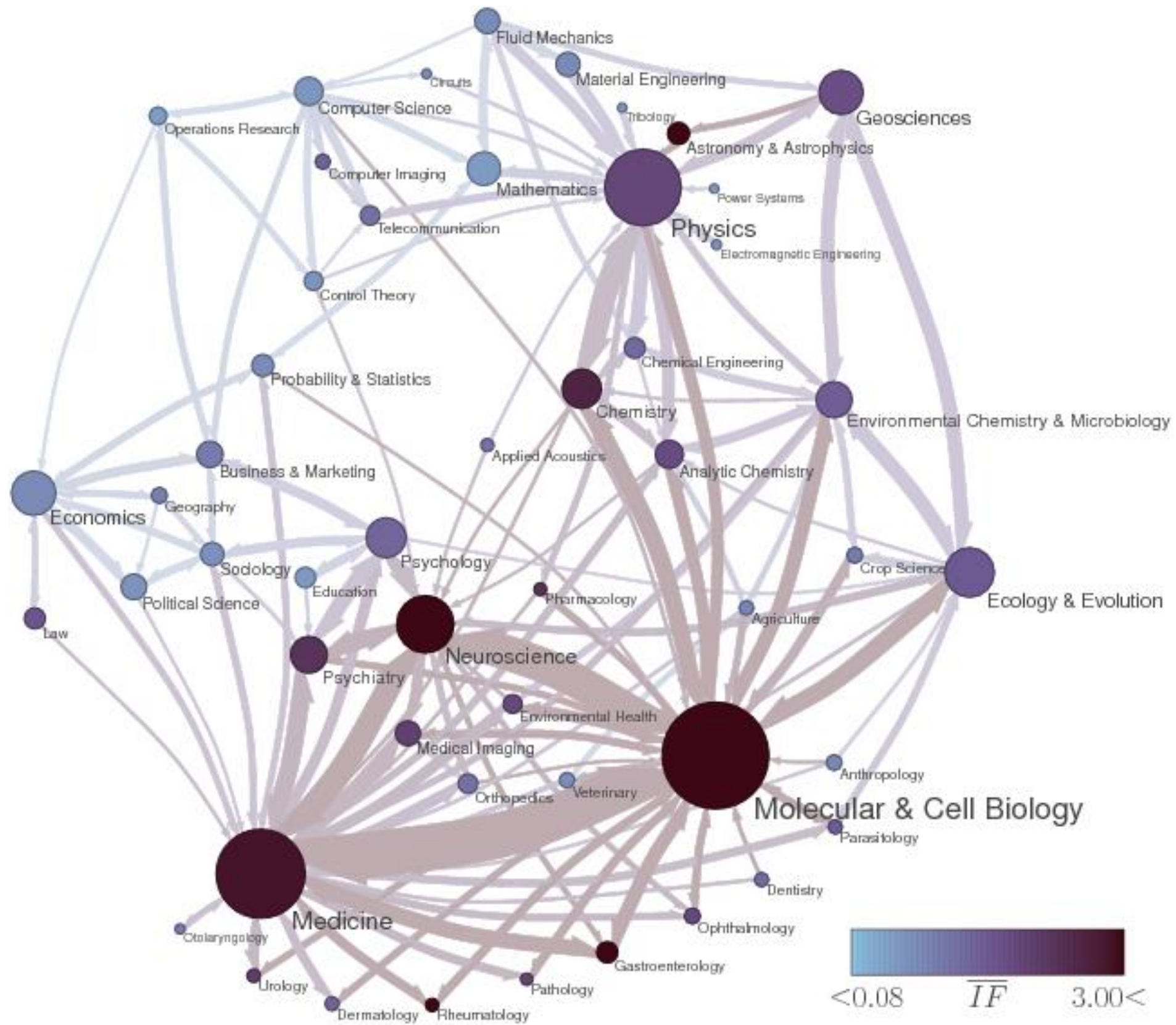


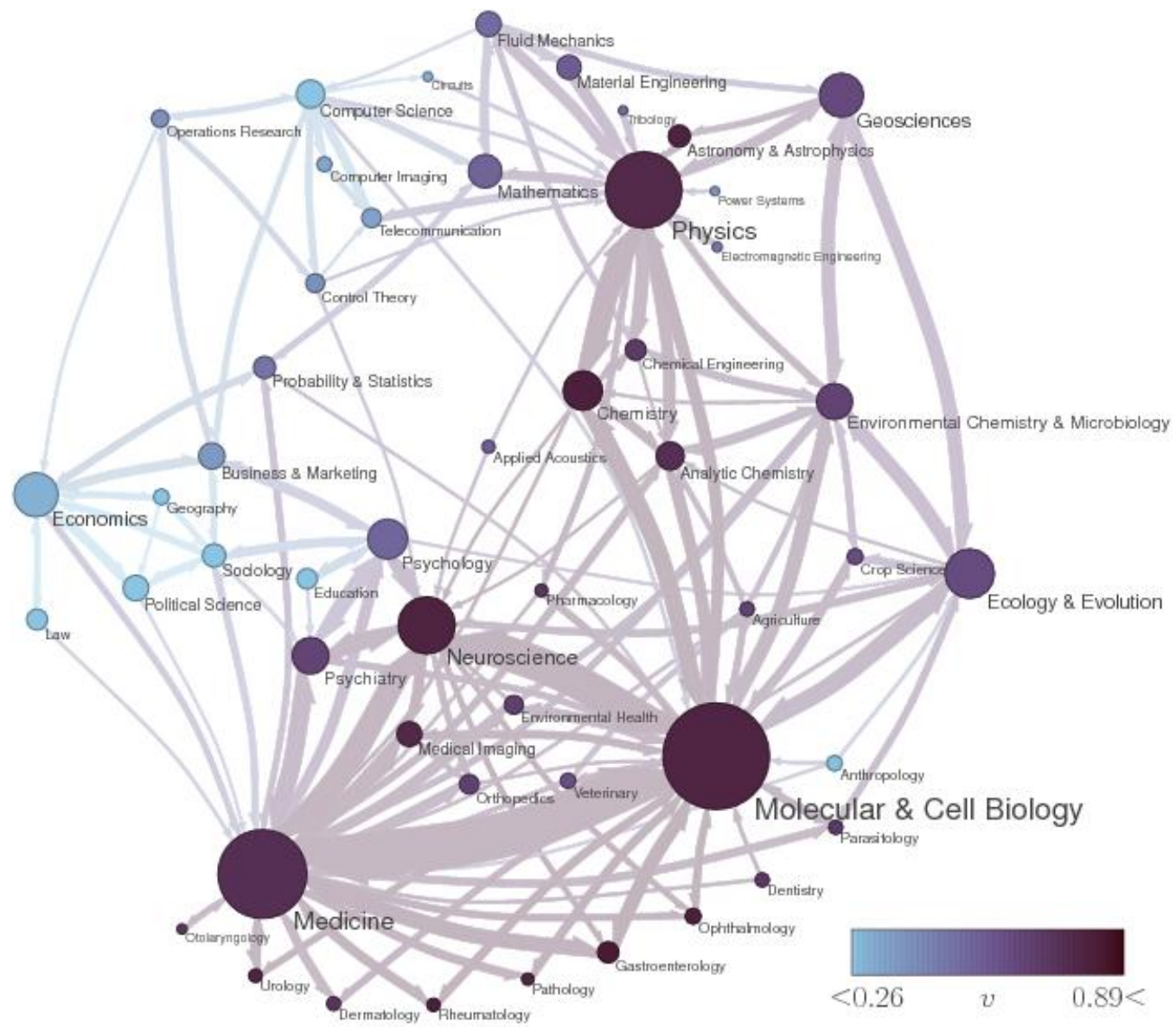
The flow of ideas through the sciences
Rosvall and Bergstrom



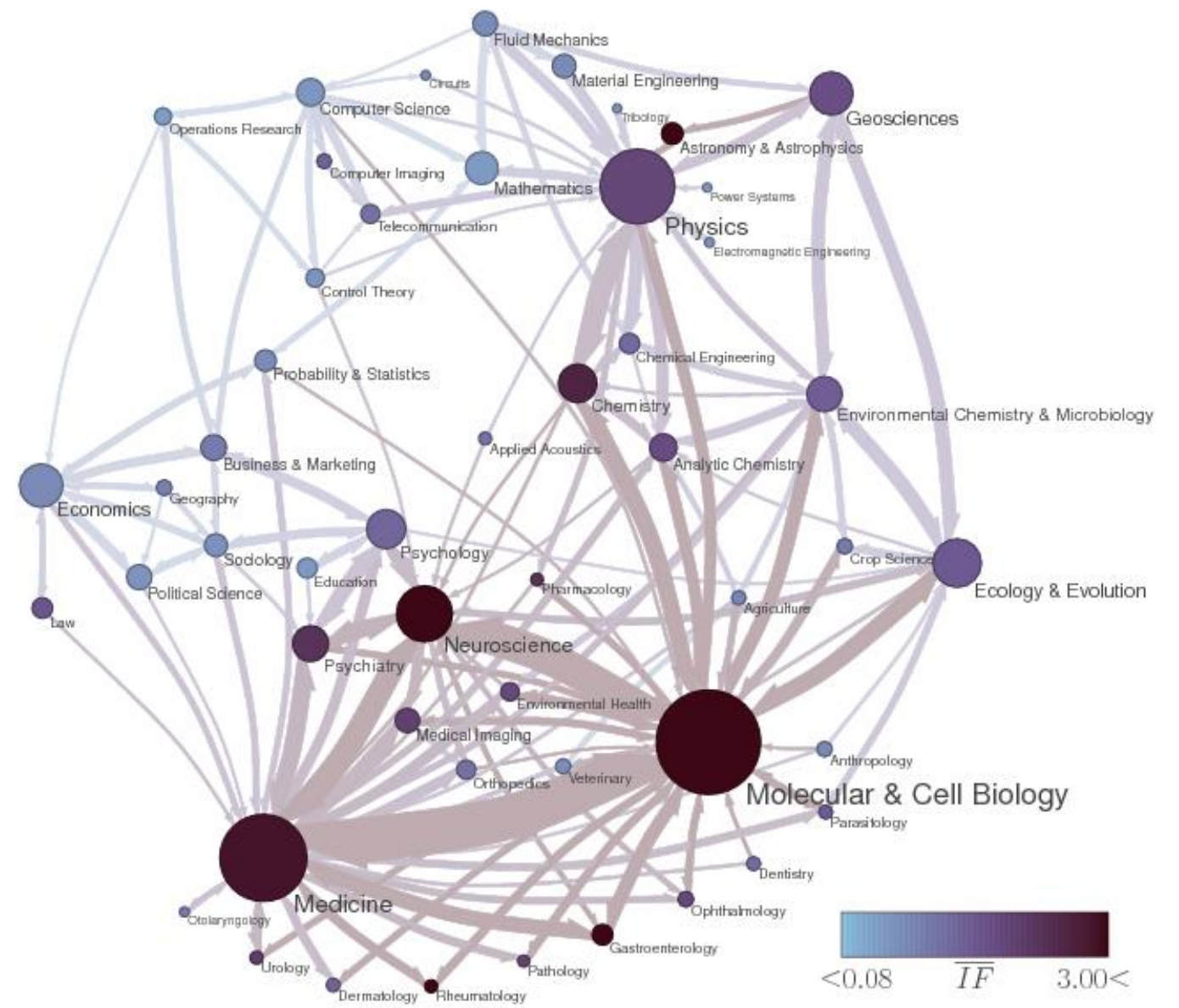
The flow of ideas through the social sciences
Rosvall and Bergstrom

Maps help us see patterns.



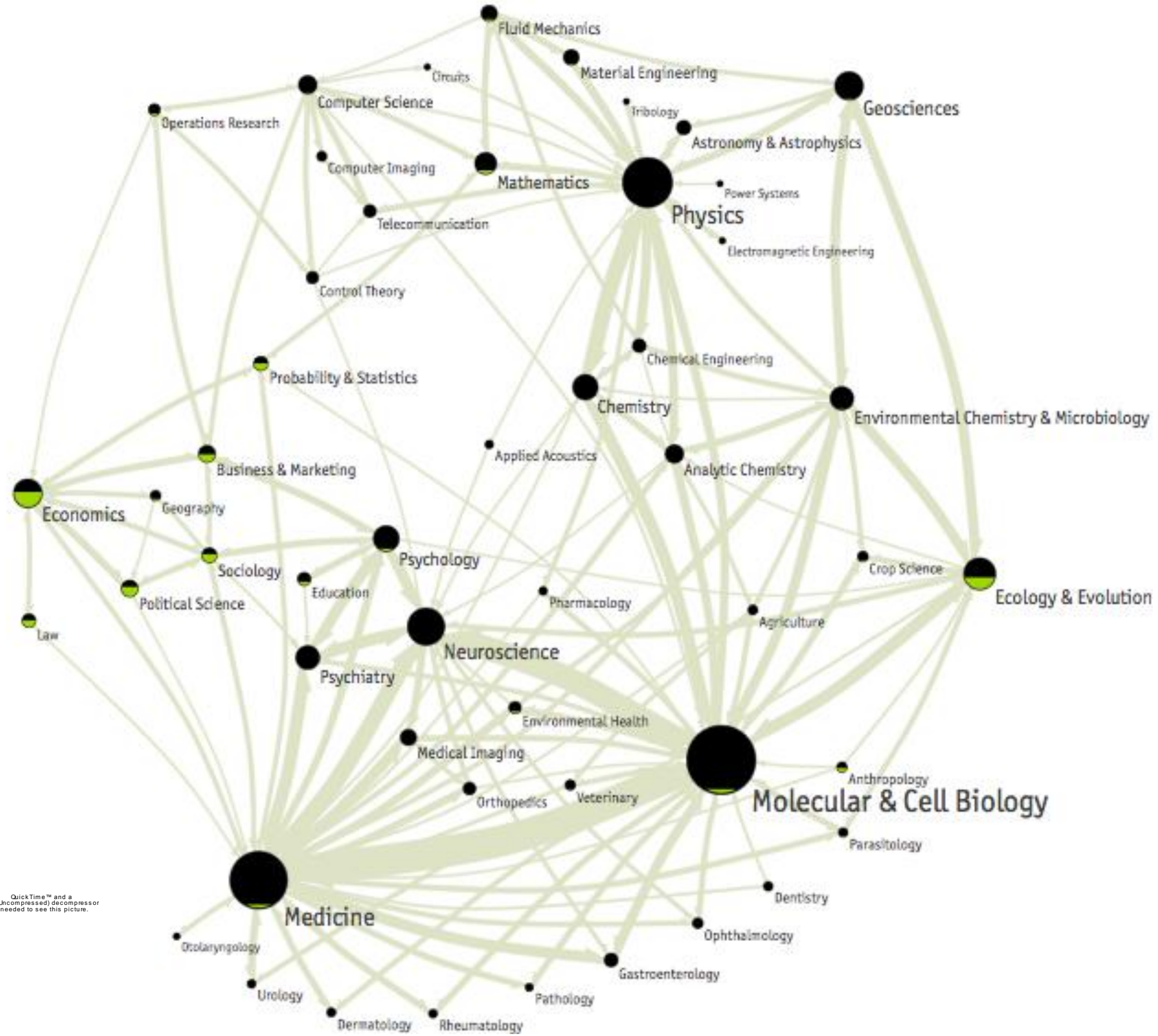


“coverage”



Impact factor

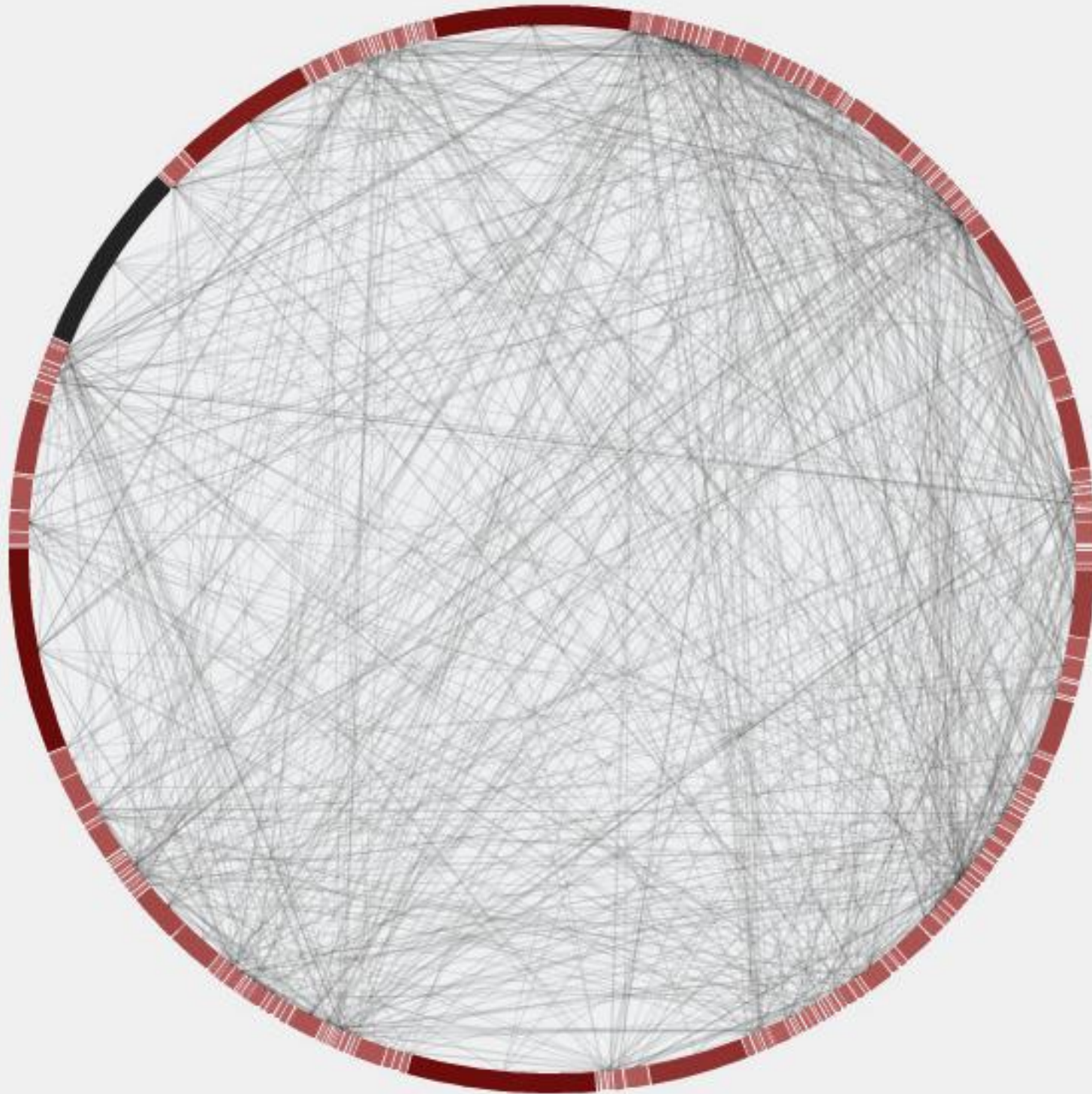
Maps give us a 30,000 foot view.



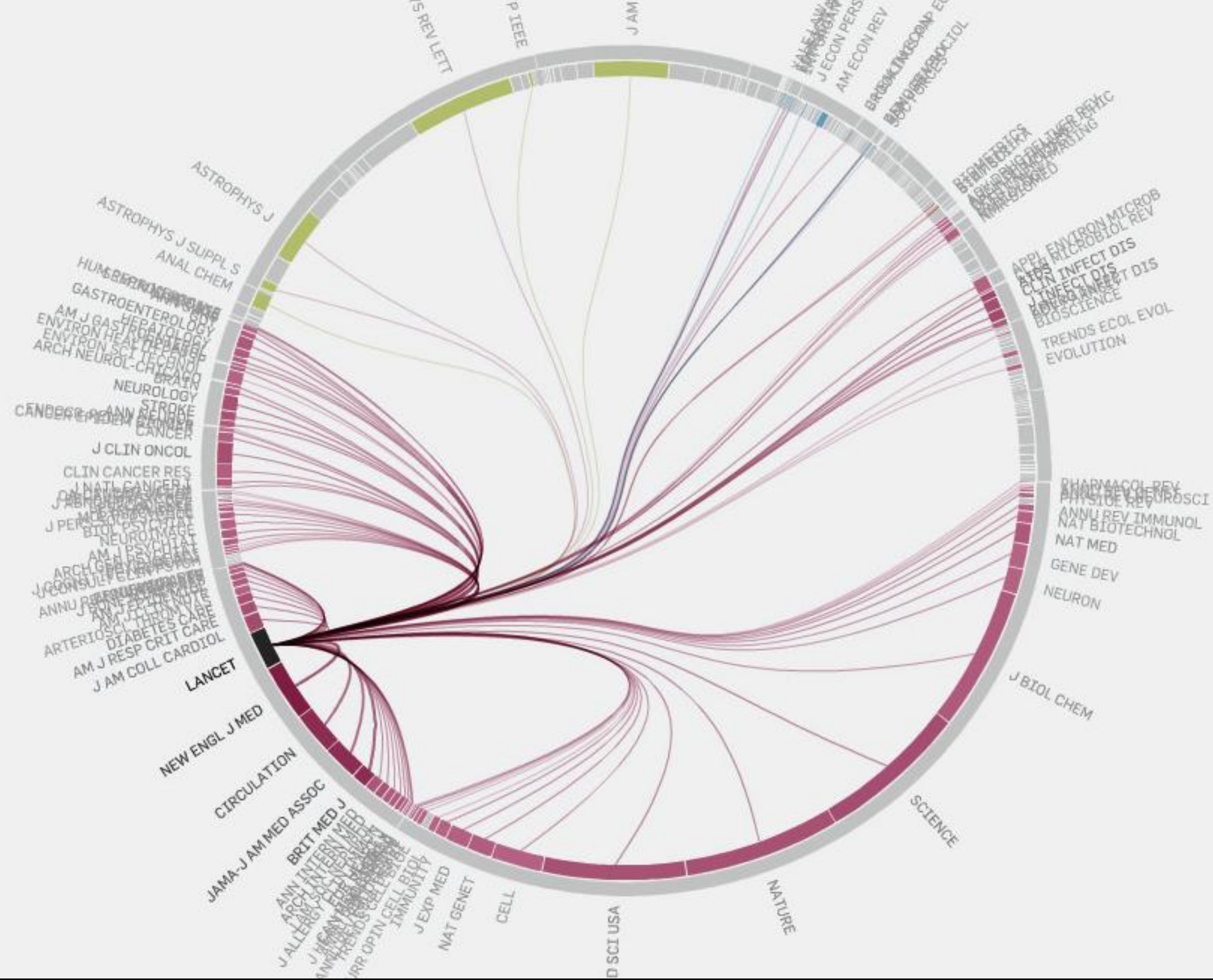
QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Maps help us organize data.









Maps help us navigate
the search process.

Ranking

Mapping

Discovering

“Which are the classic papers in a field?”

“Which are the hidden gems?”

“Which recent papers are mostly likely to have a large impact?”

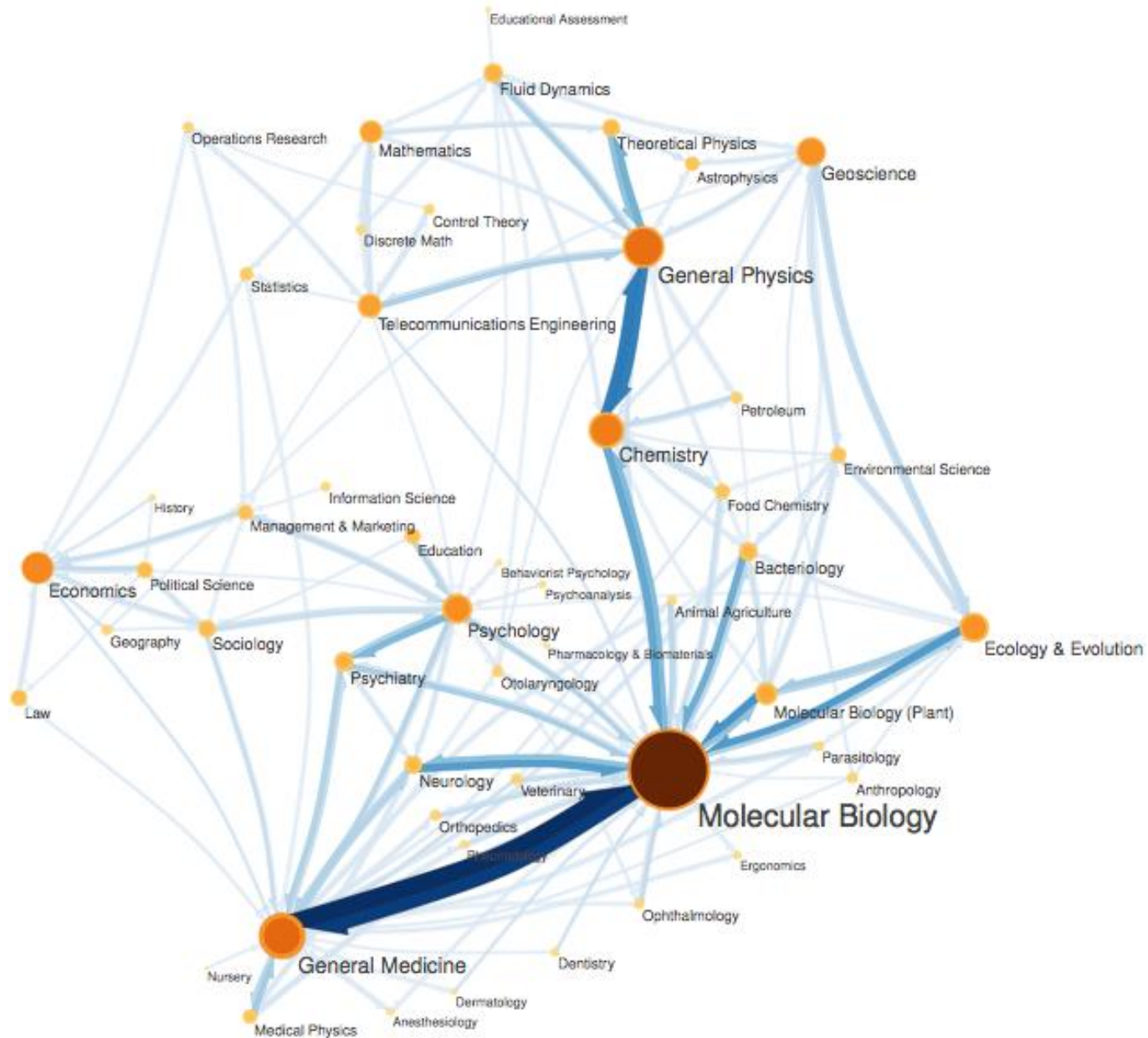
“Which papers complement
a given bibliography?”

“Where are new connections
arising in the sciences?”

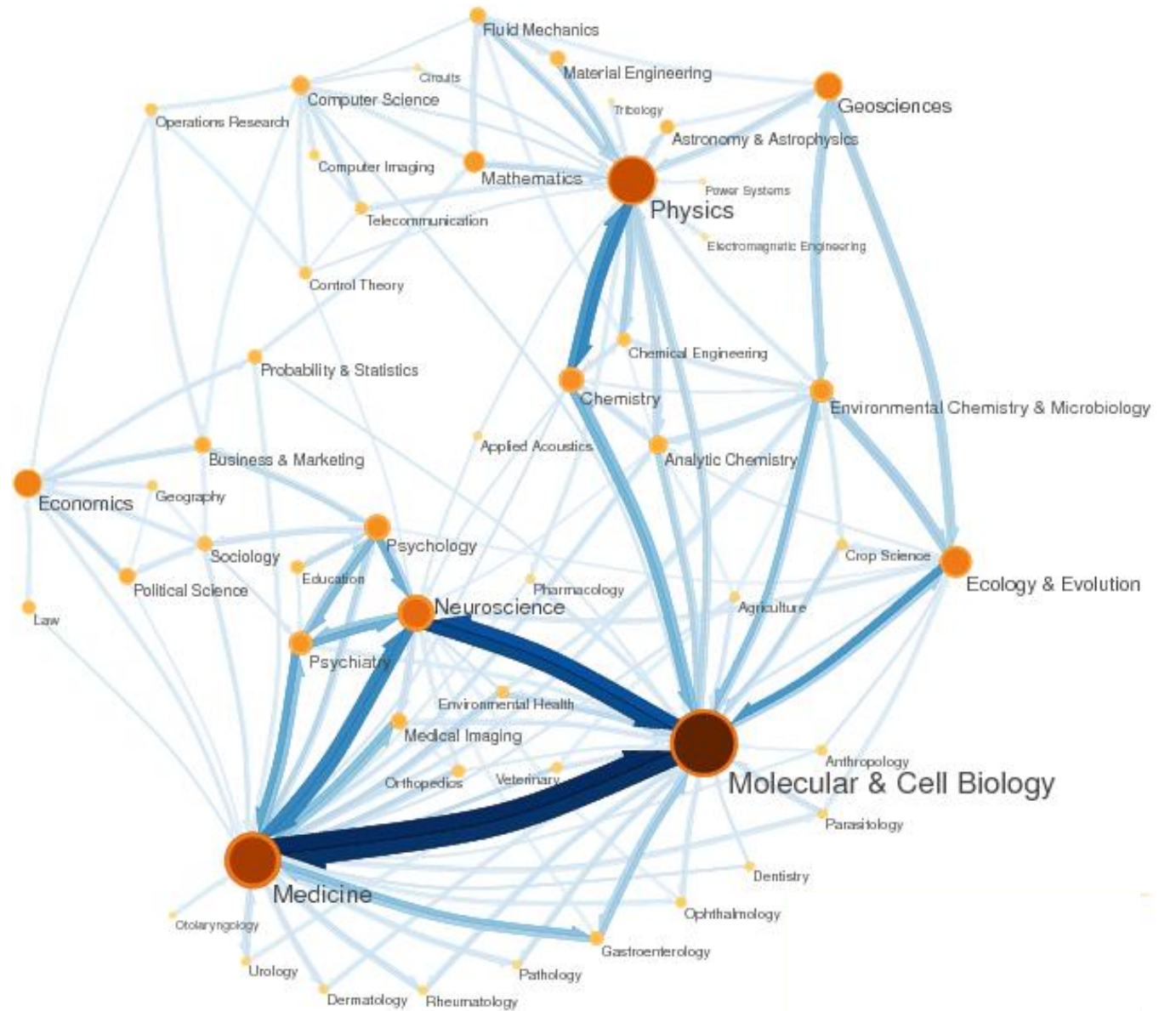
“Which journals are most important in trafficking ideas across disciplines?”

“How is the structure of science changing?”

1995



2004

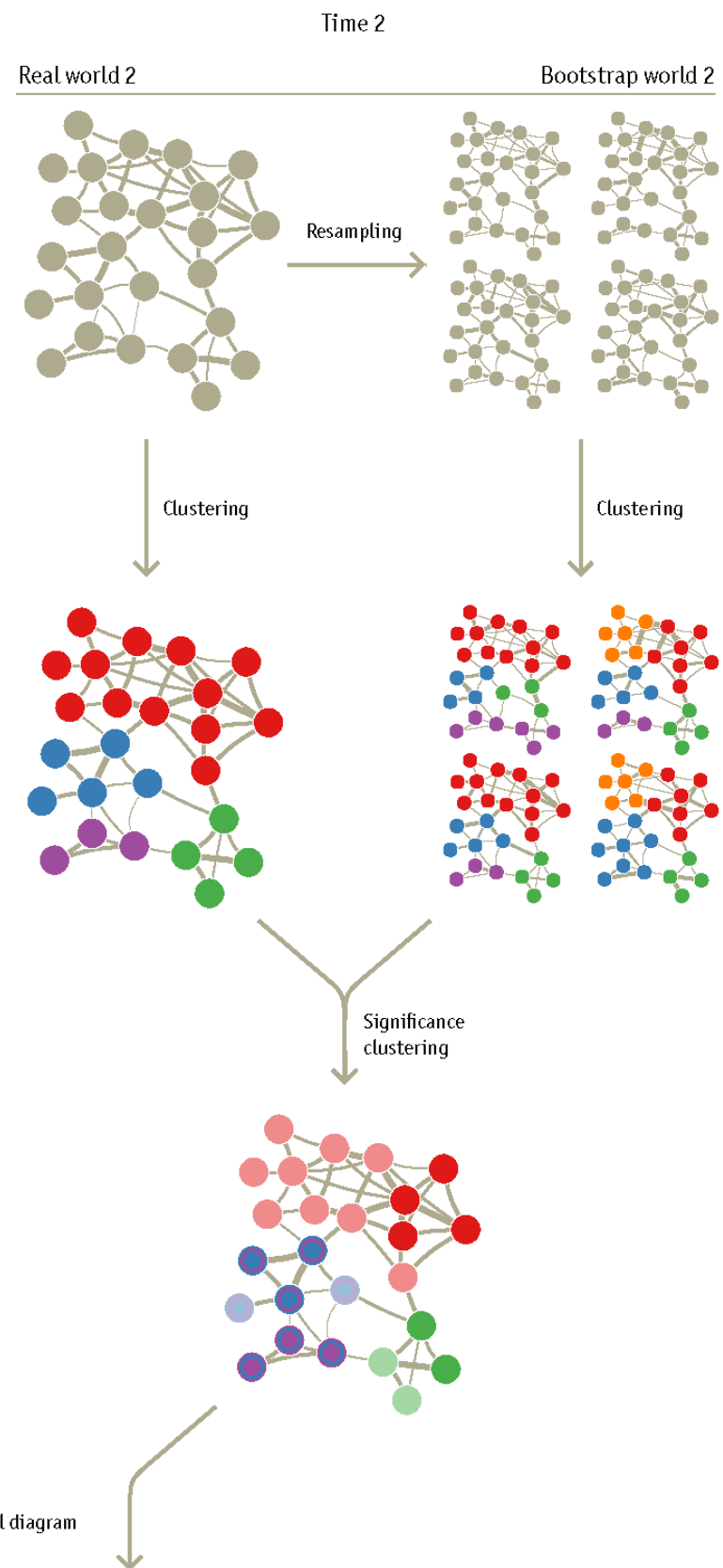
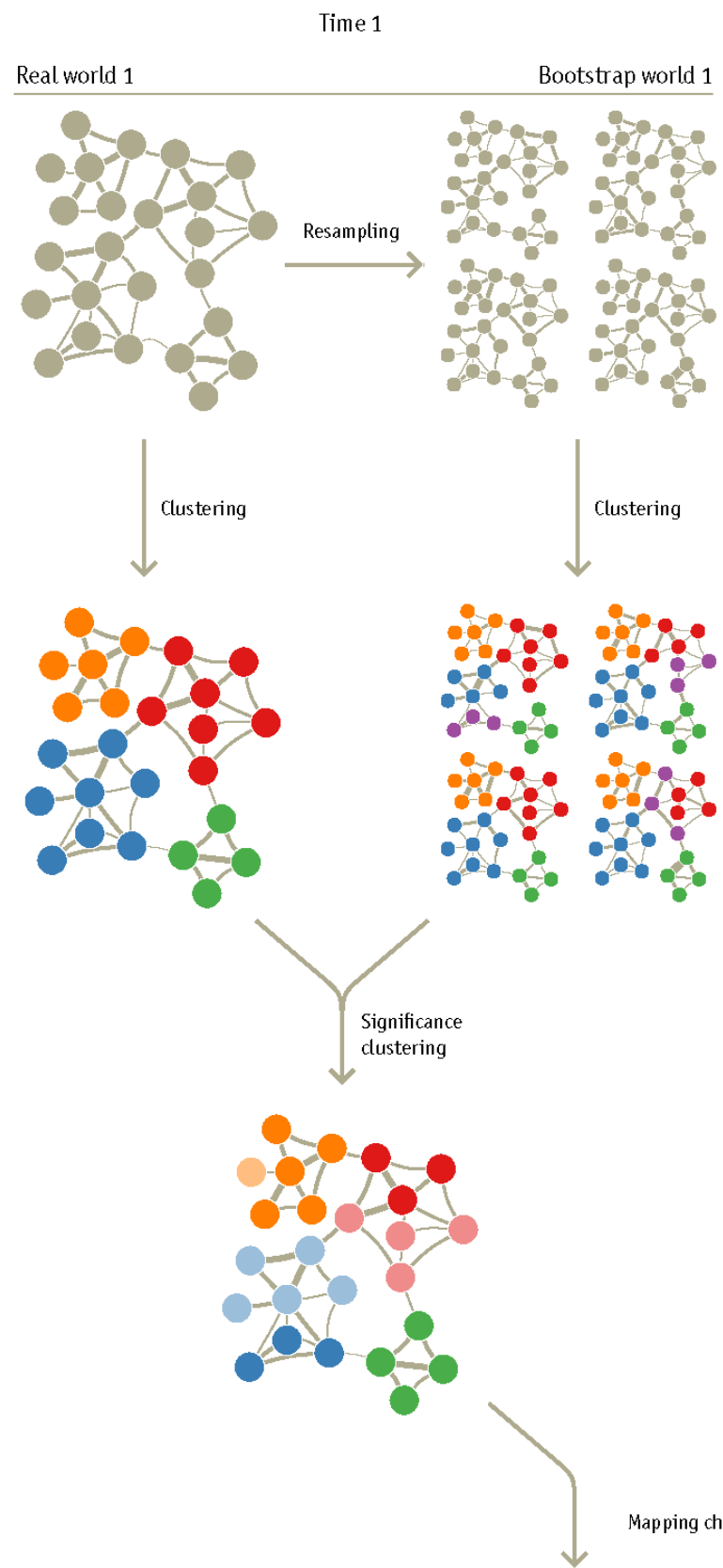


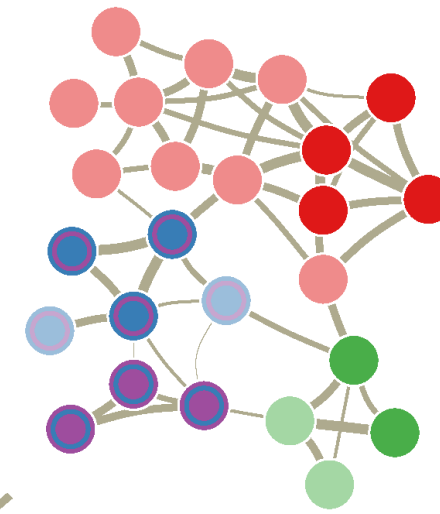
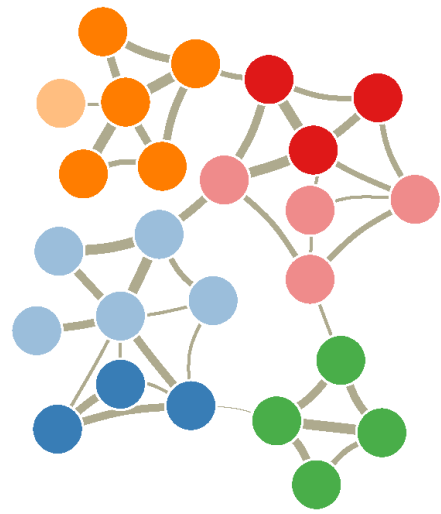
What is real **change**
and what is mere **noise**?

1. Determine which structures are statistically significant.
2. Visualize changes in those structures.

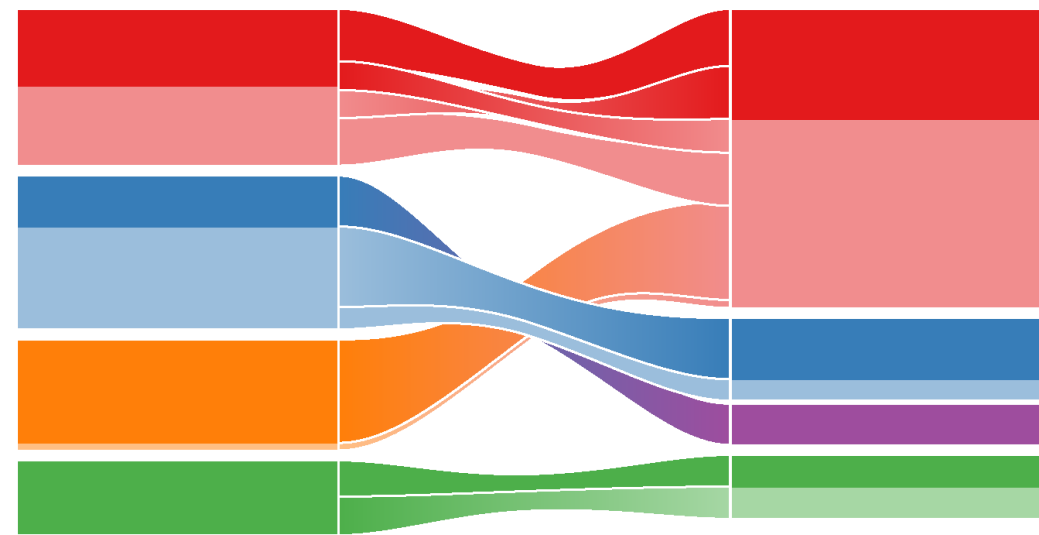


1. Determine which structures are statistically significant.
2. Visualize change in those structures.



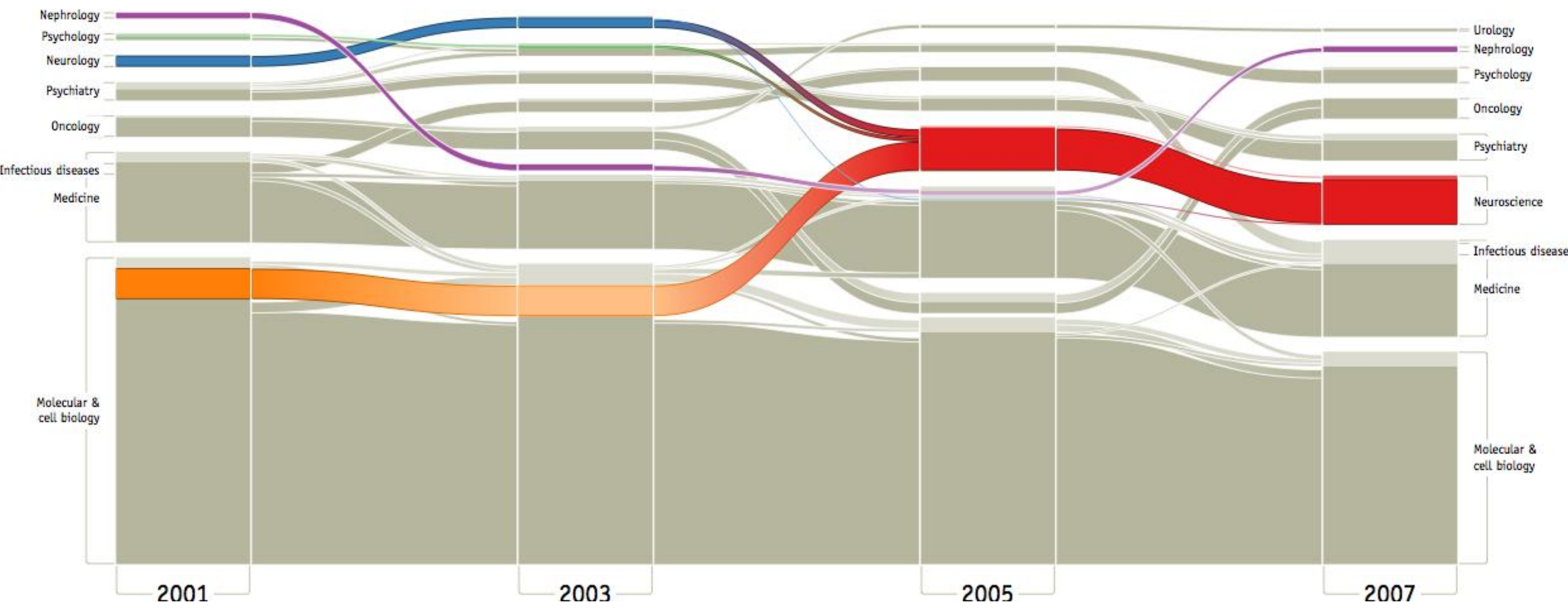


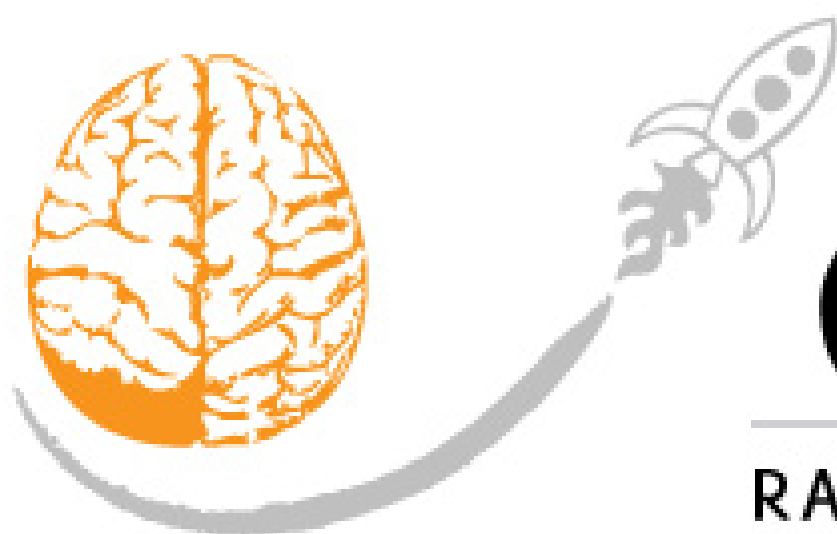
Mapping change with alluvial diagram



Time 1

Time 2





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