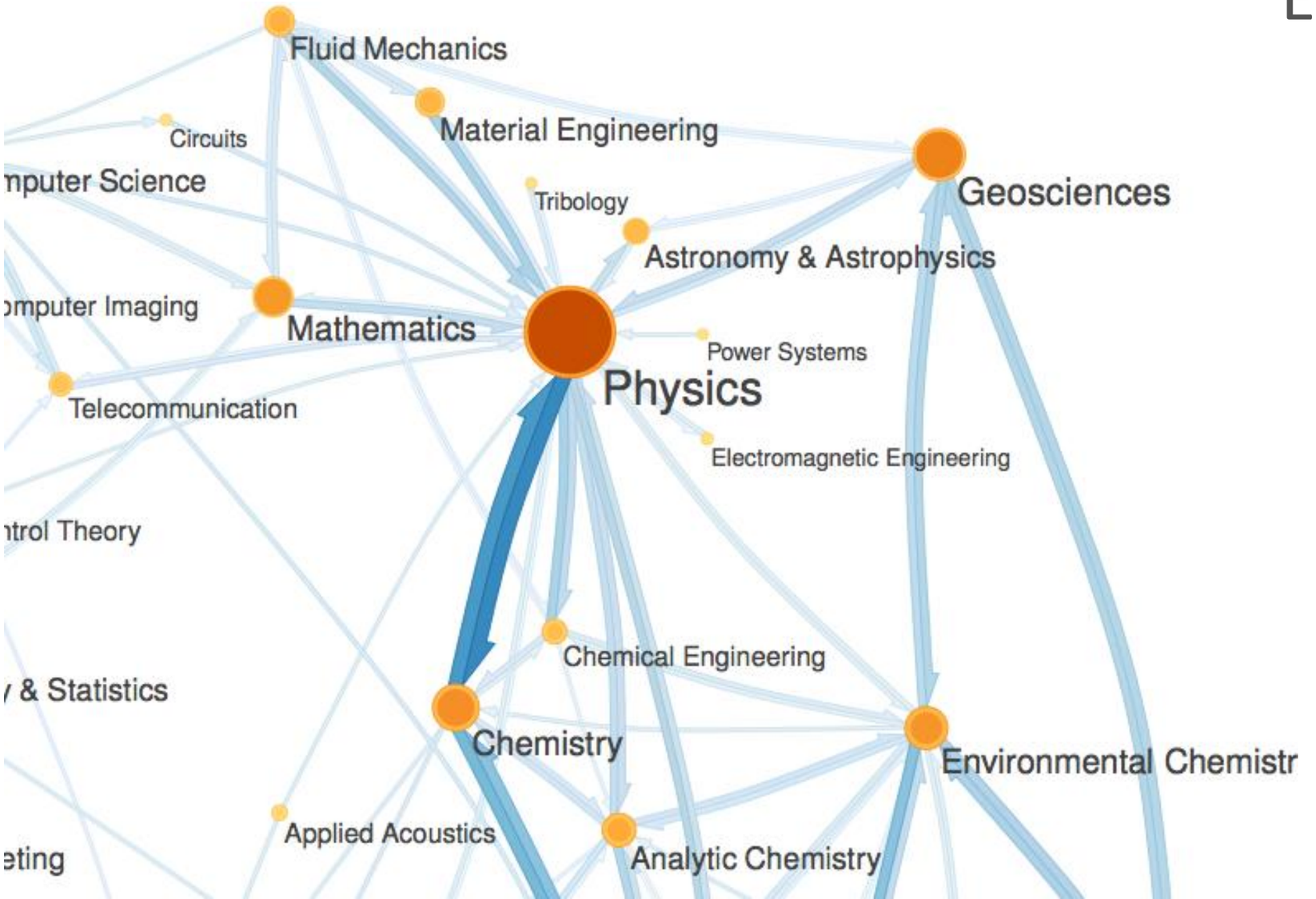

Microsoft® Research
Faculty Summit
10
YEAR ANNIVERSARY

The Eigenfactor Project

Exploring the network structure of science



Carl T. Bergstrom
Univ. Washington

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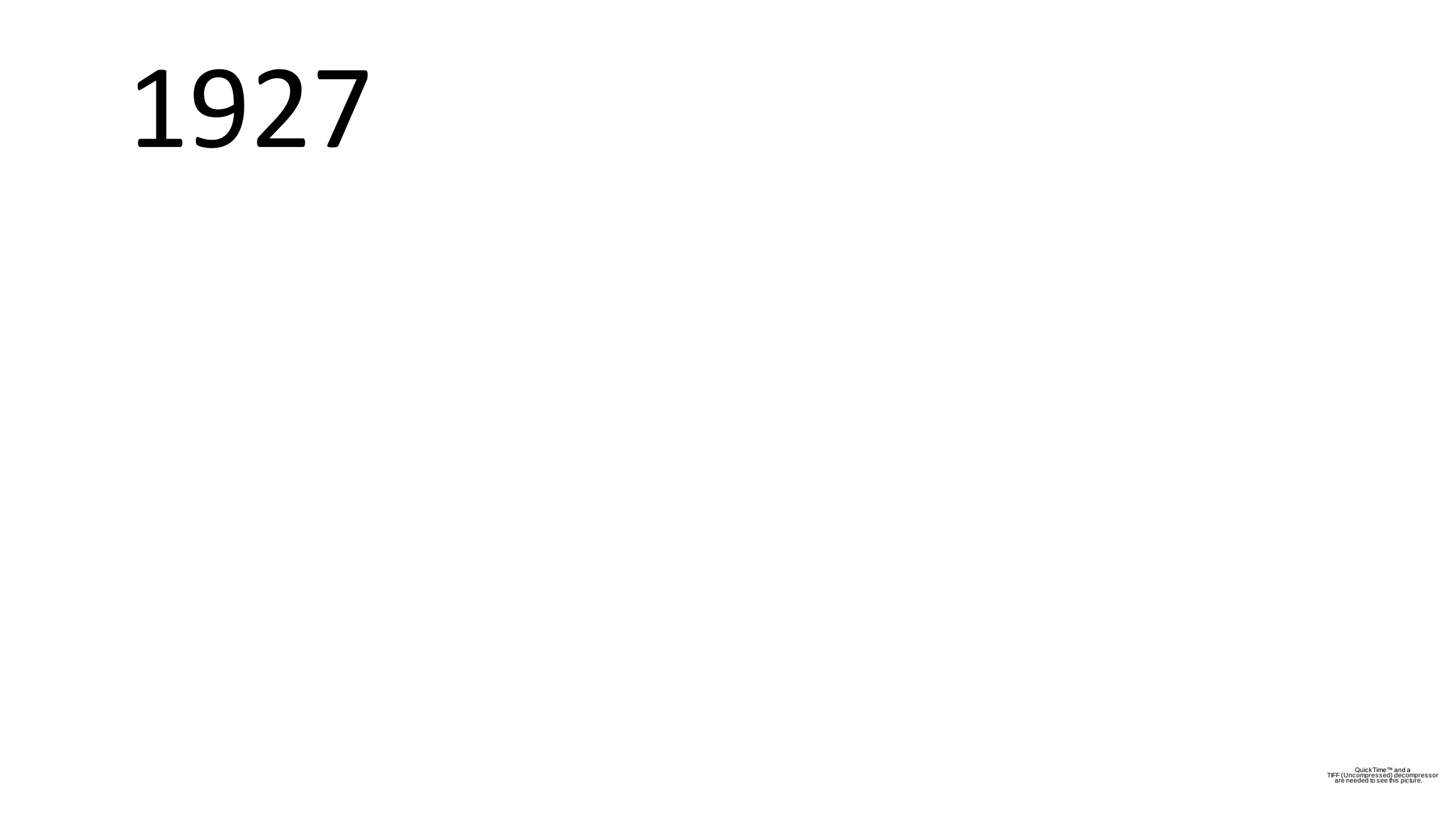
Ranking

Mapping

Discovering

1927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Not enough money.

Which journals should we buy?

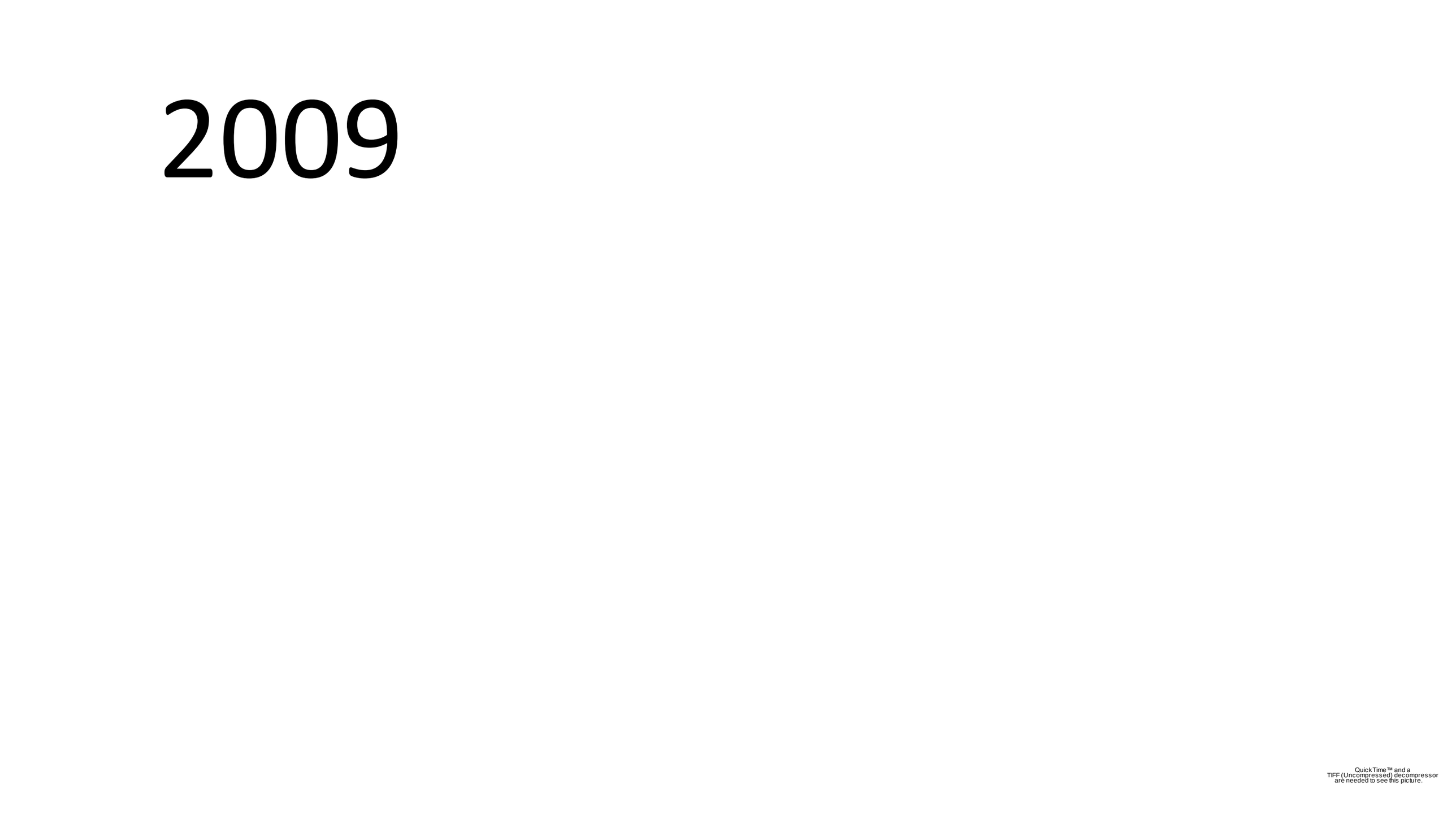
Count citations

1955

Impact factor

$$\frac{\text{Cites in 2008 to articles in 2007 or 2006}}{\text{Articles published in 2007 and 2006}}$$

2009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Impact factor drives…

Hiring decisions

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Library subscriptions

Promotion and tenure

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Ad placement

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Research funding

rae2008

Research Assessment Exercise

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University Rankings

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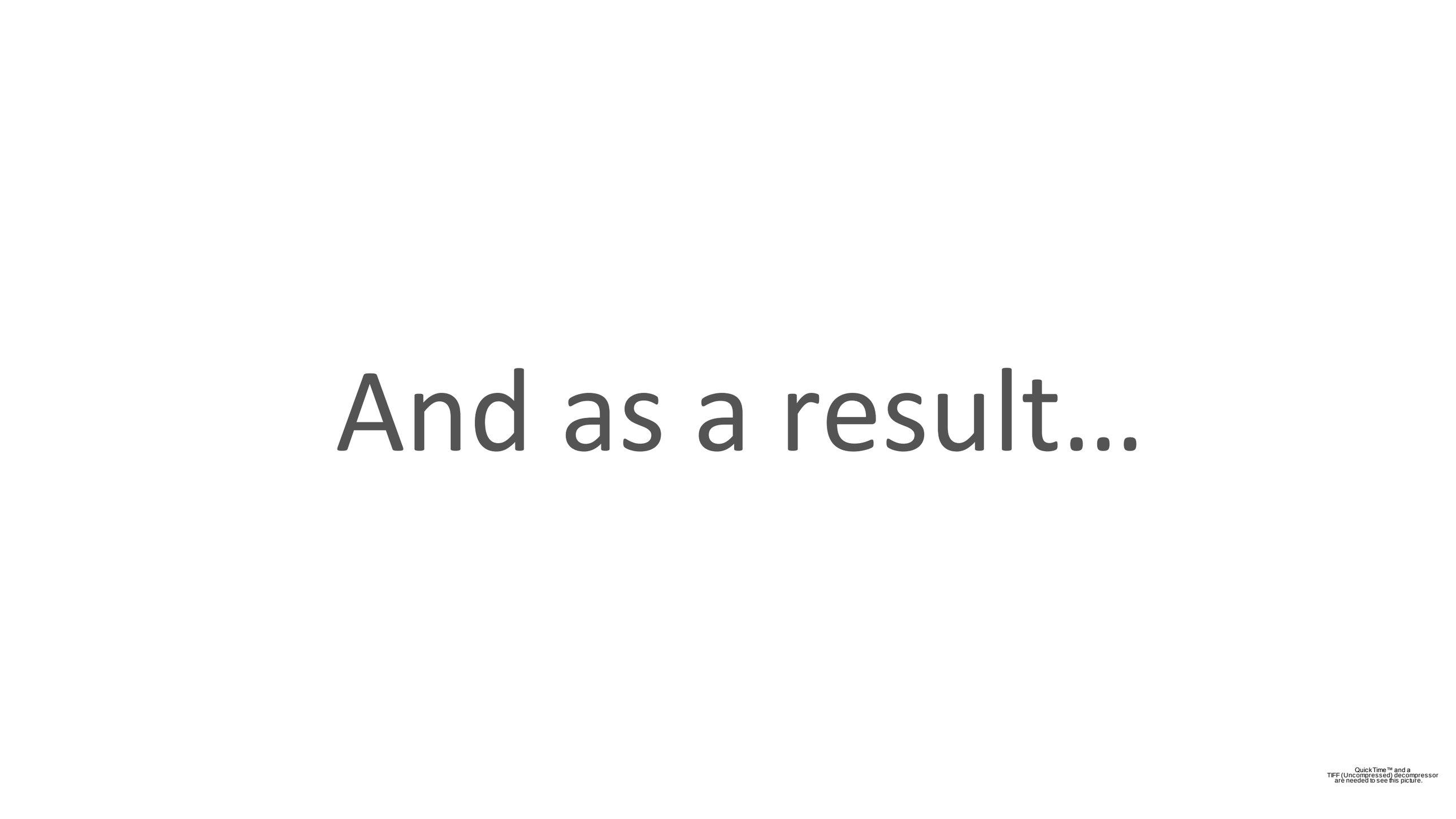
And as a result…



Scientists obsess.

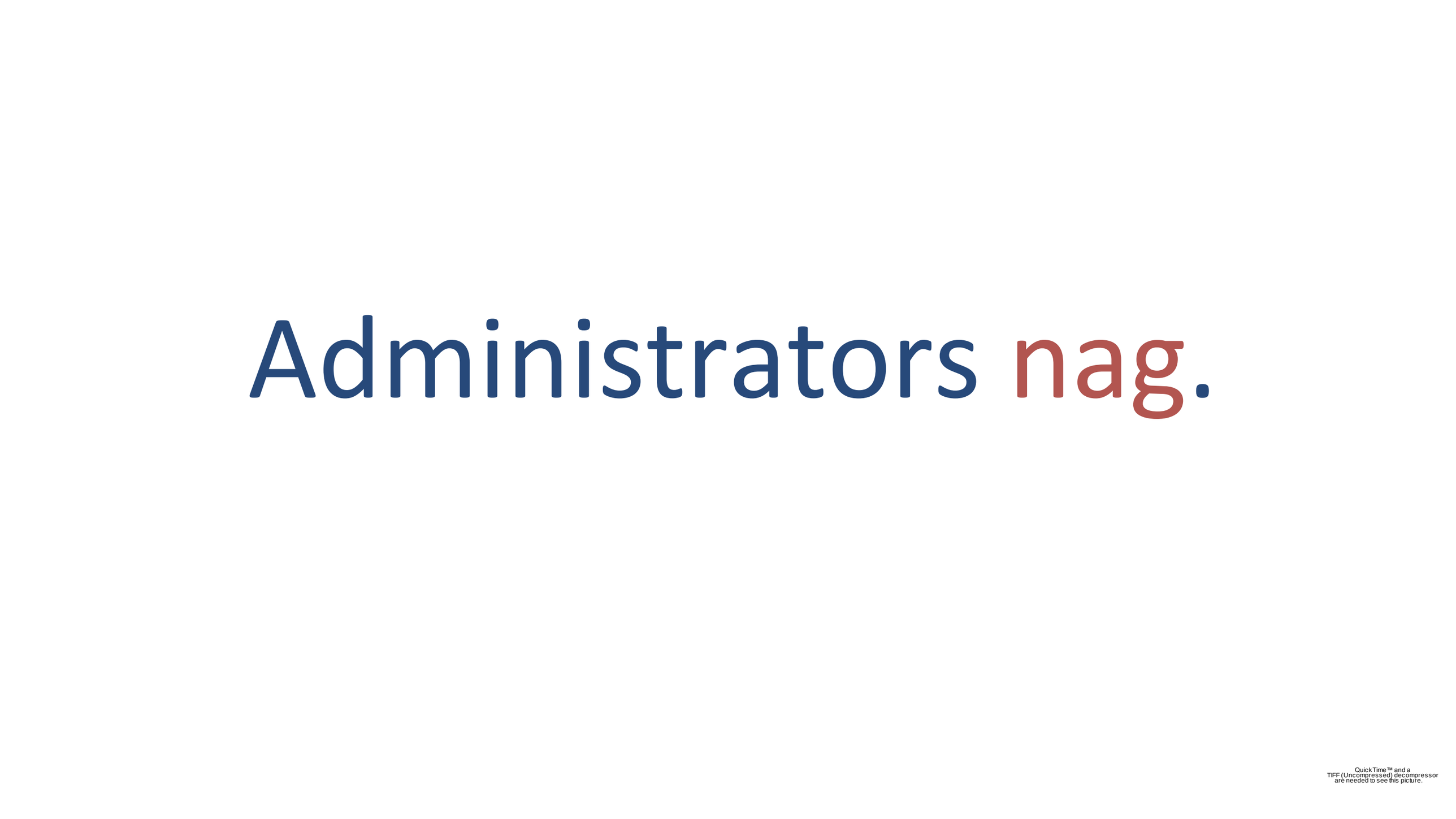
Editors scheme.

Publishers negotiate.

Journals pander.

Librarians fret.

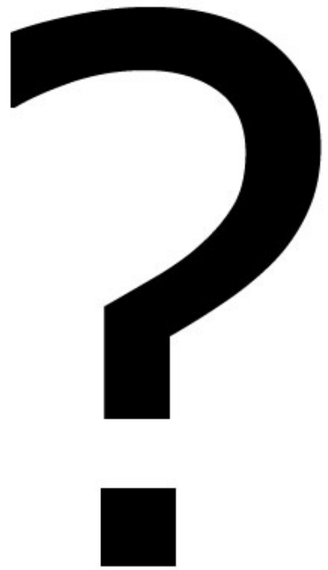
Administrators nag.



Everyone suffers.

Impact factor
was supposed to serve science

But scientists
end up serving
impact factor



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How can we better evaluate the scholarly literature?

Read it.


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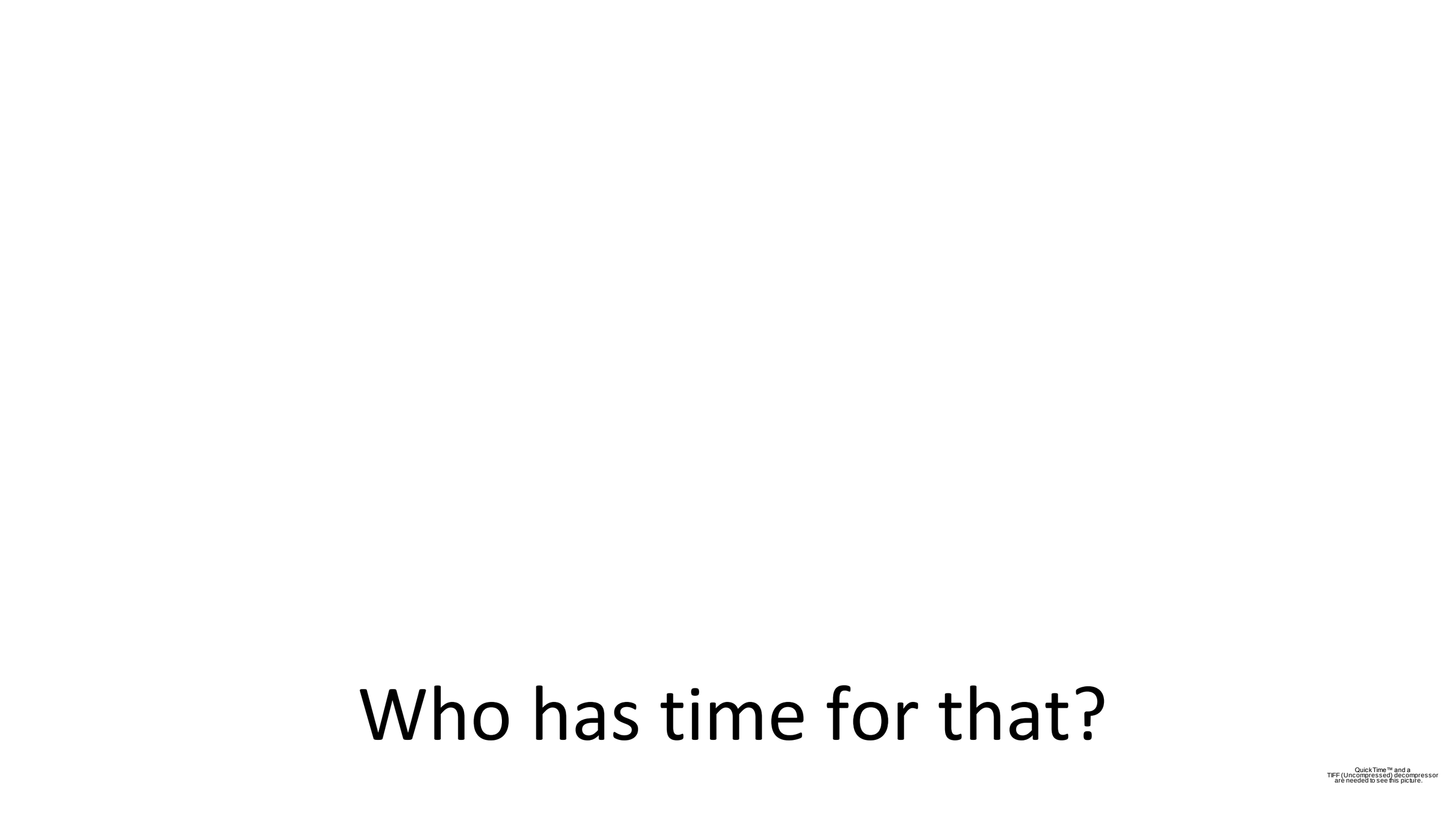
Who has time for that?



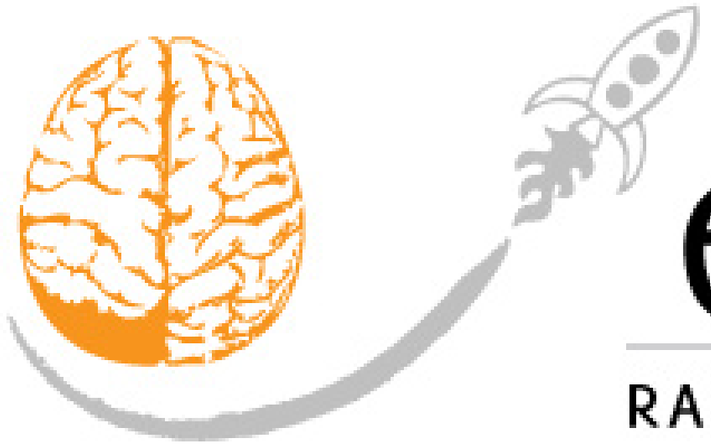
A legitimate need for quantitative measures

“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

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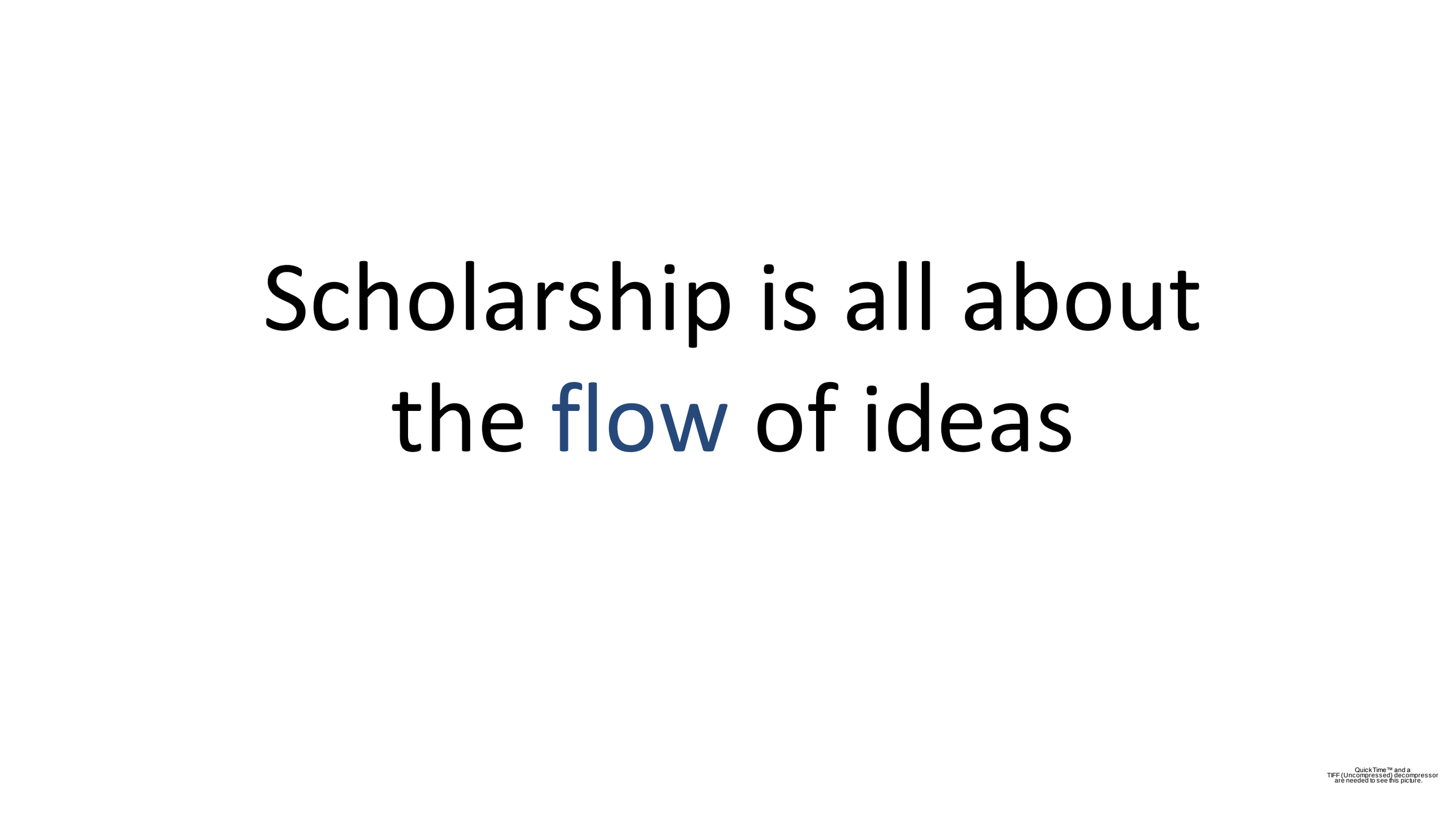
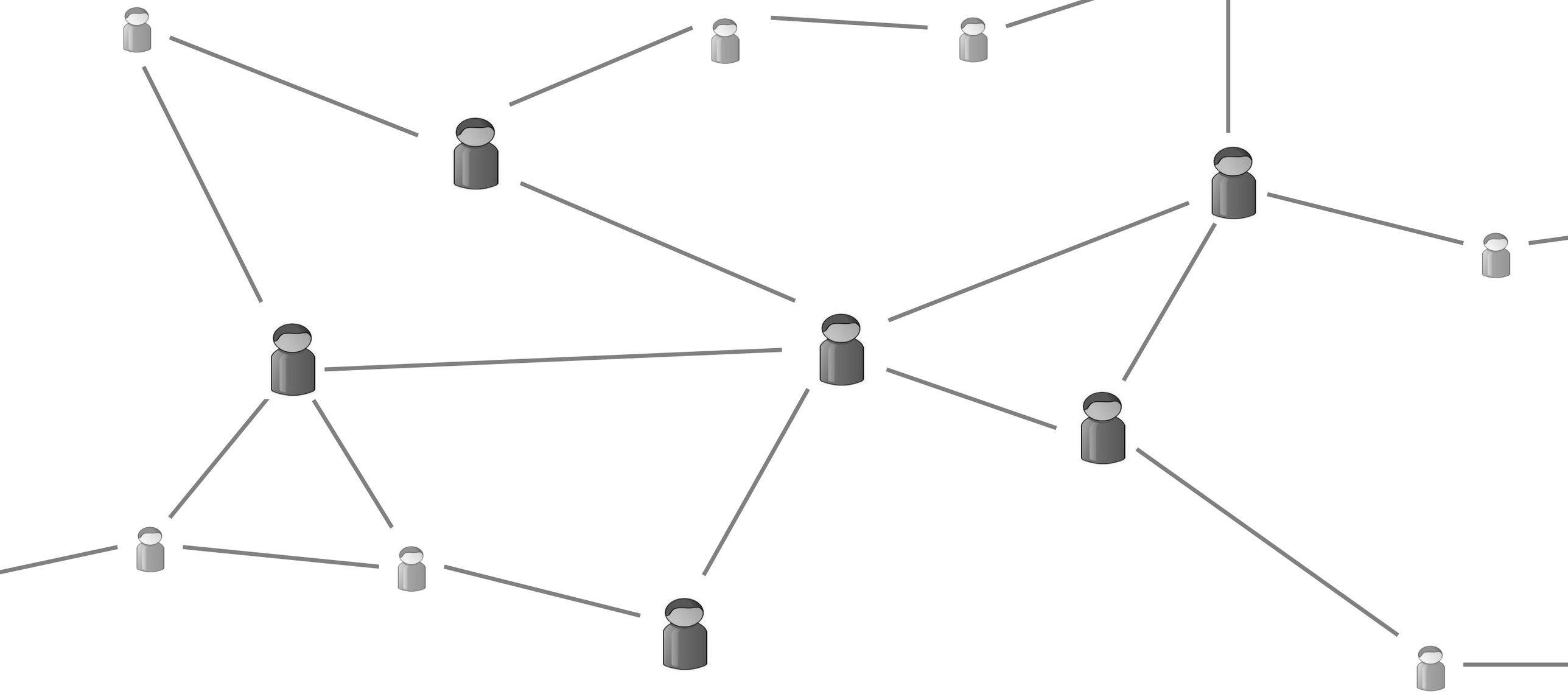
Scholarship is all about the flow of ideas

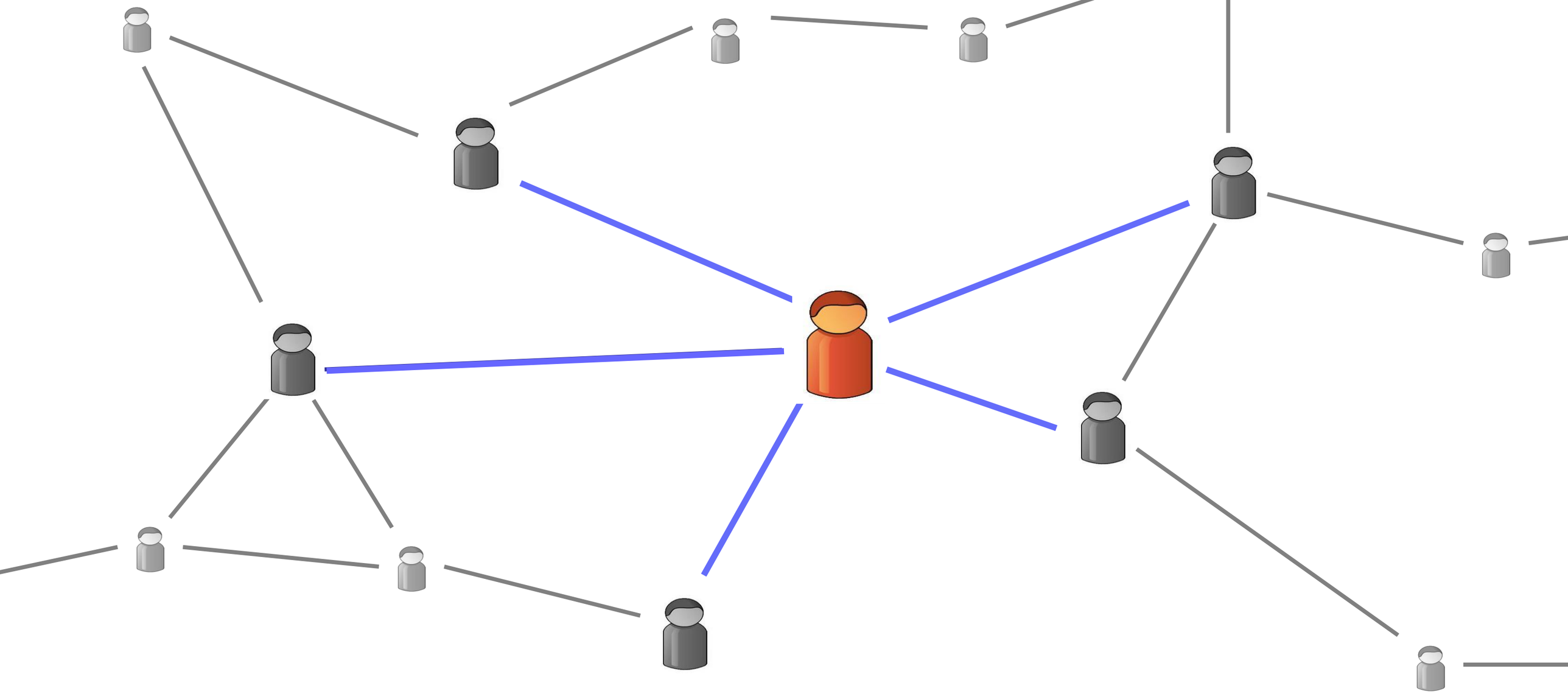


Networks are all about the flow of information

Eigenvector centrality



Who is important?



Important people have important friends

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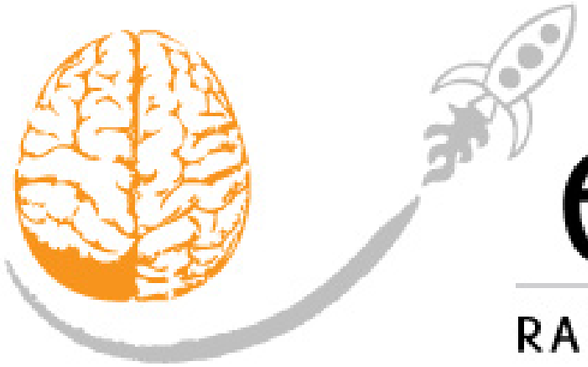
Important websites
are linked to by
important websites



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RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

Important journals

are cited by

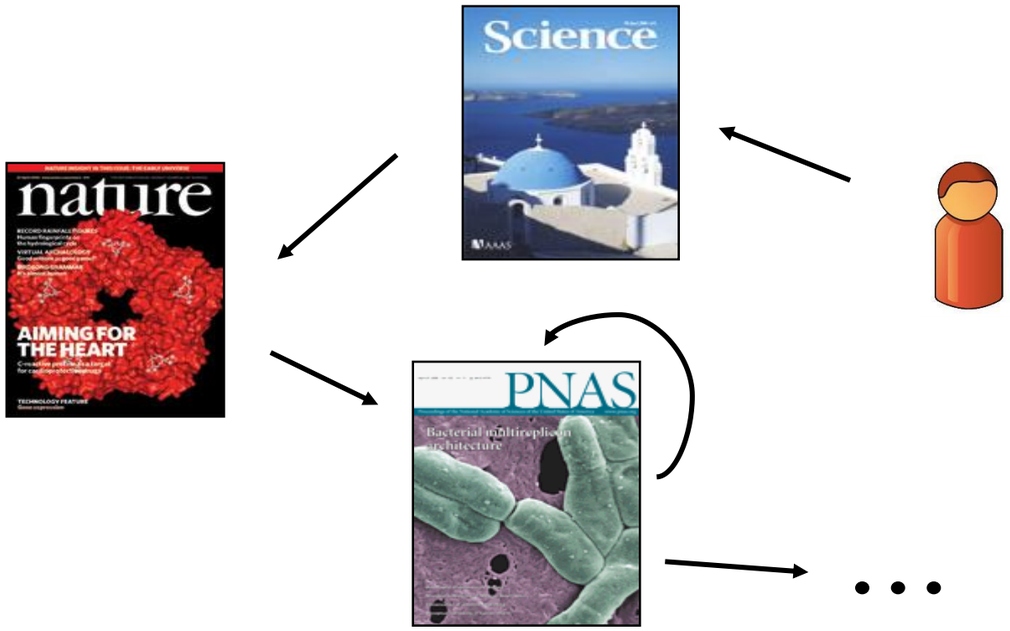
important journals

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



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RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

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

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Eigenfactor Score is a measure of total value

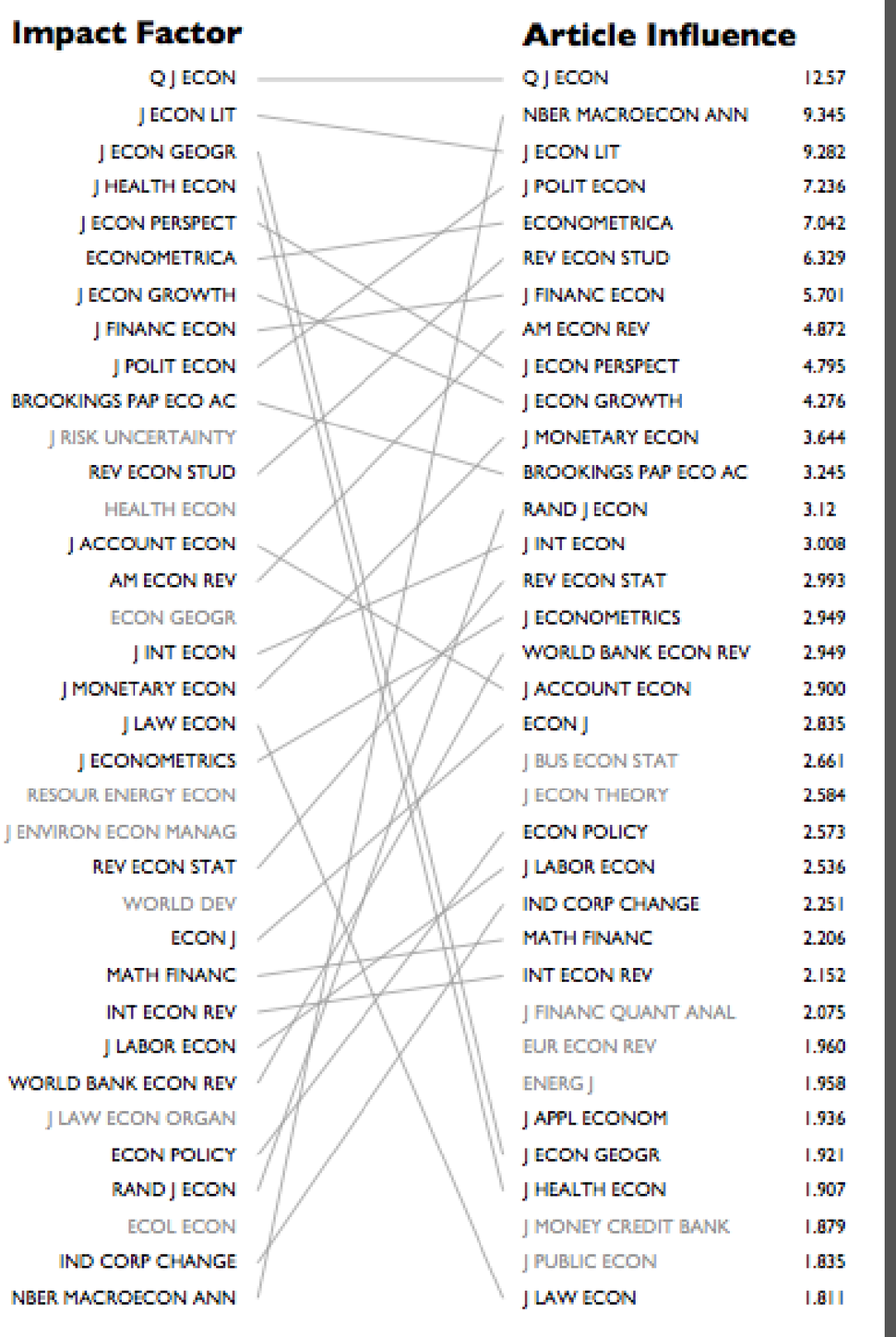
Journal	Eigenfactor™ Score
Nature	2.0%
Science	1.9%
J. Biol. Chem.	1.8%
Proc. Nat. Acad. Sci.	1.8%
Phys. Rev. Let.	1.4%
J. Am Chem. Soc	1.0%
Phys. Rev. B	0.9%
Appl. Phys. Let	0.7%
New Engl. J. Med.	0.7%
Astrophys. Let.	0.7%

Article Influence is a measure of prestige

Article Influence

$$\frac{\text{Eigenfactor}}{\text{\# Articles}}$$

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



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RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

THOMSON REUTERS™

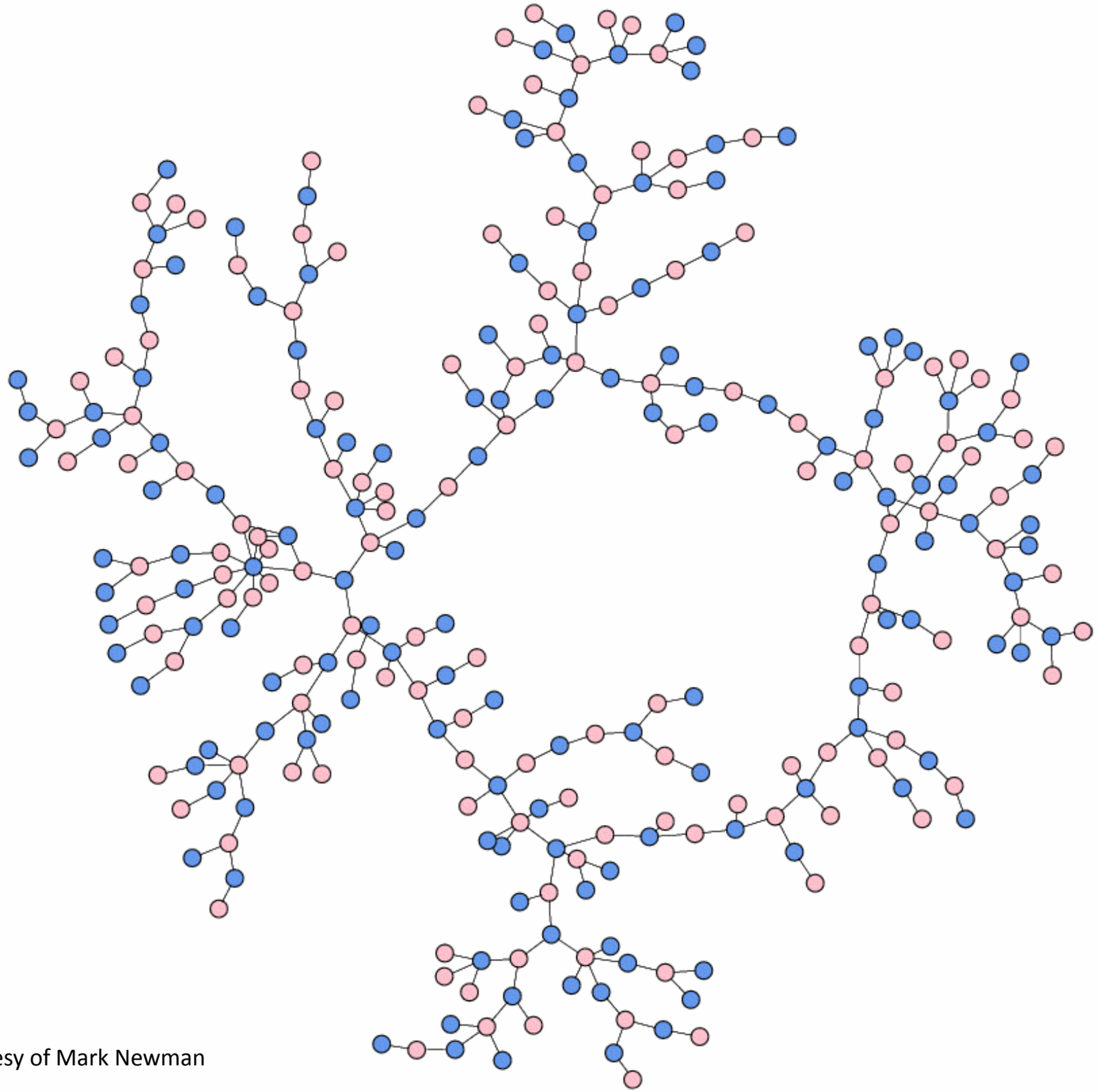
Ranking

Mapping

Discovering

Networks tell stories

High school dating network



Courtesy of Mark Newman

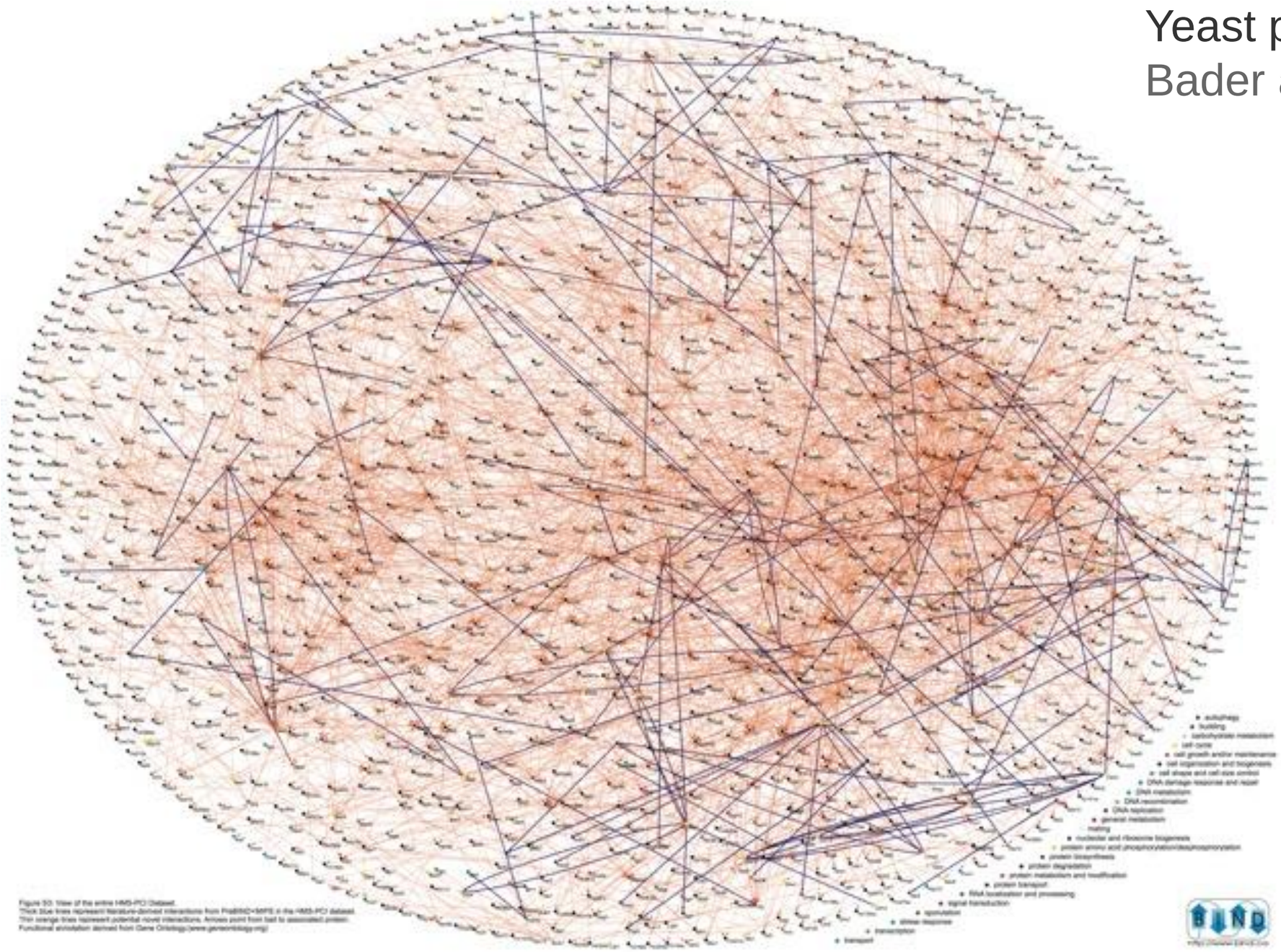
How does this approach scale up?

Social Science Journals

Loet Leydesdorff (2004)

Yeast protein interaction network

Bader and Hogue (2002) *Nature*



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good maps simplify

and highlight

relevant structures

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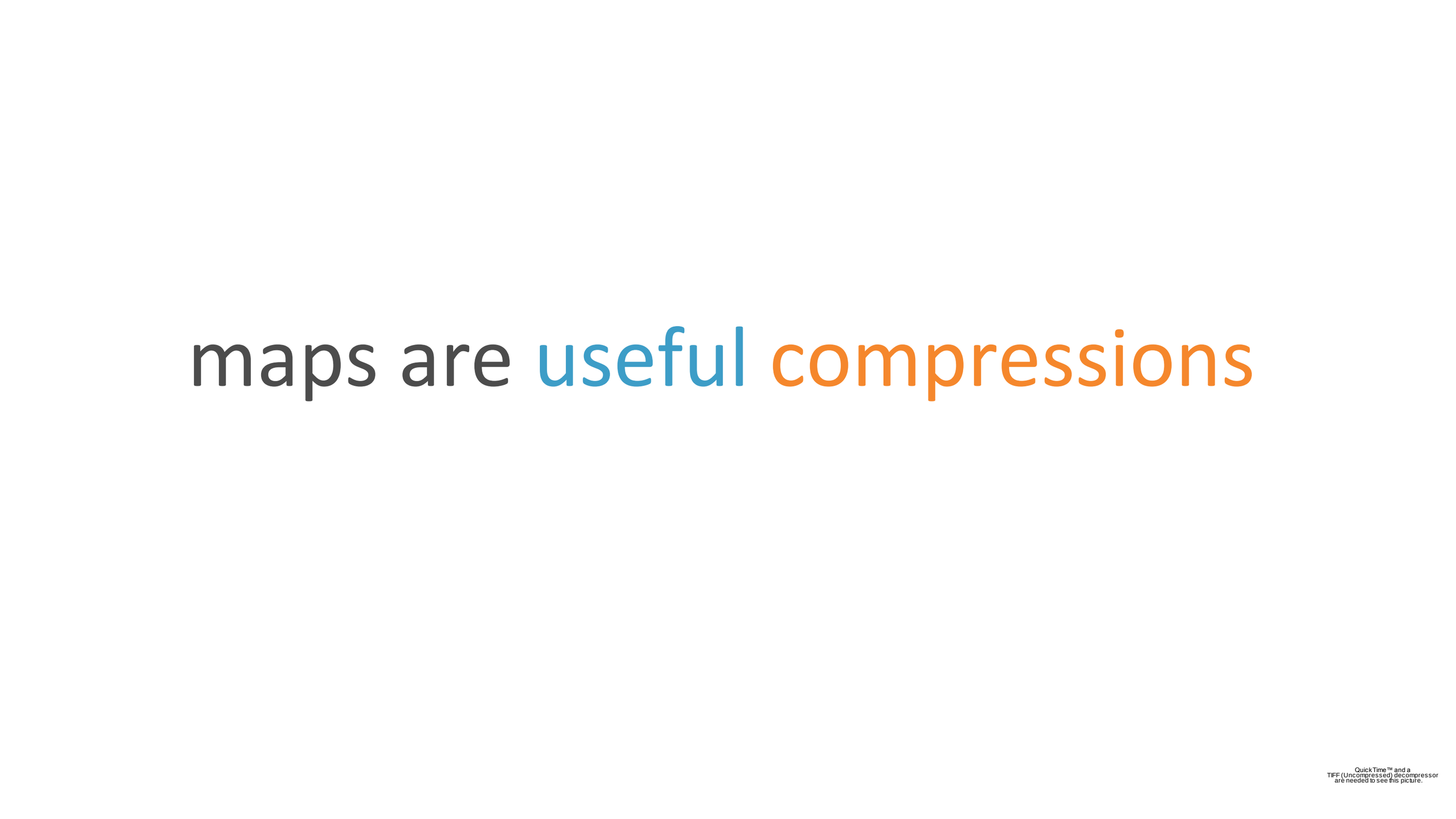
maps are useful compressions

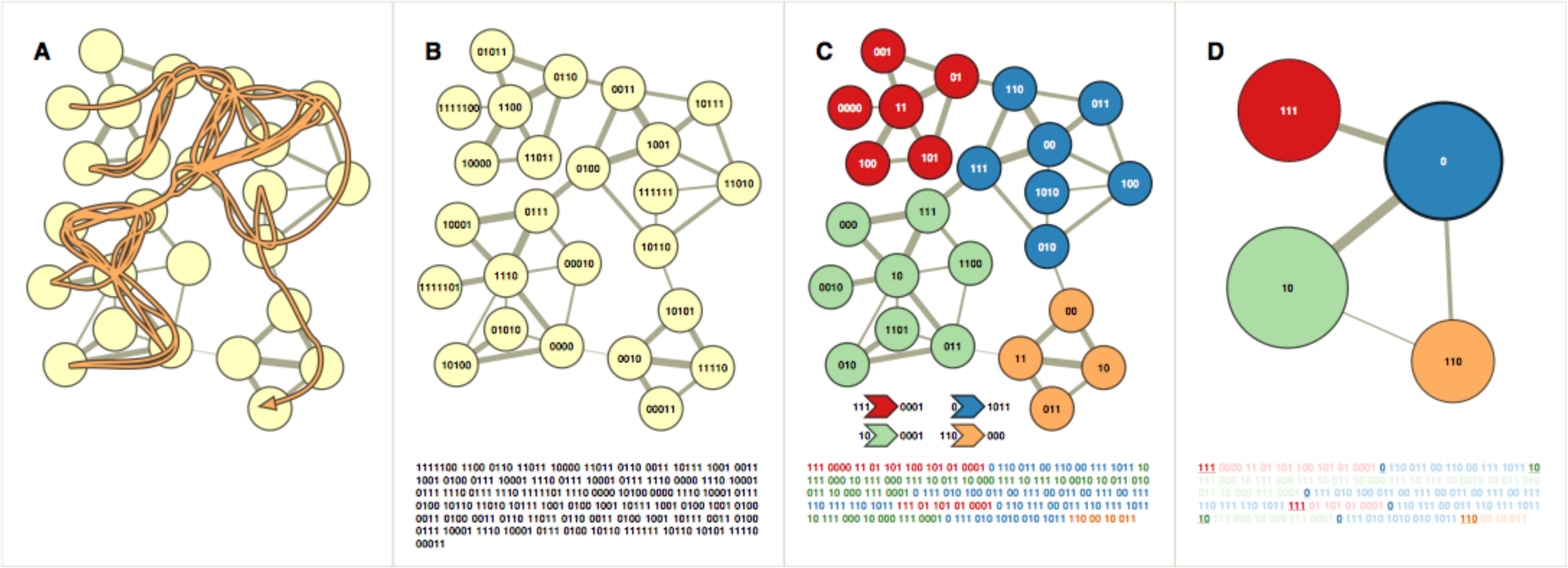


maps are useful compressions

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

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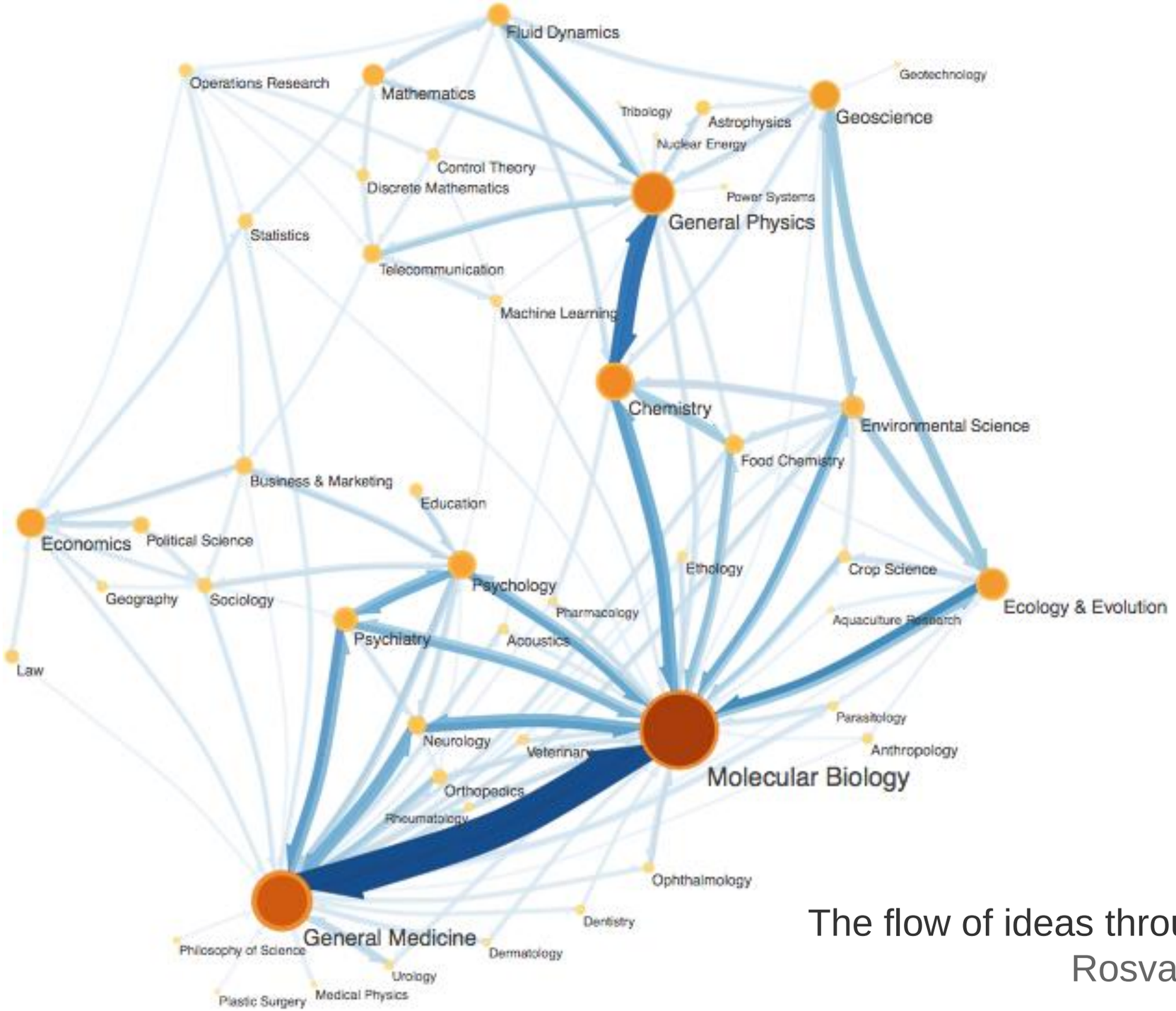
$$L(\mathrm{M}) = q_{\curvearrowright} H(\mathcal{Q}) + \sum_{i=1}^{m} p^{i}_{\circlearrowright} H(\mathcal{P}^{i})$$

The map equation

Rosvall and Bergstrom 2008 PNAS



The flow of ideas through the sciences

Rosvall and Bergstrom

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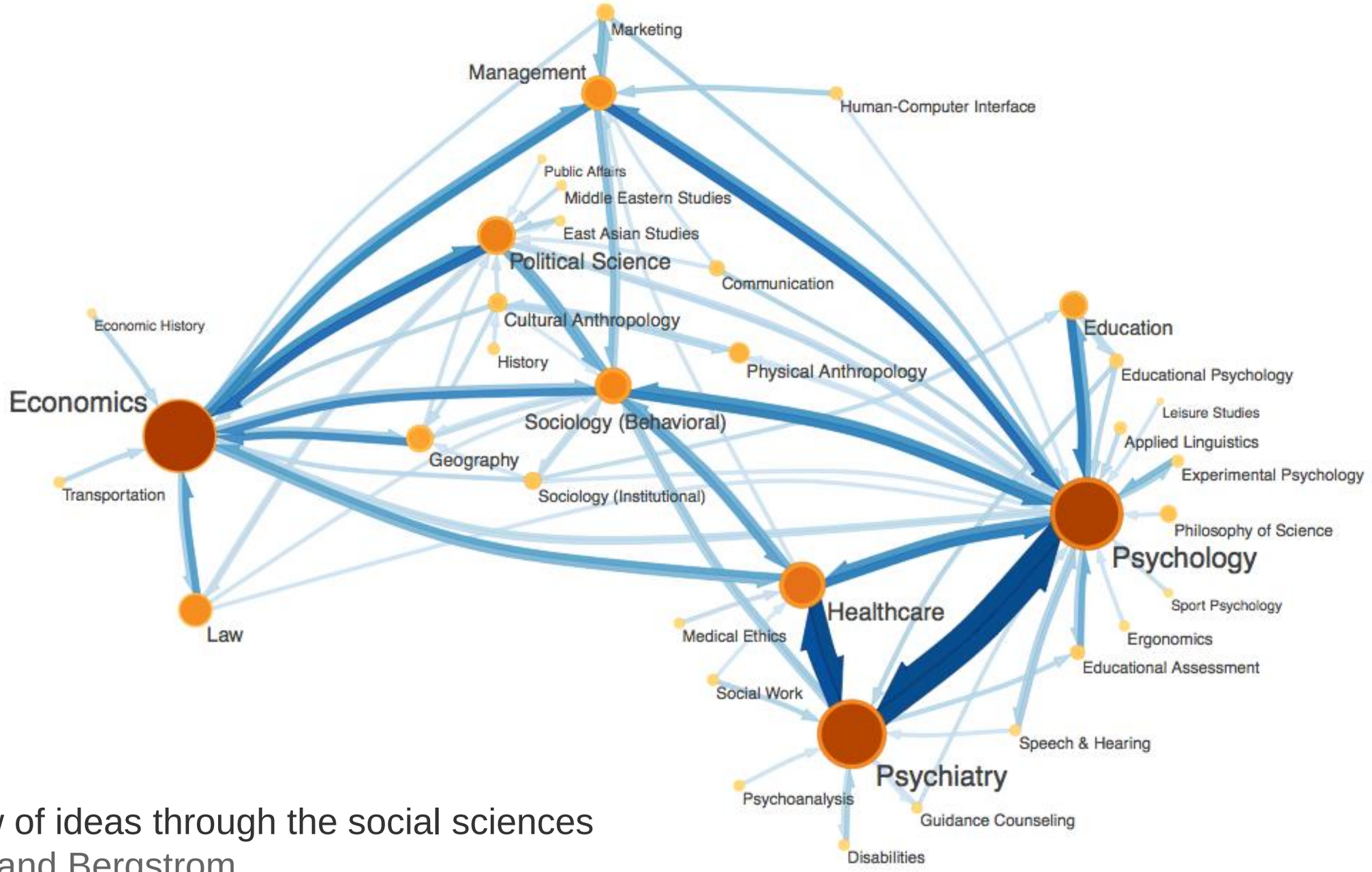
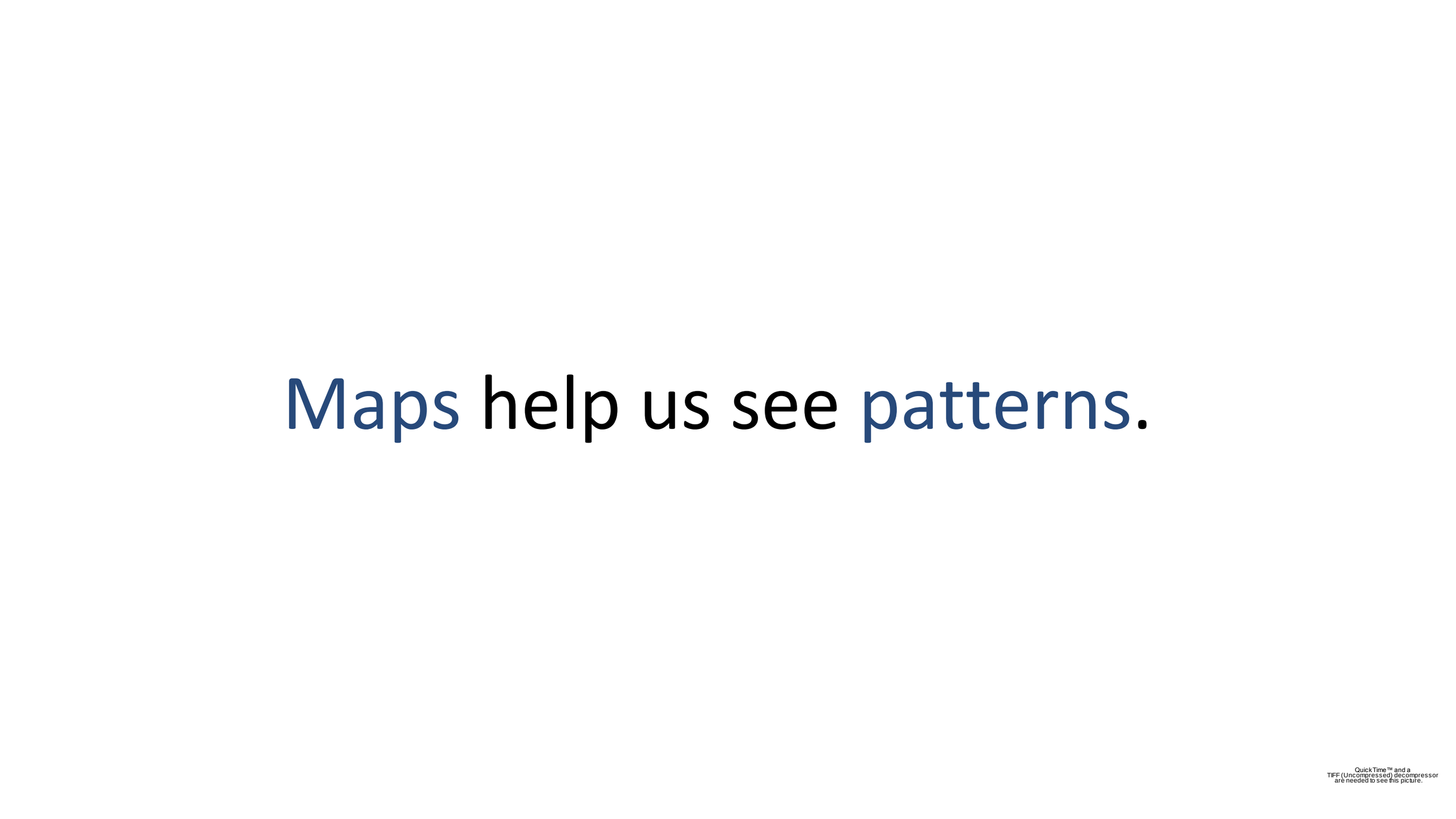
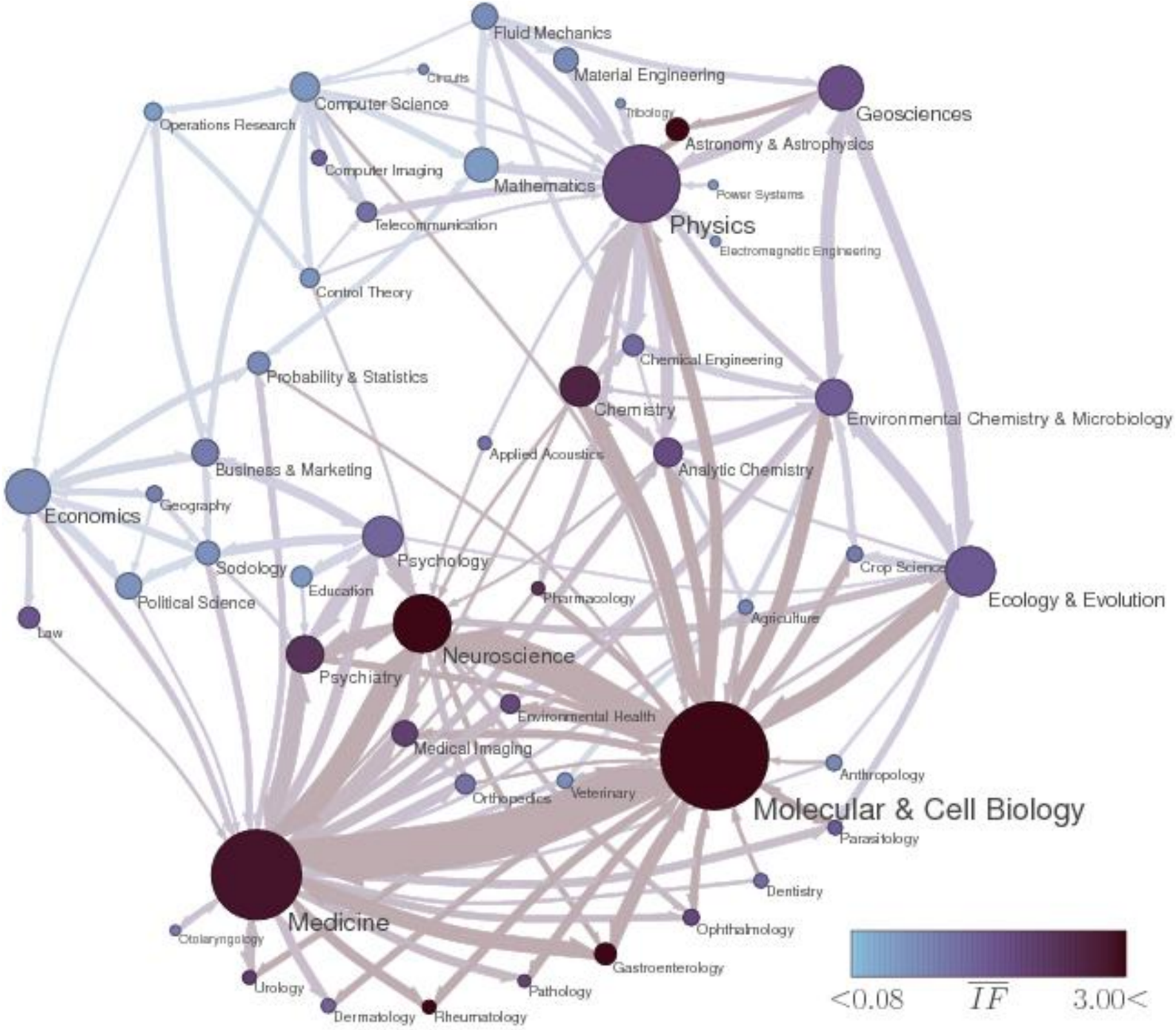


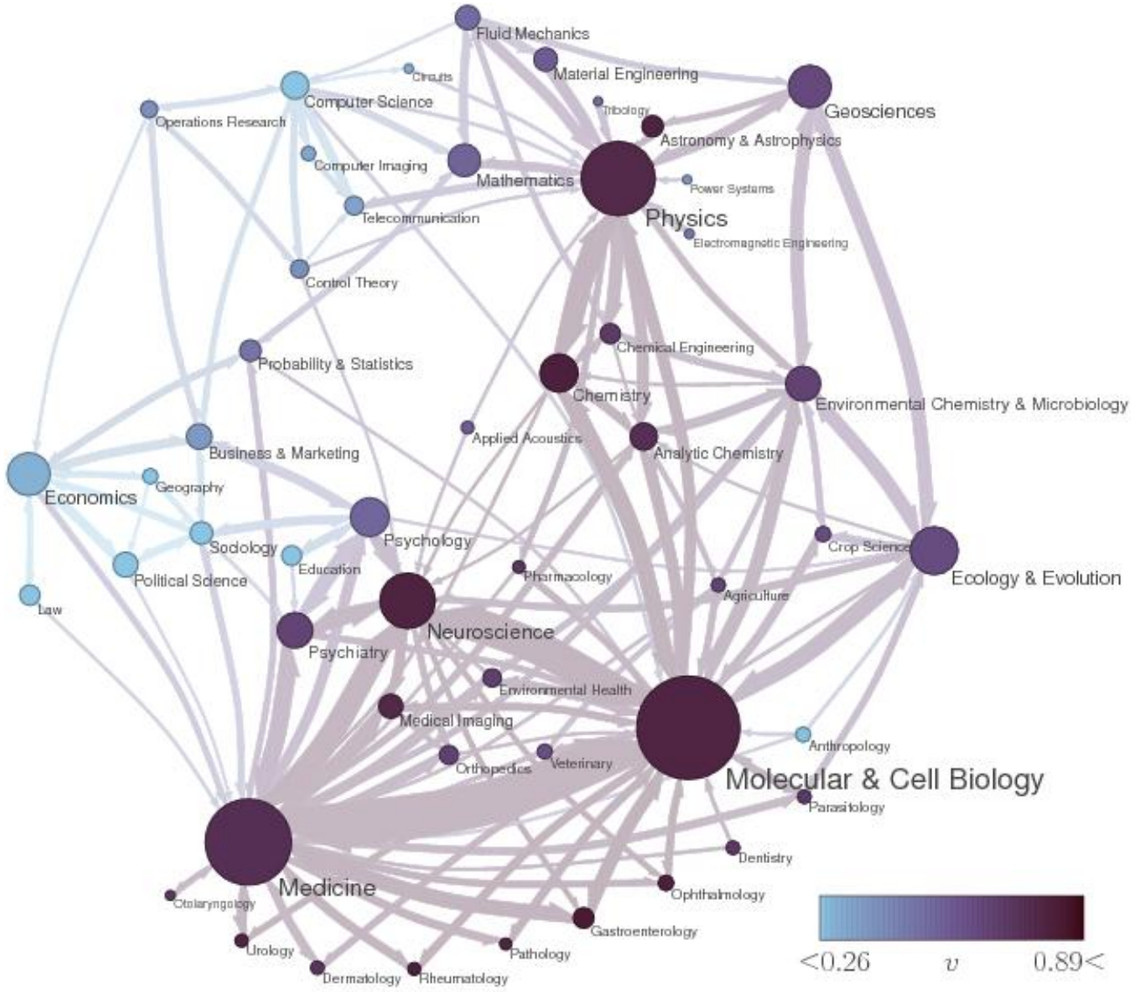
The flow of ideas through the social sciences

Rosvall and Bergstrom

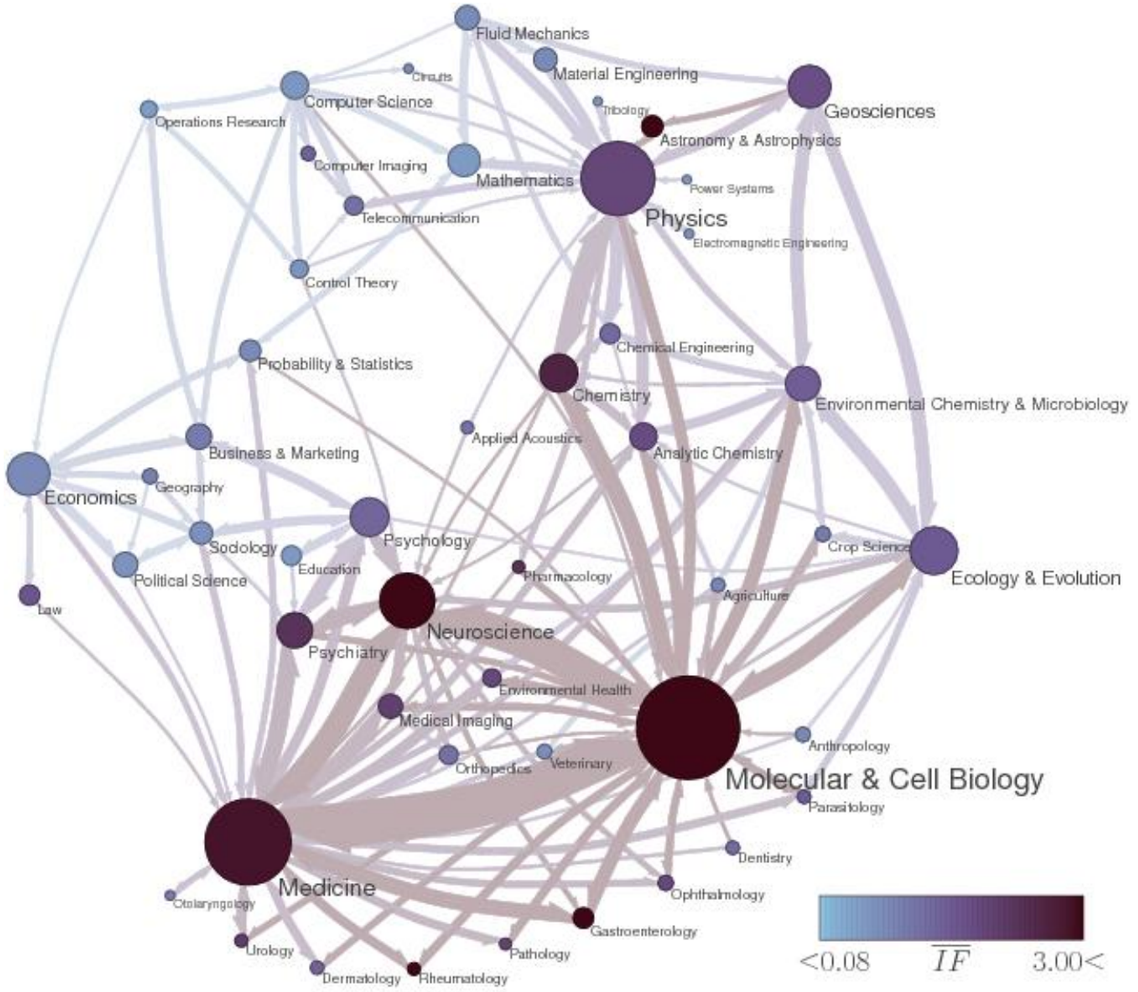
Maps help us see patterns.





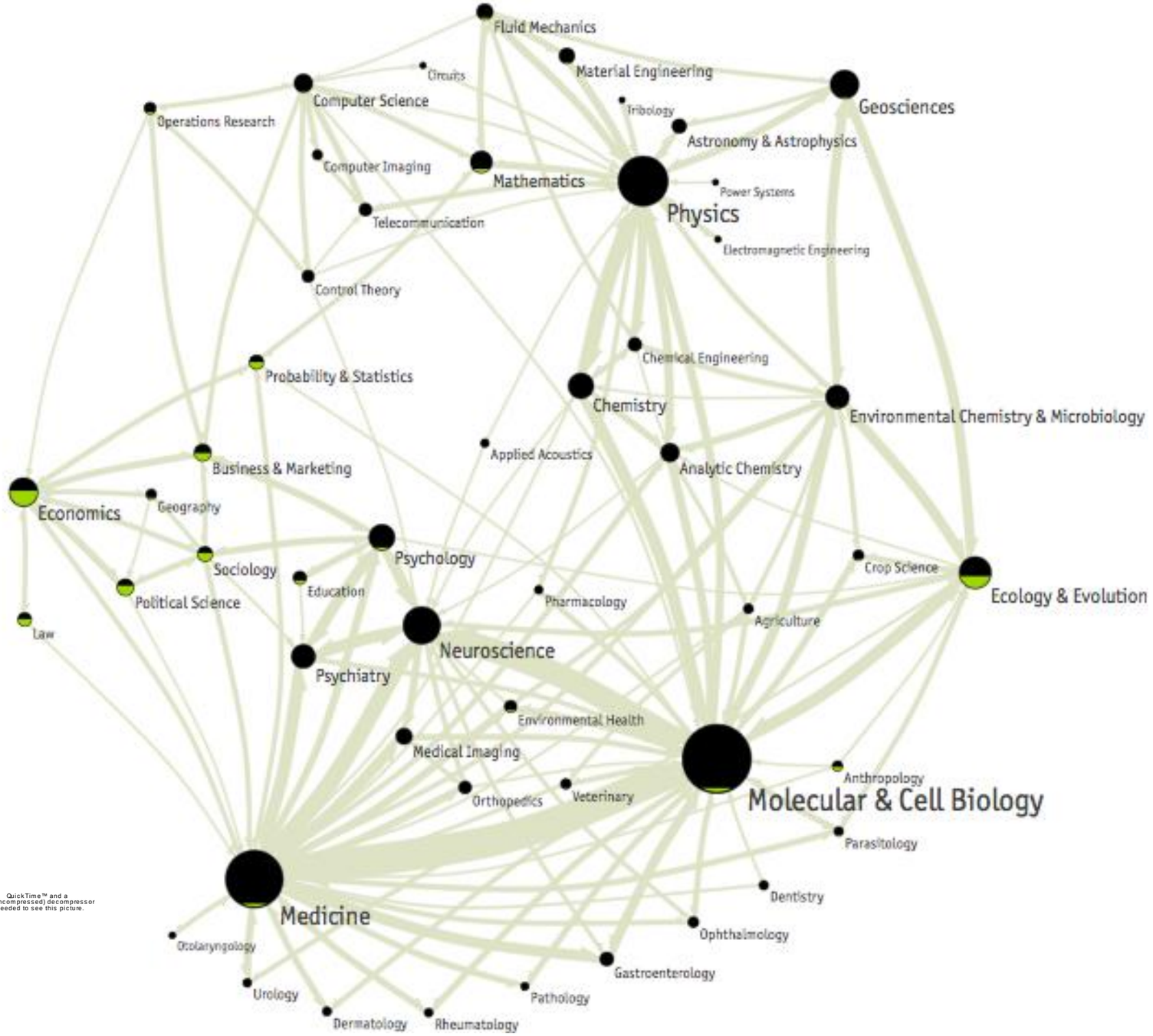


“coverage”



Impact factor

Maps give us a 30,000 foot view.



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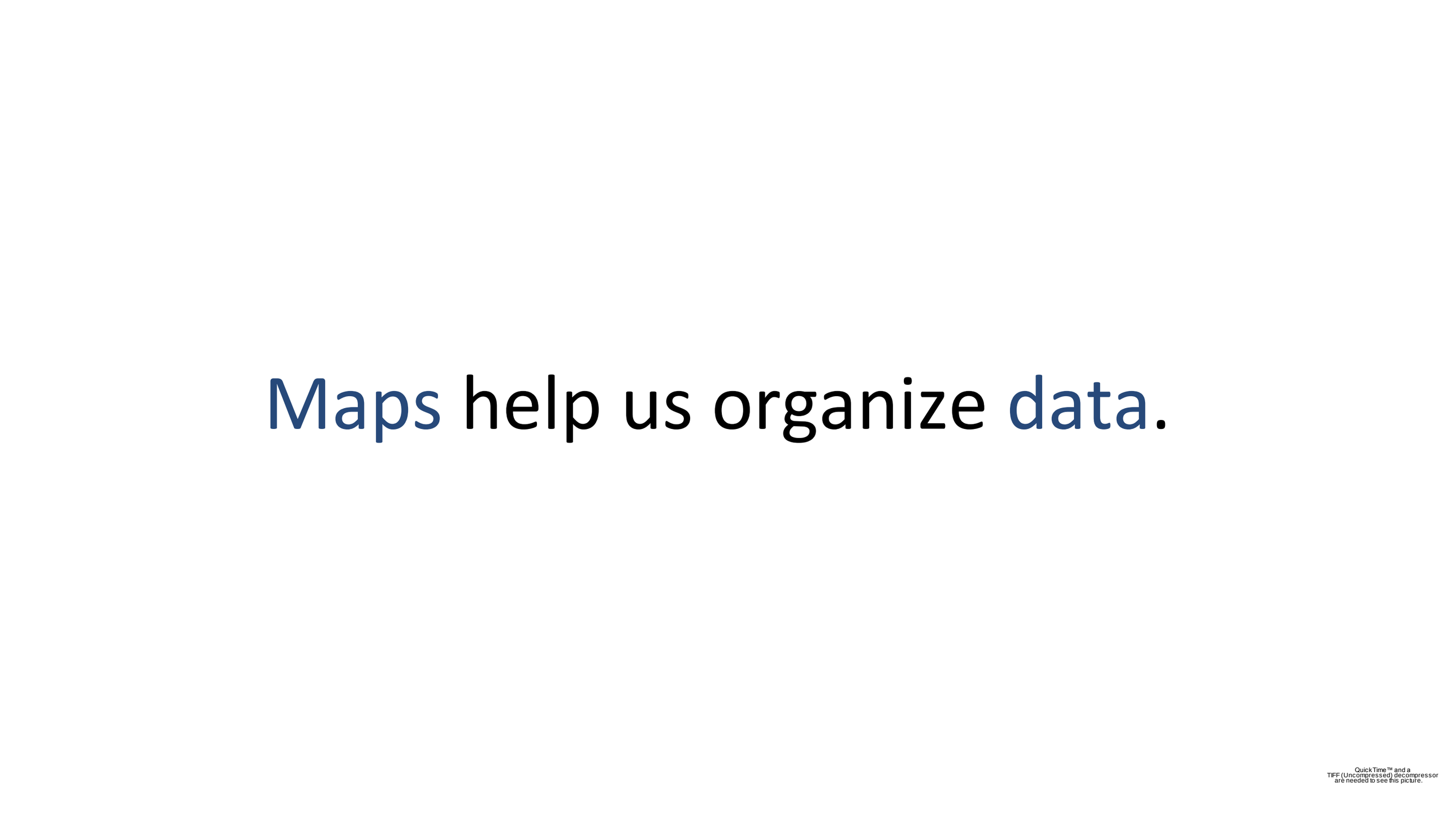
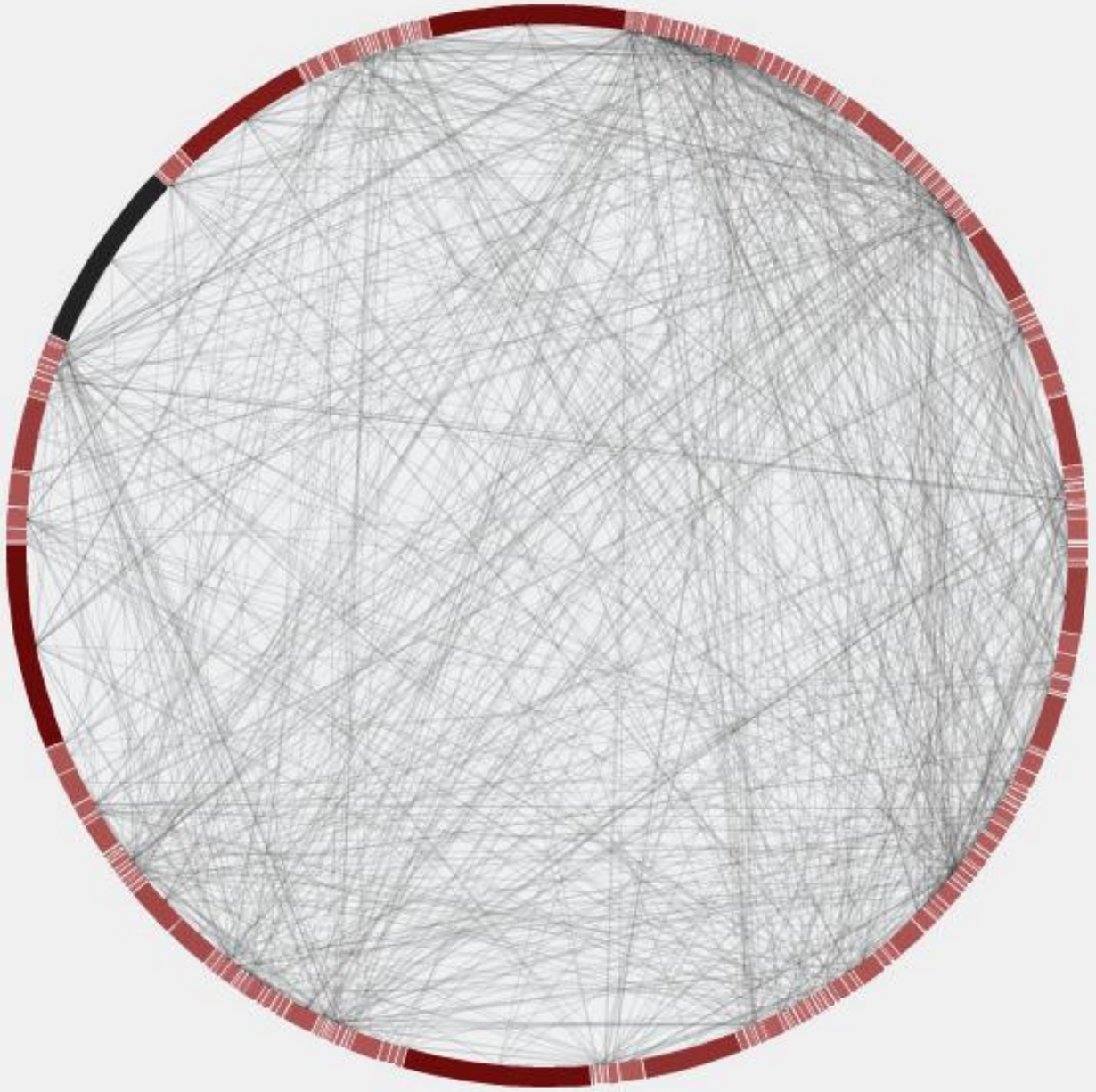
Maps help us organize data.





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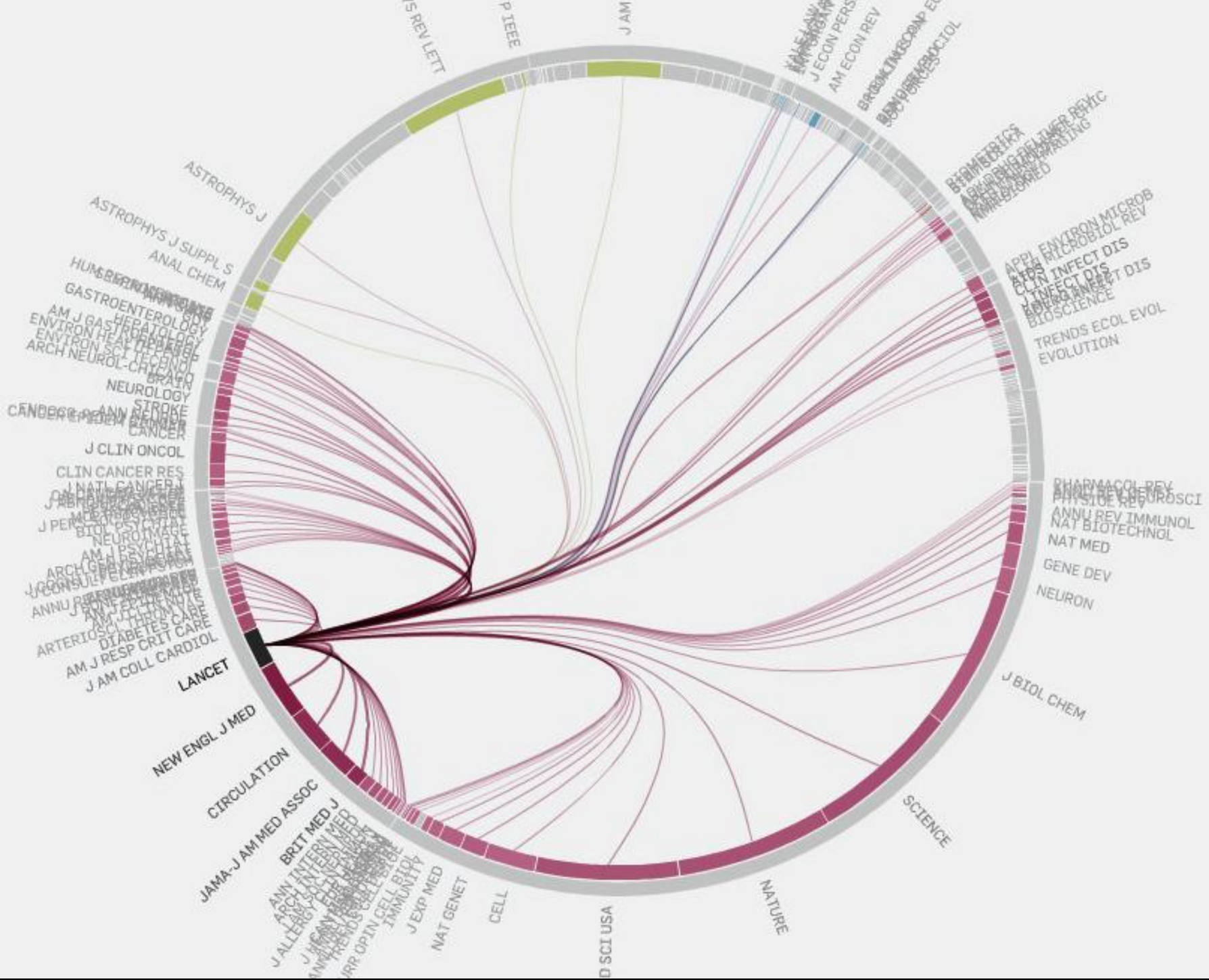

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BRAIN
CLIN CANCER RES

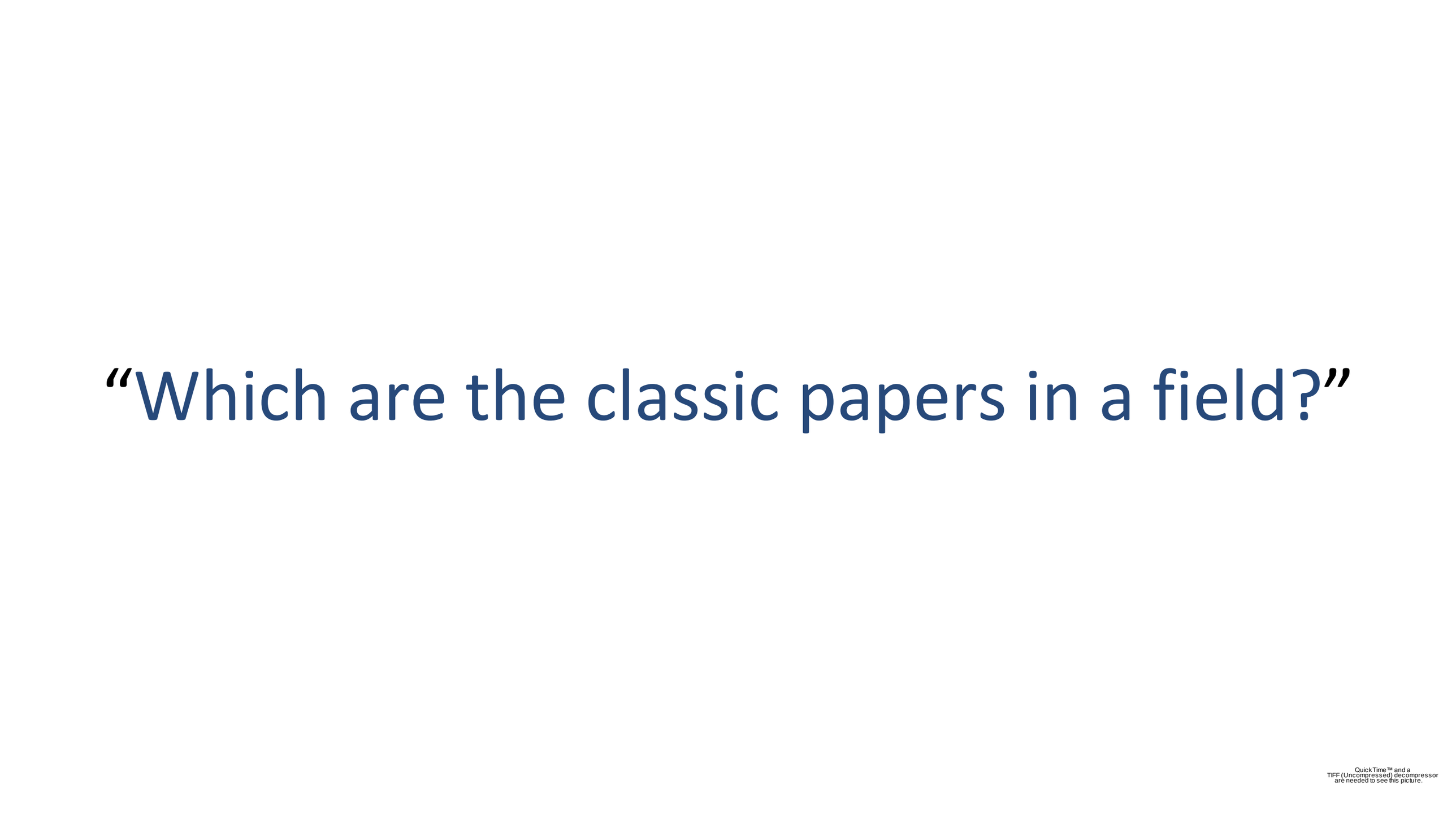
Maps help us navigate the search process.

Ranking

Mapping

Discovering

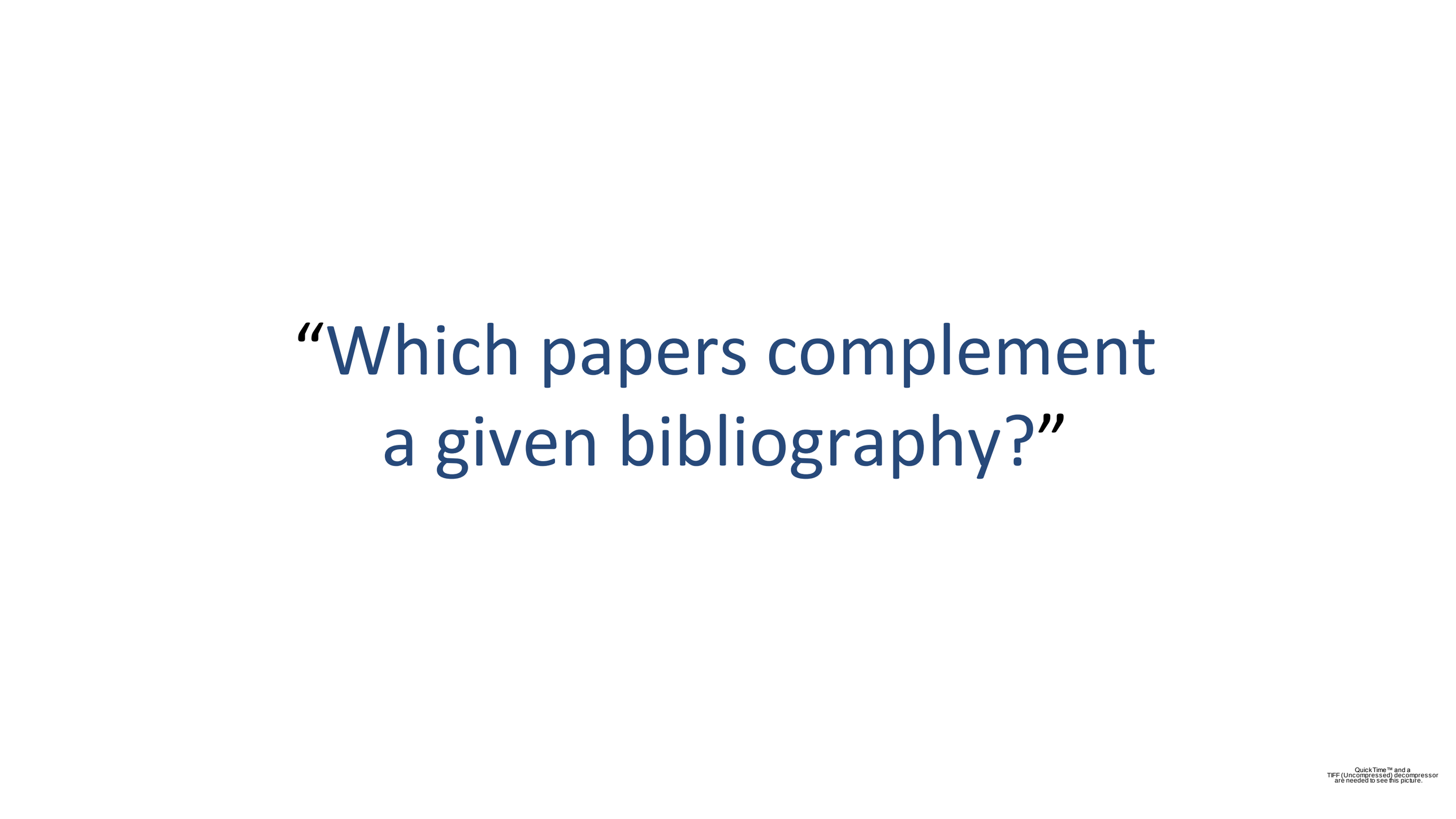
“Which are the classic papers in a field?”



“Which are the hidden gems?”

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

“Which papers complement a given bibliography?”

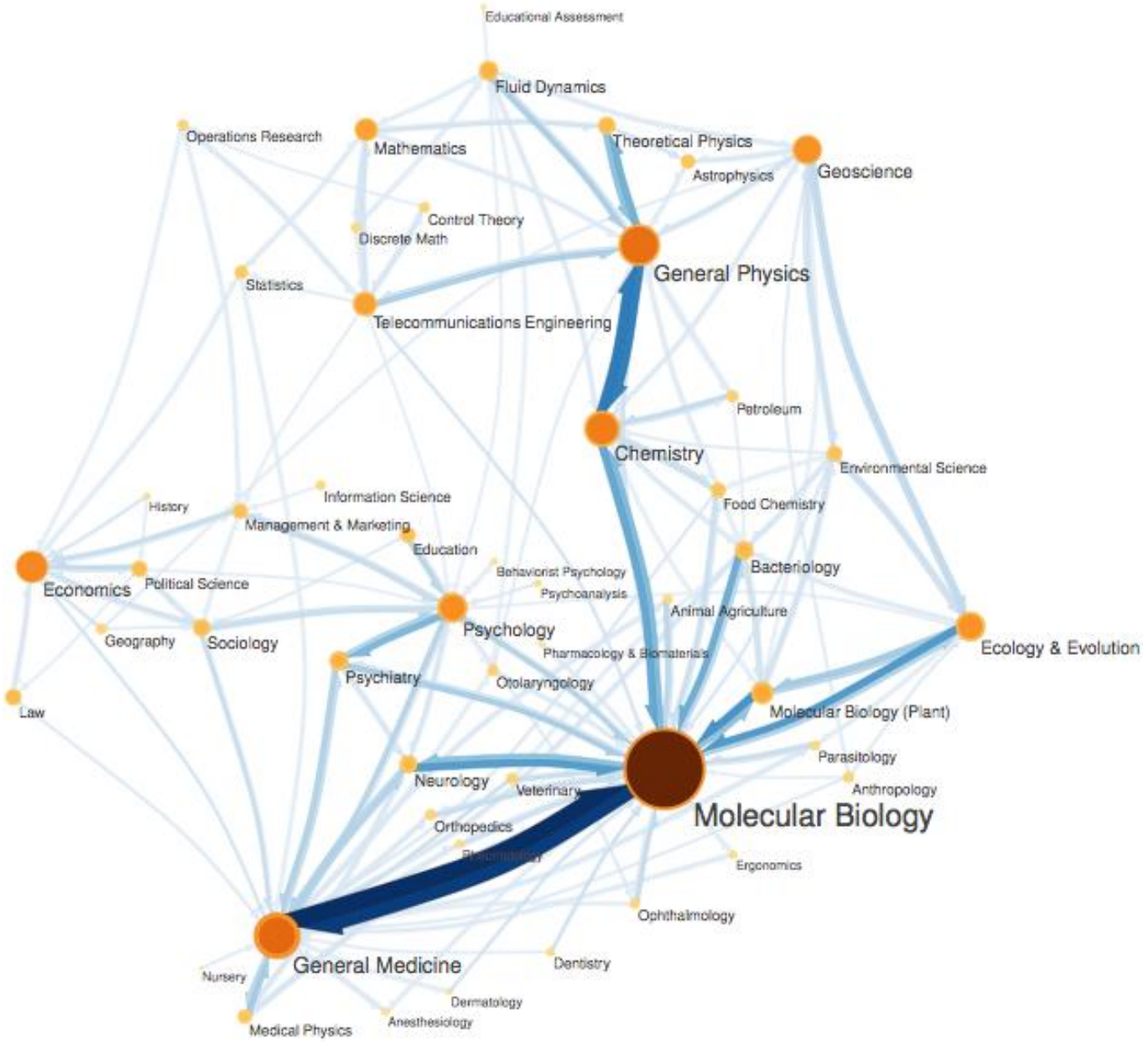


“Where are new connections arising in the sciences?”

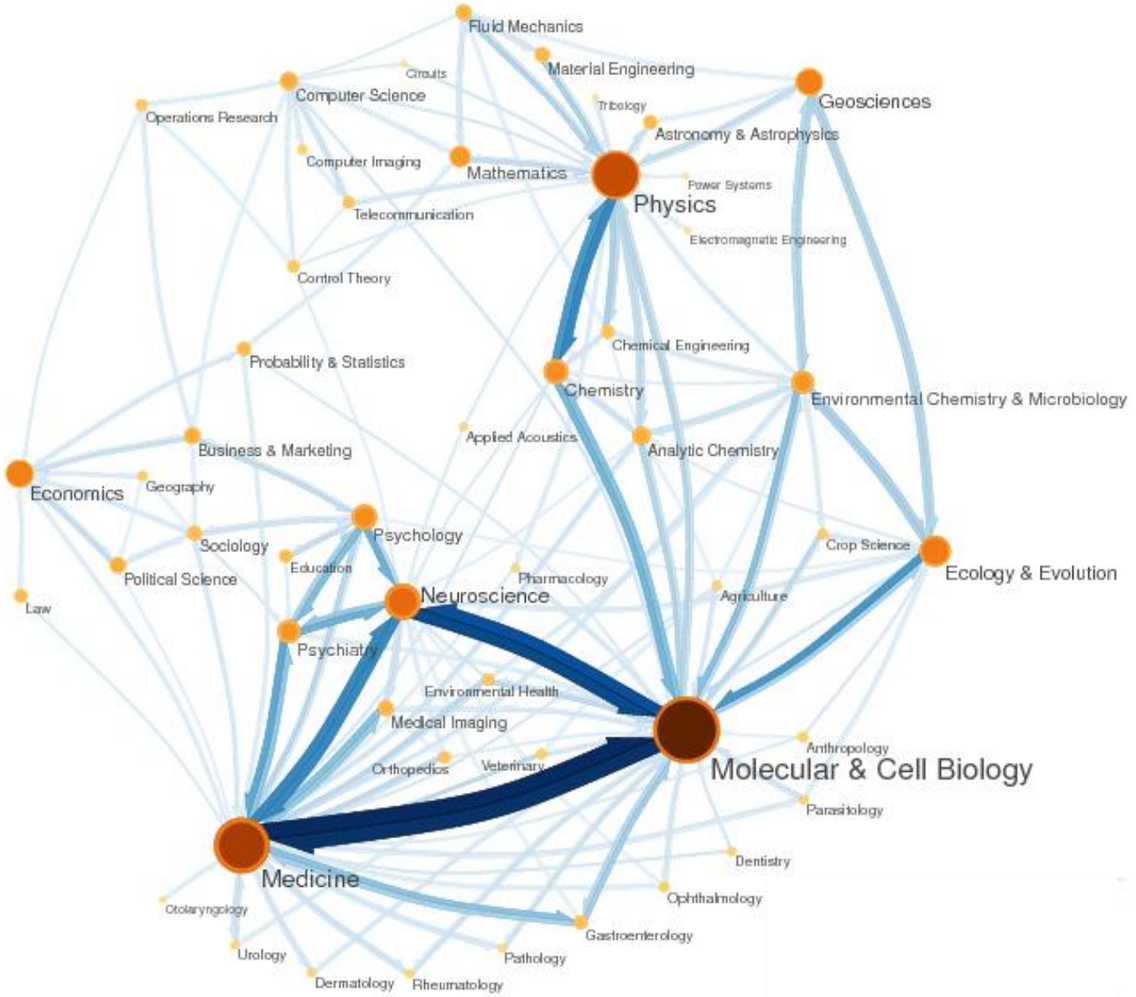
“Which journals are most important in trafficking ideas across disciplines?”

“How is the structure of science changing?”

1995



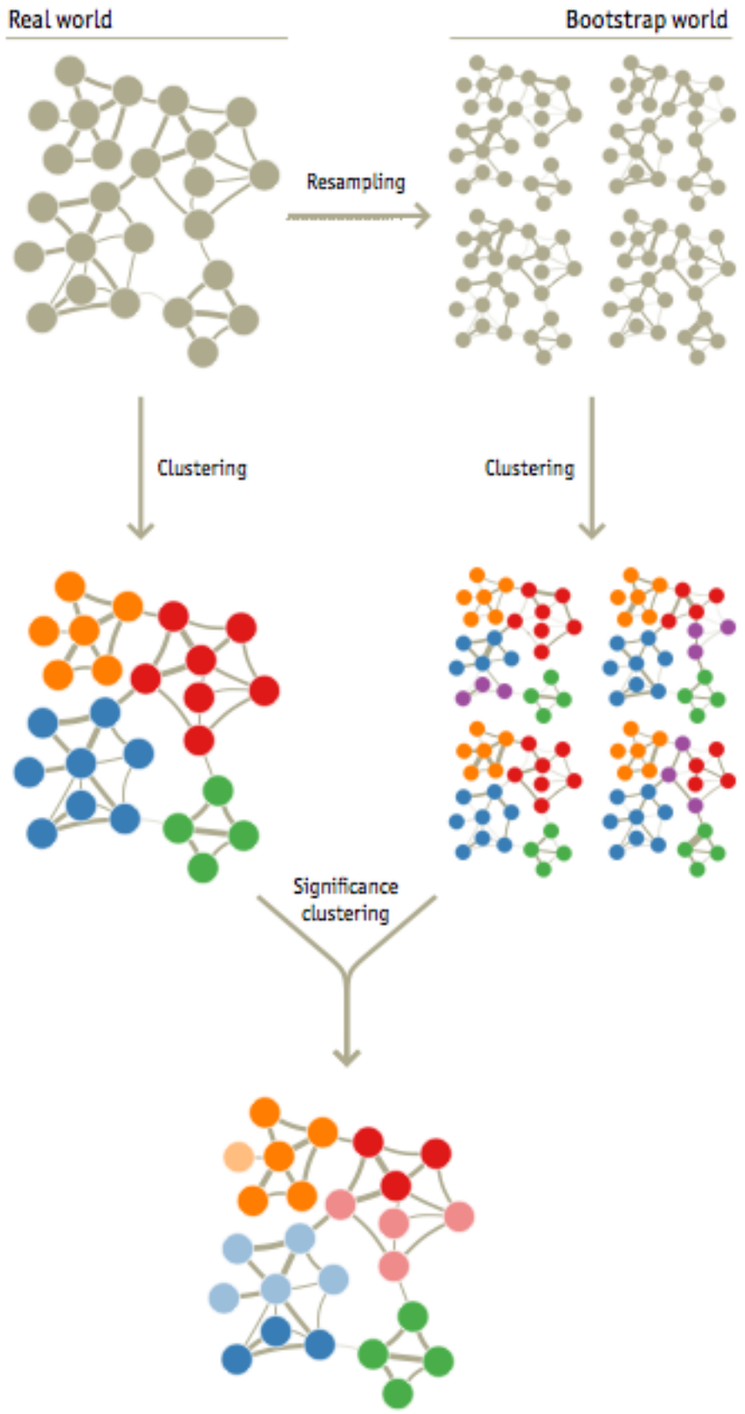
2004



What is real change and what is mere noise?

1. Determine which structures are statistically significant.

2. Visualize changes in those structures.



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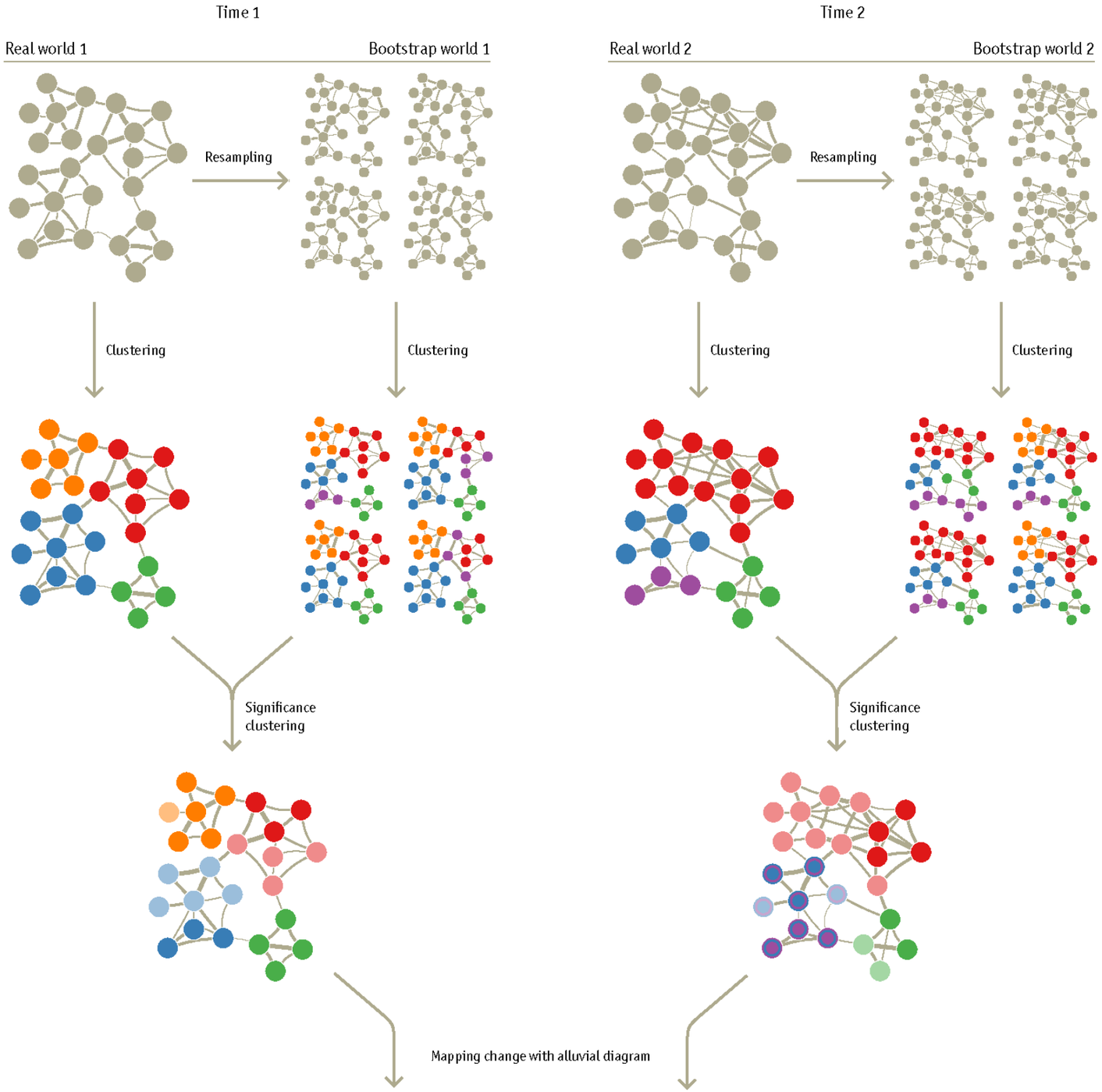
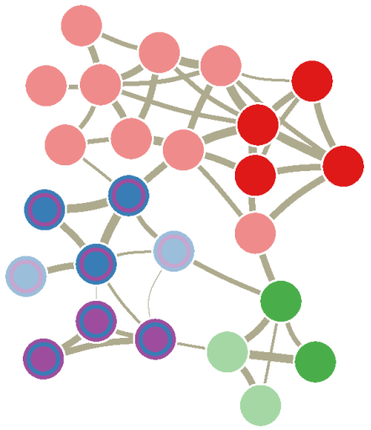
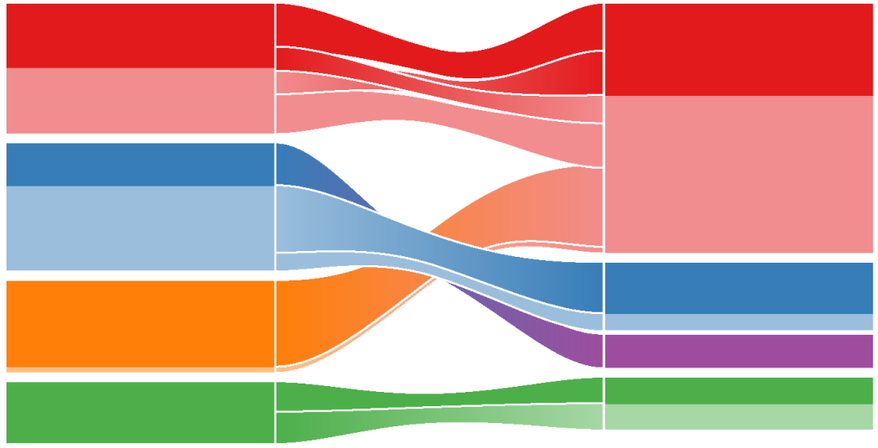


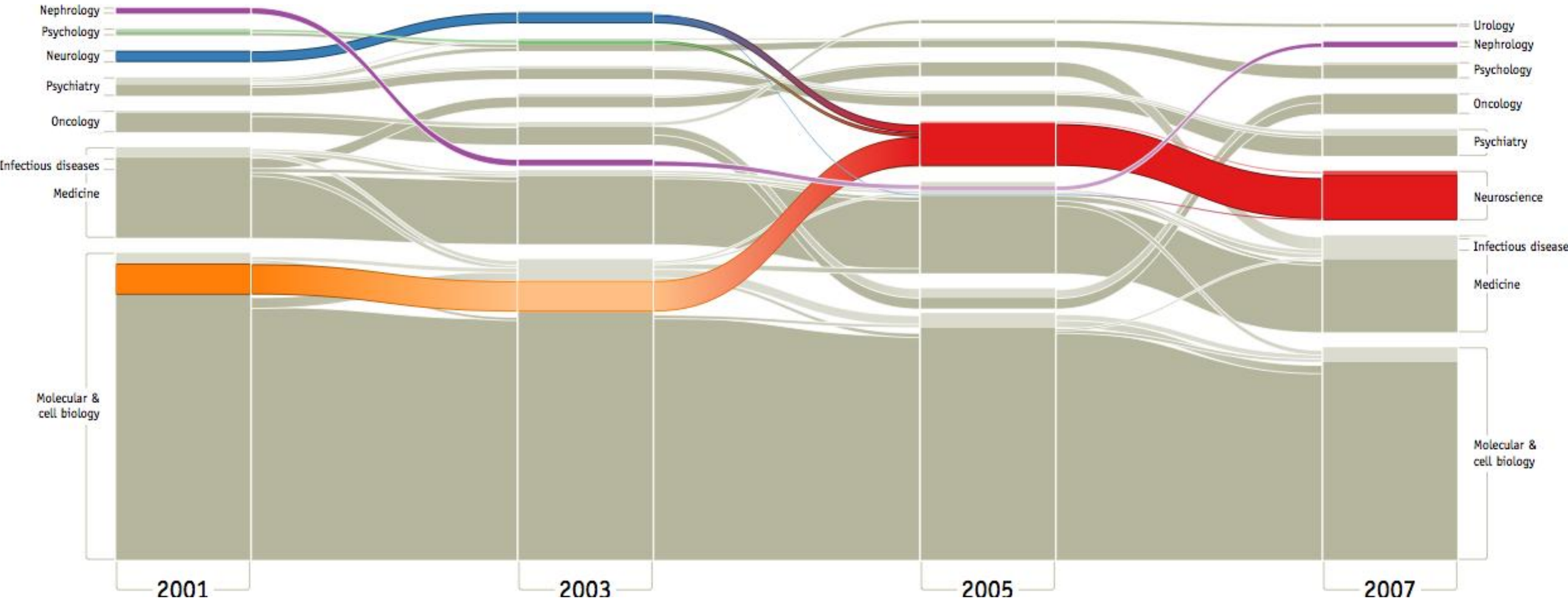


Mapping change with alluvial diagram



Time 1

Time 2



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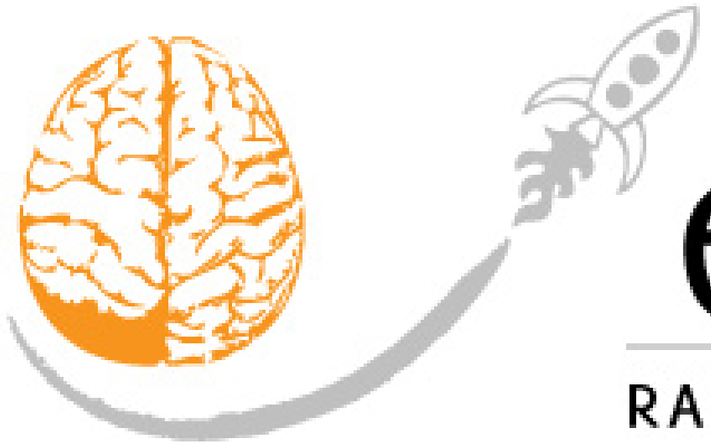

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RANKING AND MAPPING SCIENTIFIC KNOWLEDGE

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