



# Challenges in counting citations in the context of research evaluation

TU Delft

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Leiden

# Centre for Science & Technology Studies (CWTS)

## Introduction

- Founded in the later 1980s
- Originally focussed on Scientometric Research
- Developments since ~ 2010
  - Broadening of method: also qualitative (Science & Technology Studies)
  - Broadening of impact: also “societal” (e.g. altmetric)
- Besides research, also provide services (e.g. bibliometric reports)



# Focal areas

## Overview



Evaluation & Culture

Information & Openness



Engagement & Inclusion





# Citation counting challenges

## Overview

- Citation counting
- Normalisation
- Field classifications
- Fractionalisation
- Comparison with peer review

# Citation counting



# Counting citations

## Web of Science

### Systematic analysis of agreement between metrics and peer review in the UK REF

By: Traag, VA (Traag, V. A.) <sup>[1]</sup>; Waltman, L (Waltman, L.) <sup>[1]</sup>

[View Web of Science ResearcherID and ORCID](#) (provided by Clarivate)

#### PALGRAVE COMMUNICATIONS

Volume: 5

Article Number: 29

DOI: 10.1057/s41599-019-0233-x

Published: MAR 12 2019

Indexed: 2019-04-05

Document Type: Article

#### Citation Network

In Web of Science Core Collection

25  
Citations

 [Create citation alert](#)

25  
Times Cited in All  
Databases

48  
Cited References

[View Related Records](#)

13 [Evaluation practices and effects of indicator use-a literature review](#)

[de Rijcke, S](#); [Wouters, PE](#); (...); [Hammarfelt, B](#)  
Apr 2016 | RESEARCH EVALUATION 25 (2) , pp.161-169

[Get it @Leiden](#) [Free Full Text From Publisher](#) ...

14 [Not available]

[Derrick, G](#)  
2018 | The Evaluators' Eye. , pp.1-230  
Palgrave Macmillan, Cham  
URL: <https://doi.org/10.1007/978-3-319-63627-6>

15 [Not available]

[Earla, K](#) and [Simmonds, P](#)  
2015 | REF accountability review: costs, benefits and burden-report by Technopolis to the four UK higher education funding bodies  
Technopolis

# Counting citations

## Dimensions

Publication - Article

### Systematic analysis of agreement between metrics and p

Humanities and Social Sciences Communications, 5(1), 29 - March 2019

<https://doi.org/10.1057/s41599-019-0233-x>

#### Authors

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Corresponding Author

L. Waltman - Leiden University

#### Publication metrics

##### Dimensions Badge



45	Total citations
20	Recent citations
42	Field Citations
n/a	Relative Citations

#### Publication references - 39 [Show all](#)

Peer Review and Citation Data in Predicting University Rankings, a Large-Scale Analysis

David Pride, Petr Knoth

2018, Digital Libraries for Open Knowledge - Chapter

Citations 18 Altmetric 2 [Open Access](#) [Add to Library](#)

Performance-based research funding in EU Member States—a comparative assessment

Thomas Zacharewicz, Benedetto Lepori, Emanuela Reale, Koen Jonkers

2018, Science and Public Policy - Article

Citations 69 Altmetric 12 [View PDF](#) [Add to Library](#)

The Evaluators' Eye, Impact Assessment and Academic Peer Review

Gemma Derrick

2018 - Monograph

Citations 44 Altmetric 62 [Open Access](#) [Add to Library](#)

Measuring scientific impact beyond academia: An assessment of existing impact metrics and proposed improvements

James Ravenscroft, Maria Liakata, Amanda Clare, Daniel Duma

2017, PLOS ONE - Article

Citations 112 Altmetric 64 [View PDF](#) [Add to Library](#)

Microsoft Academic: is the phoenix getting wings?

Anne-Wil Harzing, Satu Alakangas

2016, Scientometrics - Article

Citations 69 Altmetric 31 [Open Access](#) [Add to Library](#)

[More](#)

# Counting citations

Google Scholar

[HTML] **Systematic analysis** of agreement between metrics and peer review in the **UK REF**

[VA Traag, L Waltman - Palgrave Communications, 2019 - nature.com](#)

... To provide an indication of the importance of the **REF 2014**, we briefly look at the funding of **UK** higher education in 2017–2018 Footnote 2 . In 2017–2018, **REF** results based on ...

☆ Save  Cite **Cited by 54** [Related articles](#) [All 12 versions](#)



# What citations count?

## Document types, self-citations

### The Leiden Manifesto for research metrics

By: Hicks, D (Hicks, Diana) <sup>[1]</sup>; Wouters, P (Wouters, Paul) <sup>[2], [3]</sup>; **Waltman, L** (Waltman, Ludo) <sup>[3]</sup>; de Rijcke, S (de Rijcke, Sarah) <sup>[3]</sup>; Rafols, I (Rafols, Ismael) <sup>[4], [5]</sup>

[View Web of Science ResearcherID and ORCID](#) (provided by Clarivate)

### NATURE

Volume: 520 Issue: 7548 Page: 429-431

DOI: 10.1038/520429a

Published: APR 23 2015

Indexed: 2015-04-23

Document Type: **Editorial Material**

#### 8 Rivals for the crown: Reply to Opthof and Leydesdorff

[van Raan, AFJ](#); [van Leeuwen, TN](#); (...); **Waltman, L**

Jul 2010 | JOURNAL OF INFORMETRICS 4 (3) , pp.431-435

[Get it @ Leiden](#) [Free Published Article From Repository](#) [Full Text at Publisher](#) ...

#### 9 The Leiden ranking 2011/2012: Data collection, indicators, and interpretation

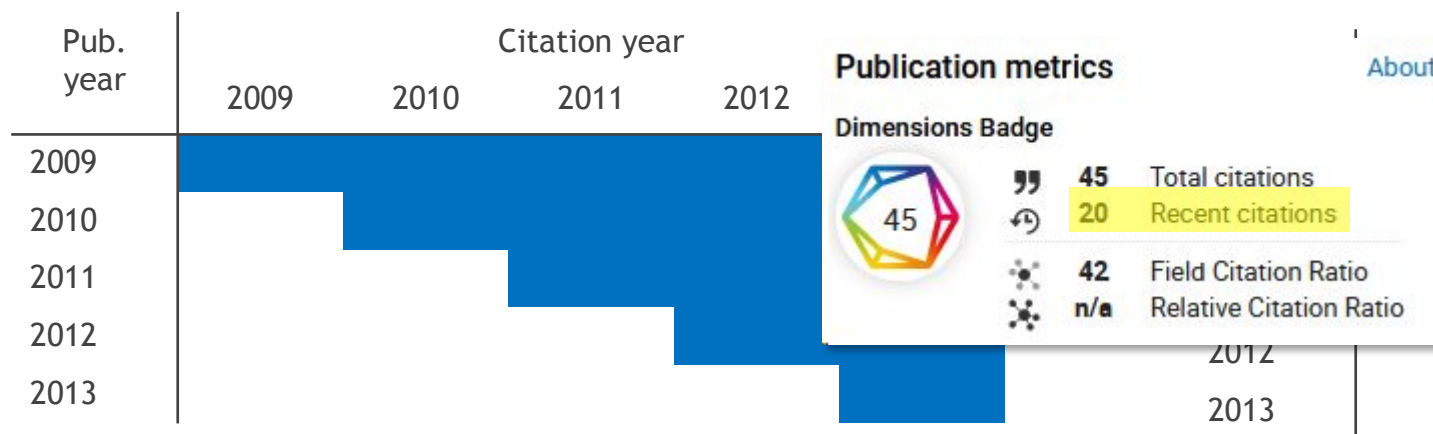
**Waltman, L**; [Calero-Medina, C](#); (...); [Wouters, P](#)

Dec 2012 | JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE AND TECHNOLOGY 63 (12) , pp.2419-2432

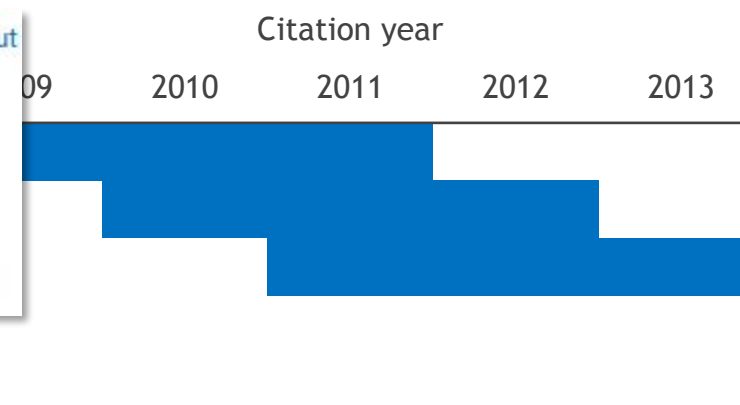
# What citations count?

## Citation window

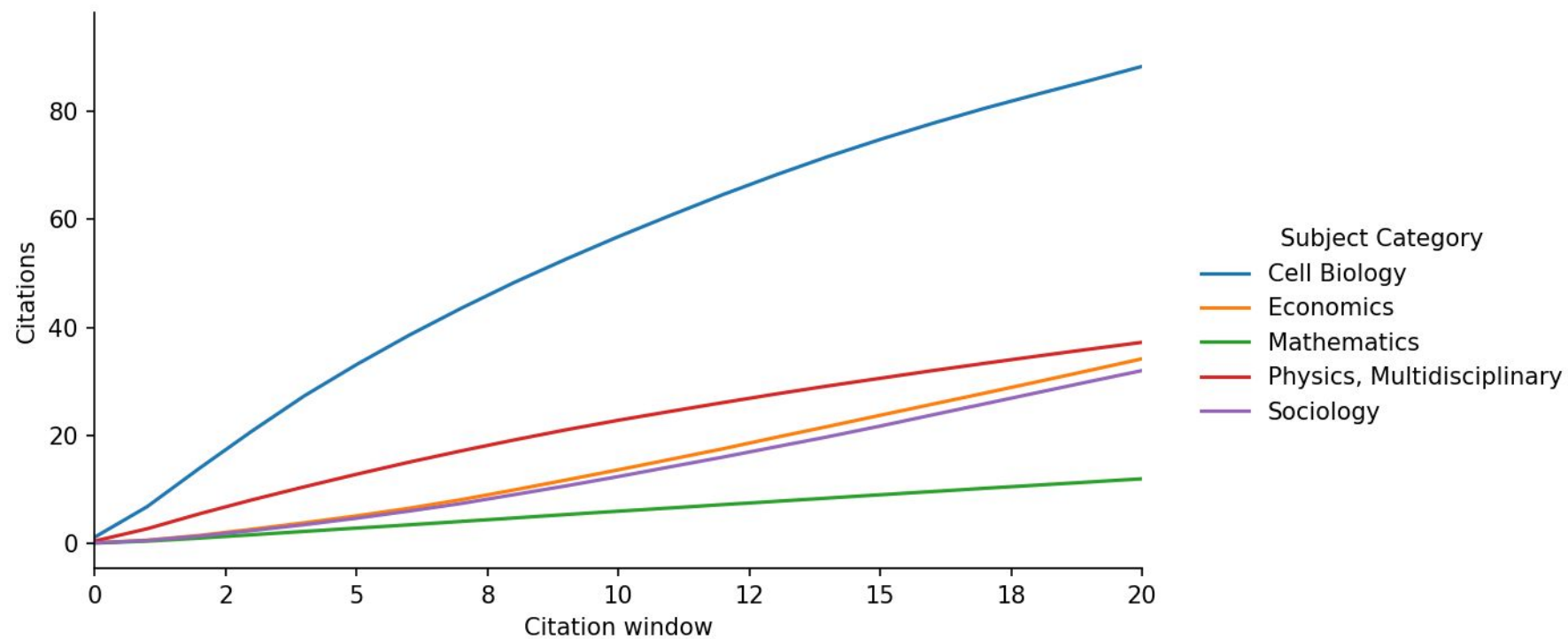
Fixed citation window



Variable citation window



# Field differences



# Does size matter?

Size-dependent

Size-independent

VS

Total, sum, number

Mean, median, percentage

Examples:

Examples:

- Total number of citations
- Total number of publications in journal

- Average number of citations
- Percentage of publications in journal

Scales with size

Does *not* scale with size

Comparisons reflect size

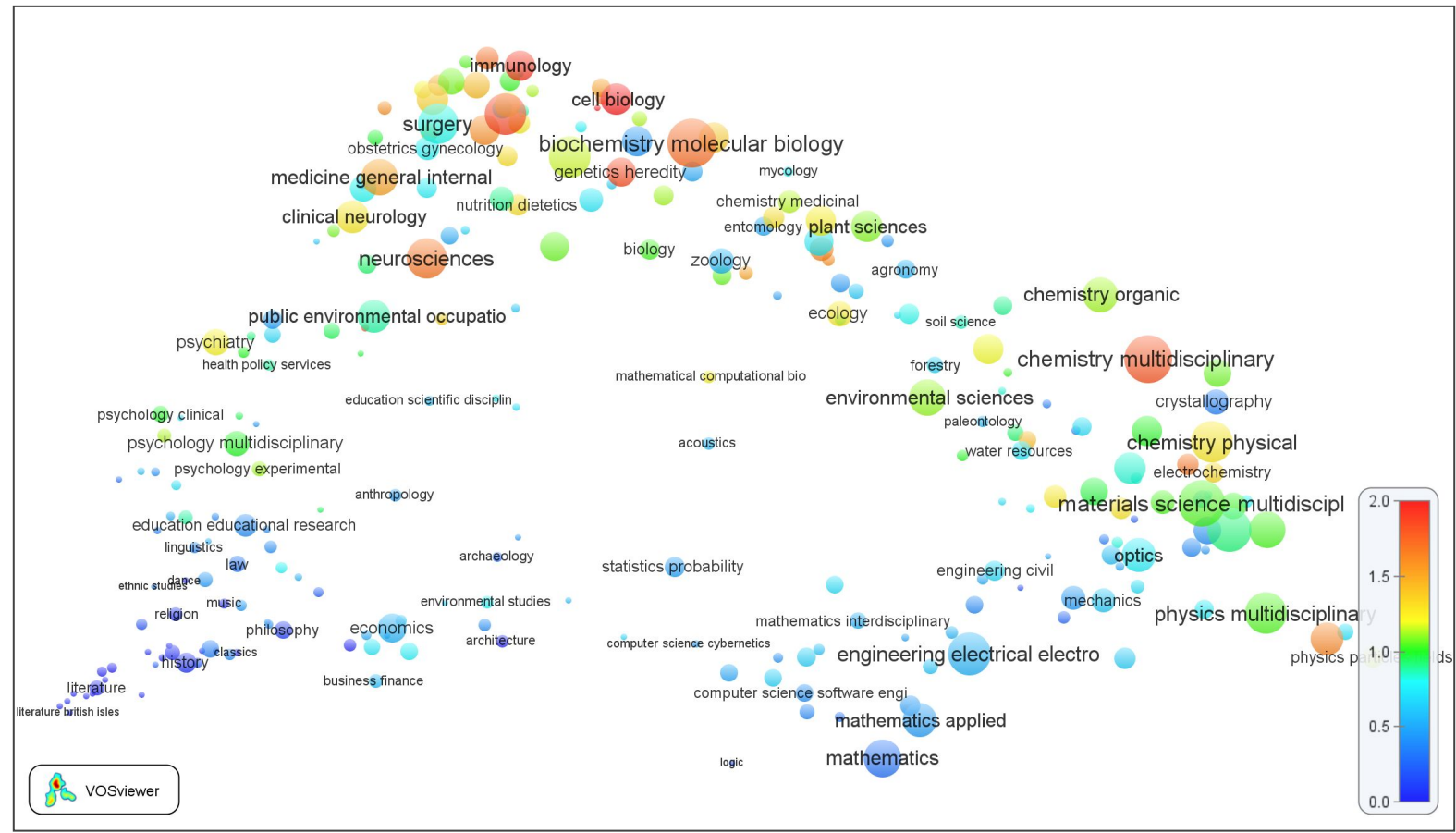
Comparisons corrected for size

# Normalisation of citation indicator



# Field differences

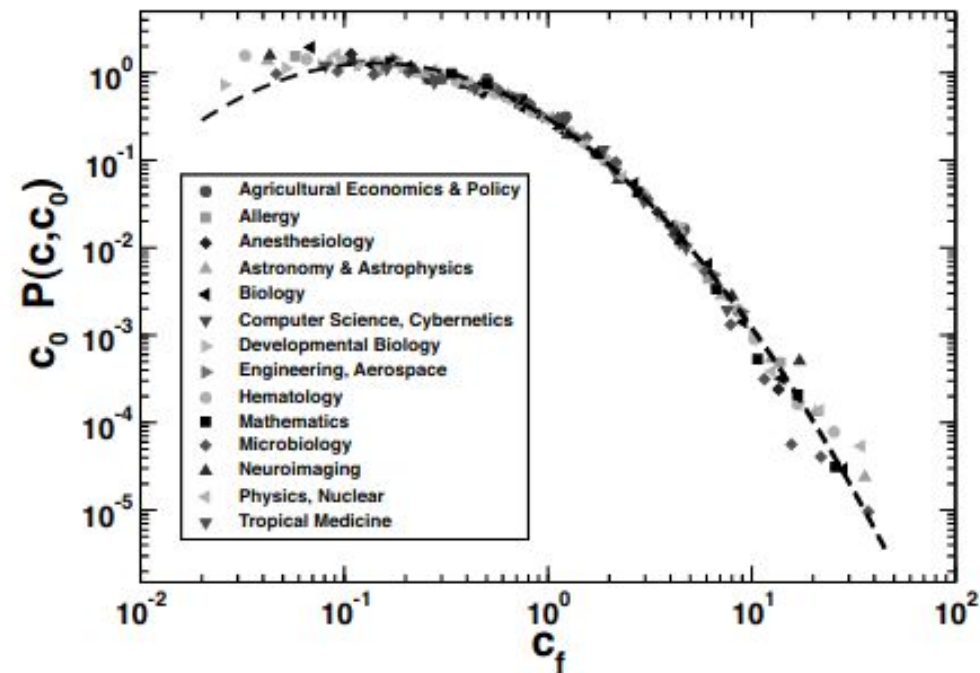
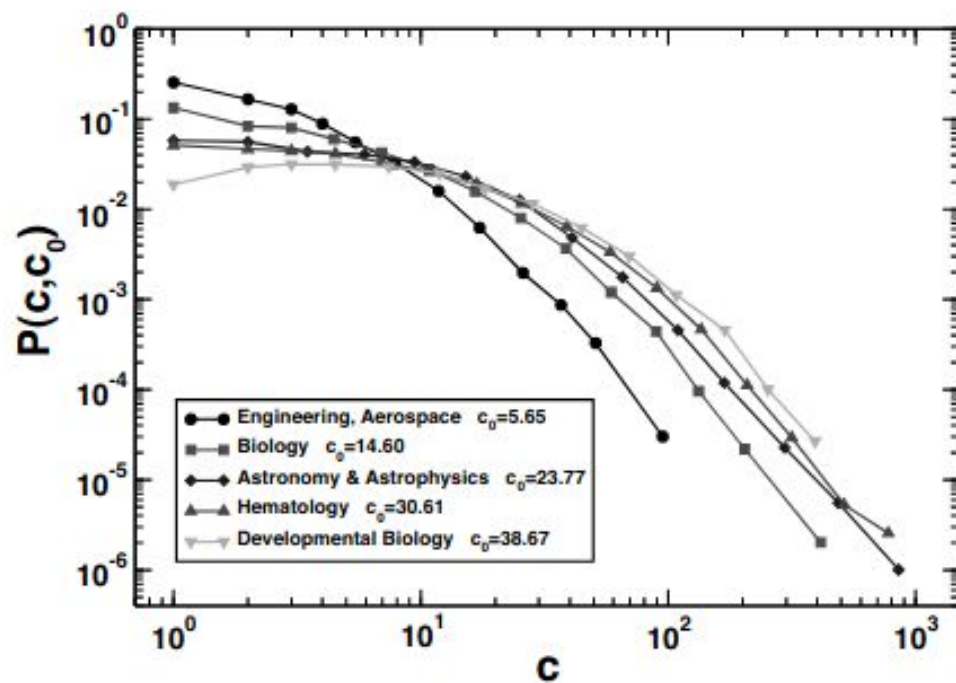
Subject categories (WoS)





# Normalisation approach

## Calculation





# Expected number of citations

- The **expected number of citations** of a publication is defined as the average number of citations of all publications published
  - in the same **scientific field** and
  - in the **same year**
  - with the same **document type**\*
  - using the same **citation window**\*

\*Not considered in all approaches similarly

# Does size matter?

## Aggregation

	Size-dependent	Size-independent
Unnormalised	Total citations	Mean citations
Normalised	Sum of normalised citation score	Mean normalised citation score

- **WoS/Incites:** Category normalised citation impact (CNCI)
- **Scopus/SciVal:** Field weighted citation impact (FWCI)
- **Dimensions:** Field Citation Ratio (FCR)

# Algorithmic field classification



# Publication clusters as indicators of scientific fields

## A New Methodology for Constructing a Publication-Level Classification System of Science

Ludo Waltman and Nees Jan van Eck

Centre for Science and Technology Studies, Leiden University, Leiden, The Netherlands.  
E-mail: {waltman|,ecknj|}@cwts.leidenuniv.nl

Classifying journals or publications into research areas is an essential element of many bibliometric analyses. Classification usually takes place at the level of journals, where the Web of Science subject categories are the most popular classification system. However, journal-level classification systems have two important limitations: They offer only a limited amount of detail, and they have difficulties with multidisciplinary journals. To avoid these limitations, we introduce a new methodology for constructing classification systems at the level of individual publications. In the proposed methodology, publications are clustered into research areas based on citation relations. The methodology is able to deal with very large numbers of publications. We present an application in which a classification system is produced that includes almost 10 million publications. Based on an extensive analysis of this classification system, we discuss the strengths and the limitations of the proposed methodology. Important strengths are the transparency and relative simplicity of the methodology and its fairly modest computing and memory requirements. The main limitation of the methodology is its exclusive reliance on direct citation relations between publications. The accuracy of the methodology can probably be increased by also taking into account other types of relations—for instance, based on bibliographic coupling.

proposed methodology consists of a large-scale clustering of scientific publications. Publications are clustered based on citation relations. Each publication is assigned to a single research area, and research areas are organized in a hierarchical structure. At the highest level, research areas may for instance correspond to broad scientific disciplines. At the lowest level, they may correspond to small subfields. The proposed methodology is able to cluster very large numbers of publications. In the application presented in this paper, a clustering of almost 10 million publications is produced. This application shows that the proposed methodology can be used to construct a classification system that includes essentially all publications in the international scientific literature in a time period of several years.

There are many different classification systems of science. For bibliometric and scientometric purposes, the most popular classification system is without doubt the system included in Thomson Reuters' Web of Science database. This system consists of about 250 research areas, referred to as subject categories. A somewhat similar system is included in Elsevier's Scopus database. The classification systems of Web of Science and Scopus work at the level of scientific journals. In these systems, a journal is assigned to

SCIENTIFIC REPORTS

Article | OPEN | Published: 26 March 2019

## From Louvain to Leiden: guaranteeing well-connected communities

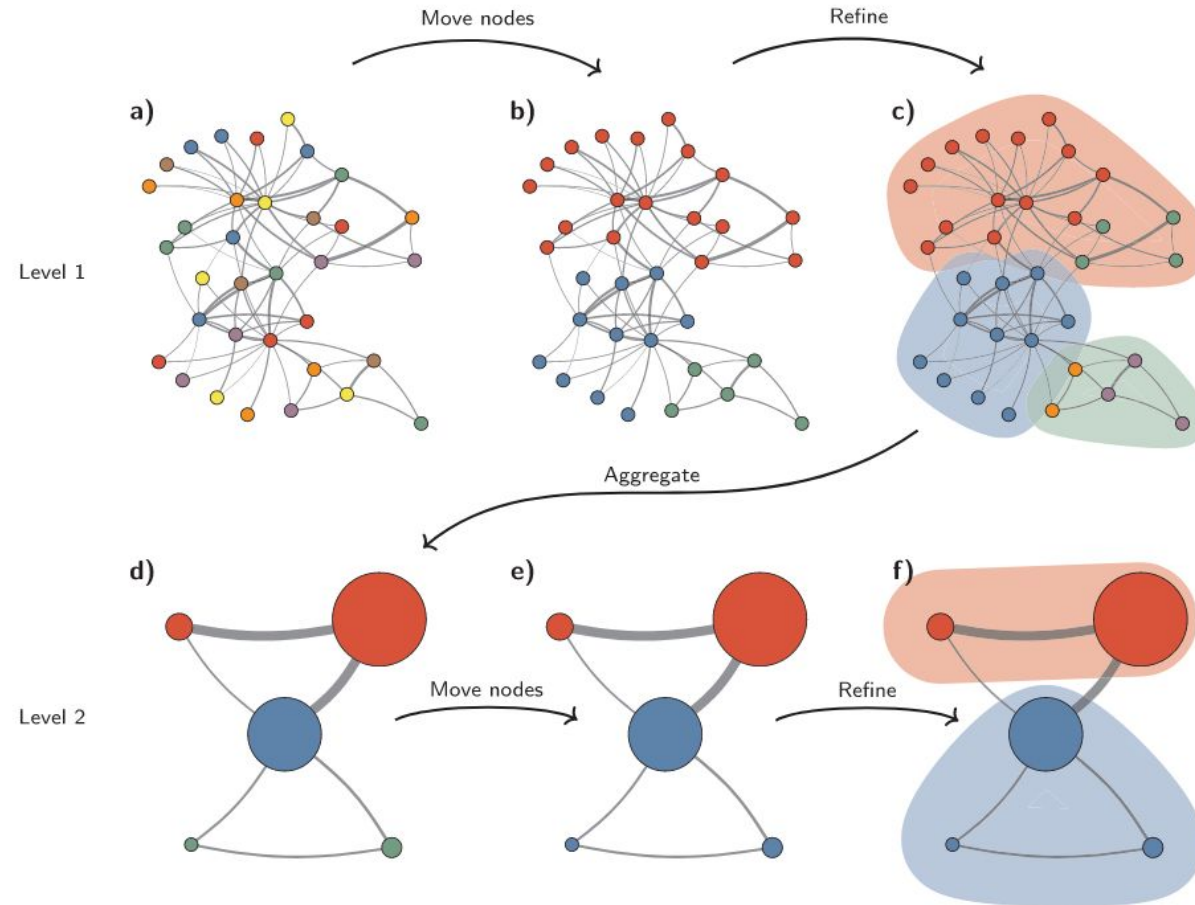
V. A. Traag✉, L. Waltman & N. J. van Eck

*Scientific Reports* 9, Article number: 5233 (2019) | [Download Citation](#) ↓

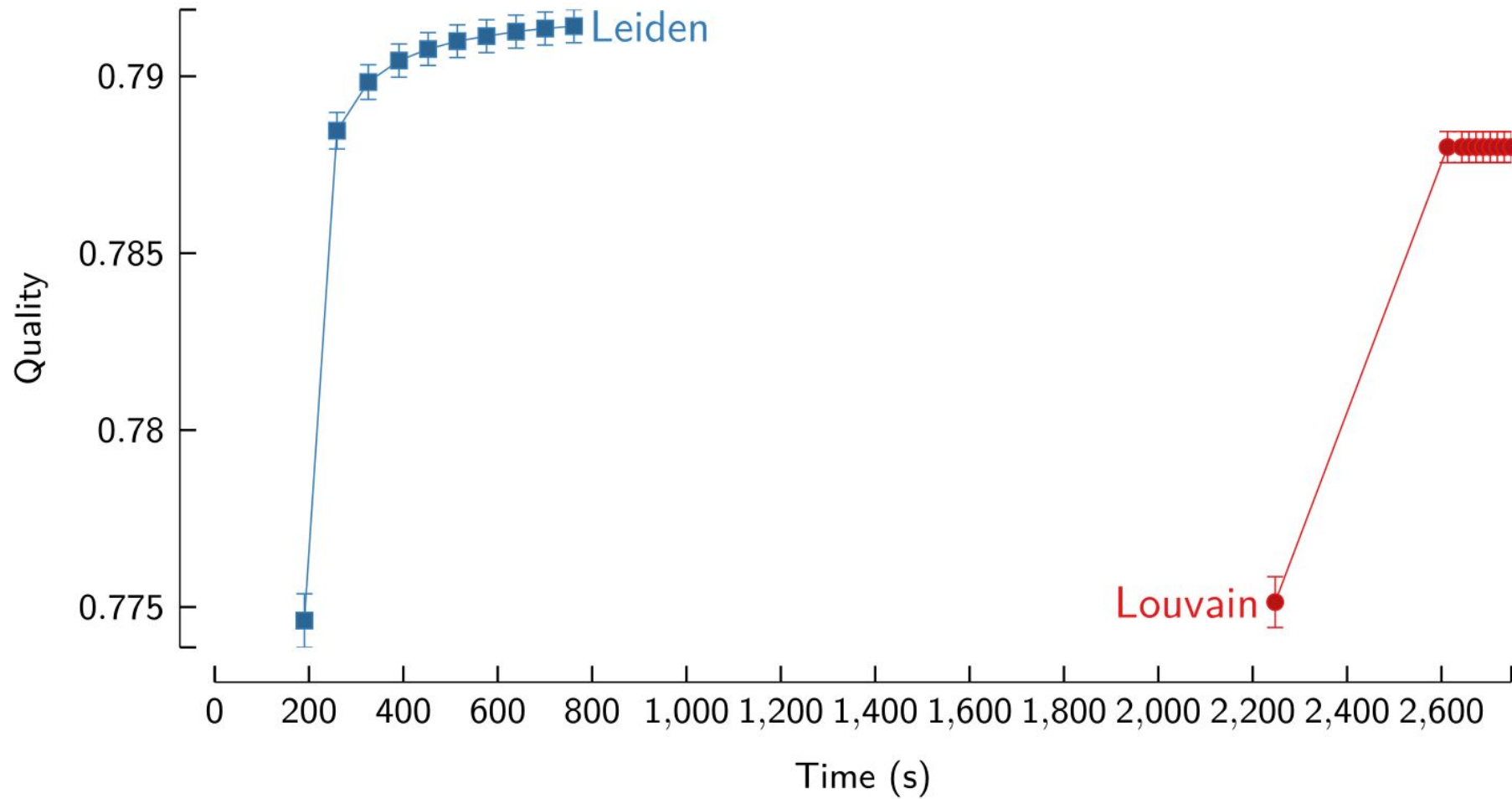
### Abstract

Community detection is often used to understand the structure of large and complex networks. One of the most popular algorithms for uncovering community structure is the so-called Louvain algorithm. We show that this algorithm has a major defect that largely went unnoticed until now: the Louvain algorithm may yield arbitrarily badly connected communities. In the worst case, communities may even be

# Leiden Algorithm



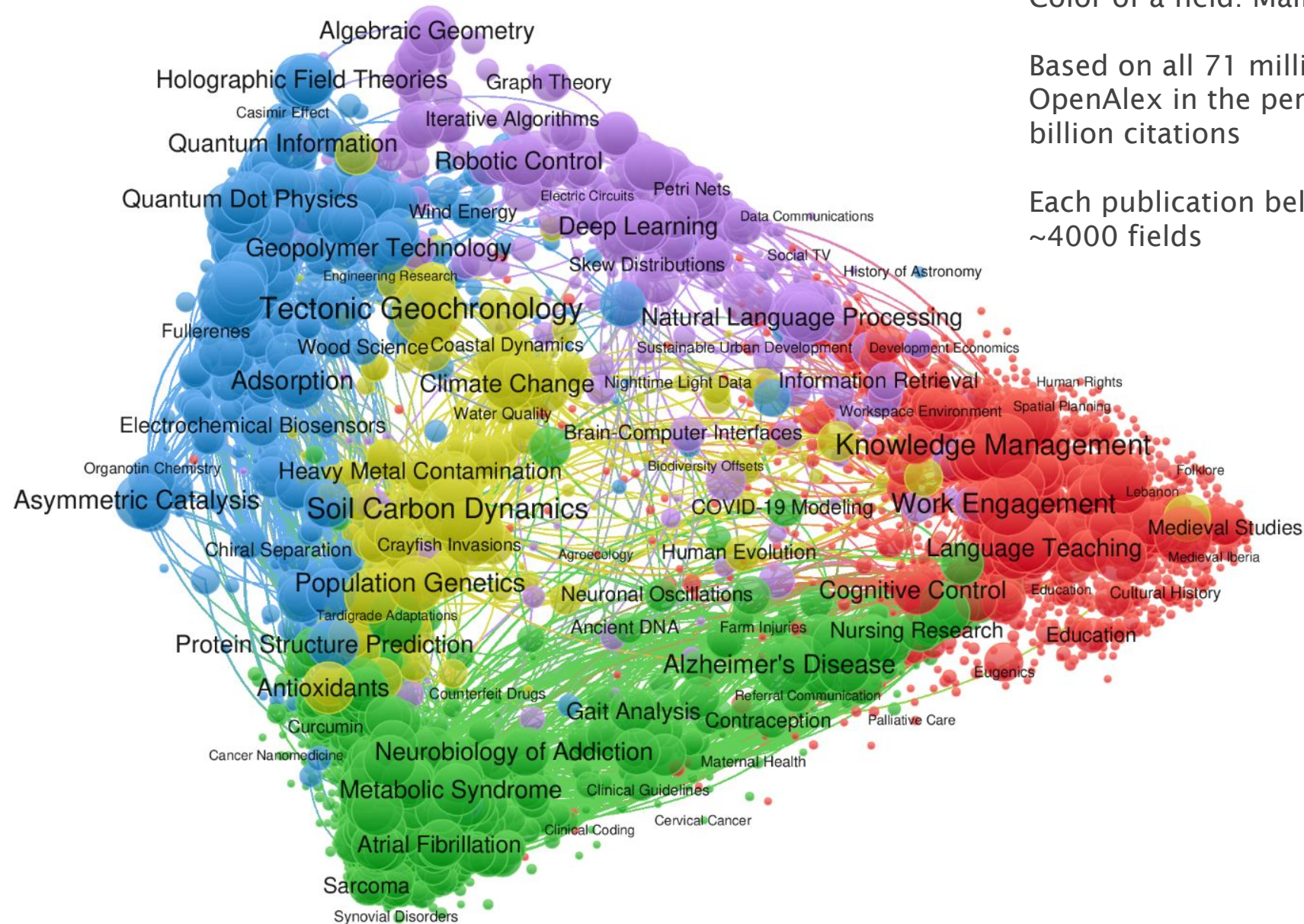
# Leiden Algorithm

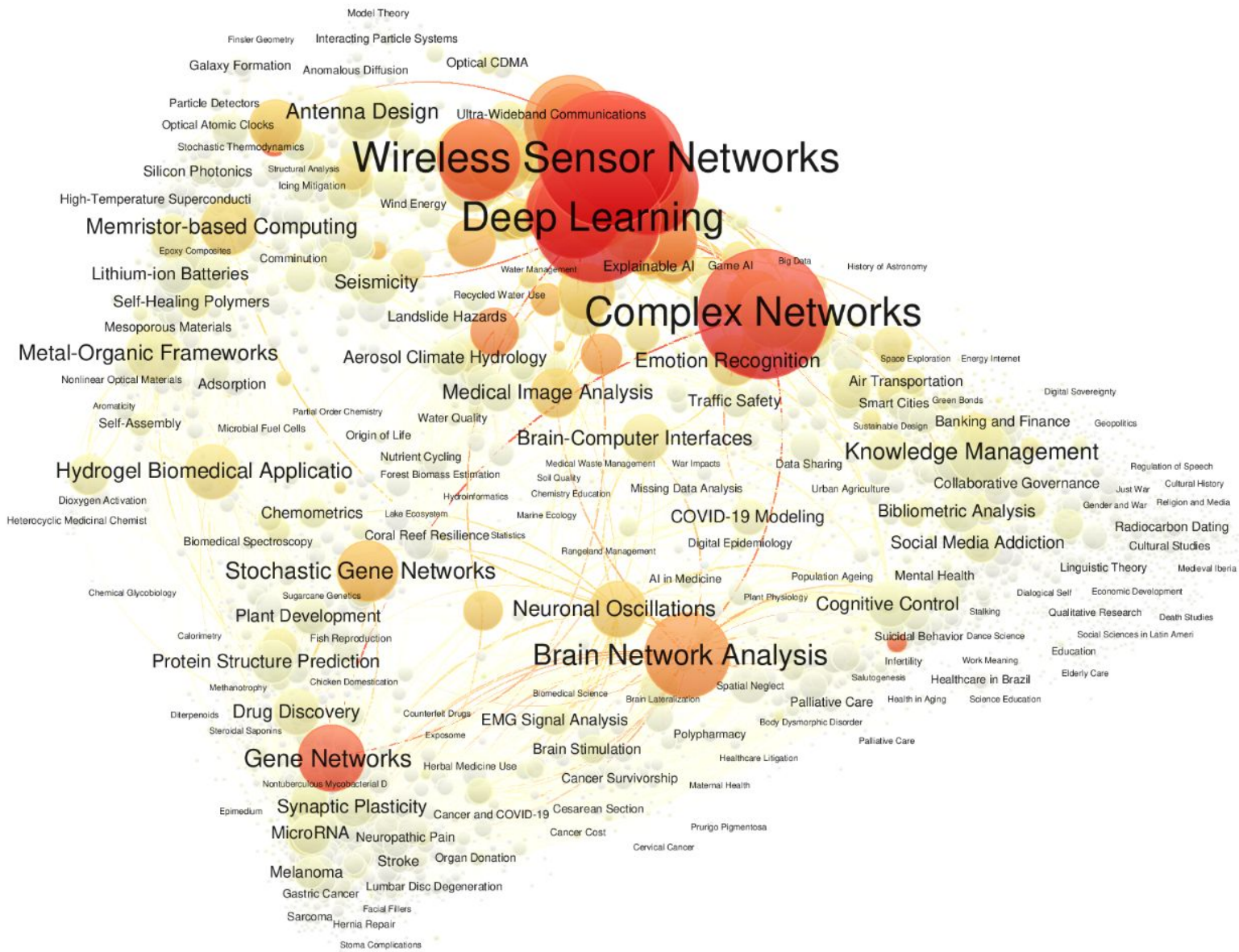


Size of a field: Number of publications  
Color of a field: Main discipline

Based on all 71 million publications in OpenAlex in the period 2000–2023 and 1.7 billion citations

Each publication belongs to one of the ~4000 fields







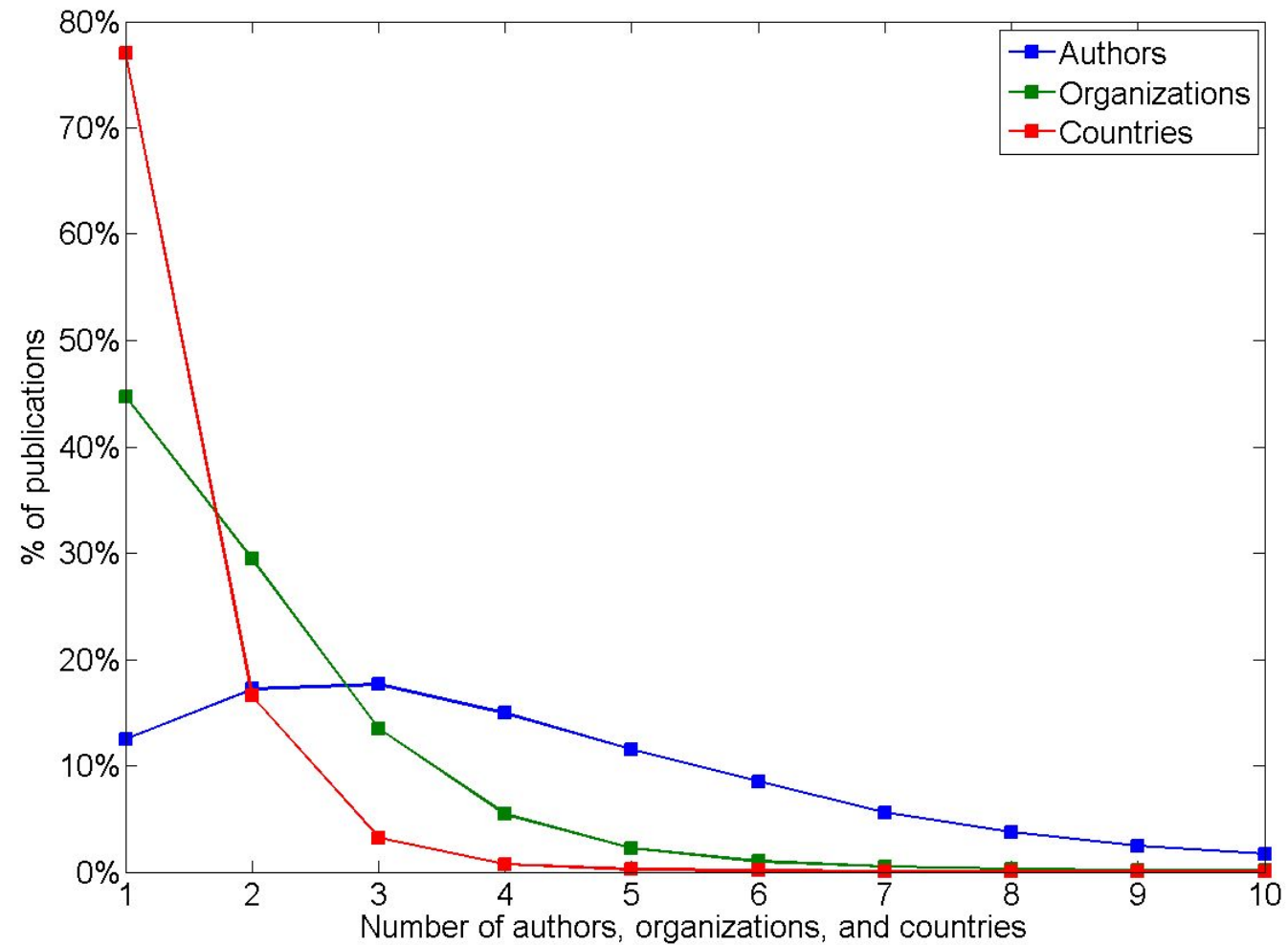
# Limits of classifications

## Field normalisation imperfect

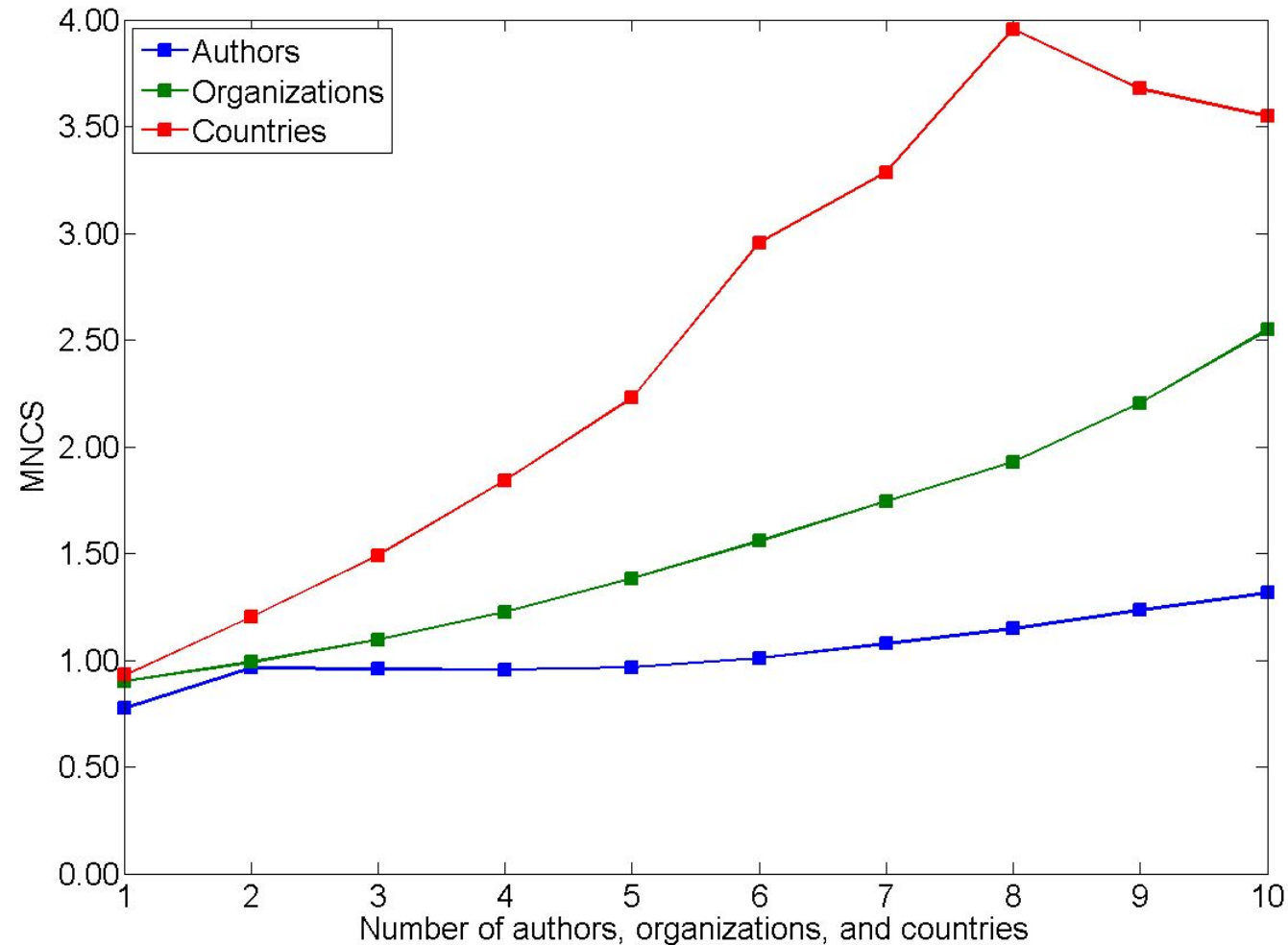
- Any classification of publications into fields is artificial; in reality, fields are overlapping and have fuzzy boundaries
- The choice of the number of fields always involves some arbitrariness:
  - Too few fields: Fields are heterogeneous, leading to biased comparisons (e.g., WoS fields).
  - Too many fields: Fields are homogeneous, but comparisons are made at a very local level, leading to irrelevant comparisons.

# Counting and fractionalisation

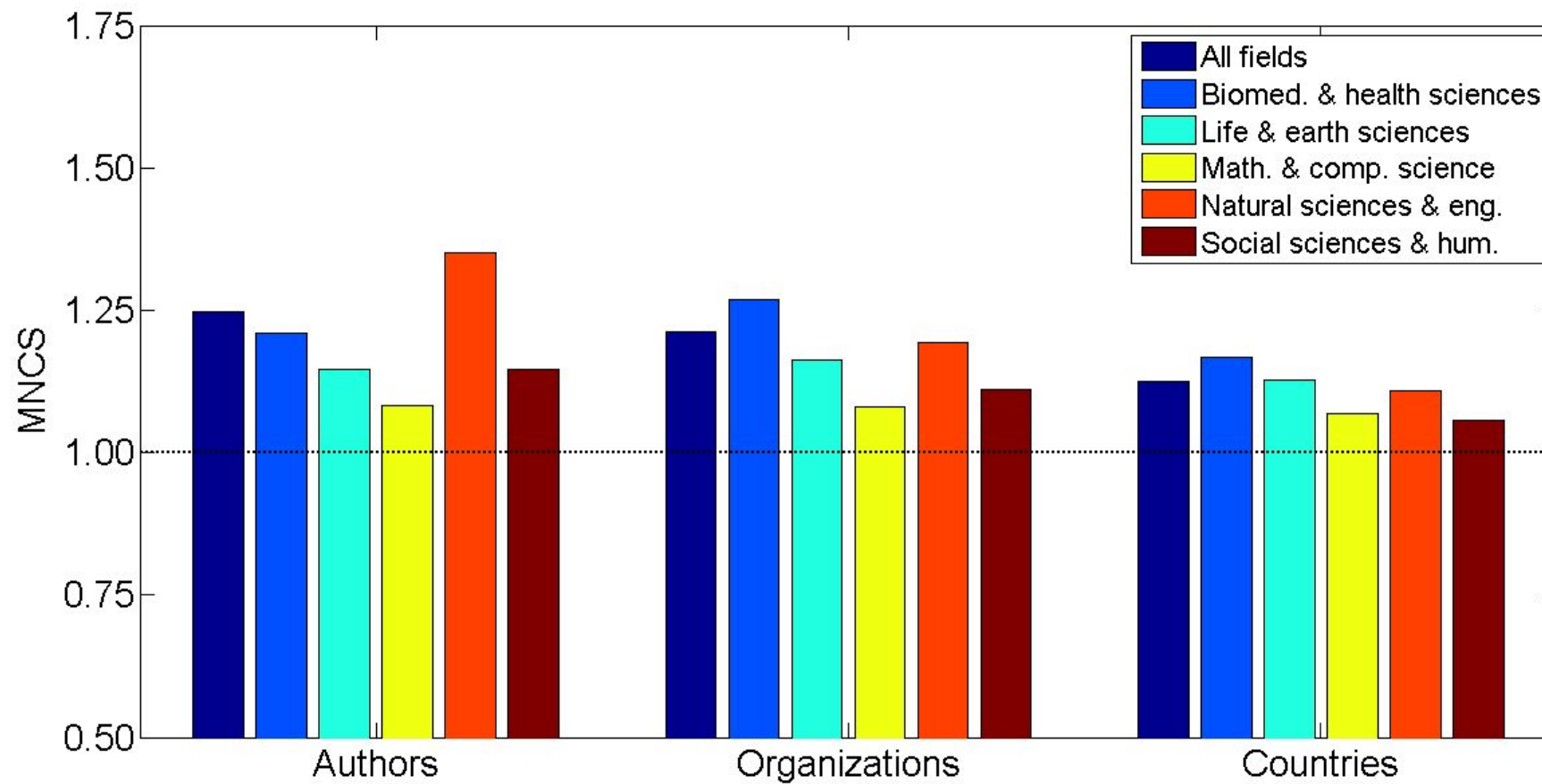
# Intensity of collaboration



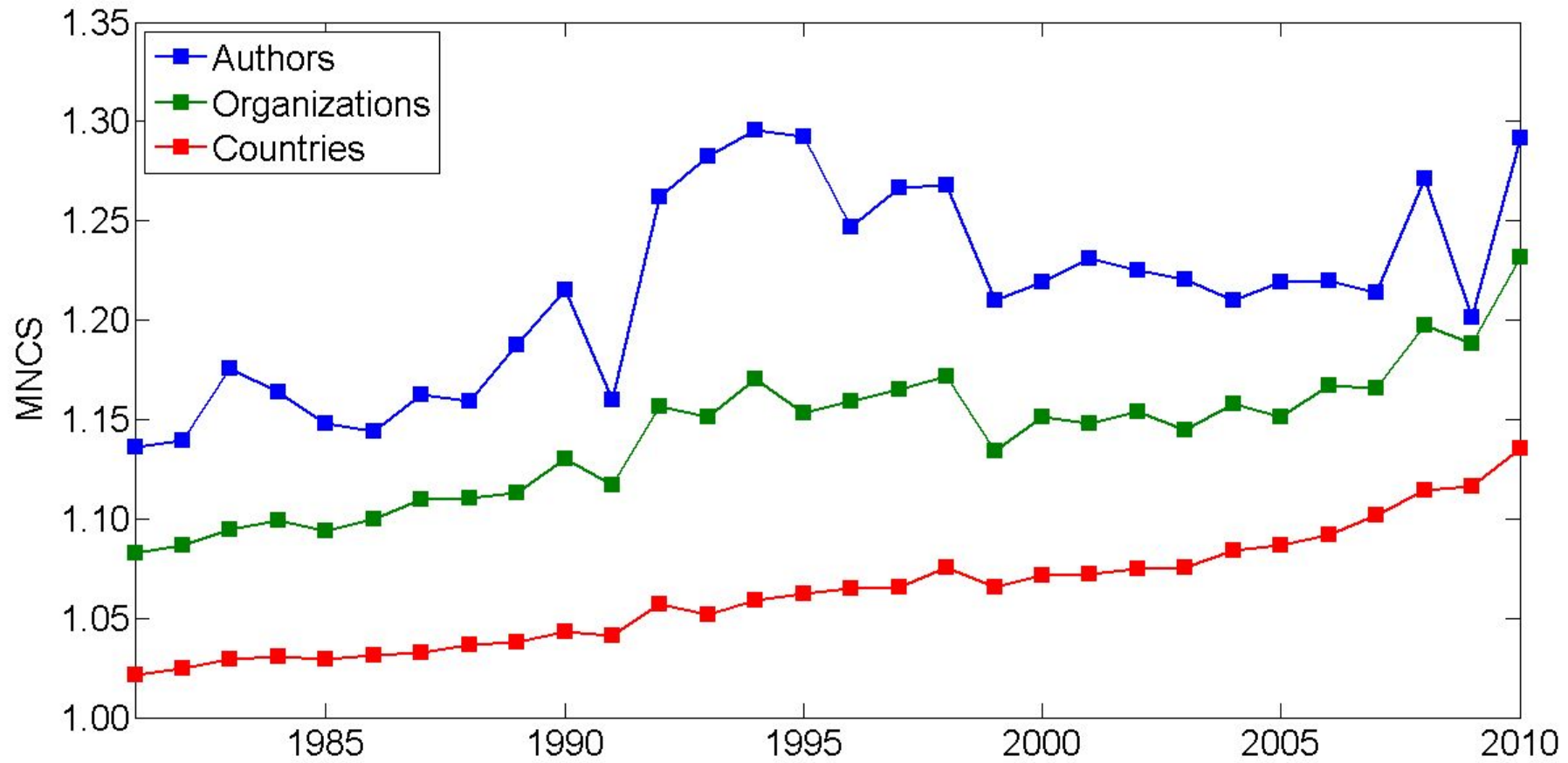
# Citation advantage of collaborative publications



# Full counting bonus per field of science



# Full counting bonus time trend



# Fractional counting in the CWTS Leiden Ranking

Leiden Ranking uses authors/address fractional counting

*BMJ Open* 2014;4:e004468 doi:10.1136/bmjopen-2013-004468

## Research methods

### Mapping patient safety: a large-scale literature review using bibliometric visualisation techniques

S P Rodrigues<sup>1</sup>, N J van Eck<sup>2</sup>, L Waltman<sup>2</sup>, F W Jansen<sup>1,3</sup>

Author Affiliations

<sup>1</sup>Department of Gynecology, Leiden University Medical Center, Leiden, The Netherlands

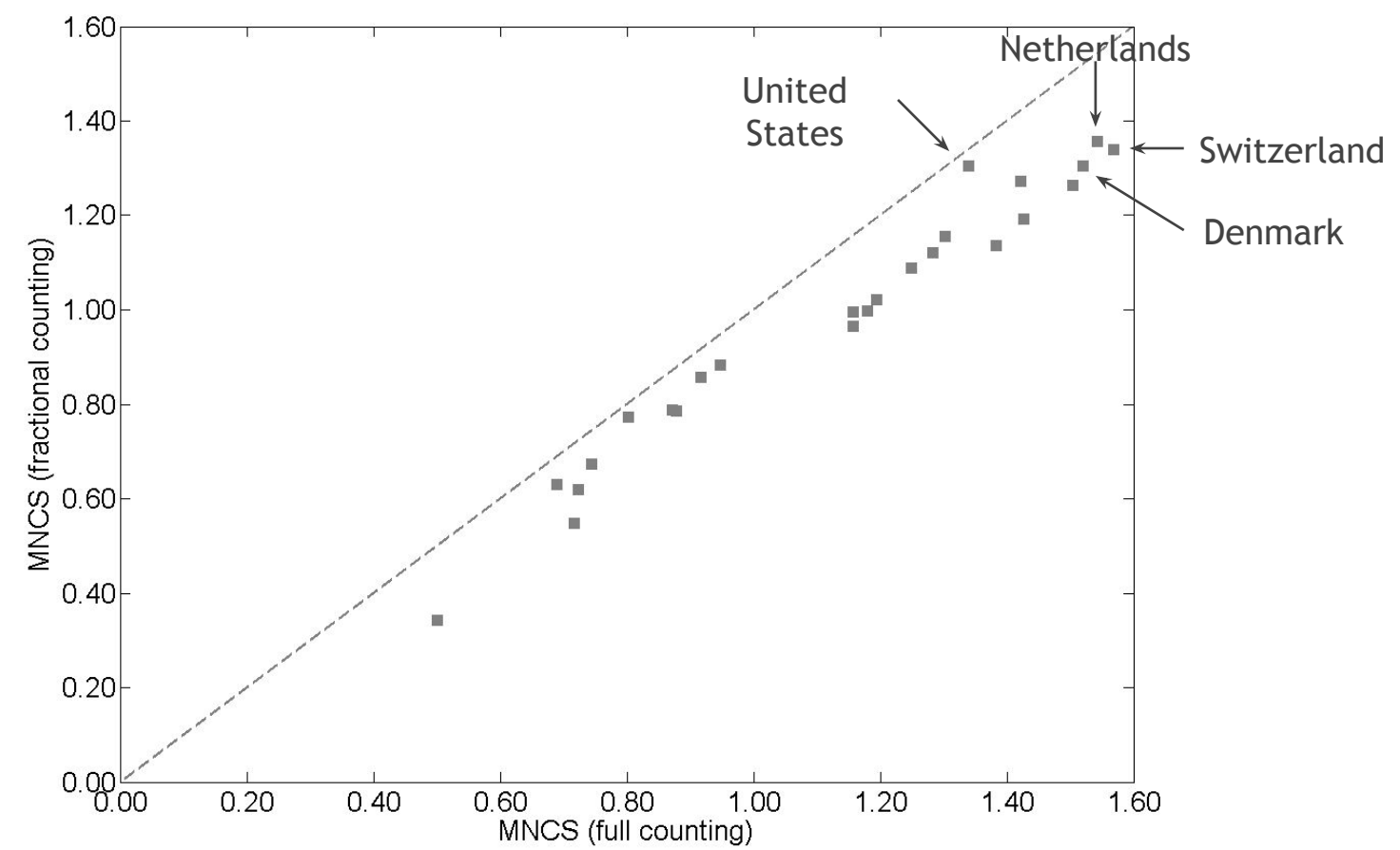
<sup>2</sup>Centre for Science and Technology Studies, Leiden University, Leiden, The Netherlands

<sup>3</sup>Department of BioMechanical Engineering, Delft University of Technology, Delft, The Netherlands

Affiliation	Weight
1	$0.25 + 0.25 \cdot 0.5 = 0.375$
2	$0.25 + 0.25 = 0.5$
3	$0.25 \cdot 0.5 = 0.125$

# Full counting bonus

Country level





# Leiden Ranking

## CWTS Leiden Ranking Open Edition 2024

Start tour



List view



Chart view



Map view

### Time period, field, and region/country

Time period:

Field:

Region/country:

Min. publication output:

### Indicators

Type of indicators:

Indicators:

Order by:

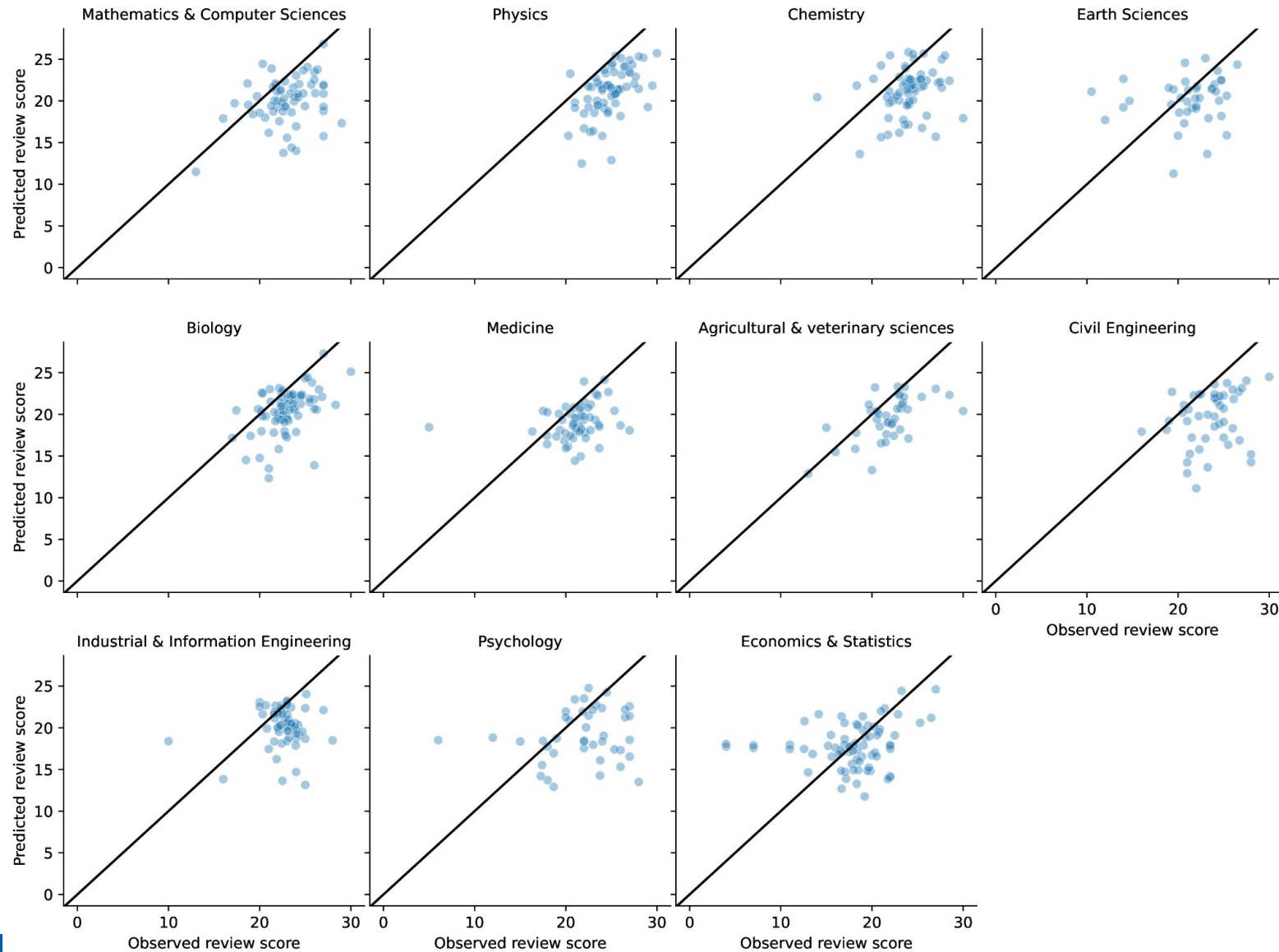
Calculate impact indicators using fractional counting

	University		P	P(top 10%)	PP(top 10%)				
1	Univ Amsterdam		8073	1306	16.2%				
2	Utrecht Univ		11543	1829	15.8%				
3	Vrije Univ Amsterdam		5788	909	15.7%				
4	Leiden Univ		8227	1270	15.4%				
5	Erasmus Univ Rotterdam		8034	1223	15.2%				
6	Wageningen Univ & Res		6281	944	15.0%				
7	Univ Groningen		10595	1585	15.0%				
8	Radboud Univ		8481	1264	14.9%				
9	Delft Univ Technol		8764	1275	14.5%				
10	Maastricht Univ		6228	846	13.6%				
11	Tilburg Univ		1757	236	13.4%				
12	Eindhoven Univ Technol		4615	611	13.2%				
13	Univ Twente		4101	502	12.2%				

# Citations & peer review

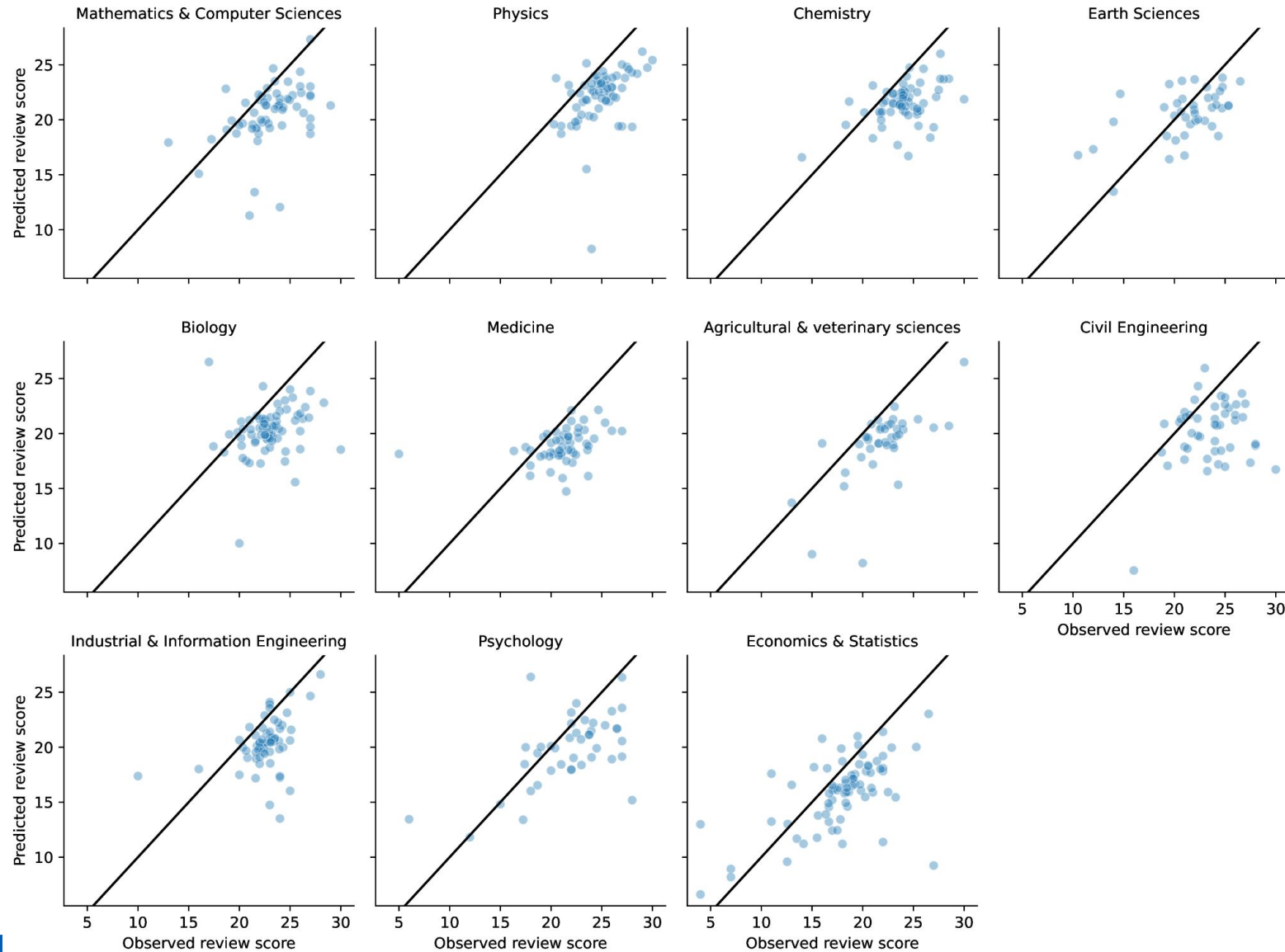


# Citations & peer review



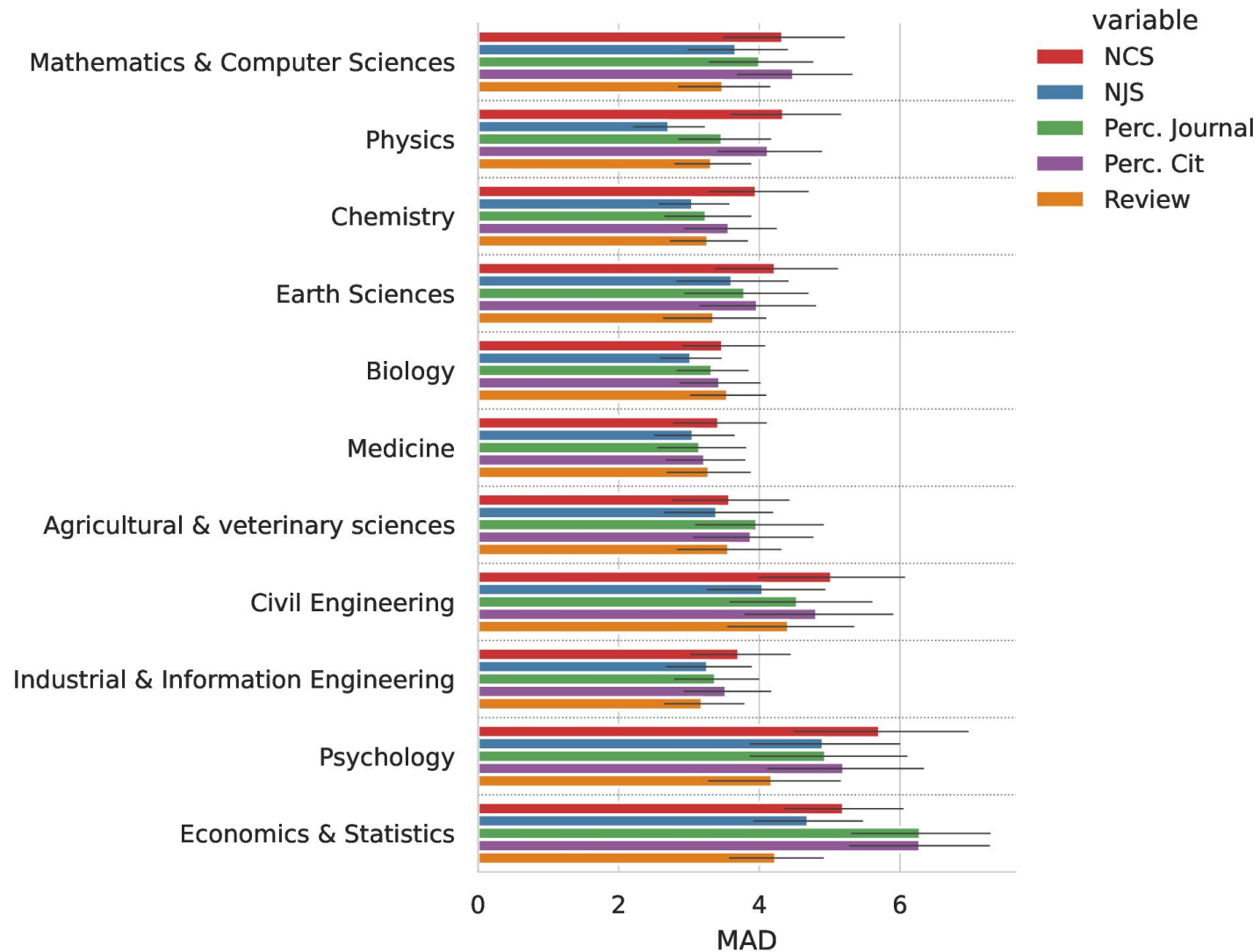
Predict based on citations

# Citations & peer review



Predict based on  
other reviewer

# Citations & peer review



# Conclusions



## The Leiden Manifesto for research metrics

