Die Verwendung von Perzentilen für die Normalisierung von Citation Impact in der Forschungsevaluation

Lutz Bornmann

Some basic information on bibliometrics

Peer review versus bibliometric indicators

Macro-level
Countries, Universities, Organizations

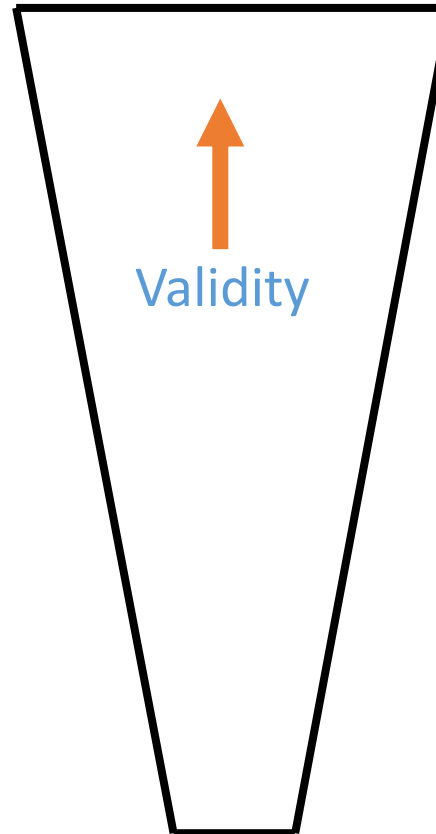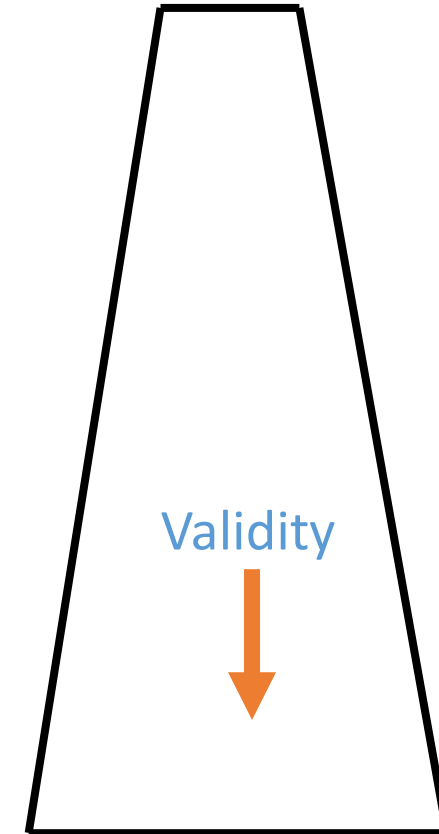**Meso-level**
Departments, Research groups, Journals

Micro-level
Young researchers, Single publications

Bibliometrics
quantitative

Peer Review
qualitative

Validity

Validity

Use of bibliometric indicators in national research assessment exercises

|		Belgium /FL	Czech Republic	Denmark	Finland	Italy (VQR)	New Zealand	Norway	Sweden	UK
Output indicators	Academic outputs	√	√	√	√	√	√	√	√	√
	Non-academic outputs	√				√			√	√
	Innovation-related outputs (IPR)	√				√				√
External funding indicators	Competitive funding / national			√	√	√	√	√	√	√
	Competitive funding / international			√	√	√	√	√	√	√
	Contract research funding			√		√	√		√	√
	Non-competitive funding			√		√	√			√
Outcomes/ impact indicators	Academic impacts (citations)	√	√			√		√		
	Socio-economic outcomes/impacts (e.g. spin- offs)					√				√

Bibliometrics-based heuristics (BBH)

- Definition of bibliometrics: use of publication and citation data to measure science
- The European Commission on Research and Innovation has defined bibliometrics as "a statistical or mathematical method for counting the number of academic publications, citations and authorship" (Directorate-General for Research, 2010)
- Definition is far from being satisfactory: it focusses on the used data
- Interpretation of bibliometrics in the fast-and-frugal heuristics approach (Gerd Gigerenzer and the ABC Research Group: heuristics are simple, task-specific decision strategies allowing quick and robust decisions)
- Heuristics are decision strategies that use part of the available information and ignore the rest
- Bibliometrics-based heuristics (BBH) are adaptive judgement strategies that ignore information about some performance aspects (e.g., amount of third-party funds raised or assessments of single publications by experts), thereby allowing quick (and robust) decisions in research evaluation

Bornmann, L., & Marewski, J. N. (2019). Heuristics as conceptual lens for understanding and studying the usage of bibliometrics in research evaluation. *Scientometrics, 120*(2), 419–459.

Databases for citation analyses

| Database	Papers
Web of Science – Core Collection (Clarivate Analytics)	1900
Scopus (Elsevier)	1788
Chemical Abstracts Service (CAS) Database	1898
INSPEC database for Physics, Electronics & Computing	1897
Google Scholar Citations	???
Microsoft Academic Graph (no longer operated)	???
Dimensions	???
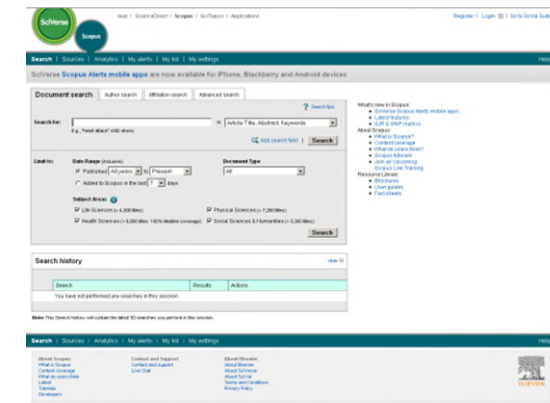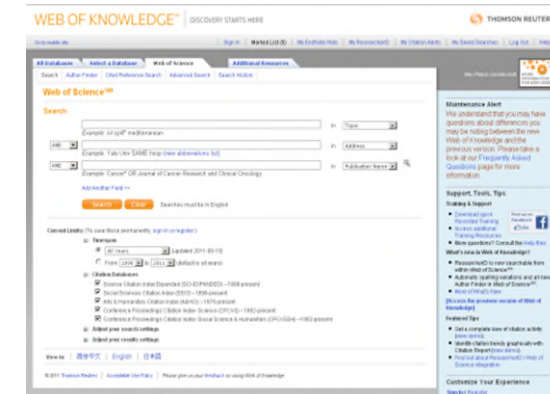
Explanations of databases:
QSS Volume 1 Issue 1

Coverage of publications from disciplines in the Web of Science

Figure 1: Discipline and Web of Science Coverage
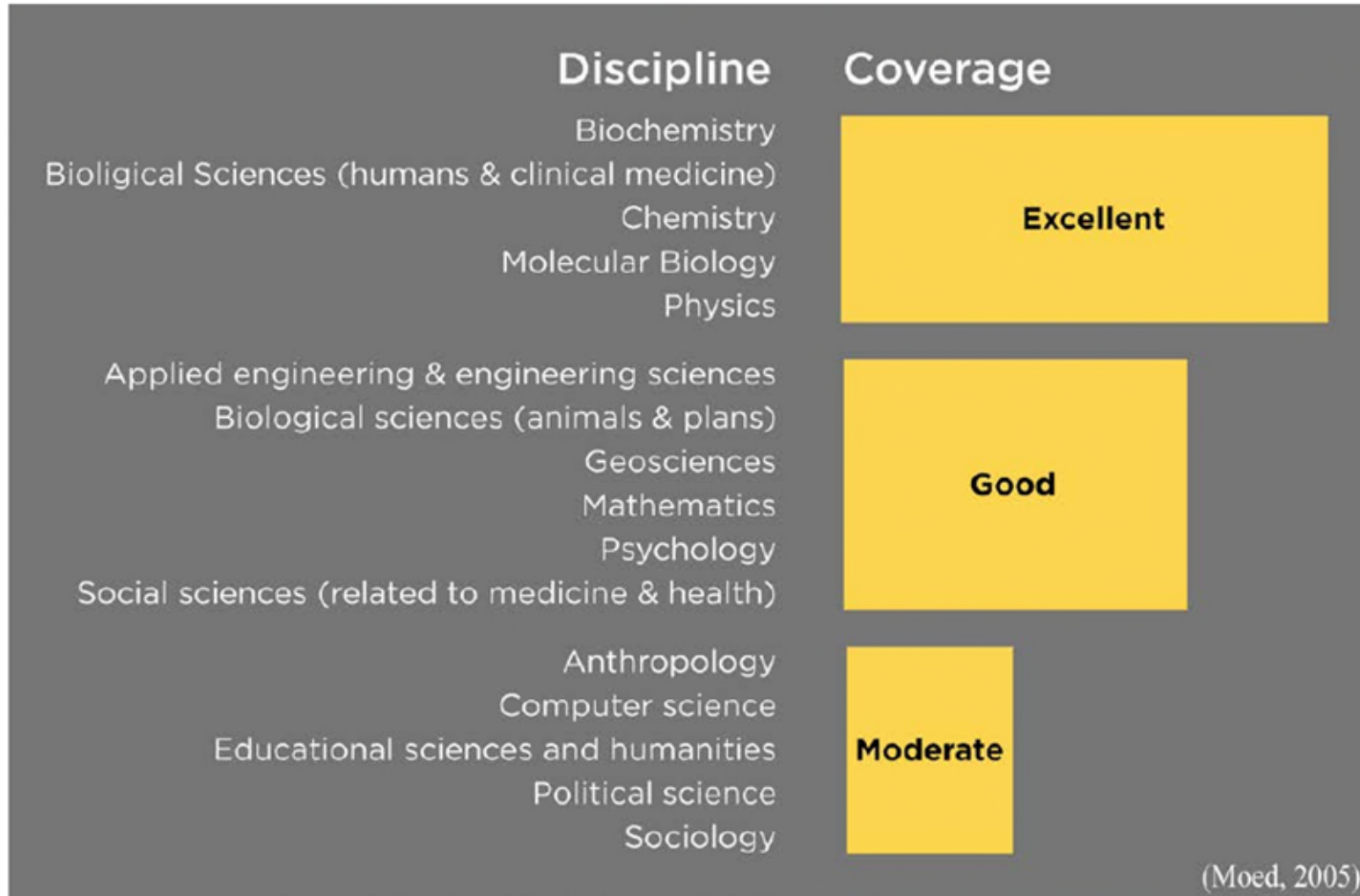
Citizen bibliometrics vs. professional bibliometrics

Citizen bibliometrics	Professional bibliometrics
• Do-it-yourself bibliometrics by researchers and research managers	• Bibliometric analyses supported by professional bibliometricians and specialized bibliometric software tools
• Journal impact factor, h-index	• Field-normalized indicators
• Google Scholar	• Web of Science, Scopus
• With small datasets (e.g. young researchers)	• Mainly with large datasets (e.g. institutions)
• Excluding field-specific experts	• Including field-specific experts (informed peer review)

Leydesdorff, L., Wouters, P., & Bornmann, L. (2016). Professional and citizen bibliometrics: complementarities and ambivalences in the development and use of indicators—a state-of-the-art report. *Scientometrics*, 109(3), 2129-2150.

Bibliometric indicators

|		
Basic indicators	Number of publications Number of citations Citations per publications (citation rate) Number of not-cited publications	Researcher Institution Country
h index-based indicators	*h* index and approximately 50 variants *m* quotient	Researcher
Normalized indicators	Field- and time-normalized indicators Cited-side and citing-side normalization	Researcher Institution Country
Technology-indicators	Number of publications cited in patents Number of patents cited in publications	Institution Country
Social indicators	Co-authorship networks	Researcher Institution Country
Journal indicators	Journal Impact Factor CiteScore	Journals
Mapping indicators	Co-citations	Institution Country

Field-normalized citation indicators

Why do we need normalized indicators? Citation counts are field-dependent (papers published in 2010)
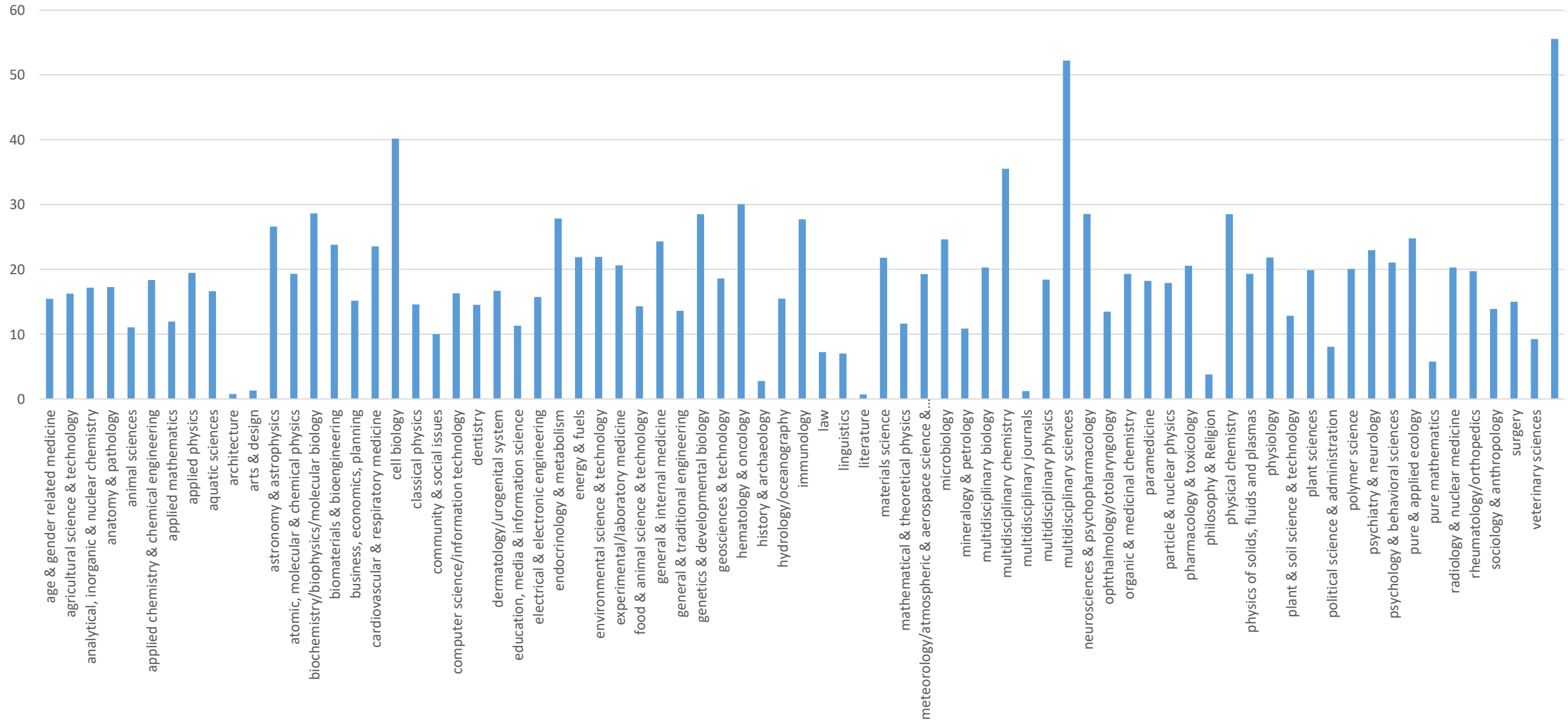
Normalized impact (NI)

- Normalized Impact (NI) = Ratio of observed citations
  (WoS: "times cited") to expected citation rate
- The expected citation rate is the mean impact of the following publications:

  - published in a journal of the same subject category

  - published in the same year

  - Suppose a publication from 2010 in an oncology journal
  - The publication has 45 citations until the end of 2015
  - On average, publications from 2010 in oncology journals have 15 citations in the same time period
  - Normalized citation score of the publication is 45 / 15 = 3

- NI values:

  NI = 1.0 : Average impact

  NI = 1.2 : 20% above average

Problem for calculation of NI: skewed distribution of citation data
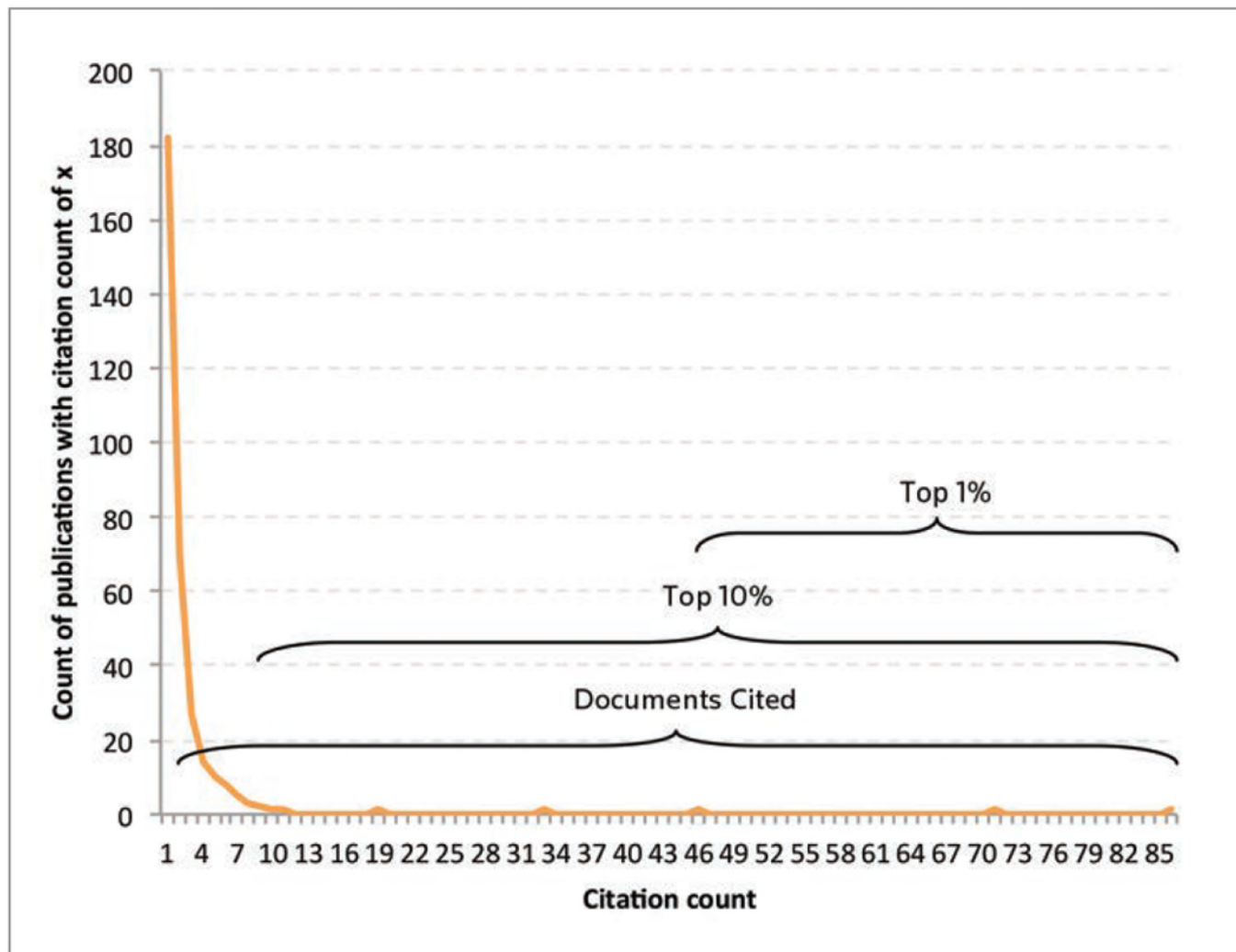
A small number of highly cited papers and many papers with relatively few or no citations (source: Thomson Reuters. (2015). *InCites Indicators Handbook*. Philadelphia, PA, USA: Thomson Reuters)

The use of percentiles as an alternative to the NI

- Problem of the NI: A few highly-cited papers significantly influence the result

- Leiden Ranking 2013: University of Göttingen on ranking position two, because of only one highly-cited paper (*Göttingen effect*)

- Solution: Calculation of percentile ranks (PR)

- Definition: PR x is defined as the citation count at or below which x% (e.g., 90%) of the papers in the subject category falls

- Procedure: Calculate the cumulative percentage of papers with certain citation counts (beginning with low impact papers or papers with zero citations)

- The use of PRs avoids the problem with outliers

- PRs can be used very flexible (e.g., by calculating the top-10%)

- The use of percentiles is recommended in the Leiden Manifesto

Citation count	Number of papers	Percent	Cumulative percentage (PR)
0	4	19.05	19.05
1	3	14.29	33.33
2	1	4.76	38.10
3	1	4.76	42.86
7	4	19.05	61.90
8	2	9.52	71.43
9	1	4.76	76.19
10	1	4.76	80.95
13	2	9.52	90.48
20	2	9.52	100.00
Total	21	100.00	

Bibliometrics on the single researcher level

Beamplots: measuring the performance of single researchers
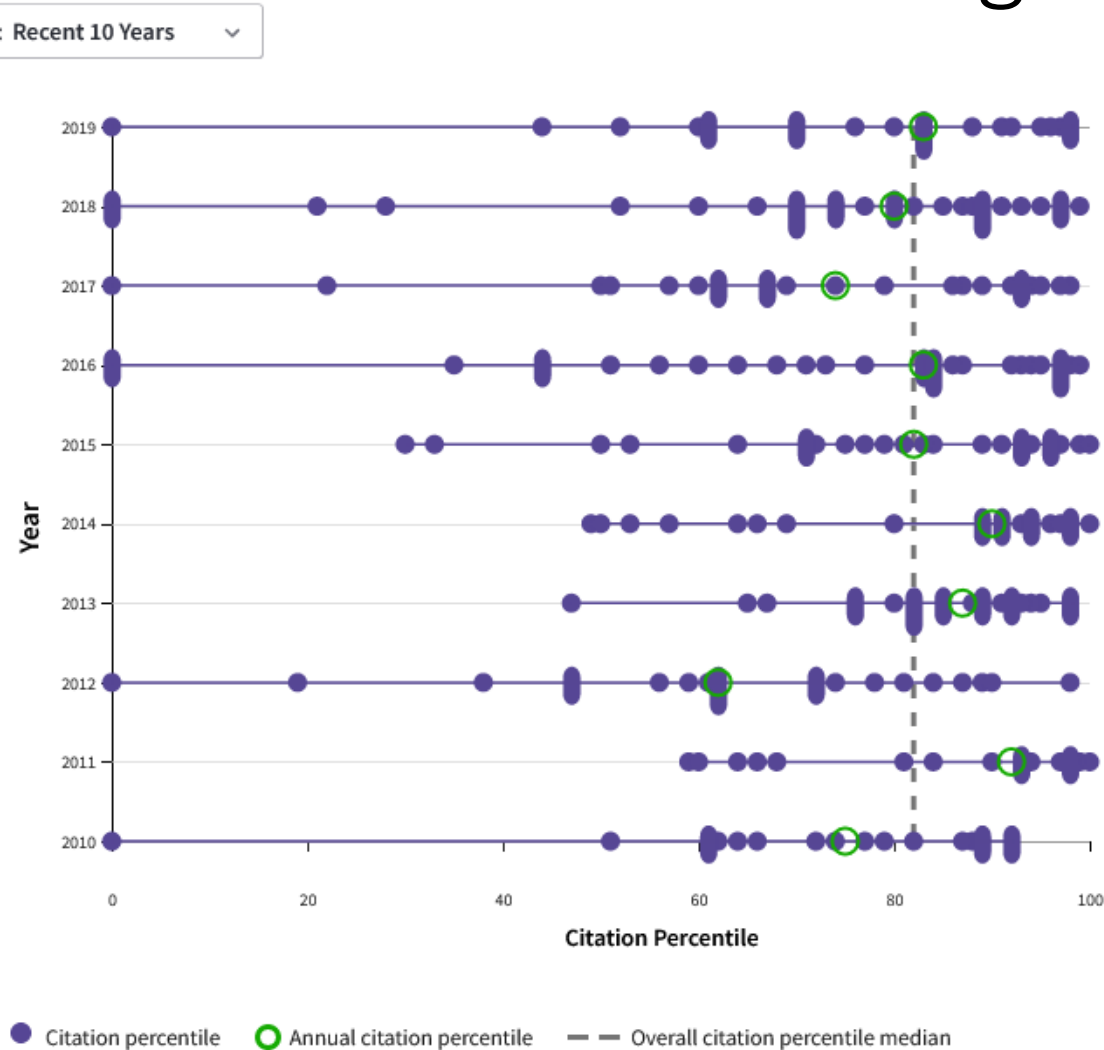

- Alternative to the popular h index

- Field-normalized indicator

- No single number

- Purple points: citation impact of single papers

- Purple horizontal lines: citation impact range of papers in one year

- Green points: median citation impact in one year

- Green dotted line: median citation impact over all years

Beamplots: the way into the Web of Science

Range: **Recent 10 Years** ∨
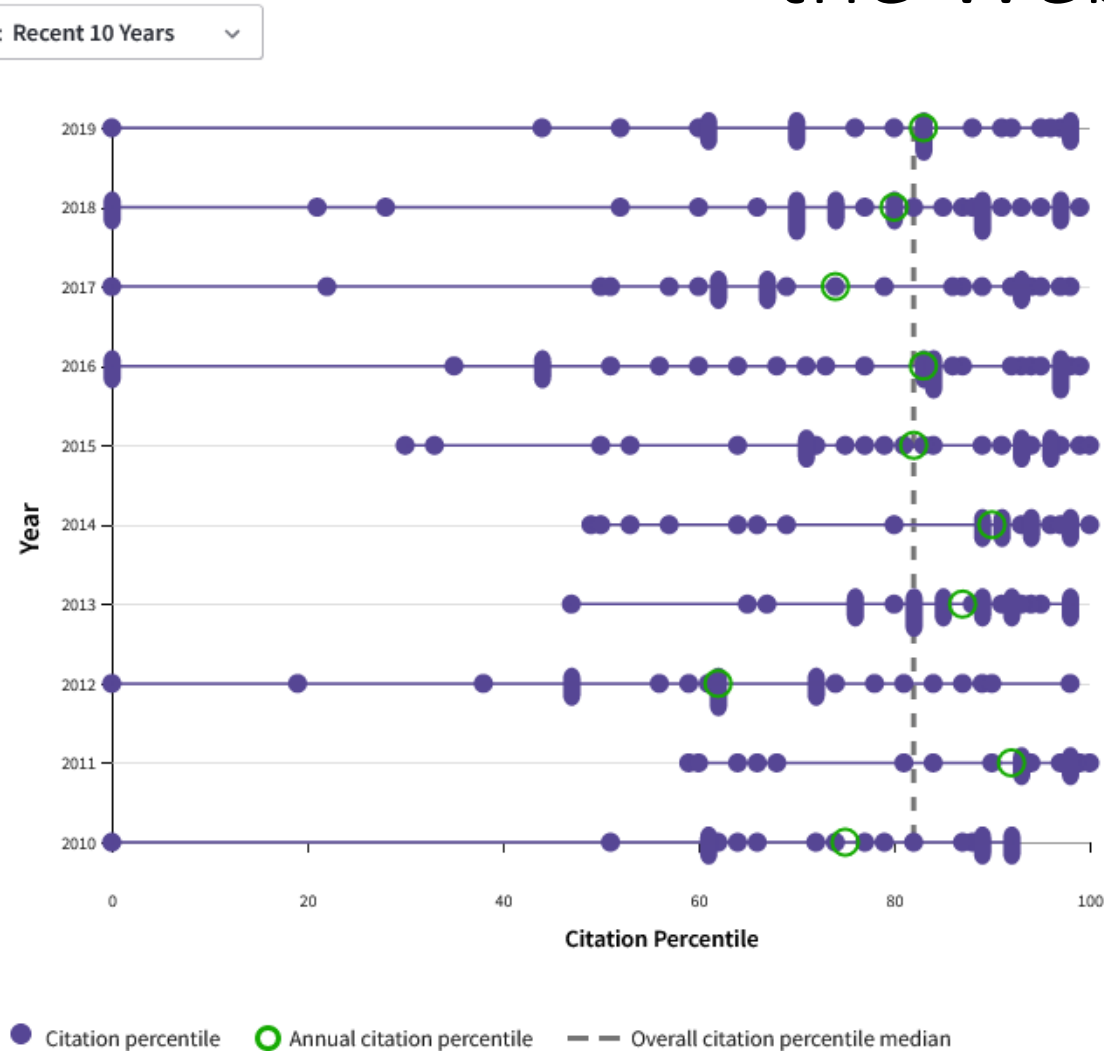
Citation counts are from Web of Science Core Collection; citation percentile data are from InCites.

- Since 2013, beamplots are used in bibliometrics reports in the MPG

- Publication in 2014 [Bornmann, L., & Marx, W. (2014). How to evaluate individual researchers working in the natural and life sciences meaningfully? A proposal of methods based on percentiles of citations. Scientometrics, 98(1), 487-509]

- Since 2021, implemented in the Web of Science [Szomszor, M., & Pendlebury, D. A. (2021). Interpreting the citation performance of individual researchers with beamplots. Philadelphia, PA, USA: Clarivate Analytics]

Overview of the scientific performance of three researchers

Impact	Researcher 1	Researcher 2	Researcher 3
Total citations	15,192	3,796	7,828
Number of citations per publication (arithmetic average)	83	52	89
Proportion of self-citations in total citations	3.4%	6%	5.8%
Average percentile (median)	15.9	6.2	8.3
$P_{top\ 10\%}$	70	31	48
$PP_{top\ 10\%}$	39.3%	52.5%	57.8%
$P_{top\ 10\%}$ quotient	2.2	2.8	1.6
Q1 indicator	25%	46%	33%

Q1 indicator: Proportion of papers published in a journal which belongs to the 25% journals with the highest Journal Impact Factor in its field and publication year

Bibliometrics on the country level

Basic map: direct citation-relations of single subject categories (based on Web of Science data)

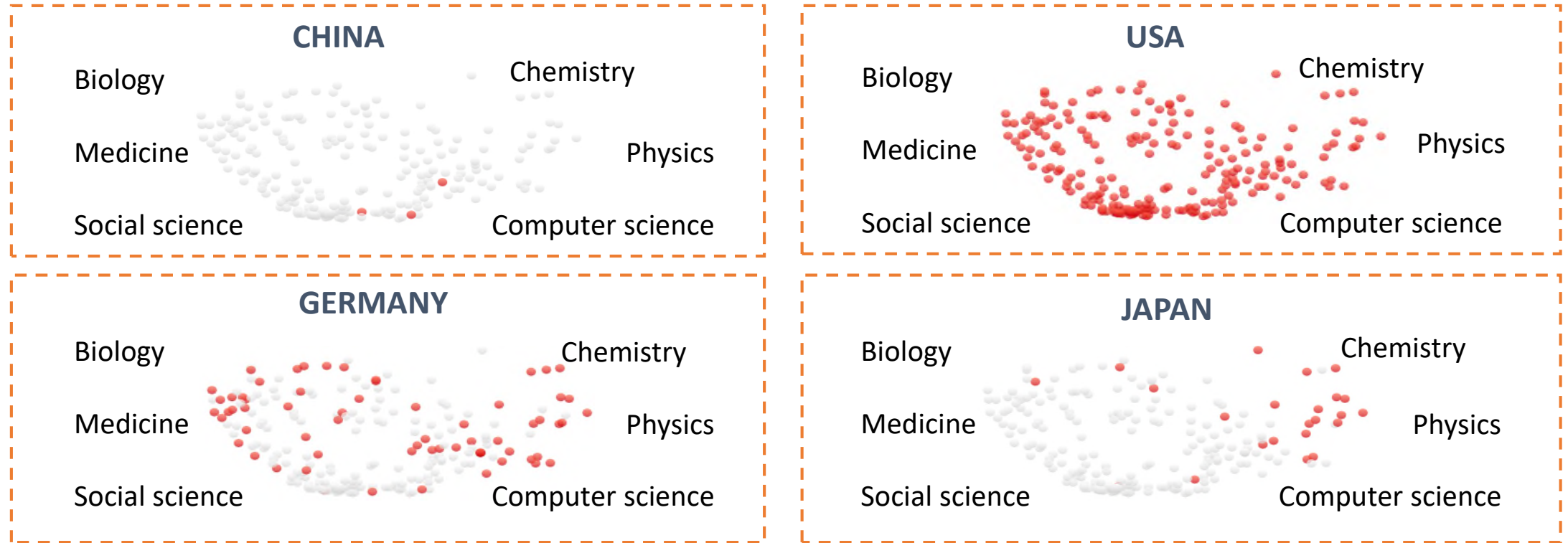Node size: number of papers in the subject category

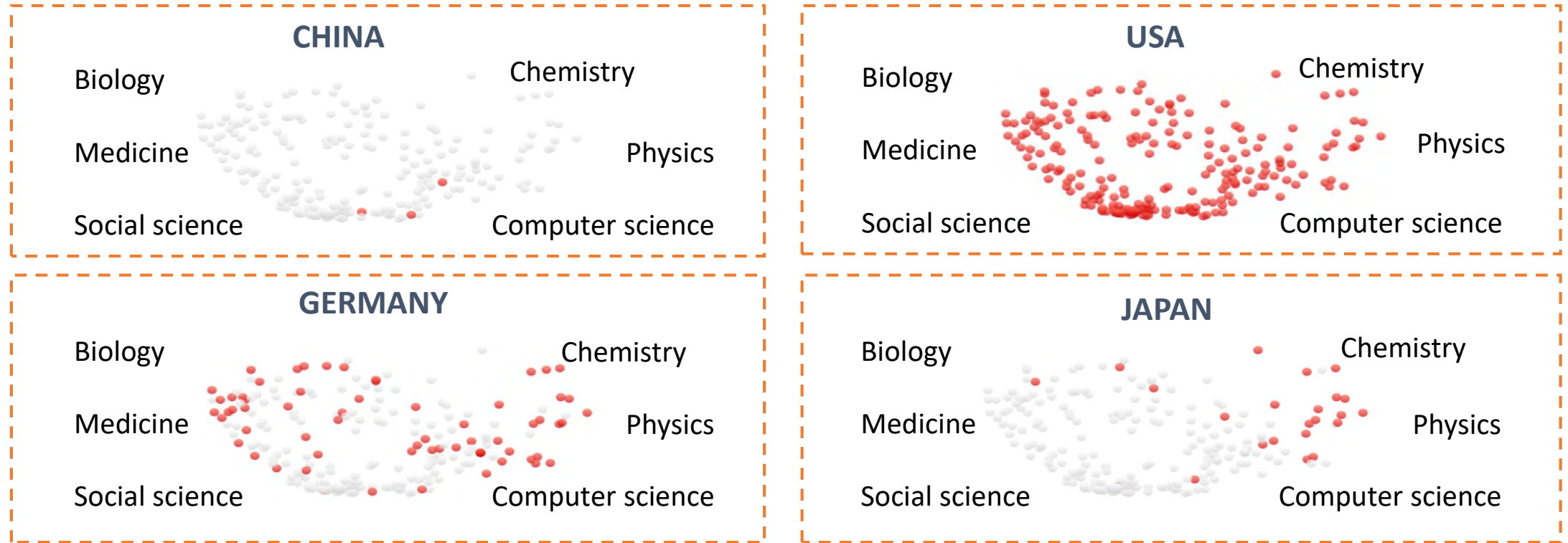Node position: Many citation relations lead to closely positioned nodes

Node colour: Cluster algorithm assigns subject categories to the same colour, if they are frequently co-cited
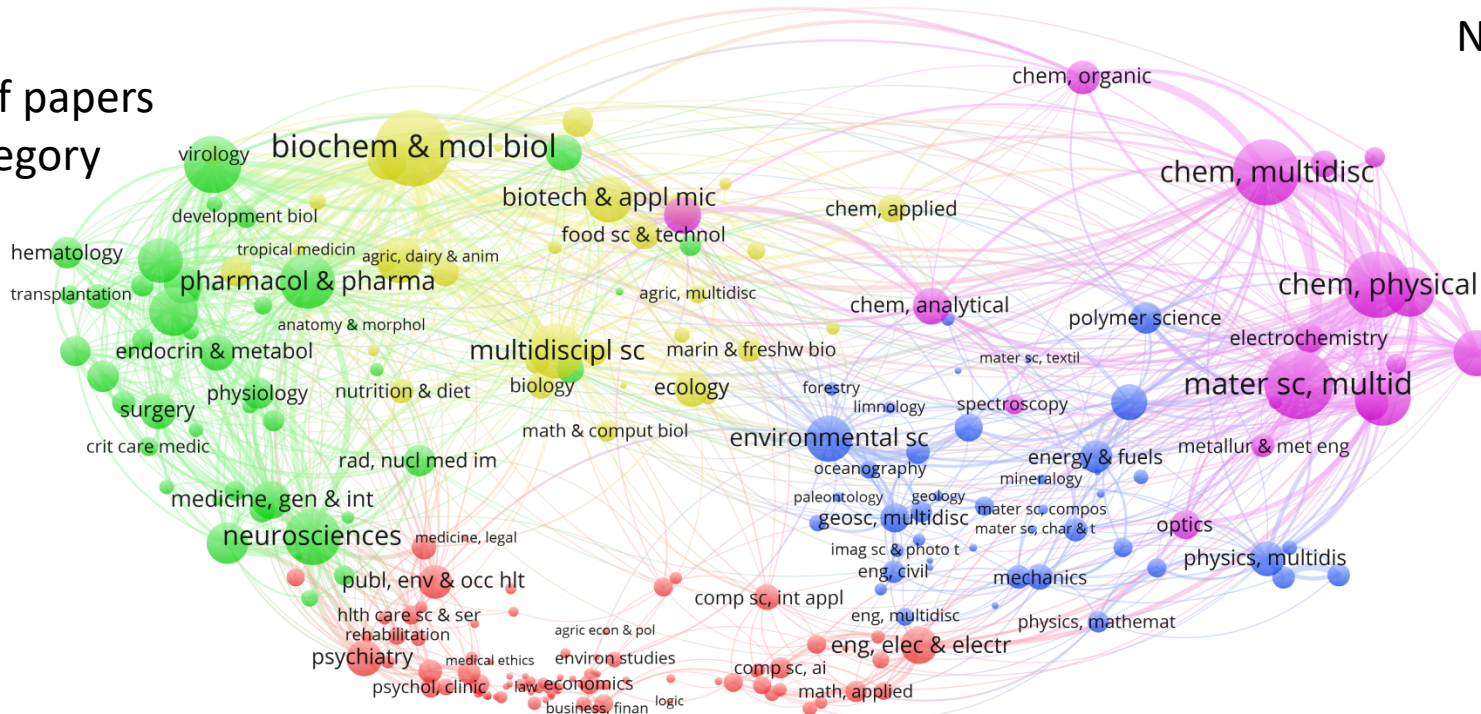
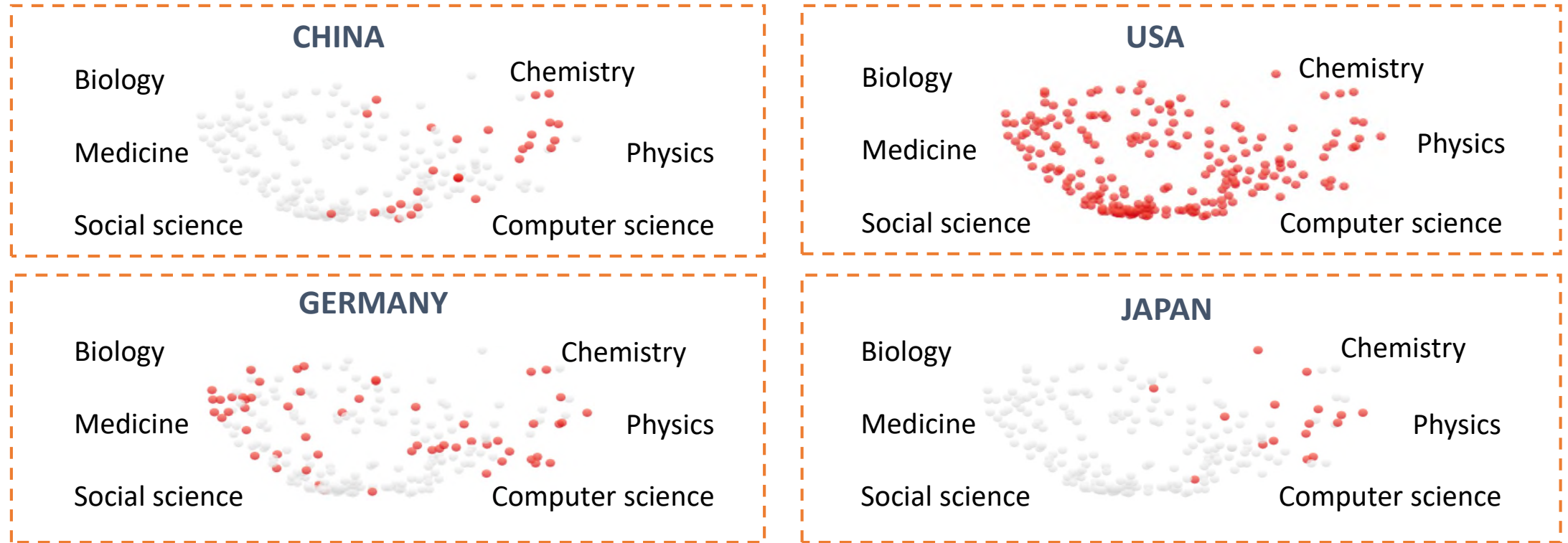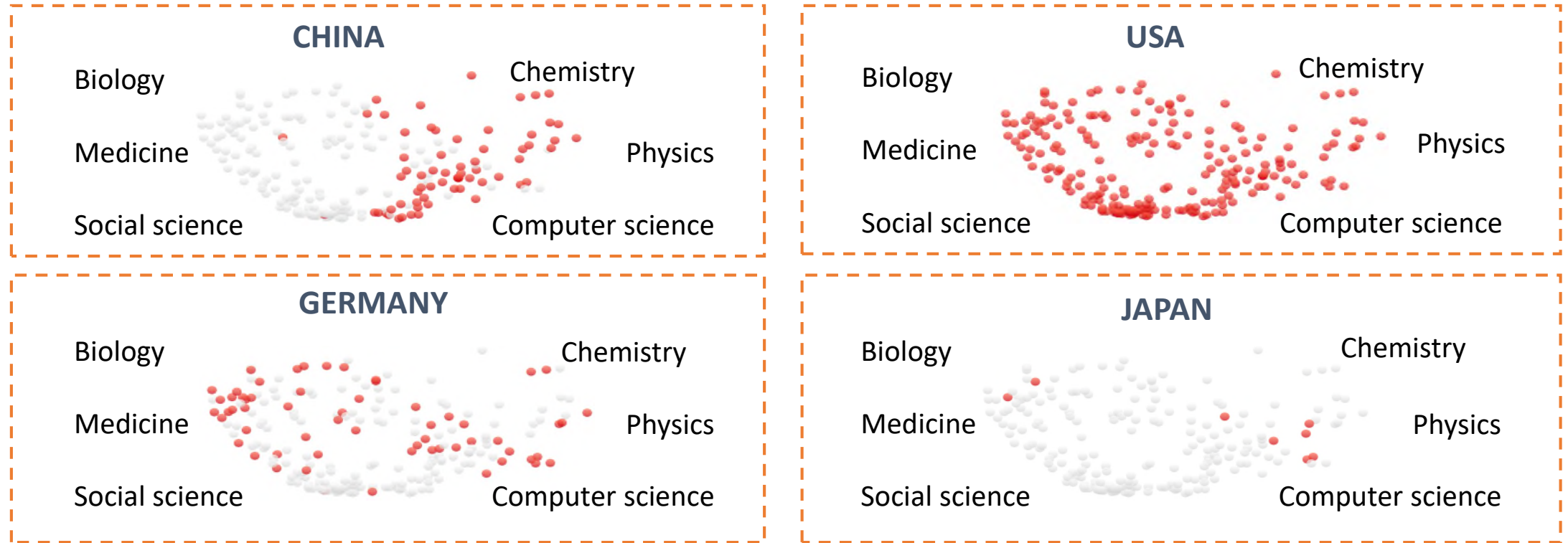Database: Articles and reviews from 2003 to 2013 and their cited references in the same period

Subject categories with more than 10% papers. The number of papers are shown which belong to the 10% most frequently cited papers in their subject category (2000-2002)

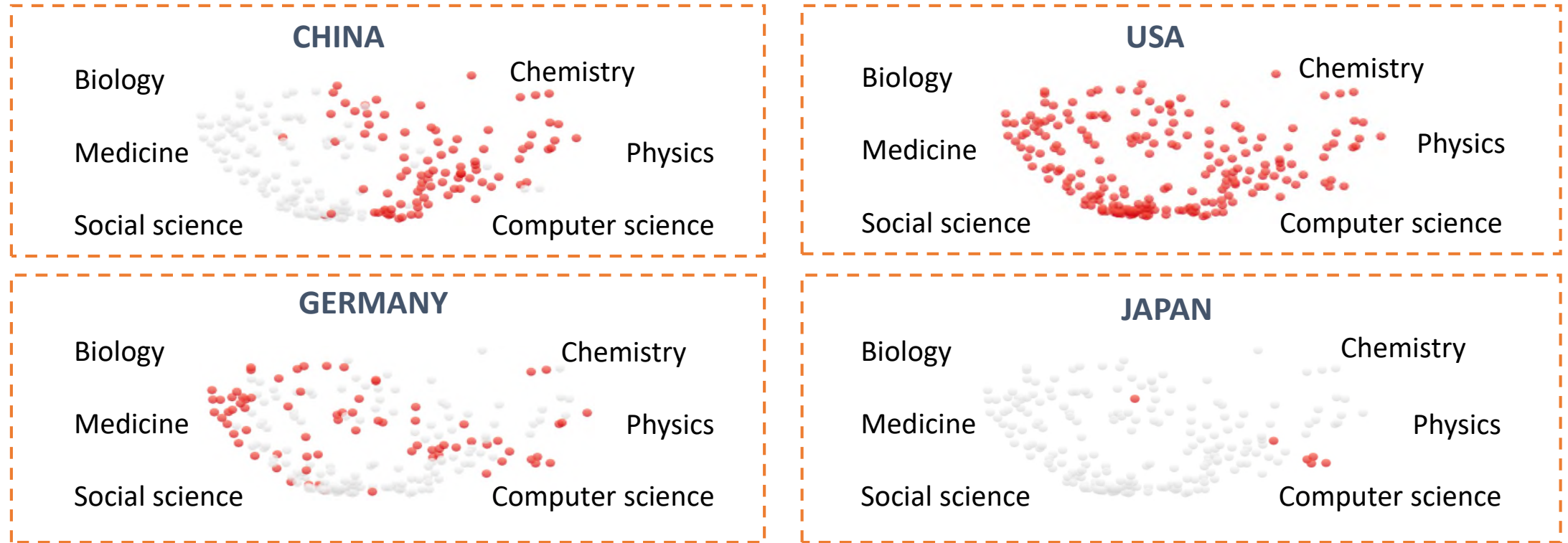# Subject categories with more than 10% papers. The number of papers are shown which belong to the 10% most frequently cited papers in their subject category (2000-2002)

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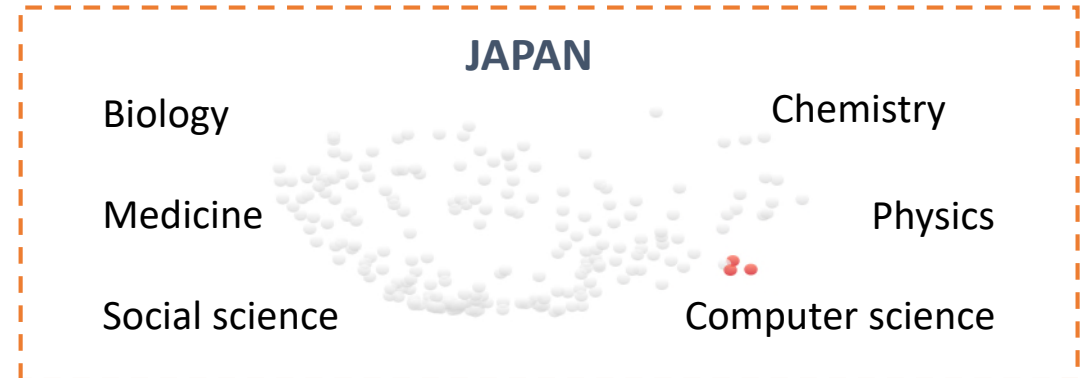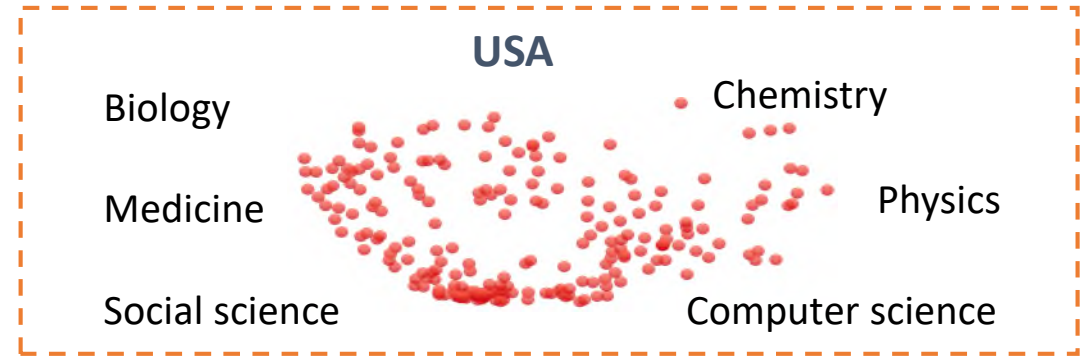
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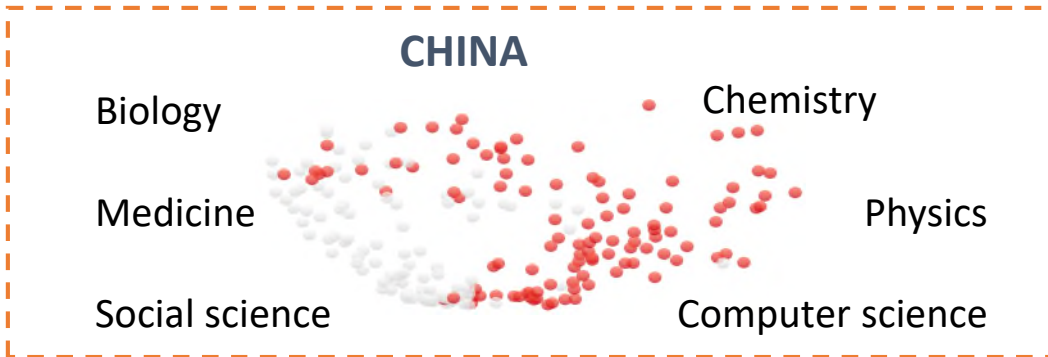
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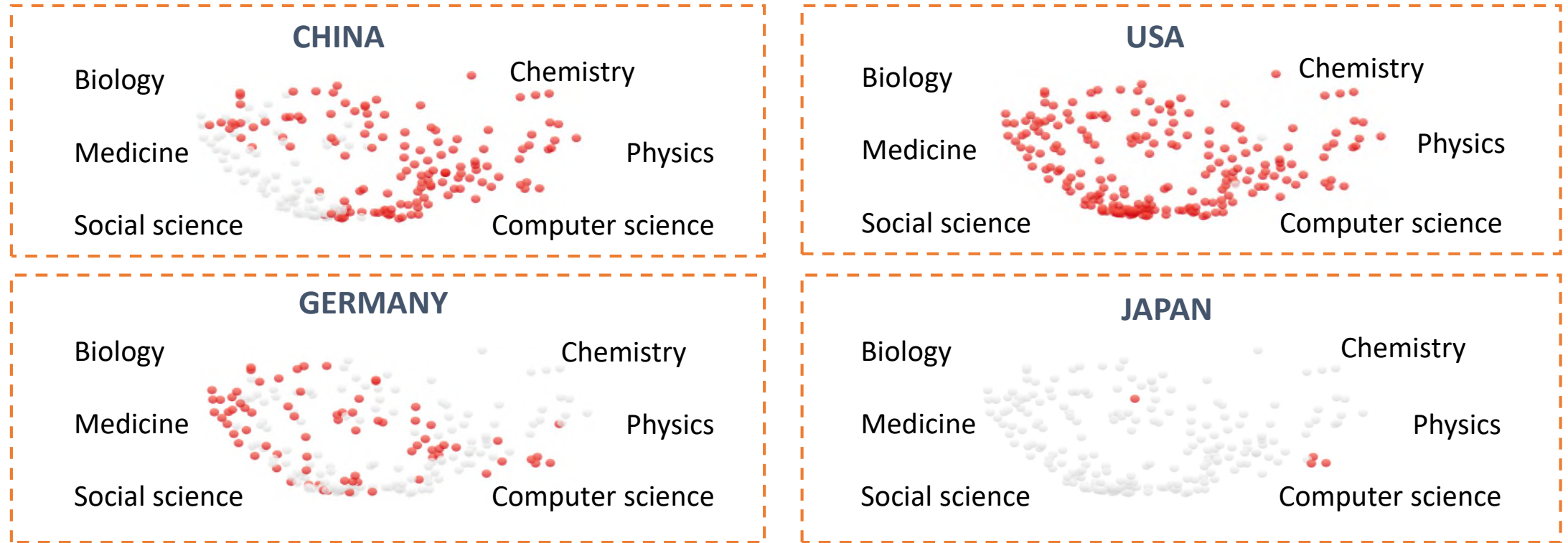
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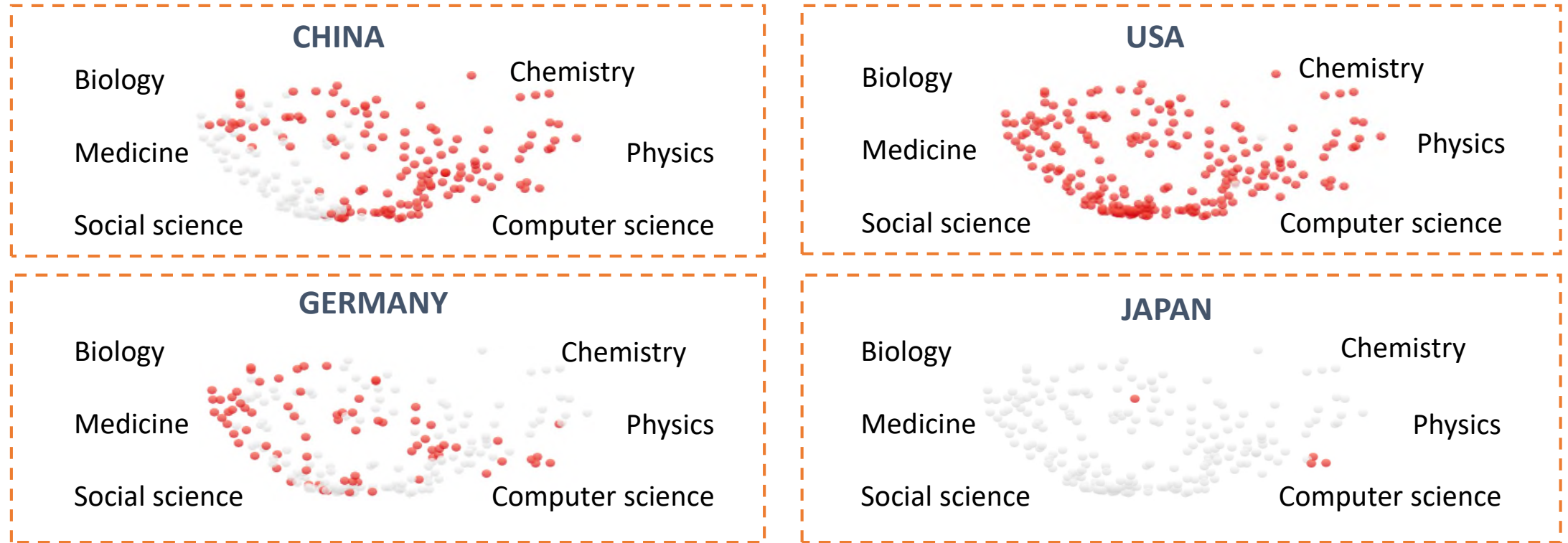
Subject categories with more than 10% papers. The number of papers are shown which belong to the 10% most frequently cited papers in their subject category (2015-2017)

CHINA

Biology Chemistry
Medicine Physics
Social science Computer science

USA

Biology Chemistry
Medicine Physics
Social science Computer science

GERMANY

Biology Chemistry
Medicine Physics
Social science Computer science

JAPAN

Biology Chemistry
Medicine Physics
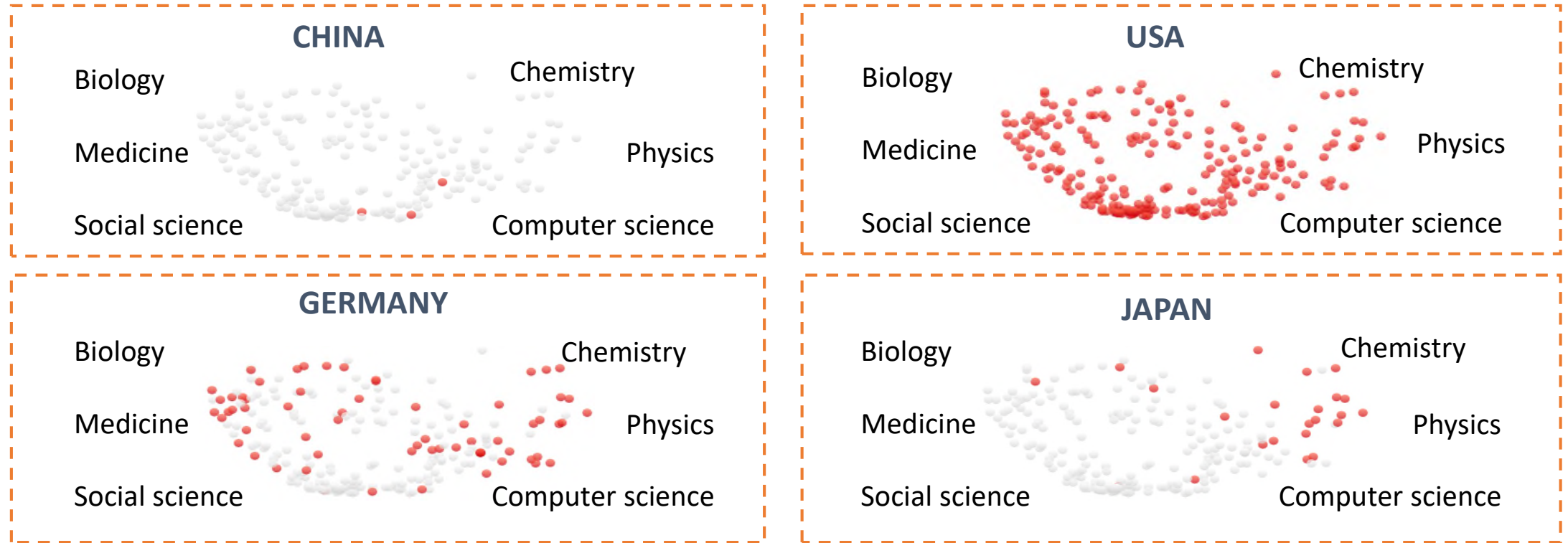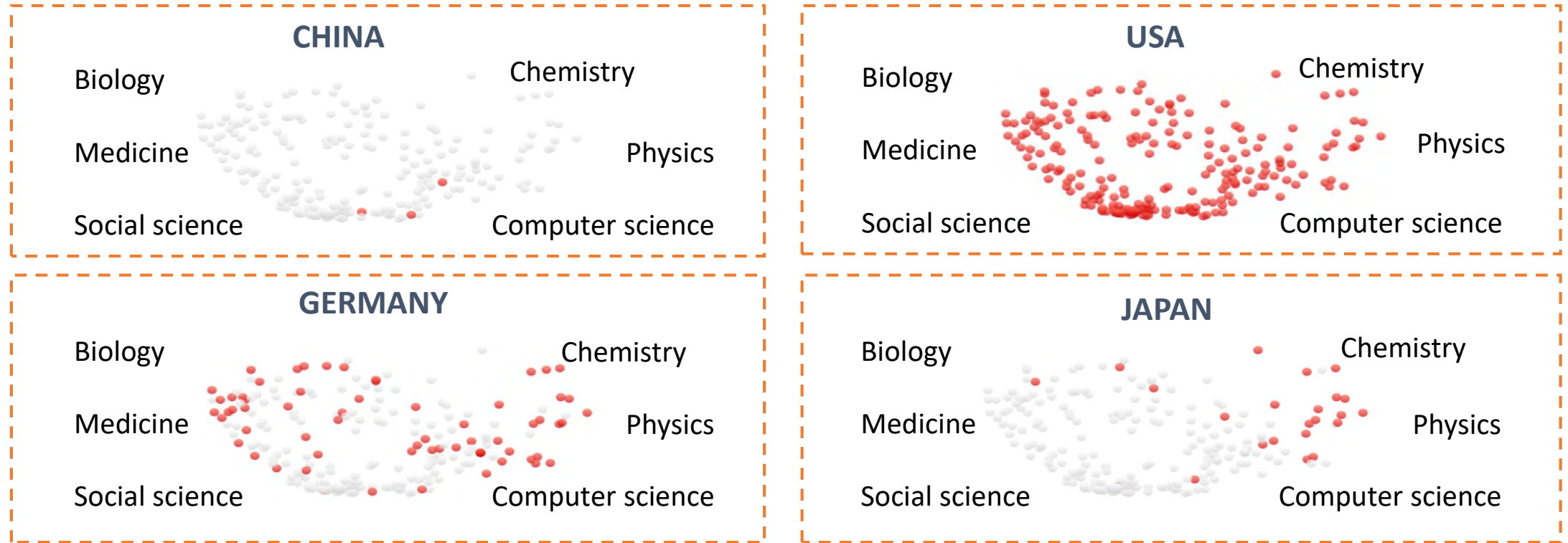Social science Computer science

Subject categories with more than 10% papers. The number of papers are shown which belong to the 10% most frequently cited papers in their subject category (2015-2017)
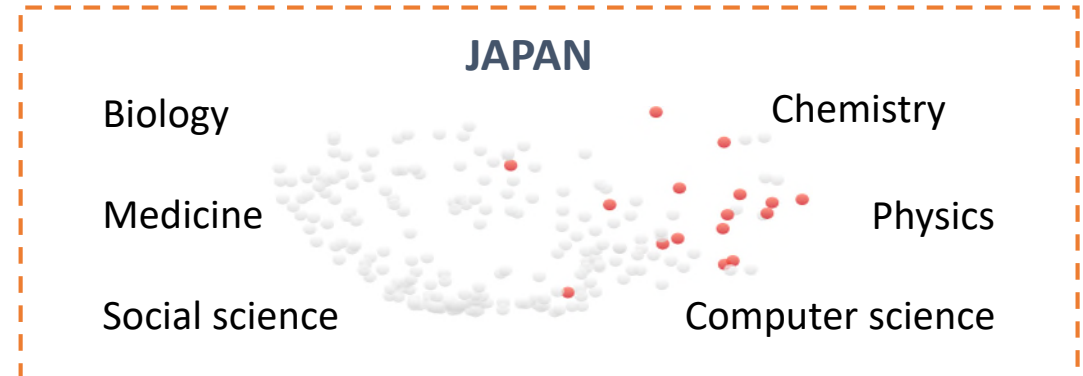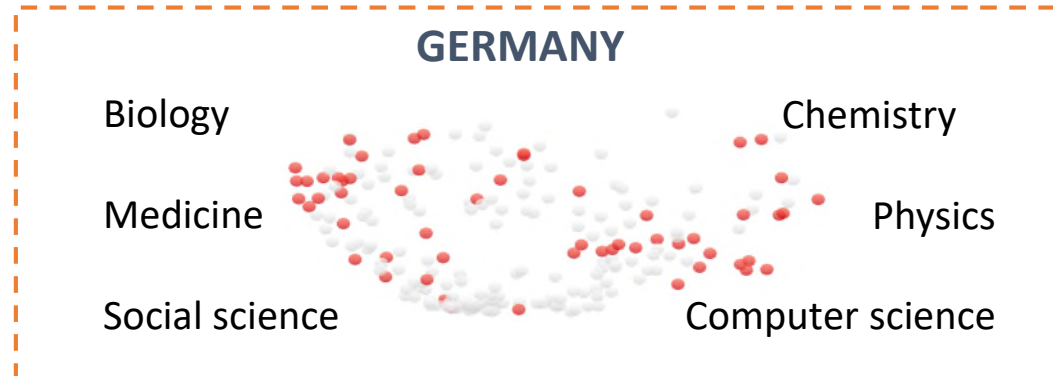
Subject categories with more than 10% papers. The number of papers are shown which belong to the 10% most frequently cited papers in their subject category (2000-2002)

CHINA
Biology   Chemistry
Medicine   Physics
Social science   Computer science

USA
Biology   Chemistry
Medicine   Physics
Social science   Computer science

GERMANY
Biology   Chemistry
Medicine   Physics
Social science   Computer science

JAPAN
Biology   Chemistry
Medicine   Physics
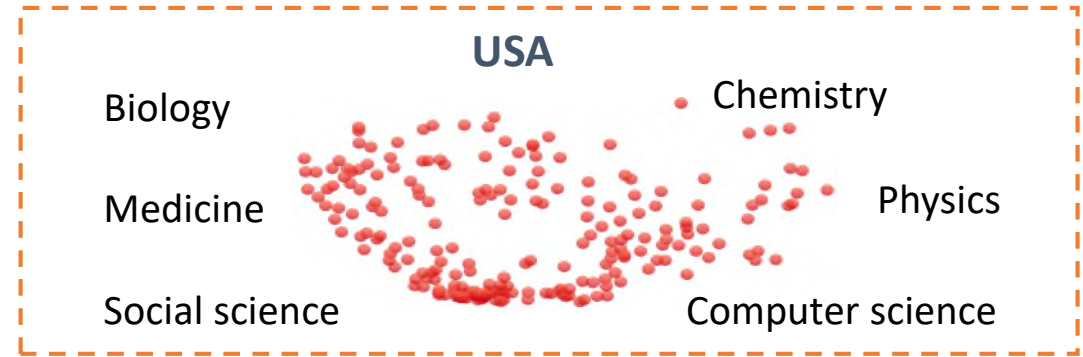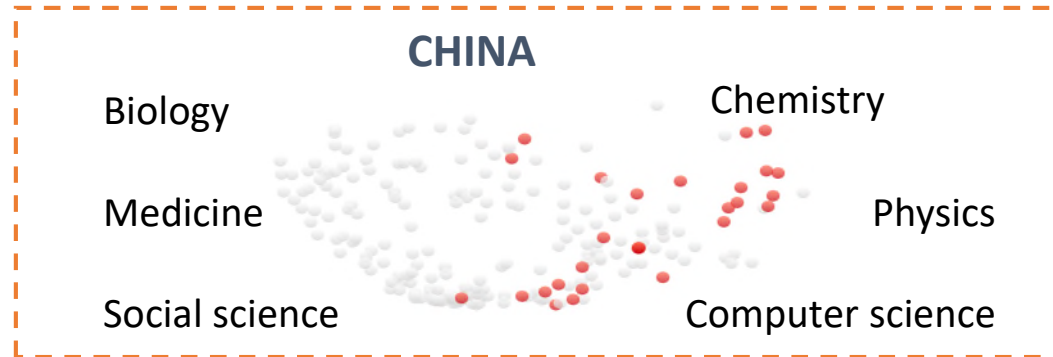Social science   Computer science

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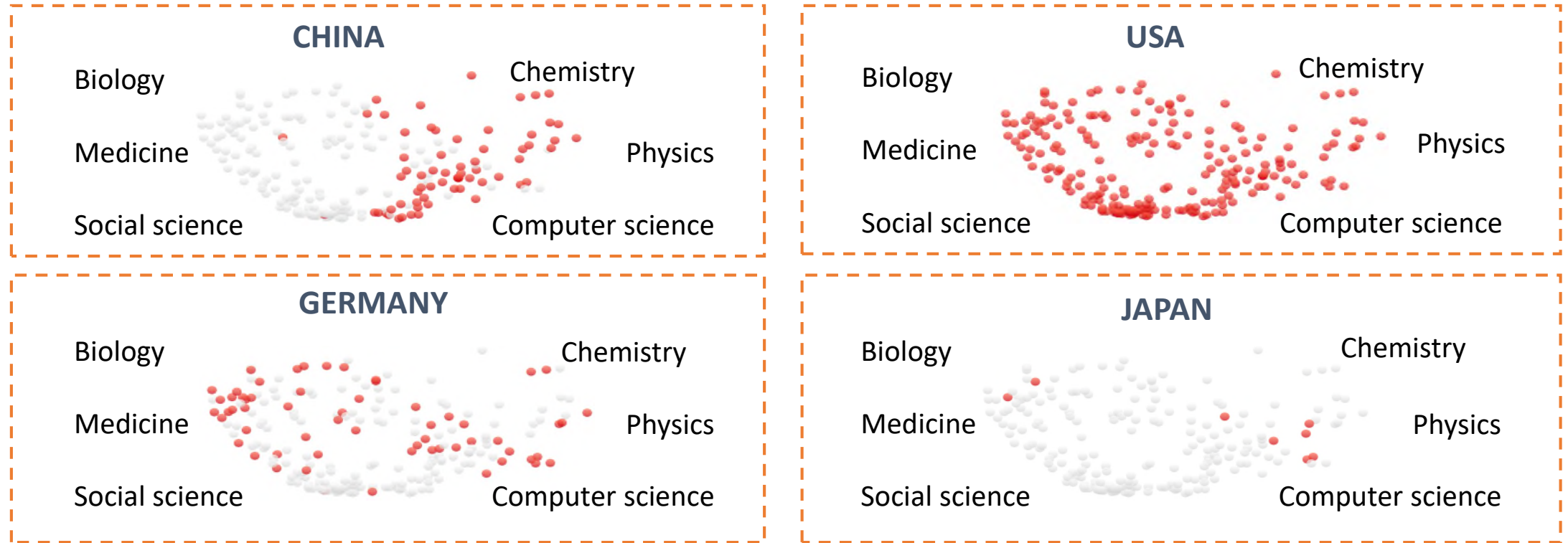
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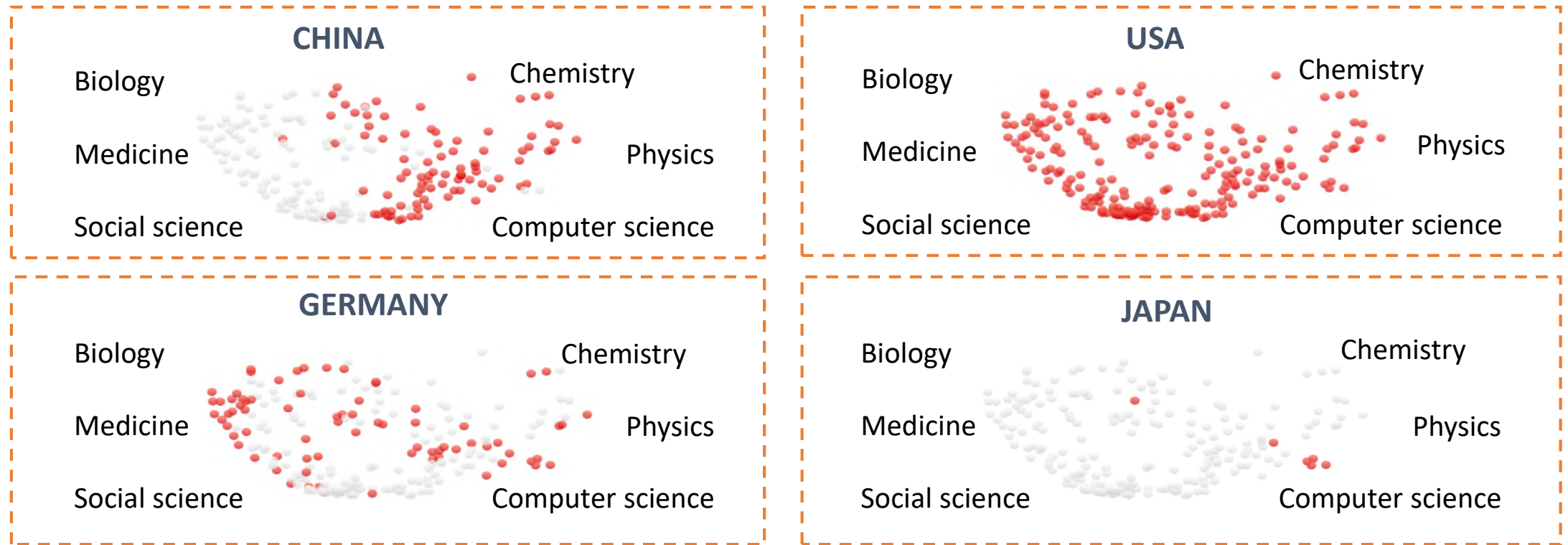
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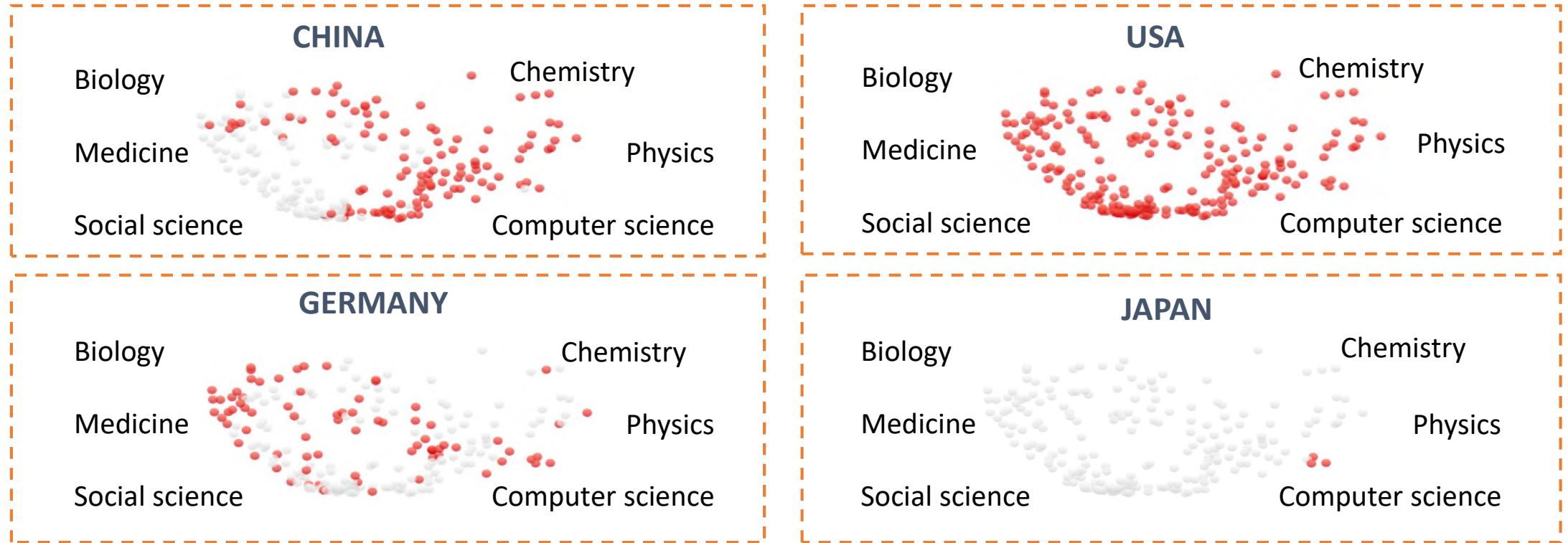
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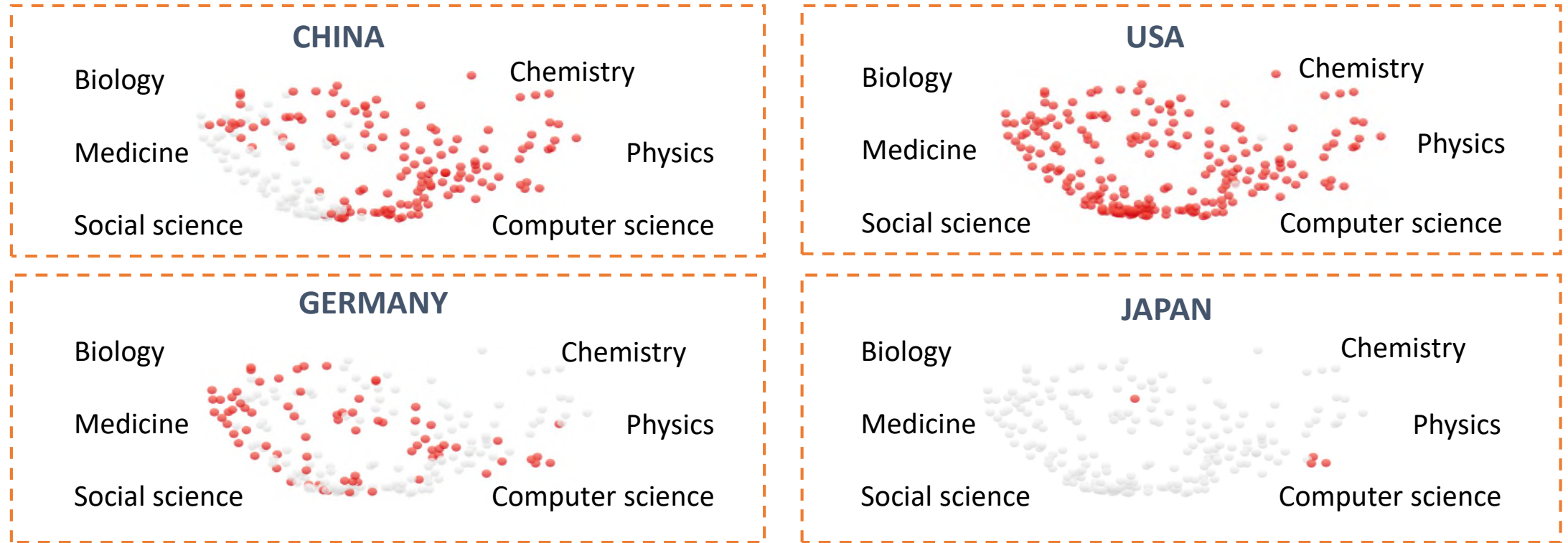
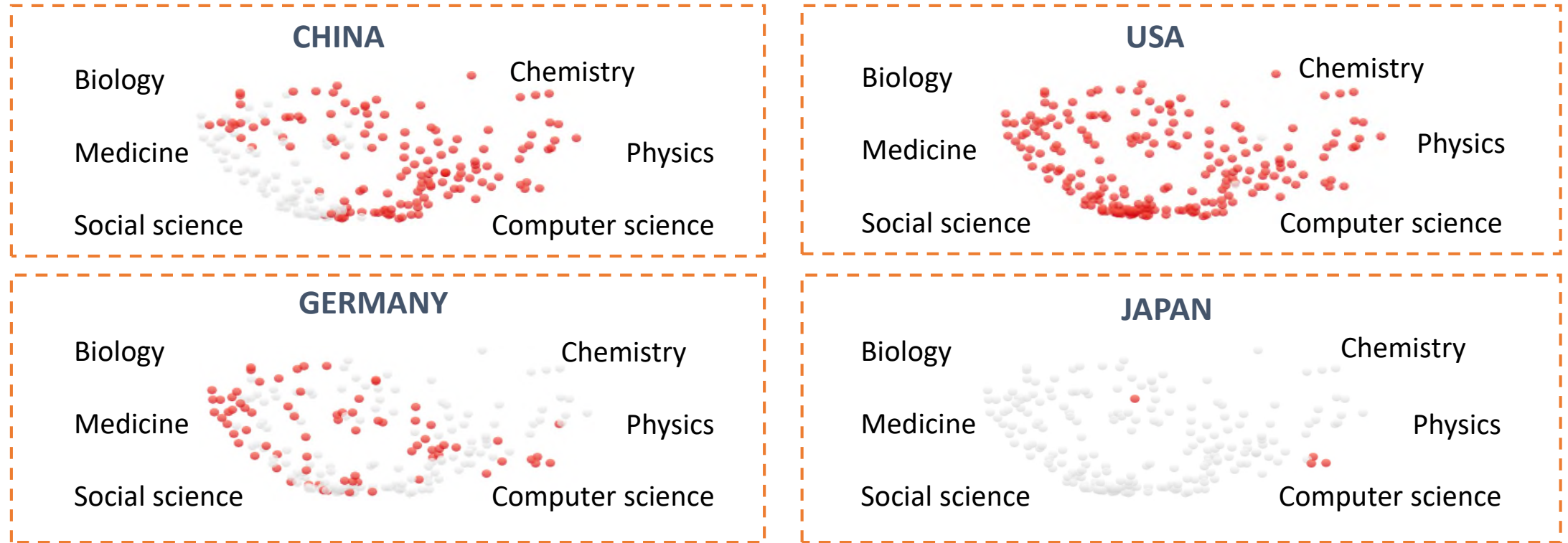# Subject categories with more than 10% papers. The number of papers are shown which belong to the 10% most frequently cited papers in their subject category (2015-2017)

Web-based tools

Web-based tools (free of charge)

- Web application which visualizes research excellence worldwide in several subject areas:

 www.excellencemapping.net

- Web application which visualizes how successful universities or research-focused institutions collaborate:

  www.excellence-networks.net

First release of the excellence mapping tool

- In 2011, first release of excellencemapping.net

- Since then a lot of feedback (e.g., MIT Technology Review)

- Recently, we finalized a new release

- Until 2021, ~500.000 views
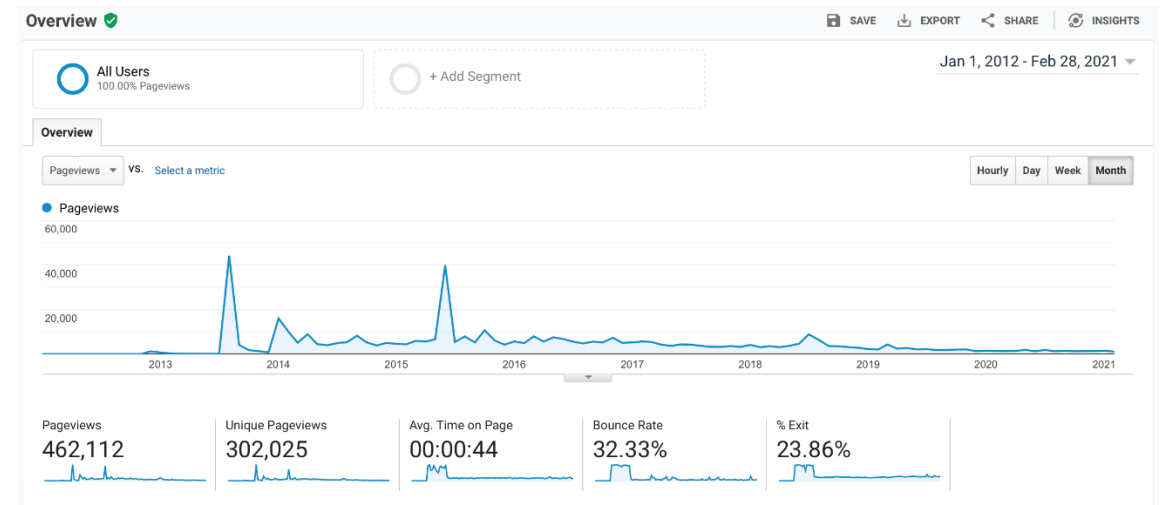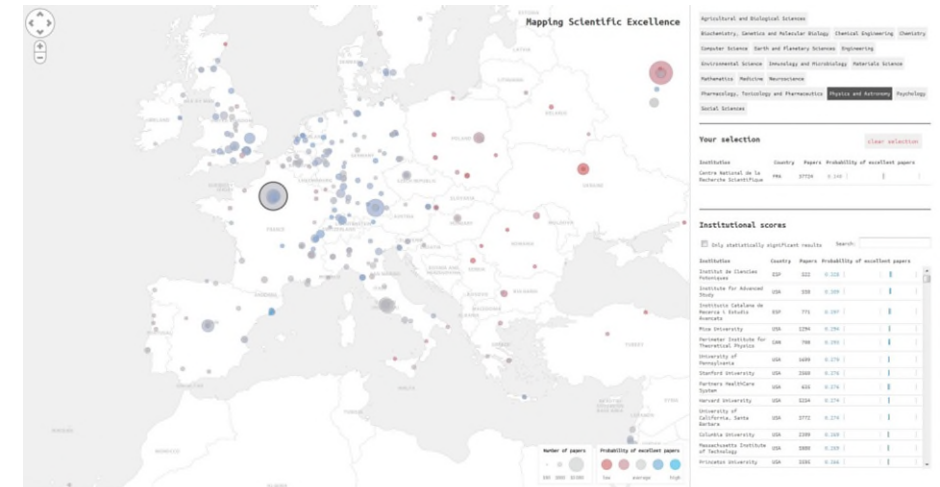
Used data

- Scopus data: institutional affiliations have been cleaned by SCImago

- Mendeley data: to measure reader impact on lecturers, librarians, professors, researchers or students

- Universities and research-focused institutions

- Articles, reviews und conference papers published between 2012 and 2016 within a subject area

- Only institutions, which have published at least 500 papers within a subject area

- Full counting: independent of the number of co-authoring institutions, an institution on a paper receives the full credit

- Indicators measuring performance: PP(top 10%)

- 24 subject areas (e.g., chemistry); all fields map: institutions worldwide with (at least 500) papers in at least five subject areas

Number of institutions by subject area

| Subject area	Frequency	Percent
All subject areas	1024	6.52
Agricultural and Biological Sciences	761	4.85
Arts and Humanities	260	1.66
Biochemistry, Genetics and Molecular Biology	1151	7.33
Business, Management and Accounting	128	0.82
Chemical Engineering	454	2.89
Chemistry	922	5.87
Computer Science	1081	6.88
Earth and Planetary Sciences	552	3.52
Economics, Econometrics and Finance	73	0.46
Energy	261	1.66
Engineering	1452	9.25
Environmental Science	553	3.52
Immunology and Microbiology	360	2.29
Materials Science	956	6.09
Mathematics	727	4.63
Medicine	2034	12.95
Neuroscience	329	2.10
Nursing	111	0.71
Pharmacology, Toxicology and Pharmaceutics	292	1.86
Physics and Astronomy	1218	7.76
Psychology	231	1.47
Social Sciences	616	3.92
Veterinary	59	0.38
Health Professions	96	0.61

Regression models

- excellencemapping.net presents results of regression models (so called predicted values)

- Advantage: Calculation and presentation of confidence interval for bibliometric results

- Dependent variable: performance indicator

- Independent variable: all institutions within a subject area

- Possible further independent variable: factors (e.g., gross national income per capita, GNI) with a possible influence on institutional performance

- These independent variables lead to adjusted rankings

Adjusted ranking

- GNI: The more money is available in a country, the better research one can expect

- Adjusted ranking: including the GNI as further independent variable leads to an adjusted ranking

- Those institutional performance values are presented as if all institutions are located in a country with the same GNI

- Further independent variable with a possible influence on institutional performance:
  - Number of institutions (universities or research-focused institutions) located in a country
  - Number of residents in a country
  - Mean economic growth
 - Corruption perception index

Mapping scientific excellence: application which visualizes research excellence worldwide in several subject areas (www.excellencemapping.net)
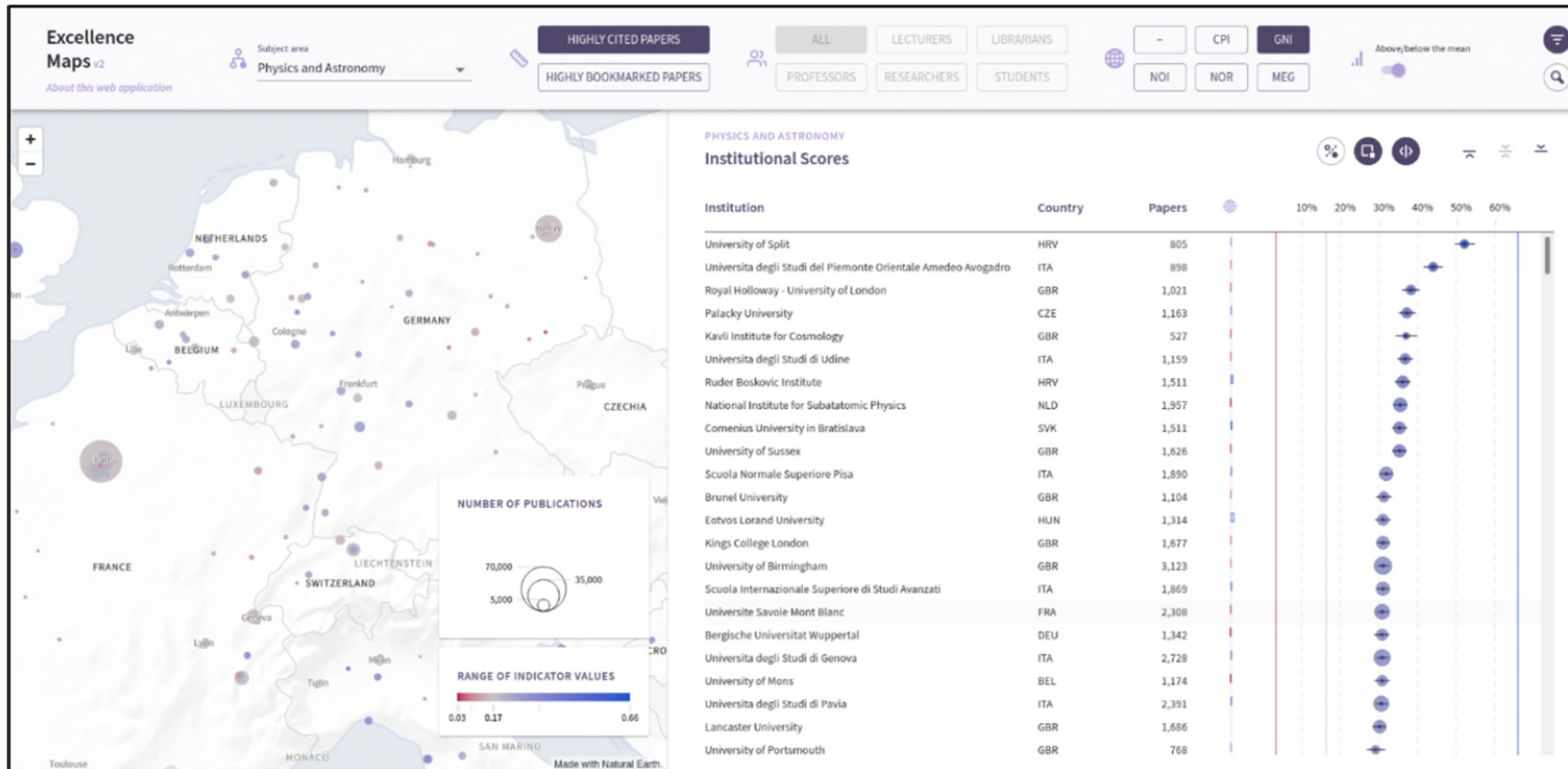
Bornmann, L., Mutz, R., Haunschild, R., de Moya-Anegon, F., de Almeida Madeira Clemente, M., Stefaner, M. (in press). Mapping the impact of papers on various status groups: A new excellence mapping tool based on citation and reader scores. *Scientometrics.* https://arxiv.org/abs/2103.10225
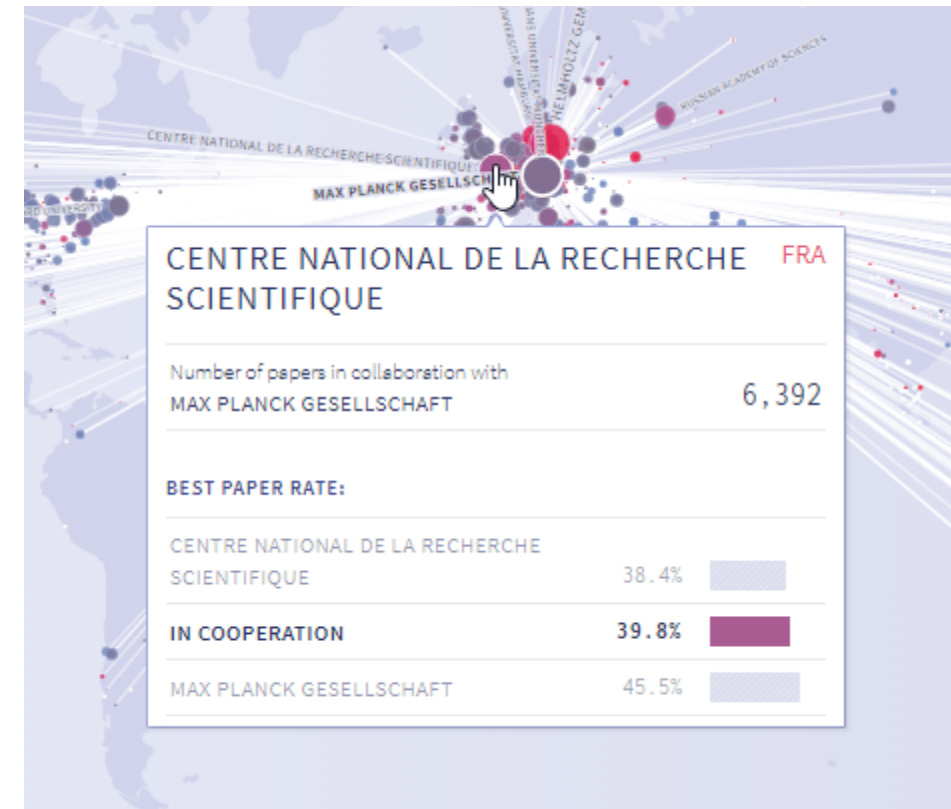
Excellence network tool

- In 2016, first release of excellence-networks.net

- Since then a lot of feedback (e.g., Twitter)

- Annual new releases
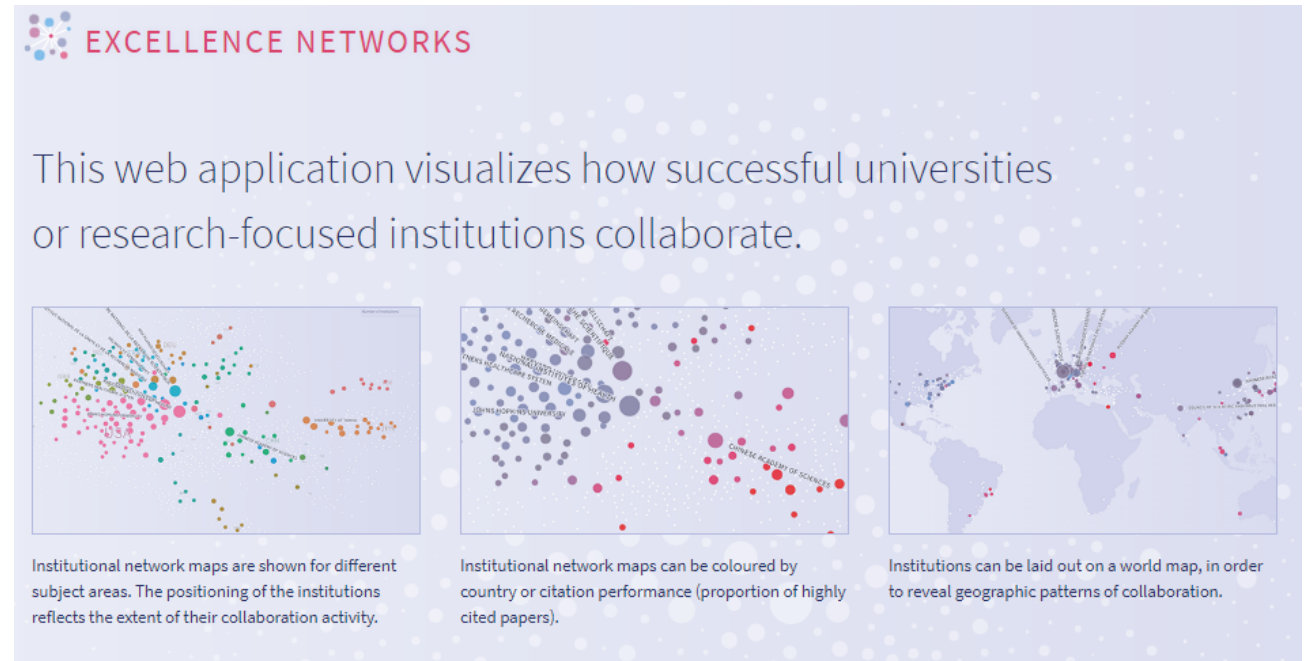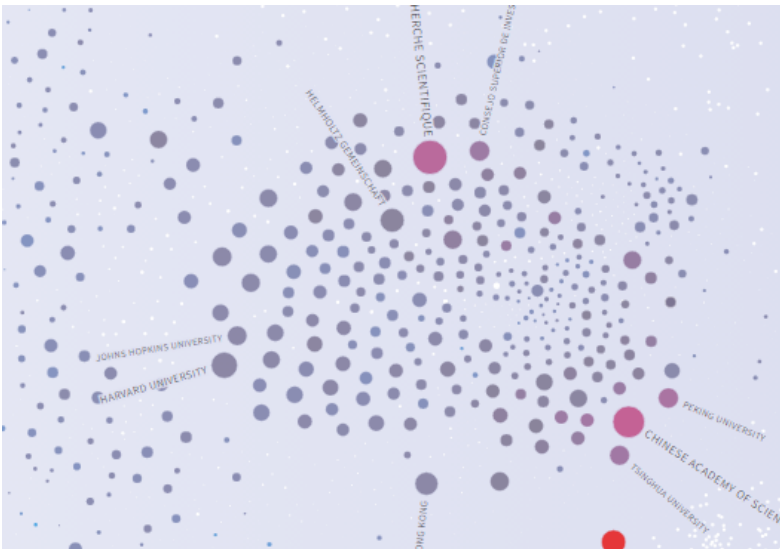
Excellence network tool

- Scopus data: institutional affiliations have been cleaned by SCImago

- Universities and research-focused institutions

- Articles, reviews und conference papers published between 2012 and 2016 within a subject area

- Indicators measuring performance:
PP(top 10%)

- Comparison of collaboration: collaboration between two institutions is compared to collaboration with all other institutions

- Does the institution profit from the collaboration?

Excellence networks: application which visualizes how successful institutions collaborate (www.excellence-networks.net)

Bornmann, L., Stefaner, M., de Moya Anegón, F., & Mutz, R. (2016). Excellence networks in science: A Web-based application based on Bayesian multilevel logistic regression (BMLR) for the identification of institutions collaborating successfully. *Journal of Informetrics, 10*(1), 312-327.

Thank you for your attention!

- Web application which visualizes research excellence worldwide in several subject areas:

  www.excellencemapping.net

- Web application which visualizes how successful universities or research-focused institutions collaborate:

  www.excellence-networks.net

- CRExplorer: A program for identifying citation classics and landmark papers of fields

  www.crexplorer.net