# RANDOM WALK IN THE ACADEMIC PUBLICATION

## A data-driven approach

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# Contents

Introduction 2

Papers 3

Affiliations 9

Authors 14

# Introduction

Open Academic Graph (OAG) is a large knowledge graph unifying Microsoft Academic Graph (MAG) and AMiner. Two projects' major purpose is to develop a heterogeneous graph comprising scientific publication records and citation linkages between those articles, as well as authors, institutions, journals, conferences, and fields of study. After unifying the two datasets, the result can be found here.

The dataset contains many tables, as:

- authors: includes some information about the authors, such as their names, affiliations, postitions, and a summary of their publications.
- affiliations: contains the name of affiliation, type, and location by latitude and longitude.
- venues: shows information about where work was published.
- papers: this table has many fields and contains publication metadata such as title, publisher, issn, and…
- links: contains id tables for joining each table from MAG to Aminer.

If you have an Azure account, Microsoft has automated uploads of new versions of MAG to Azure Storage.

In this project, we can try to find new insights from the academic publication world!

# Papers

The paper table contains information about paper's metadata. This table contains 208915369 rows. This is the biggest table in the academic graph datasets. In the below table, the fields are shown.

Table 1: Papers Table Schema

| Field Name | Field Type | Description | Example |
|---|---|---|---|
| id | string/long | paper ID | 53e9ab9eb7602d970354a97e |
| title | string | paper title | Data mining: concepts and techniques |
| authors.name | string | author name | Jiawei Han |
| author.org | string | author affiliation | Department of Computer Science, University of Illinois at Urbana-Champaign |
| author.org_id | long | author affiliation id | 157725225 |
| author.id | string/long | author ID | 53f42f36dabfaedce54dcd0c |
| venue.id | string/long | paper venue ID | 53e17f5b20f7dfbc07e8ac6e |
| venue.name | string | paper venue name | Inteligencia Artificial, Revista Iberoamericana de Inteligencia Artificial |
| year | int | published year | 2000 |
| keywords | list of strings | keywords | ["data mining", "structured data", "world wide web", "social network", "relational data"] |
| fos.name | string | paper fields of study | Web mining |
| fos.w | float | fields of study weight | 0.65969085700000007 |
| references | list of long | paper references | [4909282, 16018031, 16159250,  19838944, ...] |
| n_citation | int | citation number | 40829 |
| page_start | string | page start | 11 |
| page_end | string | page end | 18 |
| doc_type | string | paper type: journal, book title... | book |
| lang | string | detected language | en |
| publisher | string | publisher | Elsevier |
| volume | string | volume | 10 |
| issue | string | issue | 29 |
| issn | string | issn | 0020-7136 |
| isbn | string | isbn | 1-55860-489-8 |
| doi | string | doi | 10.4114/ia.v10i29.873 |
| pdf | string | pdf URL | //static.aminer.org/upload/pdf/1254/ 370/239/53e9ab9eb7602d970354a97e.pdf |
| url | list | external links | ["http://dx.doi.org/10.4114/ia.v10i29.873", "http://polar.lsi.uned.es/revista/index.php/ia/ article/view/479"] |
| abstract | string | abstract | Our ability to generate... |
| indexed_abstract | string (JSON format) | indexed abstract | {"IndexLength": 164, "Inverte dIndex": {"Our": [0], "ability": [1], "to": [2, 7, ...]}} |

Many questions concerning the Microsoft Academic Graph may be posed and searched. To begin, we attempt a statistical explorations of the data in order to obtain a better knowledge of the world of publications. We begin with a graph showing the annual publication count through time. The plot is shown below.

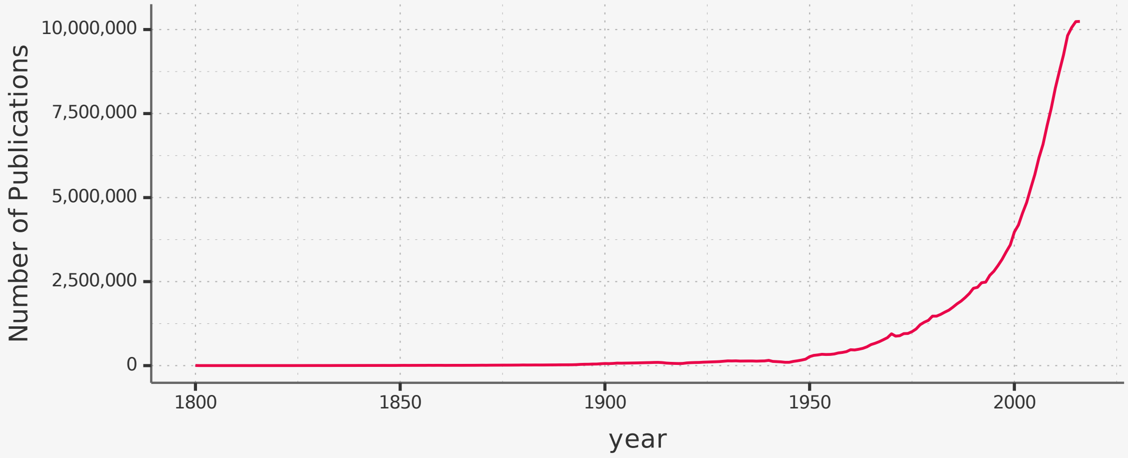


Figure 1: annual publication count through years

According to the plot, the number of publications has increased exponentially. The graph's vertical axis is scaled logarithmically in base 2 to make this clearer. In addition, the data is fitted using a regression line, and the findings reveal that the data follows an exponential model. The model slope coeficient indicates that every 25 years, the number of publications in the globe doubles.

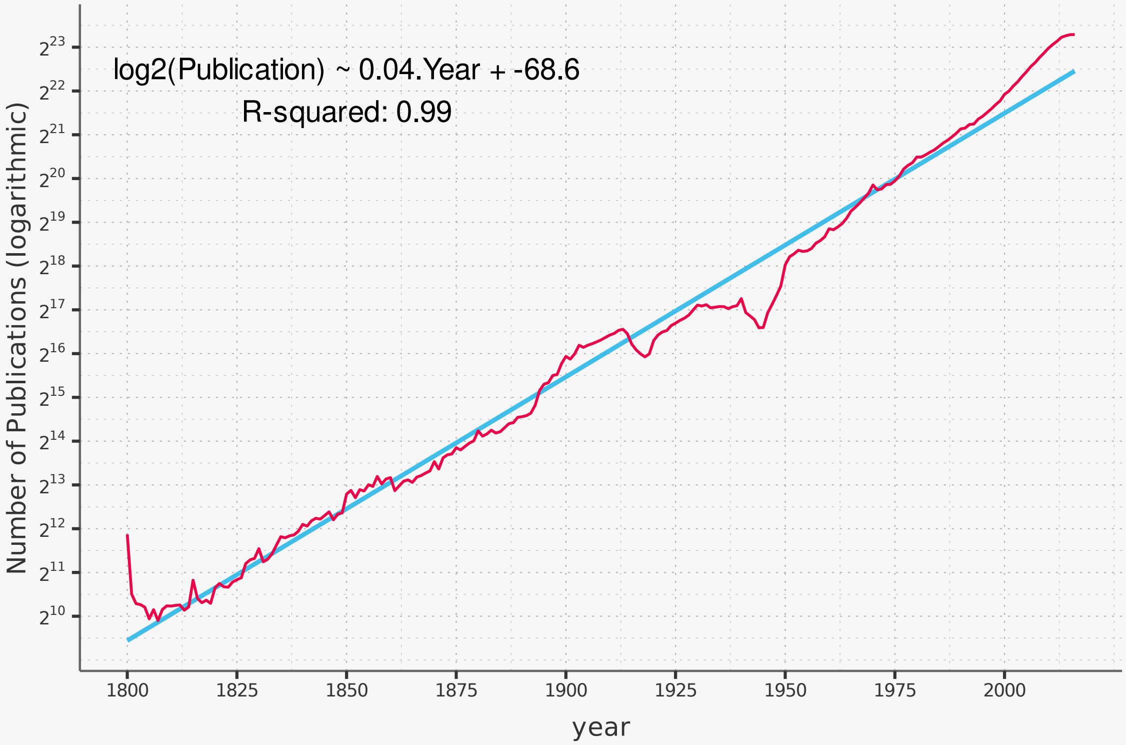


Figure 2: The behavior of annula publication's logarithmic growth

Table 2: Summary of Liear Model Log(Pubs) by Year.

| | |
|---|---|
| (Intercept) | -68.623*** |
| | (0.662) |
| year | 0.042*** |
| | (0.000) |
| Num.Obs. | 217 |
| R2 | 0.985 |
| R2 Adj. | 0.985 |

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

When you look at the annual poblicatios, you see two sudden drops. The coincidence of this event with the world wars shows the effect of war on the decline of science.

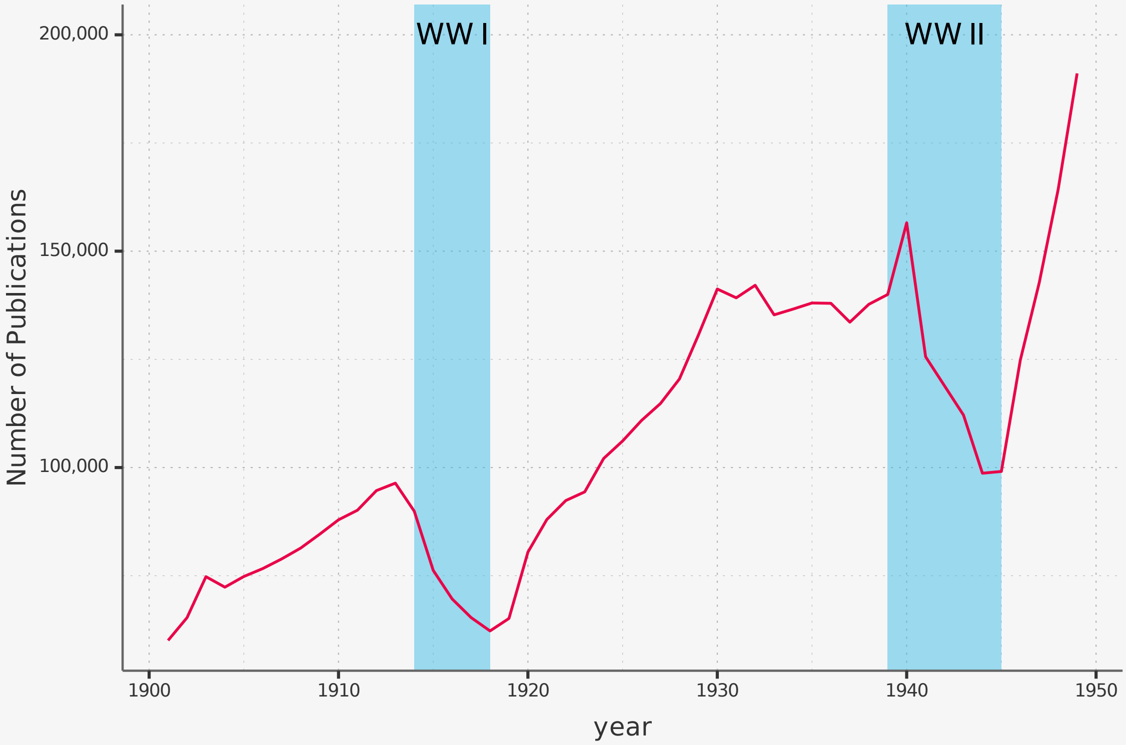


Figure 3: The effect of war on the growth of science

In the below table, we can view publications according to the type of document.

Document Frequency

| | Type | Count |
|---|---|---:|
| | Journal | 80,646,297 |
| | | 75,300,276 |
| | Patent | 45,298,165 |
| | Conference | 4,250,431 |
| | BookChapter | 2,312,088 |
| | Book | 1,108,112 |
| Total | — | 208,915,369 |

As you can see, there are a lot of publications that aren’t labeled.

The yearly number of publications is shown by document type in the graph below to illustrate the growth trend in further depth over the last fifty years (1967-2017).

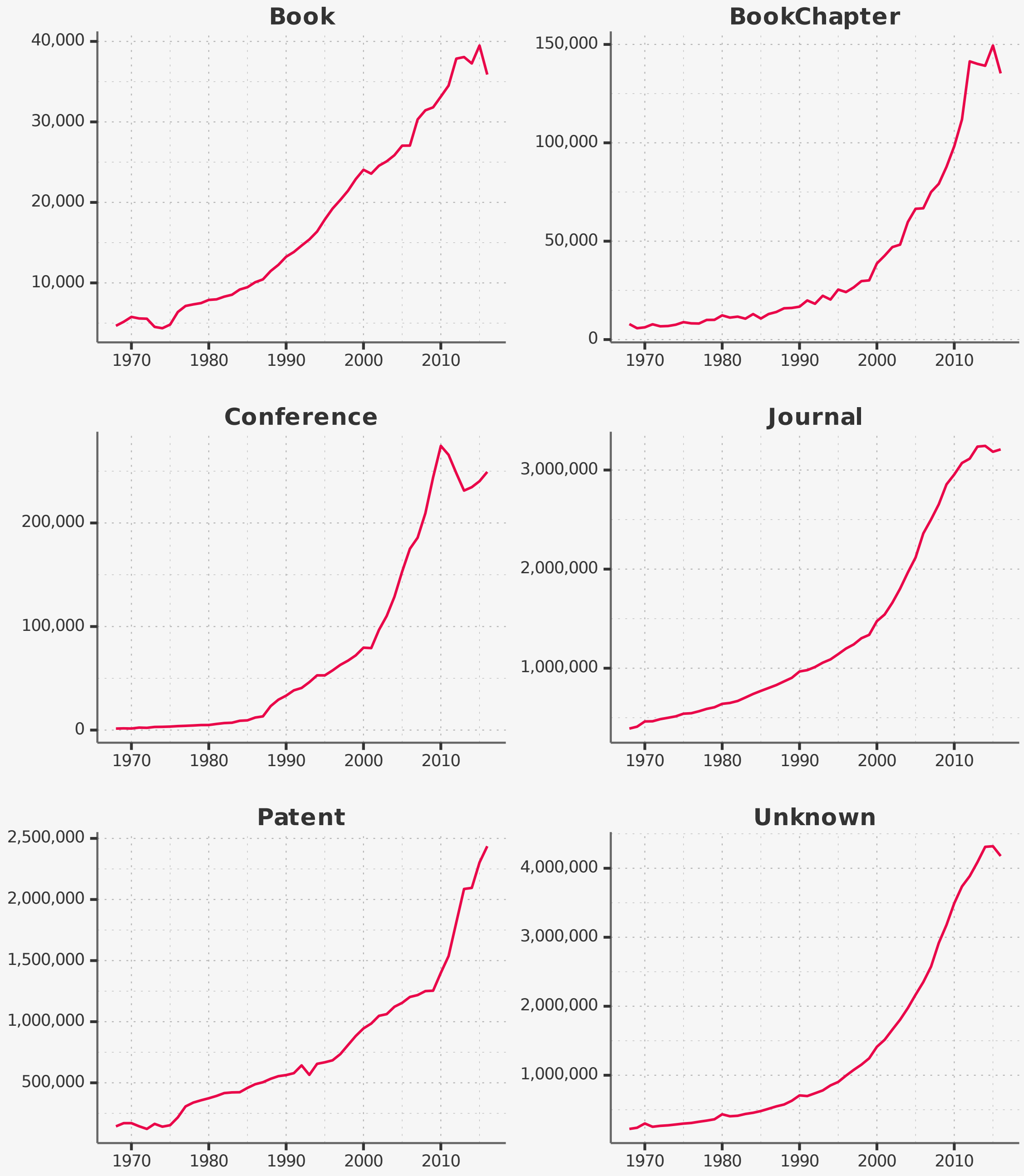


Figure 4: Annual publication number by document type

The conference publications appear to follow a slightly different pattern than the others.

The annual total number of citations was divided by the total number of articles to arrive at the impact factor. For each document, an annual chart was plotted to assess the effect of the published works.

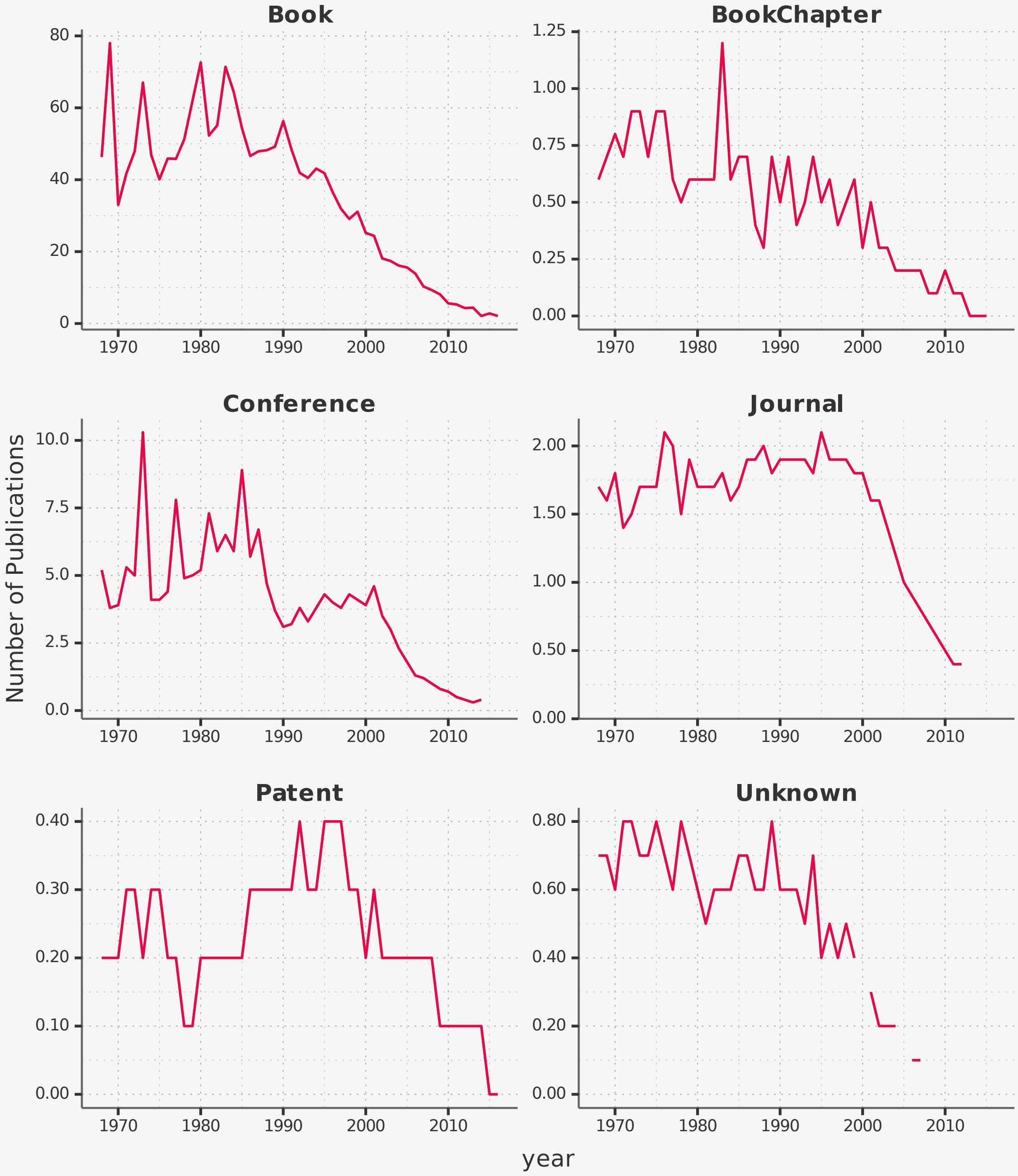


Figure 5: Annual publication impact by document type

As can be observed, all types of documentation have a decreasing impact factor.

Another aspect of the data we looked into was the number of writers for each publication. The percentage of publications per number of writers is displayed in the bar plot below.

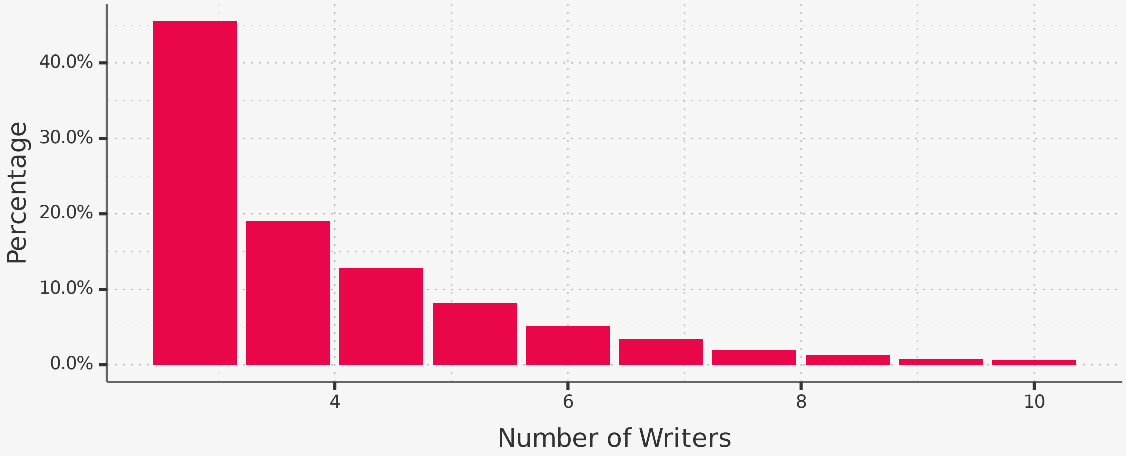


Figure 6: The percentage of the number of writers for publications

Researchers' willingness to collaborate has risen in recent years. To observe this statement in the data, we first compute the percentage of publications per year in terms of the number of writers, and then we build a heatmap of it.

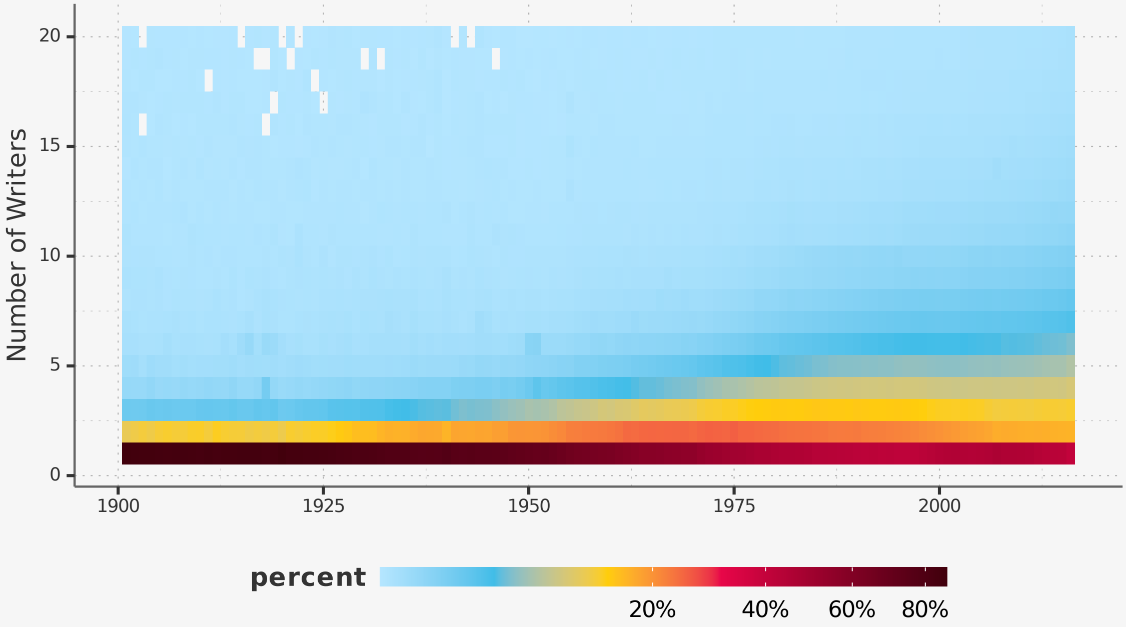


Figure 7: Anual number of writers heatmap

# Affiliations

The affiliation table contains information about where the papers were submitted. This table contains 25708 rows. In the below table, the fields are shown.

Affiliation Table Schema

| Field Name | Field Type | Description | Example |
|---|---|---|---|
| id | string/long | affiliation id | 136199984 |
| DisplayName | string | affiliation name | Harvard University |
| NormalizedName | string | normalized affiliation name | harvard university |
| type | string | affiliation type | university |
| url | string | official page | http://www.harvard.edu/ |
| WikiPage | string | Wikipedia page | http://en.wikipedia.org/wiki/Harvard_University |
| Latitude | string | latitude | 42.37444 |
| Longitude | string | longitude | -71.11694 |

To see the countries that are active in the field of research, we counted the number of research centers in each country. The heatmap below depicts the geographic distribution of research centers.

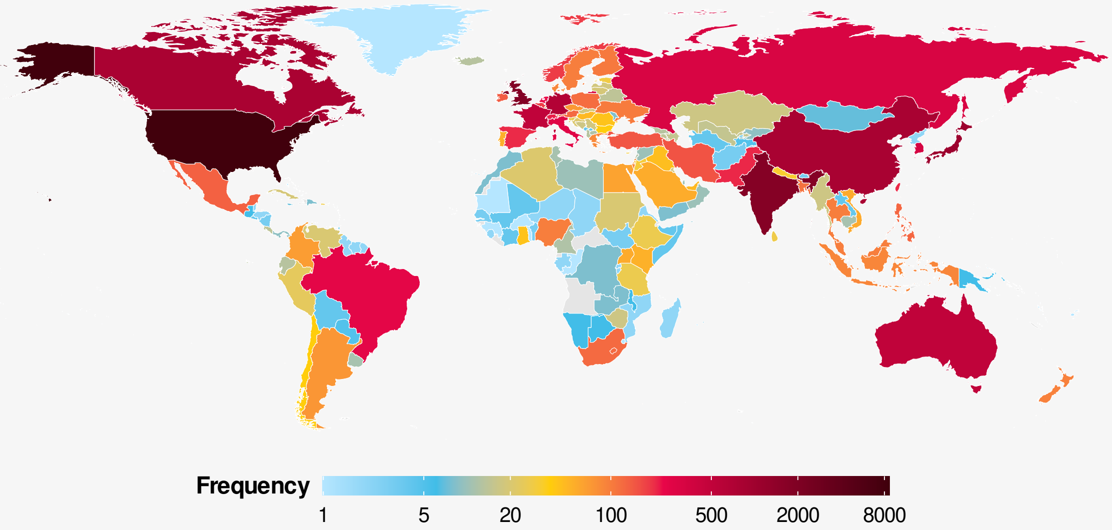


Figure 8: The distribution of acedemic organizations on the world map.

For more details, the table below shows the top ten countries with the most research centers.

Top 10 countries with the most academic organizations

| country | Frequency |
|---|---|
| USA | 8549 |
| UK | 1836 |
| India | 1767 |
| Japan | 1057 |
| China | 831 |
| Canada | 817 |
| Germany | 678 |
| Australia | 516 |
| France | 515 |
| South Korea | 338 |

The distribution of German research centers is displayed as a thermal diagram for further information.

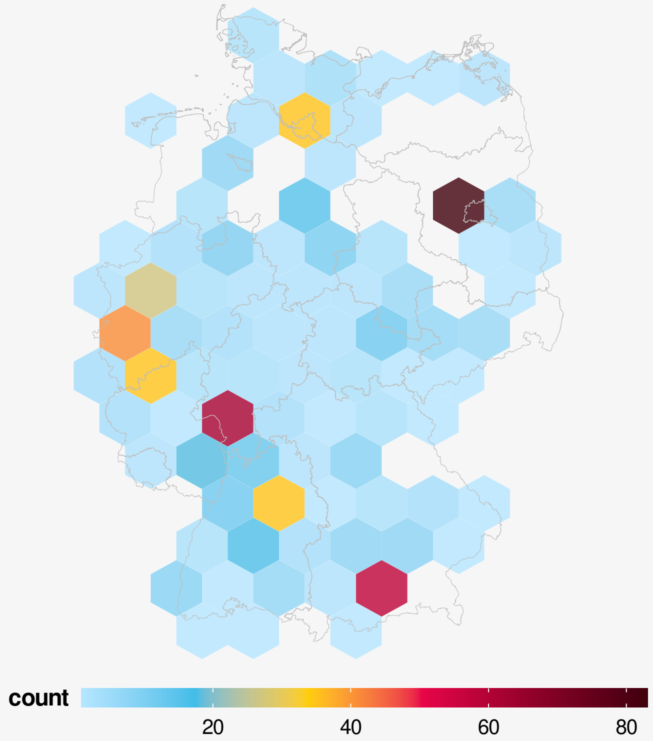


Figure 9: The location of academic organizations in Germany.

Each point on the chart reflects a research center's location. Each center's exact position on the map is depicted in the scatter plot below.

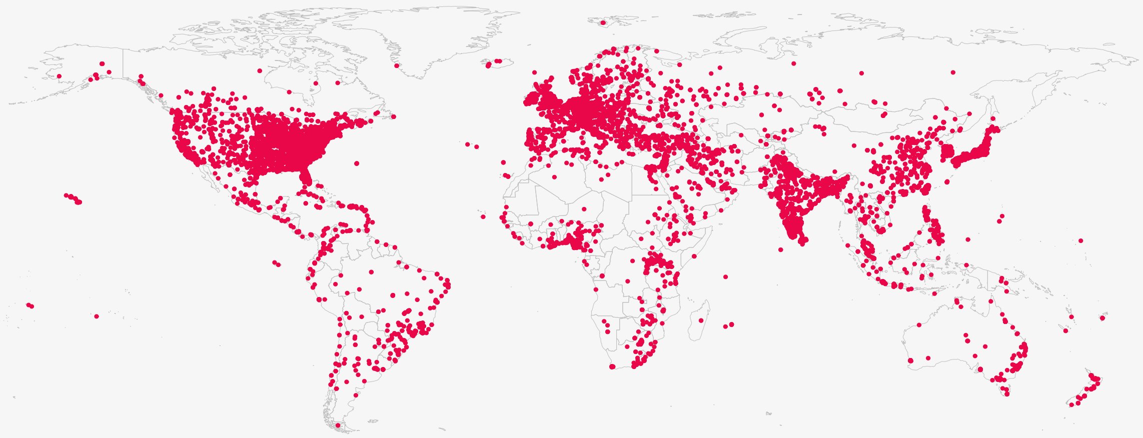


Figure 10: Location of academic organization on world map.

The total number of publications, total number of citations, and the impact factor for each institution were computed to determine the active research centers. The top 15 centers with the most publications are shown in the table below.

The Top 15 Organizations with the Most Publications.

| Organization | Number of Publication | Number of Citation | Impact Factor |
|---|---:|---:|---:|
| Chinese Academy of Sciences | 2104240 | 26953600 | 12.8 |
| Harvard University | 1527420 | 70086023 | 45.9 |
| Centre national de la recherche scientifique | 1459893 | 28020818 | 19.2 |
| University of Tokyo | 1259705 | 22020022 | 17.5 |
| Max Planck Society | 1161691 | 31926466 | 27.5 |
| CERN | 1083666 | 19513077 | 18.0 |
| Russian Academy of Sciences | 1048923 | 6814819 | 6.5 |
| Stanford University | 1039212 | 40999300 | 39.5 |
| National Institutes of Health | 1025767 | 54469411 | 53.1 |
| University of Michigan | 982389 | 29504984 | 30.0 |
| University of São Paulo | 935371 | 8788652 | 9.4 |
| Kyoto University | 850419 | 15391665 | 18.1 |
| Osaka University | 849596 | 14316967 | 16.9 |
| University of California, Los Angeles | 813389 | 27580303 | 33.9 |
| University of Washington | 798856 | 32255361 | 40.4 |

Also included were the top research centers in terms of citations as well as the top research centers with the greatest impact factors.

The Top 15 Organizations with the Most Citations.

| Organization | Number of Publication | Number of Citation | Impact Factor |
|---|---:|---:|---:|
| Harvard University | 1527420 | 70086023 | 45.9 |
| National Institutes of Health | 1025767 | 54469411 | 53.1 |
| Stanford University | 1039212 | 40999300 | 39.5 |
| University of Washington | 798856 | 32255361 | 40.4 |
| Max Planck Society | 1161691 | 31926466 | 27.5 |
| University of Michigan | 982389 | 29504984 | 30.0 |
| Centre national de la recherche scientifique | 1459893 | 28020818 | 19.2 |
| University of California, Los Angeles | 813389 | 27580303 | 33.9 |
| Chinese Academy of Sciences | 2104240 | 26953600 | 12.8 |
| Massachusetts Institute of Technology | 761634 | 26151027 | 34.3 |
| Johns Hopkins University | 707138 | 25169822 | 35.6 |
| University of California, San Francisco | 557786 | 24847360 | 44.5 |
| University of California, Berkeley | 715890 | 24248308 | 33.9 |
| University of Pennsylvania | 705037 | 24014870 | 34.1 |
| University of California, San Diego | 616412 | 23777136 | 38.6 |

The Top 15 Organizations with the Most Impacats and Over 1000 Publcations.

| Organization | Number of Publication | Number of Citation | Impact Factor |
|---|---:|---:|---:|
| Celera Corporation | 4609 | 3158398 | 685.3 |
| SRA International | 1009 | 374133 | 370.8 |
| Wellcome Trust Sanger Institute | 30396 | 5753162 | 189.3 |
| J. Craig Venter Institute | 11883 | 2149099 | 180.9 |
| American Diabetes Association | 1053 | 182241 | 173.1 |
| Broad Institute | 34194 | 5671132 | 165.9 |
| Osiris Therapeutics, Inc. | 1018 | 157242 | 154.5 |
| deCODE genetics | 4626 | 693394 | 149.9 |
| Clinical Trial Service Unit | 5061 | 719266 | 142.1 |
| American Heart Association | 5771 | 807924 | 140.0 |
| American Cancer Society | 9638 | 1276702 | 132.5 |
| Affymetrix | 5100 | 662813 | 130.0 |
| Swiss Institute of Bioinformatics | 6652 | 840026 | 126.3 |
| Illumina | 6178 | 778349 | 126.0 |
| Élan | 2842 | 334361 | 117.6 |

To see the statistical distribution of the impact factor of research centers, histogram it is plotted.

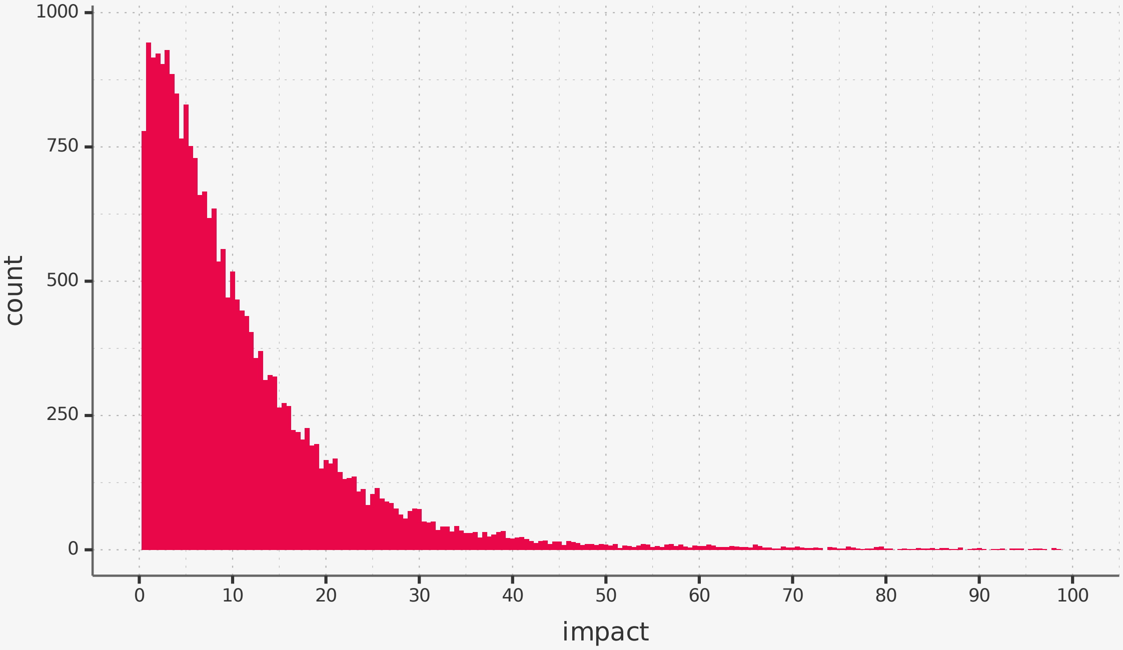


Figure 11: Histogram of Organization Imacts Less than 100 With a Binwidth of 0.5.

It is also possible to determine the degree of scientific impact for each country and display it on the globe as a heatmap.

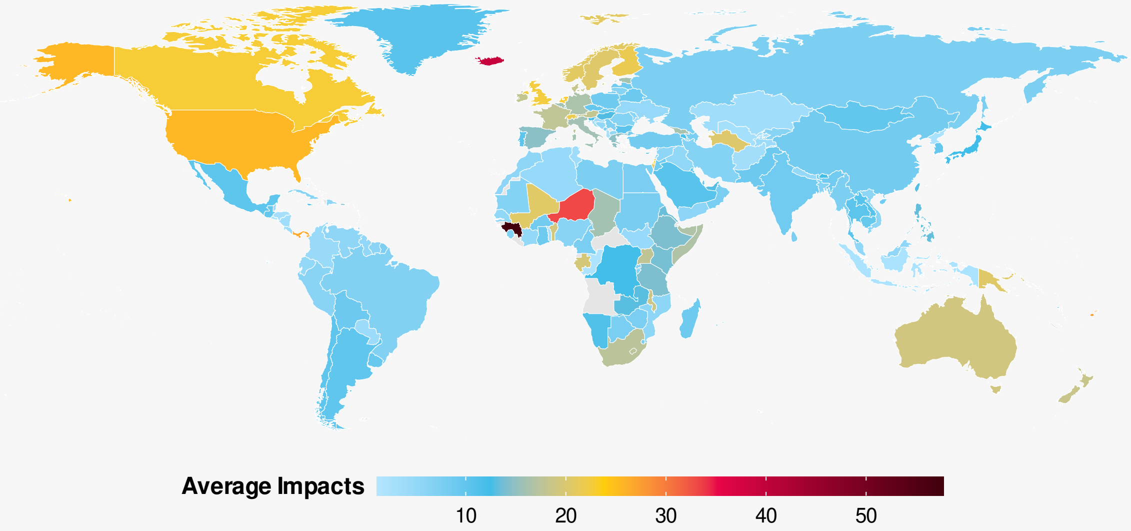


Figure 12: The distribution of acedemic organizations Impacts.

# Authors

Fields for author information, academic history, and impact measures are included in the authors' table. This table contains 253144301 rows. The fields are listed in the table below.

Authors Table Schema

| Field Name | Field Type | Description | Example |
|---|---|---|---|
| id | string/long | author id | 53f42f36dabfaedce54dcd0c |
| name | string | author name | Jiawei Han |
| normalized_name | string | normalized author name | jiawei han |
| orgs | list of strings | author affiliations | ["Department of Computer Science, University of Illinois at Urbana-Champaign"] |
| org | string | author organization | Department of Computer Science, University of Illinois at Urbana-Champaign |
| last_known_aff_id | long | last known affiliation | 157725225 |
| position | string | author position | professor |
| n_pubs | int | the number of author publications | 1217 |
| n_citation | int | author citation count | 191526 |
| h_index | int | author h-index | 175 |
| tags.t | string | research interests | "data mining" |
| tags.w | int | weight of interests | 243 |
| pubs.i | string/long | author paper id | 53e9b9fbb7602d97045f7bb8 |
| pubs.r | int | author order in the paper | 0 |

The quantity of citations is used to quantify the impact of each research paper. The frequency of citations by writers is shown in the table below.

The Top 10 Frequency of Total Authors' Citations

| Number of Citation | Frequency | Percent Share |
|---|---|---|
| 0 | 159758931 | 63.1% |
| 1 | 20144876 | 8.0% |
| 2 | 11136954 | 4.4% |
| 3 | 7359595 | 2.9% |
| 4 | 5347158 | 2.1% |
| 5 | 4136283 | 1.6% |
| 6 | 3338694 | 1.3% |
| 7 | 2791633 | 1.1% |
| 8 | 2365922 | 0.9% |
| 9 | 2049786 | 0.8% |
| 10 | 1798441 | 0.7% |
| 11 | 1597036 | 0.6% |
| 12 | 1423916 | 0.6% |
| 13 | 1288451 | 0.5% |
| 14 | 1169026 | 0.5% |

As can be seen, the research of many authors has not been used in the work of others.

A bar plot of the frequency of citations less than 100 has been displayed to observe the distribution of the number of citations.

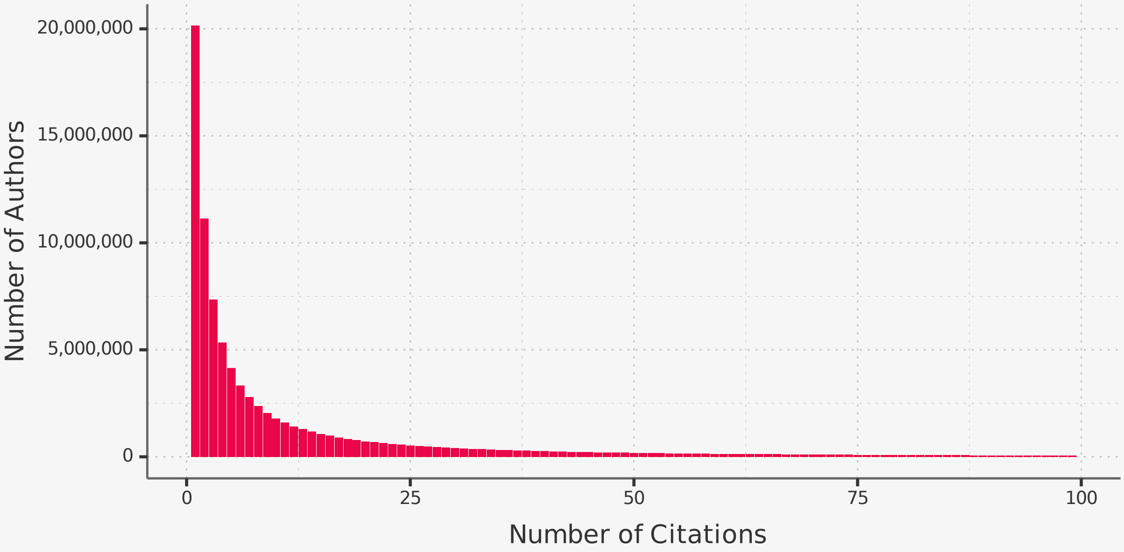


Figure 13: The Frequency of Authors by Number of Total Citations

To show the statistical behavior of writers with total citations of over 100, we used the logarithmic x-axis, the result of which can be seen below.

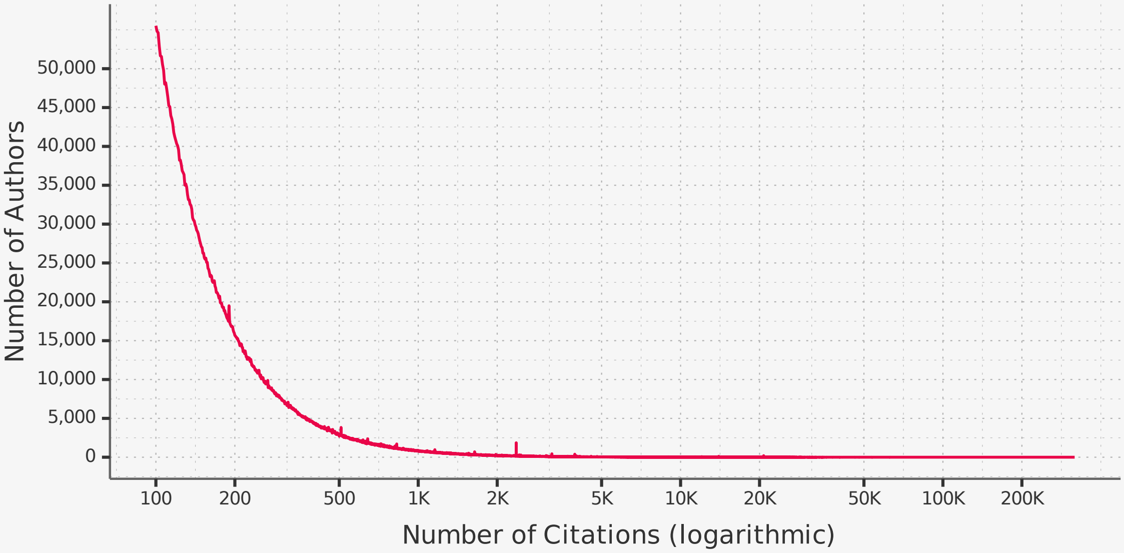


Figure 14: The Frequency of Authors by Number over Total Citations 100

To see how many people have more than specific value citations, we drew the tail Distribution of citaions. For example, about a 3.6 milion people have more than a 200 citations.

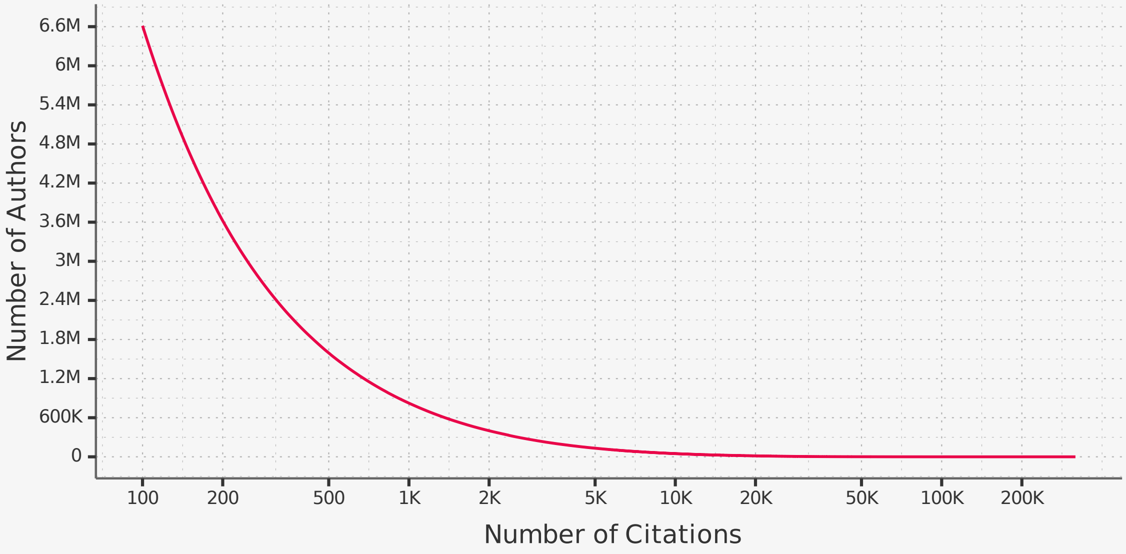


Figure 15: Tail Distribution of Authors over Total Citations 100

In the overall citation density function, there is an odd leap. A portion of the chart has been chosen for better visibility in the plot below.

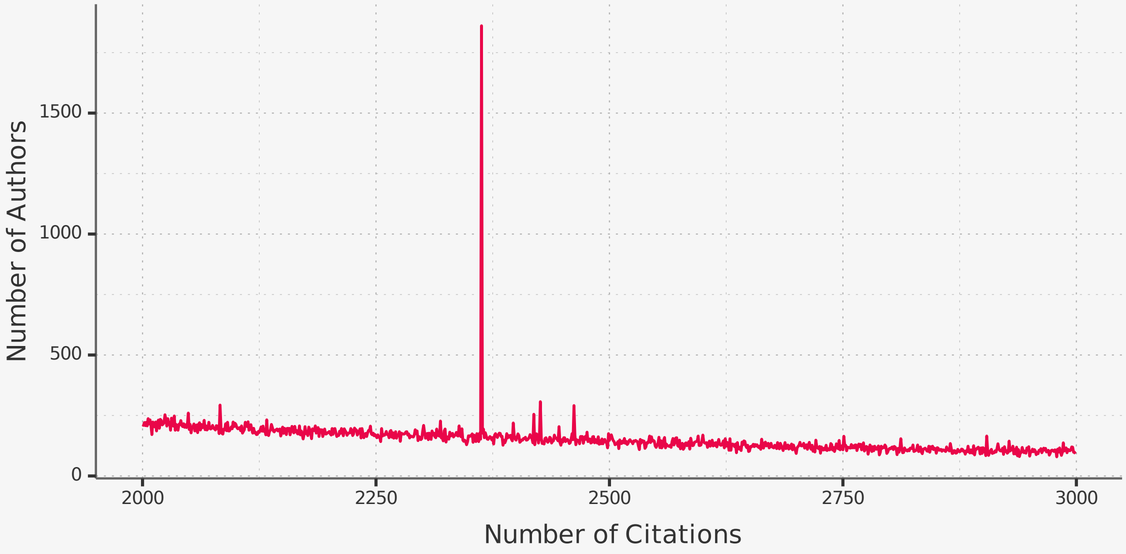


Figure 16: Strange Jump in Total Citations Density Function

The frequency of the number of articles by each author is shown in the table below.

The Top 15 Frequency of Total Number of Authors' Publications.

| Number of Publication | Frequency | Percent Share |
|---|---|---|
| 1 | 210702425 | 83.2% |
| 2 | 18059438 | 7.1% |
| 3 | 7251838 | 2.9% |
| 4 | 3950886 | 1.6% |
| 5 | 2477118 | 1.0% |
| 6 | 1718516 | 0.7% |
| 7 | 1248849 | 0.5% |
| 8 | 954450 | 0.4% |
| 9 | 748627 | 0.3% |
| 10 | 605597 | 0.2% |
| 11 | 498337 | 0.2% |
| 12 | 418605 | 0.2% |
| 13 | 354343 | 0.1% |
| 14 | 305987 | 0.1% |
| 15 | 264587 | 0.1% |

The following table shows the frequency of the number of writers in relation to the number of articles. It's a logarithmic scale on the vertical axis.

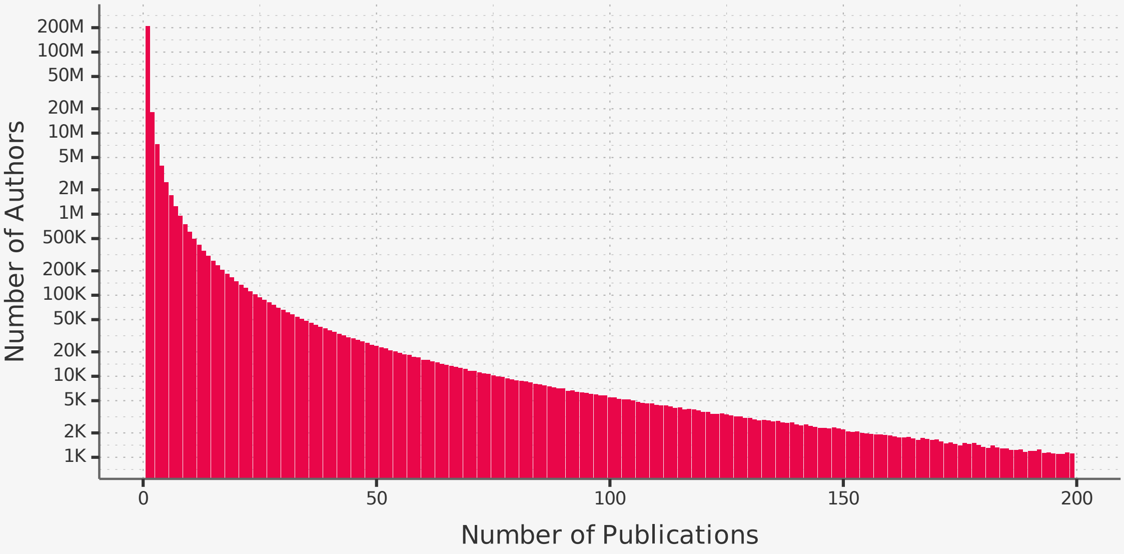
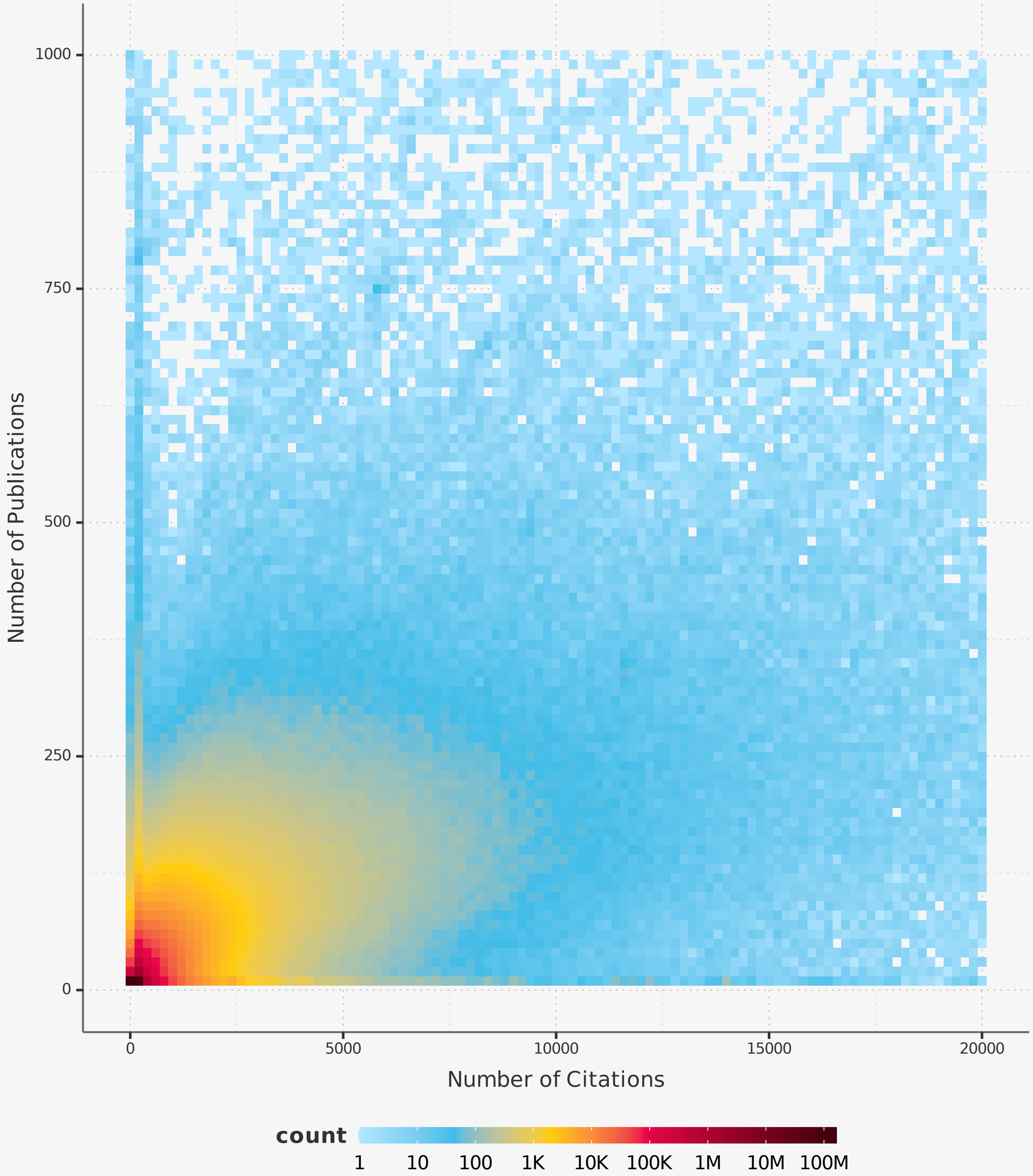


Figure 17: The Frequency of Authors by Number of Total Publications

In the following plot, the statistical behavior of the number of authors can be plotted in terms of the number of articles and the number of citations.



In the data, tags are assigned to each article. The following table shows the frequency of article tags.

The Top 10 Frequency of Publication's Tags.

| Publication's Tags | Frequency |
|---|---|
| Bioinformatics | 2311247 |
| Medical research | 2267328 |
| Therapy | 2196052 |
| Enzyme | 1644052 |
| Medicine | 1413157 |
| Text mining | 1378044 |
| Cancer | 1283007 |
| Comparative research | 1177852 |
| Surgery | 1101162 |
| Kinetics | 1088966 |

The top 100 tags, together with their frequency, are shown in the wordcloud below.

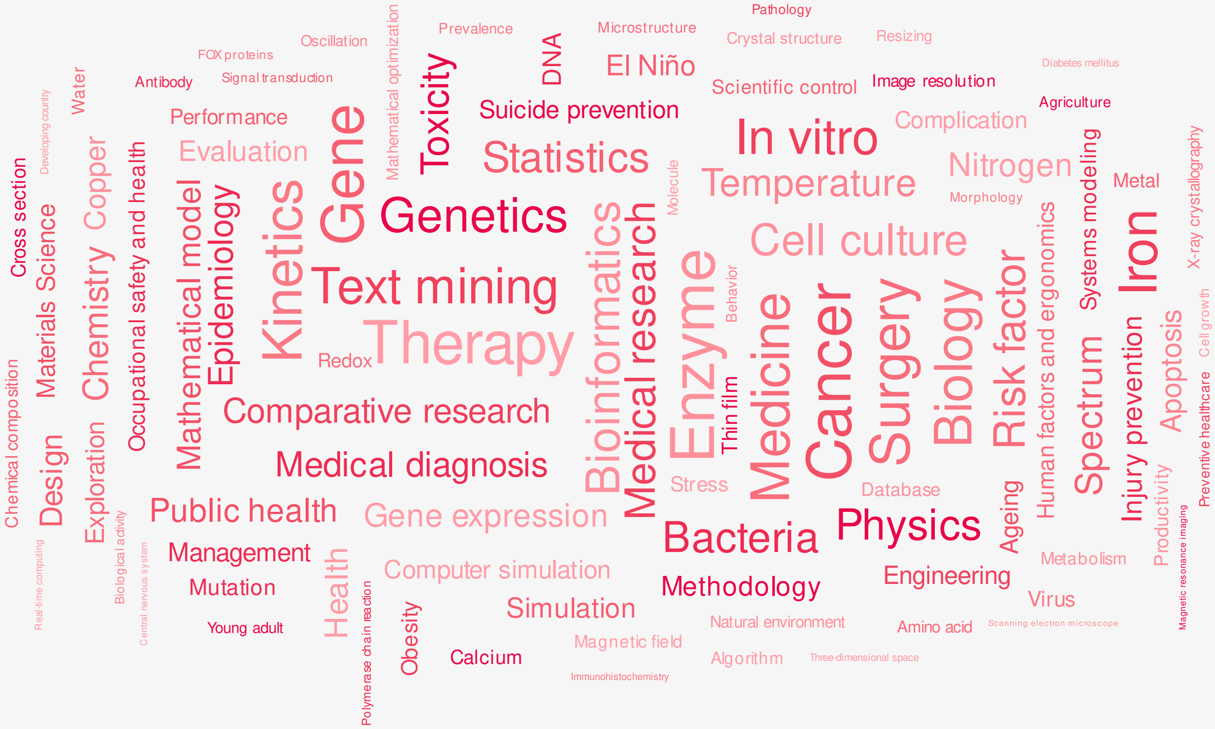


Figure 18: Top 100 Publications's Tag WordCloud

To see which organizations focus on what topics, we selected 20 universities with the highest number of articles and 20 frequent tags. The percentage of papers submitted for each organization in each subject was then computed and shown in a heatmap.

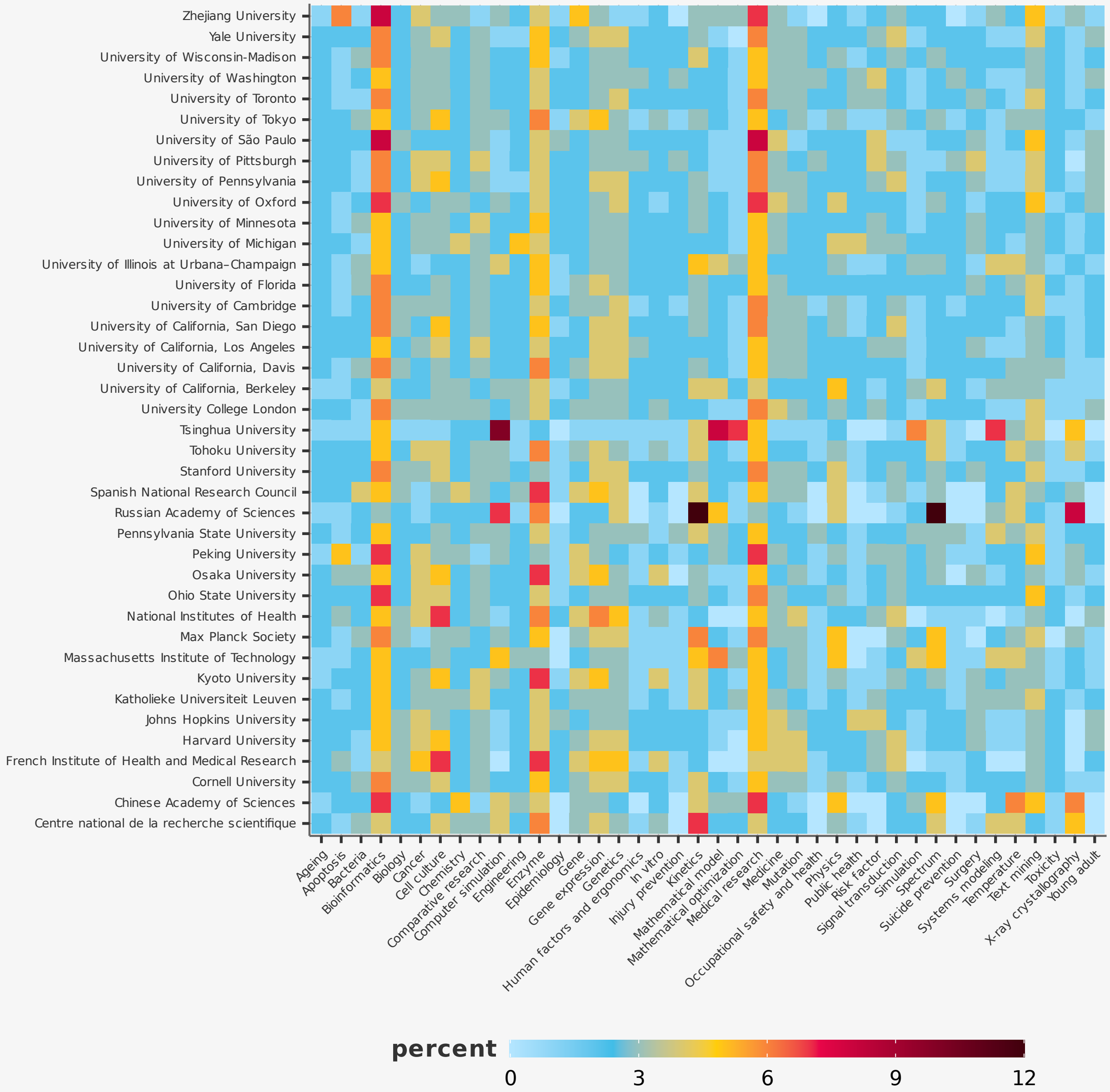


Figure 19: The percentage of publications by organizations and tags