

# SCIENTOMETRIC ANALYSIS AND VISUALIZATION OF GLOBAL RESEARCH ON BIG DATA

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## Abstract

The purpose of this study is to analyze the current state and development of scientific studies on large data sets. This research encompasses scientific method applied with a quantitative approach and scientific indicators. Big data is the accumulation of information from both traditional and modern sources inside and outside of a particular business that may be used for research and analysis. Computational sciences and related disciplines consider this to be one of the most important emerging fields of research. For this study, required data has been collected from the Scopus from 2013 to June 2022. The study examines the development and progress in the field of big data using the scientific tool MS-excel and the VOSviewer software version (1.16.6). A total of 1346 records were found in Scopus on the big data. From 2013 to 2019, the scientific production on this topic grow rapidly however, in 2020 there was a substantial decrease in the number of studies, which may be due to the Covid 19 pandemic. The findings of the study also show the highest degree of collaboration in 2022 i.e. 0.96. CellMarker: A manually curated resource of cell markers in human and mouse published in 2019 has 252 citations. Through the use of scientometrics, which analyses the global research trend, researchers can locate the countries and academic institutions that have the greatest potential for generating new scientific knowledge and advancing their careers.

**Keywords:** Big data, scientometric, degree of collaboration, collaborative index, co-authorship index, rate of single authorship.

## Introduction

Big data is a notion or type of data with a very big volume that grows rapidly over time (Agrawal et al., 2011). It deals with large and complex data sets that cannot be manipulated or managed by traditional data processing software or other technologies (Gautam & Chatterjee, 2020). Technology convergence trends study on large-scale datasets has become a frequent research approach for predictive analytics, owing to big data technology (Lin, Zhang, & Peng, 2019). There is an exponential increase in the amount of data that organizations and individuals generate nowadays. New insights can be obtained from the exabytes of data arriving at the exabyte scale. As a result of the latter, organizations will be able to gain richer insights and achieve a greater level of competitiveness. In addition, Big Data technologies become more efficient and competitive with the help of relevant information obtained through these technologies (Akoka, Comyn-Wattiau & Laoufi, 2017). Researchers typically present four V's for big data: volume, velocity, variety, and veracity. Meanwhile, another study identified three additional Vs for big data: validity, volatility, and the unique V for value (Khan, Uddin & Gupta, 2014; Kalantari et al., 2017).

Modern research and business are centred on big data and its analysis. Big data is the accumulation of information from both traditional and modern sources inside and outside of a particular business that may be used for research and analysis. Within the definition of big data, there are two types of data, i.e., unstructured data and multi-structured data. Unstructured data includes, for example, metadata, tweets, and other social media updates. Multi-structured data is generated by transactions, web applications, and human-computer interactions. As more and more multi-structured data is generated, the digital age develops new interaction and communication channels, social platforms, and marketing specialists work to enhance consumers' experiences with various electronic gadgets (Papiæ & Eskiæ, 2018). The necessity for professionals to create diverse approaches in big data research has lately grown. As a result, this scientific subject has garnered global prominence and interest in recent years, and that motivates the researchers to choose the topic.

## About Scientometric Study

For researchers, knowing the current state and advances in their field of study is advantageous to their profession and scholarly publications (Lee, Wu & Tsai, 2009; Parida & Nayak, 2021; Nayak, Hari & Verma, 2021). Scientometrics is one of the most essential measures for evaluating scientific outputs (Mooghali et al., 2012; Patel et al., 2021a; Singh et al., 2021). The study of measuring and analyzing science, technology, and innovation is known as scientometrics (Heilig & Stefan, 2014; Patel et al., 2021b). Currently, scientometrics is one of the really multidisciplinary research fields, with topics that have spread to practically all scientific subjects, mostly through the production of statistics on scientific articles indexed in databases (Singh, Nayak & Varma, 2017; Nayak, 2018). Applying mathematical equations and visualisation, scientometric analysis allows for a

more significant but succinct capture and mapping of a scientific knowledge domain by finding structural trends and delineating significant research horizons (Olawumi & Chan, 2018; Darko et al., 2020)). Scientometrics studies include calculating the effects of authors, publications, journals, institutions, and nations or areas on the citation of a variety of scientific publications, such as articles and patents (Zhao, 2017; Arulmozhi & Sanjeevi, 2020; Gaurav & Singh, 2022).

## Literature Review

Recent years have seen a proliferation of publications on scientometrics by researchers across a variety of disciplines. Srivastava, Singh, and Sonkar (2021) conducted a Scientometrics analysis of Big Data Analytics during the period of 2011-2020 and analyzed various aspects of the publications, including the total output, output growth, authorship and collaboration patterns at the national level, significant contributors, top publication sources, analytical trends, and highly cited articles are some of the statistics to consider. Rawat and Sood (2021) studied the scientometric analysis of emerging trends and the global scope of big data analytics and assessed general growth, developing trends, and worldwide reach of big data analytics research from 2010 to 2019. This study also identifies data analytics research frontiers and hotspots by analysing keyword co-occurrence using VOSviewer. A scientific study by Varma and Singh (2017) describes the annual distribution, the distribution of subjects, the main authors, the main institutions by subject and the ranking of regular characteristics of big data research in India for the period 2012-2016. Scientometric analysis by Singh et al. (2015) on research mapping on big data examined scientific production data on 'Big Data' from 2010 to 2014 that was indexed in both the Web of Knowledge and Scopus. The study maps the parameters of total output, output growth, authorship and country-level collaboration patterns, significant contributors, top publication sources, thematic trends, and emerging subjects in the area in precise detail.

## Research Questions

- RQ1. What was the year wise growth rate?
- RQ2. What was the degree of collaboration, rate of single authorship, and collaborative index?
- RQ3. What was the co-authorship index?
- RQ4. What are the most cited papers in big data research?
- RQ5. What was the co-authorship of the author's collaboration network?

## Methodology

The purpose of this study is to visualize the global research output on 'big data'. In this study, the researchers divide data processing into three main categories: data sources, data collection, and data analysis.

## **Data Sources**

There are several databases from various fields of study, including Scopus, Web of Science, Dimensions, PubMed, and Google Scholar. Scopus is the largest database of peer-reviewed literature, including scientific journals, books and conference proceedings. Therefore, this database was chosen for data collection.

## **Collection of Data**

The data was retrieved from the Scopus database and covers ten years, from 2013 to 2022. "Big data" was used as the search term. The search string used for the study was "ALL (big AND data) AND (LIMIT-TO ( PUBYEAR, 2022 ) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013))" accessed on July 18, 2022. A total of 1346 publications were collected and imported into the ".csv" file.

## **Data Analysis**

The data was collected and imported in the required ".csv" file format. For scientific measurements and a correct representation of the results, the data was examined. Researchers selected MS-Excel and VOSviewer software versions (1.16.6) to display the correct network view and tabular models for the collected data. Figure 1 shows an overview of the research process workflow.

## **Results and Discussion**

### **Annual Scientific Production**

The annual scientific production trend demonstrates that the Big Data Research has experienced steady growth. A total of 1346 documents have been published in the previous 10 years. Based on the graph below, the number of Big Data research articles published in SCOPUS indexed journals increased significantly in 2017, 2018 and 2019. However, during the COVID 2020 pandemic, the number of articles and contributions decreased. The Annual Growth Rate is 1.83%, the  $R^2$  value is 0.1372 and the growth trend shows a +ve sign.

### **Degree of Collaboration (DC), Rate of Single Authorship paper (RSA) and Collaborative Index:**

**Degree of Collaboration (DC):** Subramanyam (1983) formula was used to compute the degree of collaboration (DC). This formula is also cited by Nayak et al. (2021) and Rawat et al. (2022) in their studies. The degree of collaboration can be mathematically expressed as:

$$\text{Degree of Collaboration DC} = \frac{Nm}{(Nm + Ns)}$$

Where,

DC = Degree of collaboration.

Nm = No. of multiple-authored articles

Ns = No. of Single-authored article

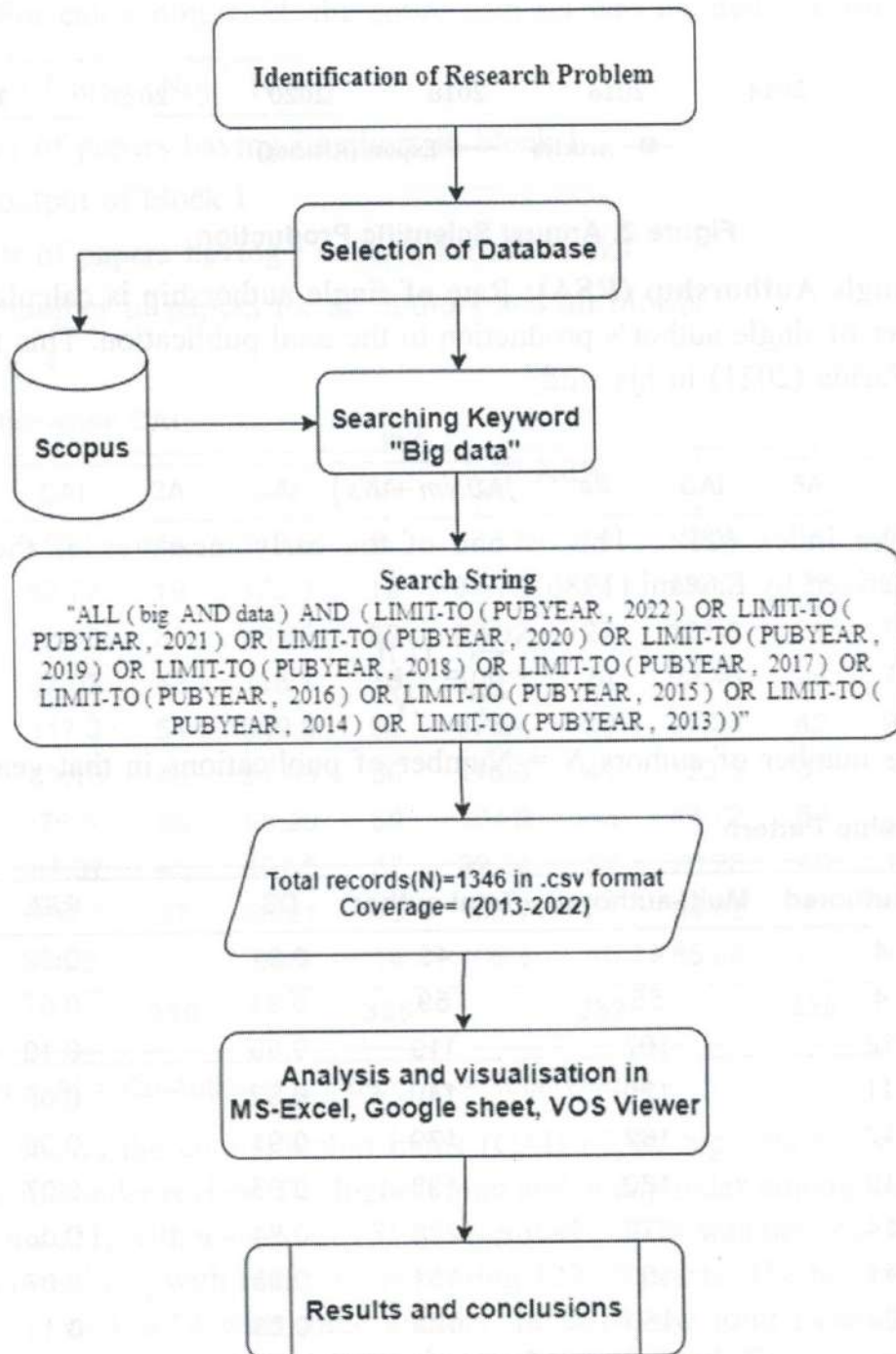


Figure 1: Workflow of the present study

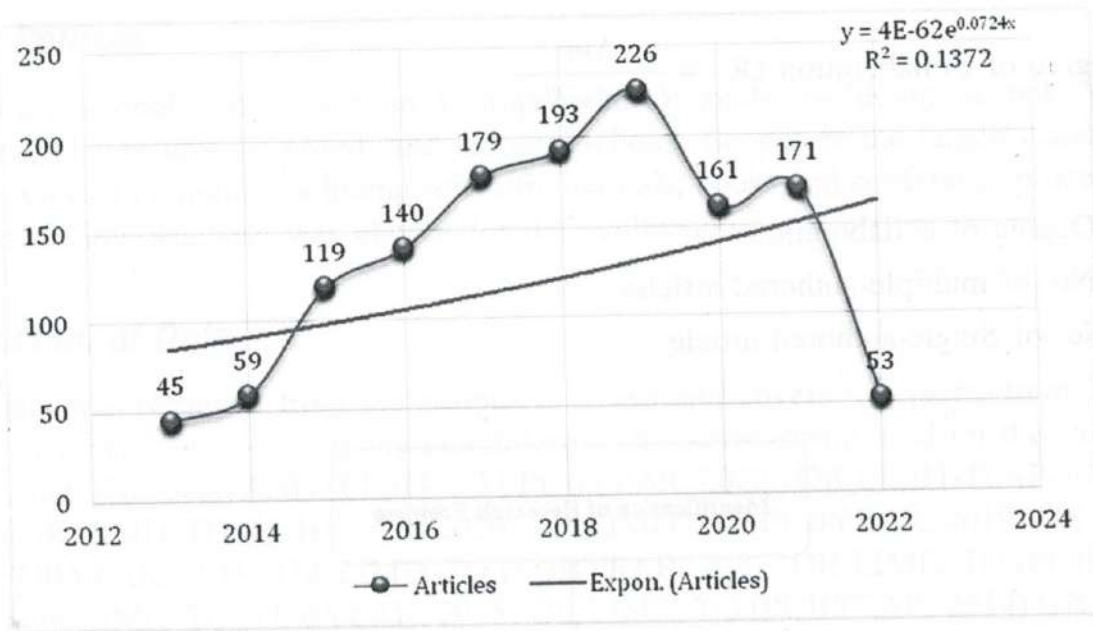


Figure 2: Annual Scientific Production

**Rate of Single Authorship (RSA):** Rate of single authorship is calculated through the total number of single author’s production to the total publication. This formula was also cited by Parida (2021) in his study.

$$RSA = \frac{Nm}{(Nm + Ns)}$$

**Collaborative Index (CI):** This is one of the early measures of the degree of collaboration derived by Lawani (1986).

$$\sum_f^A = \frac{1/f_i}{N}$$

Where,  $f_i$  = number of authors  $N$  = Number of publications in that year

Table 1: Authorship Pattern

Year	One Authored	Multi-authored	Total-author	DC	RSA	CI
2013	4	41	45	0.91	0.09	1.10
2014	4	55	59	0.93	0.07	1.07
2015	12	107	119	0.90	0.10	1.11
2016	11	129	140	0.92	0.08	1.09
2017	17	162	179	0.91	0.09	1.10
2018	13	180	193	0.93	0.07	1.07
2019	14	212	226	0.94	0.06	1.07
2020	11	150	161	0.93	0.07	1.07
2021	21	150	171	0.88	0.12	1.14
2022	2	51	53	0.96	0.04	1.04

Table 1 shows the year-wise contributions of single-authored papers and multi-authored papers. It also shows the DC, the rate of single authorship paper (RSA) and the

collaborative index. According to the results, multi-authored papers (1237) are dominating over single-authored papers (109). The year 2019 shows the highest number of multi-authored papers (212), whereas single-authored papers (21) are highest in 2021. The level of collaboration varies between 0.88 and 0.96. The year 2022 has the highest cooperation rate, followed by 2019 and 2021 in the final position with 0.88. The rate of single authorship is 0.12, highest in the year 2021, followed by 2015 with 0.10 and lowest in 2012 with 0.04. The collaborative index is highest in 2021 with 1.14 and lowest in 2022 with 1.04.

**Co-Authorship Index (CAI):** Co-Authorship Index suggested by Garg and Padhi (2001) has been used. This formula was also cited by Parida, Singh & Nayak (2022) in their study. For calculating CAI, the entire data set was divided into four blocks.

$$CAI = \frac{\{(N_{ij} / N_{io}) / (N_{oj} / N_{oo})\}}$$

$N_{ij}$  : Number of papers having  $j$  authors in block  $I$

$N_{io}$  : Total output of block  $I$

$N_{oj}$  : number of papers having  $j$  authors for all blocks

$N_{oo}$  : total number of papers for all authors and all blocks

$j = 1, 2, 3 \geq 4$

**Table 2: Author-wise CAI**

Year	1A	CAI	2A	CAI	3A	CAI	4A	CAI	5A	CAI	TA
2013	4	109.8	14	119.6	6	53.57	10	128.9	11	102.8	45
2014	4	83.72	19	123.9	12	81.72	14	137.7	10	71.29	59
2015	12	124.5	30	96.95	29	97.92	27	131.6	21	74.23	119
2016	11	97.02	43	118.1	38	109.1	24	99.46	24	72.11	140
2017	17	117.3	51	109.6	39	87.54	30	97.24	42	98.69	179
2018	13	83.18	46	91.66	56	116.6	41	123.3	37	80.64	193
2019	14	76.5	56	95.29	59	104.9	33	84.72	64	119.1	226
2020	11	84.37	45	107.5	37	92.34	22	79.28	46	120.2	161
2021	21	151.7	37	83.21	45	105.7	25	84.82	43	105.8	171
2022	2	46.6	9	65.3	14	106.1	6	65.68	22	174.6	53
<b>Total</b>	<b>109</b>		<b>350</b>		<b>335</b>		<b>232</b>		<b>320</b>		<b>1346</b>

A = Authored, CAI = Co-Authorship Index, TA = Total Output

Table 2 shows the co-authorship index (CAI) of the big data survey from 2013 to 2022, the period under review. The highest joint authorship index among individual authors was found in 2021, with a score of 151.65. Similarly, 2014 was the year with the highest number of co-authors, with two authors scoring 123.85 points. The highest co-authorship rate in 2018 was 116.58 with three authors. In 2014, the joint paternity rate was the highest among the four authors, with a score of 137.67. With five or more publications, the highest co-authorship index of 174.60 was found in 2022.

## Citation Analysis of Documents

Table 3 shows the top ten cited articles during the study period. Zhang, X., Lan, Y., Xu, J., Quan, F., Zhao, E., Deng, C., Luo, T., Xu, L., Liao, G., Yan, M., Ping, Y., Li, F., Shi, A., Bai, J., Zhao, T., Li, X., Xiao, Y. (2019) "CellMarker: A manually curated resource of cell markers in human and mouse" have the most citations (252) followed by Ning, S., Zhang, J., Wang, P., Zhi, H., Wang, J., Liu, Y., Gao, Y., Guo, M., Yue, M., Wang, L., Li, X. (2016) "Lnc2Cancer: A manually curated database of experimentally supported lncRNAs associated with various human cancers" and Ishwarappa, Anuradha, J. (2015) "A brief introduction on big data 5Vs characteristics and hadoop technology" citations with 240 and 189 respectively.

## Co-Authorship Analysis of Authors

Co-authorship analysis is a collaborative measures of research data (Patel & Singh, 2022; Patel et al., 2021c), which is done by VOSviewer visualization software, applying clustering technique. Figure 4 depicts the network visualization of the co-authorship analysis of authors. With the minimum 5 publications of an author, only 56 out of 3610 authors are selected for visualization, and there are only 40 authors highly connected with each other.

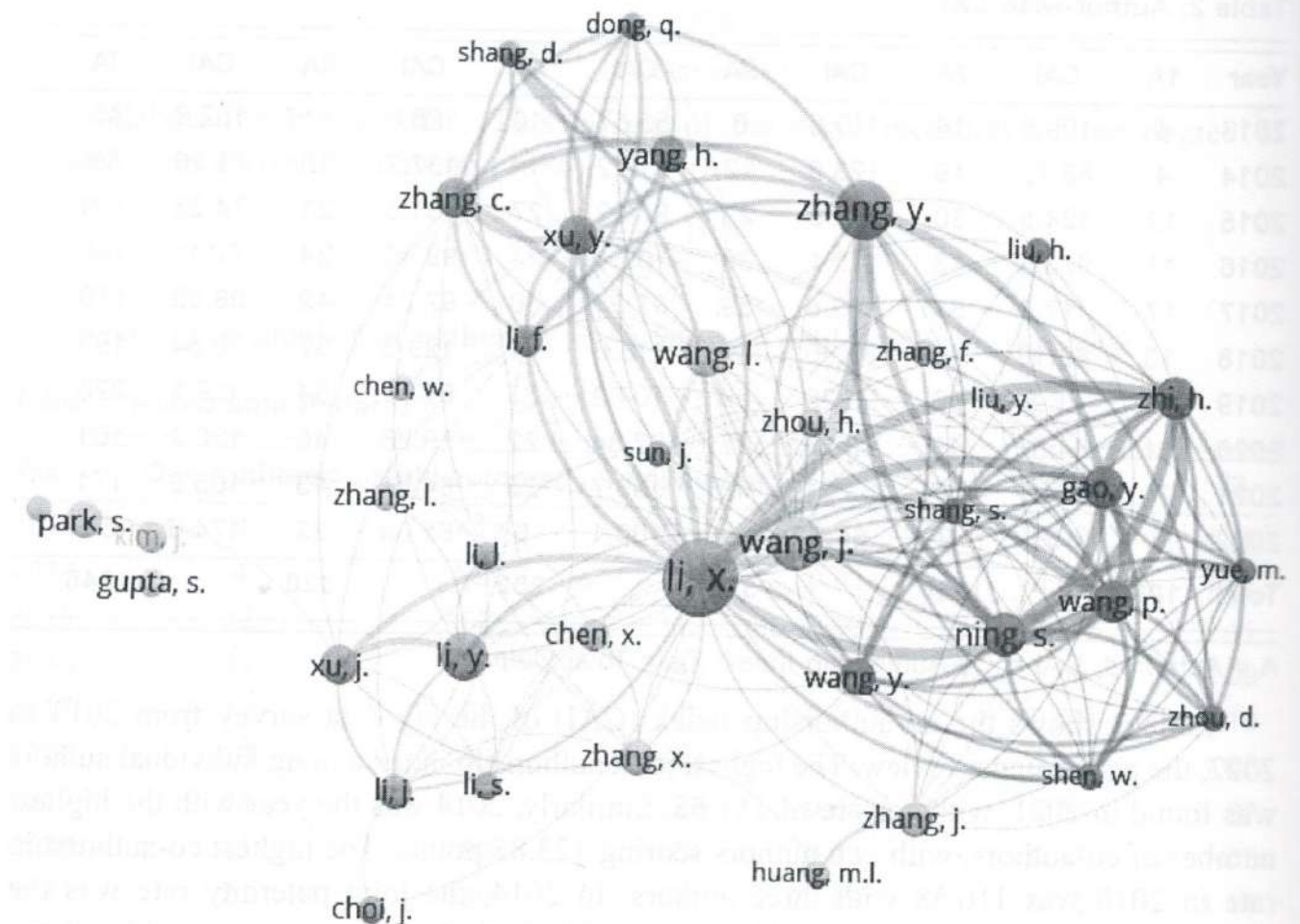


Figure 3: Network visualization of the Co-authorship Network

Table 3: Top Cited Publications

Authors	Title	Source	Year	Cit.
Zhang, X., et al.	CellMarker: A manually curated resource of cell markers in human and mouse	Nucleic Acids Research	2019	252
Ning, S., et al.	Lnc2Cancer: A manually curated database of experimentally supported lncRNAs associated with various human cancers	Nucleic Acids Research	2016	240
Ishwarappa, Anuradha, J.	A brief introduction on big data 5Vs characteristics and hadoop technology	Procedia Computer Science	2015	189
Kiourti, A., Nikita, K.S.	A review of in-body biotelemetry devices: Implantables ingestibles, and injectables	IEEE Transactions on Biomedical Engineering	2017	116
Gao, Y., et al.	Lnc2Cancer v2.0: Updated database of experimentally supported long non-coding RNAs in human cancers	Nucleic Acids Research	2019	111
Jangirala, S., et al.	Cloud Centric Authentication for Wearable Healthcare Monitoring System	IEEE Transactions on Dependable and Secure Computing	2020	90
Segatori, A., Marcelloni, F., Pedrycz, W.	On Distributed Fuzzy Decision Trees for Big Data	IEEE Transactions on Fuzzy Systems	2018	85
del Río, S., et al.	A MapReduce Approach to Address Big Data Classification Problems Based on the Fusion of Linguistic Fuzzy Rules	International Journal of Computational Intelligence Systems	2015	84
Lv, Z., Chirivella, J., Gagliardo, P.	Bigdata oriented multimedia mobile health applications	Journal of Medical Systems	2016	80
Kandula, S., et al.	Quickr: Lazily approximating complex adhoc queries in Big Data clusters	Proceedings of the ACM SIGMOD International Conference on Management of Data	2016	78

The top contributed authors are: X.Li (30 publications, 993 citations, and 162 total link strengths), Y.Zhang (19 publications, 325 citations, and 109 total link strengths), J.Wang (16 publications, 410 citations, and 68 total link strengths), Y.Li (14 publications, 66 citations, and 31 total link strengths), L.Wang (13 publications, 529 citations, and 50 total link strengths), and others; while F.Prokoshin (5 publications, 2 citations, and 3 total link strengths), J.Kim (5 publications, 3 citations, and 1 total link strengths). The 40 most highly connected authors, having 235 links and 729 total link strengths, are divided into five clusters, each distinguished a different colour. Cluster 1 (Red) contains 10 items such as Y.Gao, H.Zhi, S.Ning, and others; Cluster 2 (Green) contains 8 items such as J.Wang, J.Zhang, X.Zhang, and others; Cluster 3 (Blue) contains 8 items such as X.Li, Y.Li, J.Xu, and others; Cluster 4 (Yellow) contains 7 items such as L.Wang, S.Park, L.Zhang, and others; and Cluster 5 (Voilet) contains 7 items such as Y.Zhang, Y.Xu, C.Zhang, and others. The bigger circle shows the higher number of publications, and thicker lines show the greater connections between the authors, such as X.Li-Y.Zhang (15 connections), X.Li-S.Ning (11 connections), P.Wang-S.Ning (11 connections), Y.Gao-S.Ning (11 connections), X.Li-H.Zhi (11 connections), X.Li-Y.Gao (11 connections), Y.Zhang-C.Zhang (y connections), and others.

## Conclusion

Big data has transdisciplinary relevance and is a rapidly emerging research subject. On the basis of the distribution of bibliographic data, scientometric research has produced a body of theoretical knowledge and a set of tools and applications. The study examines the annual scientific production, most relevant sources, most frequent keywords, and average citations in big data literature. A total of 1346 publications were published on big data research during 2013-2022 and Annual Growth Rate is 1.83% and the  $R^2$  value is 0.1372. Growth trends show a +ve sign. 'CellMarker: A manually curated resource of cell markers in human and mouse' has 252 citations published in 2019, highest degree of collaboration in 2022 viz. 0.96. In order to better understand the dynamics and networks of this discipline and field, aim is to analyze and describe the collaborative structure of authors and the relationship between topics and researchers in future research.

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