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### Bibliometric Study of Bibliometric Papers about Clustering

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# **Bibliometric Study of Bibliometric Papers about Clustering**

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## **Abstract**

Bibliometric survey or bibliometric review papers generally analyses the work done previously by eminent personalities, authors, countries and various institutions which was published in giant databases like Scopus, Web of Science, Google Scholar, Research Gate and others. Bibliometric papers provide amalgamation of wide range of research papers from journals, conferences, reviews and other papers, which are working papers, papers with results, proposals and few of them are survey papers etc. Bibliometric papers are *One-Stop-Solution* for the readers and upcoming researchers to get acquainted entirely about the specific topic / domain. Bibliometric papers also help in smartly locating *research-gaps* for the aspiring PhD scholars. There are varieties of bibliometric analysis carried out so far by the authors and hence such bibliometric papers plays a vital role in the fraternity of researchers, as a stepping stone. Clustering is the widely used and beneficial method of segregating heap of information and data in a meaningful manner, so as to effectually used by decision authorities for forecasting, assessing and planning etc. Clustering is widely applicable to numeric and text form of data which is available and generated in real time on large scale, due to invent of internet, IoT and other techniques. Hence it is essential to understand the overall research details about the clustering and alike domains, with a special focus on bibliometric papers published in the domain of clustering. This paper discusses about how many authors, institutions, countries etc. have published the bibliometric analysis in Scopus and WoS databases, so as to aptly direct the readers, researchers who wish to initiate their research in the field of clustering.

*Keywords:* clustering, bibliometric survey, bibliometric review, data mining, unsupervised learning, machine learning, text mining

## **1. Introduction**

A Bibliometric survey or analysis paper provides the worldwide analysis about the specific domain or set of impactful keywords from specific research study. Bibliometric papers show previous work carried out by the several authors, from their institutions, various countries, along with funding agencies details, several research trends and patterns. Aspiring researchers find required specifics in their respective domains by interpreting such papers, as these bibliometric papers cover the entire details provided by Scopus, Web of Science and alike colossal databases along with worldwide glimpses. In this paper we wanted to understand how many bibliometric papers are already published in the areas of clustering, how many authors have published similar work, they belong to which countries and institutes etc. so as to understand the future scope in the field of clustering and alike technologies.

Bibliometric survey of incremental clustering algorithms and incremental clustering algorithms for electricity smart meter data analysis are carried out and it is observed that prominent incremental clustering algorithms are CFBA, CBICA, DBSCAN, BIRCH, COBWEB, EM and Incremental K-Mean etc. This analysis also highlighted prominent authors, affiliations, keywords, countries, highly cited articles in both of these incremental clustering areas [1, 2]. Tremendous growth in methodological papers and trial reports has been observed in British Medical Journal through the term cluster random, due to the same in 2003 all reports showed need for clustering in the analysis prior to that clustering was ignored in most of the trials [3]. Citation pattern for a particular category of journals over a specified span can be analyzed via bibliometric of citations, their ratios, impact factors and network analysis of cohesion, pattern based citations [4]. Name disambiguation algorithm used to identify common authorship [5]. This algorithm is useful for carrying out bibliometric studies of scientists and scientific collaborations [5]. Visualization and analysis of database information can be done using DIVA which in a will be very useful for bibliometric of scientific collection and patents [6]. Citation analysis in backward direction discovers additional contributions, which can be grouped into sub-communities using a clustering algorithm [7]. Local research communities based on sub-disciplines and linking different scholar communities around the world be identified using this clustering algorithm [7]. The origin, evaluation, correlation among the city concepts related to its sustainability can be revealed using bibliometric study over a substantial span like 35 years [8]. Integrated bibliometric analysis and literature review can lead to cumulative number of publications, core journals and key domains [9]. In such an integrated study, statistical analysis can be carried out using SPSS hierarchical clustering and matrix builder [9]. The bibliographic

coupling, text mining, core documents, cross-citation links is hybrid clustering which is used to identify emerging areas [10]. Microsoft Academic Search a new bibliometric way is used to analyze the relationship among research impact and co-author networks [11]. CATAR is free of cost toolkit based on bibliometric and Scientometric suggests proper set of journals, which are useful to understand research evaluation [12]. A snapshot of scientific research in the world is “Science Map” [13]. Science map used to identify research areas receiving international attention or hot research areas were identified [13]. Trend of these hot scientific RESEARCHES were identifies based on text mining of titles and abstracts of papers [13]. Overcoming of doubts, gained maturity, familiarity of background and scientific complexity leads evaluators resources commit at early-stage despite of their uncertainty [14].

In US positive influence of technology development alliances with governments was for start-up innovation [15]. Governmental partners serve up as quality signals to private sector investors for licensing alliances [15]. Bibliometric analysis of university – industry collaborations triggered economic development, innovativeness and competitiveness fostered a unremitting research rendezvous [16]. The ensemble surrogate model based on three individual surrogate models enhances the optimization process robustness for considered research scenario [17]. The hypotheses that are tested on the basis a multiple case study analysis can establish a set of guiding principles for e.g. smart city development using multiple case studies of European best practices [18]. Taking the illustration from knowledge spill overs theory of entrepreneurship (KSTE) it observed the relevance between local knowledge stocks, distinctive between clean and dirty stocks, which in a way act as a catalyst for the creation of green start-ups [19]. Trends in all-encompassing prenatal judgment for ultrasound-based indications can be effectively analyzed using data over substantial span like two decades [20]. The extreme precipitation indices can be useful to access extreme precipitation events. It highlights distributed irregular and scattered trends [21]. The Impacts from technological, economic, societal sectors constitutes Entrepreneurial ecosystems [22]. Clinical outcomes of a particular disease can be obtained by comparing elderly patients with younger ones [23]. The multi-based quality function deployment (QFD) model can act as an improviser for a specific food industry [24]. Overweight BMI can be a measure to analyze effects of Sedentary Lifestyle on Cardiovascular Disease Risk among them [25]. Current state and evolution of nursing research be obtained through bibliometric analysis of nursing journals from WoS for a period of five years [26]. Simulation game experiment evidences can be useful for making decisions and biases in cyber security related developments [27].

University spin-offs (USOs) and graduate start-ups exhibit pathways for teaching and research affecting entrepreneurial ventures [28]. Responses from recent commentaries are useful to understand about patient safety and practice research [29]. Food production and consumption leading dedicated supply chains got affected by Religiosity [30]. First twenty five years of bibliometric analysis of the Journal of Business-to-Business Marketing retrieves a quick snapshot of the leading trends occurring in the journal to the readers [31]. Automated content analysis in the comparative manner in the area of tourism and hospitality can draw useful insights on a particular context [32]. A systematic review of literature cybersecurity response plans in healthcare can be done using eight aggregated response strategies (EARS) which are under managerial and technological categories [33]. Through bibliometric Analysis and Visualization from 2000 to 2108, high involvement to the field and a scientific alliance with other related journals, JASSS (Journal of Artificial Societies and Social Simulation) had established its way in the field of social simulation and achieved an academic level [34]. A bibliometric analysis could be also useful to understand influence of complexity about complexity science in healthcare [35]. A conceptual framework and critical assessment of published papers carried by considering 105 paper since 2000 to get the idea about the growth-development-performance cycle of university spin-offs [36]. Twenty years (1998-2018) analysis through bibliometric and visualization of Library Philosophy and Practice (LPP) carried out and it is observed that it can be a useful for either library or information science (LIS) scholars or the people interested in bibliometric studies; so, they can use it as a pattern to review other journals [37]. A co-word analysis is useful to analyze knowledge areas, themes and future research on open data [38]. A bibliometric analysis about trends on enzyme immobilization researches shows usefulness towards future decision-making in the field of science [39]. A Bibliometric Analysis through WoS core collection database about research trends of macrophage polarization shows PLOS One, Journal of Immunology, and Scientific Reports were the three journals that published the most articles [40]. This bibliometric analysis also throws light on interdisciplinary research [40]. Twenty years (1997-2016) of bibliometric, analysis the Journal of Knowledge Management (JKM) showed growing interest in publishing in JKM [41]. USA and UK lead and there low participation from emerging economies [41]. Bibliometric analysis from 1988-2018 of the International Journal of Computer Integrated Manufacturing highlighted impact, topics, authors, universities and countries [42]. Mapping of knowledge domains of Chinese's tennis teaching research showed strengthening the swap over, collaboration, constructing the academic community; stabilizing the research trend and increasing the depth of the research

[43]. It also indicated opportunity for getting better the level of tennis teaching to endorse the related pertinent research development [43]. Cervical spine injury (CSI) found relationship to cervical osteogenic degeneration in Japanese professional wrestlers [44]. Integrated review methodological strategies in resilient health care studies showed qualitative methods as the most frequent approach [45]. Analytical and operational framework on researcher's scientific and societal impacts formulated interdisciplinary responses to societal problems and market requirements [46]. Cervical spondylosis motion preservation is useful in cervical disc arthroplasty [47]. Strategic viewpoints about supply chain collaboration obtained through information sharing [48]. A bibliometric ranking from 1997 to 2012 the Journal of Travel & Tourism Marketing (JTTM) showed details about annually published papers their citations, top cited papers, h-index, per paper citations etc. [49]. SCSi is a framework for Cassandra and Spark used for real time data analysis [50]. A bibliometric analysis of CSR showed moral CSR is strategic oriented [51]. Citations patterns for communication journals from 197 to 1985 enlightened that sources used in the article are different from the sources referred by them [52].

The rest of the paper has organized as follow; Section 2 describes the bibliometric analysis including yearly publication trends, author trends, journals statistics, geographical regional analysis, funding agencies, and handshaking between publications and citations so on. Section 3 provides the conclusive summary and section 4 address the future research directions.

## **2. Bibliometric Analysis**

This bibliometric analysis has been conducted for covering the articles included in Web of Science (WoS) and Scopus databases in English language only. The search procedure operates in two stages as TS=(Clustering AND “Bibliometric analysis” OR “Bibliometric survey”) and TITLE-ABS-KEY(Clustering AND “Bibliometric analysis” OR “Bibliometric survey”) are search query for WoS and Scopus along with custom range of years between 2010 and 2020 respectively.

The two stages of research procedure are as follows:

1. Initially from WoS, 250 documents are obtained. These papers/articles are from Elsevier ([www.sciencedirect.com](http://www.sciencedirect.com)), Emerald ([www.emeraldinsight.com](http://www.emeraldinsight.com)), Springer ([www.springerlink.com](http://www.springerlink.com)), Taylor & Francis ([www.tandf.co.uk/journals/](http://www.tandf.co.uk/journals/)), IEEE

(ieeexplore.ieee.org/xpl/periodicals.jsp/). The papers relating to clustering, bibliometric analysis, bibliometric survey are then selected and reviewed.

2. In the next stage, publications from Scopus database (<https://www.scopus.com/>) are obtained. 85 documents are obtained and papers relating to area of bibliometric analysis papers on clustering are only selected and reviewed.

In all 335 documents/papers are analyzed for this present bibliometric study. They are analyzed based on their different characteristics, which are recorded and distinguished accordingly using a spreadsheet prepared for their further analysis.

All types of publications retrieve from the result of the queries for the considered span are taken into account. Majority of the extracted publications are published in article. There are 93% of journal article are published in WoS (refer fig.1). Similarly 60% of journal article and 12.99% of conference papers are in Scopus (refer fig. 2). So, bibliometric analysis papers on clustering document type trend are majorly driven by journal article papers followed by article reviews.

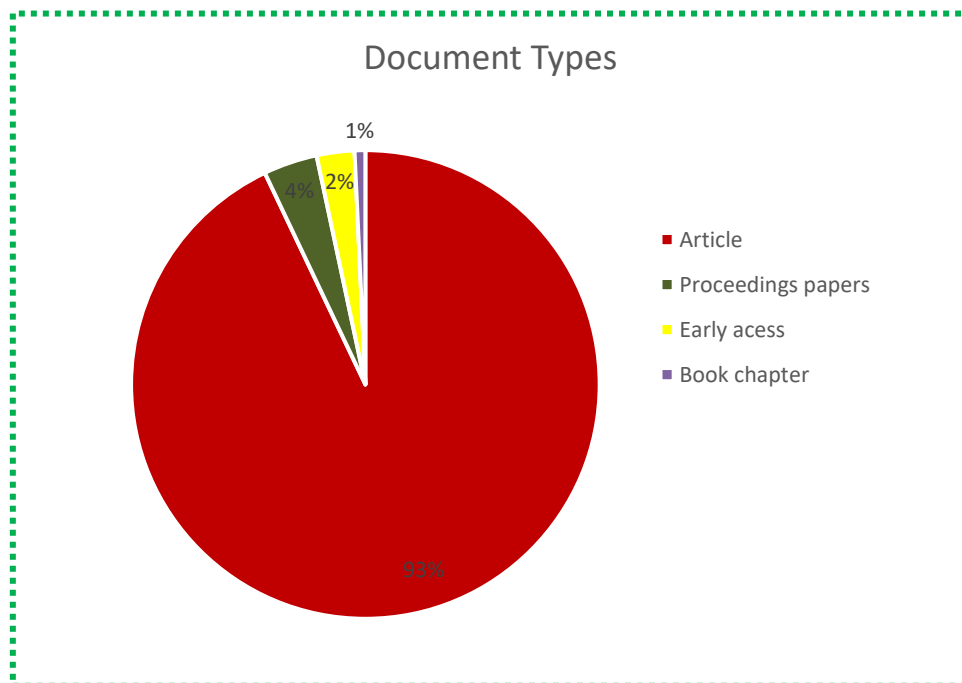


Fig 1: shows documents types published in WoS related to bibliometric papers in clustering from past 10 years.

(Source: visited webofknowledge.com accessed on 16<sup>th</sup> November 2019)

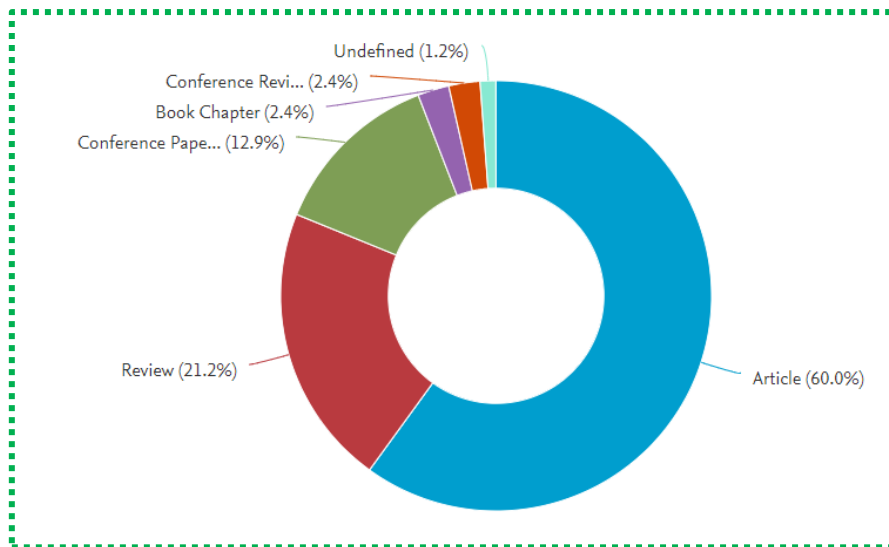


Fig 2: shows documents by types. Most papers are in the form of articles (Source: visited scopus.com/ on 16<sup>th</sup> November 2019)

### 1. Yearly Publication Trend

Table 1 and figure 3 shows yearly publication trend in bibliometric survey on clustering for the span of last 10 years for WoS and Scopus databases respectively. It is observed that the publication trends are up-down in nature and highest publication in the present research study are in the year 2k19.

Table 1: Shows no. of papers published in WoS from 2010-20 related to bibliometric survey on clustering

Year	No. of Publications
2010	4
2011	8
2012	12
2013	18
2014	9
2015	22
2016	31
2017	24
2018	52
2019	70



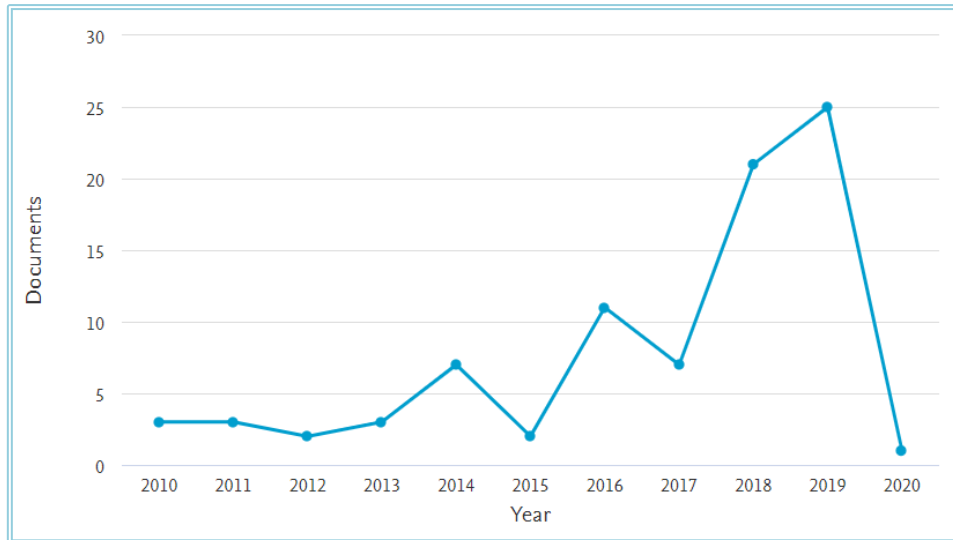


Fig 3: Shows papers published in Scopus db from 2010-2020  
 (Source: visited scopus.com/ on 16th November 2019)

## 2. Authors Researching Trend

Fig. 4 and 5 depicts top ten authors contributing and their affiliations to bibliometric study in clustering from WoS and Scopus respectively. It is clear from figure 4 that key contributing authors are Yuh-Shan Ho his affiliation is Trend Research Centre, Asia University, Taiwan.

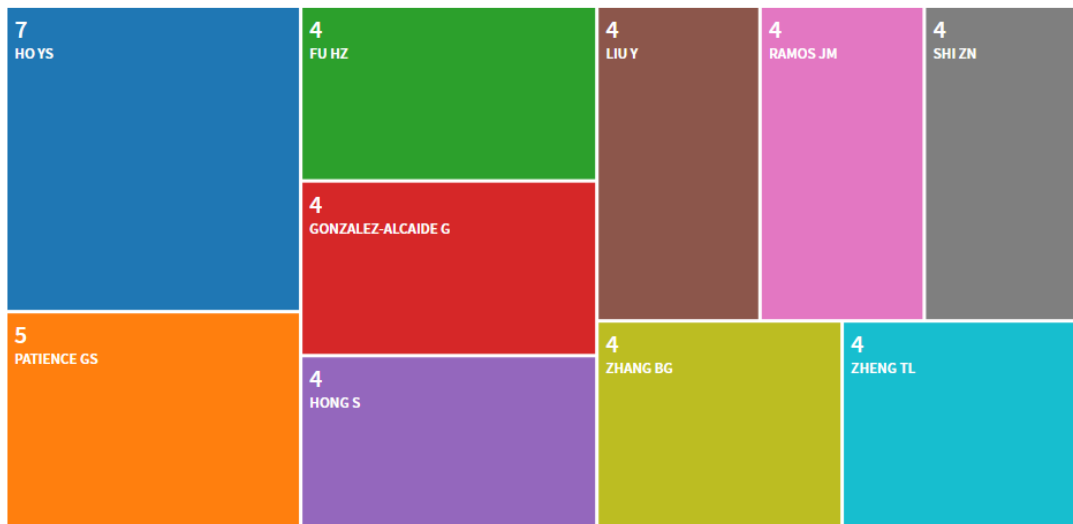


Fig 4: shows tree map indicating top 10 authors who have published bibliometric papers in WoS on clustering domain.

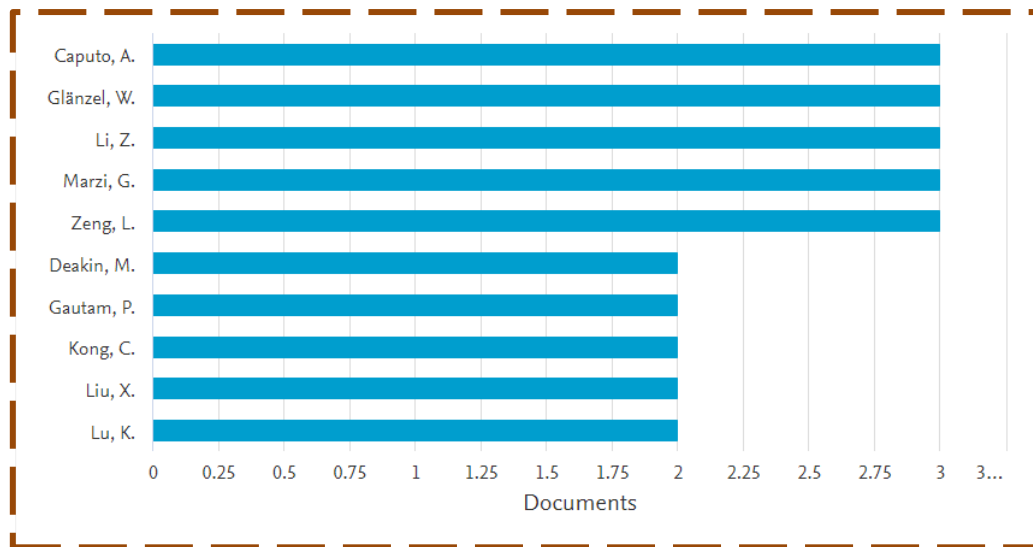


Fig 5: shows top 10 authors who have published papers in Scopus db  
(Source: visited scopus.com/ on 16th November 2019)

### 3. Journals Statistics

A total of 250 journals were listed in the WOS category of bibliometric analysis on clustering. Table 2 shows the top 10 journal which are accepted and publish the paper on bibliometric analysis in WoS. The Journal Scientometric with IF2018 of 2.77 published the largest number of articles, followed by Sustainability. The COLLNET Journal of Scientometric and Information Management now listed in the ESCI Emerging Sources Citation Index.

Table 2: The ten journals with articles in WoS category of bibliometric study in clustering

Journal	TP(%)	IF <sub>2018</sub>
Scientometric	55(22)	2.77
Sustainability	10(4)	2.59
Journal of Cleaner Production	9(3.6)	6.39
Canadian Journal of Chemical Engineering	7(2.8)	1.61
Environmental Science and Pollution Research	6(2.4)	2.91
Renewable Sustainable Energy Reviews	6(2.4)	10.55
PLoS One	5(2)	2.77
Electronic Library	4(1.6)	0.89
Journal of Business Research	4(1.6)	4.03
COLLNET Journal of Scientometric and	3(1.2)	-

Information Management		
European Planning Studies	3(1.2)	2.10

TP total number of articles, IF<sub>2018</sub> Impact Factor for 2018

Fig. 6 covers the publication source types for bibliometric analysis on clustering from Scopus. This statistics reveals that maximum numbers of publications are from Scientometric

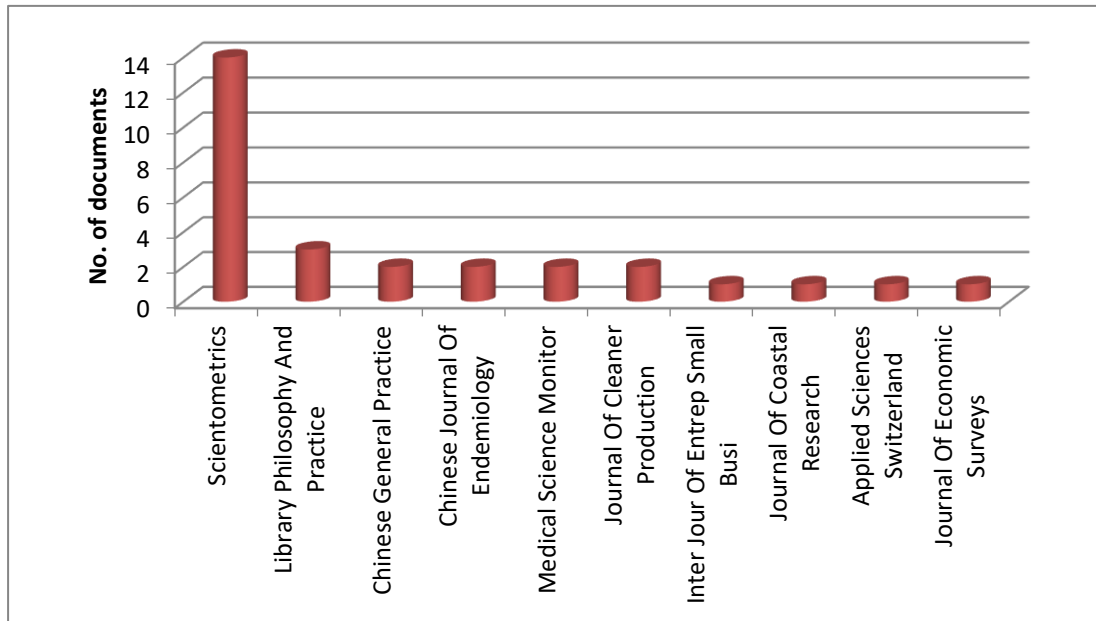


Fig 6: shows top 10 journal in which bibliometric study in clustering is undertaken and published in Scopus db (Source: visited scopus.com/ on 16th November 2019)

#### 4. Geographical Regional Analysis

Fig. 7 gives countries having publications in the area of bibliometric study in clustering from WoS and Scopus. Europe countries are the prominent publishing countries for undertaken bibliometric study.



Fig 7: shows the countries who are involved in publications related to bibliometric study in clustering domain. 📌: WoS 📌: Scopus

### 5. Funding Agencies

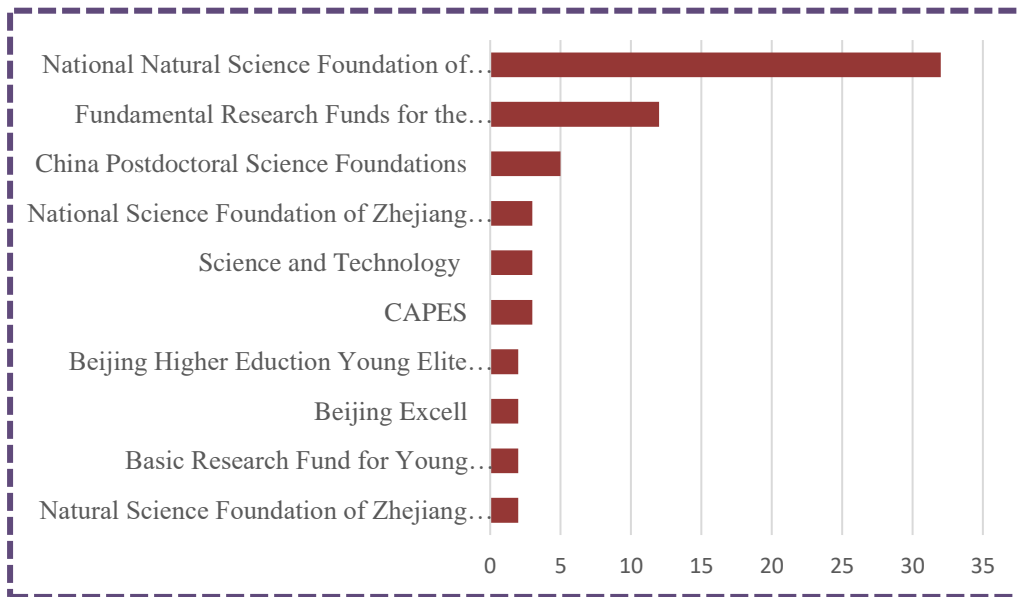


Fig 8: shows top 10 funding agencies who have given funding for the research and publications related to bibliometric study about clustering domain.

Fig. 8 depicts top ten funding agencies funding to bibliometric study in clustering publication from WoS database to get idea about prominent fund provider. National Natural Science Foundation of China is the top funding agency in the last ten years. The statistics indicates that only a few researchers have taken the lead for conceptual

development of this emerging research area by availing funding through funding agency.

Fig. 9 also indicates the top ten contributing funding agencies for bibliometric study in clustering from Scopus. Likewise WoS, research concern again for National Natural Science Foundation of China from Scopus database point of view. Interestingly four out of the top ten funding agencies are China based from WoS as well as Scopus database.

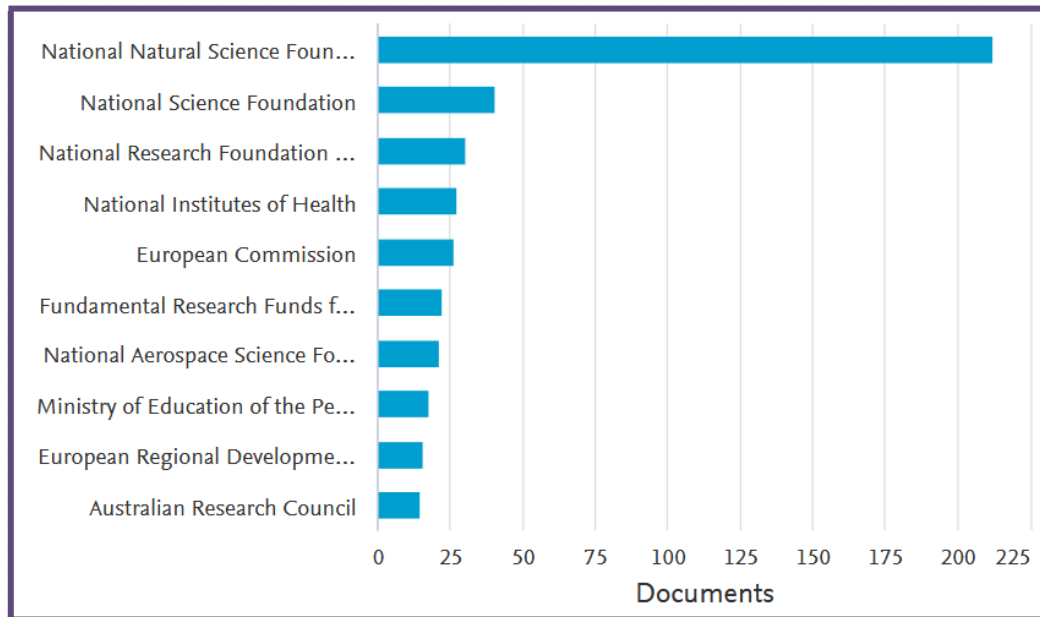


Fig 9: shows funding sponsors for the research related to clustering and bibliometric analysis study (Source: visited scopus.com/ on 16th November 2019)

## 6. Organization Trends

This section discusses the number of bibliometric papers published by various organizations in the areas related to Clustering. Fig 10 is the outcome of analysis using WoS database and fig 11 shows the top 10 eminent institutions who are involved in publishing bibliometric papers in Scopus journals primarily.

Field: Organizations-Enhanced	Record Count
CHINESE ACADEMY OF SCIENCES	11
CHINA MEDICAL UNIVERSITY	10
ASIA UNIVERSITY TAIWAN	9
PEKING UNIVERSITY	9
UNIVERSIDADE DA BEIRA INTERIOR	7
UNIVERSITY OF MONTREAL	7
UNIVERSITY OF VALENCIA	7
WUHAN UNIVERSITY	7
CHINA UNIVERSITY OF GEOSCIENCES	6
HUAZHONG UNIVERSITY OF SCIENCE TECHNOLOGY	6

Fig 10: shows top 10 organizations who are involved in publishing papers related to bibliometric study about clustering domain, in WoS journals.

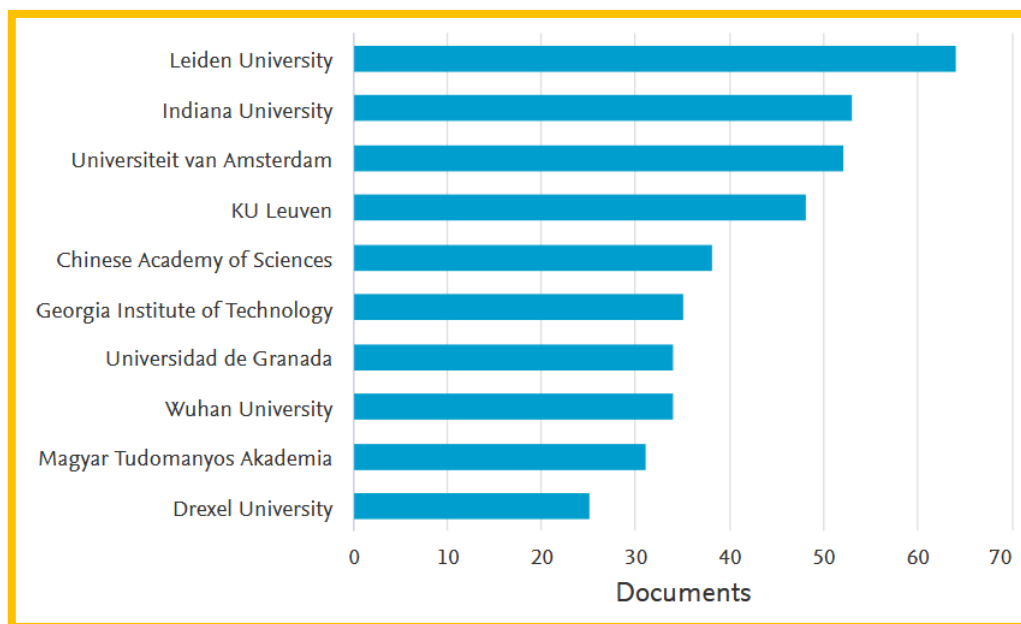


Fig 11: shows top 10 institutes who have published documents related to bibliometric analysis in clustering and alike areas in Scopus db. (Source: visited scopus.com/ on 16th November 2019)

## 7. Subject Areas

Fig 12 shows subject areas specific information for bibliometric study in clustering is undertaken and published in WoS. The maximum percentage of the publications are

concentrated in the area of Information Science Library Science computer science (30.8%), followed by Computer Science Interdisciplinary Applications (21.2%).

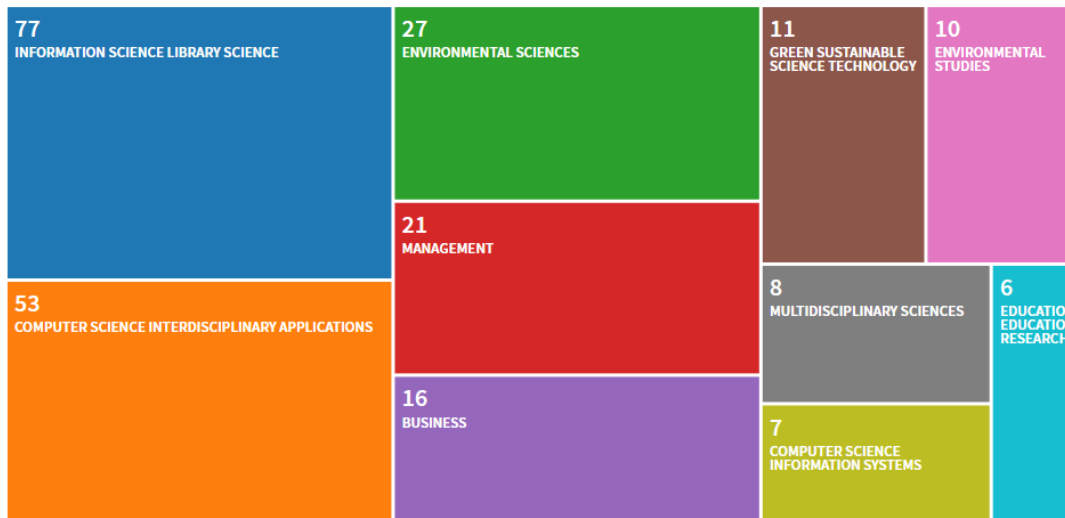


Fig 12: shows top 10 WoS categories related to bibliometric analysis papers on clustering (Source: visited webofknowledge.com accessed on 16<sup>th</sup> November 2019)

Fig. 13 shows predominant subject areas of research in clustering and in the form of bibliometric analysis papers from Scopus. The extracted information demonstrates that 24.1% of publications are from Computer Science then social science (22.5%). Fig 13 shows 17.3% other areas of research includes Economics, Econometrics and Finance; Psychology; Physics and Astronomy; Energy; Material Science; Arts and Humanities, etc.

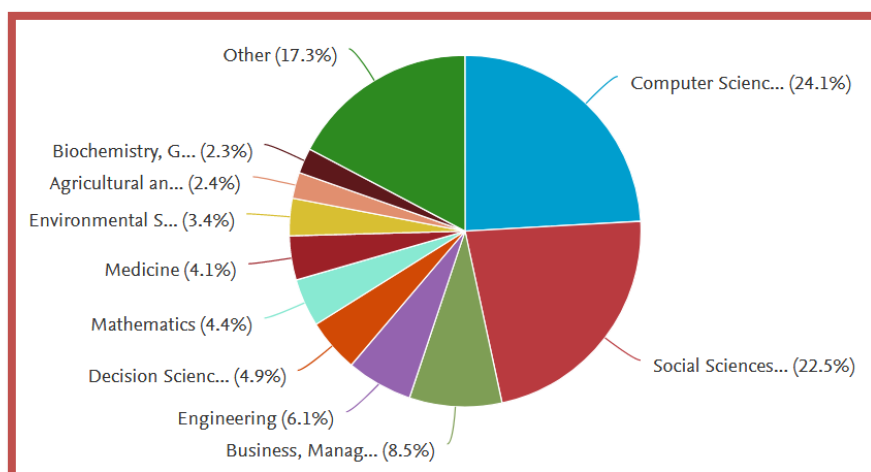


Fig 13: shows predominant subject areas of research in clustering and in the form of bibliometric analysis papers (Source: visited scopus.com/ on 16th November 2019)

## 8. Citations Analysis

Citation Analysis can be used to gauge the impact of a particular paper, indicating technology usage and value carried by that article. Till date there are in all 1973 citations to bibliometric analysis papers on clustering. The average citations per article are 7.89 cumulating to h-index of 22. Variations to annual citations can be used to track the impact of the publications shown in figure 14.

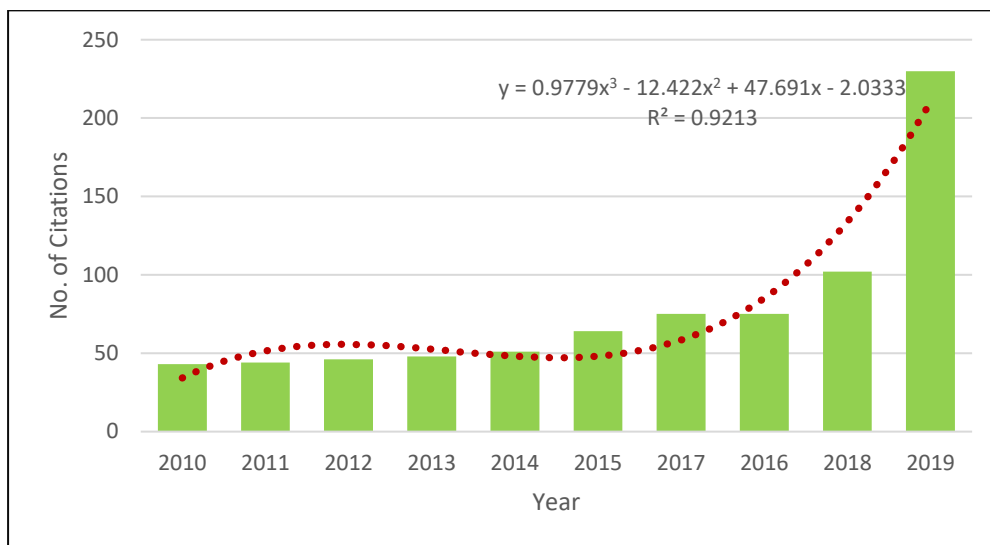


Fig 14: shows citation report of 250 publications in WoS.

Figure 15 depict the citation analysis of papers published in Scopus. There are total 753 citation till date and most frequently cited articles is Cluster randomised trials in the medical literature: Two bibliometric surveys which was published in Journal BMC Medical Research Methodology.

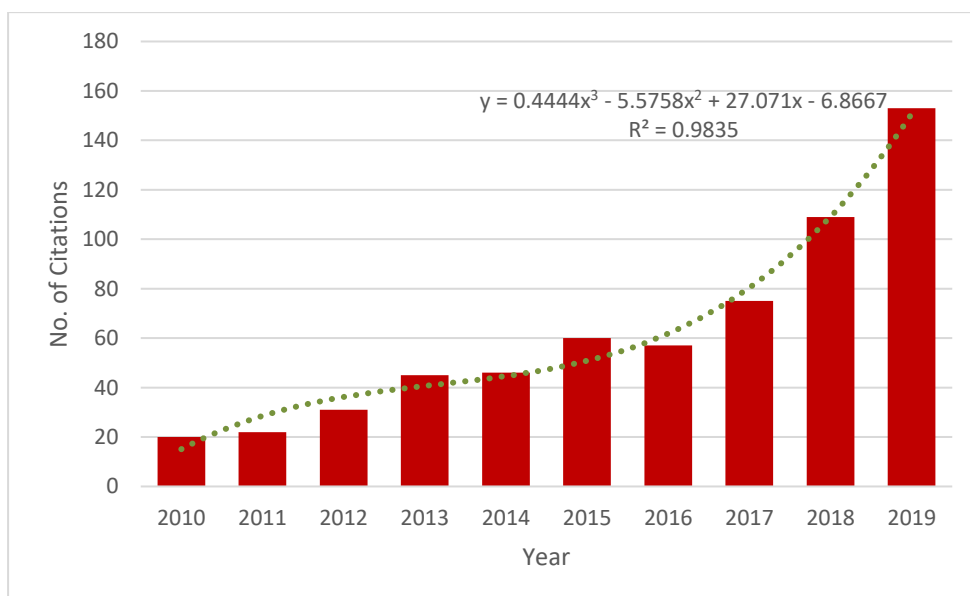


Fig 15: Citation Analysis for 85 publication in Scopus db



## 9. Ranking of Citation

Table 3 describe the proposed ranking scheme based on citation and number of authors. As Cinderella was the only one who lost her only one shoe, as per the emirical story, we have considered Cinderella rank for proud single authored papers. Romeo-Juliet was the unique couple, based on stories years ago, but now we have used this nomenclature only for the pair of authors. More than 3 authors per paper is considered as Multi-author rank in our paper. All ranks are producing papers consistently, which shows that it really doesnt matter.

Table 3: Ranking of citation analysis proposed in this research

No. of authors per paper	No. of papers	Rank details
1	11	Cinderella
2	23	Romeo Juliet
3	15	Multi-authors
4	14	
5	19	

## 10. Handshaking between Publications and Citation

The table 4 shows in early years of research, 10 years ago, none of the combination produced good results in the form of publications. As the years pass by, all combinations of authors, from solo to multiple, played very important role in publishing papers in Scopus related to bibliometric of clustering domain.

Table 4: Handshaking between authors team size and publications

Author count	Years (Number of papers published in Scopus)											
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
1			1		2		3		2	3		
2	1			2		2	2	5	7	4		
3		1	1		1		2		2	8		
4							3	2	5	3	1	
5	1	2		1	2		1		5	7		

It is clearly visible from the table 5 that larger team sizes have started the work recently and hence might be little less citations received. Less authors in team, less effect on number of citations etc.

Table 5: Handshaking between authors team size and citation

<b>Author count</b>	<b>No citation count</b>	<b>No citation since</b>	<b>Period of formation of team</b>
1	1	2013	2010-13
2	9	2016	2014-17
3	6	2018	2017-18
4	9	2018	2018-19
5	10	2019	2019-present

Table 6 shows the topics related to clustering or the equivalent terms of clustering. Table 6 shows the comparative analysis of related topics and the number of papers published in Scopus and WoS from 2010-20, which indicates lots of scope of performing Bibliometric analysis study in these related topics too, for upcoming researchers.

Table 6: Comparative Analysis of papers published in two giant databases, from 2010-20, in the terms related to clustering.

<b>Sr. No.</b>	<b>Category / related topics</b>	<b>No. of papers published in Scopus</b>	<b>No. of papers published in Web of Science</b>
1	Data Mining	120	65
2	Unsupervised learning	0	1
3	Machine learning	28	13
4	“Data Science”	4	4
5	Incremental clustering	1	0
6	Text Mining	82	83

### 3. Conclusive Summary

Bibliometric analysis provides advanced evaluative details related to authors, institutions, research areas, countries, universities, types of documents etc. Bibliometric analysis has been identified as one of the tools that have potential to assist decision-makers in understanding the specific areas of research which was analysed by the author(s). In this paper, the focus is on domain free, widely studies and researched area namely clustering. This bibliometric paper is a means for assessing

scientific output, help create a data-driven picture of scientific research within the publication landscape and offer evidence-based descriptions, comparisons, and visualizations about clustering research output to the readers. It is observed clearly from this study that there is a wide scope of work (both research and drafting bibliometric papers) in the areas such as “incremental clustering”, “unsupervised learning”, and “data science” etc. as given in the table 6 and throughout this paper.

#### 4. Future Directions

In the next phase of bibliometric of bibliometric study, we will be focusing on various others related areas of Machine Learning to provide wider glimpses to all the readers at large. We will also cover the areas related to Deep Learning and other fraternities of IT technologies. The major focus will be on locating already published bibliometric papers, their trends, matrices used, patents and funding agencies details etc. so as to be benefited to wider scale of audience.

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