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Nidhi Gupta

Panjab University, Chandigarh, India, nidhigupta@pu.ac.in

Prof. Rupak Chakravarty

Panjab University, Chandigarh, India, rupak@pu.ac.in

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Science Mapping Analysis of Digital Humanities research: A scientometric study

- i. **Nidhi Gupta, Department of Library and Information Science, Panjab University Chandigarh, India. Email: nidhigupta@pu.ac.in, <https://orcid.org/0000-0003-4244-4470>**
- ii. **Prof. Rupak Chakravarty, Department of Library & Information Science, Panjab University, Chandigarh, India. Email: rupak@pu.ac.in, <https://orcid.org/0000-0001-5046-1663>**

Abstract

Purpose– The purpose of this paper is to use scientometric analysis to identify the current state of the academic literature regarding Digital humanities(DH) and analyze its knowledge base such as highly contributing researchers, countries, organizations, sources, keyword analysis and subject areas.

Design/methodology/approach– This study carried out a scientometric study on DH literature, 2909 records were retrieved from Scopus database, time span chosen as 2005-2020 as 15 years of study in DH research area. Retrieved data can be analyzed by using VOSviewer, Bibliometrix R package scientometric tools.

Findings – The findings suggested the enormous proliferation of DH research during last 15 years, social sciences scores highest position in subject category with (30.3%) publications. Hyvonen, Eero is the highly contributing author. USA is the most productive country. The King's College London tops as the highly productive institutions in the DH research area. This study also shows strong co-authorship pattern between authors, countries and institutions. The most frequently used keyword in DH research is “Digital humanities”.

Originality/value– This study on scientometric analysis in DH literature may inform researchers and scholars of current trends and development in DH research area.

Keywords: Scientometrics, Digital Humanities, Co-authorship, Co-occurrence, VOSviewer, Bibliometrix R package

Introduction

Digital humanities first emerged in the late 1940s as “humanities computing,” when it formed the basis for such projects as the Index Thomisticus conceived by an Italian priest named Father Roberto Busa. Today, digital humanities are applying advanced computational tools to more diverse disciplines, ranging from history and literature to cultural studies (Mone, 2016). On “What is humanities computing?” McCarty stated that “it is methodological in nature and interdisciplinary in scope...focusing both on the pragmatic issues of how computing assists scholarship and teaching in the disciplines and on the theoretical problems of shift in perspective brought about by computing” (McCarty 2005).

DH is a field of research mainly concerned with the intersection between computing and various disciplines in humanities (Tang, MC 2017). It is not limited to any one discipline or field, in the digital era it has become a catch-all term for anyone who is engaging in the discovery, preservation and interpretation of humanities materials

(documents, images, sound) to enable a better and deeper understanding of current society. To some extent it is difficult to understand and interpret what digital humanities actually is, but a core feature is that it encourages researchers and practitioners to think about application probability of digital methods in traditional humanities disciplines.

The term scientometrics is first proposed by Mulchenko (Mulchenko 1969) as “a quantitative study of the research on the development of science”. It can be considered as a technique that includes measuring research impact, understanding the citation process, mapping the knowledge structure and evolutions in a domain based on the large-scale scholarly dataset (Börner, K.K 2003). Through processing enormous bibliometric data, scientometric methods help researchers find systematic literature-related discoveries by linking literature concepts that may be overlooked in manual review studies (Su, H.N 2010).

Literature Review

Benito-Santos and Theron (2020) presented a study “Pilaster: A collection of citation metadata extracted from publications on visualization for the digital humanities.” The paper presents Pilaster (<https://visusal.github.io/pilaster/>), a collection of citation metadata extracted from publications in visualization for the digital humanities. The collection is generated from a seed set of relevant publications from which we extracted cited works, including journal and conference papers, books, theses, or blog posts, among other resources. The main aim of this paper revolves around three main points: first, the collection may serve as an entry point to the discipline for digital humanists and visualization scholars without previous experience in the field. Second, Pilaster can be regarded as a meeting point for more established visualization or humanities scholars seeking to collaborate in the development of novel research ideas and related visualization design studies in the context of the humanities. Third, and given the large amount of visualization design spaces that were captured, we believe the dataset has the potential to become the starting point for future studies aimed at understanding the particularities of problem-driven visualization research in this and other contexts.

Yang, M. et.al, (2020) conducted a study entitle as “Exploring the transdisciplinary nature of digital humanities”. The article contributes to the ongoing discussion on the transdisciplinary nature of DH research quantitatively. A bibliometric analysis of published articles in DH is conducted to examine the structure and patterns of transdisciplinary collaborations, as well as the evolving overall pattern. The findings indicate that the scope of disciplines involved in DH research is broad, but that the disciplinary distribution is unbalanced. Centering around a few important disciplines, all disciplines related to DH research are aggregated into communities, suggesting multiple related research areas and disciplines for DH research. The evolving graph of disciplines provides support for the transdisciplinary nature of DH. The aim of this paper is to make manifest the structure and patterns of transdisciplinary collaborations in DH by means of bibliometric analysis and visualization techniques. The results of this study have shown the transdisciplinary collaborative nature in digital humanities research, which is propelled by wide applications in a broad range of disciplines.

Wang, Tan and Lie (2020) conducted a study “The Evolution of Digital Humanities in China”. The study presents during the last decade in China, digital humanities (DH) has rapidly developed as a research area, attracting widening circles of inquiry and gaining prominence as an internationally recognized emerging discipline. In order to review the history and current status of DH scholarship in China, the research team conducted historical analysis and bibliometrics to reveal the conception and development of DH in China. The research findings indicate that the history of the evolution of DH in China may best be divided into two stages. In the preliminary

period, DH had just been introduced into China, and emphasis was placed on the exploration of its connotation. Once the concept had been explored and research about DH had been widely accepted, DH in China gradually entered into the phase of rapid development, in which China witnessed a wide variety of DH inquiries and applications in the field of library and information science, linguistics, history, literature, art, cultural heritage preservation, and so on. DH in China is facing opportunities as well as challenges with regard to digital practice, such as DH infrastructure, interdisciplinary research, and DH education. As an essential part of DH communities in China, libraries are playing an important role in resource construction, space sharing, and training services, which may provide strong support to deal with opportunities and challenges in the future. In order to review the history and current status of DH scholarship in China, we chose the largest literature database and publicly funded project data sets in China as data sources to conduct a historical analysis and bibliometric study. At the macro level, the historical context of DH in China since 2009 can be divided into two periods. Important research events in each period were recounted. At the micro level, emerging fields and topics of DH in China were discussed, including the disciplines of LIS, linguistics, history, literature, art, and CH preservation. At present, DH in China has entered into a period of rapid development, which is causing substantial changes in Chinese academic research through new methods, tools, platforms, and research paradigms. Both opportunities and challenges exist in DH infrastructure, interdisciplinary research, DH education, DH communities, and DH work in libraries.

Wang, Q (2018) conducted a study entitled as “Distribution features and intellectual structures of digital humanities A bibliometric analysis”. The purpose of this paper is to conduct a retrospective bibliometric analysis of documents about digital humanities, an emerging but interdisciplinary movement. It examines the distribution of research outputs and languages, identifies the active journals and institutions, dissects the network of categories and cited references, and interprets the hot research topics. The source data are derived from the Web of Science (WoS) core collection. To reveal the holistic landscape of this field, VOSviewer and CiteSpace as popular visualization tools are employed to process the bibliographic data including author, category, reference, and keyword. Furthermore, the parameter design of the visualization tools follows the general procedures and methods for bibliometric analysis. There is an obviously rapid growth in digital humanities research. English is still the leading academic language in this field. The most influential authors all come from or have scientific relationships with Europe and North America, and two leading countries of which are the UK and USA. Digital humanities are the result of a dynamic dialogue between humanistic exploration and digital means. This research field is closely associated with history, literary and cultural heritage, and information and library science.

Objectives Of The Study

The main objectives of the present study are as follows:

1. To analyze the annual growth of the DH literature.
2. To identify the highly contributing authors, countries, institutions, sources in DH literature.
3. To analyze the co-authorship pattern between authors, organizations and countries in DH literature.
4. To analyze the co-occurrence pattern of all the keywords in DH literature.

Data Source And Methodology

To conduct this bibliometric study on DH, Scopus database as a data source was used for obtaining the bibliographic data. The search string used for obtaining the bibliographic data was (TITLE-ABSKEY (“Digital humanities”). The time-span chosen for this study includes 2005-2020, 15 years of study on DH literature. The

search was carried on march 2021. The database search resulted in obtaining the bibliographic data of 2909 publications. Scopus database facilitates data in different data formats. For this analysis, the data was extracted in CSV file format. The basic data processing work was carried out using the CSV file formats and tables, graphs were generated out of the processed data using Microsoft Excel. For developing the network visualization maps from the data, a freely available software VOSviewer and Bibliometrix R package was used. The data was loaded in the software in the same CSV file format and various visualization maps were obtained to analyze the various patterns of research from different dimensions. VOSviewer, as a visualizing and mapping software (Van Eck and Waltman, 2010), was used for mapping co-authorship networks of authors, institutions and countries, and co-occurrence of all the keywords in DH literature.

Results And Discussions

Annual Growth Trends In DH Literature

The annual growth trend in Figure 1. revealed the development in the research area of DH from 2005-2020, 15 years of study of DH literature. The study included a total of 2909 publications. As shown in Figure 1. over the past 15 years, the number of publications on DH increased steadily, and reached its peak in 2019. It showed exponential growth in the publications on the topic per year, with most in 2019. Particularly, the rate of publications accelerated from 2013 to 2019.

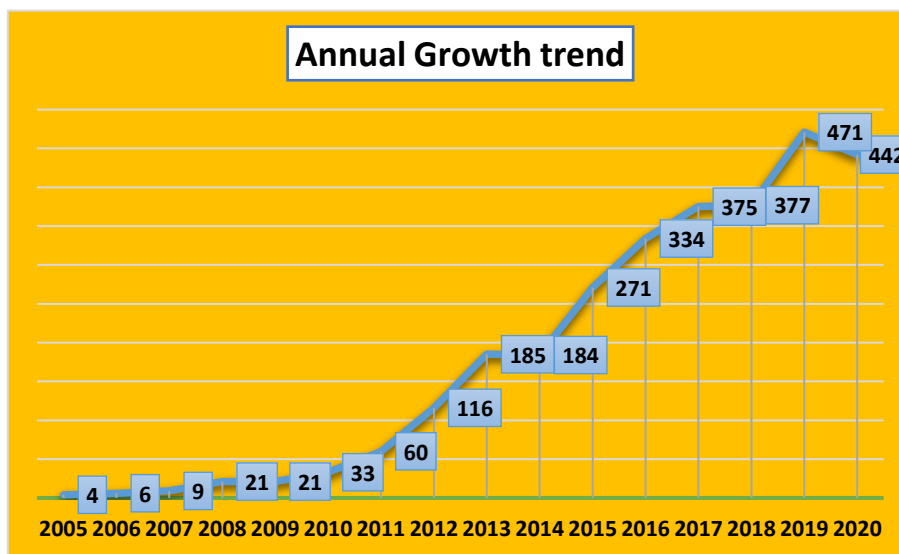


Fig.1 Annual Growth trends in DH literature from 2005-2020

Subject Category

The analysis of subject categories (Figure 2.) in DH research area from 2005-2020 was carried out which showed that out of total 2909 publications retrieved from Scopus database, the social sciences scores highest position with 1464 (30.3%) publications followed by computer science 1337 (27.5%), Arts and humanities 1285(26.6%), Mathematics 220(4.5%) and Engineering 159(3.3%) respectively.

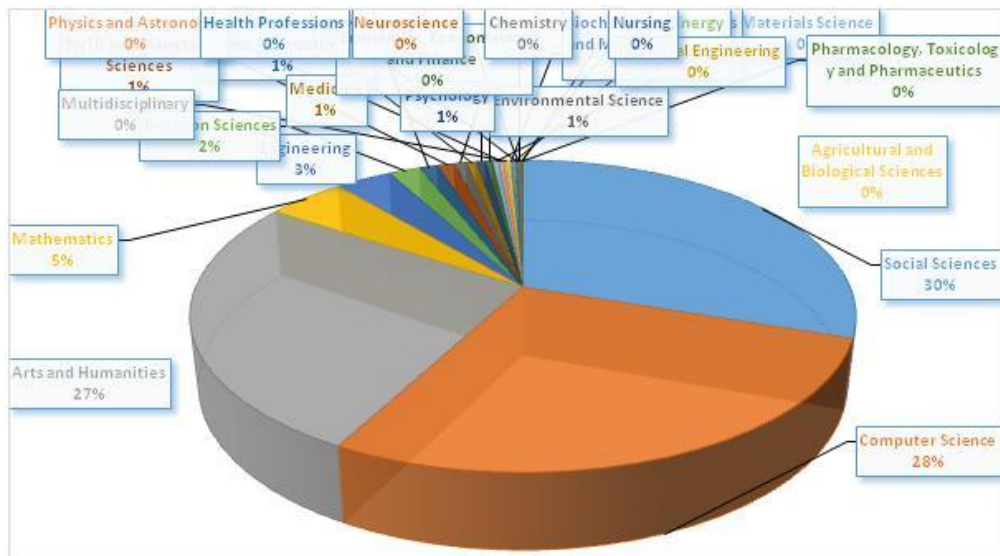


Fig.2 Subject Category in DH literature from 2005-2020

Highly productive authors, countries, institutions and sources

Most prolific authors

The top ten most productive authors in DH research area from 2005- 2020 were presented in Table.1 For getting a general picture of the activities of each author, the table considered several bibliometric indicators, including author rank, author name, number of publications, their affiliations and countries, the number of citations (TC), the average citations per paper(CPP), average publication year(APY), h-index and their total link strength (TLS).

Top three productive authors according to highest number of publications were Eero Hyvonen (n=20) from Aalto University,Finland spotted the 1st rank and M.Terras (n=16) from University of Edinburgh,UK spotted 2nd rank followed by J. Tuominen from Aalto University,Finland and E Wandl-vogt from Austrian academy of sciences, Austria (each with n= 14) were top four highly-productive authors in DH research area.

M.Terras (CPP=16.18) from University of Edinburgh, UK was the top of the list followed by J. Nyhan (CPP=8.0) from University College London, UK and O. Conlan (CPP=6.6) from Trinity college Dublin, Ireland were the top three influential authors according to highest number of citations per paper (CPP) published in DH research area.

Authors with highest h-index were Eero Hyvonen (h index =19) from Aalto University,Finland followed by M.Agosti (h index =17) from University of Padova, Italy and M.Terras, UK and O. Conlan from Trinity college Dublin, Ireland (each with h-index 13) were the top three authors in the list.

Rank	Author	Number of Publications(N)	Affiliation	Country	Total Citations (TC)	Average citation per pub. (CPP)	Average Pub.Year APY	H index	total link strength (TLS)
1	Eero Hyvonen	20	Aalto University	Finland	85	4.25	2018.70	19	56
2	M. Terras	16	University of Edinburgh	UK	259	16.18	2012.73	13	11
3	J. Tuominen	14	Aalto	Finland	73	5.2	2018.7	5	53

			University						
4	E.Wandl-vogt	14	Austrian academy of sciences	Austria	26	1.85	2017.79	4	14
5	P. Leskinen	12	Aalto University	Finland	66	5.5	2017.67	6	41
6	M. Koho	11	Aalto University	Finland	52	4.7	2018.27	6	43
7	J. Nyhan	11	University College London	UK	89	8.0	2015.27	5	9
8	M. Agosti	10	University of Padova	Italy	50	5	2013.40	17	16
9	O. Conlan	10	Trinity college Dublin, Ireland	Ireland	66	6.6	2013.30	13	31
10	A. Dorna	10	Austrian academy of sciences	Austria	17	1.7	2018.80	4	9

Table 1. The top 10 most productive authors in DH research area 2005-2020

Active Countries

The top 10 most productive countries in DH research area from 2005-2020 were presented in Table 2. The United States (n=862; cit=4062) was the most prolific country ranked 1st followed by United Kingdom (n=305; cit=2069), Germany (n=304; cit=964), Italy (n=164; cit=647) and Spain (n=153; cit=301) ranked from second to fifth, respectively.

SN	Country	Documents	Total Link Strength (TLS)	Citations	Avg. citation (AC)	Avg. Pub Year (APY)
1	USA	862	451	4062	4.71	2016.5
2	UK	305	308	2069	6.78	2015.53
3	Germany	304	155	964	3.17	2016.99
4	Italy	164	88	647	3.94	2016.66
5	Spain	153	94	301	1.96	2017.37
6	Canada	146	129	595	4.07	2015.71
7	France	144	54	496	3.44	2017.06
8	Netherlands	135	109	710	5.25	2016.69
9	Australia	77	35	524	6.80	2016.30

10	Finland	71	32	191	2.69	2018.25
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Table 2.The top 10 most productive countries in DH research

area 2005-2020

Contributing Institutions

Figure 3 depicted research institutions with more than 25 publications in DH research area from 2005 -2020. The top 10 most contributing institutions in DH were presented in Table.3 the King's College London(n=58) topped the list followed by University College London (n =42), Helsingin Yliopisto(n=38), Utrecht University(n=33) and Vrije Universiteit Amsterdam(n=33) respectively.

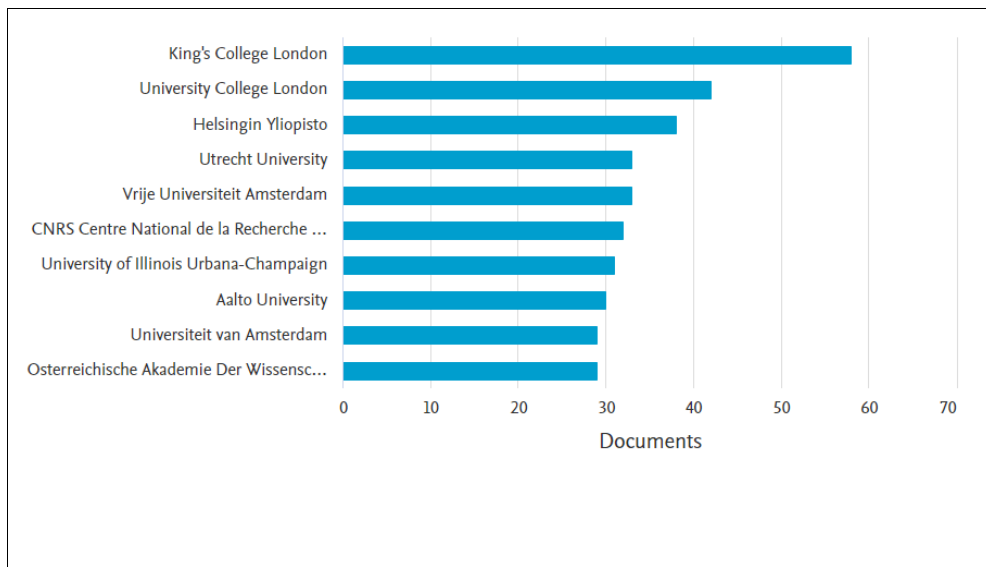


Fig.3 Top ten institutions in DH from 2005-2020

SN	Organization/ Institutions	Country	Documents
1	King's College London	UK	58
2	University College London	UK	42
3	Helsingin Yliopisto	Finland	38
4	Utrecht University	Netherlands	33
5	Vrije Universiteit Amsterdam	Netherlands	33
6	CNRS Centre National de la Recherche Scientifique	France	32
7	University of Illinois Urbana-Champaign	US	31
8	Aalto University	Finland	30
9	Universiteit van Amsterdam	Netherlands	29
10	Osterreichische Akademie Der Wissenschaften	Austria	29

Table.3 Top ten contributing institutions in DH literature 2005-2020

Core Sources

The top ten most productive sources in DH research area from 2005-2020 were presented in Table.4 and Figure4. The leader of this ranking was the Ceur Workshop Proceedings (n=151) followed by Lecture notes in computer science including subseries lecture notes in artificial intelligence and lecture notes in Bioinformatics (n=114), ACM

International Conference Proceeding Series(n=110), Digital Scholarship in the humanities (n=60) and Communications in Computer and Information Science(n=45) respectively.

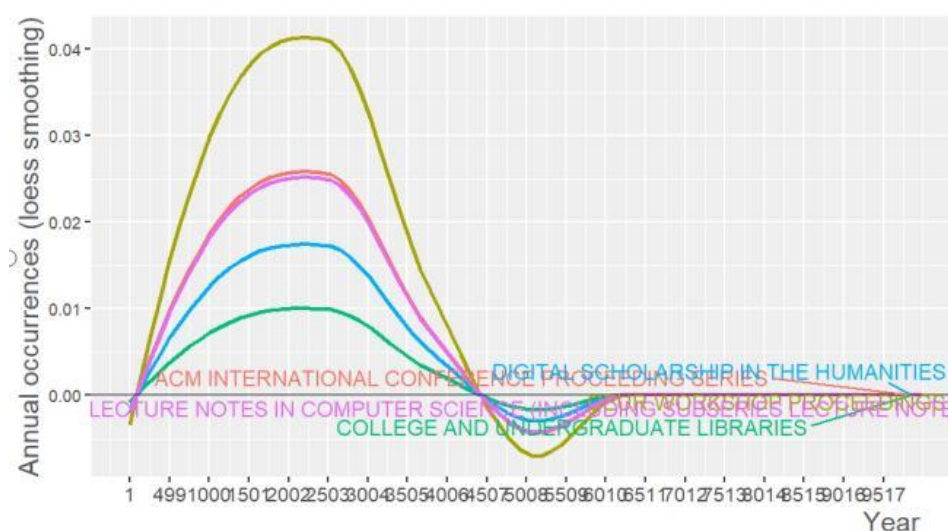


Fig.4 The core sources in DH literature from 2005-2020

SN	SOURCES	SOURCE TYPE	Total Publications	SUBJECT AREA
1	Ceur Workshop Proceedings	Conference Proceeding	151	Computer science
2	Lecture notes in computer science including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics	Book Series	114	Computer science, and Mathematics
3	ACM International Conference Proceeding Series	Conference Proceeding	110	Computer science, Networks and communication and software
4	Digital Scholarship in the humanities	Journal	60	Arts & Humanities, Social science and Computer science
5	Communications In Computer and Information Science	Book series	45	Mathematics, Computer science
6	Literary And Linguistic Computing	Journal	35	Arts & Humanities, Social science and Computer science
7	College And Undergraduate Libraries	Journal	31	Social science, library and information science

8	Digital Studies Le Champ Numerique	Journal	21	Arts & Humanities, Social science and Computer science
9	Journal Of Documentation	Journal	17	Social science, computer science
10	Historical Social Research	Journal	16	Arts & Humanities, Social science and Computer science

Table .4 Top ten core sources in DH literature 2005-2020

Co-Authorship Network Analysis

Unit of analysis: author

Based on the bibliographic data collected from the Scopus database, the authors co-authorship network visualization map was created (Figure 5) with VOSviewer. In the process of mapping, the minimum document of an author was set at 3. There were 5036 authors out of which 344 listed as visualization items. The co-authorship network consisted of 4 clusters.

Cluster 1. (Red) Fiser, D (n=6; L=5; TLS=8) was the largest node in this cluster and had strong collaboration with Erjavec, T (3 times), Maegaard, B (2 times) and Krauwer, S and Pancur, A (1times) each. It was also observed that some of the authors belong to this cluster had collaborative relation with cluster 2 also.

Cluster 2. (Green) Hyvonen, Eero (n=20, L=12, TLS=61) from Aalto University,Finland was the largest node and had collaborative relation with J. Tuominen from Aalto University Finland (12 times) followed by Koho, M and Leskinen, P (from Aalto University,Finland ,10 time). It also collaborated with cluster 1. authors De Jong, F, Tonelli,S and Aroyo (1 times each) and cluster 4. authors Rantala, H (4times) and Jokipii, I (3 times).

Cluster 3. (Blue) Tolonen, M (n=7; l=5; TLS=16) from Finland was the largest node in this cluster and had collaborative links with Golub, K and Lahti,I (5 times each) followed by Marhanen,J (4 times) and Roivainen, H (3 times).

Cluster 4. (Yellow) Rantala, H (n=6; L=9; TLS=23) from Finland was largest node and had strong collaboration links with Hyvonen, Eero and J. Tuominen (4 links) both from cluster 2. It was also observed from the network visualization on DH literature (Figure.5) that there was strong collaboration between cluster 2 and cluster 4.

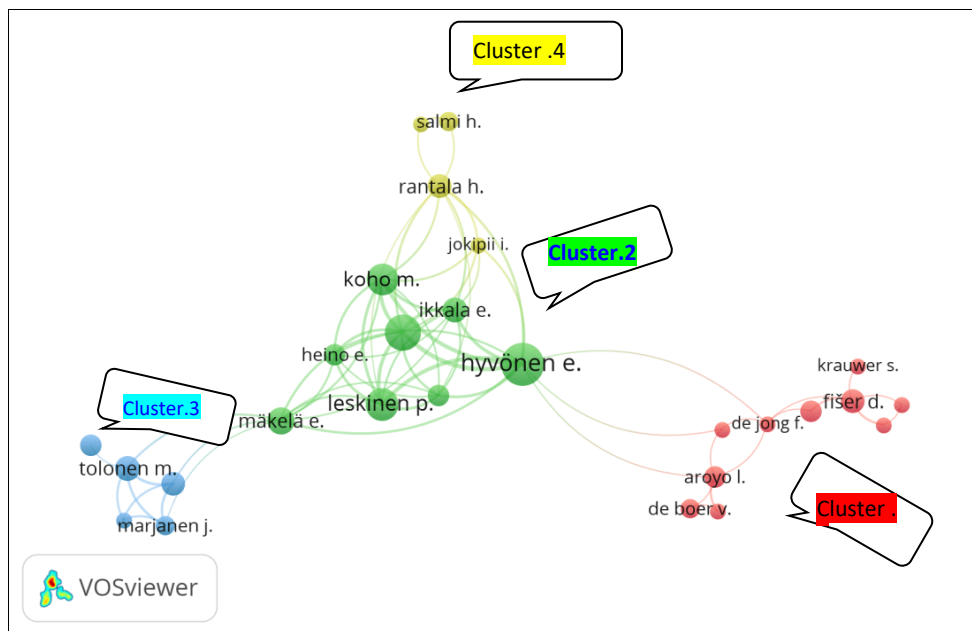


Fig.5 Author Co-authorship network visualization analysis in DH literature 2005-2020.

Unit of analysis: Country

Figure 6a and 6b. presented the country co-authorship network in DH research area. In the process of mapping, the minimum document of a country was set at 5. There were 109 countries out of which 44 listed as visualization items. The co-authorship network of countries consisted of 9 clusters. The main countries in the density map included the United States, United Kingdom, Germany, Italy and Spain. The United States with (L=35; TLS= 193), and United Kingdom with (L=26; TLS=177) were the top two countries with strong collaborative links followed by Germany (L=28; TLS=147), Italy (l=20; TLS=96), Spain (L=22; TLS=68).

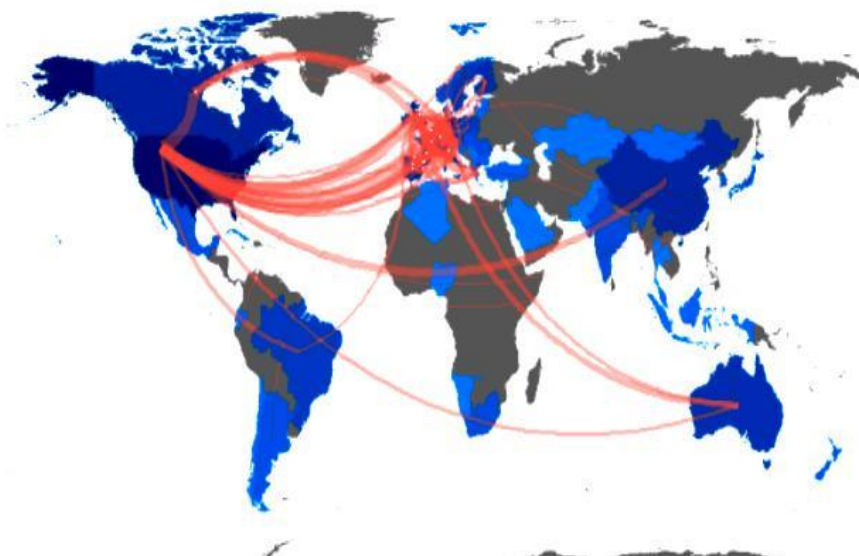


Fig.6a Country collaboration Map by Biblioshinny

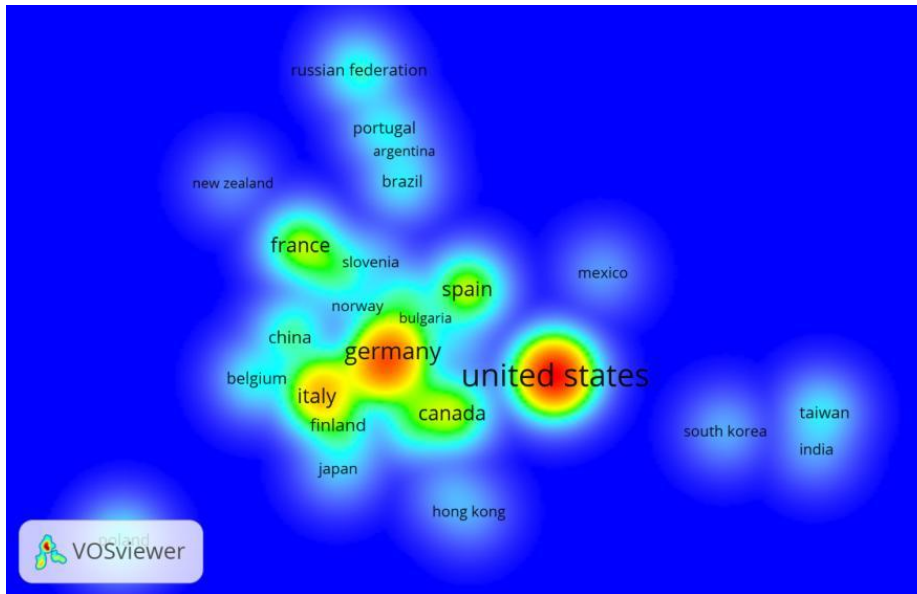


Fig.6b Country co-authorship density visualization analysis in DH from 2005-2020 by VV

Unit Of Analysis: Institutions

Figure 7. presented the Institute co-authorship network in DH research area. Out of 4050 contributing research institutions in DH literature from 2005-2020, institutions with at least 3 papers were included in Institute co-authorship network. As depicted in Figure 6, three clusters were identified.

Cluster 1. (Red) Vrije University, Amsterdam was the largest node with (3 Links and 3 TLS).

Cluster 2. Utrecht University was the largest node in the cluster with (5 links and 10 TLS). Collaborated with Vrije University Amsterdam in cluster 1.

Cluster 3. King's college London was the largest node in the cluster with (1 link and 1 TLS) with Aalto University, Finland.

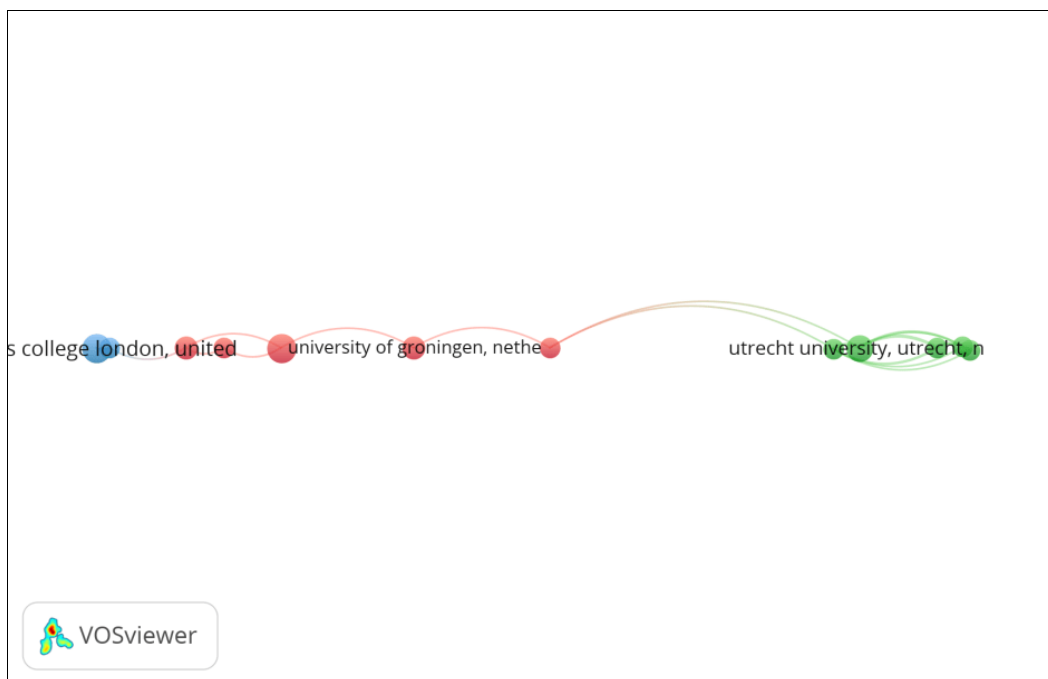


Fig 7. presented the Institute co-authorship network in DH research area.

The Three-Field Plot Analysis Author, Country and Organizations

The three-field plot of top 10 authors, countries and organizations was generated in DH literature from 2005-2020. The left field presented authors, middle field presented countries and the right field presented affiliations. The size of block presented the associational relationship with each factor. In the right field Tuominen,J, Hyvonen,E,Koho,M and Leskinen,P from Aalto University,Finland were showing strong association with institutions from UK, USA and Italy.

The highly associated country USA was showing associational links with the Texas a and m university, university of California, Indiana university, university of Minnesota libraries, computer science department and National Chengchi university. The second most associated country UK was strongly associated with university college London followed by King’s college London and Swansea university.

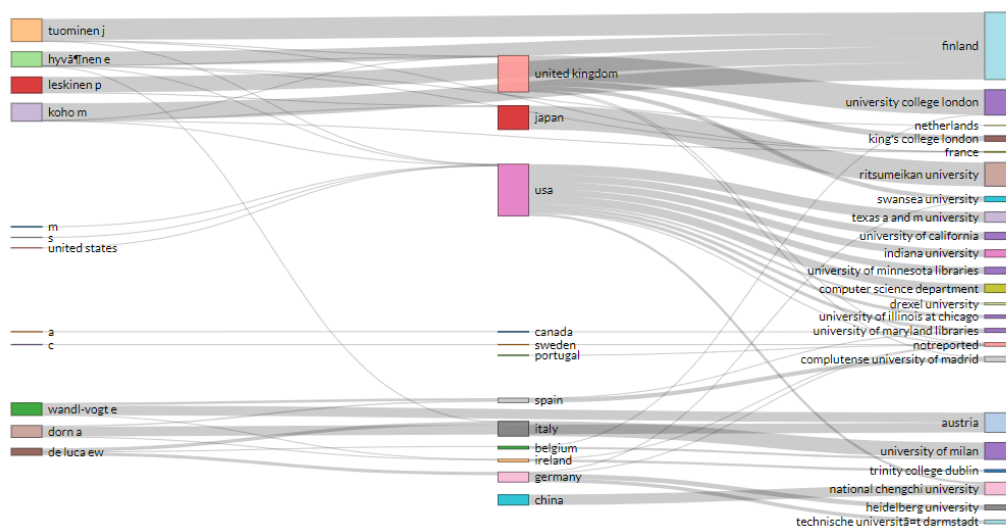


Fig.7The three-field plot analysis of authors, countries and organizations by Bibliometrix.

Co-Occurrence Analysis

Unit of analysis: All the keywords

The 10 highly-frequent keywords used in DH research area were shown in Table 6. Minimum number of co-occurrences of a keyword was 5. Out of 9151 keywords 572 met the threshold. The first to five ranks belonged to the Digital humanities (1790), Digital libraries (161), Semantics (126), History (115), and Visualization (114) respectively.

SN	Keywords	Frequency	Total Link Strength (TLS)	Average pub. Year (APY)
1	Digital Humanities	1790	5062	2016.95
2	Digital libraries	161	805	2015.62
3	Semantics	126	657	2017
4	History	115	545	2016.63
5	Visualization	114	571	2016.76
6	Humanities computing	112	560	2016..64
7	Metadata	100	522	2015.92

8	Semantic web	94	546	2017.13
9	Natural language processing systems	82	504	2017.39
10	Ontology	76	404	2016.99

Table.6 Top 10 most co-occurred keywords.

Keyword clustering is visualized in Figure 7. Highly frequent keywords were included in seven clusters, with 249 keywords. Some keywords are invisible in the map due to their much overlap. The keyword that occurs at least 10 times were included in the map.

Cluster 1(Red) named as “digital libraries” included 59 keywords, including among others metadata (100), digitization (40), libraries (39), archives (35) and digital devices (33) so on.

Cluster 2. (Green) named as “History” included 49 keywords, such as humanities (115), big data (56), social networking (online) (50), digital history (49) and collaboration (48) so on.

Cluster 3. (Blue) named as “Semantics” included 43 keywords, such as natural language processing systems (82), data mining (63), artificial intelligence (53), text mining (50) and computational linguistics (44) so on.

Cluster 4. (Yellow) labeled as “Digital Humanities” included 37 keywords, such as cultural heritages (75), human computer interaction (43), crowd sourcing (38), digital archives (31) so on.

Cluster 5. (Purple) named as “Semantic Web” included 24 keywords such as ontology (76), linked data (62), linked datum (31), search engines (31) and so on.

Cluster 6. (Turquoise) named as “Linguistics” included 22 keywords such as computer science (31), network analysis (28), Tei (24), xml (23) so on.

Cluster 7. (Orange) named as “Visualization” included 15 keywords such as humanities computing (112), information systems (46), ecosystems (43), humanities research (27), and visualization (22) so on.



Fig.7 Network visualization of all the keywords.

Figure.8 presented the overlay visualization map that depicted the time-based co-occurrence map of highly frequent keywords. As the mapguide, the colored bar below the map shows what keywords were predominant and when they were so. As the highly frequent keywords in digital humanities research belong to 20016–2019, this time span was

shown in the map. The most recent predominant key words included with their frequency and average publication year such as knowledge graph (6;2019.50), text annotation (6;2019.20) visual analysis (6;2019.33), data science (6;2019) spatial history (5;2019) deep learning (20;2018.80), Knowledge graphs (17;2018.76), computer vision (21;2018.71), data analysis (10;2018.70), research process (13;2018.69), Open science (18; 2018.33) so on. The overlay network analysis of these keywords showed that these terms or studies on these terms gaining more attention in the study of DH research area in recent years.

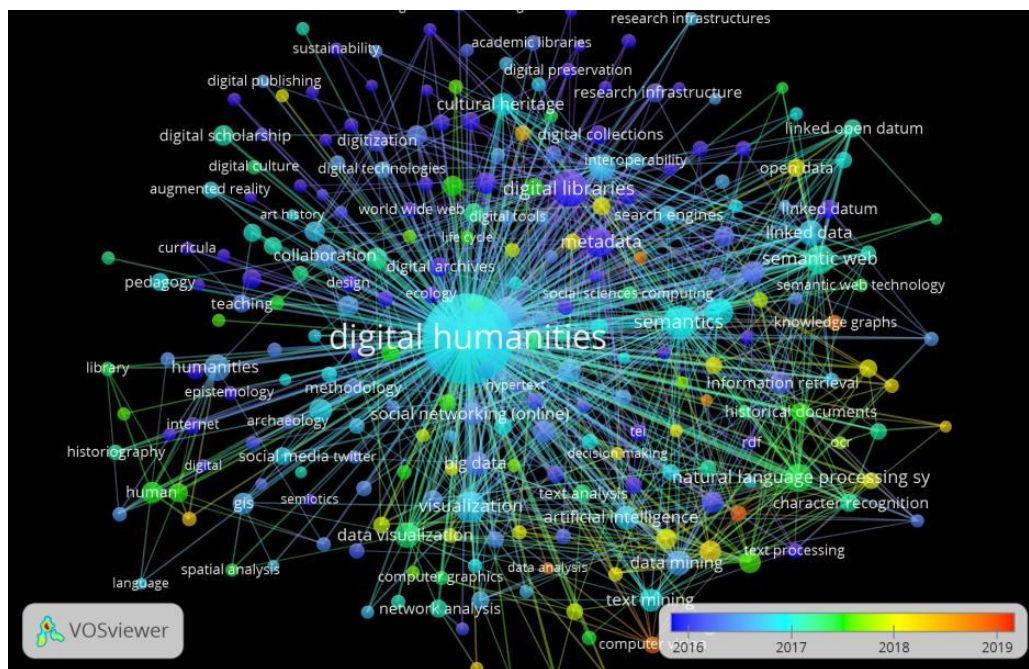


Fig.8 Overlay visualization of all the keywords.

Conclusion

In this study, we used scientometric analysis methods to explore the current research trends in DH research area from 2005-2020. The study shows the continuous growth of research in DH literature, publications tend to be communicated mainly through articles published in social sciences subject area (30.3%) followed by computer science 1337 (27.5%), Arts and humanities 1285(26.6%). The most productive authors are Eero Hyvonen, M. Terras, J. Tuominen, E. Wandl-vogt and P. Leskinen. The most prolific countries are The United States followed by UK, Germany, Italy and Spain. The organizations which perform a higher number of research Publications are King's College London followed by University College London, Helsingin Yliopisto, Utrecht University and Vrije Universiteit Amsterdam. The main keywords that describe research in the DH literature are Digital Humanities, Digital libraries, Semantics, History and Visualization is a field which has had an important growth particularly during the 15 years. It has applications in multiple areas among which social science, computer science is of the most important.

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