A bibliometric study of digital humanities research in China from 2012 to 2021

Fangli Su, Shihao Li, Qinghua Liu, and Yin Zhang

Abstract

Introduction. We investigated the main research topics of digital humanities in China from 2012 to 2021, as well as the journals, authors, and institutions that produced the most research in this field.

Method. Based on a sample of relevant digital humanities literature from the China National Knowledge Infrastructure (CNKI) database, we applied bibliometric methods and visualisation tools for a longitudinal examination.

Analysis. This study took CNKI as the data source and extracted keywords for an analysis of the research output, intellectual structures, and distribution features of authors and institutions.

Results. Digital humanities research in China is strongly associated with library and information science, with eight major reoccurring topics and themes identified. The leading research contributors in China are authors and institutions that are also identified and highlighted.

Conclusions. Digital humanities research in China rapidly grew between 2012 and 2021. This study depicts the overall situation and knowledge structure of the research and establishes a benchmark for further theoretical research and practical innovation of digital humanities in China.

Introduction

Digital humanities is a discipline based on *humanity computing* that has been developing for more than seventy years. Since definitions of *digital humanities* are changing because the field is changing, we define digital humanities in this paper as an interdisciplinary field of study, research, teaching, and invention concerned with the intersection of computing and the disciplines of the humanities. Roberto Busa is known as one of the pioneers of digital humanities for his work with IBM in the 1940s. In the late 1960s and early 1970s, scholars were devoted to exploring how computer technology could be integrated with the arts to lead innovative developments in artistic creation, and by this time, digital humanities already covered a variety of fields such as statistical linguistics, digital history, and library statistics. In the 1990s, under the background of the emergence and prosperity of new media research and Internet research, Text Encoding Initiative (a key aspect of digital humanities) was born. In the 21st century, digital humanities has transformed from an academic frontier to an independent discipline; many universities offer undergraduate, master's and doctoral programmes in digital humanities; and academic research has increased.

Digital humanities is characterised by openness, collaboration, experimentation, and diversification, which reflects the important academic value and social utility of the field: promoting knowledge innovation and knowledge service (Spiro, 2012). Activities and research topics in this area are diverse, including archiving historical documents, studying media and art, evaluating infrastructure, mining data, and developing best teaching practices (Poole, 2017; Poole and Garwood, 2018). As one of the seven developmental trends of future academic libraries (ACRL, 2014), digital humanities applies digital technology to the research of history, geography, linguistics, literature, and other disciplines, profoundly affecting the research content and progress of humanities.

With impetus from the international digital humanities wave and humanities revolution, many projects, institutions and researchers were funded in China to promote the opportunities offered by emerging technologies within the humanities and social sciences. Chinese scholars have begun to study digital humanities from different perspectives and at various levels. By 2021, digital humanities research had become one of the research hot spots in library and information science in China. A series of research and practice achievements have been made in digital humanities infrastructure construction, key technology breakthroughs, knowledge base and platform construction, public participation projects, open data competition, the roles of libraries and librarians in digital humanities, talent training, and other aspects.

At present, the research of digital humanities in China is in a period of rapid growth. Therefore, clarifying the status quo of the development of digital humanities can help identify research directions, and guide research and practices. This study aims to extend earlier efforts and further our understanding of digital humanities research and development in China. We focus on three research questions:

> RQ1. What is the trend of research output of digital humanities research in China during the period of 2012 to 2021?
>
> RQ2. What are the themes of digital humanities research in China?
>
> RQ3. Which journals, authors and institutions produce the most digital humanities research in China?

Based on the findings, recommendations are made for future research and practice in digital humanities in China. Digital humanities research is closely related to library and information science in China. Findings of this study will therefore help libraries, museums, and archives provide effective digital services. This research also constructs a collaboration network of authors, and summarises the current situation of scientific research cooperation, which can further promote collaboration in the multidisciplinary digital humanities field.

Literature review

Digital humanities research and development in China

Digital humanities, as a technical term, was first introduced into China in 2009 by Xiaoguang Wang (Wang et al., 2020). In 2011, the School of Information Management at Wuhan University established the first Center for Digital Humanities in China. Digital humanities was first listed as one of the key topics of library and information science in China in the Tenth Advanced Digital Library Seminar held in 2013. Since 2015, digital humanities in China has entered a rapidly developing period and made remarkable progress. Digital humanities scholars have held various activities, established a greater number of institutes, set up associations, and offered courses in universities.

Many conferences related to digital humanities have been held, including the Language and Digital Humanities Symposium held by the College of Chinese Language and Literature of Wuhan University in 2015, and the International Symposium on Digitisation of Cultural Heritage held in Mogao Grottoes of Dunhuang in 2019. The increase in digital humanities institutes also characterises this rapid development period. Examples of such major research institutions include the Digital Humanities Research Center in Shanghai Library and the Institute of Quantitative History in Peking University. At present, digital humanities research institutions in China mainly focus on thematic projects, with historical geography, ancient books, and documents comprising the majority of projects.

In 2019, based on the philosophy of promoting academic innovation through interdisciplinary research, Tsinghua University and Zhonghua Book Company jointly sponsored *the Journal of Digital Humanities*. In 2020, the journal *Research in Digital Humanities* was launched, and the School of Information Resource Management of Renmin University established a new master's degree in digital humanities, which is the first academic master's degree programme in digital humanities in China.

At present, digital humanities has become a hot topic and trend of academic research in China. Scholars in many disciplines have stepped up their efforts in research and development of digital humanities. Library, information, archives, museums and related cultural institutions are major participants in the theory and practice of digital humanities. Related efforts include introducing foreign theories and successful cases (e.g., Shang, 2021; Shi, 2019; Su, 2020); providing status reports (Li, et al., 2019; Song and Guo, 2020); exploring the role, orientation, and function of libraries, archives, and museums (Liu, 2020; Li and Xu, 2020; Niu, et al., 2019) and discussing the disciplinary context in digital humanities (Xie, 2019; Zhou and Liu, 2019).

In the linguistics area, efforts have been made on multimodal corpus construction and statistical analysis to emphasise the feedback function of digital humanities to the humanities and to realise text mining from different perspectives (Du, et al., 2021; Guo, et al., 2019; Liu, et al., 2020; Wang and Zhang, 2020; Xu and Wang, 2021; Yang and Shang, 2019). The focus in literature is on document database construction and text mining (Bian, 2020; Fan, 2013; Wang and Graham, 2019; Xiang, et al., 2020; Yang, 2017, 2019; Zhao, 2018; Zheng and Duan, 2020). In the discipline of history, related efforts include large-scale historical materials digitisation and the advanced application of geographic information systems and spatiotemporal visualisation data (Cai, 2018; Chen, 2014; Cheng, 2021; Deng, et al., 2020; Gao, 2019; Gao and Wang, 2021; Pan, 2018, Yao, et al., 2020).

Previous efforts in assessing the status of digital humanities research

Previous researchers have tried to identify the knowledge structure of the digital humanities field by analysing its research progress and describing its future directions, lessons, and themes of earlier research and accomplishments to observe and explain the development of digital humanities and where it may lead in the future. Gaffield (2018) observed and explained the developmental course of digital humanities by using the lessons, themes and digital humanities practices in the past fifty

years and analysed the possible developmental direction in the future. Clement and Carter (2017), following a similar approach, and tried to promote a better understanding of digital humanities by examining the motivations and practices of scholars as information workers in the humanities. In China, Sun (2018) described the framework of digital humanities based on the principles of independence and relevance. The framework is composed of eleven independent but interactive layers such as network computing storage, humanistic, resource, problem and model. Liu and Ye (2017) suggested a framework to unify both the technical and theoretical cores of digital humanities.

Bibliometric approaches and tools have been commonly applied to explore and understand the development of a specific field. There have been several recent bibliometric studies that focused on revealing digital humanities research trends globally. Wang (2018) examined 803 papers of digital humanities research and identified four research topic communities world-wide: 1) library and information science for digital humanities projects, 2) digital history, 3) digital literacy, and 4) digital cultural heritage. Tang et al. (2017) focused on the intellectual distribution of digital humanities research during 1989-2014 globally. Based on keyword occurrence and their visualisation network, Li (2021) reviewed the relevant articles on international digital humanities research and identified major research topics during 2001-2020. Wang and Ye (2021) explored the interdisciplinary and knowledge diffusion of international digital humanities and found an increasingly interdisciplinary trend in this field.

These bibliometric studies of digital humanities research are based on data from the two largest citation databases, Web of Science (e.g., Li, 2021; Wang, 2018, Wang and Ye, 2021) and Scopus (e.g., Tang et al., 2017). The databases' coverage of Chinese literature is extremely limited. To the best of our knowledge, there has not been a recent bibliometric and longitudinal analysis of digital humanities literature from the China National Knowledge Infrastructure (CNKI) database. This database covers all Chinese academic journals and contains related work published in Chinese, which is not covered in the Web of Science or Scopus. It has also not been used as a data source for previous research in this area. This study will fill this gap and complement previous studies to highlight digital humanities research and development in China.

Methods

Data collection

China National Knowledge Infrastructure (CNKI) is the largest continuously and dynamically updated full-text database of Chinese academic journals. It is the most authoritative document retrieval tool and network publishing platform for Chinese academic journals, containing all the academic journals in China and all disciplines. Researchers from humanities, social, natural and application sciences use CNKI as a network publishing platform. Researchers publish their work in Chinese, but provide some bibliographic elements in English, such as article titles, keywords, abstracts, authors, institutions, and journal titles. Therefore, we can accurately obtain relevant fields when conducting a bibliometric study. This database is one of the most important sources of bibliometric information in China (Feng, 2022; Yan, et al., 2022; Yun, et al., 2022).

Because of its comprehensive coverage of China's academic journals, the CNKI database was chosen as the data source for literature related to digital humanities for this study. Although digital humanities-related efforts could be traced back and associated with early work on humanities computing, as a novel item, it has been put forward and researched for more than twenty years. Our research is more directly focused on and relevant to *digital humanities* itself. After pre-analysis and comparison, *digital humanities* (数字人文) was used as the search subject term. After excluding conference notices, journal topic selection guidelines, and literatures with little relevance to digital humanities research, 1,529 records were obtained with the earliest published in 2012. The data set was last updated on January 1, 2022. Metadata were downloaded as the basic sample for analysis.

Data analysis

To reflect the developmental trend and distribution features of digital humanities research in China, this paper analysed the research topics and distribution of journals, subject areas of the publications as indexed in CNKI, authors, and author-affiliated institutions. Three tools were used in the data analysis: Excel, Pajek, and VOSviewer that have been commonly used for bibliometric studies (Van Eck and Waltman, 2017).

Firstly, through the retrieved literature information, quantitative analysis was conducted on output trends, journals, and disciplines distributions in the digital humanities field using Excel software.

Secondly, VOSviewer was used to extract field information and calculate the occurrence frequency of terms from keywords, authors and institutions. This study also extracted the co-occurrence knowledge map of keywords and cooperation network of authors by using VOSviewer software (Van Eck and Waltman, 2009).

Finally, the co-occurrence data of keywords and authors were imported into Pajek. Using the Louvain method, we detected the community partitions, reflecting clusters of terms extracted from keywords and authors (De Meo, et al., 2011).

Results

Digital humanities research output in China

The cumulative trend of academic literatures over time can reflect the macro trend of the development of a research field. Analysing the trend is helpful to objectively understand and grasp the status of the development and to predict the future developmental trend. The trend of annual research output indexed by CNKI from 2012 to 2021 is shown in Figure 1.

The earliest relevant research included is the article, 'Librarians' Role in Digital Humanities: Reflections after the 2011 International Conference on Digital Humanities' published in 2012. Based on the annual research output, the study of digital humanities in China can be divided into two main periods: the preliminary period from 2012 to 2016, and the developmental period from 2017 to the present.

In the preliminary period, during which the concept of digital humanities had just been introduced into China, digital humanities scholarship was in its initial stages. From 2012 to 2015, the total number of publications was only fifty. Scholars mainly focused on the introduction of foreign digital humanities application project operations, cutting-edge practices, technology research, and service innovations in libraries. Since 2017, Chinese digital humanities research has entered a much more prosperous period. Led by Peking University, Tsinghua University, and Nanjing University, digital humanities seminars have been held many times around the innovative issues and application projects, intricately linking digital humanities technology with history, literature, geography, and art. Academic research in the development period has achieved great progress, with 400 papers published in 2020 and 443 in 2021.
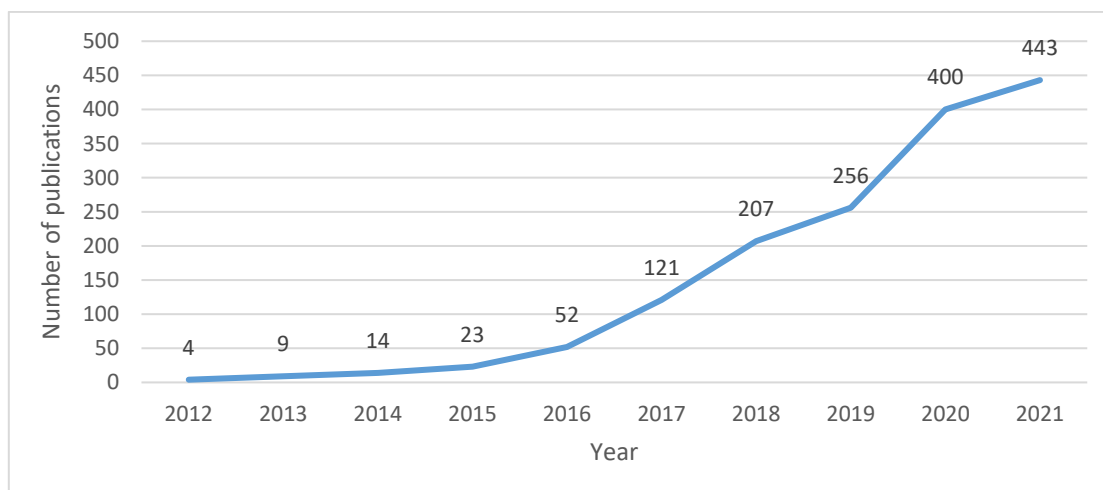
Figure 1. Number of published papers in digital humanities in China from 2012 to 2021

Typical publishing sources include journals, newspapers, masters' and doctoral theses, conferences. Journals are the main source for digital humanities literature. From 2012 to 2021, 383 different publishing sources published digital humanities-related articles.

Table 1 shows the top ten journals in digital humanities field indexed by CNKI. Although the journals publish papers in Chinese, each journal has its own official English journal title. Of the top ten most productive sources, eight journals belong to library and information science, one belongs to archives and museums science, and the other one focuses on digital humanities itself. Although digital humanities research was

also included in other fields, the number of outputs is relatively small and there is still space for development. Library and information science is the main subject category, which shows that it has an important influence in the Chinese digital humanities research field. In theory, library and information science journals focus on the roles and research progress of digital humanities in libraries, knowledge services and comparative studies at home and abroad, while in practice, they focus on the natural language processing of ancient texts, semantic knowledge organisation, linked data, visualization technology, infrastructure construction, and other topics.

Source	Subject Category	Publication Type	Output
Library Tribune (图书馆论坛)	Library and Information Science	Journal	84
Library Journal （图书馆杂志）	Library and Information Science	Journal	55
Library and Information Service （图书情报工作）	Library and Information Science	Journal	48
Digital Humanities （数字人文）	Digital Humanities	Journal	47
Shanxi Archives （山西档案）	Archives and Museums Science	Journal	40
Library （图书馆）	Library and Information Science	Journal	33
Information and Documentation Services （情报资料工作）	Library and Information Science	Journal	32
Research on Library Science （图书馆学研究）	Library and Information Science	Journal	30
Journal of Library Science in China （中国图书馆学报）	Library and Information Science	Journal	29
Journal of Academic Libraries （大学图书馆学报）	Library and Information Science	Journal	28

Table 1. Top ten active publishing sources of digital humanities research in China 2012-2021

All the content collected in CNKI is divided into ten albums: basic science; engineering science and technology I; engineering science and technology II; agricultural science and technology; medicine and health science and technology; philosophy and humanities; social science I; social science II; information technology; and economics and management science. The ten albums are further divided into 168 categories. Each paper that is indexed is assigned to one or more categories based on its content. A classification of the literature shows that the publications of digital humanities are mainly concentrated in library and information science (823 papers), computer science (434 papers), archives and museums science (225 papers) and are also distributed in higher education (70 papers), literature and art theory (69 papers), culture (56 papers), news and media (49 papers), Chinese literature (48 papers), and world literature (40 papers), as shown in Table 2. This demonstrates that the current research is concentrated in the fields of library and information science, computer science, and archives and museums science. It is also active in many other disciplines, showing the interdisciplinary characteristics of digital humanities research. It prompts current researchers and potential entrants to expand on related topics from multiple perspectives. It is demonstrated that library and information science continues to be the main component and important participation force of digital humanities research in China.

Rank	Categories	The number of occurrences	Rank	Discipline	The number of occurrences
1	Library and information science	823	11	Chinese linguistics	29
2	Computer science	434	12	Ancient Chinese history	26
3	Archives and museums science	225	13	Publishing	26
4	Higher education	70	14	History theory	25
5	Literature and art theory	69	15	Geography	19
6	Culture	56	16	Foreign linguistics	18
7	News and media	49	17	Archaeology	16
8	Chinese literature	48	18	Theatre, film and television Arts	16
9	World literature	40	19	Automation technology	15
10	Social science theory and method	39	20	Educational theory and educational administration	15

Table 2. Disciplines with at least fifteen occurrences in the sample

Research topics detected from author keywords

Keywords are the concise expression of literature content. Through the keywords co-occurrence network analysis, hot spots in a certain research field can be presented. For emerging interdisciplinary fields, co-occurrence analysis is an effective way to define the research scope, establish the research content and methods, and build the academic ecosystem within the field. Based on the perspective of keyword analysis and investigation, this paper used VOSviewer to analyse high-frequency keywords.

Table 3 lists the top thirty-eight keywords that occurred more than fifteen times. The most frequent author keywords include university libraries, libraries; digital scholarship; knowledge graph; big data; linked data; visualisation, digitisation; humanities computing; and knowledge service. It is worth noting that the keyword archives also appears as part of other ranked keywords, totalling 72 occurrences. Through the statistical analysis of keyword frequency, we can determine the distribution of hot topics and master the knowledge structure and research scale of research topics.

Rank	Keyword	Occurrences	Rank	Keyword	Occurrences
1	University libraries	123	20	Library services	22
2	Libraries	102	21	Artificial intelligence	21
3	Digital scholarship	50	22	Knowledge organisation	20
4	Knowledge graph	39	23	Social network analysis	19
5	Big data	38	24	Distant reading	19
6	Linked data	37	25	Humanities	18
7	Visualisation	34	26	Library science	18
8	Digitalisation	34	27	Research hotspot	18
9	Service mode	34	28	Digital libraries	17
10	Humanities Computing	32	29	Bibliometrics	17
11	Knowledge service	32	30	New liberal arts	17
12	Interdisciplinarity	32	31	Archives	17
13	Database	31	32	Records	17
14	Archival science	27	33	Visualisation analysis	16
15	Archives resources	24	34	Archives work	16
16	America	24	35	Resources construction	16
17	Geographic information services	23	36	Library, information and archives management	15
18	Humanists	22	37	Development and utilisation	15
19	Library And information science	22	38	Digital humanities education	15

Table 3. Top thirty-eight keywords in digital humanities research in China

We used VOSviewer to extract the keywords with a word frequency greater than five and built the keywords co-occurrence network of Chinese digital humanities research. Using the Louvain method, Pajek was used to detect the keyword co-occurrence communities, reflecting clusters of terms extracted from keywords. According to the clustering, semantic characteristics and relationships, the research hotspots can be divided into eight core topic clusters as summarised in Table 4.

Cluster	Research topics and themes	Representative terms and frequency
1	Relationship between digital humanities and library and information science	Library and information science (22); library science (18); digital library (17); library information and archives management (15); public libraries (13); smart library (11); talent training (8); librarianship (7); subject construction (7); research methods (6); subject development (6); academic community (5); researchers (5)
2	Case analysis of digital humanities in European and American libraries and its enlightenment to China	Libraries (102); humanities computing (32); America (24); digital humanities education (15); digital humanities services (12); digital humanities project (11); crowdsourcing (11); American university libraries (10); digital humanities centres (10); case analysis (9); strategy (7); enlightenment (7); citizen science (6); Brown University (5); development strategy (5); practice (5)
3	Digital scholarship services and digital humanities services in university libraries	University libraries (123); digital scholarship (50); service mode (34); library services (22); digital scholarship services (12); digital scholarship centres (12); colleges and universities (11); scientific research support (10); academic libraries (9); reading promotion (9); digital humanities librarian (8); subject service (8); librarian (7); academic publishing (5)
4	Big data and digitisation	Big data (38); digitalisation (34); database (31); digitisation of ancient books (14); digital technology (13); resource integration (12); deep learning (9); ancient literature (8); Data literacy (7); digital resources (7); ancient Chinese character information processing (6); International Image Interoperability Framework (6); open data competition (6); data service (6); data management (6); data driven (6); digital tools (5); digital history (5); information literacy (5)
5	Linked data and knowledge organisation	Linked data (37); knowledge service (32); geographic information services (23); artificial intelligence (21); knowledge organisation (20); ontology (14); metadata (13); intangible cultural heritage (12); text mining (11); special collection resources (10); data mining (8); text analysis (7); knowledge discovery (7); knowledge production (7); local chronicle (5); special resources (5); knowledge base (5)
6	Bibliometrics and knowledge graph analysis of digital humanities	Knowledge graph (39); visualisation (34); interdisciplinarity (32); social network analysis (19); research hotspot (18); bibliometrics (17); visual analysis (16); Citespace (11); hotspot (10); conference review (9); CSSCI (8); co-word analysis (6); data visualisation (6); research topics (6); text visualisation (5); knowledge diffusion (5)
7	Humanities and literary studies	Humanists (22); distant reading (19); humanities (18); new liberal arts (17); humanities research (9); world literature (7); challenge (7); literature research (7); innovation (6); digital humanities era (6); network literature (6); comparative literature (5); workshop (5); Internet (5); computational criticism (5); human vision (5); Shakespeare (5); literature (5); transformation (5)
8	Archival work and the development and utilization of archival resources	Archival science (27); archival resources (24); records (17); archives (17); archives work (16); resources construction (16); development and utilisation (15); cultural heritage (13); museum (10); archives development (9); digital memories (9); mobile visual search (9); urban memory (8); archives management (7); archival memory (6); archival resources development (6); historical archives (6); social memory (5); digital archives (5)

Table 4. Theme clusters of research topics based on author keywords

Topic 1 cluster has a theme on the relationship between digital humanities and library and information science. This cluster highlights the connections and exemplifies how library and information science contribute to digital humanities.

Topic 2 cluster focuses on case analysis of digital humanities in European and American libraries and its enlightenment to China. Digital humanities becomes a new direction of library service innovation, and it is also a hot research topic in the field of libraries in China.

Topic 3 cluster relates to digital scholarship services and digital humanities services in university libraries. Digital scholarship services and digital humanities services are important measures of service innovation in university libraries. At present, more university libraries are becoming the incubators of digital humanities projects.

Topic 4 cluster centres on big data and digitisation, and applications in China. The thinking mode of big data provides innovative ideas and methods for humanities research. Integration and fusion of digital data and computer analysis have become two important components of digital humanities studies.

Topic 5 cluster has the theme of linked data and visualization. In the past ten years, scholars have conducted fruitful research on the related data, knowledge organisation and visualisation of digital humanities.

Topic 6 cluster focuses on bibliometrics and knowledge graph analysis of digital humanities. Through bibliometrics and knowledge graphs, we can track the research hotspots of digital humanities, helping scholars grasp the trend of scientific research, mining potential research topics and forming characteristic research directions.

Topic 7 cluster relates to humanities and literary studies. Driven by digital technology, humanities and literature research presents a different development trend and has gradually become a characteristic direction in the digital humanities field.

Topic 8 cluster centres on archival work and the development and utilisation of archival theories, practices, resources for digital humanities research and development in contexts such as cultural heritage and museums.

Digital humanities research contributors and distribution features

Authors

There were 1,516 papers with author information, of which 757 papers were co-authored and 759 papers were single authored. Table 5 lists the prolific authors who have published more than twelve papers. Among the twelve most productive authors, five are from the College of Information Management, Nanjing Agricultural University; three are from the Shanghai Library; three are from the School of Economics & Management, Nanjing University of Science & Technology; and the other one is from the School of History, Nanjing University. Dongbo Wang tops this list with thirty-two papers, followed by Cuijuan Xia with twenty-three papers, Wei Liu with twenty-one papers, Tao Chen and Yuxiang Zhao with seventeen papers each, and Weidong Zhang with sixteen papers. The number of papers published by these authors is high, which is not only related to their own high academic reputation and wide influence, but also closely related to the established digital humanities research centre in each institution and the active digital humanities research initiatives.

Author	Institution	Number of papers
Wang, Dongbo	College of Information Management, Nanjing Agricultural University	32
Xia, Cuijuan	Shanghai Library	23
Liu, Wei	Shanghai Library	21
Chen, Tao	Shanghai Library	17
Zhao, Yuxiang	School of Economics & Management, Nanjing University of Science & Technology	17
Zhang, Weidong	School of Management, Jilin University	16
Xiao, Peng	School of Information Management, Sun Yat-sen University	14
Zhu, Qinghua	School of Information Management, Nanjing University	13
Huang, Shuiqing	College of Information Management, Nanjing Agricultural University	13
Li, Bin	College of Information Management, Nanjing Agricultural University	12
Xu, Xin	School of Economics & Management, East China Normal University	12
Wang, Tao	School of History, Nanjing University	12

Table 5. Authors with the greatest number of digital humanities publications from 2012 to 2021

This study extracted the author knowledge module unit in digital humanities literatures indexed by CNKI and drew the author co-occurrence knowledge map by using VOSviewer software according to the cooperation relationship. As shown in Figure 2, each node represents one author. The size of the node represents the number of collaborators of the author. The strength of the collaboration relationship between authors is defined by co-authorship frequency as expressed by the thickness of the connection between nodes. Through the co-occurrence network of authors (those that published at least five papers), nine collaboration communities were detected with six networks containing at least three co-authors being highlighted in the figure and described below.
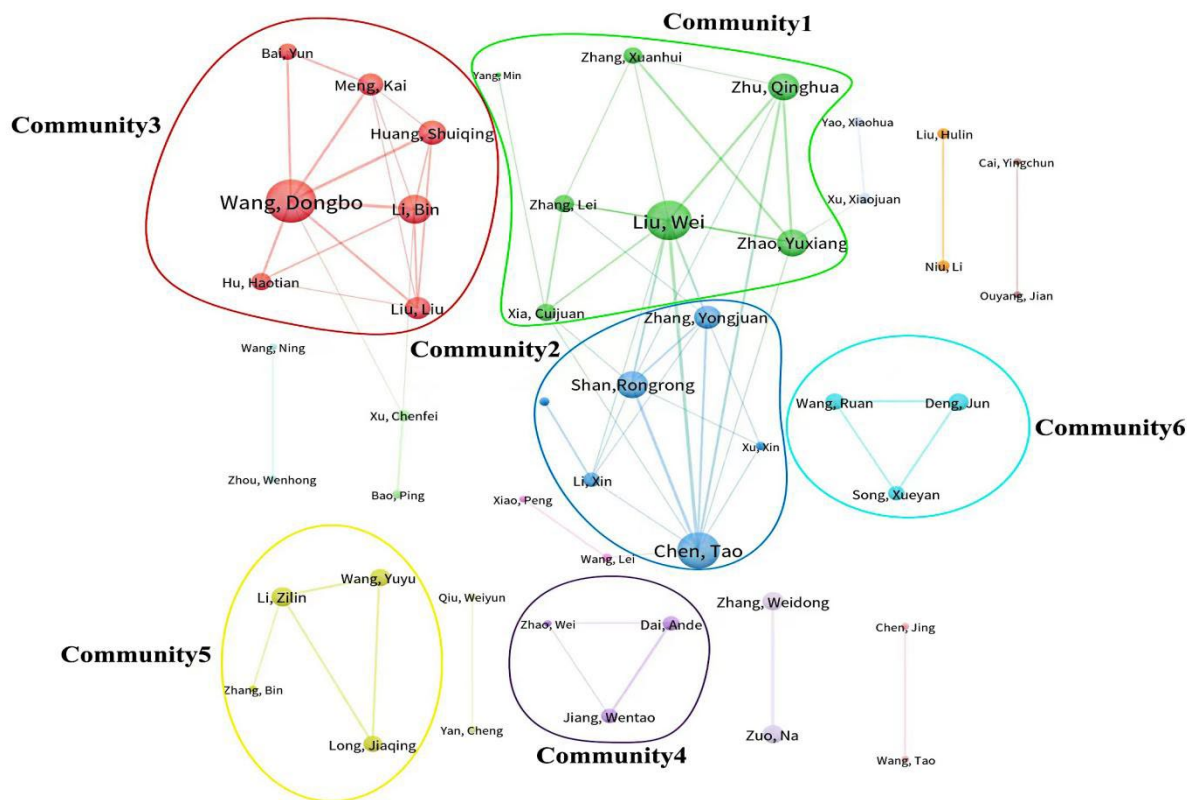
Figure 2. Collaboration network based on co-authorship

The Cuijuan Xia and Wei Liu group (community 1) has a total of seven authors. The research topics of this group include the technical system and theoretical structure of digital humanities, the national data infrastructure for humanities research, linked data, the open application of Chinese historical geographic data in library digital humanities project, digital scholarship, and public science.

The Tao Chen and Xin Xu group (community 2) has a total of six authors. Their main research topics include semantic construction of digital humanities image resources, the semantic knowledge model of bibliographic data, integration of heterogeneous special library resources, knowledge graph construction and knowledge network research of digital humanities.

The Dongbo Wang group (community 3) has a total of seven authors. Their research areas include construction and application of an entity recognition model, automatic processing of ancient Chinese characters, ancient text annotation and visualisation, classification of

pre-Qin classics questions, and automatic recognition of the basic entity component of historic events.

The Wei Zhao and Wentao Jiang group (community 4) has a total of three authors. The research topics focus on transformation of humanistic knowledge from the perspective of disciplinary history, digital humanities as a literary research method, the rise of digital humanities in literary and cultural studies, translation practice from blank verse to prose poems, and style choice and cultural strategy of prose poems.

The Zilin Li group (community 5) has a total of four authors. The research topics include application of archives in digital humanities research, the interaction between digital humanities and archives, the impact of digital humanities on China's archival field, the development of archives under the background of digital humanities, and the correlation and path of digital humanities research and archival work.

The Jun Deng group (community 6) has a total of three authors. The research topics include oral history, archives resources, knowledge organisation, knowledge association, knowledge discovery, content mining, domain ontology, spatiotemporal network structure, and celebrities' diary.

Institutions

There were 992 unique contributing institutions identified in the sample. Table 6 lists the top organisations which have published at least ten papers. Among these top contributing institutions, six are in Shanghai, five in Jiangsu province and two in Beijing. Colleges and universities and the institutions in the south accounted for a relatively high proportion.

Organisation	Region	Papers Output
School of Information Management, Nanjing University	Jiangsu	61
Shanghai Library	Shanghai	57
School of Information Management, Wuhan University	Hubei	51
School of Information Resource Management, Renmin University of China	Beijing	49
Department of Library, Information and Archives, Shanghai University	Shanghai	39
College of Information Management, Nanjing Agricultural University	Jiangsu	39
School of Management, Jilin University	Jilin	30
School of Information Management, Sun Yat-sen University	Guangdong	28
School of History and Culture, Shandong University	Shandong	21
Department of Information Management, Peking University	Beijing	17
School of Economics & Management, Nanjing University of Science & Technology	Jiangsu	16
Center for Studies of Information Resources, Wuhan University	Wuhan	15
Shanghai Jiaotong University Library	Shanghai	14
School of History and Archives, Yunnan University	Yunnan	14
East China Normal University Library	Shanghai	14
Faculty of Economics and Management, East China Normal University	Shanghai	14
School of History, Nanjing University	Jiangsu	13
School of Chinese Language and Literature, Nanjing Normal University	Jiangsu	12
Yanshan University Library	Hebei	12
Shanghai International Studies University Library	Shanghai	10
School of Public Administration, Sichuan University	Sichuan	10
School of Management, Anhui University	Anhui	10

Table 6. Institutions with the highest paper output

The School of Information Management, Nanjing University published sixty-one papers and collaborated with twenty-nine other institutions, indicting its key role and strong influence in digital humanities research and publication. The research topics of its published papers are mainly digital humanities research practice and key technologies. The main research focus is summarising and analysing digital humanities practice in European and American countries, as well as the application of text mining, semantic organisation, humanities visualisation, linked data and other technologies; these publications have played an important reference role for the development of digital humanities in China.

Shanghai Library published fifty-seven papers and collaborated with twenty-six other institutions. Since 2016, the public and

academic libraries represented by Shanghai Library have also made practical progress in the application of digital humanities. Shanghai Library tried to realise common sense popularisation and genealogy knowledge services for the public and knowledge discovery and knowledge mining services for humanities research scholars. Using modern technologies such as the semantic Web, linked data, knowledge mapping, big data, machine learning, geographic information systems, and visualisation, Shanghai Library has built a comprehensive historical humanities big data platform to support the application scenarios of different humanities research.

The School of Information Management, Wuhan University published fifty-one papers in the digital humanities field. Founded in 2011, the Centre for Digital Humanities at Wuhan University was the first centre for digital humanities in China and is one of the five founding members of the Centernet Asia-Pacific Alliance. This Centre pays special attention to the digitisation, data and semantic processing of literature and cultural heritage resources; theory, methods and technology of intelligent data; semantic publishing and linked data publishing of academic literature; and humanities and social science data resources construction.

The School of Information Resource Management, Renmin University of China published forty-nine papers in the digital humanities field and collaborated with twenty-four other institutions, indicating its key role in digital humanities publications. Renmin University of China set up a master's degree programme in digital humanities under the discipline of library, information and archives management in June 2020. In July 2020, the *Research in Digital Humanities* journal was approved to be published, making it the first official academic journal in the field of digital humanities in China.

Summary and conclusions

In this study, we set out to examine the intellectual structures, main contributors, and distribution features of digital humanities in China in its published literature. Based on research output in the CNKI database, this study analysed and revealed the status of digital humanities research in China. The findings of this study show that in the past ten years, digital humanities research has focused on three areas: library and information science (as shown in keywords co-occurrence clusters 1, 2 and 3 in Table 4), archive science (as shown in keywords co-occurrence cluster 8 in Table 4) and humanities and literary studies (as shown in keywords co-occurrence cluster 7 in Table 4). Specifically, *digital scholarship services and digital humanities services in university libraries, humanities research and literary studies and the development and utilisation of archival resources* are the core topics. In recent years, the study of digital humanities techniques and methods is being developed rapidly in China (as shown in keywords co-occurrence cluster 4, 5 and 6 in Table 4).

More specific research topics have been developed. For example, in library and digital humanities research, a research framework was formed consisting of the relationship between digital humanities and library and information science (e.g., digital library, public libraries, academic library, and smart library), case analysis of digital humanities in European and American libraries and its enlightenment to China (e.g., America, American university libraries, case study, and enlightenment) and digital humanities services in university libraries (e.g., digital scholarship, knowledge services, and resources construction). In digital humanities techniques and methods research, a research framework was formed consisting of big data and digitisation (e.g., database, digitisation of ancient books and knowledge production) and linked data and visualisation (e.g., geographic information services, social network analysis and knowledge organisation).

The results of this study show significant correlation, and the most common category is library and information science, which is the largest component with a frequency of 823, followed by computer science (434) and archives and museums science (225), as shown in Table 2. This pattern is in line with an earlier study with an international sample: Su et al. (2021) detected fifty-seven disciplines involved

in digital humanities research in the Web of Science database from 1998 to 2018 with the top three disciplines being arts and humanities, computer science, and library and information science.

This study identified the Chinese journals *Library Tribune, Library Journal, Library and Information Service* and *Shanxi Archives* as the four major publishing outlets for digital humanities, as shown in Table 1. In addition, the study identified the major contributing authors and institutions of digital humanities research, as shown in Table 5 and 6. Overall, the main and leading contributors were authors and institutions in Beijing, Jiangsu, and Shanghai. This regional distribution is related to economic development and national education levels in China.

Implications for practice and recommendations

Although digital humanities research in China started late, the research results are quite rich. The research perspective has changed from the role of libraries and infrastructure construction in the context of digital humanities to multi-dimensional research perspectives. The research scope is no longer stagnating in the comprehensive exploration of foreign digital humanities research. New research topics include geographic information services technology application, knowledge organisation, text mining, the digitisation and disclosure of special collection resources, ancient book visualization, knowledge mapping, and other technologies. By further analysing the distribution of journals, disciplines, high-frequency keywords, keyword co-occurrence communities, authors, and institutions, we can find that Chinese digital humanities research has the following characteristics:

First, the research on digital humanities is highly concentrated, especially in the field of library and information science. Among the keywords in 1,529 articles, 123 articles include *university library*, 102 include *library*, twenty-two include *library service*, eighteen include *library science* and seventeen include *digital library*. These articles mainly study the

theoretical research and practical activities of digital humanities in universities and public libraries at home and abroad. In addition, eight journals of the top ten most productive sources belong to library and information science, showing that library and information science tops the disciplines list. Many library and information science journals have set up Digital Humanities Research columns to guide scholars to pay attention to digital humanities research. For example, *Library Tribune* and *Library Journal* each have digital humanities columns.

Second, digital humanities research focuses on the application of digital humanities technology. Relevant most frequent keywords include knowledge graph, big data, linked data, visualisation, digitalisation, database, geographic information services, artificial intelligence, knowledge organisation, social network analysis, and visualisation analysis. It mainly studies the application of GIS, visualisation, linked data, knowledge graphs, and other technologies to realize the construction of structured and semantic data resources and intelligent knowledge retrieval functions, and to provide more convenient and diversified resource utilization methods for scholars.

Finally, with the application of digital humanities methods and tools, as well as the integration of library resources and digital services, China's digital humanities research has also begun to penetrate into other fields, such as higher education (seventy), literature and art theory (sixty-nine), culture (fifty-six), news and media (forty-nine), Chinese literature (forty-eight), Chinese linguistics (twenty-nine), ancient Chinese history (twenty-six), and theatre, film and television arts (sixteen). With the proposal of new liberal arts and the construction of digital humanities systems, Chinese digital humanities research has gradually extended to digital humanities education systems.

In view of the characteristics of digital humanities research in China, some recommendations are made for future research and practice.

First, continue to strengthen library and information science's support for digital humanities. This field has the resources, technology, and space advantages necessary for digital humanities, and has become an indispensable supporting force for digital humanities research. Therefore, Chinese libraries, museums and archives need to give full play to their advantages in the field of digital humanities, take the initiative to participate in the practice of digital humanities-related projects, build basic platforms, and accelerate the exploration of corresponding theories and methods of digital humanities.

Second, continue to innovate at the technological and methodological level. Technological progress is the most important internal driving force of digital humanities, including big data, digitisation, resource integration, linked data, geographic information systems, artificial intelligence, knowledge organisation and other data analysis technologies. In China, more specific applied research is conducted at the practical level: most of the research focuses on the application of existing digital technologies and lacks more tools and methods suitable for humanities research from the developmental level. We need to continue to innovate at the technical and methodological levels, establish more effective education and training systems,

attract more humanities scholars to participate in a wider range of fields, and change the current situation of *fighting alone* in the field of library and information science.

Finally, continue to deepen interdisciplinary collaboration. Humanities is the centre of digital humanities. Without humanities, digital humanities research will lose its value. Therefore, the research and practice of digital humanities need to focus on solving the problems encountered by humanities scholars in the digital age. Following the interdisciplinary characteristics of digital humanities, researchers in the field of computer science can customize tools and software according to humanists' research needs, guide humanists to use them and make suggestions; libraries can popularize databases, data sets, and digital tools commonly used in the field of humanities to humanities scholars. Digital humanities should go deeper into more disciplines, such as humanities, arts, social sciences, geography, medicine, and other disciplines. Cooperation within one institution or one region is the most common form of collaboration now. As a multidisciplinary field, scientific research results can be better promoted through cross-institutional cooperation. In the future, cooperation between different institutions and different regions should be strengthened.

About the authors

Fangli Su is a Professor in the School of Information Management at Zhengzhou University of Aeronautics, China. She holds a Ph.D. in Informatics from Nanjing University, China. Her primary research areas are digital humanities, bibliometrics, and text mining. She can be reached at suli_2000@163.com

Shihao Li is a graduate student in the School of Information Management, Zhengzhou University of Aeronautics, China. He received his master's degree in 2023. His research focuses on policy analysis and digital humanities. He can be reached at lishihao1325@163.com

Qinghua Liu is a graduate student in the School of Information Management, Zhengzhou University of Aeronautics, China. She received her master's degree in 2023. Her research focuses on digital humanities. She can be reached at 934510979@qq.com

Yin Zhang is a Professor at the School of Information at Kent State University. She received her Ph.D. in Library and Information Science from University of Illinois at Urbana-Champaign. Her research areas include human information behaviour, scholarly communication, data science, informetrics, and scientometrics. She can be reached at yzhang4@kent.edu

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