Research Progress and Future Trends of Intelligence Studies in China over the Past Two Decades: A Case Study of Articles Published in *Advances in Intelligence Studies* (Postprint)

Authors: Aftermath, Guo Lei, Wen Liangming, Zhang Yanyan, Li Yang

Date: 2023-08-27T00:00:00+00:00

Abstract

[Purpose/Significance] Reviewing and summarizing the historical development of China's information science over the past two decades is of great significance for understanding its developmental trajectory, and can provide reference and guidance for subsequent research in information science. [Method/Process] Taking the articles published in volumes 1-11 of *Advances in Information Science* as the research object, this study employs content analysis to summarize the research topics, themes, and characteristics of each topic; on this basis, it predicts the development trends of China's information science in three aspects—theoretical research, paradigm methods, and applied practice—within a certain future development cycle. [Results/Conclusion] The analysis reveals that basic theories of information science, information resources and their management, and emerging information technologies are the main research topics of the articles published in *Advances in Information Science*, with each topic exhibiting distinct characteristics. In the future, intelligent information science will integrate multiple disciplines, be oriented towards scientific discovery, serve national economic construction and defense security, and provide intellectual support for the construction of new-type national think tanks.

Full Text

Research Progress and Future Trends of Information Science in China Over the Past 20 Years: Taking *Advances in Information Science* as an Example

Yu Bo[1], Guo Lei[1], Wen Liangming[2],[3], Zhang Yanyan[4], Li Yang[5]

[1]School of Economics and Management, Southwest University of Science and Technology, Mianyang 621010
[2]Computer Network Information Center, Chinese Academy of Sciences, Beijing 100190
[3]University of Chinese Academy of Sciences, Beijing 100049
[4]Library of China Aerodynamics Research and Development Center, Mianyang 621000
[5]Library of Chengdu Sport Institute, Chengdu 610041

Abstract

[**Purpose/Significance**] Reviewing and summarizing the historical trajectory of information science in China over the past two decades holds significant importance for understanding the discipline's developmental path and can provide references and guidance for subsequent research. [**Method/Process**] This study examines articles published in volumes 1-11 of *Advances in Information Science*, employing content analysis to categorize article topics and themes while summarizing the characteristics of each topic. Based on this analysis, the paper predicts future development trends of China's information science in three dimensions: theoretical research, paradigm methods, and practical applications. [**Result/Conclusion**] The analysis reveals that foundational theories of information science, information resources and their management, and emerging information technologies constitute the main topics in *Advances in Information Science*, with each topic demonstrating distinct characteristics. In the future, intelligent information science will integrate multiple disciplines, orient toward scientific discovery, serve national economic construction and defense security, and provide intellectual support for building new types of national think tanks.

Keywords: information science; *Advances in Information Science*; intelligence; scientific discovery; national defense security; think tank

Classification Number: G359.21

DOI: 10.13266/j.issn.0252-3116.2018.21.016

Introduction

In 1945, American scholar Vannevar Bush published "As We May Think" in *The Atlantic Monthly*, a work that has exerted lasting influence on the development of information science and technology. Numerous experts consider this article the true birthmark of information science [1]. Since its inception, information science has experienced a history of just over 70 years, making it a relatively young discipline. However, youth does not imply slow growth. Emerging scientific technologies and analytical tools have provided wings for the development of information science, endowing it with new concepts, ideas, and contexts [2]. Against this backdrop, scholarly debates and academic activities have flourished, frequently appearing in review literature of information science, with *Advances in Information Science* serving as a platform for these publications.

Advances in Information Science is a biennial review-type serial publication on information science and information technology application research, compiled under the auspices of the China Defense Science and Technology Information Association. The editorial board invites domestic and foreign experts to contribute articles, most of which are mature reviews or commentaries that focus on evaluating developments in specific fields over the previous two years. Since its first publication in 1995, *Advances in Information Science* has maintained characteristics of being foundational, authoritative, practical, cutting-edge, and forward-looking, earning widespread acclaim among Chinese library and information science professionals [3]. By 2016, the publication had released 11 volumes spanning more than two decades—a crucial period of transformation and development for Chinese information science. Studying the articles published during this stage provides concrete insights into the developmental trajectory of Chinese information science over the past 20 years and helps identify research hotspots and predict future directions.

1. Related Research on *Advances in Information Science*

Through a joint search of CNKI and Wanfang Data using the keyword "*Advances in Information Science*," we identified 10 relevant articles, including 7 single-volume commentaries and 3 multi-volume analyses spanning 1996-2017.

1.1 Single-Volume Commentaries on *Advances in Information Science*

Single-volume commentaries primarily introduce the characteristics of individual volumes without discussing the development and trends of information science as a whole. Notably, commentaries on volumes 5, 6, 8, and 9 are missing, which represents a significant gap. Wang Yiming [4] was among the earliest researchers on *Advances in Information Science*, viewing the birth of volume 1 as a sign of the discipline's maturity. Liu Li [5] considered volume 2 a continuation of the first volume's success, noting its novel content, prominent hot topics, integration of Chinese and foreign comparative research, and strong tertiary literature functions. Ma Haiqun and Qiu Junping [6] observed that volume 3 featured innovative approaches, highlighted key issues, covered extensive and specialized topics, strengthened applied research, and maintained a stable author team, demonstrating new progress in Chinese information science at the turn of the century. Qiu Junping and Hou Jingchuan [7] believed that volume 4 summarized the impact of the network information revolution on information science, ushering readers into the network era. Wang Zhijin and Fan Zhenjia [8] described volume 7 as closely tracking theoretical and methodological advances, timely 梳理 ing the development of information technology and services, and consistently grasping the latest trends in disciplinary research, making it both a feast for information science study and a navigational beacon for the discipline's development. Wang Zhijin and Zhu Hui [9] summarized the numerous strengths of volume 10, concluding that after two decades and ten volumes, *Advances in Information Science* had become a banner in China's information

science community. When volume 11 was published, Hu Changping and Xu Yilei [10] noted its international perspective, particularly highlighting articles on information ecology theory, new thinking on information services in the big data context, and information service organization and quality evaluation in open access environments.

1.2 Multi-Volume Analyses of *Advances in Information Science*

Multi-volume commentaries provide overviews of approximately 10-year periods. Li Jian and Han Yi [11] analyzed volumes 1-5 from the perspectives of topic orientation and authorship, offering insights into development directions. Huang Guowei [12] employed bibliometric methods to analyze volumes 1-5, incorporating citation data and providing brief commentary on volume 5. Leng Fuhai and Yu Weiwei [13] expanded the scope internationally, comparing articles from *Annual Review of Information Science and Technology* (ARIST) during 2002-2011 with those from volumes 5-9 of *Advances in Information Science*, presenting research dynamics from both foreign and domestic perspectives. These three multi-volume studies collectively span 18 years, offering readers a clear understanding of Chinese information science development during this period.

Overall, existing research on *Advances in Information Science* remains limited in quantity, lacking both commentary on some individual volumes and comprehensive comparisons across all published volumes. Therefore, systematic comparative analysis across different volumes is necessary and significant for understanding the discipline's development.

2. Research Topics in *Advances in Information Science*

2.1 Topic Distribution of Published Articles

Article titles provide highly condensed representations of content and directly reflect themes. We first categorized articles based on their titles, then read each article thoroughly to extract primary keywords. Combining titles and keywords, we narrowed down broad categories and invited two professors in the field to review the classification. For articles with inconsistent classifications, we conducted further discussions and reached consensus on a primary topic category for each article. For hybrid-topic articles, we used keyword frequency as the classification criterion. For instance, Professor Li Yuelin's article "Research Progress on Information Services in Mobile Technology Application Fields" in volume 11 could be classified under either "user information behavior" or "information services." After thorough reading, we determined "information services" as the primary topic due to more frequent related terminology. Drawing on existing research and our actual circumstances, we categorized 108 articles into 15 major topics, with detailed distribution shown in Table 1 .

Table 1 reveals that the main topics include foundational theories of information science, information resources and their management, information organization

and retrieval, and emerging information technologies, each with 10 or more articles. Additionally, information services, information dissemination and communication, information analysis and forecasting, information systems, user information behavior, knowledge management, and information discipline clusters have also become popular topics among authors.

2.2 Topic Categorization

Drawing on classification frameworks by Jing Jipeng et al. [14], Zhu Qing et al. [15], and Xiao Yong [16], we merged the 15 topics into three major themes: information science theory, information science methods and technology, and information science application and innovative practice.

2.2.1 Information Science Theory Theme This theme encompasses six topics: foundational theories of information science, information resources and their management, information organization and retrieval, information discipline clusters, knowledge organization and management, and information science education. Secondary topics include: (1) theoretical research on information science, development trends, information architecture, and Qian Xuesen's thoughts on scientific and technical intelligence; (2) concepts of information resources, information resource construction, intellectual property protection, CIO, and information management and quality evaluation; (3) information retrieval theory, information retrieval technology, and information organization technology; (4) information economics, social informatics, information law, informatics discipline clusters, and information ecology; (5) professional education, graduate education, and current status of information science education; and (6) knowledge organization and management, knowledge management science, knowledge maps and knowledge graphs, and knowledge sharing.

This theme comprises 52 articles (49.14% of the total), indicating that theoretical articles constitute the primary focus of *Advances in Information Science*. As the publication mainly carries reviews and commentaries on extensive original literature published within specific periods, these tertiary documents contain substantial information content, with writing methods and approaches that reflect the development of information science theory and practice.

2.2.2 Information Science Methods and Technology Theme This theme includes four topics: emerging information technology, intelligence analysis and processing, informetrics, and databases and information systems. Secondary topics cover: (1) multimedia technology, computer communication technology, intelligent information processing, information visualization, and big data technology; (2) intelligence research methods, content analysis, literature knowledge mining, text information analysis, patent intelligence analysis, and social public opinion analysis; (3) bibliometrics, Bradford's Law, webometrics, Lotka's Law, and altmetrics; and (4) database technology,

digital libraries, metadata registration systems, and semantic web classification systems.

This theme involves 28 articles (25.93% of the total), demonstrating that research methods and technologies have become a major focus. Technological transformations have changed information carriers, existence forms, transmission modes, and organization forms, making information technology itself a research object in information science.

2.2.3 Information Science Application and Innovative Practice Theme
This theme includes five topics: information services, information dissemination and communication, information forecasting and strategy, user information behavior, and information markets and industries. Secondary topics encompass: (1) information service industry, information service technology, knowledge services, information service evaluation, and personalized information services; (2) electronic publications, scientific information communication, information release patterns, knowledge networks, open access, and social networks; (3) think tanks, competitive intelligence, patent technology analysis, and science and technology policy research; (4) information seeking and searching behavior; and (5) global information markets and information industry development.

This theme also comprises 28 articles (25.93% of the total). Information practice serves as the touchstone for testing theories and methods. As research scope expands, methods innovate, and analytical techniques improve, scholars continuously contemplate optimizing information/intelligence dissemination content and methods, analyzing and predicting user behaviors, and providing personalized, targeted services.

2.3 Analysis of Topic Characteristics

2.3.1 Multi-Perspective Theoretical Research For any discipline, foundational theory serves as its cornerstone. The establishment and maturation of disciplinary theory signify the discipline's establishment and maturity, determining the direction of disciplinary system construction and future development trends. Discussions on information science theory in *Advances in Information Science* have continuously expanded with disciplinary development, encompassing both comprehensive studies [17-19] and specialized research on disciplinary nomenclature [20], research paradigms [21], cognitive perspectives [22], research trends [23], and disciplinary integration and development [24-26], as well as studies on information architecture [27]. On the 100th anniversary of Qian Xuesen's birth, the China Defense Science and Technology Information Center published a special article on his thoughts on scientific and technical intelligence [28]. These theoretical discussions address fundamental questions about information science—its origins, nature, research content, and methodologies—demonstrating broad research perspectives. Theory guides practice, and only through thorough theoretical research can information science effectively serve practical applications. The existence of numerous theoretical debates also indi-

cates that information science remains a relatively young discipline with theoretical systems requiring continuous improvement.

2.3.2 Information Organization and Retrieval Relying on New Technologies When text, images, and audio are stored in digital formats, traditional manual methods can no longer effectively organize and retrieve digital information. Employing emerging technologies to extend our functional capabilities and assist in organizing and retrieving massive information has become essential. Articles on information organization and retrieval primarily discuss technology and method applications [29], initially focusing on information retrieval theory [30]. With the emergence of database technology [31] and digital libraries [32-33], scholars explored using metadata [34], XML [35], and standard protocols [36] for information organization [37] and retrieval [38]. During this period, information retrieval focus shifted from external forms to intrinsic content features, as evidenced by research on language-based retrieval [39-40] and task-based retrieval [41]. With digital libraries, digital resource collection, organization, storage, and retrieval have become systematic knowledge-based virtual entities, with computer and network technologies ensuring their viability and demonstrating powerful vitality in the digital age.

2.3.3 Personalized Information Services Information services represent a pathway for information value-added, providing valuable information to users through systematic processing of scattered information across various carriers. With the advent of the electronic information age, user information needs, service content, and delivery methods have all changed. Authors in *Advances in Information Science* have kept pace with electronic information [42] and broadband [43] developments, closely monitoring the development status of the information service industry [44-45] and contemplating service innovation [46]. Addressing information needs in network-based scientific information services [47] and mobile technology application fields [48], they have employed information filtering, security, and intelligent agent technologies [49] to provide personalized information services and construct comprehensive evaluation systems [50]. As a supplement and extension to information services, knowledge services have emerged to address limitations of existing service models [51]. It is foreseeable that information science in the digital age will evolve from information services to knowledge services with greater emphasis on personalization, though balancing standardization and personalization remains crucial [52].

2.3.4 Emphasis on Informetrics Theory and Methods Since the 1960s, three similar metrological sub-disciplines have emerged in informetrics: bibliometrics, informetrics, and scientometrics, collectively known as the "Three Metrics." Their development represents an important choice for the quantitative development of information science research. Informetrics-related topics in *Advances in Information Science* primarily discuss the progress and development trends of bibliometrics [53-54], with two articles specifically focusing on Brad-

ford's Law [55] and Lotka's Law [56]. In the 1990s, webometrics (using network information as measurement objects) and knowledge metrics (using knowledge units as measurement objects) emerged, forming the "Five Metrics" alongside the original three [57]. To address limitations of traditional citation-based evaluation, J. Priem innovatively proposed "Altmetrics" in 2010, translated in China as "supplementary metrics," "alternative metrics," or "selective metrics." Altmetrics focuses on online novel measurement indicators, particularly those based on social network data, and can be considered an upgraded version of webometrics in the Web 2.0 environment [58]. As a new concept, Altmetrics still faces considerable controversy regarding indicator selection. Overall, informetrics research focuses on foundational theories or employs metrological methods to study disciplinary development [59], though these articles rarely demonstrate practical applications through case studies. Notably, nearly half of the articles in *Advances in Information Science* implicitly use informetrics methods or thinking, which itself constitutes a form of application.

2.3.5 Information Technology Research Following Scientific Hotspots The importance of modern information technology to intelligence work has become increasingly evident, accelerating disciplinary transformation, expanding the spatial-temporal structure of intelligence service institutions, changing service models, enhancing professional competence, and promoting modernization. *Advances in Information Science* features substantial research on information technology: volume 1 covered multimedia technology [60], electronic publications [61], optical disc technology [62], and computer communication technology [63]; volume 2 addressed multimedia and hypertext technology [64]; volume 5 discussed intelligent processing [65]; volume 6 covered semantic web [66] and information visualization [67]; volume 7 explored knowledge networks [68]; volume 9 examined cloud computing [69]; and volumes 10-11 focused on big data technology [70-71]. Each volume addressed contemporary scientific hotspots—for instance, intelligent processing technology mentioned in volume 5 remains a current hot topic—demonstrating authors' accurate grasp and prediction of technological trends. These emerging technologies have been widely applied in information resource retrieval [72-73], preservation [74], dissemination and communication [75-77], construction [78-79], and management [80].

2.3.6 Transition from Information Resource Management to Knowledge Management As information has become one of the three "social pillars" alongside materials and energy, "information resource-based" management has marked a new stage in human information management activities. Articles on information resource management in *Advances in Information Science* primarily address information resources and their management [81-83] and information quality assessment [84-85]. After W.R. Synnott and W.H. Gruber proposed the CIO (Chief Information Officer) concept in 1981 [86], CIO gradually entered researchers' vision [87]. In 1985, M.L. Blake provided a list of information science knowledge subjects, including intelligence work and profes-

sion, information science theory, information science methods, and information technology [88], demonstrating that professional information management talents represented by CIO or CKO (Chief Knowledge Officer) have become indispensable components of enterprises or government functions. When information management activities reached a certain stage, users' information needs shifted from simple data to knowledge or wisdom supporting decision-making. Information management could no longer manage tacit knowledge or capitalize on knowledge resources for value-added operations, leading to the emergence of knowledge management. Beyond one article specifically reviewing knowledge management progress [89], other related topics closely integrated contemporary characteristics, such as comprehensive studies on knowledge organization and management [90], intellectual property protection in network environments [91], knowledge organization in E-knowledge environments [92], knowledge sharing support for scientific and technical information work [93], and knowledge maps and knowledge graphs [94]. As the strategic value of knowledge increases, information resource management is transitioning toward knowledge management, accompanied by a new research paradigm—the IRM-KM paradigm [95].

2.3.7 Emphasis on Information Science Education Professional education and talent cultivation constitute important components of information science development. Chinese information science education has experienced five periods: recovery (June 1978-August 1983), development (April 1983-July 1992), hesitation (March 1992-June 1998), adjustment (July 1998-October 2003), and improvement (November 2003-present) [96], gradually forming a professional education system primarily based on three-degree education (bachelor-master-doctor) supplemented by continuing education, basically meeting societal demands for information science professionals. *Advances in Information Science* includes three articles on education: in 1997, Jing Jipeng et al. systematically reviewed research on training objectives, models, discipline cluster construction, and curriculum design [97]; in 2009, Wang Zhijin's team identified problems in Chinese information science education and proposed development strategies by referencing international trends [98]; and in 2015, Zhao Rongying's team presented a comprehensive analysis from historical, current status, and enrollment distribution perspectives [99]. Scholars such as Yan Yimin [100], Wu Cici [101], Sun Jianjun [102], Ye Jiyuan [103], Qiu Junping [104], and Xiao Ximing [105] have continuously explored development paths for Chinese information science education from various perspectives, gradually narrowing the gap with international standards and producing internationally renowned schools like Wuhan University's School of Information Management.

2.3.8 Expanding Interdisciplinary Clusters Interdisciplinary research represents a new model for scientific exploration, with single-discipline research gradually shifting toward interdisciplinary integration—a notable characteristic of contemporary disciplinary development. Information science has continuously absorbed and transplanted theories and methods from other disciplines,

forming complex interdisciplinary relationships with many discipline clusters. *Advances in Information Science* features terms such as information economics [106], social informatics [107], information law [108], and information ecology [109], spanning social and natural sciences. Additionally, Professor Yu Liangzhi introduced Community Informatics to address low-efficiency issues in China's community/rural informatization [110]. These terms reflect the cross-integration between information science and economics, sociology, law, ecology, and other disciplines, demonstrating broad applicability and strong permeability. Interdisciplinary approaches have not only revitalized information science but also provided excellent opportunities for its development. The discipline must therefore focus on both internal development and inter-cluster integration. With emerging fields demanding involvement from information science clusters, this expansion is a continuous process without end, with research depth constantly deepening and clusters moving toward integration through differentiation.

2.3.9 Information Analysis Serving Enterprise Competition and Government Decision-Making Information analysis relies on users' information needs, employing qualitative and quantitative methods to collect, organize, authenticate, evaluate, analyze, and synthesize information, creating new value-added information products that provide deep intellectual support for decision-making. Through information analysis, the structure and function of information change, transforming into knowledge describing general patterns, with knowledge and social dynamic information becoming higher-level intelligence after activation and absorption. Beyond discussing methods [111-112] and technologies [113-114] of information analysis, *Advances in Information Science* includes multiple articles exploring applications in think tank construction [115], competitive intelligence [116-118], technology forecasting [119], science and technology policy research [120], patent analysis [121], and social public opinion [122]. These analyses demonstrate that information analysis methods have gradually shifted from theoretical research such as text analysis and content analysis toward social practice, with researchers focusing on serving enterprise competition and national policy formulation. In the future, establishment of computer intelligent analysis models will place higher demands on intelligence professionals, with traditional manual analysis inevitably being replaced by intelligent analysis.

3. Future Development Trends of Information Science in China

On October 29, 2017, the "Forum on the Development of Information Science and Intelligence Work (2017)" was held in Nanjing, where over 100 experts reached the following consensus [123]: redefining development goals for information science, 重新认识 ing the nature and role of intelligence work, redesigning information science curricula, 重新认识 ing the importance of theoretical methods

and technologies, and 重新认识 ing intelligence capabilities. The "Nanjing Consensus" points the way forward for China's information science and intelligence work in the new era. Based on the topic characteristics of *Advances in Information Science* and relevant viewpoints from the "Nanjing Consensus," this paper predicts future development trends along the "theory-technology-application" 主线.

3.1 Theoretical Research Aspects

3.1.1 Deepening Disciplinary Cluster Integration For an extended period, Chinese information science primarily focused on documentary intelligence, belonging to the humanities tradition of Information Science, with research scope mainly addressing human literature needs and services. With the development of information network technology, information science-related technologies have also become research objects, belonging to the technical tradition of Information Science, with research scope primarily within machine systems. These two traditions are parallel yet functionally complementary. Informatics absorbs user service needs and outcomes from the humanities tradition and information technology achievements from the technical tradition [124]. Currently, Informatics comprises three sub-clusters: (1) Natural Informatics, applying information technology to natural sciences to enhance human capacity to understand and transform nature, including bioinformatics, cheminformatics, environmental informatics, geoinformatics, and ecological informatics; (2) Social Informatics, applying information technology to social sciences to examine both information's impact on society and social constraints on information, including political informatics, community informatics, social informatics, and legal informatics; and (3) Humanities Informatics, using information technology to describe human cultural practices and help transform spiritual realms, including educational informatics and music informatics. These sub-clusters constitute the disciplinary structure of Informatics: basic disciplines providing principles and theories, supporting disciplines offering methods and technologies, and applied disciplines providing domain knowledge. With the deepening popularization of the iSchool movement, information discipline clusters will continuously integrate internally, forging a path with Chinese characteristics under innovation-driven strategies and national security concepts.

3.1.2 Necessity of Establishing Information Science as a First-Level Discipline Since the late 1970s, information science has developed as an independent discipline in China, though some scholars argue it has lost meaning as an independent discipline and should be merged with others. In response to Bao Changhuo's initiative to "establish information science as a first-level discipline," the *Journal of Intelligence* organized a focus forum where scholars generally agreed that establishing information science as a first-level discipline is necessary and logical for disciplinary development [125]. Huang Changzhu raised several issues that information science might face as an independent first-level discipline [126]; Yuan Qinjian argued that separating information science

from the original "Library, Information, and Archives Management" first-level discipline to form new first-level disciplines would help establish a "Grand Information Science" perspective domestically and clarify disciplinary boundaries and development directions [127]. Thus, constructing a grand intelligence science integrating scientific intelligence, social science intelligence, security intelligence, and military intelligence is necessary—not only for teaching and research needs but also for building a "national intelligence think tank" with Chinese characteristics. We must accurately grasp the discipline's nature, definition, and boundaries, establishing confidence in disciplinary systems, problem-solving capabilities, theoretical method applications, and talent cultivation [128].

It is important to clarify the relationship between "deepening disciplinary cluster integration" and "establishing a first-level discipline." Disciplinary integration emphasizes borrowing—information science draws on theories, methods, and technologies from other disciplines to develop itself, but must maintain its disciplinary 内涵 and independence. Establishing a first-level discipline emphasizes independence, separating information science from "Library, Information, and Archives Management" and subsuming military intelligence, public security intelligence, and medical intelligence as second-level disciplines. These second-level disciplines also exhibit interdisciplinary characteristics, so no contradiction exists between these two directions.

3.2 Paradigm and Methodology Aspects

3.2.1 Research Paradigms Oriented Toward Scientific Discovery Thomas Kuhn first proposed using paradigms to explain the historical evolution of scientific knowledge in his classic *The Structure of Scientific Revolutions* [129]. Dominant research paradigms have evolved through experimental science (first paradigm), theoretical science (second paradigm), and computational science (third paradigm). In the new scientific development stage, scientists have produced massive scientific data from various facilities and activities, using data not only to monitor and analyze scientific problems but also as research objects themselves. Data has become the foundation of scientific research, with researchers focusing on how to use ubiquitous networks and massive data to construct data-driven research models. Consequently, the data-intensive scientific discovery paradigm has emerged as a new research paradigm—the fourth paradigm—characterized by big data-driven approaches and "cloud services" as means [130]. As a new approach to changing human life and understanding the world, big data has become a new engine for scientific discovery and knowledge innovation. Guo Huadong noted at the 2014 International Conference on Big Data and Scientific Discovery that humanity has entered the "big data + big science = big discovery" era [131]. He Defang also proposed a comprehensive research method of "factual database + tools and methods + expert wisdom," which organizes research teams around specific problems to conduct in-depth analysis of factual data using systematic integration methods, discovering patterns and 提炼 ing policy

recommendations through expert wisdom [132]. Therefore, future information science research must break data barriers and limitations, correctly utilizing both self-generated and externally sourced massive relevant data. Blockchain technology, with characteristics of decentralization, collective maintenance, privacy protection, and immutability, provides solutions for data/information sharing and dissemination, with scholars already exploring its applications in library and information science.

3.2.2 Intelligent Research Methods Research methods constitute the pathway for information science research, with methodology construction laying the foundation for disciplinary development. Methodological support enables intelligence research to avoid detours and demonstrates strong viability and competitiveness [133]. Traditional information science research methods were primarily literature-based, data-based, organization-based, expert-based, and cognition-based. In the big data environment, information science orientation has shifted toward exploring information space-time structures and other foundational research and applications, focusing more on discovering patterns and evolving from static knowledge organization to user cognition-based interactive behavior, and from process-oriented information resource management to knowledge and intelligence-centered research. Between 2010-2015, several renowned American universities, research institutions, and information companies launched intelligent learning systems or research programs, such as Carnegie Mellon University's "Never-Ending Language Learner," DARPA's "Foresight and Understanding from Scientific Exposition" and "Crowdsourcing Evidence, Argumentation, Thinking and Evaluation" programs, and Google's Knowledge Vault. These projects aim to automatically collect network information, help intelligence professionals discover potentially valuable information through intelligent analysis, transform information into usable knowledge via machine learning, achieve automatic judgment of knowledge credibility, and develop new human collective intelligence analysis platforms to identify potentially disruptive technologies and predict their development trends. Therefore, future information science research should not only borrow theories and methods from other disciplines but also actively apply and adapt its own methods to other disciplines to expand its influence. Artificial intelligence, machine learning, and deep learning provide 借鉴 able research methods, with future research oriented toward statistics, mining, discovery, forecasting, and integration, combining quantitative and qualitative methods and employing fuzzy sets, rough sets, neural networks, and other information technologies to enhance the precision and efficiency of information analysis [134].

3.3 Application and Practice Aspects

3.3.1 Serving National Economy and Supporting Defense Security Current domestic and international situations are increasingly complex, with national economic development and security governance entering a critical period of comprehensive reform. This requires information science and intelligence

work to align the "soul" of intelligence with national innovation development strategies and security needs. The 13th Five-Year Plan mentions the "Belt and Road" initiative, targeted poverty alleviation, and national defense and military construction [135], providing opportunities for information science to contribute in several ways: (1) For the "Belt and Road" initiative, information science can support database construction and strategic information resource development. Peking University's "Belt and Road" data analysis platform serves as a data, information, and intelligence center for countries along the route, effectively supporting trade and government decision-making. (2) For targeted poverty alleviation, information science thinking, technologies, and methods can be applied to precise identification, assistance, and exit. Poverty alleviation departments can use networked data to analyze farmers' economic income, consumption behavior, and health status to accurately identify poor households; assistance departments can formulate personalized poverty alleviation plans based on causes of poverty, providing various information services; and evaluation can confirm whether exit criteria have been met. (3) For national security and military construction, the National Intelligence Law enacted on June 27, 2017, stipulates that national intelligence work provides intelligence references for major national decisions and supports preventing and resolving national security risks [136], demonstrating information science's role in decision support. The military parade on July 30, 2017, for the 90th anniversary of the People's Liberation Army featured information warfare groups, showing how information technology-enabled intelligence work provides intellectual support and technical assurance for national security risk decision-making and defense informatization.

3.3.2 Supporting Construction of New-Type National Think Tanks

The policy consultation system constitutes an important component of China's democratic political construction, with the Party consistently emphasizing decision-making consultation. Reports from the 14th to 19th Party Congresses have proposed giving full play to experts and research institutions, gradually forming decision-making mechanisms that broadly concentrate public wisdom, reforming and improving decision-making mechanisms, perfecting information and intellectual support systems, and strengthening new-type think tank construction with Chinese characteristics. The "Opinions on Strengthening the Construction of New-Type Think Tanks with Chinese Characteristics" issued on January 20, 2015, states that such think tanks should possess "fully functional information collection and analysis systems" [137]. Thus, tapping national intellectual resources to support think tank construction and serve national policies represents a new direction for intelligence institutions. Both intelligence research and think tank research serve as "eyes, ears, vanguards, and staff officers" for specific audiences, emphasizing evidence-based analysis—advantages that give intelligence institutions unique strengths in think tank research. Intelligence research can be considered a type, component, and method of think tank research. Effective think tank research must 借鉴 intelligence research approaches, emphasizing both data and facts through

collection, analysis, and quantification for policy analysis and consultation.

Traditional information/intelligence service institutions must clearly understand information science's important role in leading scientific progress, promoting social development, and safeguarding national security, actively constructing information resource guarantee systems oriented toward major decisions and striving to cultivate intelligence institutions into important think tanks for national development and security. Moreover, think tank intelligence functions consist of several core components requiring coordinated organization. Institutionalizing think tank intelligence processes enables continuous provision of high-quality intelligence products through rapid information network response capabilities. Therefore, think tank research and construction should be guided by information science theories and methods against national development and security needs, supported by advanced technologies and analytical tools, strengthening multi-source data mining and application, and completing intelligence work 全流程 using engineering models [138]. Li Yang et al. proposed an "engineering perspective-based think tank intelligence function model" that integrates information collection, knowledge innovation, and intelligence decision-making into think tank capability systems, with information chains, knowledge-wisdom chains, and intelligence-countermeasure chains jointly acting on business and information flows representing intelligence needs to form a complete think tank product production line [139].

Conclusion

Advances in Information Science represents an excellent publication gathering the wisdom of Chinese information science scholars, receiving continuous attention since its inception. Many scholars' latest research 成果 have been introduced to readers through this platform, with numerous experts contributing commentaries. This paper analyzes articles from volumes 1-11 to glimpse research changes in Chinese information science over two decades. Through hotspot mining and thematic analysis, we find that main topics include foundational theories, information resource management, information organization and retrieval, and emerging information technologies, each presenting distinct characteristics. Data-driven research paradigms provide new development opportunities. In the future, information science will witness deepening disciplinary integration, with technology continuously driving the discipline forward. Information science and intelligence work must establish a "Grand Information Science" positioning and paradigm, enhance disciplinary and professional confidence, strengthen theoretical research and practical innovation, and strive to achieve socialized functions serving national economy and defense security [140].

Limitations of this study include: (1) selecting only *Advances in Information Science* as the sample, resulting in a relatively small number of articles; and (2) limited discussion on future development. Future research could compare *Advances in Information Science* with foreign publications like ARIST to analyze domestic and international research content and hotspots, and conduct thematic

studies by referencing relevant professional literature.

References

[1] Wang Zhijin, Li Mingzhen. An immortal chapter in information science—commemorating the 60th anniversary of "As We May Think" [J]. Information Studies: Theory & Application, 2005, 28(1): 1-5.

[2] Wu Cici, Zhang Jiuzhen. Construction of library and information science sub-disciplines under the influence of the information technology revolution [J]. Journal of Library Science in China, 2001, 27(5): 3-8, 62.

[3] Editorial Department of Information Studies: Theory & Application. Advances in Information Science [EB/OL]. [2017-06-25]. http://www.itapress.cn/CN/column/column4732.shtml.

[4] Wang Yiming. China has its own information science annual review—review of *Advances in Information Science: 1994-1995 Annual Review* [J]. Information Studies: Theory & Application, 1996, 19(1): 63-64.

[5] Liu Li. A successful continuation—review of *Advances in Information Science* [J]. Information Studies: Theory & Application, 1997, 20(6): 376-377, 344.

[6] Ma Haiqun, Qiu Junping. New progress at the turn of the century—review of *Advances in Information Science* (Volume 3) [J]. Information Studies: Theory & Application, 2000, 23(2): 158-160.

[7] Qiu Junping, Hou Jingchuan. Information science in the network era—review of *Advances in Information Science* (Volume 4) [J]. Information Studies: Theory & Application, 2003, 26(1): 89-90.

[8] Wang Zhijin, Fan Zhenjia. An intelligence feast and disciplinary beacon—review of *Advances in Information Science* (Volume 7) [J]. Information Studies: Theory & Application, 2009, 32(3): 125-128.

[9] Wang Zhijin, Zhu Hui. Ten volumes sharpened into one sword, leading the new trend—review of *Advances in Information Science* (Volume 10) [J]. Information Studies: Theory & Application, 2015, 38(9): 140-144.

[10] Hu Changping, Xu Yilei. International vision-oriented information science research development—review of *Advances in Information Science* (Volume 11) [J]. Information Studies: Theory & Application, 2017, 40(3): 143-144, 118.

[11] Li Jian, Han Yi. Informetric analysis of *Advances in Information Science*—discussion on research focuses and hotspots of Chinese information science in recent 10 years [J]. Information Studies: Theory & Application, 2005, 28(2): 187-190.

[12] Huang Guowei. Quantitative analysis of five volumes of *Advances in Information Science* annual review [J]. Library Work in Colleges and Universities, 2005, 25(1): 18-21, 41.

[13] Leng Fuhai, Yu Weiwei. Research dynamics and development of information science from the perspective of ARIST and *Advances in Information Science* articles during 2002-2011 [J]. Journal of the China Society for Scientific and Technical Information, 2013, 32(10): 1012-1025.

[14] Jing Jipeng, Bi Qiang. Theoretical foundations of information science [M]. Changchun: Jilin Science and Technology Press, 1996: 255-289.

[15] Zhu Qing, Zhang Wei. Construction of information science disciplinary system under modern information environment [J]. Science and Technology Information (Academic Research), 2008(8): 51.

[16] Xiao Yong. On constructing contemporary Chinese information science disciplinary system and disciplinary cluster system based on "three major research paradigms" [J]. Journal of the China Society for Scientific and Technical Information, 2017, 36(9): 894-907.

[17] Yan Yimin. Theoretical research on information science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 1-17.

[18] Miao Qihao. Theory and application of social intelligence and its significance for developing countries [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 1-28.

[19] Wang Bing, Yue Jianbo. Progress in foundational theoretical research of information science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 1-30.

[20] Shen Guchao. Two ISs in information science—rethinking the introduction of Intelligence Studies into Information Science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 73-110.

[21] Lü Bin, Li Guoqiu. Domain analysis—a new paradigm for information science research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 29-50.

[22] Zou Yongli, Hosono Kimitoshi. Cognitive perspectives in information science research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 53-77.

[23] Wang Zhijin, Li Desheng. The knowledge-based trend of information science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 31-52.

[24] Zhang Jin. Introduction and integration of communication studies into library and information science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 108-127.

[25] Zhang Xinmin, Liang Zhanping. Research on disciplinary development of information science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 1-54.

[26] Xiao Yong, Zhao Chengmou. Current status of Western informatics research and its disciplinary relationship with Chinese information science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 111-151.

[27] Zhou Xiaoying, Zhang Dandan, Zhou Zhou, et al. Research on eight years of progress and impact of information architecture [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 55-80.

[28] Shi Bingneng, Yuan Youxiong, Lu Shengjun. Research on Qian Xuesen's academic thoughts on scientific and technical intelligence and their significance [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 1-44.

[29] Lai Maosheng. Review of research on intelligence retrieval technology and methods [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2002-2003 Annual Review. Beijing: National Defense Industry Press, 2003: 164-202.

[30] Zhou Zhiyou. Annual review of information retrieval theory [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 81-107.

[31] Zhou Ning. New progress in database technology [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 101-127.

[32] Yang Zongying, Zheng Qiaoying, Sun Hua. Development of digital libraries [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 128-150.

[33] Liu Wei. Digital libraries: repositioning in cyber infrastructure [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 59-79.

[34] Zhao Huiqin. Research on metadata [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 202-227.

[35] Chen Yu, Xu Sheng, You Hongliang. XML technology and applications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2002-2003 Annual Review. Beijing: National Defense Industry Press, 2003: 203-233.

[36] Zhen Zhen. Z39.50 standard, protocol and applications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 228-260.

[37] Zhen Zhen, Tang Shanhong, Xu Ruhong. Current status and trends of information organization technology development [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 187-243.

[38] Zeng Lei, Lu Xin. Information retrieval technology and applications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 108-128.

[39] Cao Shujin. Foreign intelligence retrieval languages and natural language retrieval [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 126-141.

[40] Gao Yingfan, Wang Huilin, Xu Hongjiao, et al. Research progress on cross-language information retrieval [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 275-307.

[41] Li Yuelin. Task-based information seeking and retrieval [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 198-237.

[42] Zeng Minzu. Information services and management in the electronic information age [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 139-170.

[43] Zeng Minzu. Technical trends and model prospects of information service industry in the broadband era [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 142-180.

[44] Shi Wensheng, Jin Yunwen. Current status and prospects of global information service industry development [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 263-308.

[45] Gan Liren, Shi Tianhua, Wang Yuefen, et al. Overview of foreign Internet information service development [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 66-98.

[46] Tang Shanhong. Research on innovation and development of information services [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 307-332.

[47] Xu Xuewen, Chen Wenbin, Tao Guoqiang. Current status and development trends of network scientific information service technology [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 139-178.

[48] Li Yuelin, He Pengfei, Liang Na. Research progress on information services in mobile technology application fields [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 102-131.

[49] Ma Hongmei, Luo Wei, Liu Shizhang. Review of personalized information service research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 149-213.

[50] Wang Zhijin, Sun Lili. Research on information service evaluation systems [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 149-213.

[51] Zeng Minzu. Current status and key areas of knowledge service research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 119-148.

[52] Li Yang, Fan Shuli, Li Jian, et al. Research on standardization and personalization of library services: issues, relationships, and coordination mechanisms [J]. Library Development, 2017(3): 11-16.

[53] Wang Chongde, Xu Jiuling, Liu Chunmao. Chinese bibliometrics in the 1990s [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 18-37.

[54] Qiu Junping. Progress and trends of bibliometrics [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 38-58.

[55] Wang Chongde. Development history of Bradford's Law [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 51-74.

[56] Xu Jiuling, Liu Chunmao, Zhang Hui. Research on Lotka's Law [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 1-39.

[57] Xu Jiuling, Liu Chunmao, Liu Yaxuan. Research on webometrics [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 78-107.

[58] Tang Shanhong, You Qingbin, Li Tianyang. Development and application of altmetrics [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 76-101.

[59] Liu Zhihui, Zhao Xiaoyuan, Xu Xiaoyang, et al. Research progress on information science theory from the perspective of bibliometric analysis [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 27-46.

[60] Chen Rui, Ouyang Peng, Xie Xinzhou. Multimedia technology and its applications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 171-190.

[61] Xie Xinzhou, Wang Jun. New progress in electronic publications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 191-210.

[62] Lai Maosheng. Progress in optical disc technology and applications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 211-243.

[63] Sheng Youzhao. Application and development of computer communication technology [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 244-262.

[64] You Hongliang, Yang Hongtao, Chen Yu. Review of multimedia and hypertext technology [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 101-127.

[65] Wang Yongcheng. Overview of network information intelligent processing [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 46-58.

[66] Qin Jian. Review of semantic web and practical classification system research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 195-238.

[67] Wang Weixin, Dai Guozhong. Information visualization [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 80-118.

[68] Ma Dehui, Bao Changhuo. Rise and development of knowledge networks [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 152-193.

[69] Chen Yu, Zeng Zheng, Wang Sanmei, et al. Research progress on information technology for scientific and technical information work [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 244-286.

[70] Chen Yu, Zeng Zheng, Wang Sanmei. Application and development of big data technology in scientific and technical information work [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 198-237.

[71] Pang Jing'an. Big data era: thinking transformation, industrial transformation, and rise of data science [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 186-218.

[72] Xia Xu, Fang Ping. Research on World Wide Web information resource search engines [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 183-206.

[73] Pang Jing'an. Web information collection and quality control [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry

Press, 2008: 239-270.

[74] Wang Fang, Ji Xuemei, Shi Haiyan. Management, preservation, and web archiving of digital information resources [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 308-342.

[75] Fang Qing. Research on scientific information communication in network environments [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 122-138.

[76] Zhu Qinghua, Zhao Yuxiang, Tan Xiaojie, et al. Research progress on user-generated content [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 198-237.

[77] Xie Xinzhou, Zhang Chunming. Development of information release models [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 246-266.

[78] Yuan Youxiong, Tang Shanhong, Zhao Yue, et al. Research progress on construction and development of scientific and technical information resources at home and abroad [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 324-338.

[79] Zhang Xu, Lei Xiaoping. Research progress on construction and service of scientific and technical information resources at home and abroad [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 287-321.

[80] Zhen Zhen, Tang Shanhong, Wang Xin, et al. Development and application of network new media resources [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 45-80.

[81] Meng Guangjun, Huo Guoqing, Xie Yangqun, et al. On information resources and their activities [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 75-100.

[82] Xie Yangqun, Li Xiaoxiang. Review of crisis information management research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 333-361.

[83] Zhou Xiaoying, Wang Bing. Research progress on government online information management and services [C]//China Defense Science and Technology

Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 116-156.

[84] Zhu Qinghua. Review of network information resource evaluation research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 281-323.

[85] Liu Bing. Research progress on information quality evaluation [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 266-302.

[86] SYNNOTT W R, GRYBER W H. Information resource management—opportunities and strategies for the 1980s [M]. New York: John Wiley & Sons, 1981: 66-68.

[87] Huo Guoqing. Review of CIO research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 265-296.

[88] Lai Maosheng. Development perspectives of information science [J]. Library and Information Service, 2000(4): 2-4, 11.

[89] Qiu Junping, Wang Feifei. Research progress on knowledge management science in recent years [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 1-32.

[90] Liu Chunmao, Xu Jiuling, Zhang Hui, et al. Comprehensive research on knowledge organization and knowledge management [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2002-2003 Annual Review. Beijing: National Defense Industry Press, 2003: 107-135.

[91] Wang Zhengrong, Huo Zhongwen. Intellectual property protection of information products in network environments [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1998-1999 Annual Review. Beijing: Aviation Industry Press, 1999: 207-228.

[92] Zeng Minzu, Zhou Qian, Lu Shengjun, et al. Knowledge organization in E-knowledge environments [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 152-193.

[93] Chu Jiewang, Chu Yili, Huang Jieqin, et al. Tacit knowledge sharing, transformation, and scientific and technical information work [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 388-423.

[94] Zhao Rongying, Chen Bikun. Research progress on knowledge maps and knowledge graphs [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 350-387.

[95] Ma Feicheng. IRM-KM paradigm and information science development research [C]. Wuhan: Wuhan University Press, 2008: 297-307.

[96] Wang Zhijin, Xu Fang, Pan Yongchao, et al. Thirty years of library and information science education in China (1978-2008): review and prospect [J]. Library and Information, 2010(2): 23-30.

[97] Jing Jipeng, Lu Xiaobin. Research on information science professional education in China [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1996-1997 Annual Review. Beijing: Ordnance Industry Press, 1997: 193-210.

[98] Wang Zhijin, Xu Fang, Yan Beini. Research on progress of information science graduate education [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 1-32.

[99] Zhao Rongying, Guo Fengjiao, Wei Xuqiu. Analysis of information science education development in China [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 47-75.

[100] Yan Yimin. Information science and information science education [J]. Journal of Information Science, 1982(4): 4-9.

[101] Wu Cici. New mission of library and information science education under social informatization [J]. Library Work and Research, 1993(3): 11-14.

[102] Sun Jianjun, Cheng Ying. The path of information science professional education reform [J]. Journal of Library Science in China, 2004, 30(2): 85-88.

[103] Ye Jiyuan. Discussion on quality evaluation of library and information science education [J]. Journal of Academic Libraries, 2011(5): 10-14.

[104] Qiu Junping, Lou Wen. Coordinated development of information science discipline and doctoral education in China—visual analysis of information science papers in the early 21st century [J]. Library and Information Knowledge, 2014(2): 18-27.

[105] Xiao Ximing. Reflections on several issues regarding professional master's education in library and information science [J]. Library and Information Knowledge, 2016(1): 30-34.

[106] Yang Liexun. Information economics oriented toward practice in the 1990s [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 1994-1995 Annual Review. Beijing: China Defense Science and Technology Information Association, 1995: 59-80.

[107] Liu Lina. Formation and development of social informatics [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2000-2001 Annual Review. Beijing: National Defense Industry Press, 2001: 40-65.

[108] Zhou Qingshan. Review and progress of information law research [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2002-2003 Annual Review. Beijing: National Defense Industry Press, 2003: 68-106.

[109] Jing Jipeng, Zhang Xiangxian, Wang Xiwei. Research progress on information ecology [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 1-26.

[110] Yu Liangzhi. The "Western learning spreading to the East" of Community Informatics—expectations and reflections [J]. Journal of Library Science in China, 2013, 39(3): 63-67.

[111] Qiu Junping, Wang Yuefen, Yan Ruiwu. Review of content analysis method research and development [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2004-2005 Annual Review. Beijing: National Defense Industry Press, 2006: 1-45.

[112] He Defang. Research progress on multi-perspective-based intelligence analysis methods [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 154-197.

[113] Wu Xia, Leng Fuhai. Literature-based knowledge mining: concepts, key technologies, and applications [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 271-306.

[114] Hua Bolin. Intelligence technology based on text information analysis [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 244-279.

[115] Hou Jingchuan, Zhao Rongying, Qiu Junping. Review of think tank development at home and abroad [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2002-2003 Annual Review. Beijing: National Defense Industry Press, 2003: 136-163.

[116] Bao Changhuo, Zhang Yan, Huang Ying. Rise and development of competitive intelligence [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2002-2003 Annual Review. Beijing: National Defense Industry Press, 2003: 136-163.

[117] Li Yan. Theoretical construction and empirical research progress of technical competitive intelligence [C]//China Defense Science and Technology In-

formation Association. *Advances in Information Science*: 2006-2007 Annual Review. Beijing: National Defense Industry Press, 2008: 81-118.

[118] Chen Feng. Research progress on industrial competitive intelligence [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2012-2013 Annual Review. Beijing: National Defense Industry Press, 2014: 123-153.

[119] Xu Feng, Leng Fuhai. Future-oriented technology analysis methods and practical research progress [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2008-2009 Annual Review. Beijing: National Defense Industry Press, 2010: 202-243.

[120] Zhao Yunhua, Zheng Jia. Research progress on fact-based science and technology policy research methods and practices [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 87-115.

[121] Zhang Xu, Lei Xiaoping. Research progress on patent intelligence analysis methods, technologies, and applications at home and abroad [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 287-321.

[122] Wang Yuefen, Wu Peng, Ding Shengchun, et al. Review of social public opinion analysis research and progress [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2014-2015 Annual Review. Beijing: National Defense Industry Press, 2016: 132-185.

[123] China Society for Scientific and Technical Information, China Social Sciences Information Society. Nanjing Consensus on the development of information science and intelligence work [J]. Library and Information Service, 2018, 62(1): 142-143.

[124] Wang Zhijin, Han Zhengbiao, Zhou Peng. Research progress on Informatics discipline clusters [C]//China Defense Science and Technology Information Association. *Advances in Information Science*: 2010-2011 Annual Review. Beijing: National Defense Industry Press, 2012: 1-45.

[125] Editorial Department of Journal of Intelligence. Focus topic: disciplinary construction of information science [J]. Journal of Intelligence, 2017, 36(5): 208.

[126] Huang Changzhu. Considerations on establishing information science as a first-level discipline [J]. Journal of Intelligence, 2017, 36(5): 6-8.

[127] Yuan Qinjian. My views on establishing information science as a first-level discipline [J]. Journal of Intelligence, 2017, 36(6): 8-9.

[128] Si Xiangyun, Li Xianxin, Zhou Liqin, et al. Strategic discussion on the development of information science and intelligence work in the new era—summary

of the Forum on the Development of Information Science and Intelligence Work (2017) [J]. Library and Information Knowledge, 2018(1): 122-129.

[129] KUHN T. The structure of scientific revolution. 2nd ed [M]. Chicago: University of Chicago Press, 1970: 174-210.

[130] HEY T, TYABSLES T, TOLLE K. The fourth paradigm: data-intensive scientific discovery [M]. Translated by Pan Jiaofeng, Zhang Xiaolin. Beijing: Science Press, 2012: i-vii.

[131] Guo Huadong. Big data, big science, big discovery—summary of the International Conference on Big Data and Scientific Discovery [J]. Bulletin of Chinese Academy of Sciences, 2014, 29(4): 500-506.

[132] He Defang. Thoughts on fact-based scientific and technical intelligence research [J]. Journal of the China Society for Scientific and Technical Information, 2009, 28(5): 764-770.

[133] Yu Bo, Wen Liangming, Zhang Yanyan. Research on intelligence research methodology system under big data environment [J]. Information Science, 2016, 34(9): 7-12.

[134] Liu Ziqiang, Yue Lixin, Wang Xiaoyue, et al. Analysis of international information science research hotspots and frontiers from the perspective of thematic evolution [J]. Library, 2017(3): 14-22.

[135] China.com.cn. The 13th Five-Year Plan for National Economic and Social Development of the People's Republic of China (full text) [EB/OL]. [2018-02-10]. http://www.china.com.cn/lianghui/news/2016-03/17/content_{38053101}.htm.

[136] Ministry of National Defense of China. National Intelligence Law of the People's Republic of China [EB/OL]. [2018-02-10]. http://www.mod.gov.cn/regulatory/2017-06/28/content_{4783851}.htm.

[137] Government.cn. General Office of the CPC Central Committee and General Office of the State Council issue "Opinions on Strengthening the Construction of New-Type Think Tanks with Chinese Characteristics" [EB/OL]. [2017-11-31]. http://www.gov.cn/xinwen/2015-01/20/content_{2807126}2.htm.

[138] Deng Sanhong, Guo Hua. The Forum on the Development of Information Science and Intelligence Work (2017) was grandly held and formed the "Nanjing Consensus" [J]. Information Studies: Theory & Application, 2017, 40(11): 1-2.

[139] Li Yang, Li Gang, Zhang Jiannian. Research on think tank intelligence functions from an engineering perspective [J]. Journal of Intelligence, 2016, 35(3): 36-41, 48.

[140] Chu Jingli. New positioning and understanding of information science and intelligence work in the new era—reflections on the "Forum on the Development of Information Science and Intelligence Work (2017)" [J]. Library and Information Service, 2018, 62(1): 140-142.

Author Contributions

Yu Bo: Proposed the research framework and writing ideas;
Guo Lei: Drafted and revised the paper;
Wen Liangming: Drafted and revised the paper;
Zhang Yanyan: Revised the paper;
Li Yang: Revised the paper.

Note: Figure translations are in progress. See original paper for figures.