The Inheritance and Development of Intelligence Science in the Big Data Environment: Postprint

Authors: Wang Zhijin

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Abstract

[Purpose/Significance] This study analyzes the opportunities and challenges confronting information science in the big data era, and explores approaches for inheriting and developing its academic traditions. [Method/Process] Based on a review of the history of information science, it examines the field's position in the big data era and proposes the "four inheritances" and "five developments". [Results/Conclusion] The author argues that there can be no development without inheritance, nor innovation without reference—a principle of paramount importance to information science.

Full Text

Inheritance and Development of Information Science in the Big Data Environment

Wang Zhijin School of Management, Guangxi University for Nationalities, Nanning 530006 Business School, Nankai University, Tianjin 300071

Abstract: [Purpose/Significance] This paper analyzes the opportunities and challenges facing information science in the big data era, and explores how to inherit and develop the academic tradition of information science. [Method/Process] Based on a review of the history of information science, this paper examines the situation of information science in the big data era and proposes "four inheritances" and "five developments." [Result/Conclusion] The author believes that there can be no development without inheritance, and no innovation without reference. This is crucial for information science.

Keywords: big data environment; information science; inheritance and development

2. The Situation of Information Science in the Big Data Era

Data has always been a key concept and essential element in information science research. With the advent of the big data era, information science has encountered unprecedented challenges.

2.1 A Colorful Era: New Concepts Emerge Endlessly

Since the beginning of the 21st century, our era has often been called the "cloud-IoT-mobile-big data-AI" era (cloud computing, Internet of Things, mobile Internet, big data, artificial intelligence). In the second decade of this century, blockchain, data science, data-driven approaches, and machine learning have also gained prominence. These new concepts emerge endlessly, creating a dazzling array of ideas that continue to attract academic attention and become frequent topics of discussion within the information science community.

From a central government perspective, between 2017 and 2019, the Political Bureau of the CPC Central Committee held three collective study sessions focused on big data, artificial intelligence, and blockchain, providing strategic guidance for China's economic and social development while also pointing out the direction for information science research. When presiding over these sessions, General Secretary Xi Jinping emphasized that big data development is changing with each passing day, and that we should assess the situation carefully, plan meticulously, lay out plans ahead of schedule, and take the initiative to implement the national big data strategy and accelerate the construction of a digital China [2]. Driven by new theories and technologies such as mobile Internet, big data, supercomputing, sensor networks, and brain science, artificial intelligence is developing rapidly. AI is a strategic technology leading this round of technological revolution and industrial transformation, with a strong "head goose" effect of spillover and driving force. Accelerating the development of new-generation artificial intelligence is an important strategic lever for us to win the initiative in global technological competition, drive China's scientific and technological leapfrog development, optimize and upgrade industries, and enhance the overall productivity [3]. The integrated application of blockchain technology plays an important role in new technological innovations and industrial transformations. We must regard blockchain as an important breakthrough in core technology independent innovation, clarify the main direction of attack, increase investment, strive to overcome a batch of key core technologies, and accelerate the promotion of blockchain technology and industrial innovation development [4].

The rapid emergence and application of new technologies have brought new opportunities for the development and construction of information science and posed new research questions.

2.2 A Dazzling World: The Confusion of Information Science

Opportunities and challenges coexist, and new opportunities inevitably bring new challenges. In the big data era, various new terms float around constantly. Within the information science community, heated discussions about these new terms show a dual nature: on the one hand, they can be appropriately introduced into information science, combined with its characteristics and reality, and used to promote innovation and boost development; on the other hand, they may become popular terms that mislead, intimidate, or confuse people. Some individuals hype these new concepts without implementing them concretely in information science, or use them ambiguously, objectively inducing information science to deviate from its fundamental direction and stray onto the wrong path.

In this rapidly changing world and era, information science cannot avoid being misled, intimidated, or confused. To correct the deviation in introducing new terms and rectify the development direction of information science, many insightful scholars in the field have published articles on the confusion and disorientation of information science. Judging from the titles of publicly published articles alone, we can find the following pairs of words that clarify the tasks and directions of information science: transformation and upholding fundamentals, upholding fundamentals and expanding innovation, adherence and expansion, cross-boundary and expansion, crisis and transformation, dilemma and redirection, positioning and reflection, redirection and breakthrough, transformation and development, construction and innovation, problems and methods, review and reflection, and so on.

Just as these article titles reflect, in an era where data speaks, information science is at a crossroads. Faced with the sudden application of many new technologies and methods, some say it is a deviation, some say it is a bias, and some say it is a departure. So how should we view and treat this phenomenon? In other words, in an era where technological innovation dominates the world, how can information science achieve its inheritance and development?

3. Inheritance of Information Science in the Big Data Context

Newton once famously said, “If I have seen further, it is by standing on the shoulders of giants.” “Standing on the shoulders of giants” is inheritance, and surpassing giants is development. Inheritance and development are a pair of categories that are both contradictory and unified, existing in a unified entity. They are not absolutely opposed or mutually exclusive, but rather interdependent and inclusive. Inheritance does not reject or deny development, and development does not reject or deny inheritance. Inheritance and development drive things forward in the same direction.

Under dual pressures, how can information science actively introduce and apply new technologies and methods to expand its research fields and enhance

its disciplinary status, while simultaneously adhering to its original mission and purpose, carrying forward its disciplinary characteristics, and ensuring that information science continues to advance on the right path? This raises the question of what the foundation and purpose of information science are—what information science should inherit.

3.1 Inheritance One: Establishing the "Warfare" Concept

In early 1956, when leaders of the Chinese Academy of Sciences reported to Premier Zhou Enlai on the formulation of the "1956-1967 Science and Technology Development Long-term Plan" (referred to as the "Plan"), and mentioned that since its establishment, the Academy had known very little about international scientific and technological development, Premier Zhou said, "You have been working for several years without even establishing an intelligence agency. How have you been fighting your battles?!" [5]

From Premier Zhou's remarks, we can see that intelligence agencies were established for "fighting battles." To "fight battles," one needs intelligence agencies, and the fundamental task of intelligence agencies is to "fight battles," even for scientific and technological intelligence agencies. Specifically, military intelligence agencies "fight battles" on the military front, political intelligence agencies on the political front, economic intelligence agencies on the economic front, and scientific and technological intelligence agencies on the scientific and technological front.

Based on Premier Zhou's instructions, establishing specialized scientific and technological intelligence work as an indispensable and urgent component of developing China's science and technology was included as Item 57 in the Plan [6]. Thus, China's scientific and technological intelligence enterprise began.

Theory originates from practice and transcends it. Information science was formed on the basis of intelligence work practice and in turn guides practice. Therefore, the concept of "warfare" must necessarily run through the entire process of information science research. Premier Zhou's thought was proposed in a specific historical period. In the early days of the People's Republic, Western countries led by the United States blockaded and isolated China from all sides. Militarily, they launched the Korean War, sent the Seventh Fleet into the Taiwan Strait, and interfered in the Indochina War in Southeast Asia, attempting to spread the flames of war to China. Politically, the United States led NATO and other countries to refuse recognition of the legitimacy of new China, manipulated the United Nations to obstruct new China's legitimate representatives from replacing the seats illegally occupied by the Kuomintang, and economically imposed blockades and embargoes on new China, preventing merchant ships from all countries from entering its ports.

To break the encirclement and containment by Western countries, the CPC Central Committee with Mao Zedong at its core adopted a series of measures: diplomatically leaning to the Soviet Union in the north to gain support and

assistance; sending volunteers to Korea in the east at the critical moment of US intervention in the Korean War to resist US aggression and aid Korea and defend the homeland; and actively promoting the ceasefire in Indochina in the south to restore peace and ease pressure on new China's southern flank.

The Soviet Union had already established the All-Union Institute of Scientific and Technical Information, and China followed suit by establishing the Institute of Scientific and Technical Information of China. China's scientific and technological intelligence enterprise was thus created and born against this international background of breaking Western blockades and isolation.

More than half a century has passed, and the world is undergoing major changes unseen in a century. The current suppression and technological blockade that China faces from the United States and some Western countries are remarkably similar to the international environment at the beginning of new China. Under the still severe current international situation, information science should re-establish the "warfare" mindset, strengthen its proper position and role in "fighting battles," and make due contributions to the "battles" of this once-in-a-century great change. This is the historical responsibility that information science cannot shirk. Inheriting the academic tradition of information science means inheriting this "warfare" thinking and concept.

3.2 Inheritance Two: Clarifying Its Role Positioning

At the beginning of China's scientific and technological intelligence enterprise, under the direct care of central leadership, it gradually formed its own role positioning, which became the guiding principle, ideological foundation, and historical mission of China's intelligence work.

The role positioning of intelligence work can be summarized in six characters: eyes and ears, vanguard, advisor. In the 1960s, Vice Chairman Nie Rongzhen of the Central Military Commission inscribed for the National Defense Science and Technology Intelligence Work Conference: "Scientific and technological intelligence is the eyes and ears and vanguard of scientific and technological work." Deputy Secretary-General Zhang Aiping of the Central Military Commission pointed out during a visit to the exhibition of achievements in ordnance science and technology intelligence work: "Intelligence research work should participate in decision-making and serve as a good advisor." [7] In 1965, Marshal Nie Rongzhen proposed: "More than 90% of our efforts should be placed on intelligence research to serve as the scientific and technological intelligence advisor to the Central Military Commission and the Commission of Science, Technology and Industry for National Defense." [8]

The inscriptions and speeches of central leaders pointed out the direction for China's scientific and technological intelligence work and clarified its mission and tasks. Central leaders not only emphasized the position and importance of intelligence research in scientific and technological intelligence work but also made an accurate positioning of the mission and tasks of China's scientific and

technological intelligence work. At the same time, they revealed the nature and characteristics of scientific and technological intelligence work.

Since the establishment of China's scientific and technological intelligence enterprise, this role positioning has guided its development for more than half a century. Scientific and technological intelligence agencies at all levels have always regarded "eyes and ears, vanguard, advisor" as their historical mission and strategic positioning, and always considered these six characters as the cornerstone of their survival and development. Intelligence work is the practical foundation of information science, and the role positioning of intelligence work is the disciplinary positioning of information science. Therefore, Chinese information science also takes these six characters as the characteristic of indigenous information science, distinguishing it from information science in other countries [9]. These three roles form an organic whole that cannot be separated. They also reveal three main stages of information science that are interconnected and progressive. If one only completes information collection and analysis without further comprehensive research and proposing solutions or recommendations—that is, only serving as "vanguard" and "eyes and ears" but not as "advisor"—it is not complete and genuine information science.

In the big data era, information science must innovate and adjust itself, constantly improving and endowing itself with new content. But no matter how it changes, firmly maintaining the role positioning of "eyes and ears, vanguard, advisor" and remembering the basic nature, historical mission, and fundamental tasks of information science are of great significance for its steady development in the big data era. Inheriting the academic tradition of information science means inheriting this role positioning without wavering.

3.3 Inheritance Three: Strategic Decision-Making Goal Orientation

More than 60 years of history show that China's intelligence work has always served decision-making. Strategic intelligence first appeared in warfare and has now expanded to many fields such as science and technology, economy, and society. Generally speaking, strategic intelligence has a guiding and decision-making function for overall plans and strategies [10]. In 2016, leaders of the Ministry of Science and Technology pointed out that scientific and technological intelligence agencies should actively carry out technology forecasting, decision analysis, public opinion monitoring, and other work to provide intelligence support for government and innovation decision-makers, and transform themselves into high-end think tanks [11]. From the perspective of the history and current guidelines of China's scientific and technological intelligence work, serving decision-making has always been, is, and will be the core task and ultimate goal of China's intelligence work. Similarly, strategic decision-making has inevitably become the goal orientation and basic task of China's information science research.

Decision-making is divided into strategic decision-making and tactical decision-

making. The differences between them are:

(1) Different adjustment objects. Strategic decision-making adjusts the direction and content of organizational activities, solving the problem of "what to do" and is a fundamental decision. Tactical decision-making adjusts the ways of activities under established directions and content, solving the problem of "how to do it" and is an executive decision.

(2) Different time scopes. Strategic decision-making faces activities over a relatively long period in the future, while tactical decision-making concerns action plans for specific departments in a relatively short period in the future. Strategic decision-making is the basis for tactical decision-making, and tactical decision-making is formulated under its guidance to implement strategic decisions.

(3) Different impacts. The implementation effects of strategic decision-making influence organizational benefits and development, while those of tactical decision-making mainly affect organizational efficiency and survival. Tactics serve strategy and are the means and links to achieve it.

Decision-making also has high-level, middle-level, and low-level categories, with the following characteristics and relationships: high-level decision-making is global and long-term, belonging to strategic decision-making. Middle-level decision-making is global and long-term relative to low-level decision-making (belonging to strategic decision-making) but local and short-term relative to high-level decision-making (belonging to tactical decision-making). Low-level decision-making is local and short-term, belonging to tactical decision-making.

Taking enterprises as an example, strategic decision-making concerns major issues related to the overall and long-term development of an enterprise, such as development direction, business policy and objectives, product R&D, technological transformation, market development, enterprise transformation, and human resources. These are non-programmed and risky decisions that determine the survival and development of the enterprise.

The core of strategic decision-making goal orientation is strategic intelligence research, which is an intelligence research process serving long-term or overall strategic objectives. Based on the needs of strategic decision-making, strategic intelligence researchers use strategic intelligence research methods and various information technologies to analyze and synthesize collected strategic intelligence content, revealing the development laws, trends, and future directions of research objects.

Taking competitive intelligence as an example, strategic decision-making goal orientation is concentrated in strategic competitive intelligence. Strategic competitive intelligence describes problems encountered in the development process of corporate strategy, structure, and culture, and provides coping strategies. It is the knowledge foundation for enterprises to evaluate opportunities and risks and formulate future strategic plans. Strategy-oriented competitive intelligence

provides high-level information about competition, economy, law, and politics that enterprises and their competitors need now or in the future.

It can be seen that strategic intelligence connects with and serves strategic decision-making. For information science to serve strategic decision-making well, it must firmly grasp strategic intelligence and adopt the research path and model of "strategic intelligence → strategic decision-making" to achieve strategic decision-making goals.

Abroad, the prominent position of strategic intelligence in information science is particularly reflected in competitive intelligence. The "Society of Competitive Intelligence Professionals" (SCIP), established in 1986, was renamed the "Strategic and Competitive Intelligence Professionals" (SCIP) in 2010. In its renaming statement, SCIP firmly believed that competitive intelligence is inevitably linked with strategy. The name change reflected the evolution of competitive intelligence, which increasingly tends to support high-level decision-making.

3.4 Inheritance Four: Tactical Decision-Making Goal Orientation

Tactical decision-making is made to achieve strategic decision-making and solve specific problems, using the goals stipulated by strategic decision-making as decision-making standards. Specifically, tactical decision-making refers to adjustments in the ways of activities under established directions and content by certain specific departments of an organization in various short-term future periods, solving the problem of "how to do it" and being an executive decision.

In the tactical decision-making goal orientation of information science, the final result is expressed as tactical intelligence. Tactical intelligence is the intelligence needed to solve current specific problems. For example, in scientific, technological, and economic activities, it refers to intelligence used to solve specific problems.

The core of tactical decision-making goal orientation is tactical intelligence research, which is an intelligence research process that provides intelligence for solving current or specific problems. It mainly focuses on solving practical problems in scientific research or production, providing specific technologies and solutions, and emphasizing applicability and economic benefits.

Taking enterprise competitive intelligence as an example, tactical competitive intelligence supports and describes specific tactical arrangements of enterprises. Compared with strategic competitive intelligence, it functions at a lower level, mainly involving enterprise supply chains, human resources, product R&D, production processes, and marketing strategies. Tactics-oriented competitive intelligence concerns the latest activities and near-term plans of enterprises in the process of market development, especially the detailed analysis of customer consumption data, including market intelligence or marketing intelligence.

It can be seen that tactical intelligence is highly compatible with and closely related to tactical decision-making. For information science to serve tactical

decision-making well, it must firmly grasp tactical intelligence and adopt the research path and model of "tactical intelligence → tactical decision-making" to achieve tactical decision-making goals.

Based on the concepts of "warfare" and role positioning, strategic decision-making goal orientation and tactical decision-making goal orientation are the core content and ultimate goals of information science. Therefore, in a sense, competitive intelligence best reflects the "intelligence" characteristic of information science. Because of "warfare," intelligence is needed; because of competition, intelligence is even more necessary.

The author conducted a statistical analysis of competitive intelligence papers on CNKI in the past five years (2016-2020). Searching only for "competitive intelligence" in titles yielded 681 papers, with the annual distribution shown in Figure 1 [Figure 1: see original paper].

As can be seen from Figure 1, the number of competitive intelligence papers published in China in the past five years has shown a continuous downward trend, which to some extent reflects the shortcomings of information science research in China—that is, the dilution of the "warfare" concept, role positioning, and strategic and tactical decision-making goal orientation.

Additionally, according to the author's statistics, at the jointly held "2020 China Information Science Annual Conference and Forum on the Development of Information Science and Information Work" and the "10th (2020) National Doctoral Student Academic Forum on Information Science," among the more than 240 papers collected, not a single one was on the theme of competitive intelligence! None of the 60 special reports during the conference were related to competitive intelligence either!

From the trends in both journal articles and conference papers, the above phenomenon reflects a dangerous sign: as the big data era approaches us, faced with dazzling new technologies, methods, and terms, information science research in China has become somewhat disoriented. While emphasizing the introduction of new technologies, methods, and terms, it has neglected to integrate them with the main tasks of information science and overlooked its primary responsibilities. At a time when a century's great change has us surrounded layer by layer, competitive intelligence—the most vital element of information science—has been ignored and forgotten. This situation, which runs counter to the severe international situation, cannot but be confusing, regrettable, and disappointing, and must sound an alarm for the information science academic and professional communities.

4. Development of Information Science in the Big Data Context

In the big data era, for information science to develop, it must innovate; and to innovate, it must learn from theories, methods, and technologies outside

information science that can contribute to its innovation and integrate them into its own disciplinary system. Without such reference, innovation is empty talk, and development has no foundation.

4.1 Development One: Elevating from Information Analysis to Intelligence Research

Since September 15, 1992, when "scientific and technological intelligence" was announced to be changed to "scientific and technological information" at the National Scientific and Technological Intelligence Work Conference, "intelligence research," the most distinctive feature of China's information science, has gradually been replaced by "information analysis" in both name and content.

Over the past 30 years, the extension of information analysis has expanded infinitely, covering almost all aspects of human survival needs (learning, work, life), far beyond the "specific" category that is most characteristic of intelligence. In other words, the core function of intelligence is to provide for specific organizations or individuals for decision-making, not for the general public. What the general public needs is information, not necessarily intelligence. In society, intelligence work is not the only or even the main profession that provides information to the public. Similarly, in the big data context, information science is not the only discipline that studies information.

Although rapidly evolving information technology applications have made tremendous contributions to information analysis, information science has not done enough in implementing the "warfare" concept, playing the role of "eyes and ears, vanguard, advisor," or serving strategic and tactical decision-making. Intelligence research was the original intention of China's scientific and technological intelligence work and is the core content and fundamental task of information science, being both the starting point and the end point. The concept of "information analysis" cannot be completely equated with "intelligence research," and replacing "intelligence research" with "information analysis" is inappropriate, as it will inevitably lead information science astray.

From a semantic perspective, "information analysis" means analyzing information, where the object of analysis is "information" and the essence of the task is "analysis." "Intelligence research," however, means researching intelligence, where the object of research is "intelligence" and the essence of the task is "research." According to the *Modern Chinese Dictionary*, analysis means "dividing a thing, phenomenon, or concept into simpler components to find the essential attributes of these parts and their relationships with each other (as opposed to 'synthesis')." In other words, analysis is the process of gradually breaking down complex topics or things to achieve better understanding. "Research," however, means "exploring the truth, nature, and laws of things."

Thus, "analysis" and "research" are at different work levels or stages, with analysis being the foundation and prerequisite for research. Additionally, the counterpart of "analysis" is "synthesis." Synthesis means "combining the various

parts and attributes of analyzed objects or phenomena into a unified whole (as opposed to 'analysis')" [12]. Obviously, analysis comes first, followed by synthesis, forming a complete logical thinking chain.

Through the above discussion of conceptual meanings, we can conclude: analysis ≠ research, but analysis + synthesis = research. Therefore, combined with the earlier discussion of "information" and "intelligence," the conclusion is that information analysis ≠ intelligence research. For information science, information analysis is an essential stage of intelligence research, equivalent to the "vanguard," while intelligence research is conducted on the basis of information analysis, representing a further high-level synthesis of various information analysis results, equivalent to the "advisor."

The drawback of the term "information analysis" for information science is that it can easily lead people into the trap of "analysis for analysis's sake." Because information analysis can be conveniently completed using various analytical tools, it is easy to neglect the decision-support function and role positioning of information science, drifting away from its ultimate goals and tasks.

In the big data era, the term "data analysis" appears frequently. For information science, the object of information analysis has simply moved forward to data, making data a new object of analysis for intelligence research. Although data is more original and objective than information, and despite the use of more advanced modern analytical tools and technologies, data analysis remains at the "analysis" level and has not yet reached the stages of "synthesis" and "research."

The development of information science should, on the basis of inheriting the tradition of intelligence research, introduce applicable new technologies and methods to eliminate the dross and retain the essence of information, and then enable intelligence research to proceed from the surface to the essence and from one thing to another, thereby improving the efficiency, quality, and level of intelligence research and promoting innovation and development in information science.

4.2 Development Two: Taking Data as the Starting Point of Intelligence Research

Human society is entering the data era. Following information analysis, we have welcomed data mining, data science, data analysis, and data-driven approaches. How to apply data analysis techniques and tools to information science has become a new subject for information science, especially intelligence research, in the big data era.

Taking the data-driven approach as an example, the "data-driven" concept that has emerged in recent years has opened up new avenues for intelligence research and may further deepen intelligence research. Data-driven approaches collect massive amounts of data through mobile Internet and related software, organize data into information, and then integrate and refine relevant information. Based

on data, training and fitting form automated decision-making models. When new situations occur and new data is input, the system can use previously established models to make decisions through artificial intelligence.

Data-driven is a dynamic, spiral, iterative process that completes decision after decision. It consists of a series of conceptual nodes connected in chronological order, which coincides with the information chain in information science, as shown in Figure 2 [Figure 2: see original paper].

In the era of artificial intelligence, data-driven decision-making is decision-making based on data and algorithms, especially machine learning, which establishes and uses models. In the mobile Internet era, because many businesses require massive millisecond-level instant decisions that cannot be completed by the human brain alone, this type of decision-making must be made directly through artificial intelligence.

In the context of artificial intelligence, the data pyramid can help us understand the relationship between data, information, knowledge, and artificial intelligence. The data pyramid oriented toward artificial intelligence is shown in Figure 3 [Figure 3: see original paper].

Information is organized data that has been processed and internally correlated to give data meaning. Information can answer who, what, where, and when questions. Knowledge is the summary and refinement of information, summarizing patterns and methodologies based on relationships between information, mainly used to answer why and how questions. Artificial intelligence is the autonomous application of information and knowledge by machines, where systems form thinking abilities similar to the human brain (including learning, reasoning, decision-making, etc.) based on data, information, and knowledge.

Knowledge is the foundation of all intelligent behavior, while intelligence is the ability to acquire and apply knowledge to solve problems, representing the concrete manifestation of thinking activities in the mind. Generally, intelligence refers to an individual's comprehensive ability to reasonably analyze, judge, and purposefully act on objective matters and effectively handle environmental issues. Intelligence includes at least three capabilities: understanding, analyzing, and solving problems; inductive and deductive reasoning abilities; and the ability to adapt to the environment for survival and development. In the field of science and technology, it can specifically refer to the automatic control ability of machines and their ability to self-regulate according to the environment or their stress response [14].

At the information and knowledge levels, data plays a role in providing decision support, while at the artificial intelligence stage, the system imitates human thinking and reasoning to make autonomous decisions using information and knowledge. Therefore, under data-driven artificial intelligence, decision-making is conducted autonomously by the system, not manually by humans.

Whether it is human decision-making or system autonomous decision-making,

data itself is meaningless if it cannot be transformed into information and knowledge. However, without data, or with scarce data, the generation of information and knowledge becomes water without a source or a tree without roots.

Most current information analysis and data analysis techniques and methods are quantitative and objective. No matter how advanced, sophisticated, or intelligent these techniques and methods are, they cannot completely replace intelligence research. Intelligence research requires not only quantitative and objective analytical techniques and methods but also qualitative and subjective ones, and it needs to combine various techniques and methods. It should be a human-machine combined decision-making system.

The big data era reminds us that the development of information science should not only take information as the starting point and object to carry out information analysis but also take data as the starting point and object to carry out data analysis. The two should be used alternately and deeply integrated to jointly support intelligence research. From the perspective of the information chain, "new technologies such as artificial intelligence and big data have largely changed the structure of the information chain. …Intelligence is no longer gradually refined and sublimated along the information chain in the traditional model, but is generated through in-depth data mining and analysis using big data" [13]. What is more needed is human wisdom, with human-machine collaboration serving intelligence research.

4.3 Development Three: Intelligence as the Fusion of Intelligence and Wisdom

It must be admitted that humans are emotional beings, and the decisions they make are not necessarily completely objective and may contain subjective factors. In contrast, artificial intelligence decision-making based on data, algorithms, and models is more reliable.

At the top of the data pyramid, some say it is intelligence, some say it is intelligence (in the sense of artificial intelligence), and some say it is wisdom rather than artificial intelligence. There are different views on this.

In English, "Intelligence" means both intellectual ability and intelligence (in the sense of information gathering). In Chinese, "智能" (intelligence) is also called "智力" (intellect). Intelligence is the sum of knowledge and intellectual ability. Artificial intelligence usually refers to the technology of presenting human intelligence through ordinary computer programs, studying how to enable computers to simulate certain human thinking processes and intelligent behaviors (such as learning, reasoning, thinking, planning, etc.) [15].

Ancient Chinese thinkers generally regarded wisdom and ability as two relatively independent concepts. Wisdom is different from intelligence or intelligence (information), and intelligence does not represent wisdom. The two have certain differences in meaning. Wisdom is an advanced creative thinking ability based

on physiological and psychological organs possessed by life, including all abilities of perception, memory, understanding, analysis, judgment, and sublimation of nature and humanity. Wisdom expresses the comprehensive ultimate function of intellectual organs, similar to the "metaphysical Dao," while intelligence is the "physical instrument," a part of life's skills [16].

Those who place artificial intelligence at the top of the data pyramid believe that artificial intelligence is built on the foundation of knowledge, and knowledge is a necessary condition for artificial intelligence. However, wisdom is not built on the foundation of knowledge, and knowledge is not a necessary condition for wisdom. Many ancient Chinese monks possessed great wisdom but did not have much knowledge. For example, the Sixth Patriarch Huineng, a great Zen master, could understand the meaning of scriptures by listening to them despite being illiterate. The reason is that knowledge comes from experience (data), from human observation of the three-dimensional space (length, width, height) or four-dimensional space (real world + time) of the real world, while wisdom can come from spaces beyond four dimensions without necessarily requiring experience (data).

From this perspective, we can also see the limitations of data-driven approaches: they can maximize human rationality, but they can only imitate and cannot create. They cannot replace human sensibility and intuition. It is this sensibility and intuition that adds interest and excitement to life, and true creation arises from it.

"With the maturation of artificial intelligence technologies, especially cognitive intelligence technologies such as situational awareness, human-machine collaborative cognition, and intelligent decision-making, human-machine integration is gradually becoming an important characteristic and development trend in the intelligence field." "Human-machine integration refers to the fusion and mutual supplementation of probabilistic machine intelligence and organic human intelligence in intelligence work, jointly collaborating to complete complex intelligence tasks" [17]. For information science, human-machine integration is the fusion of artificial intelligence and human wisdom, which is an important task for developing information science in the big data context.

Distinguishing between wisdom and intelligence is of great significance for information science, as it firmly grasps the soul and essence of the discipline. Taking intelligence research as an example, even when applying new technologies and methods, conclusions drawn under data-driven and artificial intelligence conditions must be fully combined with the wisdom of experts to realize the functions of "eyes and ears, vanguard, advisor" and achieve the purpose of supporting decision-making.

4.4 Development Four: Diversification of Intelligence Collection Means

Intelligence collection is an important component of information science, equivalent to "eyes and ears" in role positioning—that is, observing in all directions and listening to all sides. Judging from current information science papers, whether information analysis or data analysis, regardless of the technology and methods used, the analysis objects are still mainly information or data from the Internet and databases, not truly massive in scale. At the same time, these information sources or data sources mostly belong to formal channels, with few from semi-formal channels and even fewer from informal channels. This is far from what information science requires.

Regarding the acquisition of data, information, or intelligence, people usually use the two terms "收集" (shōují) and "搜集" (sōují). Although these two words have similar pronunciations and meanings, the difference between the characters "收" (receive) and "搜" (search) makes their meanings different. The *Modern Chinese Dictionary* explains "收集" as "making things gather together" and "搜集" as "searching everywhere for things and gathering them together" [12].

"收集" contains the morphemes "收" and "集," meaning to bring external things into one's hands or to gather existing, scattered things together, which does not require much effort. Perhaps the things were already there but disordered or scattered, or perhaps they were sent by others and only needed to be received and organized. "搜," however, means searching everywhere. The combination of "搜" and "集" is divided into two steps: first searching, then gathering what is found. Therefore, "搜集" is not simply gathering but requires effort and hard work in the searching process.

In summary, both "收集" and "搜集" mean gathering things that are not together, but they emphasize different aspects. "搜集" means searching first and then gathering, while "收集" means gathering directly without searching. Before the action of "收集," the objects to be collected can mostly be seen, while before the action of "搜集," the objects to be gathered are mostly invisible. "收集" focuses on "收" (receiving), with objects being ready-made things, while "搜集" focuses on "搜" (searching), with objects being things that can only be seen after searching. The action targets of "收集" and "搜集" are different: the former tends toward ready-made targets, while the latter tends toward needed targets. Moreover, compared with "收集," "搜集" has a certain selectivity and directionality.

For information science, distinguishing between "收集" and "搜集" is of great significance. Specifically: "Intelligence 搜集" is more accurate and appropriate, while "intelligence 收集" is at a lower level and unsuitable for information science. Intelligence collection cannot be limited to formal or semi-formal information or data but must also include informal information or data, such as un-networked and un-archived, scattered, and disordered but valuable information or data. More importantly, it must also collect intelligence from interpersonal networks, including oral and physical information.

In the real world, based on the difficulty of intelligence collection, information can be divided into white information (cold information, accounting for about 80% of total information), gray information (hot information), and black information (confidential information). For competitive intelligence collection, 75% comes from white and gray information, and 25% from black information, as shown in Figure 4 [Figure 4: see original paper].

The objects of intelligence collection in information science are diverse, not limited to the Internet and databases but also including other types of digital carriers and many non-digital carrier types. Taking competitive intelligence as an example, intelligence collection also includes field investigations, conferences and exhibitions, interpersonal networks, mass media, government departments, industry associations, consulting companies, financial institutions, legal institutions, intermediary agencies, and so on, even including non-public but legally obtained information.

Judging from information science papers, information sources and data sources mainly come from the Internet and databases, with relatively single sources, resulting in certain limitations in analysis results. In the big data environment, the development and innovation of information science should adopt diversified collection means, broaden channels and sources, and meet the requirements of "broad, fast, refined, and accurate."

4.5 Development Five: Creating New Branches of Information Science

A prominent feature of current information science research in China is that it focuses on increasingly more and newer fields. Social hotspots easily become research hotspots in information science. For example, in recent years, online public opinion, emergencies, COVID-19, online medical care, and online shopping have all become research hotspots in information science. While it is understandable for information science to seize the most concerned hotspot issues in society for research, two unfavorable tendencies are likely to emerge: on the one hand, blindly following trends and clustering, simply chasing hotspots, and "labeling" information science as if it were omnipotent and all-inclusive; on the other hand, failing to put the academic tradition and ultimate goals of information science in the first place and integrate them into hotspot research. Although advanced technologies and methods are applied, most remain at the level of dealing with issues as they arise, lacking targeted decision-making support and practical academic and application value.

Although information science produces many research results on social hotspot issues, few truly reflect the functions, values, and goals of intelligence. There is even much simple repetition, and more importantly, there is little reflection of innovation in information science. That is, while introducing and drawing on theories, methods, and technologies from related disciplines, more consideration should be given to how to combine them with the reality of information science

to develop and build the discipline.

The development of information science should not only keep pace with the times, broaden research scope, enrich research content, and better serve society but also pay attention to its own disciplinary development and make achievements and innovations in discipline construction. Based on practical research, it should be elevated to the theoretical level to strengthen the theoretical system of information science.

In the process of transforming social hotspots into research hotspots in information science, efforts should be made to develop in depth, penetrate various appearances, explore the essential characteristics and evolution laws of intelligence, and the underlying mechanisms that govern these appearances, thereby forming surface mechanisms with universal guiding significance and contributing to the theoretical system of information science. Based on existing extensive research (especially empirical research), we should theoretically summarize, closely combine the characteristics of information science, extract the essence from numerous research results, refine theoretical elements useful for discipline construction, and form new branches of information science, thereby making contributions to the enrichment and development of information science.

To this end, the author proposes:

Could a complete systematic monograph—*Emergency Intelligence Science*—be published based on existing research on emergencies, crisis management, and emergency management, creating a new branch of information science?

Could a complete systematic monograph—*Public Opinion Intelligence Science*—be published based on existing research on online public opinion and public opinion identification, creating a new branch of information science?

The birth of new branches of information science marks the innovation of information science in an era where technological innovation leads everything, signifies that information science is maturing from exploration, and demonstrates that information science is making its own contributions to our society.

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