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Intelligence without Data

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Received: 11 December 2019 Accepted: 31 December 2019 Published: 15 January 2020

Abstract

This article explores intelligence without data. More specifically, it reveals what the study of big data ignores in the trinity age of big data, analytics, and intelligence, and looks at DIKEW intelligence through presenting an integrated framework of intelligence. It then examines intelligence without data and wisdom algebra. It demonstrates that intelligence without data consists of information intelligence without data, knowledge intelligence without data, experience without data, intelligence without data, and wisdom intelligence without data, based on the hierarchy of wisdom. It argues that big data must incorporate intelligence without data to serve the world. At the same time, intelligence without data could enhance human intelligence, cognitive intelligence, machine intelligence, and business intelligence.

Index terms— DIKEW intelligence, data, information, big data, knowledge, artificial intelligence, wisdom.

1 Introduction

ntelligence without data reflects a social reality because most people live in the environment of intelligence without data, although they are living in the age of big data . Big data are generated from various instruments, billions of calls, texts, tweets, phones, payment systems, cameras, sensors, Internet transactions, emails, videos, clickstreams, social networking services, and other sources (Henke & Bughin, 2016). Big data has become one of the most important research frontiers for innovation, research, and development (Chen & Zhang, 2014) (Sun & Huo, 2019). Big data and its emerging technologies including big data analytics and Hadoop (Coronel, Morris, & Rob, 2015) have been not only making dramatic changes in the way the business, e-commerce and cloud services operate but also making traditional data analytics and business analytics bring new opportunities for academia, industry, and government **??**Sun, Sun, & Strang, 2016) (Howson, Richardson, Sallam, & Kronz, 2019).

The nomenclature "intelligence" means intelligence in artificial intelligence (AI), machine intelligence, cognitive intelligence, and human intelligence (Wang, 2015). This building block has a history of at least three scores ever since 1956 (Russell & Norvig, 2010) . Big data intelligence (BDI) is a kind of intelligence driven by big data **??**Sun, Sun, & Strang, 2016) (Sun, Strang, & Li, 2018). However, either AI or machine intelligence or BDI has technically ignored significant and fundamental questions on intelligence, that is, 1. What is intelligence without data? 2. How can classify intelligence without data? 3. What is the impact of intelligence without data on AI?

These questions are significant because people can live without data sometimes; people have intelligence without data sometimes. On the other hand, these questions are fundamental for AI and machine learning because if we can understand the above issues better, then people need not explore deep learning People can enjoy the environment without data sometimes.

This article addresses intelligence without data, different from the linear traditional thinking of big data, and intelligence . More specifically, it reveals what the research of big data ignores in the trinity age of big data, analytics, and intelligence. It looks at DIKEW intelligence through presenting an integrated framework of intelligence. The research demonstrates that intelligence without data consists of information intelligence without data, knowledge intelligence without data, experience intelligence without data, and wisdom intelligence without data. It argues that big data can incorporate intelligence without data to serve the world; at the same time, intelligence without data can enhance human intelligence and machine intelligence as well as business intelligence.

The remainder of this article is organized as follows: Section 2 looks at DIKEW intelligence by presenting an integrated framework of intelligence. Section 3 explores intelligence without Data. Section 4 examines wisdom algebra. Section 5 provides a unified perspective on intelligence without data and illustrates intelligence without data using a few examples. Section 6 and 7 discuss implications and end this article with some concluding remarks and future work.

In the big data world, it seems that all digital things online are data, but much of it is not really "data" outside the big data world **??**Williams, 2016, p. 34). Information, knowledge, experience, and wisdom are I using a waste set of big data and oversupplied funds. more popular than data in computer science, business and management, and many other fields. This section will overview them and explore DIKEW intelligence using an integrated framework.

2 a) DIKEW Hierarchy

Data, information, knowledge, experience, and wisdom (DIKEW) form a hierarchical structure with a pyramid as a basis of intelligence (e.g., human intelligence, cognitive intelligence, AI, and machine intelligence) (Sun & Finnie, 2004; (Sun & Finnie, 2005) (Rowley, 2007) (Wang, 2015) (Liew, 2013), as shown in Figure **??**. DIKEW is an extended form with the reverse pyramid of DIKW (Rowley, 2007; Wang, 2015) (Liew, 2013). Data are raw, unorganized and unprocessed materials such as facts, numbers, signals, assertions, perceptions or observations that represent the properties of objects and events (Rowley, 2007) (Wang, 2015). Data usually are devoid of meaning, context, content, and value (Sabherwal & Becerra-Fernandez, 2011).

Information is processed data, a set of data, with the usefulness, content, relevance, purpose, and value (Ackoff, 1992;Sabherwal & Becerra-Fernandez, 2011). For example, the manipulation of raw data for a company, as a data processing, is to obtain more meaningful information on the trend for daily sales (Sabherwal & Becerra-Fernandez, 2011).

Knowledge is processed, organized, or structured information with the insight of experts (Laudon & Laudon, 2016) (Liew, 2013). Knowledge is a central concept in intelligent systems and cognitive systems (Wang, 2015) (Sun & Finnie, 2004;. In computer science and information science, knowledge is usually defined as the beliefs, objects, concepts, and relationships that are assumed to exist in some areas of interest (Sabherwal & Becerra-Fernandez, 2011), for example, knowledge discovery from a large database (Sun & Finnie, 2005).

Experience can be taken as previous knowledge and skill one obtained in the past or through social practice for some time (Sun & Finnie, 2005) (Oxford, 2008). In computer science, business and management, experience-based reasoning and experience management are important for understanding human reasoning and knowledge management (Sun & Finnie, 2005) (Sun & Finnie, 2004;. Case-based reasoning is a kind of experiencebased reasoning .

Wisdom is defined as "the ability to make sensible decisions and give good advice because of experience and knowledge that you have" (Oxford, 2008) (Liew, 2013). Wisdom can be defined as the ability to increase effectiveness through processing experience, knowledge, information, and data, all together (Ackoff, 1992). Wisdom adds value through appropriate judgments and creative ideas (Rowley, 2007). For example, the key idea in Page Rank of Google is a wisdom. The business model of Uber is also a business wisdom. Wisdom usually consists of revolutionary ideas that can bring big decisions and value for an organization. A question for wisdom is as follows. Why has only Peter pointed out such a wisdom in our big organization? Therefore, wisdom is closest to innovation, creativity, and ingenuity, comparing with experience, knowledge, information, and data, although the latter can be used for producing wisdom.

We have the following relationships among data, information, knowledge, experience, and wisdom based on the above discussion (Sun & Xiao, 1994) (Johnsonbaugh, 2013).Data ? information ? knowledge ? experience ? widom**(1)**

These relationships can be illustrated in Figure **??**, which can be also considered as the DIKEW pyramid.

Fig. **??**: Interrelations among data, information, knowledge, experience and wisdom

In the DIKEW pyramid, information is defined in terms of data (Rowley, 2007), knowledge in terms of information and data (Sabherwal & Becerra-Fernandez, 2011), experience in terms of knowledge, information, and data (Sun & Finnie, 2004; There are two transformations in this DIKEW hierarchy, as illustrated in Figure **??**. The first is the data-to-information-to-knowledge-to-experience-wisdom transformation, it can be called bottom-up transformation. This transformation reflects operations such as abstract (Wang, 2015), generalize, mine, process, manipulate, select, copy, summarize, and search, to name a few, from data up to wisdom via information, knowledge and experience. For example, data mining is a data-to-information-to-knowledge technique that transforms data and information to knowledge (Kantardzic, 2011), because the knowledge discovery from a database is the key task of data mining . Search, select, and copy are fundamental transformation from data up to wisdom in the age of big data and the age of the Internet.

The second is the wisdom-to-experience-toknowledge-to-information-to-data transformation; it can be called top-down transformation. This transformation usually includes operations such as specify, process, manipulate, select, apply, and search, to name a few. For example, how to use Uber to book a car for traveling from the city mall to the university is a kind of application. One then needs to search and select the nearest Uber car to realize "service provision just as booked" using a smartphone.

Each of above-mentioned transformation corresponds to a series of ICT techniques, algorithms, and methods.

For example, the management of data includes database definition language (DDL) and structured query language (SQL) in database management systems (Coronel, Morris, & Rob, 2015). Search and selection have been realized through search engines like Google and Baidu in the big data age. It is a life-long time study for one to properly search and select right data or information or knowledge or experience or wisdom.

It should be noted that establishing correspondences between these two bidirectional transformations (in Figure **??**) and the ICT techniques, algorithms, and methods are the tasks of DIKEW computing. DIKEW computing consists of data computing, information computing, knowledge computing, experience computing, and wisdom computing, where computing is about computing science, technology, engineering, management, and systems (ACM/IEEE/AIS, 2019). For example, data computing includes data science, technology, engineering, management and systems, and so on. Therefore, DIKEW computing covers almost all the activities of current ICT with applications.

We searched Amazon.com, and have not found a book whether on "wisdom science" or on "engineering of wisdom" or "wisdom engineering," but there is one book on "management of wisdom" or "wisdom management," that is, Optimal Knowledge Management: Wisdom Management Systems Concepts and Applications (Thierauf & Hoctor, 2006). However, this book focuses on "the essentials of knowledge management, business intelligence, and smart business systems" rather than wisdom management. This research demonstrates that wisdom computing in general, wisdom science, wisdom management, wisdom engineering in specific have not yet drawn much intention in academia and industries. However, some have tried to do so (McDonald, 2017). This paper does not go into each of them because of the limitation of space and beyond the scope of this research. Instead, we look into DIKEW intelligence.

3 b) Basic Intelligence

Intelligence is the ability of "learning, thinking, and understanding" (Oxford, 2008). These three abilities are the core of basic human intelligence. Machine learning including deep learning aims to automate ability of human learning through "improving the performance on future tasks after making observations about the world" (Russell & Norvig, 2010, p. 693). However, only learning, thinking, and understanding are not enough in modern society, because a human is also a social animal, connecting (or connect) should be another component of human intelligence. Advanced communication technologies and tools such as mail, telephone, fax, email, and information sharing on the Web aim to develop the skill of connecting (communication) as a form of intelligence. For example, the current advanced ICT technology and system (Laudon & Laudon, 2016) have brought about social networking services such as Facebook, LinkedIn, and WeChat. All these have developed the skill of connecting as a part of intelligence (e.g., human intelligence).

Therefore, the dimension of intelligence (e.g., human intelligence) consists of learning, thinking, understanding, and connecting.

4 c) DIKEW intelligence: An Integrated Framework of Intelligence

The above discussion leads to present an integrated framework for intelligence, as illustrated in Table 1, which can also be called DIKEW intelligence.

In Table 1, from left to right (Dimension 1), the first row presents basic intelligence: learning, thinking, understanding, and connecting. From top to bottom (Dimension 2), the first column represents enabling components: wisdom, experience, knowledge, information, and data. In the information row, we have informationbased learning, thinking, understanding, and connecting. All these are the main part of informationbased intelligence, for short, information intelligence (Hauch, Miller, & Cardwell, 2005). Information intelligence also includes the process of transforming data into information (Guang, Nie, & Li, 2009), because any transformation mentioned above is a kind of intelligent activity.

In the knowledge row, we have knowledgebased learning, thinking, understanding, and connecting. All these are the main part of knowledgebased intelligence, for short, knowledge intelligence (Guang, Nie, & Li, 2009). Knowledge intelligence also includes the process of transforming data into information and transforming data and information into knowledge.

In the experience row, we have experiencebased learning, thinking, understanding, and connecting. All these are the main part of experiencebased intelligence, for short, experience intelligence (Blake-Plock, 2017). Experience intelligence also includes the process of transforming data, information, knowledge into experience.

In the wisdom row, we have wisdom-based learning, thinking, understanding, and connecting. All these are the main part of wisdom-based intelligence, for short, wisdom intelligence (Ma, 2020). Wisdom intelligence also includes the process of transforming data, information, knowledge, experience into wisdom.

Therefore, DIKEW intelligence consists of data intelligence, information intelligence, knowledge intelligence, experience intelligence, and wisdom intelligence, as listed in the rightest column of Table 1. Combing this result and Figure **??**, we have the following inclusion relationship for DIKEW intelligence:data intelligence ? information intelligence ? knowledge intelligence ? experience intelligence ? wisdom intelligence (2)

Machine learning can be considered as a part of data intelligence or big data intelligence (Sun & Huo, 2019). We seldom consider machine learning to be a part of information intelligence, knowledge intelligence, experience

intelligence, and wisdom intelligence. In this regard, DIKEW intelligence could be ranked from lowest to highest. Wisdom intelligence is the highest intelligence, whereas data intelligence is the lowest intelligence. Therefore, machine learning is still a part of the lowest intelligence. AI has not realized the highest intelligence like wisdom intelligence to some extent. The above analysis provides an answer to why wisdom intelligence has not drawn significant attention in computer science, data science, and artificial intelligence (Ma, 2020).

5 III.

6 Intelligence Without Data

As mentioned above, data is the raw material for computer (computing machinery) processing. The processed data is information. Knowledge is the processed information with the help of experts (Laudon & Laudon, 2016). Experience is processed knowledge from social practice. Wisdom can be defined as the collective and individual experience of applying knowledge, information, and data to solve problems **??**Laudon & Laudon, 2016, p. 462). Wisdom is the integrated form of processed data, information, knowledge, and experience (Sun & Finnie, 2004;. Therefore, transformation from data up to wisdom is a process of applying ICT to each of them. The corresponding ICT technologies consist of data processing and management, information processing and management, knowledge processing and management, experience processing and management, wisdom processing and management to obtain DIKEW intelligence.

In the age of trinity, big data, analytics and AI (Minelli, Chambers, & Dhiraj, 2013) (Sun & Wang, 2017) (Sun Z., 2019), most people including researchers and developers have flattened the hierarchical structure from data via information, knowledge, and experience up to wisdom to data level, so that wisdom, experience, knowledge, and information have been used as data without any doubt (see Fig. **??**). In other words, wisdom as data, experience as data, knowledge as data, and information as data become popular. Similarly, in the age of knowledge, most people would consider wisdom, experience, information, and data as knowledge. Therefore, there lacks some rigor in the usage of wisdom, experience, knowledge, information, and data in the academic community.

From Figure **??**, we can infer, based on set theory (Sun & Xiao, 1994) , that. Information = (Information -data) ?data, Knowledge = (Knowledge -data) ?data, Experience = (experience -data) ?data, Wisdom = (wisdom -data) ?data.

Remark: These four formulas will also be verified in the next section. In other words,

? Information is the union of a set of information without data and a set of data, ? Knowledge is the union of a set of knowledge without data and a set of data, ? Experience is the union of a set of experience without data and a set of data, ? Wisdom is the union of a set of wisdom without data and a set of data.

Integrating these discussions with what we mentioned in the previous section on DIKEW, the following is valid.

? Information intelligence is the union of a set of information intelligence without data and a set of data intelligence.

? Knowledge intelligence is the union of a set of knowledge intelligence without data and a set of data intelligence. ? Experience intelligence is the union of a set of experience intelligence without data and a set of data intelligence. ? Wisdom intelligence is the union of a set of wisdom intelligence without data and a set of data intelligence.

Therefore, intelligence without data consists of information intelligence without data, knowledge intelligence without data, experience intelligence without data, and wisdom intelligence without data.

IV.

7 Wisdom Algebra

This section looks at wisdom algebra. Different from the wisdom hierarchy (Rowley, 2007) and experience hierarchy (Sun & Finnie, 2004;, this discussion can be considered as a deep investigation into the DIKEW hierarchy.

Definition 1: Let ?? be a set of operations, ?? is a nonempty set, then < ??, ?? > is an algebra (Sun & Xiao, 1994). Algebra is a kind of algebraic system, which can be considered as a mathematical abstraction of systems such as software systems, communication systems, and operational systems. Definition 2: Let ?? be a universe of all wisdom, experience, knowledge, information, and data. ?? is a set of operations. Then < ??, ?? > is a wisdom algebra. Now we elaborate ?? as a set of operations, each operation is an abstraction of computer processing in general and an ICT technique, an algorithm, and a method in specific. At a relatively lower level, an operation is an abstraction of a "click", or abstraction of a command related to a program. Based on the above discussion, an algorithm discussed in AI, computer science, data science, and information technology, is an operation sequence (Russell & Norvig, 2010) (Kantardzic, 2011).

At a higher level, computer processing includes data processing and management, information processing and management, knowledge processing and management, experience processing and management, and wisdom processing and management.

More generally, if ?? ? ?? is the set of all data, ?? ?? ? ?? is the set of operations, then < ??, ?? ?? > is data algebra, a mathematical abstraction of data processing and management system. For example, when ?? ??

includes select, project, and join, then < ??, ?? ?? > can be considered as a database algebra, an abstraction of database management systems (Coronel, Morris, & Rob, 2015).

If ?? ? ?? is the set of all data and information, ?? ?? ? ?? is the set of operations for processing and Intelligence without Data managing information, then < ??, ?? ?? > is an information algebra, a mathematical abstraction of information processing and management systems. When ?? ?? includes operations for information management and information systems, then < ??, ?? ?? >can be considered as an abstraction of information management systems (Laudon & Laudon, 2016). For example, when ?? ?? includes collect, analyze, and visualize, then < ??, ?? ?? > can be considered as an information algebra, an abstraction of information systems (Laudon & Laudon, 2016, p. 397).

If ?? ? ?? is the set of all data, information, and knowledge, ?? ?? ? ?? is the set of operations for processing and managing knowledge, then < ??, ?? ?? > is a knowledge algebra, a mathematical abstraction of a knowledge processing and management system. When ?? ?? includes operations for knowledge reasoning and knowledge management, then < ??, ?? ?? > can be considered as an abstraction of knowledge management systems (Laudon & Laudon, 2016).

If ?? ? ?? is the set of all data, information, knowledge,and experience, ?? ?? ? ?? is the set of operations for processing and managing experience, knowledge, and data, then < ??, ?? ?? >is an experience algebra, a mathematical abstraction of an experiencebased system (Sun & Finnie, 2005). Case-based reasoning (CBR) is a kind of experience-based reasoning. CBR has five operations, that is, case retrieval, reuse, revision, retention, and repartition , then < ??, ?? ?? > can be considered as a case-based algebra, an abstraction of case-based systems (Sun & Finnie, 2005).

If ?? ? ?? is the set of all data, information, knowledge, experience, and wisdom, ?? ?? ? ?? is the set of operations for processing and managing wisdom, experience, knowledge, information, and data, then < ??, ?? ?? > is a wisdom algebra, a mathematical abstraction of wisdom processing and management systems.

Generally, for any wisdom ??, there exist some data d and operators ?? ?? ? ?? ?? , ?? ?? ? ?? ?? , ?? ?? ? ?? ?? , ?? ?? ? ?? ?? such that?? = ?? ?? (?? ?? (?? ?? (?? ?? (??))))

In other words, data can generate wisdom through computer processing or transformation of data into information, knowledge, and experience. When ?? ?? = ?? ?? , ?? ?? = ?? ?? , ?? ?? = ?? ?? , ?? ?? = ?? ?? , ?? ?? = ?? ?? are identity operators, then?? = ?? ?? (?? ?? (?? ?? (?? ?? (?? ?? (??)))))

And ?? = ?? ?? (??) . That is, through identity transformation, data has been transformed into information, information into knowledge, knowledge into experience, experience into wisdom, and wisdom can be transformed into wisdom through identity transformation, so do experience, knowledge, and information. This conforms to the work of (Rowley, 2007) in that information is defined in terms of data, etc. It also demonstrates the soundness of the DIKEM hierarchy in Figure **??**. This also demonstrates that data is a part of the set of all the information, which proves that the statement of "information is a subset of data" (Sabherwal & Becerra-Fernandez, 2011) is not valid. The concise representation of all the information is as follows.

Information = data + processed data.

?? ?? , ?? ?? , ?? ?? , ?? ?? , and ?? ?? are allidentity operators, each of them is a mathematical representation (or abstraction) of ICT functions such as photocopy, copy, scan, print, and fax. Just as print, copy, and scan for ICT systems, identity operations are crucial for wisdom algebra because they keep the integrity of data, information, knowledge, experience, and wisdom.

More generally, based on the discussion of Section 2.1, we briefly have that?? ?? (????????) = ??????????????????????, ?? ?? (??????????????????????) = ??????????????????, ?? ?? (??????????????????) = ??????????????????????, ?? ?? (??????????????????????) = ????????????.

Therefore, we have(?? ?? ? ?? ??)(????????) = ?????????????????????? ????????????? ????????, (?? ?? ? ?? ??)(??????????????????????) = ?????????????????? ????????????? ????????, (?? ?? ? ?? ??)(??????????????????) = ?????????????????????? ????????????? ????????,

(?? ?? ??? ??)(??????????????????????) = ???????????? ????????????? ????????. Remark: data, information, knowledge and experience in the parentheses should be replaced by D, I, K, E respectively in order to keep mathematical integrity. The above representations can appeal to more readers.

V.

8 Intelligence Without Data: A Unified Perspective

This section will illustrate intelligence without data using examples from a unified perspective, based on the above-proposed wisdom algebra.

9 a) Information intelligence without data

We use Q-A-R (Question-Answer-Remark) (Sun & Finnie, 2005) to differentiate information from knowledge as follows.

Q1: What are you learning in your school? A1: I am learning knowledge. R1: Few say that "I am learning information". Now we differentiate information from data as follows. Q2: Do you know data about PA5510898? A2: I believe that this is an Australia passport number. R2: Few say that "Do you know information about

PA5510898". The answer A2 has been based on the knowledge or experience of the person. Maybe s/he has a friend with an Australian passport.

The answer A2 is correct, after computer processing, one finds that Dr. Peter Davison (an artificial name) is the holder of the Australian passport with the No. PA5510898. Peter is a millionaire in real estate and lives in Melbourne. The information is processed based on the data PA5510898 using a computer software. Therefore, such information-driven intelligence is information intelligence without data.

Remark: the above discussion implies that data is any data, information, knowledge, experience that as an input for computer processing.

10 b) Knowledge intelligence without data

Algebra is a system without data (Sun & Xiao, 1994). Mathematical logic is a logical system without data (Russell & Norvig, 2010).Graph theory is a system without data. We use Q-A-R (Question-Answer-Remark) to differentiate knowledge from data (Sun & Finnie, 2005).

Q3: What do you study at the university? A3: I study the knowledge on logic, algebra and graph. R3: Few said that they study the data on logic, algebra and graph. Therefore, algebra, mathematical logic, and graph theory can be considered as knowledge rather than data, at least to some extent. Therefore, logicdriven intelligence, algebra-driven intelligence, and graph-driven intelligence are knowledge intelligence without data.

The above discussion also implies that the students at a university mainly study knowledge rather than data. Therefore, the intelligence of students is, in essence, knowledge intelligence without data.

Further, Lisa likes to draw a picture from childhood on. Later she becomes a famous artist. The intelligence of Lisa is a kind of intelligence without data.

11 c) Experience intelligence without data

As well know, case methods are a successful instruction means for Harvard Business School (HBS) over the past century (McDonald, 2017). Many cases used at HBS are summaries of experience intelligence without data. These cases are results of integrating industry with Harvard Business School's teaching and research.

We use Q-A-R (Question-Answer-Remark) (Sun & Finnie, 2005) to differentiate the experience from knowledge as follows.

Q4: What are you learning in your school? A4: I am learning knowledge. R4: Few say that "I am learning experience". Q5: Why did you visit that old doctor? A5. Because he has profound experience in diagnosing and treating the disease that I suffered. R5: In this case, the knowledge of the doctor in diagnosing and treating the mentioned disease is not sufficient to attract the customer (or patient) to see the doctor. This is a common sense.

Knowledge and experience are intelligent assets of human beings (Sun & Finnie, 2005). The above discussion implies that experience is more important than knowledge in some fields such as clinic and hospital.

Furthermore, the following experience is also an example (Sun & Finnie, 2007):

If John has money, then John will fly to Beijing for a holiday tomorrow. However, John has not enough money. The consequence is that John cannot fly to Beijing tomorrow. This example is a kind of experience-based reasoning, although this reasoning is logically invalid (Sun Z., 2017). Such experience-driven intelligence is experience intelligence without data. The four new inference rules for experience-based reasoning (Sun Z., 2017), different from traditional deduction (based on modus ponens), abduction (based on abduction rule), refutation (based on modus tollens) are also inference rules without data (Russell & Norvig, 2010) (Sun Z., 2017). Therefore, the intelligence based on these experience-based inference rules are also experience intelligence without data.

12 d) Wisdom intelligence without data

The exemplar for wisdom intelligence without data is the theory of relativity developed by Albert Einstein. Einstein is best known for his mass-energy equivalence formula E = mc 2 which has been considered "the world's most famous equation" (Bodanis, 2000).

In 1905, Einstein published four groundbreaking articles, which contributed substantially to the foundation of modern physics and changed views on space, time, mass, and energy (Wikipedia-Annus, 2020). At the time these four papers were written, Einstein did not have easy access to a complete set of scientific reference materials nor big data on physics, although he did regularly read and contribute reviews to Annalen der Physik. Additionally, scientific colleagues available to discuss his theories were few. The experimental confirmation of Einstein' theory of relativity could not be obtained until the time dilation experiments of **??**ves and Stilwell (1938) and Rossi and Hall (1941) (Wikipedia-Annus, 2020). However, Einstein received the 1921 Nobel Prize in Physics.

It is obvious that Einstein's wisdom without data and thought experiment without data had played a decisive role in writing the above-mentioned papers and his theory of relativity.

13 e) A Unified Example for intelligence without data

The exemplar for DIKEW intelligence without data, taking into account DIKEW intelligence, is the Art of War, a book written by the Chinese ancient military strategist Sun Tze 2000 years ago (Giles, 2007).The book is composed of 13 chapters. Each one is devoted to a distinct aspect of warfare and how that applies to military strategy and tactics. For almost 1,500 years, the book has been the lead text in an anthology and always affected

Chinese military strategies and Chinese culture. For example, every Chinese has learned in the primary school that "If you know both yourself and your enemy, you can win numerous (literally, "a hundred") battles without jeopardy," which is directly extracted from the book.

In the Art of War, there are no data but affluent information, knowledge, experience, wisdom, and intelligent methods and strategies for using information, knowledge, and experience for military battles, summarized by Sun Tzu. Therefore, this book reflects an ancient Chinese military intelligence for wisdom without data, experience without data, knowledge without data, information without data, and their integration. VI.

14 Discussion and Implications

Intelligence without data reflects a social reality because most people live in the environment of intelligence without data, although more and more digital citizens live in the digital age. Hate or love is related to intelligence without data. Logical thinking, algebraic systems are results of intelligence without data. All these are the motive for doing this research.

This article is also motivated by the work of R.A. Brooks on Intelligence without Representation and Intelligence without Reason . Following the ideas of Brooks, intelligence without data can be extended to intelligence without information, intelligence without knowledge, intelligence without experience, intelligence without wisdom. Their interrelationships can be represented as a pyramid of intelligence without wisdom, as illustrated in Figure **??**.

15 Fig. 2: A pyramid of Intelligence without wisdom

The hierarchy of data, information, knowledge, experience, and wisdom (DIKEW) is an integrated form of the results in , (Sun & Finnie, 2005), and the DIKW (Ackoff, 1992) (Rowley, 2007) . Sun and Finnie propose a DIKED hierarchy, from data up to deception via information, knowledge and experience . They states that from the history of modern computing, the abstraction process from data to deception requires corresponding processing technology such as data processing and knowledge processing, which further involve data reasoning, data management and knowledge reasoning, knowledge management (including intelligent agents) and experience management respectively (Sun & Finnie, 2004;. The DIKEW hierarchy removes deception and keeps data, information, and experience because possessing knowledge is only one necessary condition for a field expert. The experience is more important than knowledge for a field expert to deal with tough problems (Sun & Finnie, 2005). Further, accumulation of knowledge is the necessary condition of accumulating experience for a field expert (Sun Z., 2017). Therefore, the DIKEW hierarchy is an extended form of DIKW hierarchy (Rowley, 2007) (Liew, 2013)and DIKED hierarchy by adding experience as a level between knowledge and wisdom.

We search Google scholar (www.scholar.google.com.au; on 29 May 2020) and find that there are round11 searched results on "Intelligence without Data," including the preprint of the author. Going into these results, "Intelligence without Data" has been used, to some extent, in the related four results are as follows: 1) Producing environmental intelligence without data that can be shared by multiple user communities; 2). SAP Operational Process Intelligence without data replication; 3). There was no intelligence without data collection, and 4). Business intelligence without data ware houses. It implies that there are no real researches on intelligence without data from either information systems or artificial intelligence or intelligent systems. This article provides the first attempt to explore intelligence without data.

16 Intelligence without data

17 Intelligence without information

18 Intelligence without knowledge

19 Intelligence without experience

20 Intelligence without wisdom

In Section 2, we proposed DIKEW intelligence: Data intelligence, information intelligence, knowledge intelligence, experience intelligence, and wisdom intelligence. These can be considered as a natural consequence of the DIKEW hierarchy. They are also the integration between the DIKEW hierarchy and intelligence or the result of the integrated framework of intelligence. Each of them has drawn some attention to some extent in computing and related discipline, based on the searched results using Google Web, Google Scholar (Retrieved on 29May 2020),and SCOPUS (Retrieved on 29 May 2020), illustrated in Table 2. In Table 2, Google web (https://www.google.com.au/?gws_rd=ssl) and Google Scholar (https://scholar.google.com.au) are used to search each of DIKEW intelligence. The researched results are listed in each cell of the second and third columns. For example, there are about 2,100,000results from Google Web and about 13,100 results from Google Scholar when searching "data intelligence" (on 29May 2020). SCOPUS is also used to search "article title" containing every item of DIKEW intelligence, and its searched number of articles (z). The rightest column is the searched number of articles containing every item of DIKEW using Google Scholar, for example, the searched number of articles containing wisdom is 2,930,000. From the searched results based on SCOPUS, we can find that data, information,

knowledge, and experience have drawn lasting attention in academia, in contrast, wisdom seems not easy to be studied towards scientific publications (McDonald, 2017).

As shown in Table 2, data intelligence, information intelligence, and knowledge intelligence have drawn significant attention in the general community (Google Web search) and increasing attention in the scholarly community (Google Scholar and SCOPUS). For example, Hauch, et al, have received some results on information intelligence (Hauch, Miller, & Cardwell, 2005). However, there are few genuinely scholarly publications on experience intelligence and wisdom intelligence in Google Scholar and SCOPUS at the moment, although there are several searched results. For example, experience intelligence can explore the value of experience data (Blake-Plock, 2017), big data intelligence and experience intelligence have also drawn some attention (Blake-Plock, 2017) . Therefore, there is a big space for developing information intelligence, knowledge intelligence, experience intelligence, and wisdom intelligence as a part of DIKEW intelligence.

VII.

21 Conclusion

This article extended the DIKW hierarchy to knowledge, experience and wisdom and proposed a novel perspective on data intelligence, information intelligence, knowledge intelligence, experience intelligence and wisdom intelligence. It demonstrated that intelligence without data consists of information intelligence without data, knowledge intelligence without data, experience intelligence without data, and wisdom intelligence without data based on the proposed DIKEW hierarchy and intelligence and wisdom algebra. Intelligence without data has not drawn much attention in AI and machine learning. It argued that big data should incorporate intelligence without data to serve the world; at the same time, intelligence without data can enhance human intelligence and artificial intelligence. The proposed approach in this article might facilitate research and development of big data analytics, AI, machine learning, and business intelligence as well as intelligent agents.

In the future work, we will illustrate the DIKEW hierarchy and intelligence with cases extracted from the real world. We will delve into the proposed intelligence without data with more references. We will explore intelligence without information, intelligence without knowledge, intelligence without experience, intelligence without wisdom, and their interrelationships.

DIKEW can be considered as a dimension as enabling components or techniques to develop intelligence.

Abstract generalize search summarize copy manage manipulate mine select process	Wisdom	Apply search select copy manage manipulate mine synthesiz specialize
	Experience	
	Knowledge	
	Information	
synthesize	Data	

Figure 1:

1

Enabling Components	Learning	Basic Intelligence Thinking	Understanding	Connecting	DIKEW intelligence
wisdom	Wisdom based learning	Wisdom based thinking	Wisdom based understanding	Wisdom based connecting	Wisdom intelligence
experience	Experience based learning	Experience based thinking	Experience based understanding	Experience based connecting	Experience intelligence
knowledge	Knowledge based learning	Knowledge based thinking	Knowledge based understanding	Knowledge based connecting	Knowledge intelligence
information	information based learning	information based thinking	information based understanding	information based connecting	Information intelligence
data	data based learning	data based thinking	data based understanding	data based connecting	Data intelligence

Figure 2: Table 1 :

2

DIKEW intelligence	Google Web (x)	Google scholar (y)	SCOPUS (z) in 2017	Stem of DIKEW on Google Scholar (m)
Data intelligence	2,100,000	13,100	23	Data 10,400,000
Information intelligence	411,000	31,100	26	Information 7,750,000
Knowledgeintelligence	271,000	11,100	15	Knowledge 5,860,000
Experience intelligence	121,000	4,220	4	Experience 5,850,000
Wisdom intelligence	254,000	4,550	3	Wisdom 2,930,000

Figure 3: Table 2 :

.1 Acknowledgement

Our thanks to Prof Paul P Wang of Duke University, Mr Lee Sun and Mrs Qing Chang of T.Rowe Price for their motivation and discussion during the early stage of this research. DIKEW hierarchy consisting of data, information,

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