A Theoretical Paradigm of Information Retrieval in Information Science and Computer Science

SHAILESH KHAPRE and M.S SALEEM BASHA

Department of Computer Science & Engineering
Pondicherry University
Pondicherry-605014, India.

Abstract

This paper describes the theoretical paradigms of information retrieval in information science and computer science, and constructs the theory framework of information retrieval from three perspectives that are user, information and technology. It evaluates the research priorities of the two disciplines and cross-domain of information retrieval theory. Finally, it points-out the theory status and development trend of information retrieval in information science and computer science, and provides exploration direction in information retrieval theory.

Keywords: *Information Retrieval, Information Science, Computer Science.*

1. Introduction

Both Information science and computer science research areas of information retrieval mainly focus on user and system interaction. In field of information science, information retrieval refers to the interaction of people with information retrieval system for relevant judgments of the information retrieval results from the selection of the search strategy [1]. Its research focuses on the specific behavior of people search for location information [2]. In computer science, information retrieval is extraction of relevant information that meets user needs from the large amount of unstructured information stored in the computer[3].

Earlier views of VanRijsbergen [4] are basically the same - Information retrieval is automatic (as opposed to manually), to provide information or documents processing (comparative data), and notify the user whether there is a query, it does not change the user's knowledge. From the definition of the two disciplines of information retrieval it is easy to see that the two disciplines share a common perspective of information retrieval - users, information technology and research directions. The two disciplines in field of information retrieval have a large number of researches. Information retrieval in computer science as a field of study is already very mature, their own journals and conferences focused on information retrieval Research (ACMSIGIR, conferences, journals the Transactions on Information Systems and Information Retrieval). Unlike computer science, information retrieval doesn't have a unique field status in information science. Its meetings (such as the ASIS&T), and journals (Journal of the American Society for Information & Technology, Journal of Documentation) often contain information science related works. However according to Wilson, "To Create New Knowledge- A point of view", because of the increasing number of researchers in information retrieval field of information science, many research communities has been established recently, therefore it can be said that in information science, information retrieval is the de-facto research area.

Table 1: The field of information science and the field of computer information retrieval theory framework

RESEARCH PERSPECTIVE DISCIPLINE	INFORMATION SCIENCE	COMPUTER SCIENCE	CROSS-CUTTING AREAS
INFORMATION	• Multi-layer Information • Hierarchical relationship of Information • Information usefulness	• Information representation • Information ranking • Text similarity	• Relevance
USER	• principle of least effort • Iterative process of retrieval	• Information provision	• Uncertainty principle • Interactions
USER TECHNOLOGY	• Channel preferences	• Query • Technical bias • Memex-vision	• Access to information

2. Information Science Field of Information Retrieval Theory Framework

2.1. Information Perspective of Information Retrieval Theory in the Field of Information Science

2.1.1. Multi-Layer Information

Information retrieval literature has been repeatedly stressed: Even though Information and the specific context of separation cannot be defined. As per Belkin and others [6] information is the core concepts of information science, Capurro [7] provides an overview of the definition of an information, both states the central role of information in the field of information science. The definition of information has a different point of view, such as the physical point of view, the cognitive perspective or context perspective. From the physical perspective, little information is involved in cognitive processes and it is possible to calculate the value of information [8]. Cognitive point of view elaborates information on how to influence and change the thinking. Inwersen [9] states that any information process can shift knowledge of information producers and information recipient. Belkin [10] states that the cognitive points of view explicitly consider the interactions of the human state of knowledge in the reception and perception of information; he proposed that the cognitive point of view is the leading information science theory and practice of the theoretical framework. Situational view or Context Perspective is concerned about the incentive and willingness of the user as well as social context (such as culture, work, etc.).

Schrade [11] Statistics information in the Information Sciences has come up with a lot of work to provide the classification of information defined framework. Buckland, [12] proposed three meanings: Information - process, Information - knowledge, Information - the fact, he has also added a property, Information is true. In the field of information science, information retrieval has basically accepted the multilevel nature of the concept of information. Whereas Information retrieval in the field of computer science looks from the point of view of information that is, the fact that information is unit of physical presence, such as text, images, and clips.

2.1.2. The Hierarchical Relationship of Information

Ackoff [13] proposed the continuity of knowledge: the data symbol and object or attribute represents information of the time; information is a description of the specific things; knowledge is a guidance level; Knowledge is an understanding of the interpretation of the facts or reason; Intelligence is the level of evaluation and judgment. Kochen [14] made a similar frame structure: What is the process of learning, the growth of knowledge, the improvement of understanding and intelligence improved. This frame structure forms the base of most of the information retrieval research background. Ackofff theory of evolution for the data - information - knowledge - intelligence (Data-Information–Knowledge-Wisdom, DIKW), also known as knowledge level, level of information, knowledge pyramid, forms the basis of information hierarchy which is widely recognized, and also help solve the problem of inconsistent information.

Many researchers have built on the DIKW level on the basis of the information system model, focusing on the relationship between data, information and knowledge [15]. Wilson explored the difference between the relationship between information and data and information and knowledge. Kari [17] describes information in the spirit of outcomes (eg, knowledge) which he included in the hierarchical classification. Oppenheim, etc. [18] Data from multiple perspectives, information and knowledge into the Line definition, that they are separate but related categories. DIKW concept represents the basic structure of the field, but not always clearly expressed.

The focus of attention of the field of information retrieval in information science, information and data is occasionally concerned about the knowledge; very few involve intelligence [19]. Computer science in the field of information retrieval is generally only concerned with the information and data to the database researchers, knowledge reserved for artificial intelligence researchers. Computer science in the field of information retrieval, information as fact decomposition [12] to convert the data (such as text, coding, etc.), but it does not concern the change of user knowledge or intelligence.

2.1.3. Perceived Usefulness

Moore proposed in some situations or environments, the user does not need the information, though it may be useful [20, 21]. People may avoid the use of information systems, because they know that the provided information is accurate or best suited. He believes that the information in these cases may be painful, costly, or troublesome. Individuals in the organizational environment compared to the use of information, avoiding information may reduce trouble. This is one of the few examples in the theory of information retrieval beyond the individual involved to the organization or institution. A lot of research on the basis of Mooers study, Koieng [22] Moores law of information systems design, Hertzum [23] explores the interaction between the engineers in a particular organization to retrieve information. Ryker [24], discussed the complexity of the organizations internal information system with user

expectations management. Hall's survey shows that employees believe that whatever information provided should be used, otherwise they will not be motivated.

Mooers's Law is very important in the field of information science, but he basically has no effect on information retrieval research in the computer field. Compared to the algorithm, organizational culture, policy, group interaction is far from the focus of information retrieval research in computer science.

2.2. User Perspective of Information Retrieval Theory in the Field of information Science

2.2.1. Principle od Least Effort

The principle of least effort is to resolve any problems, always strive hard to bring all possible costs, to minimize the average work. People of various social activities are subject to the principles that govern the theory that is to obtain the maximum benefit with a minimum price. As per Simon [26] people should choose a subset of the possible options in order to make decisions faster, rather than considering all the options. In statistics, a subset of the best choice may be close to the best choice for the entire collection; this theory has been the practically confirmed [27]. The principle of least effort also applies to the information foraging theory. Actively search for information on user behavior and animal foraging behavior is very similar, to achieve an optimal balance between the users need to spend time, money and effort to obtain the required information, this kind of information behavior is therefore referred to as information foraging [28]. Given the ever-increasing speed of information abundance and new information, the information foraging that human beings should adopt appropriate strategies to maximize the useful information received by the per unit of cost. People want to spend a minimum cost to get what they want, it's the basic example to illustrate the application of the principle of least effort in information foraging theory.

In the field of information retrieval in computer science the principle of least effort is recognized. Because its effect is indirect, so it is difficult to determine the direct impact on information retrieval system design. Element retrieval, contextual help, and results page design is an indirect example of the impact of the principle of least effort, but the focus of this principle is not the concern of the field of information retrieval in computer science.

2.2.2. Iterative(Iterations) Process

Information retrieval is an iterative process; it is the core content of the information retrieval research in the field of information science. In the field of information science, retrieval is a dynamic & changing process it may involve a fairly long time span. This iterative process as the concept of retrieval is the basic in almost all of the information retrieval models [29]. Belkin et al. [30] pointed out that information needs are dynamic, because of user ability to express information needs which is likely to change each time. The iterative process is also an information retrieval model, including a variety of information retrieval strategies, the Belkin et.al [31], choo [32] information retrieval mode and Marchionini [33] the electronic environment information query. The focus of the iterative search process is the based on user cognitive with affective changes in the state. Hider [34] pointed out that through the user interaction with the system only retrieval target can be amended.

Iterative retrieval, compared to information science computer science-information retrieval research area is narrow, because most of the technology based on query expansion and query modification for the centers. In computer science, information retrieval, some early models contains information retrieval iteration elements: inquiry, assessment inquiries. Relevance feedback techniques have been developed to support the results of a single price, or duplication of multiple iterations, the use of user feedback that the user needs.

2.3. Technical perspective of Information Retrieval Theory in the Field of information Science

2.3.1. Channel Preferences

Channel preferences of the field of information science are the preferred channel for information retrieval. The channel is a mechanism that allows users to search, find, select and receive information. These channels some are not even technology-based. Information retrieval researchers pointed out that people choose different sources of information depends on the information needs, context and other factors. This theoretical framework has rich practical research support. .Some studies have tried to explain the reasons for channel selection [35]. In the field of information science it is widely recognized that people with similar beliefs, values, education level and social status often choose the same channel [36]. There are some factors that influence channel choice: accessibility, trust, task complexity and minimum effort.

In information science to understand user preferences of the channels the key element is to determine the user's information needs [37]. The field of computer science there is no channel preferences, however, the expansion of the search results were studied and variety of information

sources were discussed, Including vertical and horizontal content acquisition.

3. Computer Science Field of Information Retrieval Theory Framework

3.1. Information Perspective of Computer Science Field of Information Retrieval Theory

3.1.1. *Information Representation*

Computer science, information retrieval researchers often treat the information as fact, and use information to do some work, such as an index of information, information coding, decomposition and analysis of information. This view is based on the nature of the information, i.e. specific, definable and can be encoded. Computer Science Information Retrieval follow the rational and traditional principle that information is the factual existence of the external world of things. VanRijsbergen [4] believe that, an information retrieval system contains a statistical analysis of the text, Follow-up study and also included the user and context. Since then, the field of computer science information retrieval researchers has recognize the equally important task and the environment i.e. Information retrieval from information systems to the information encoding. These concepts and methods including the statistical decomposition of the text file index within the collection, including the vector space model and probabilistic model, and efforts to integrate into the mathematical model. This view has led to research (such as the inverted file index, etc.) are valued, had a significant impact on the non-text information retrieval.

Computer science in the field of information retrieval has a relatively stable point of view, i.e. information can be broken down into the relevant text, which in-turns promote the development of several algorithms. In information retrieval research in the field of information science, there is lack of information centers to define the simultaneous development of research in several ways, this also limits the development of information retrieval is more formal model.

3.1.2. Information ranking

In dissimilar information systems, Ranking or scoring function may have significant difference in their results. Ranking is a typical response to user input query which results in retrieval of sorted documents. Database system, retrieves series of correct ordered results [40]. For query and response system, there are a series of answers to solve the problem, matching algorithm to calculate the query results. VanRijsbergen [4] states that the ranking of information in the information retrieval systems is the response to user requirements with a series of results and ranking of those results according to the users. A lot of work has to be done in order to improve the accuracy of ranking. The basic concept of ranking is based on the assumption that all of the search results have different values, such as the correlation measure.

Computer science, information retrieval research tends to focus on the rank count method to match the query or feedback, the file is not in accordance with the relevant rate of the text row column but rather on the matching algorithm. In Information science Research, information ranking is also a generally accepted concept, however, their research studies tend to focus on the cognitive, emotional, search results evaluation, end-use and environmental factors.

3.1.3. Text Similarity

Text similar to the rules are closely related, but different in some places, this means that if the query to a file with other documents associated with similar characteristics. The concept part of the cluster hypothesis i.e. Close relevant documents meeting same information need. Large number of studies of the cluster in the field of information retrieval [41], document clustering will lead to faster and more effective retrieval, not yet achieved in any case or system in implementation. Of course, if you find the most relevant literature, but no new information for the user of this text, then this text is of little value. Therefore, in order to ensure the validity of the document similarity rules, there must be certain types of noise. In other words, the user needs is not the same as a similar document. Document similarity rules are infiltrating in all aspects of computer science-information retrieval, the most significant is the acceptance of the document clustering and relevance feedback and ranking.

Text similarity is a key concept in computer science in the field of information retrieval, but it did not arouse the attention of information retrieval in the field of information science.

3.2. User Perspective of Information Retrieval Theory in the Field of Computer Science

3.2.1. Information Provisions

Computer science field of information retrieval research is built on the theory to provide useful information to the user. At the system level, the focus of information retrieval is to provide useful information to users; the resulting behavior makes storage and indexing possible for more information. The researchers believe that collecting more information will not only be beneficial to individual but

also to society as a whole [42]. Most information retrieval research is exploring more ways in order to provide more relevant information, more effective ways to store information, more successful way to index and retrieve information & Way for more effective use of information [43]. These are based on the user's information with useful cognitive assumption that user wants to obtain more information [44].

Information retrieval in the field of computer science researchers rarely examined that under certain circumstances more information is better, will it lead to more informed decision, or whether people would like more information. These also acknowledged that more information is always good, but in some cases, may actively avoid information [45]. More information does not necessarily improve decision making, although it increases the confidence of the decision-making. Assumption of information retrieval researchers in the field of information science, one cannot always rationally weigh the costs and benefits of the information [46]. Therefore, information and interests is one of the contradictions of the theory of information retrieval between the two disciplines.

3.3. Technical perspective of information retrieval theory in the field of computer science

3.3.1. Query

The query is the key theoretical information retrieval research area in computer science. Query is to use one or more symbols in combination with other syntax as command to locate the index the contents of an information retrieval system. In the query the symbols may be words, word sets, sample documents, there can be more than one possible combination. The query is the general form of information retrieval techniques, including basic of Boolean, probabilistic, vector space model. The query is a key factor in information retrieval; affect the ranking of the results, document clustering and almost all of the key field of information retrieval [47]. The query is a critical theory particularly in areas such as query expansion, query rewrite and relevance feedback. In field of information science researchers also believes that the query is the center of the content of the information retrieval process, thus signifying a fairly consistent between the two disciplines.

3.3.2. Technical Bias

In the computer field, most of the information retrieval research has focused in improving the technical performance, little reference to the inherent bias of the technical design decisions. In other areas of major studies have shown that technology may have a negative impact. Postman [47] warned that we tend to be a wonderful effect as machine surrounded us and are encouraged to ignore the ideas embedded in them, which means that we ignore the ideological significance of technology. Fogg [48] pointed out that technology can change our thoughts. Power and infrastructure to make Web2.0 Ubiquitous, technology is making it difficult for users to recognize that it is external, known only to the simple "interface value".

The field of computer information retrieval does not attach importance to these unintended consequences of the decision-making. Studies have shown that the computer field does not discuss the concept of a wide range of technical bias; it also has not been a focus in field of information science information retrieval. However, a small amount of research in the field of information science has been carried out to study the unintended consequences of technology.

3.3.3. MEMEX Vision

This is probably the most influential information retrieval theoretical framework, throughout all the literature in the field of information retrieval, from the personal library to Google-Global information integration mission. It can be said that the whole field of information retrieval research is the impact of this technology. As the Salton [49] most of the earlier studies have focused on the benefits of the use of technology, though there was some objection. Studies have shown that the use of technology benefits both individuals and society as whole. In addition, in the field of information retrieval researchers also implicitly put forward the technological determinism, but did not directly state. In essence, these two disciplines are concentrated to consider the benefits of technology use, with little regard for the other.

4. Cross- Cutting Areas

4.1. Cross-Field Theory Based on the Information Perspective

4.1.1. Relevance

Relevance as the key factors of information behavior has played a central role in information retrieval in both field of information science and computer science. Relevance has become academic consensus because of its dynamic, multidimensional, cognitive features and can measure views [50]. Saracevic [51] states that the relevance is the relationship between information and text, such as: information needs, intentions, themes, problems. Information retrieval system in Computer science is able to predict. Information systems using the algorithm and system memory matches the stored information objects

and files the querying result set. Earlier the concept of relevance was widely used in algorithm development process. Precision and recall rates are widely used as information retrieval system performance evaluation measures, evaluation criteria is a potential precision and recall rate. In field of information science, information retrieval researchers focus on users- user's state of knowledge, intentions, objectives and motivation of the use of information. Schamber, et.al. [52] states that relevance depends on the user in a certain time or in the Context between information and information needs to judge. Borlund [53] emphasizes dynamic relevance to expand the concept of situational relevance, that is, a user evaluation may change over time. Therefore, even if the relevance is a central element of information retrieval, it needs to be carefully studied & compared to determine the concept of relevance in the two disciplines.

4.2. Cross-Field Theory Based on the User Perspective

4.2.1. The Uncertainty Principle

In the field of information science, several researchers are working on uncertainty in Information Retrieval (Belkin, etc), uncertainties are present in many aspects of information retrieval research. Wilson [5] pointed out that uncertainty is always from a user perspective. K h hu5] states that in early stages of information retrieval there was lack of understanding or limited knowledge, this cognitive state is uncertainty, fuzziness & unclear is the basic characteristics and theme of the uncertainty. Uncertainty levels and information needs and search strategies [55]. With step-by-step information retrieval, the subject matter more clearly, from the uncertainty, confusion and frustration into confidence increases. The uncertainty principle also the ASK model [30], in the ASK model the users are defined as the abnormal state of knowledge. Users believe that there is lack of knowledge, and is determined by the information retrieval to solve his or her lack or abnormal knowledge. In general, the uncertainty of user knowledge in the particular related context is always limited.

In computer science, information retrieval has the same problem. The user may not accurately clarify the basic needs of the query result of the uncertainty, throughout the entire process of information retrieval. In the field of computer science, information retrieval research is focused on the use of algorithms to reduce uncertainty, such as re-query, query refinement, vocabulary problem, relevance feedback, the purpose is to help users to define clearer query. Query vocabulary problem is the focus of the uncertainty query algorithm.

4.2.2. Interaction Principle

Information retrieval in information science and computer science are related to the concept of interaction. It is a key factor in the information retrieval process and implementation. Interaction is an important part of the information retrieval is included in almost every model and mode of information retrieval, it provides additional information about a query or search information retrieval behavior. As pointed out in Xie [29], the interaction is a basic human characteristic, in the digital environment more & more people communicate in a variety of information systems. Ellis et al. [56] focus on the systematic analysis of the user query behavior. Cognitive model of Ingwersen [9], Belkin [10] interact with the text mode, the hierarchical model of a Saracevic [51] have stressed the importance of interaction in the information retrieval process. Belkin's model focuses on the interaction between the user and the text, Saracevic model focus on the different levels of interaction between user and system, but all the three models provide a series of interactive filter.

On the concept of interactive both disciplines of information retrieval has the same theoretical framework.

4.3. Cross-Field Theory Based on the Technical Perspective

4.3.1. Access to Information

In both disciplines, concept of access to information is same, that is, the easier access to information, the more people are likely to use it. As Pemberton [57] refers, the more time spent by users in the use of information systems, the more difficult for other to use this information system. Information degree obtained is directly proportional to ease of use. Wilson [1] states that every development in this field makes easier for users to access text or relevant information. In order to make information more accessible in both disciplines the query expression, context help and information visualization should be deeply studied. Although the principle of least effort, one should focus on access to information technology, rather than the user. It is especially suitable for computer science in the field of information retrieval, because it is more concerned about the design and development of system software. In the field of information science, a lot of work is aimed at improving the ease of access. Therefore, the architecture is the core of the two disciplines.

5. Conclusions

In this paper a comparative analysis of information retrieval in the field of information science and computer

science is shown in a theoretical framework, and found that the two disciplines theory presents a different trends, some theoretical development towards the trend of integration, some theory are moving in different directions, some theory is relatively static, specific development conditions shown in Table 2.

Overall, the identification of the theoretical framework can help researchers to understand their field of study and research. With the increasing similarities between the cross-cutting areas, the theoretical framework of information science and computer science, information retrieval continue to work towards the convergence trend.

In fact, the similarity of the two disciplines field of information retrieval is more active and cross the field of personalized, adaptive and implicit evaluation of information use of this technique has significantly improved the retrieval performance.

Table 2: The field of information science and the field of computer science theory development trends

THEORY	THE FIELD OF INFORMATION SCIENCE THEORY OF INFORMATION RETRIEVAL	THE FIELD OF COMPUTER SCIENCE THEORY OF INFORMATION RETRIEVAL	THE THEORY OF TWO DISCIPLINES DEVELOPMENT TRENDS
MULTI-LAYER INFORMATION	CENTRAL THEORETICAL	TREAT THE INFORMATION AS A FACTS	RELATIVELY STATIC
THE HIERARCHICAL STRUCTURE OF INFORMATION	THE BASIC THEORETICAL FRAMEWORK	LITTLE ATTENTION	IN THE OPPOSITE DIRECTION
INFORMATION USEFUL	CONCERNED ABOUT THE ORGANIZATIONS AND INSTITUTIONS	UNIMPORTANT	IN THE OPPOSITE DIRECTION
THE PRINCIPLE OF LEAST EFFORT	USER BEHAVIOR	WIDELY RECOGNIZED, THE IMPACT IS DIFFICULT TO DETERMINE THE FOCUS OF INFORMATION RETRIEVAL	FUSION
ITERATIVE PROCESS OF RETRIEVAL	INFORMATION RETRIEVAL MODEL	MANAGEMENT PROCESS IN VARIOUS STAGES OF INFORMATION RETRIEVAL	FUSION
CHANNEL PREFERENCES	DETERMINE THE INFORMATION NEEDS OF KEY	LIMITED IMPACT	FUSION
INFORMATION REPRESENTATION	THE SCOPE OF THE STUDY IS SMALL	THE BASIS OF THE RETRIEVAL ALGORITHMS	FUSION
INFORMATION PROVIDERS	DIFFERENCES WITH THE COMPUTER FIELD	DRIVE THEORY	IN THE OPPOSITE DIRECTION
INQUIRY	STUDY IS MORE DETAILED	SYSTEMS PERSPECTIVE	RELATIVELY STATIC
TECHNICAL BIAS	ALMOST NO ATTENTION	IMPLICITLY PROPOSED	RELATIVELY STATIC
MEMEX VISION	AS A VARIETY OF MEDIA	BASIC THEORY	RELATIVELY STATIC
CORRELATION	USER-ORIENTED	FOR INFORMATION SYSTEM	FUSION
INFORMATION RANKING	EVALUATION CRITERIA	KEY ALGORITHMS	FUSION
TEXT SIMILARITY	ARE NOT CONCERNED	CENTRAL THEORETICAL	RELATIVELY STATIC
THE UNCERTAINTY PRINCIPLE	THE BASIS OF THE INFORMATION RETRIEVAL MODEL	CONCERNED ABOUT THE EXPRESSION OF UNCERTAINTY	RELATIVELY STATIC
INTERACTION PRINCIPLE	INFORMATION RETRIEVAL BEHAVIOR	INFORMATION RETRIEVAL PROCESS	FUSION
ACCESS TO INFORMATION	ACCESS EASE	FOCUS ON TECHNOLOGY	FUSION

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Shailesh P. Khapre is a Research Scholar in Department of Computer Science & Engineering, Pondicherry University. His Area of interest includes Web-Services, Cloud Computing, Service Personalization & Information Retrieval. Currently he is working on Uncertainty in information Retrieval.

M.S. Saleem Basha is working as Assistant Professor in Department of Computer Science & Engineering, Pondicherry University. His area of research includes Web Services, Cloud Computing and Software Metrics. Currently he is working on Automated and proficient discovery of service by context based bi-matchmaking technique (CBT) funded by University Grant Commission- Govt. of India.