Facilitating Knowledge Intelligence Using ANTOM with a Case Study of Learning Religion

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Abstract. The growth of online/offline electronic materials obtained freely from the Internet may add a huge burden on learners. Users however need to understand the relationships among documents, for example how one document is related to others at a high level. This can be time-consuming and it has been unrealistically assumed that the users have already understood, to some extent, what the documents actually are. Knowledge Intelligence, part of knowledge management, is an area to study how to link up a set of given documents according to different user requests and to provide advice regarding what other types of information could be needed to complement the documents. This paper will demonstrate the automated knowledge management tool, called ANTOM, to facilitate the process of organizing learning materials so that learners may learn effectively. A real case study is given in this paper.

Keywords: Knowledge Intelligence, Knowledge Management, e-Learning, ANTOM, Domain Ontology

1 Introduction

The emersion of e-learning technologies promotes distance learning as well as brings revolutionary changes to face-to-face learning. Technology has become an essential utility in contemporary teaching and learning environment. Digital natives [1] perceive IT as a part of life naturally and as a utility in learning. A face-to-face teaching environment also adopts different technology components to facilitate learning, e.g., course management systems, lecture capturing, personalized applications [2]. Known as Blended Learning, this hybrid approach has gained popularity owing to the widespread use of the Internet and the advancement of mobile technologies. Mortera-Gutierrez [3] defines Blended Learning as "a combination [of] computer technology and Internet components with traditional face-to-face teaching forms and e-learning formats." The definition is implicitly limited to the applications of the technology in Blended Learning only for materials presented on different interactive media such as online/offline text chat, virtual face-to-face learning, edutainment games which are a form of entertainment designed to educate as well as to amuse learners, etc. It is not

related to classification and completeness of learning materials themselves. From this perspective, when sets of learning materials are given, learners will then be confronted with a problem of how pieces of information are connected or what relationships are among them. This helps people to learn much more intelligently than before.

A typical learning-intelligence problem exists long before the age of information explosion, which is that when there is more than one book on a particular subject, learners have to decide how these books are related to each other and which one of them should be read first, which ones can be used as reference, or whether the learners should look for additional materials to complement the existing ones. Surely, the problem can get much worse when available learning materials to the learners or teachers may at any time grow exponentially. We need an effective way to manage knowledge (i.e. online/offline electronic learning documents) even before we start studying them. This paper proposes a tool ANTOM to support knowledge intelligence.

The paper will provide a real-case study to demonstrate the application of ANTOM and Knowledge Intelligence. Two sets of religious documents are downloaded from the Internet and then are uploaded to ANTOM. First-time learners of Religion may quickly tell similarities and differences between these two materials by a concept map. Furthermore, scope questions serving as a learning scope will be provided to the learners so as to direct them what learning outcomes could be achieved and what might be understood at first.

This paper is organized as follows. Section 2 discusses Knowledge Intelligence and provides the background about the Automated Ontology Management tool, named ANTOM (www.askantom.com). Section 3 provides a real case study of learning two set of religious documents. Through this case study, we demonstrate how and why the application of ANTOM can facilitate knowledge intelligence. Section 4 discusses outstanding issues of knowledge intelligence and ANTOM's potential applications for the education and training industry. Section 5 describes the contributions of this work.

2 Knowledge Intelligence and ANTOM

In this section, we will provide the definition of "Knowledge Intelligence." Its demand and need for e-learning are then addressed. A knowledge-based system named ANTOM is discussed. ANTOM is an automated ontology management tool which can assist user to classify their documents and provide concepts maps.

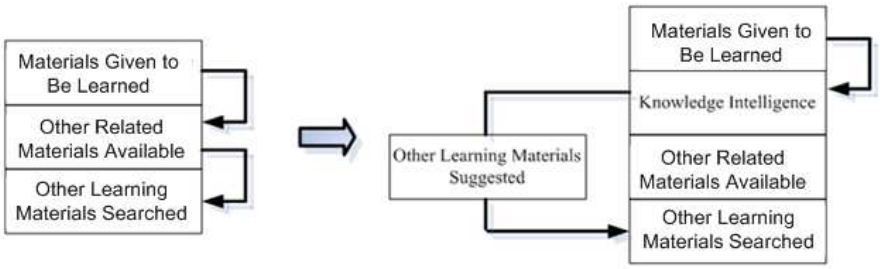
2.1 Knowledge Intelligence

The number of electronic documents has grown rapidly and hence finding the appropriate ones becomes critical to the success of learning faster and better. Two common approaches to searching documents are term frequency and lexical-cohesion [4]. Term frequency is to measure how often the same term appears in a document as a whole while lexical-cohesion is to analyze how terms appear in the text of a document. The

primary terms can then be extracted in a document and subtopics among them can be formed. The strength of association between terms and subtopics can be analyzed and ranked. Although both approaches are simple, intuitive and straightforward and they have been widely used in assisting users to locate their interested documents or parts of documents, the approaches provide no intelligent and/or heuristic mechanism to prioritize documents according to the user needs. For example, given a set of documents and two keywords, what parts of the documents should users need to read so as to cover an appropriate scope indicated by the two keywords and their related concepts in-between.

Note that two keywords are necessary to provide a scope from one concept to another. For example, "God" and "Science" are given and the learning scope will be anything between "God" and "Science." Based on the learning scope, we may assess whether given documents and which parts of them are within the learning scope. This process is referred as Knowledge intelligence which is a computer-based technique adopting ontology concepts used in analyzing and classifying any associative relationship among any kind of written information contents such as daily news articles, historical events, textbooks, personal blogs etc.

In Fig 1, traditionally, when users, who can be students and teachers, are given a topic to study, they need to look for related materials which could be on-line documents or websites. Afterward, they will judge which materials are related to their interested topic and they will prioritize what needs to be read [see Fig 1a]. With the help of knowledge intelligence, the priority of the reading documents and the need for complementary documents all can be advised to users [see Fig 1b].



(a) (b)

Fig. 1. Knowledge Intelligence

2.2 Automated Ontology Management Tool (ANTOM)

ANTOM, Automated Ontology Manager, is a semantic search tool [Fig 2] that is readily integrated with any content management system (or just a set of documents) to provide advanced search and annotation to facilitate knowledge management. ANTOM is designed to be affordable and can be operable by everyone without technical background. Semantic search is based on the actual meaning of document being

searched. Semantic web technology has been used to power the inside logic of the system.

ANTOM is powered by a lightweight, universal domain ontology that consists of over 7 million concepts which practically represent the entire knowledge domains. In other words, uploaded documents which are related to any specific domain can be categorized by ANTOM. Documents as the input to the ANTOM are assigned to related concepts based on the meaning of the documents when they are uploaded to the system. User can perform an exploratory search by navigating through concept maps generated by the system [5].

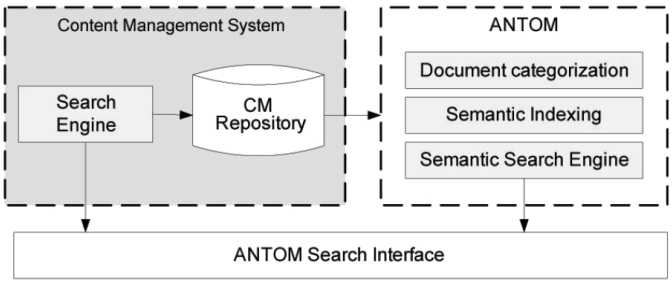


Fig. 2. Architecture of ANTOM

3 Application of Knowledge Intelligence

We provide a real case study to demonstrate the application of knowledge intelligence. It is reported that if religious education is to be taught well its essence as a subject must be grasped by those responsible for its teaching [6]. This suggests that learning and teaching religious for first-time learners and new teachers be challenging. This paper will discuss why and how Knowledge Intelligence provides some help to deal with the problem. Documents are downloaded from two Internet sites: www.biblegateway.com and www.quran.com as the input of ANTOM. It has been assumed that we, as the learners of Religion, do not really understand the contents of documents. These documents are then uploaded to ANTOM. Two pairs of keywords are selected as “Science and Bible” and “Science and Qur’an.” These keywords are about our learning requirements. Fig 3 and 4 are the results of the ANTOM output, respectively. Note that “science (0%)” means the documents are not related to science.

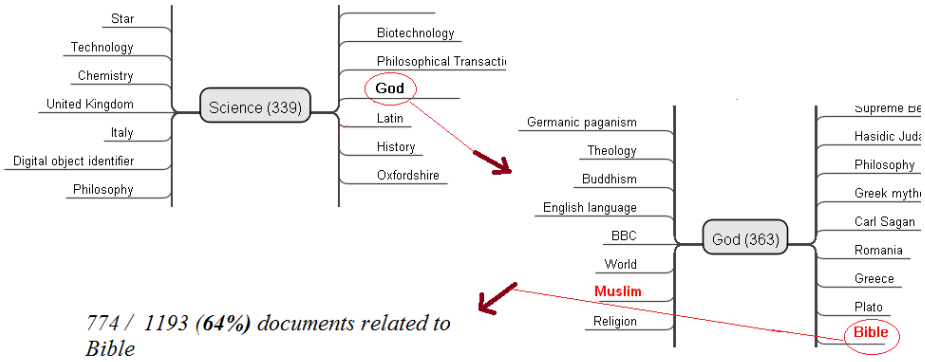


Fig. 3. ANTOM Result Concept Tree:
Science (0%) → God (0%) → Bible (64%)

Based on a concept tree in Fig 3, learners may need to get additional materials for Science and God. The uploaded documents have nothing to do with two concept trees (i.e. Fig 3 and Fig 4). However, the concept tree as a roadmap provides the background to learners and teachers about the uploaded materials.

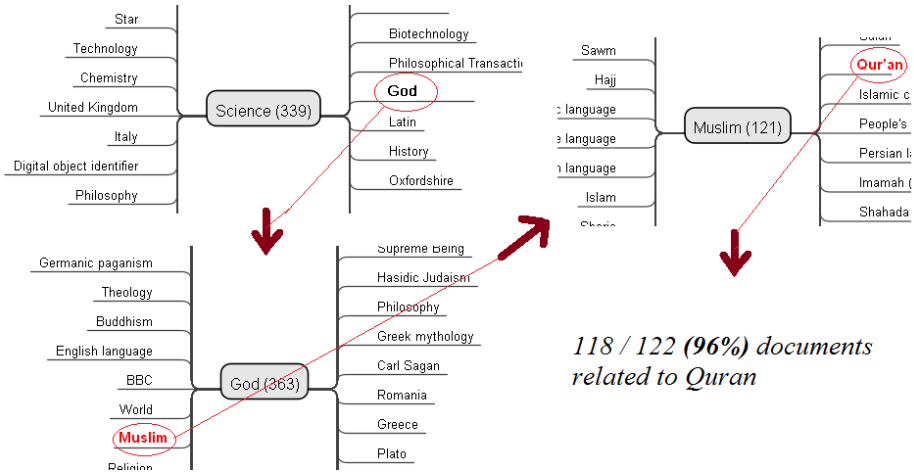


Fig. 4. ANTOM Result Concept Tree:
Science (0%) → God (0%) → Muslim (0%) → Qur'an (96%)

As far as there is at least one common concept term in two concept trees, we can merge more than one concept tree into one map shown in Fig 5. The benefit is that more concept terms are connected to build our learning scope. Without knowing what Bible and Qur'an are, we are able to define our learning scope from the concept trees or concept maps.

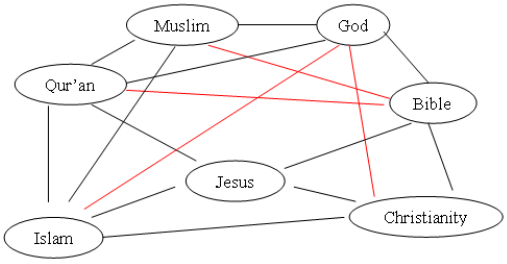


Fig. 5. ANTOM Result: Concept Map

Fig 5 shows the concept map. Although the map is useful and objective, people interpretation can be subjective. Learners and teachers with different backgrounds may have their own understanding to the concept map. Therefore, we define some rules to convert the concept map into a set of text statements as a mini guide to understanding the map.

These rules are that: if two nodes, A and B, are directly connected as A ↔ B and we can say A **is connected with** B or B **is connected with** A. When the concept map is as A ↔ B ↔ C, it can be stated as A and C **are related via** B or A **is not** C. Example statements given from the concept map in Fig 5 are below:

(1) Bible **is connected with** Jesus.
(2) Bible **is connected with** Qur'an.
(3) Bible and Qur'an **are related via** Jesus.
(4) Jesus **is not** God.

Fig. 6. Factual Statements

These factual statements may be used to motivate passive first-time learners to explore more. For example of Jesus is not God, when the learners do not really know the term Jesus, they might be misled to interpret it as the same as "Peter is not God." Therefore, we have to convert statements into questions so that we provide the learning scope to the users, rather than facts.

(1) Is Jesus connected with Bible? Why?
Or, is Jesus not connected with Bible? Why?
(2) Is Bible associated with Qur'an? Why?
Or, is Bible not associated with Qur'an? Why?
(3) Are Bible and Qur'an connected with (or via) Jesus? Why?
Or, are Bible and Qur'an not connected with (or via) Jesus? Why?
(4) Is Jesus God? Why?
Or, is Jesus not God? Why?

Fig. 7. Scope Questions

An example of scope questions are given above. These scope questions can be used for any form of learning such as face-to-face learning, computer-mediated learn-

ing and self-paced learning. They are practical for both teachers and students. They can also be used as the materials for an edutainment game serving as a pre-test or post-test assessment. A traditional format will be as “Select the best answer: Is Jesus God? (a) Yes , (b) No”

New learners of Religion may try to look at the part of the uploaded learning materials related to (1) ~ (4) given in Fig 7. If there is no document being attached to the concepts (say “Jesus” and “Bible” in the first question of Fig 7), the learners may need to look at other materials to complement the existing ones. In our case, Fig 3 and Fig 4 show that the uploaded documents do not include the topics of “God” and “Muslim” and learners of Religion should look for other materials about these topics.

Although two sets of documents are uploaded, the learners can simply look at those parts of the documents related to the concepts given in the scope questions, instead of studying these two documents, one by one.

4 Discussion

One may note that the trees of Fig 3 and Fig 4 can be huge and the search for these trees is an NP complete problem. To cope with this problem, we have to limit the breadth and the depth of the tree for searching. This approach, for many first-time learners, is satisfactory as the learners will be confused if the depth of the concept tree has more than four. The ideal case will be three and the maximum case is four.

However, the suggestion will become less useful when the users are a bit familiar with subject materials or even are experts in that area. They would like to explore how one concept to another concept via a longer path as this is exactly what they might want to see. This is the area we need to improve ANTOM in future.

ANTOM is a semantic search tool to facilitate intelligent learning. Although the paper merely proposes a case study, a teaching framework based on Knowledge Intelligence and ANTOM can be developed as the future work. In addition, controlled experiments need to be conducted to quantify the teaching and learning improvements.

Another interesting topic about ANTOM application is about the first-time users. It is expected that the first-time users with different age groups of 11-15 and of 16-20 may perform differently owing to their backgrounds. Therefore, an assessment of ANTOM for different age groups of first-time learners will be an important future research topic.

5 Contributions

This paper proposes an emerging field related to e-Learning called Knowledge Intelligence. The needs of knowledge intelligence are that users not only demand documents taxonomy for the existing documents but also want to understand how a type of documents are linked with another (i.e. what type of useful documents has not been included).

ANTOM provides a solution of generating a list of learning-scope questions based on a set of teaching materials and potential keyword pairs. This will definitely help self-paced learners, classroom students, coachers and teachers.

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