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A Web-Based Intelligent Tutoring System to Facilitate the Children's Understanding of Animals' Stories Through Keywords Extraction and Multimedia Elements

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Abstract: *Teaching children with intellectual challenges requires significant efforts to be done by the special education instructors. They needs to repeat each lesson several times and in different periods of times. They also need to simplify the meaning of each entity and concept in the lesson by using different elements including physical objects. To find such elements that suit the understanding capabilities of each child in the classroom the instructors spend a considerable amount of time. In addition, many of the children cannot understand with the retrieved objects. In this paper we propose a fully Arabic integrated intelligent tutoring system in which the lesson's script (i.e., animal story) is processed and the main entities such as animals and habitats named entities are visualized by using different images and mutimedial objects. Our proposed system entitled "Understanding Children Arabic Educational Texts (UCAET)" is based on an Arabic ontology for the animal domain, which is used to retrieve the corresponding multimedia elements and to extract new knowledge from the existing one.The proposed approach is highly apprecaited by the insttuctor in the special education center in Doha, Qatar.*

Keywords: *Ontology, Keywords Extraction, Multimedia, Special Education, Arabic Natural Language Processing.*

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1. Introduction

Children with intellectual disability (ID) need special education services that suit and meet their needs and learning skills. They need a longer time to learn and understand new concepts compared to their normal peers. The intellectual disability is classified as the most prevalent type of developmental disability for children and early intervention is highly recommended to alleviate the problem [1]. There are around 6.5 million people with intellectual disability in the USA [2]. In 2013-14 around 6.5 million students with ages from 3 to 21 suffer from some level of ID and get a special education service under IDEA [3]. According to a demographic survey there are approximately 135,000 people with disabilities in Saudi Arabia, which represents about 0.8% of the total population [4]. Another study of official statistics in the State of Qatar [5] indicates that in 2014, there are around 9,600 disabled persons registered in more than one special needs center to receive special services. Most children with ID in the Arab world did not attend normal schools. The most likely reason behind this is the lake of suitable educational programs, qualified instructors and the huge cost that many families cannot afford. This leads to the importance of providing the instructors and parent with an assistive educational system, that can be used in special education setting (i.e., schools, center, homes). A child with ID needs a special education to make progress in her/his well in school, and this type of special education depends on the degree of his/her intellectual disability. Some students can comprehend concepts with repetition and touching objects. These students do not need to be removed from general education classrooms but to provide them with suitable education services such as special instructional learning content, right equipment or other accommodations that can help them learn properly. Teachers and parents can help their children to develop their skills such as taking care of their personal need, building relationships or communicating with others, reading, writing, and doing basic mathematics. In previous work, an Arabic-based tutorial system was developed to teach the children with ID by using multimedia technology

[6, 7, 8]. For each tutorial there are number of games and puzzles with a different levels of difficulty. Developing a suitable content is one of the proposed system main problems. Each lesson requires several weeks to be designed properly. The designer creates an animation element for each character in the script, which is written by the special education instructor. Then the children in the classroom test the lesson. The content of the lesson could not fit the understanding capability for all students in the classroom even they are classified by the degree of disability (i.e., same IQ) test to have same intellectual challenges. Because of that, an intelligent system is required, in which it takes the story script as input and produce the suitable multimedia elements. Building such a system will help the children to understand the lesson much better and the teachers to have a set of multimedia objects available on-demand, which will cause a progress in the education service, as well as parents who can use this system to help their children in revising the lessons at home. In this paper, we propose an intelligent system for Arabic educational texts that get the script of the story as input and generates the corresponding multimedia elements. We use text segmentation and content mining to extract the keywords from the story' script. We propose an Arabic ontology for the animal domain that is used to recognize the main entities within the story script (i.e., characters, habitats, event, etc.). Ontology is generally used to represent and describe an area of knowledge. Moreover, the ontology describes the domain concepts and defines the relations among these concepts. The basic ontology blocks are concepts, properties and attributes for each concept. An animal ontology that we built combine animals' names and their multimedia elements and define the relation between these animals and other objects in the same domain such as plant and meat. From this ontology, we can infer that the animal lion, fox and wolf eat meat while other animals such as giraffe, horse and cows eat plants. Our Arabic ontology groups animals with their habitats (i.e., desert, forest, and sea), behaviors and locomotion (i.e., run, hunt, fly, attack). Special education instructors can choose the appropriate images that fit the understanding capabilities for each student in the classroom. We have built a simple prototype in [9] based on the English texts and built a simple English ontology for the same domain to recognize the main entities of the text. The paper is organized as follows: in Section (2), we discuss the Arabic text processing module. In Section (3) we discuss the development of the Arabic Ontology for the animal domain. In section (4) we discuss how the teacher can enrich the multimedia elements for a particular animal. In section (5) we show some scenarios of using our system by both teacher and student and we discuss the evaluation results. Section (6) discusses the future works. Finally, we conclude the paper in section (7).

2. Arabic Text Processing

The special education instructor should prepare the story script in a very simple format and input it into our system. Then the process of Arabic text processing will start as described in the next sub-sections.

2.1 Tokenization

Tokenization is a process that consists of dividing the text into proper units or chunk by extracting alphanumeric string or word included between two white spaces. We used the "String Tokenizer" java class, which fits our need to enumerate the individual tokens contained in the text.

2.2 Part-Of-Speech Tagger (POS Tagger)

To assign POS to each token, we have used Stanford Log-linear Part-Of-Speech Tagger [10]. From the output, we just picked up the nouns to find the names of the existing animals and habitats.

Figure 1. Part-of-Speech (POS) Output.

2.3 Stop Words Removal

To remove the stop words, we created a text file with a set of Arabic stop words and compare each word with the stop word map.

2.4 Selecting Animals & Habitats

To get names of the animal and habitats, we compare the extracted nouns with the entries of our animal ontology by running a set of SPARQL quires.

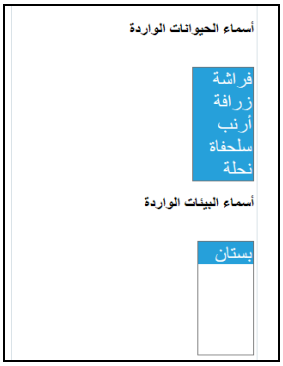

Figure 2. Animal & Habitat Names.

3. Development of Arabic Ontology for Animal Domain

Our goal is to build an Arabic Ontology for a specific purpose, thus we've created our ontology from scratch instead of reusing existing ones. We adopted the steps given in "Ontology Development 101" [11]. This method is simple and consists of many guidelines to help beginners build an ontology.

3.1 Specify both the Domain and the Scope of the Ontology

We need to answer a set of competency questions to specify the domain and the scope of our ontology, these question are: (a) what is the domain of the ontology? (b) For what is the ontology going to be used? (c) Who will use this ontology and who will maintain it? For our research, the domain of our ontology is "animals". It will introduce the characteristics of the animals to the children with ID.

3.2 Consider Reusing Existing Ontologies

Since we need to build a specific Arabic ontology for a specific education purpose, we have built it simply from scratch to facilitate the delivery of information in an easy and simple manner.

3.3 Enumerate the Main Terms of the Ontology

We enumerated the main terms required to describe the animal domain as following: حيوان ، نبات ، لقب ، صورة ، سلوك ، بيئة ، اليف ، كساء ، بيئة ، عاشب فصيلة ، زوج ، لون.

3.4 Specify the Class Hierarchy of the Ontology

To define the class hierarchy for our ontology, we adopted the top-down approach by defining the general concept first then the subsequent subclasses. For example: the top-level classes are حيوان ، إنسان ، بيئة ، تكاثر ، سلوك ، فائدة ، فصيلة ، صورة ، صوت ، كساء ، لون ، نبات while لاحم ، عاشب ، متعدد ، اليف ، وحشي are the most specific classes that exist at the bottom level in the class hierarchy.

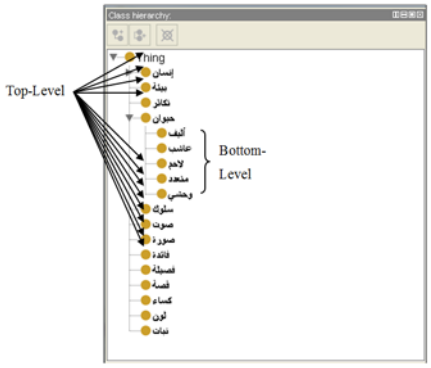

Figure 3. The Class Hierarchy of the Animal Ontology.

3.5 Define the Properties of the Classes-Slots

We defined the properties that describe the classes, and allow the ontology to answer the predefined competency questions. The properties are divided into two types: Object and Data property.

3.6 Define/Specify the Facets of the Slots

Facet of the slots means role restrictions. Slots may have several facets which describe the value numbers and types and other features of the values the slot can take [13]. For example: in the لاحم class, we used the extensional restriction some with the object property لـه-سلوك and يعيش-في as shown in Figure 4.

Figure 4. Facet Applied on لاحم Class

3.7 Create Instances

In this step, we created some instances for the listed classes in the ontology hierarchy by filling the properties/slots values. Figure 5 shows our Arabic ontology for the Animal domain. To build this ontology we used the java based open source platform Protégé 4.3 [12].

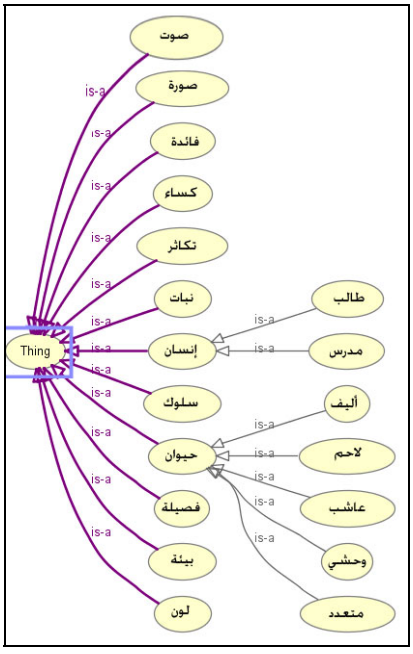

Figure 5. Arabic Ontology for the Animal Domain.

4. Multimedia Elements Enrichment

Special education instructors always need new multimedia elements for each object to simplify its meaning for the student with ID; finding these elements needs a lot of efforts, thus we provided the teacher with a screen that query the Google Image Search service [13] through its Java script interface to get a set of images for the selected animal, the teacher can select the suitable image which fits the understanding capability for each student.

5. Evaluation

To evaluate our ontology, we used the general evaluation criteria: conciseness, completeness, consistency, sensitiveness and expandability [14]. The result shows that there are no logical inconsistencies in our ontology. In addition, the completeness of the relationships definition was achieved by specifying the domain and the range for all objects and data properties, also the definition of both class hierarchy and the properties of each class that represents those of the real world. Moreover, we have tested the whole system by adopting several scenarios such as following:

5.1 Processing the New Lesson Script

Figure 7. Processing the script of a new story

Figure 8. Viewing the visualized Main Entities in the Story Script (Habitats and Animals).

5.2 Extracting More Information about a Particular Animal/Habitat from our Ontology

Figure 9. More Information About " أسد "

5.3 Adding New Images to Particular Animal

Figure 10. Adding new image to a particular animal

6. Conclusion and future work

Students with ID need custom education content with particular multimedia elements to simplify the understanding of words and to suit their intellectual needs. We developed a web-based intelligent tutoring system to facilitate the students understanding of animals' stories through keywords extraction and multimedia elements. This system is supported by an Arabic ontology on the animal domain to extract a new knowledge from the existing information. By using this system each student will have a suitable script with suitable multimedia elements. We tested the components of our system by using different scenario. We think that, the proposed system will simplify the meaning of different keywords and will ease the understanding of lessons' scripts.

For the future work, we can extract other keywords in the lesson script such as: actions, behaviours, and foods by using formal concept analysis as a mathematical tool that unifies data and knowledge. Another work could be enriching the ontology automatically by implementing semantic similarity as well as the relatedness measures depends on the information that are found in the lexical database WordNet.

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