

# Semantic Web Services for Nubian Language

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**Abstract**—A pilot study was conducted to test the ability of semantic web tools to design the Nubian Ontology for Nubian civilization. An important objective of the pilot study was to investigate the capability of the tools which help in developing semantic web services such as multilingual Dictionary and information retrieval (IR) services to design Nubian Ontology. TobBraid Composer was used as a tool in this study to test if it supported Nubian letters. Also the pilot Ontology which had been designed consisted of 18 classes and 4 properties representing the translation and pronunciation form/to Nubian, Arabic and English languages. Simple Knowledge Organization System (SKOS) was used for first the time in semantic research to represent Arabic and Nubian letters. The results indicated TobBraid composer displayed Nubian letters correctly and the inference engine answered the simple and complex queries. Multilingual dictionary designed and tested with simple query and complex query and the result was displayed correctly as plain text and as visual map.

**Index Terms**— Ontology development, Semantic web, Nubian Language, Simple Knowledge Organization System (SKOS).

## I. INTRODUCTION

Semantic Web (SW) has received substantial attention in recent years because of providing a standardized way of expressing the relationships among terms and allowing machines to understand the meaning of hyperlinked information and words in the same way people do; which is called "web of data" or "data about data".

SW Services (SWS) has many applications especially in Cultural Heritage such as:

- Search engines within integrated Cultural Heritage collections and artifacts
- Context-aware information presentation
- Navigation and browsing through museums
- Faceted search which can provide 3 Dimensions user interfaces
- Social aspects in Cultural Heritage access and representation

The semantic field theory is based on an analytical approach; which considers the meaning of a word within certain perspectives of the world. Ontologies defines the terms and relationships utilized to describe and specify an area of concern [1]. Ontologies are used to classify the terms employed in a particular application, defining possible relationship, and determine possible constraints on using those terms. Ontologies and linked data vocabularies normally are defined only in English. Being defined in a singular language creates a biased semantics and a corresponding world view. An infrastructure should be in place for developing ontologies and vocabularies in multiple languages.

When representing controlled vocabularies, taxonomies, and thesauri, (SKOS) is normally used. SKOS being an OWL1 ontology, is a Resource Description Framework (RDF)2 vocabulary for representing controlled vocabularies. In this paper, Nubian cultural concept was listed as a SKOS concepts in three languages, Arabic, English and Old Nubian, to provides a low-cost migration path for porting existing organization systems to the Semantic Web with Web Ontology Language (OWL) [2].

This study presents Nubian Semantic Services which will be instrumental in the domain of cultural heritage and as a multilingual dictionary tool using new fields of Semantic Web and SKOS.

The head of the First Nubian Cultural Tourist Festival high committee Abdulmajid Mohammed state :

"It is a responsibility on our shoulders to restore the ancient glory of the Nubian people, dust off their heritage and make the Nubian civilization shine again. We must attract tourists to come and get to know a civilization that has its roots deeply embedded in history"[3].

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1 OWL: The Web Ontology Language (OWL) is a family of knowledge representation languages for authoring ontologies.

2 The Resource Description Framework (RDF) World Wide Web Consortium (W3C) specifications [1] originally designed as a metadata data model.

Abdulmajid seeks to present the heritage of the Nubian people to the world in a scientific fashion. In addition, he suggests the promotion of tourism.

A pilot ontology using thirty one Nubian language letters [4] [5] was developed. The aim was to:

1. Return documents written in Arabic, Nubian and English
2. Return the translation and pronunciation of Arabic, Nubian and English terms.

W3C recommends using SKOS cultural heritage institutions especially for libraries and museums:

"Knowledge Organization System (KOS) is a set of elements often structured and controlled, which can be used for describing (indexing) objects, browsing collections, etc (see SKOS cases)" [2]. Typical examples of KOS are thesauri and classification schemes, which typically fit the scope of this paper. SKOS provides a standard way to represent knowledge organization systems using the RDF.. Encoding in RDF allows information to be passed between computer applications in an interoperable way.

This study is organized as follows. Section 2 discusses works in Nubian Semantic Web. In Section 3 the Nubian language is analyzed. The methodology for designing the SKOS Ontology is illustrated in Section 4. Section 5 presents the experiment and discussion of test results for the proposed SKOS. Finally, Section 6 outlines conclusions and future works.

## II. RELATED WORKS

Most of the works in Nubian Language in Web are driven by non-profit organizations which have helped to spread the language of the Nubian people.

In 2001, Abdelwahab and Abdel Gadir [6] affiliation with the NAPATA FOUNDATION<sup>3</sup>, published an informative website which contains a Virtual Keyboard for writing Nubian letters and MP3 audio files to hear the sound of printed character. Also the website contains songs from a Nubian singer (see Fig. 1).



Fig. 1. The Nubian Alphabet

The aforementioned works are promising as a strong background to start building the Ontology. A website for Nubian Language learning, which could be considered as web 2.0 is present. However, currently there is no type of Ontology developed in Nubian language or even any semantic services dedicated or related to Nubian language in any domain.

Nubian Ontology is the foundational creation of semantic based applications which supports content in Nubian language.

Tim Berners-Lee (1998) introduced the Semantic Web describing it as a hierarchy of formalisms, which are all based on Unicode Texts and Web-addresses (URIs). In addition to the formalisms are the classical web languages from the XML-family. The next two layers are the descriptions of texts with RDF and RDF-Schema which are in connection to Ontologies described in OWL. The upper most three layers are viewed as Berners-Lee's Inferences and Proof-procedures (see Fig. 2).

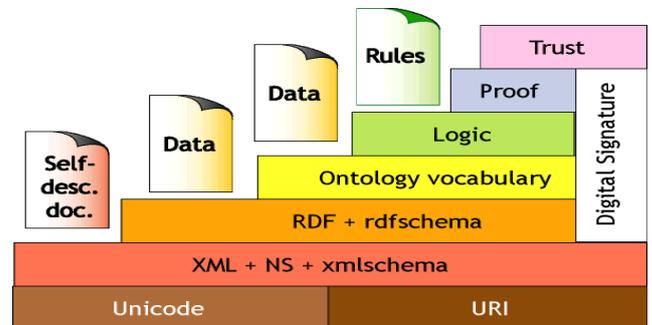


Fig. 2. Berners-Lee's Layer Cake

## III. NUBIAN LANGUAGES STRUCTURE DESCRIPTION

Nubba is a region along the Nile River, which is located in northern Sudan and southern Egypt [7].

Although Nubba is no longer an independent region, many of residents are still considered to be Nubians. Furthermore, numerous residents speak Nubian and some can trace their heritage back to centuries of African history. Visitors to this region can see a number of ancient archaeological sites and visit museums with Nubian cultural artifacts.

TABLE I. NUBIAN LANGUAGE DESCRIPTION

<sup>3</sup> NAPATA Foundation for Rural Community Development is a section 103 (c) tax exempt non-profit organization registered in the state of Washington.

<b>Nubian</b>	
Geographic distribution	southern Egypt, Sudan
Linguistic classification	Nilo-Saharan
Family	<ul style="list-style-type: none"> <li>• Eastern Sudanic <ul style="list-style-type: none"> <li>○ Nubian</li> </ul> </li> </ul>
ISO 639-2 /5	NUB

TABLE II. OLD NUBIAN LANGUAGE DESCRIPTION

<b>Old Nubian</b>	
Geographic distribution	southern Egypt, Sudan
Linguistic classification	Nilo-Saharan
Family	<ul style="list-style-type: none"> <li>• Eastern Sudanic <ul style="list-style-type: none"> <li>○ Nubian <ul style="list-style-type: none"> <li>• Northern <ul style="list-style-type: none"> <li>○ Old Nubian</li> </ul> </li> </ul> </li> </ul> </li> </ul>
ISO 639-2 /5	ONW

#### IV. DESIGNING THE NUBIAN SKOS ONTOLOGY

As mentioned in the previous sections, the Nubian ontology aims to represent different types of Nubian culture using three languages: Arabic, English and Nubian language. "Ontology Development 101: A Guide to Creating Your First Ontology" [3] was followed in the development process. The choice of this development process has been dictated by the need to allow novices in ontology modeling to contribute to the ontology design. This development process was used because of its efficiency and simplicity.

The ontology was modeled by using TopBraid Composer Standard Edition from TopQuadrant. TopBraid Composer is a popular modeling environment and an IDE for developing semantic services applications. TopBraid Composer is fully compliant with W3C standards. Composer offers complete support for building, managing and testing configurations of ontologies and linked data [8]. As part of TopBraid, the Composer provides a comprehensive Interactive Development Environment (IDE) for developing Semantic Web ontologies and building semantic. Composer is used to develop ontology models, configure data source integration, create semantic web services and provide a graphical representation of the ontology [8]. The ontology development process consists of seven steps [3]:

- 1) Determine the domain and scope of the ontology. A number of competency questions were identified to limit the scope of the ontology.  
The competency questions were:
  - What are the most important aspects of Nubian Heritage?
  - What are the most common terms?
- 2) Consider reusing existing ontologies. As previously discussed, resources were reused from SKOS library.
- 3) Enumerate important terms in the ontology. The main terms used in this ontology were the nouns describing generic types of Nubian Heritage such as Nubian Animals and Nubian Family Members.
- 4) Define the classes and class hierarchy. There are eighteen classes in this ontology.
- 5) Define the properties of classes. The four properties added were :
  1. skos:hasArabicPronunciation
  2. skos:hasArabicTranslation
  3. skos:hasEnglishPronunciation
  4. skos:hasEnglishTranslation
- 6) Define the facets of the slots.. There are no cardinality constraints here because the pilot scope was focused on investigating if Nubian characters are supported and building small prototype of Nubian terms.
- 7) Create instances: in this pilot study, instances have been created such as father, mother, brother, son, and daughter.

#### V. RESULTS AND DISCUSSION

TopBraid Composer mainly creates and displays ontology in Arabic and Nubian. One contribution of this study is displaying Arabic and Nubian text as shown in Fig. 7 and Fig.8. TopBraid is an applicable tool to build and manage conceptual terminology in ontology. This system uses the RDF standard and the UTF-8 encoding.

The Nubian prototype ontology created resulted from the development process described in the above section. The prototype is composed of a total of 18 classes, 4 properties and 5 instances.

Nubian Ontology needs top level to be defined from the known Top Level Ontologies such as Suggested Upper Merged Ontology (SUMO) and the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE).

The top levels of the Nubian Core Ontology was built manually based on DOLCE and SUMO upper level Ontologies. The ontology should take into consideration philosophical and historical aspects of the Nubian concepts

terms.

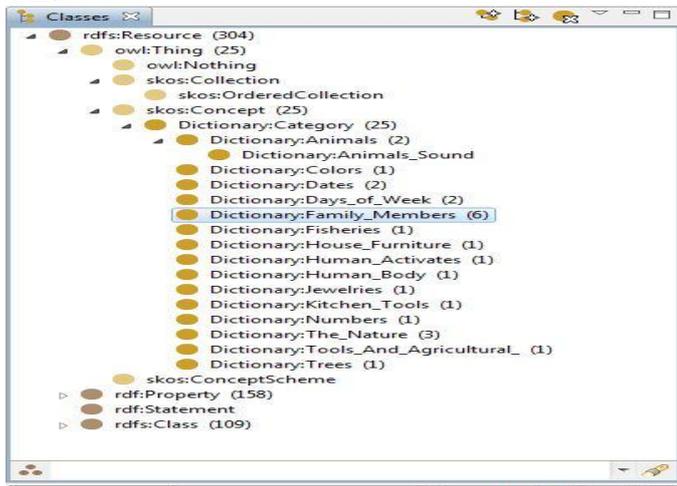


Fig. 3. The main Nubian categories for the pilot Nubian Ontology

Dictionary is the root concept for this ontology, all the other concepts inherit the properties associated with it. The developed pilot Ontology consists of 18 cultural specific classes such as: Dictionary:Animals: which contains Animals instances, Dictionary:Colors: which contains Colors instances and Dictionary:Family\_Members which contains Family Members instances. And the added properties (see Fig. 4,5) were:

- A. skos:hasArabicPronunciation: This property represents the Arabic pronunciation of the Nubian term.
- B. skos:hasArabicTranslation: This property represents the Arabic translation of the Nubian term.
- C. skos:hasEnglishPronunciation: This property represents the English pronunciation of the Nubian term.
- D. skos:hasEnglishTranslation: This property represents the English translation of the Nubian term.

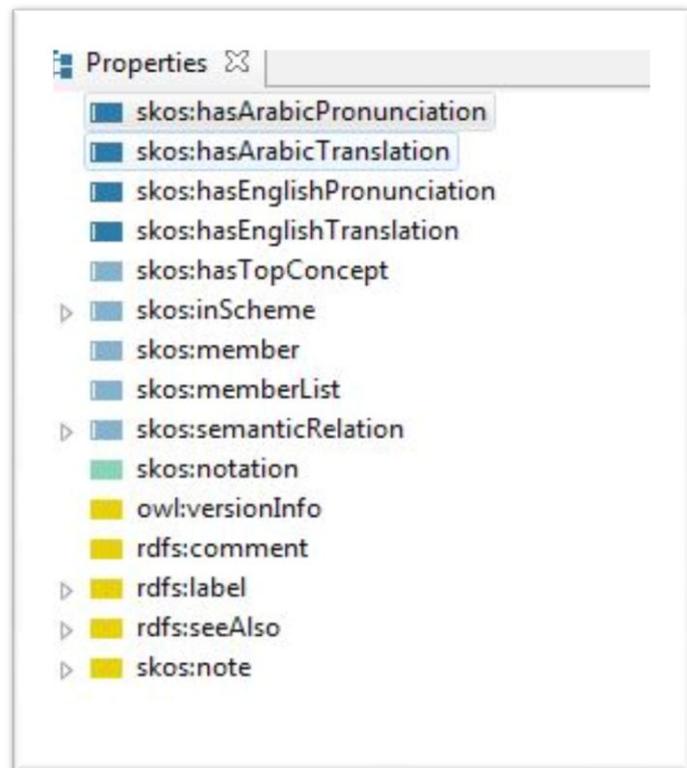


Fig. 4. The main properties in the designed Ontology

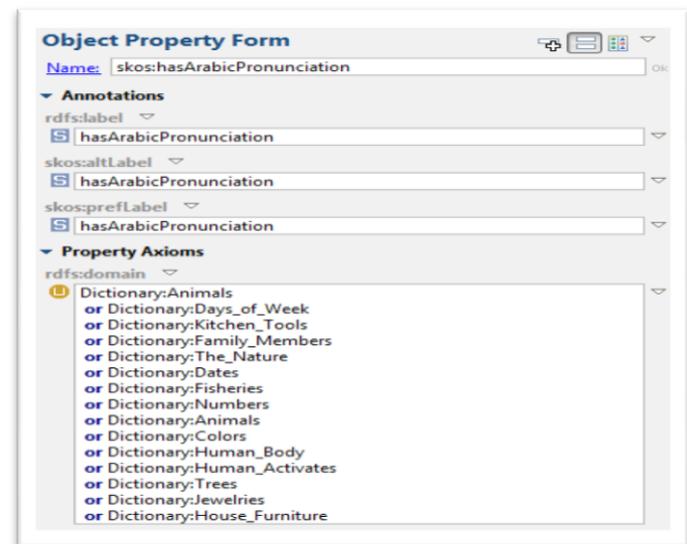


Fig. 5. Example for skos:hasArabicPronunciation property

Consider if some Nubian people needed to query about a Nubian term which they pronounced in arabic "انغا" - "Anga" (see Fig. 6) :

```
SELECT *
WHERE
{
  ?what_is_the_Nubian_word skos:hasArabicPronunciation
  "انغا"
```

}

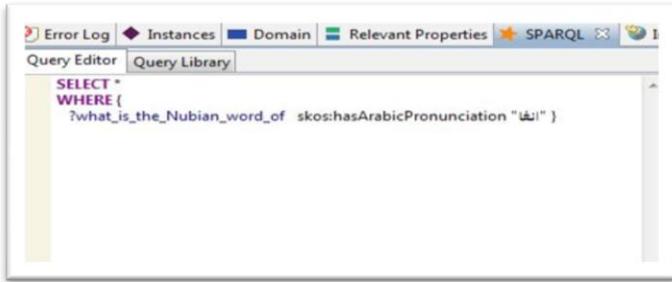


Fig. 6. Simple "Anga" query

The result of query was ENFäCFFä , it display Nubian letters and the inference engine works properly. (see Fig. 7).



Fig. 7. Simple "Anga" query result

Consider if some Nubian people needed to query about a term they always used to pronounce as "انغا" and also will query about :

- English translation
- Arabic translation
- English pronunciation

This is a complex query containing Arabic, English and Nubian (see Fig. 8).



Fig. 8. Complex "Anga" query

The executed query is :

```

SELECT * WHERE

```

{

```

?what_is_the_Nubian_word skos:hasArabicPronunciation

```

"انغا".

```

?what_is_the_Nubian_word skos:hasEnglishTranslation
?English_Translation.

```

```

?what_is_the_Nubian_word skos:hasArabicTranslation
?Arabic_Translation.

```

```

?what_is_the_Nubian_word skos:hasEnglishPronunciation
?Arabic_Pronun.

```

}

And the result is shown in Fig. 9.

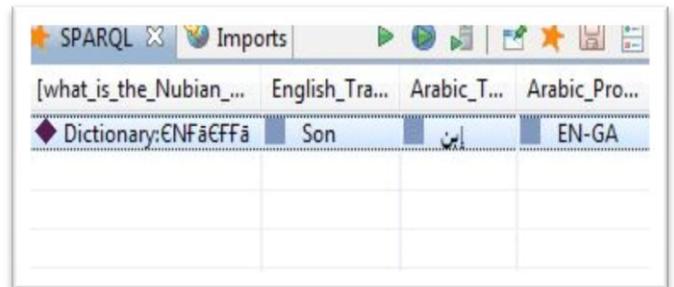


Fig 9. Complex query result

An increased attention to Nubian civilization has contributed to the need for a better understanding of culture heritage. The need for exploring relevant information quickly and accurately is a challenge for the Nubian websites. Currently, research has not been conducted in the area of Nubian semantic search.

In this paper, a pilot study has been conducted using SKOS. The following results were found:

- 1- The Nubian letters can be read and displayed by TopBraid Composer .(see Fig. 6,7,8)
- 2- The inference engine supports Nubian letter.
- 3- Multilingual Dictionary (Arabic, English, and Nubian) has been developed and proved to work properly. The Multilingual Dictionary can translate and provide the pronunciation of terms in Arabic, English and Nubian.

## VI. CONCLUSION AND FUTURE WORK

A pilot ontology using thirty one Nubian language letters has been developed which can :

1. Return documents written in Arabic, Nubian and English
2. Return translation and pronunciation of the terms in Arabic, Nubian and English

The proposed ontology was modeled by using TopBraid Composer Standard Edition from TopQuadrant. Simple and complex queries have been executed on the created ontology. TopBraid Composer was able to manipulate the

Nubian character and return the translation and pronunciation of Arabic, Nubian and English terms.

Another future challenge is applying Ontology learning to Nubian Ontology. Ontology learning is inherently multidisciplinary due to its strong connection with the Semantic Web, which has attracted researchers from a variety of disciplines such as knowledge engineering, databases, linguistics, machine learning, natural language processing, image processing, etc. In the Semantic Web context, Ontology learning is primarily concerned with knowledge acquisition of web content. Thus Ontology learning is shifting from small and homogeneous data collections to tackle the massive data heterogeneity of the World Wide Web [1] [9].

The results provide an opportunity to apply this research to Nubian texts in order to enrich Nubba core ontology. Further research can be conducted for mining historical Nubba civilization texts, extracting innovative information about pyramids location and historical customs and traditions of Nubian people .

## VII. ACKNOWLEDGMENT

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