MUHIT: A Multilingual Harmonized Dictionary

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Abstract

This paper discusses a trial to build a multilingual harmonized dictionary that contains more than 40 languages, with special reference to Arabic which represents about 20% of the whole size of the dictionary. This dictionary is called MUHIT which is an interactive multilingual dictionary application. It is a web application that makes it easily accessible to all users. MUHIT is developed within the Universal Networking Language (UNL) framework by the UNDL Foundation, in cooperation with Bibliotheca Alexandrina (BA). This application targets to serve specialists and non-specialists. It provides users with full linguistic description to each lexical item. This free application is useful to many NLP tasks such as multilingual translation and cross-language synonym search. This dictionary is built depending on WordNet and corpus based approaches, in a specially designed linguistic environment called UNL^{ariam} that is developed by the UNLD foundation. This dictionary is the first launched application by the UNLD foundation.

Keywords: MUHIT, multilingual lexical database, English WordNet.

1. Introduction

Much effort has been exerted into lexical databases over the years. The effort invested in the study and representation of lexical items to express the underlying difficulties existing in; first, language vagueness and polysemy. Second, language gaps and mismatches. To develop multilingual lexical resources, there are two approaches. 1) Reusing existing resources. 2) Building machine readable dictionaries from scratch. A multilingual lexical database should ideally have a structured set of language-independent meanings, operating as its interlingua and should meet a number of requirements (Hans C. Boas, 2009e). 1) languages will be connected at the level of meanings, and not at the level of words. 2) The number of language pairs in a database grows exponentially, so the meanings of the different languages should not be linked up in pairs, but should be connected via an intermediate set of meanings. 3) Since not all meanings are lexicalized in every language, there will be lexical gap. This problem cannot be solved by forcing every meaning in the interlingua to be expressed in every language to overcome lexical gaps (Maarten Janssen, 2000; Sammer, Soderland, 2007).

This paper presents an attempt to build a multilingual lexical database that includes more than 40 languages within the universal networking language (UNL) framework focusing on the Arabic part explaining its methodology, size, characteristics and types of information it provides.

Section 2 presents what is MUHIT explaining the size of the Arabic share and of other languages. Section 3 represents how MUHIT was developed, illustrating some of the challenges that were faced during the development. Section 4 explains the Arabic linguistic infrastructure of MUHIT. Finally section 6 discusses how to use MUHIT and its search options accompanied by results.

2. What is MUHIT

MUHIT is an ocean of knowledge. It is an abbreviation for (MUltilingual Harmonized dIcTionary), however, it is not just an abbreviation, it constitutes a meaningful word. The name "MUHIT" has been inspired by the Arabic word “المحيط” (al-Muhit), which means "Ocean" and "comprehensive". It also involves the ideas of “environment”, “ambience” or “surroundings”. The Arabic name of the application may have been inspired by the fact that MUHIT contains more than 2 million Arabic word forms, most of which we owe to the work done at the Library of Alexandria.

MUHIT is a multilingual lexical database produced by the UNDL Foundation within the UNL framework (Uchida, Zhu, Della Senta,1999) (S. Alansary, M. Nagi and N. Adly, 2010), where entries have been interlinked by sense, and natural language word forms have been associated to a uniform concept identifier (UW) (Martins and Avetisyan, 2009), which makes it possible to search for words with the same sense in the same language or in different languages. MUHIT contains more than 10,000,000 word forms collected from more than 40 languages, the number of entries varies from one language to another and is continuously increasing. The Arabic language ranks first in terms of the number of word forms inside MUHIT as it represents about 20% of the whole size; the Arabic share is 2,332,765 word forms. Languages vary in terms of the number of word forms each language includes, some languages include few word like Abkhazian language which has only one word form, lao language has only (30) word forms and Hindi language has (67) word forms. While some other languages have substantially larger number of word forms like English which includes (398,304) word forms, Russian which includes (1,585,693) word forms and Spanish includes (1,374,495) word forms. for more information about languages of MUHIT (http://www.unlweb.net/muhit/index.php?muhit=report).

Figure 1 shows the graph of the most active participating languages in MUHIT, Arabic is the most active participant.

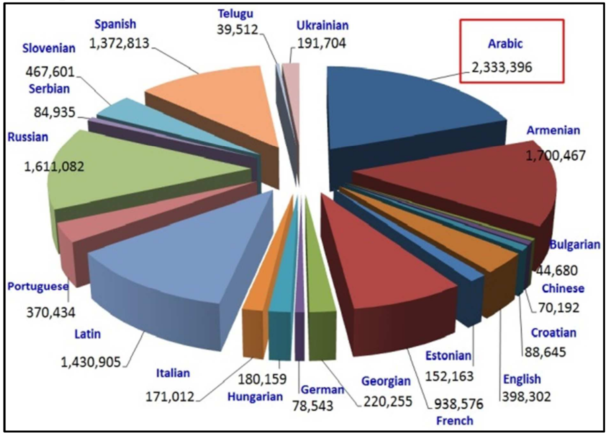


Figure 1: Arabic among the most active participants

MUHIT contains rare languages that are not found in other multilingual lexical databases. For example, it includes languages as Baatonum, Panjabi, Nepali and Sinhala that are not found in famous multilingual dictionary like Google.

All the entries of MUHIT have been introduced through the UNLarium which is a web-based integrated development environment for creating and editing language resources for natural language processing (NLP), especially related (but not limited) to the UNL framework. The data source of each language can be downloaded separately from the UNL^{arium} environment[1].

3. Methodology

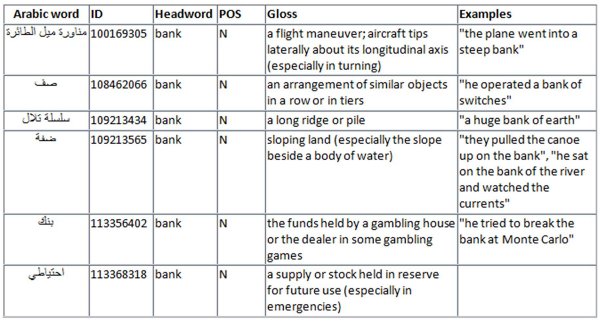
This section will present the sources of the Arabic words of MUHIT, and the environment that MUHIT was developed within, focusing on some challenges that have been faced during the development of MUHIT.

3.1. How MUHIT was Developed

This sub-subsection describes the approach adopted in building MUHIT. There are several approaches to build multilingual lexical databases such as Parallel Wordlists approach, Hub-and-Spoke Mode approach, WordNet approach, Acquilex et al. approach and Corpus Based approach (Maarten, 2002). The methodology adopted in developing the lexical database "MUHIT" depends on the combination of WordNet approach and corpus based approach which have been developed through the UNLarium environment. MUHIT was built by integrating two language resources The International Corpus of Arabic (ICA) and the English WordNet 3.0. All languages were required to link their dictionaries with the English WordNet as the first phase and collect 50,000 most frequent natural language words as the second phase. Arabic collected the most frequent 50,000 lexemes from ICA. There were two starting points. The first was from the WordNet and the second was from the natural language in order to increase the richness of MUHIT and grantee that most of the words were covered.

3.1.1. The English WordNet

The English WordNet 3.0 has been used in building MUHIT. The English WordNet is a large lexical database of English developed at the Cognitive Science Laboratory of Princeton University, it is widely used in the fields of computational linguistics and natural language processing (Fellbaum, 1998; Vossen, 1998). In the WordNet, nouns, verbs, adjectives and adverbs are grouped into sets of cognitive synonyms (synsets) each expressing a distinct concept and each assigned a distinct ID number. Synsets and their IDs (accompanied by a gloss, examples and a frequency number) can differentiate between even the slightest nuances of meaning. For example, "bank" have six meanings in the WordNet, they would be represented by six different IDs and six different Arabic words that represent their meanings in Arabic as shown in figure 2. English WordNet contains 117,659 senses. To integrate the English WordNet 3.0 in building MUHIT, the team tried to link every concept "sense" in the English WordNet with a suitable Arabic head word. Consequently, about 117,000 new Arabic words have been introduced to MUHIT.



Arabic word	ID	Headword	POS	Gloss	Examples
مناورة ميل الطائرة	100169305	bank	N	a flight maneuver; aircraft tips laterally about its longitudinal axis (especially in turning)	"the plane went into a steep bank"
صف	108462066	bank	N	an arrangement of similar objects in a row or in tiers	"he operated a bank of switches"
سلسلة تلال	109213434	bank	N	a long ridge or pile	"a huge bank of earth"
ضفة	109213565	bank	N	sloping land (especially the slope beside a body of water)	"they pulled the canoe up on the bank", "he sat on the bank of the river and watched the currents"
بنك	113356402	bank	N	the funds held by a gambling house or the dealer in some gambling games	"he tried to break the bank at Monte Carlo"
احتياطي	113368318	bank	N	a supply or stock held in reserve for future use (especially in emergencies)	

Figure 2:different meanings of the word "bank" in the English WordNet

3.1.2. The International Corpus of Arabic (ICA)

The International Corpus of Arabic (ICA) has been used in building MUHIT, because it contains 100 million words. The collection of samples is of written Modern Standard Arabic selected from a wide range of sources. It is designed to represent a wide cross-section of regional variety of Arabic; it is stimulating the first systematic investigation of the national variety as being used all over the Arab world (Alansary, Nagi and Adly 2006). Corpora have proven to be very useful resources for linguists who believe that their theories and descriptions of Arabic should be based on real, rather than contrived data. A list of most common 50,000 Arabic lexemes have been extracted from the ICA, these lexemes were mapped with our dictionary, about 30,000 new words were added to the MUHIT.

3.2. The UNL^{arium} Environment[2]

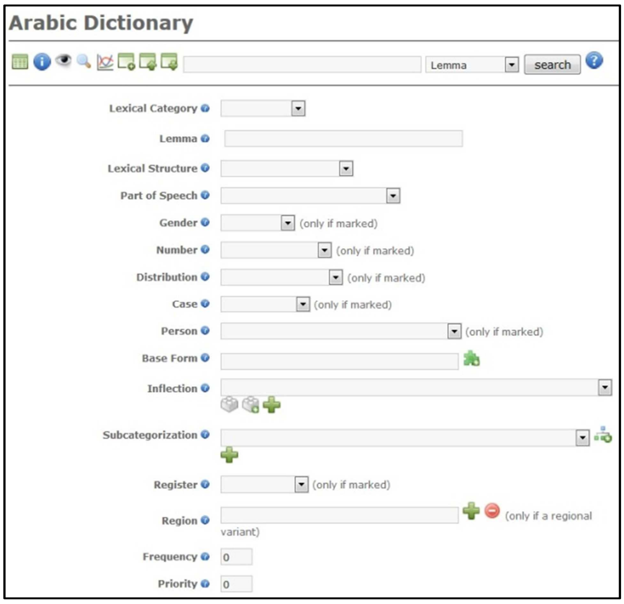
MUHIT was developed in The UNL^{arium} environment. The UNLarium is an integrated development environment for producing language resources for natural language processing (NLP). It is mainly a web-based database management system where registered users are able to create, edit and export dictionary entries and grammar

[1] http://www.unlweb.net/unlarium/index.php?action=export

[2] http://www.unlweb.net

rules according to the UNDL Foundation[3] standards for language engineering. Although originally conceived inside the UNL framework, the UNL^{arium} intends not to require any deep knowledge on UNL, and its data may be used in several NLP systems, in addition to UNL-based applications. Furthermore, the system is supposed to be used as a research workplace for exchanging information and testing several linguistic constants that have been proposed for describing and predicting natural language phenomena. One of our main goals is to create a language-independent meta-language that would be as comprehensive, as harmonized and as confluent as required by multilingual processing.

Arabic entries in MUHIT were added through the UNL^{arium} environment by adding the Arabic lemma then choosing its appropriate lexical category, lexical structure and part of speech. By choosing certain lexical category, a number of other linguistic features appear in the entry creation form. If the chosen lexical category is noun the gender, number, inflectional paradigms and Subcategorization frames of nouns will appear. If the chosen lexical category is verb the aspect, transitivity, inflectional paradigms and Subcategorization frames of verbs will appear. If the chosen lexical category is adjective the degree, distribution , inflectional paradigms and Subcategorization frames of adjectives will appear. After adding all linguistic features of the Arabic lemma the entry is added to UNL^{arium} and to MUHIT through Submitting the entry in UNL^{arium} which would be directly reflected in MUHIT. Figure 3 shows the form in the UNLarium environment for creating entries in MUHIT. All information appearing in this form will be discussed in details in section 4.



Arabic Dictionary

Lemma search

Lexical Category	
Lemma	
Lexical Structure	
Part of Speech	
Gender	(only if marked)
Number	(only if marked)
Distribution	(only if marked)
Case	(only if marked)
Person	(only if marked)
Base Form	
Inflection	
Subcategorization	
Register	(only if marked)
Region	(only if a regional variant)
Frequency	0
Priority	0

Figure 3: The entry creation form in The UNLarium environment

In order to ensure the quality of the created entries, users are assigned a profile, which is defined according to several characteristics. They can be promoted or demoted at any time depending on their participation in the project. The initial (default) level is Observer. Permissions are related to the scope of actions, as follows:

- Observers are allowed to browse dictionaries and grammars, navigate the system, but cannot add entries or grammar rules;
- Trainees are allowed to add entries, but only under supervision;
- Authors are allowed to add entries, but may edit only their own data;
- Editors may also edit authors' data, but cannot edit other editors' data;
- Revisers may edit editors' data, but cannot edit other revisers' data;
- Managers may edit any data, create projects and delete entries; and
- Super managers may edit the source code of the system.

In order to avoid problems, every entry or rule is double-checked inside the UNLarium: first by the editor, and then by the reviser. Permissions may be canceled depending on the users' track history. Authors can be demoted to Observers, if their entries achieve more than 10% of errors.

3.3. The Unified Tagset

The set of features in any dictionary depends on the structure of the natural language and may vary a lot. In order to better standardize lexical resources inside the UNL framework, the UNDL Foundation recommends the adoption of a set of tags for some specific and pervasive grammatical phenomena. This section presents the role of the unified tagset in building MUHIT. This tagset is a set of features and several of the linguistic constants have been already proposed in the Data Category Registry (ISO 12620)[4], they also represent widely accepted linguistic concepts. The purpose of this Tagset is providing the technical means for describing any linguistic behavior which should be done in a highly standardized manner, so that others could easily understand and exploit the data for their own benefit. The main intention is to create a harmonized system in order to make language resources as easily understandable and exchangeable as possible. The linguistic information inside MUHIT is a list of features extracted from the tagset.

The tagset is capable of defining the pervasive morphological, semantic, syntactic and even pragmatic phenomena. Each language can, then, choose the set of values applicable to the phenomena it reflects. For instance, the UNL tagset covers all possible values of countability; singular, dual, trial and quadral, paucal, multal, plural, singular tantum, plural tantum and invariant although the value of “dual”, for example, would never be used in languages such as English or French; however, it will definitely be used in Arabic. The tagset is arranged in a taxonomic hierarchy depicted in a tree that contains list of attributes with their values. For example, tagset includes the attribute “Gender” which has the values; “feminine”, “masculine”, “neuter”, “common” and “variable”. Also, part of speech, number, valency, voice, distribution, etc have lists of values.

[3] www.undl.org

[4] http://www.isocat.org/

The Tagset was designed in order to be as comprehensive, few, short and mnemonic as possible in order to ensure comprehensibility and consistency. It standardizes both: the tags of the linguistic attributes, and the tags of the values they may assume. Such standardization is crucial in ensuring translatability across the languages participant in the MUHIT. In addition, standardizing the set of tags across the UNL community facilitates understanding and exchanging the available language resources of different languages among the various UNL language centers. The tagset can be reached at http://www.unlweb.net/wiki/Tagset.

3.4. Challenges of Building MUHIT

This section presents some of the linguistic challenges that have been faced during building MUHIT. Some of these challenges are related to the selection of Arabic words and others are related to linking the Arabic words with the English WordNet.

3.4.1. Linking Arabic Words with English WordNet

In the attempt of linking the Arabic words with the English WordNet many challenges have appeared, such as lexical gaps, culture specific words and technical and scientific terms.

- Lexical gaps

Words in the WordNet are classified into different parts of speech according to the English language, however, their Arabic counterparts does not always belong to the same part of speech. For example, the word “summa cum laude” which means (with highest honor; with the highest academic distinction) is classified as an adjective in the WordNet, but the correct Arabic translation is “بامتياز” which is classified as an adverb.

- Missing appropriate UW

Some Arabic words do not have an appropriate UW (ID) to represent its exact meaning; for example the Arabic verb “بسمل” which means (saying “In the name of God the Merciful”) has no ID to represent its meaning; also the Arabic noun “إزميم” which means (saying “Crescent in the end of the month”) has no ID to represent its meaning. Such Arabic words were assigned appropriate UW according to the ontology. For example the UW of the Arabic noun “إزميم” is crescent(icl>natural object).

- The UW is a culture-specific words

Some UWs represent culture-specific words which do not have Arabic equivalent, because these concepts are not found in the Arabic culture. In this case, we transliterated the name into Arabic. For example, “mudra” which means “ritual hand movement in Hindu religious dancing”. There were two options to translate this word into Arabic; first, to transliterate it to be “مودرا”. Second to describe its meaning by Arabic words to be “حركة أيدي في الرقص الهندوسي”. The decision was to translate it into“مودرا”.

- Technical term

The headword of the UW is a name referring to a specific entity, but translatable (can be translated with Arabic lexical items). In this case the UW is represented by Arabic words, as in ”pac-man strategy” with the gloss ”the target company defends itself by threatening to take over its acquirer”, it will be represented in Arabic as “استراتيجية باك مان”.

- Biological Taxonomy

Biological classification, or scientific classification in biology, is a method to group and categorize organisms into groups such as genus or species. Each organism is given a scientific (or Latin) name and occasionally a common name. These types of words consists of two parts; the classifications (Kingdom, Phylum, Class, order, family, Genus, etc) and the scientific name. we translated the classification and added the scientific nameas it is. For example, the word “family Jungermanniaceae” was translated as “Jungermanniaceae فصيلة”.

3.4.2. Selecting Arabic Words

The task of finding free electronic sources in order to obtain lists of Arabic words was very difficult; it took long time and a lot of searching. Even if found, these lists were unusable, because they were always lists of word forms not lemmas which means that morphological analysis was needed.

3.4.3. Named Entities Insertion

It is planned to enrich MUHIT with the most common named entities found in Wikipedia. The insertion of this type of words will make MUHIT more useful for different uses and research studies that require information about named entities such as question answering. They will be fully described linguistically.

4. Arabic Linguistic Infrastructure of MUHIT

The linguistic infrastructure of MUHIT is a set of linguistic information developed to describe every natural language word. In order to better standardize lexical resources inside the UNL framework, the UNDL Foundation recommends the adoption of what so called “Tagset” which is a standard and universal list of features that is required for providing lexical resources. These tags have been proposed to the Data Category Registry (ISO 12620). This list of features is suitable for describing all linguistic phenomena of all languages. The focus here will be on the Arabic language.

4.1. Morphological Information

Morphological information is the information that can describe the morphological behavior of the words such as part of speech, inflections of words, etc. This section presents some morphological information that are assigned to the Arabic words of MUHIT.

4.1.1. Part of speech

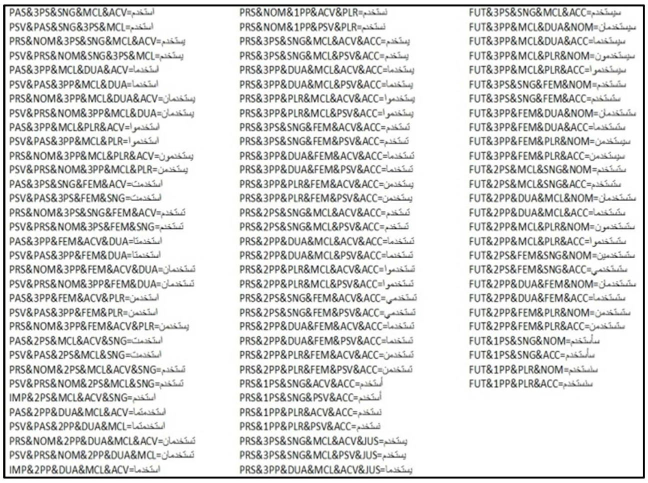
The Arabic entries are classified into different classes and each class may include subclasses. These classes are noun, verb, adjective, adposition, adverb, etc. For example, nouns are classified into common nouns and proper nouns, so words like “مكتب” ‘disk’ is common noun where words like “محمد” ‘Mohamed’ is proper noun. Verbs are also classified into subclasses, full verb, copula verb, and modal verb. For example, the verb “أكل” ‘eat’ is a full verb, “بدا” ‘seem’ is a copula verb, and “كان” ‘was’ is an auxiliary verb. All the other parts of speech are also classified into subclasses (Alansary, 2012). For more information see (http://www.unlweb.net/wiki/Part_of_speech).

4.1.2. The lexical structure feature

Arabic words are classified into sub word (bound morphemes) such as "س" /sin/ the future prefix, simple words as "قرأ" 'read' and multiword expressions which are lexical structures made up of a sequence of two or more lexemes such as "جمهورية مصر العربية" 'Arab Republic of Egypt'. For more information see (http://www.unlweb.net/wiki/Lexical_structure).

4.1.3. The inflectional paradigms

Inflection is the modification of words to express different grammatical categories such as tense, mood, voice, aspect, person, number, gender and case. Conjugation is the inflection of verbs; declension is the inflection of nouns, adjectives and pronouns. In the UNL framework, inflection is indicated by a set of transformations carried over the base form for generating the different word forms. Arabic is one of the highly inflected languages. For example, by assigning a feature such as M121 to the verb "استخدم" 'use', 146 different verb forms will be generated including the forms "يستخدم" 'he uses' - "استخدما" 'both used' - "يستخدمان" 'both are using - "يستخدمون" 'they are using' - "استخدمت" 'she used' - "تستخدم" 'she is using' - "استخدمتا" 'both (feminine) used' - "يستخدمن" 'they (feminine) are using' – "استخدمي" 'you use (imperative, feminine)'. Each paradigm contains a list of inflectional rules that are responsible for generating different word forms. Figure 4 shows a sample of the different inflectional forms of the Arabic verb "استخدم". The Arabic lexical database contains 343 inflectional paradigms, representing 10,566 morphological rule (Alansary, 2012).



PAS&3PS&SNG&MCL&ACV=استخدم	PRS&NOM&1PP&ACV&PLR=نستخدم	FUT&3PS&SNG&MCL&ACC=سيستخدم
PSV&PAS&SNG&3PS&MCL=استخدم	PRS&NOM&1PP&PSV&PLR=نستخدم	FUT&3PP&MCL&DUA&NOM=سيستخدمان
PRS&NOM&3PS&SNG&MCL&ACV=يستخدم	PRS&3PS&SNG&MCL&ACV&ACC=يستخدم	FUT&3PP&MCL&DUA&ACC=سيستخدما
PSV&PRS&NOM&SNG&3PS&MCL=يستخدم	PRS&3PS&SNG&MCL&PSV&ACC=يستخدم	FUT&3PP&MCL&PLR&NOM=سيستخدمون
PAS&3PP&MCL&DUA&ACV=استخدما	PRS&3PP&DUA&MCL&ACV&ACC=يستخدما	FUT&3PP&MCL&PLR&ACC=سيستخدموا
PSV&PAS&3PP&MCL&DUA=استخدما	PRS&3PP&DUA&MCL&PSV&ACC=يستخدما	FUT&3PS&SNG&FEM&NOM=ستستخدم
PRS&NOM&3PP&MCL&DUA&ACV=يستخدمان	PRS&3PP&PLR&MCL&ACV&ACC=يستخدموا	FUT&3PS&SNG&FEM&ACC=ستستخدم
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PAS&3PP&FEM&ACV&PLR=استخدمن	PRS&2PS&SNG&FEM&ACV&ACC=تستخدمي	FUT&2PP&DUA&FEM&ACC=ستستخدما
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PSV&PAS&2PS&MCL&SNG=استخدمت	PRS&2PP&PLR&FEM&ACV&ACC=تستخدمن	FUT&1PS&SNG&ACC=سأستخدم
PRS&NOM&2PS&MCL&ACV&SNG=تستخدم	PRS&2PP&PLR&FEM&PSV&ACC=تستخدمن	FUT&1PP&PLR&NOM=سنستخدم
PSV&PRS&NOM&2PS&MCL&SNG=تستخدم	PRS&1PS&SNG&ACV&ACC=أستخدم	FUT&1PP&PLR&ACC=سنستخدم
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PSV&PRS&NOM&2PP&DUA&MCL=تستخدمان	PRS&3PS&SNG&MCL&PSV&JUS=يستخدم	
IMP&2PP&DUA&MCL&ACV=استخدما	PRS&3PP&DUA&MCL&ACV&JUS=يستخدما	

Figure 4: All the rules of the paradigm M121 and the generated forms of the verb "استخدم"

4.2. Morpho-syntactic Information

Morpho-syntactic feature is a feature which is relevant to syntax, means that it is involved in either syntactic agreement or government. Gender, number, and person are involved in agreement in a large number of languages. This section presents some of this information that are assigned to the Arabic words of MUHIT.

4.2.1. Transitivity

It is used to describe the syntactic behavior of the verbs and the type of their arguments. The Arabic lexicon classifies verbs according to transitivity into two main classes, intransitive verbs and transitive verbs. The intransitive verbs are in turn classified into unaccusative verb whose subject is not the agent, as in the sentence "تدفق الماء" (Water flow) and unergative verb whose subject is the agent, as in the sentence "مشى الولد" (the boy walk). Transitive verbs are further classified into four types, direct transitive; a verb which takes a subject and a single direct object, such as the verb "شرب" 'drink' in "شرب الرجل الماء" 'the man drink the water', indirect transitive; a verb which takes a subject and a single indirect object, such as the verb "رحب" 'welcome' in the sentence "رحب الرجل بضيوفه" 'the man welcomed his guests', ditransitive; a verb which takes a subject and two objects, such as the verb "أمر" in the sentence "أمر الله الناس بالحق" 'Allah ordered people the truth', and tritransitive verb which takes a subject and three objects, such as the verb "أري" in the sentence "كذلك يريهم الله أعمالهم حسرات عليهم"'Thus will Allah show them their deeds as regrets'. Some other verbs are without transitivity as copula (Alansary, 2012). For more information see (http://www.unlweb.net/wiki/Transitivity).

4.2.2. Tense

It is used in the grammatical description of verbs, referring primarily to the way the grammar marks the time at which the action denoted by the verb took place. It can be broadly classified as: past tense as in "كتب" 'wrote', present tense as in "يكتب" 'writes' and future tense as in "سيكتب" 'will write'. For more information see (http://www.unlweb.net/wiki/Tense).

4.2.3. Gender

Linguistically, some languages like Arabic has two genders; masculine and feminine, however, Gender of natural language words within the UNL framework is classified into four genders; masculine such as "كرسي" 'chair' - "رجل" 'man' - "جدار" 'wall', feminine such as "طاولة" 'table' - "بنت" 'girl' - "جريدة" 'newspaper', common such as "ضحية" 'victim' - "موديل" 'model' - "نكرة" 'nobody' and variable such as "كأس" 'glass'. In the case of common and variable, the words may be classified as either masculine or feminine. The difference is that, in common gender, a change of the gender implies a change of the natural gender of the reference. For example, " رجل ضحية" 'victim = man' and "امرأة ضحية" 'victim = woman'. whereas, in variable gender, a change of the gender does not affect the reference, we can say "كأس هذا" or "كأس هذه" both mean 'this glass'. Gender attribute is important in generating the different word forms of both adjectives and verbs as in the adjective "نشيط" 'active', the word form " نشيط"'he active' describes masculine noun and the word form "نشيطة"'she active' describes feminine noun. Similarly with the verb "كتب" 'write' the word form " يكتب" 'he is writing' indicates that the verb agent is a masculine noun and the word form "تكتب"'she is writing' indicates that verb agent is feminine noun. For more information about gender see (http://www.unlweb.net/wiki/Gender).

4.2.4. Number

The number feature is mainly for describing nouns. Some languages like Arabic classify nouns according to numbers into three classes; singular, plural and dual, other languages like English classify nouns into two classes; singular and plural. The UNL Tagset classifies nouns into three main classes; singular, plural and invariant and each class includes subclasses. For example, the first main class singular includes the subclass “singular tantum” which describes words that are singular but do not have plural form such as “كتابة” ‘writing’. The second main class plural includes; dual nouns such as “كتابان” ‘two books’, paucal nouns which are nouns that refer to few of a class such as “بضع” ‘few’ as in “بضع سنين” ‘few years’, multal nouns which are nouns that refer to many of a class such as “كثير من” ‘Many of’, plural nouns such as “أطفال” ‘children’, and plural tantum which refers to plural nouns that do not have a singular form such as “توابل” ‘spices’. The number attribute is also assigned to verbs to specify the number of their subject and to adjectives to specify the number of the Substantive. For example, the verb “كتب” ‘he wrote’ is assigned as singular to indicate that its subject is singular, and the verb “أكلوا” ‘they ate’ is assigned plural feature to indicate that its subject is plural and so on so forth. As for adjectives, “جميل" ‘describes singular masculine noun’ and "جميلان" ‘describes dual masculine noun’. For more information about number see (http://www.unlweb.net/wiki/Number).

4.2.5. Person

It is a category that defines the deictic reference to a participant in an event, such as the speaker, the addressee or others. It is classified into first person, second person and third person. First person have two subclasses: first person singular as the Arabic word "أنا" ‘I’ (1PS) and first person plural as "نحن" ‘we’ (1PP). Second person have two subclasses: second person singular as in "أنت" ‘you’ (2PS) and second person plural as in "أنتم" ‘you’ (2PP). Third person have two subclasses: third person singular as in "هو" ‘he’ (3PS) and third person plural as in "هم" ‘they’ (3PP). Person attribute is also assigned to verbs to specify the person of the verb subject. For example, the Arabic verb “سمع” ‘hear’ is assigned the person feature (3PS) to specify that the verb subject is third person singular (3PS) and the verb form"أسمع" ‘I hear’ is assigned the person feature (1PS) to describes that the verb subject is first person singular (1PS). For more information about person see (http://www.unlweb.net/wiki/Person).

4.3. Syntactic Information

Syntactic information describes the principles and processes by which sentences are constructed. It deals with phrase and sentence formation out of words. This subsection will discuss some syntactic information that are assigned to words in MUHIT such as valency, aspect and subcategorization information.

4.3.1. Valency

Valency or valence is a category that indicates the number of syntactic arguments required by any predicate. Verb valency can be: monovalent such as in the sentence "مشى الولد"‘the boy walked’, divalent such as in the sentence "كتب الولد الدرس"‘the boy wrote the lesson’, trivalent such as in the sentence "أعطي الرجل جاره هدية" ‘the man gave his neighbor a gift’ and tetravalent such as in the sentence "كذلك يريهم الله أعمالهم حسرات عليهم"‘Thus will Allah show them their deeds as regrets’. In some cases the predicate is considered avalent which means that this predicate does not have arguments. For example “beautiful” (adjective) is avalent. For more information about valency see (http://www.unlweb.net/wiki/Valency).

4.3.2. Aspect

Grammatical aspect is a feature for verbs which is used to indicate the temporal internal structure of an action, event, or state, from the point of view of the speaker. There are two types of grammatical aspect inceptive(ICP) as in the Arabic sentence "بدأ يشرح الدرس" ‘start to explain the lesson’ and causative (CAU) as in the Arabic sentence "جعله يتقبل الأمر"‘made him accept it’. For more information about aspect see (http://www.unlweb.net/wiki/Aspect).

4.3.3. Subcategorization Frames

They are sets of rules used to generate syntactic structures out of the base form. Subcategorization frames that determine the number and types of the necessary syntactic arguments (specifiers, complements and adjuncts) of the verb. Subcategorization frames that are used in case of valent words whose syntax needs to follow a general rule, i.e., whenever there can be stated a regular pattern for generating constituents linked to the base form, such as specifiers, complements and adjuncts. For example the Arabic sentence "وهب الرجل المال لجاره"‘the man gave money to his neighbor’, The Subcategorization frame is:

VS(+NP,+NOM,+APER,+ANUM,+AGEN)VC(+NP,+ACC)VC(PH([ل]),+DAT);

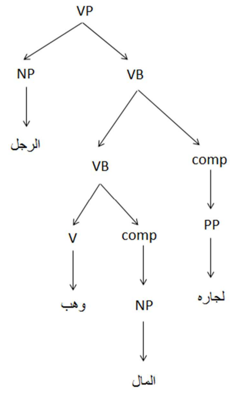


Figure 5: The syntactic tree of the sentence

This subcategorization frame indicates that the verb “وهب” ‘give’ has three arguments; verb specifier (noun phrase), verb complement (noun phrase), another verb complement (adverbial phrase) and the head of this phrase is the preposition “ل” ‘to’ as shown in figure 5.

4.4. Semantic Information

It focuses on the relation between on the one hand signifiers, like words, phrases, signs, symbols, and on the other hand what they stand for, their denotation.

4.4.1. Semantic classification of the words

The semantic classification adopted in MUHIT is the English WordNet 3.0. ontology. In WordNet, English nouns, verbs, adjectives and adverbs are organized into sets of synonymous words (called synsets), each synset representing one distinct concept. Each entry in this classification carries a set of features and attributes, all subclasses of this concept inherit the properties of that class (Fellbaum, 1998).

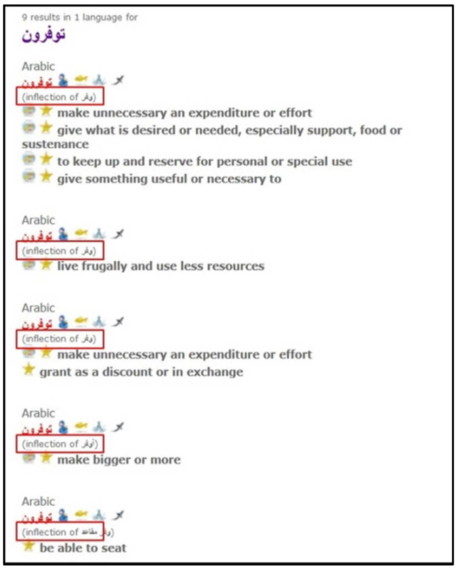
4.4.2. Animacy

It is a semantic category assigned to nominal concepts. It indicates human or animal referents. Animacy may assume two possible values: animate (ANM), if the referent is a living object; human or animal, as "مدرس" 'teacher' - "رجل" 'man' - "قطة" 'cat' or inanimate (NANM) which refers to any other non-living referent as "سيارة" 'car' - "مركب" 'boat' - "حرية"'freedom'.

5. Search options and results of MUHIT

The usage of MUHIT could not be easier. The interface is very simple and intuitive. It only consists of a search bar and a help button. The system searches for the string in all existing dictionaries. This search is performed not only for the citation forms of the words but for all existing inflections as well. For more information see (http://www.unlweb.net/muhit/index.php?muhit=help#C).

All this linguistic information appears with the results of using MUHIT multilingual lexical database. MUHIT allows searching by lexeme, word form or wildcard search options, it also allows searching by the concept. The results provide the user with a number of information such as the number of results and number of languages that include the search word. In addition, the results inform about the different parts of speech of the search word if found. Figure 6 shows the different related information of the search word.



9 results in 1 language for
توفرون

Arabic
توفرون
(inflection of وفر)
make unnecessary an expenditure or effort
give what is desired or needed, especially support, food or sustenance
to keep up and reserve for personal or special use
give something useful or necessary to

Arabic
توفرون
(inflection of وفر)
live frugally and use less resources

Arabic
توفرون
(inflection of وفر)
make unnecessary an expenditure or effort
grant as a discount or in exchange

Arabic
توفرون
(inflection of أوفر)
make bigger or more

Arabic
توفرون
(inflection of وفر مقاعد)
be able to seat

Figure 6: Results of Searching by Inflection

For more information see (http://www.unlweb.net/muhit/). There are four pieces of information related to the results that appear which are,

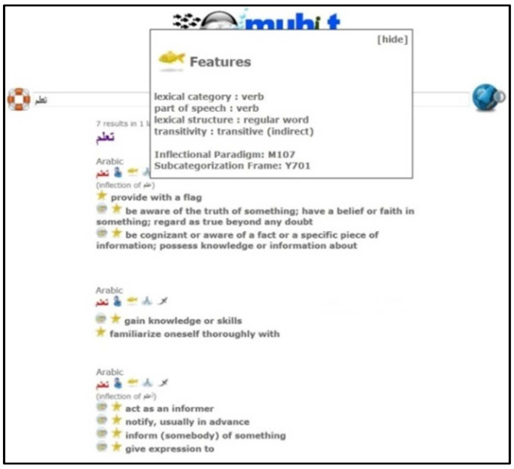
(1) The features of the search word such as part of speech, the lexical structure, number, inflectional paradigm and subcategorization frame of the word.

(2) Different inflections of the word such as plural, dual and feminine of nouns. All these inflectional forms are not stored in MUHIT, but generated by the stored inflectional paradigms, see section a.2, c.

(3) All the different possible translations from other languages.

(4) The available synonyms of the word in the same language.

Figures 7, 8 and 9 shows these types of information for the word "تعلم".



[hide]

Features

lexical category : verb
part of speech : verb
lexical structure : regular word
transitivity : transitive (indirect)

Inflectional Paradigm: M107
Subcategorization Frame: Y701

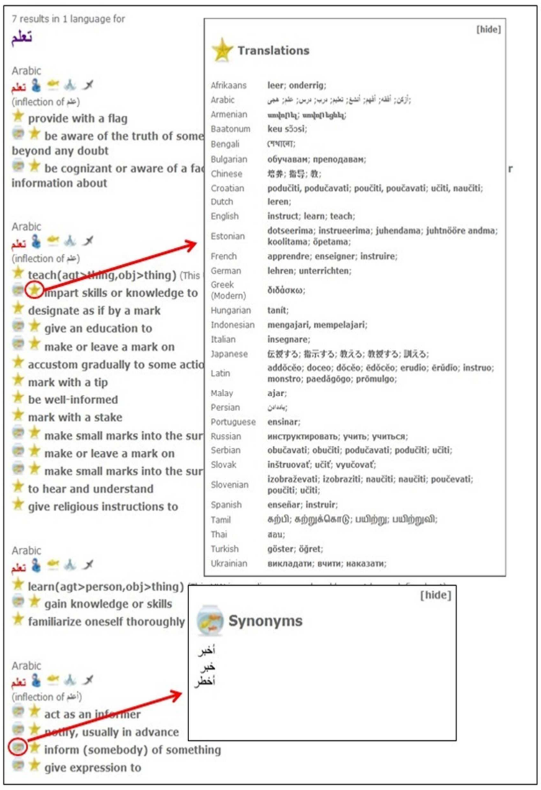
7 results in 1 l
تعلم

Arabic
تعلم
(inflection of علم)
provide with a flag
be aware of the truth of something; have a belief or faith in something; regard as true beyond any doubt
be cognizant or aware of a fact or a specific piece of information; possess knowledge or information about

Arabic
تعلم
gain knowledge or skills
familiarize oneself thoroughly with

Arabic
تعلم
(inflection of أعلم)
act as an informer
notify, usually in advance
inform (somebody) of something
give expression to

Figure 7: Linguistic Features Appears in MUHIT



7 results in 1 language for
تعلم

Arabic
تعلم
(inflection of علم)
provide with a flag
be aware of the truth of some
beyond any doubt
be cognizant or aware of a fa
information about

Arabic
تعلم
(inflection of علم)
teach(agt>thing,obj>thing) (This
impart skills or knowledge to
designate as if by a mark
give an education to
make or leave a mark on
accustom gradually to some actio
mark with a tip
be well-informed
mark with a stake
make small marks into the sur
make or leave a mark on
make small marks into the sur
to hear and understand
give religious instructions to

Arabic
تعلم
learn(agt>person,obj>thing)
gain knowledge or skills
familiarize oneself thoroughly

Arabic
تعلم
(inflection of أعلم)
act as an informer
notify, usually in advance
inform (somebody) of something
give expression to

[hide]

Translations

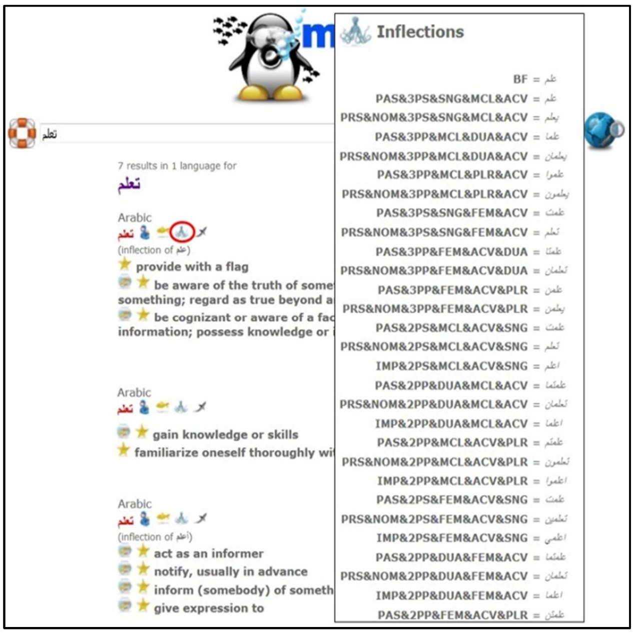
Afrikaans	leer; onderrig;
Arabic	أزكن; أفقه; أفهم; أشع; تعلم; درب; درس; علم; هجى;
Armenian	սովորել; սովորեցնել;
Baatonum	keu sɔ̃ɔsi;
Bengali	শেখানো;
Bulgarian	обучавам; преподавам;
Chinese	培养; 指导; 教;
Croatian	podučiti, podučavati; poučiti, poučavati; učiti, naučiti;
Dutch	leren;
English	instruct; learn; teach;
Estonian	dotseerima; instrueerima; juhendama; juhtnööre andma; koolitama; õpetama;
French	apprendre; enseigner; instruire;
German	lehren; unterrichten;
Greek (Modern)	διδάσκω;
Hungarian	tanít;
Indonesian	mengajari, mempelajari;
Italian	insegnare;
Japanese	伝授する; 指示する; 教える; 教授する; 訓える;
Latin	addŏcĕo; doceo; dŏcĕo; ēdŏcĕo; erudio; ērŭdio; instruo; monstro; paedăgōgo; prōmulgo;
Malay	ajar;
Persian	یاددادن;
Portuguese	ensinar;
Russian	инструктировать; учить; учиться;
Serbian	obučavati; obučiti; podučavati; podučiti; učiti;
Slovak	inštruovať; učiť; vyučovať;
Slovenian	izobraževati; izobraziti; naučiti; naučiti; poučevati; poučiti; učiti;
Spanish	enseñar; instruir;
Tamil	கற்பி; கற்றுக்கொடு; பயிற்று; பயிற்றுவி;
Thai	สอน;
Turkish	göster; öğret;
Ukrainian	викладати; вчити; наказати;

[hide]

Synonyms

أخبر
خبر
أخطر

Figure 8: Different Translations and Synonyms



تعلم

7 results in 1 language for

تعلم

Arabic

تعلم

(inflection of علم)

provide with a flag

be aware of the truth of some

something; regard as true beyond a

be cognizant or aware of a fac

information; possess knowledge or i

Arabic

تعلم

gain knowledge or skills

familiarize oneself thoroughly wi

Arabic

تعلم

(inflection of أعلم)

act as an informer

notify, usually in advance

inform (somebody) of someth

give expression to

Inflections

BF = علم

PAS&3PS&SNG&MCL&ACV = علم

PRS&NOM&3PS&SNG&MCL&ACV = يعلم

PAS&3PP&MCL&DUA&ACV = علما

PRS&NOM&3PP&MCL&DUA&ACV = يعلمان

PAS&3PP&MCL&PLR&ACV = علموا

PRS&NOM&3PP&MCL&PLR&ACV = يعلمون

PAS&3PS&SNG&FEM&ACV = علمت

PRS&NOM&3PS&SNG&FEM&ACV = تعلم

PAS&3PP&FEM&ACV&DUA = علمتا

PRS&NOM&3PP&FEM&ACV&DUA = تعلمان

PAS&3PP&FEM&ACV&PLR = علمن

PRS&NOM&3PP&FEM&ACV&PLR = يعلمن

PAS&2PS&MCL&ACV&SNG = علمت

PRS&NOM&2PS&MCL&ACV&SNG = تعلم

IMP&2PS&MCL&ACV&SNG = اعلم

PAS&2PP&DUA&MCL&ACV = علمتما

PRS&NOM&2PP&DUA&MCL&ACV = تعلمان

IMP&2PP&DUA&MCL&ACV = اعلما

PAS&2PP&MCL&ACV&PLR = علمتم

PRS&NOM&2PP&MCL&ACV&PLR = تعلمون

IMP&2PP&MCL&ACV&PLR = اعلموا

PAS&2PS&FEM&ACV&SNG = علمت

PRS&NOM&2PS&FEM&ACV&SNG = تعلمين

IMP&2PS&FEM&ACV&SNG = اعلمي

PAS&2PP&DUA&FEM&ACV = علمتما

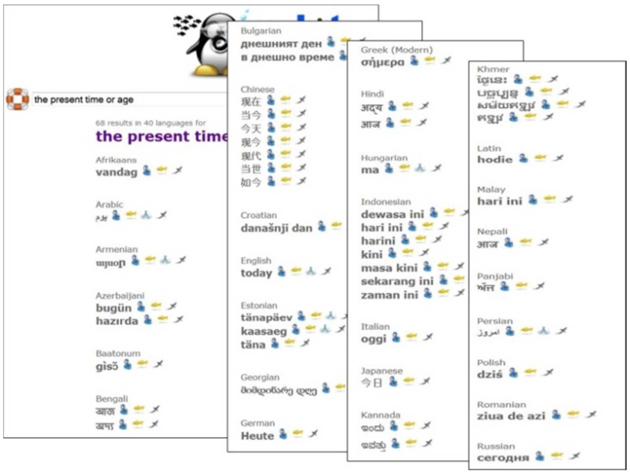
PRS&NOM&2PP&DUA&FEM&ACV = تعلمان

IMP&2PP&DUA&FEM&ACV = اعلما

PAS&2PP&FEM&ACV&PLR = علمتن

Figure 9: Inflections Appears in MUHIT

MUHIT has the possibility to search with the concept and the results provide the number of languages that have translated this concept. For example, searching for the concept “the present time or age” shows that 42 languages have translated this concept and shows the different synonyms in each language. The total number of results that were found for this search is 70 results as shown in figure 10.



the present time or age

68 results in 40 languages for

the present time

Afrikaans
vandag

Arabic
يوم

Armenian
այսօր

Azerbaijani
bugün
hazırda

Baatonum
gìsɔ̃

Bengali
আজ
অদ্য

Bulgarian
днешният ден
в днешно време

Chinese
現在
当今
今天
現今
現代
当世
如今

Croatian
današnji dan

English
today

Estonian
tänapäev
kaasaeg
täna

Georgian
მიმდინარე დრო

German
Heute

Greek (Modern)
σήμερα

Hindi
अद्य
आज

Hungarian
ma

Indonesian
dewasa ini
hari ini
harini
kini
masa kini
sekarang ini
zaman ini

Italian
oggi

Japanese
今日

Kannada
ಇಂದು
ಇವತ್ತು

Khmer
ថ្ងៃនេះ
បច្ចុប្បន្ន
សម័យឥឡូវ
ឥឡូវ

Latin
hodie

Malay
hari ini

Nepali
आज

Panjabi
ਅੱਜ

Persian
امروز

Polish
dziś

Romanian
ziua de azi

Russian
сегодня

Figure 10: Results of Search by Concept

6. Conclusion

The paper presents a multilingual lexical database “MUHIT” that has been built within the UNL framework that includes about 40 languages. The linguistic infrastructure of the system has been introduced with special reference to Arabic. MUHIT can be useful for specialists and non-specialists and many applications can be built depending on MUHIT such as multilingual machine translation systems and cross language search systems. The paper has presented the search options of MUHIT and the types of results illustrated with screen shots.

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