Arabic Morphemes and Machine Translation

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Abstract

This article aims to familiarize lecturers and researchers with the ambiguities of the Machine translation and to make understand the importance of the morphemes functions to identify words and later sentences meanings. This manner to do is also useful to learn or teach Arabic, because it gives another way to approach linguistics or simply languages. Therefore, for the Arabic language, letters and short vowels are important for lexical and syntactic understanding, for that we should not neglect any of them. For the Turkish language, machine translation encounters same difficulties and more, because of its unusual syntax for Arabs and European people, so we need to think differently to resolve teaching and translation problems. We have the lexical ambiguity, which is introducing word into the syntax, which should be able to link between syntax's words to give the appropriate meaning. This work is trying to open a window to look through it to the language as machine can look and see it.

Intrudoction

I begin by introducing an example to illustrate this big science. The problem of the Machine Translation is to be able to identify words individually in sentence and combine between them to get the possible meanings. So there are a lot of problems, to reach this goal. We call these problems ambiguities.

I had defined in my researches, in Lucien Tesniere researches centre, a typology of ambiguities that we encounter in Machine Translation, with goals to improve translation's quality.

One of these ambiguities is the segmental ambiguity; it means how we should segment a word that we want identify or we cannot, as a unit, identify.

We take this lexis to illustrate this ambiguity. This word:

"أقال"

How it should be identified?

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The system (the computer) will identify it as one word that means "Dismiss", but depending of its syntax, this identification can be an error. So lexical identifications can be limited by their syntaxes and meanings.

If we say "أقال المدير الموظف", if this sentence is limited to theses vocabulary, our first identification (dismiss أقال=) is right; and in this case, it means, "The director dismissed the employee." Moreover, this is a right translation.

But if the sentence is "أقال الطالب الحقيقة"; and if it is translated as "The student dismissed the truth"; this translation is wrong or can be wrong, because, in the literal sense, the student could not dismiss the truth; otherwise, in the figurative sense, it can be discussed.

So what is the other translation?

In this other way, we need to propose another identification; for that this other way is the segmentation.

Maybe I need to introduce this term of "segmentation": It is the operation necessary to divide a syntagmatic word, which is composed of many lexical or grammatical units, in smaller units recognisable in dictionary.

If we consider that, this word "أقال" is including two units (identities) and that because the first letter "أ" is an affixal identity, and more precisely, it is a prefixal one[1]. So our word becomes:

"أ+قال" what means "Said he / Did he say / has he said"; so this identification opened a new possibility. So our sentence "أقال الطالب الحقيقة" becomes:

"The student said he / did he say / has he said the truth."

So this last identification, if it is applied to our first sentence, it becomes:

"The director said he the employee."

What is also right, if we consider possibilities.

The essential here is that, the system should give these two possibilities, if it wants to be outstanding.

So we need to inventory affixal morphemes, with idea to be able to identify them when that is necessary.

As we know the Arabic language is morphological, that means we can identify any word by the knowledge of its morphemes, as these morphemes are internal or affixative.

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1   With idea to distinguish between the three positions of affixes, prefix, infix and suffix..

By this report, we need to identify all morphemes, as it is nominal, verbal or prepositional. Moreover, define its position in the word, prefixal, infixal or suffixal. As we will see, this method defines the adoptive segmentation to operate on the word. For that, we begin by defining "the morphology."

1 – The morphology:

In introducing this idea, we take the definition showed by al-Labdī Muhammad S. N. in his "Dictionary of the grammatical and morphological terminologies", so he says:

البُنية: بنية الكلمة و بناؤها و مبناها ألفاظ مترادفة، تعني كلها ذات اللفظ و تركيبه و مادته و أصوله...''
''2.فبنيةِ الفعل ''نزل'' تعني حروفه التي يتكون منها، و الهيئةِ التي تنتظم هذه الأحرف من حركة أو سكون

«The morphology: The morphology of the word, its grammatical vocalization and interne vowels, are synonyms. All these terms means the composition, the material and the radical of the word... so the morphology of the verb «نَزَلَ» (*nazala*) is composed of its letters and short vowels.»

Therefore, we call all these elements morphemes. This definition is easy for a simple word, but for a syntagmatic word, is not. If we take this affixed word « فَنَزَلَ » (*fanazala*), we need to be capable to define it with its affixes, so we must identify its morphemes and segment the word as a function of its morphemes. What are morphemes?

2- Morphemes:

Morphemes can have many appellations, as lexeme or grameme, as a function of its role lexical or grammatical in the word. Therefore, some morphemes can affect the word's grammaticality or lexicality.

a- Lexical and grammatical morphemes:

As I said, morphemes can have one or tow of these functions. The morpheme and its functions have this classification, illustrated by this table:

Morpheme	Alphabetic	Vocalic
Nominal	X	X
Verbal	X	X
Prepositional	X	

Table (1): Morphemes and its appellations.

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2   AL-LABDĪ Mohammad, The dictionary of the grammatical and morphological terminologies *(Muʿǧam al-musṭalaḥāt an-naḥawiyya wa aṣ-ṣarfiyya)*, Beyrouth, Muʼasasat ar-risala, 1986, p. 27.

The next table shows among letters that are morphemes. So we mention these morphemes and its functions:

Morpheme	Paradigmatic	Grammatical
ء	X*	(أَ ءِ)
ا	X	ا
ب		بِ
ت	X	تَ**
س	X	سَ
ف		فَ
ك		كَ / كُ / كِ
ل		لَ / لِ / لُ
م	X	مُ
ن	X	نَ / نُ
ه		هُ
و	X	وَ
ي	X	ي /يُ

Table (2): Paradigmatic and grammatical morpheme's functions.

This table shows only letters which have lexical or grammatical functions. These functions are shown by any lexis. The grammatical morphemes modify grammatically the morphology, but the paradigmatic morphemes haven't any morphological (a morphological modification is done by the paradigmatic creation) impact on lexis.

Morpheme can have lexical or grammatical function, so some morpheme can introduce lexical and syntactic ambiguities.

Let us take these examples, which contain many affixes:

"تمرين" and "تمرين" these words have, without their morphological vowels, the same morphemes, which are lexical and grammatical. Therefore, the morphemes "ت" and "ين" affix noun and verb. This written form (*graph*) is composed of word and its affixes:

- ت + مر + ين

- ن + ي + مر (ت + مرن)

The verbal roots are respectively: "مَرَّ" and "مَرَّنَ"

The difference between of these graphs is categorical. The noun is identified by dictionary's entries, as for the neutral (infinitive verbal form) verb.

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*   This morpheme is borne by the morpheme lexical «ا» (A) for its grammatical and paradigmatic functions, it is also written on the line.

**   Fastened to the name « الله », it modifies its determinative vowel, so we have «تَاللّهِ».

So we have:

تمرين = Exercise.

But the identification of our verbal form is not done.

These morphemes have these functions:

تمرين		
Noun	تمرين ن ي مر ت	
Noun	ين	تمر
Verb	ين	مر ﹍ ت

Table (3): Lexical or grammatical morphemes.

The recognition of morphemes is not enough to resolve this ambiguity and distinguish between these words, but for more easiness, we do not neglect any morphological identification.

Our system must give us the tow possibilities. The choice of one of these categories is decided by its syntactic situation.

b- Grammatical morphemes:

Many morphemes can have a grammatical function. Therefore, these morphemes can be prefixal, infixal or suffixal. They can affix nouns, verbs and prepositions.

Morpheme*	Grammatical Function	Affixations	Prefixal	Infixal	Suffixal
ء	Interrogative	Nominal	أرجل		
ء	Interrogative	Pronominal	أهو		
ء	Interrogative	Verbal	أنفعل		
ء	Dual	Nominal		ولدان	ولدا المعلم
ء	Dual	Verbal	اضربُ	يقولان	قالا
ء	Vocalic morpheme	Nominal			ولداً**

*   This classification is basic and need to be developed.
**   It bears the vocalic nominal morpheme « ﹷ », which can have many grammatical functions.

ب	Completive	Nominal	يركب		
	Neuter*	Pronominal	بِه		
	Neuter**	Prepositional	بِأن		
ت	Completive Affirmative	Nominal	تَاللَّه		
	Paradigmatic***	Verbal	تَلعب	لَعَبُنَّ	لَعبَتْ
ف	Succession et conjunction	Nominal	فَرجل		
	Neuter	Pronominal	فَهو		
	Conjunction and consecution	Verbal	فَيركب		
	Neuter	Prepositional	فَإن		
ك	Completive	Nominal	كقلم	قلمكُم قلمكُما قلمكُن	قلمكَ / قلمكِ
	Neuter	Prepositional	كما	فيكُم	بكَ / بكِ
ل	Completive	Nominal	لِرجل		
	Accusative	Verbal	لِيفعل		
	Neuter	Prepositional	لأَنَّ		
ل	Neuter	Nominal	لَرجلِّ		
	Neuter	Pronominal	لأَنت		
	Neuter	Prepositional	لَفي		
ل	It replaces the morpheme verbal « ل », when this last is preceded by « فَ » or « وَ »				
م****	Neuter	Nominal		قلمكَمَا	(قلمكَم)هم
	Neuter	Verbal		ركبتَمَا	ركبتَمُ
	Neuter	Prepositional		عليهَمَا	عليهَمُ

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*   This neutrality is due of the invariability morphologic of pronouns.

**   Idem.

***   This morpheme can have this paradigmatic function (nominal and verbal), a lexical aspect or a grammatical aspect; that depends of the adopted consideration.

**** This morpheme designates the plural (tow and more.)

ن	Affirmative	Verbal			افعلن
					لَيفعلن
	Completive	Nominal		قلمنا	قلمهنَّ
	Neuter	Verbal	تَعمل		يعملنَ
		Prepositional			فيهنَ / فينا
ه	Completive	Nominal		قلمهُم	قلمهُ
	Accusative (COD)	Verbal		حملتهُم	حملتهُ
	Completive	Prepositional		عليهم	عليه
و	Conjunctive	Nominal	عليّ وَ أحمدّ		
	Completive		وَ اللّهِ		
	Appellative		وا أماه		
	Conjugation	Verbal		يعملون	
	Conjunctive		وَ يعملون		
	Conjunctive	Pronominal	أنت وَ هو		
		Prepositional	وَ عليه		
ي	Completive	Nominal			قلمي
	Accusative			قلمين	قلَمَيُ
	Conjugation	Verbal	يكتب	تكتبين	(لم تكتبي)
		Prepositional			عليُ
	Adjectival				دهنيّ

Table (4): Morphemes and grammatical functions.

All these words in this table are ambiguous and need segmentation, because we cannot identify them by consulting dictionary. So we know, from this table, which morpheme we should segment.

c- Paradigmatic morphemes:

The paradigmatic morphemes have other utilities; they can be used to create mechanism able to generate neologisms and all possible lexical forms.

Morpheme	Paradigmatic Function	Prefixal	Infixal	Suffixal
ء				رجاء / وقاء
أ / أ / إ	Nominal/verbal	أنزل / إنزال		
ا	Nominal/verbal	اضرب / اضراب	كاتب / كتابة...	اً
ت	Nominal/verbal	تفعّل / تفاعل	... اكتتب / اكتتاب	صالحات
س	Nominal/verbal	سيفعل	استفعل / استفعال	
ل	Nominal/verbal		فعل / تفعل	
م	Nominal/verbal	...مفعول / مفعال		
ن	Nominal/verbal	نلعب	انفعل / انفعال	معلمون/معلمان
و	Nominal/verbal		معلمون / يعلمون	أخو
ي	Nominal/verbal	يعلمون	معلمين / معلمين	أخي/أخيك

Table (5): Morphemes and paradigmatic functions.

These morpheme's classifications have many utilities, which can used in linguistics, grammar and Machine Translation.

Identifications and segmentations are necessary for any lexical analysis; that means, a first identification it isn't enough to close other identifications.

The identification of these morphemes resolves many ambiguities from the lexical, syntactic to semantic one.

d- Syntactic models:

The next step is the right management between the sentence's elements. If we look to sentences, only from these two aspects of lexis or syntax, with all segmentations possible, we could not arrive to the right translation. To get the right translation we need the semantics, which can certify and justify connections between words.

For our first examples:

- "أقال المدير الموظف"

- "أقال الطالب الحقيقة"

The verb "أقال" should be understood with its lexical neighbours; otherwise, we do not know how we can connect them semantically. Therefore, the identification of each lexical item should provide with all necessary information. For this reason the system of translation from Google to other translators, if they want to ameliorate their results they should include all these informations.[3]

This verb "أقال" should include in its entry in the dictionary its connections with possible other lexis. If we develop this idea, it means, we

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3   Google is doing that in margin of the window of translation, as they are doing with their service online; they joining these informations and leaving user do that alone and choose the meaning what he wants, and that doesn't mean, he is choosing the right one.

need to write the longest sentence possible to account the neighbours. So, for example, we write:

أقال المدير الموظف من عمله في يوم الأحد و ذلك لسبب / بسبب / لسبب عدم تقيده بأوقات الدوام.

The sentence contains elements, which should be considered when our verb is identified.

We can include this sentence in a table, to define neighbours, so:

لسبب / بسبب إهماله		في يوم الأحد			من عمله		الموظف	المدير	أقال	Lexis
إهماله	لسبب / بسبب	الأحد	يوم	في	عمله	من	Noun	Noun	Verb	
اهمال+هو	ل/بـ+سبب	الـ+أحد	ظرف زمان	حرف جر	عمل+هو	حرف جر	الـ+موظف	الـ+مدير	ماضي+هو	Category

Table (5): Sentence's components.

This sentence can be written categorically:

Verb+noun+noun+preposition(place)+noun+preposition+time adverbial+noun+preposition+noun.

By this manner, this representation is creating syntactic models, which can simplify the syntactic identification and resolve two important ambiguities the lexical and the syntactic.

3- Conclusion:

The knowledge of morphemes is primordial to identify word manually or automatically; what means, by human, teacher, student or any user, or by machine. This knowledge is useful for students when they begin to study grammar and morphology; it can simplify courses and makes Arabic grammar and morphology more attractive. The problem of identification needs an exhaustive algorithm able to identify morphemes and work the necessary segmentations; because as we have seen, there are many possibilities, and only an excellent linguist-researcher can envisage them and program the right algorithm.

For example Translate.Google.com.tr has a lot of mistakes due to the incomplete identification of lexes and syntaxes. This article can be useful for researchers in Machine translation for the Turkish language. This step needs a lot of researches to scan all problems and to find the right algorithms to correct lexical and syntactic Identifications.

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