A Parser Generation with the LKB for the Arabic Relatives

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Abstract: The relative phenomenon is considered as a rather delicate linguistic phenomenon and not explored enough by researchers, especially for the Arabic language. In an attempt to deal with this phenomenon, we propose in this paper a study about different forms of relative clauses. This study will be used for the building of a parser that can process relative sentences. This parser is constructed using the HPSG formalism (Head-driven Phrase Structures Grammar), whose fundamental structure is the feature’s one. In fact, an adaptation of HPSG for the Arabic language is made here in order to integrate the features of the arabic language. The established HPSG grammar is specified in TDL (Type Description Language). This specification is used by the LKB platform (Linguistic Knowledge Building) to generate the already mentioned parser.

Keywords: Arabic relative clauses, Unification grammar HPSG, TDL, LKB.

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1. Introduction

The relative phenomenon is of great importance in all natural languages and in all corpus kinds. That’s way researchers in linguistics or in computer sciences pay great attention to this phenomenon (i.e., [5], [10], [12]). Indeed, a phase of parsing of this phenomenon is fundamental for several types of Natural Language Processing (NLP) applications such as grammatical correction and automatic translation. Nevertheless, the research concerning the parsing of relatives have not reached an advanced stage yet. Indeed, there are not reliable Arabic parsers able to take into account complex phenomena of the Arabic language such as the relatives, object of this work. This is due, on the one hand, to the complexity of this phenomenon and, on the other hand, to the interaction with simple and complex linguistic phenomena (i.e., ellipse, anaphora) [13].

Thus, one of the objectives of this work is to study the various forms of the Arabic relative sentences. This study is based on old grammatical theories [2], [5], [9] and on discussions with linguists. From the study carried out, we also want to identify all possible syntactic representations of the Arabic relative sentences. The choice of the HPSG is justified by the fact that this formalism has shown great efficiency in several languages such as German.

In order to construct a HPSG parser, we can follow one of two approaches. The first one consists in designing and developing our own parser. This approach supports maintenance and extensibility. Nevertheless, it requires the proposition of an adequate analysis algorithm and the description of the inputs/outputs. Thus, the proposition can influence the robustness of the results.

As for the second approach, it is based on the use of a parser generation tool. It allows the designer to concentrate on the identification part of grammar. Moreover, the inputs and outputs of the parser are well defined from the beginning. In the same way, the ergonomic of the interface is already tested. This approach is rather powerful; it makes it possible to generate reliable parsers. Indeed, there are several generation tools designed for various formalisms such as the LKB (Linguistic Knowledge Building) [8] and the TRALE for the HPSG formalism [17].

Our work consists in generating an Arabic parser from a HPSG grammar in the LKB linguistic platform. The generated parser can process complex sentences containing relatives. The originality of this work consists, on the one hand, in the identification of a relative sentences typology, and on the other hand, in the proposition of a HPSG extension detailing under-categorization. This extension is
specified in TDL (Type Description Language) [14],
the language supported by the LKB platform.

In this paper, we begin with presenting some projects
dealing with the phenomenon of the relatives. Then, we
give a typology for Arabic relative sentences. After
that, we introduce the HPSG formalism and we present
the modifications made on this formalism to adapt it to
the Arabic language. Using this formalism, we
elaborate a grammar for the Arabic language which can
process relatives and we specify this grammar in TDL.
We test this specification by generating a parser in
LKB and applying it to a corpus of complex sentences.
Finally, we conclude the paper and give some
perspectives of our work.

2. Related Works

Researchers on the Arabic Language Processing began
in the 1970’s. The projects carried out since then and
which have proposed parsers based on HPSG are
limited. To our knowledge, most of these projects have
proposed prototypes of parsers covering some
phenomena (i.e., simple sentence, ellipsis). For
example, in [3] and [4] the authors studied the simple
Arabic sentences and their representation with HPSG.
They proposed some modifications on HPSG to adapt
it to the Arabic language. These works are integrated in
a multi-agent platform. In [1], the elaborated grammar
makes it possible to analyze the Arabic nominal
sentences. Also, priorities were introduced while
applying HPSG schemata.

For the complex Arabic sentences, we take as an
example the work presented in [10]. It allows
processing of simple sentences as well as complex
ones. This work is based mainly on the use of a large
number of production and dynamic rules because the
HPSG used version is old. Also, we take the research
project presented in [16] which deals with Arabic
sentences containing joint components and makes
modifications on HPSG to adapt it to coordination.
Note that all these works are based on their own parser.
The relative phenomenon is also studied in [5].
This work shows that conjunctive nouns are not considered
determinants but as modifiers.

Concerning, the projects using the second approach
which consists in the use of a tool for generation, we
find essentially researchers studying Latin languages.
For example, the project proposed in [12] aims to
analyze the relative subordinate clauses of Spanish.
This analysis is made on the LKB platform and is
specified in TDL. In the same way, the project
presented in [19] deals with the French phrase affixes.

3. Proposition of an Arabic Type Hierarchy

The Arabic language is very rich. Several criteria
should be used to categorize the Arabic words. The
type hierarchy proposed in [7] is based on the old
grammatical theory [2] and [9]. Indeed, our study
shows that the type root is the linguistic sign «الفظ».
It is subdivided into two sub-categorizations: word
«كلمة» and phrase «مرآكث». A simple word (اسم
أعمال », a noun «حروف », a particle «حرف », as represented below:

```
word
  ↓
verb noun particle
```

Figure 1: The Arabic word

For the verbs «الأفعال », according to [2], several
criteria are presented to categorize a verb. It can be
subdivided according to the number of letters that
compose it or according to whether they are augmented «مزيج » or denuded «جرد ».
We choose, in this article to subdivide them according to the first
criterion. Thus, a verb can be triliteral «بالمثنى» or quadriliteral «رباعي».
A type hierarchy is proposed in Figure 2.

```
verb
  ↓
triliteral quadrilateral
    ↓↓
sound sound
    ↓↓
intact intact
    ↓↓
doubled doubled
    ↓↓
having a HaM’ZaT having a HaM’ZaT
    ↓↓
defective defective
    ↓↓
doubled doubled
    ↓↓
having a HaM’ZaT having a HaM’ZaT
```

Figure 2: The verb’s categories

The above figure shows that a triliteral verb or quadriliteral can be sound “صحيح” or defective “مختلط”.
For the nouns «الأسماء », we choose to subdivide them according to their declension «لغات».
Thus, we find declined nouns «الأسماء المميزة» and indeclinable nouns «الأسماء المئذية», as shown in below
figure 3.
In fact, a declined noun can be variable “متصرف” when it varies in gender and in number in the sentence. For an invariable declined noun “غير متصرف”, it remains always invariant. Moreover relative pronouns “الاسماء الإشارة” and demonstrative pronouns “الاسماء موصولة” are considered in Arabic as nouns which do not have any meaning. They have a meaning only when they are connected with another declined noun. That’s way, they are known as no significant nouns.

For particles “الحروف”, according to [2] and [11], we can classify them in two different categories. The first category represents operative particles “حروف عامة”, which influence either on the nouns or on the verbs. The second represents neglected particles “حروف مهملة” that don't have any influence on the verbs nor on the nouns. Figure 4 illustrates the two distinguished categories.

4. Relative Phrase Typology

The linguistic phenomenon of relatives is frequent in sentences and exists in all languages. In written Arabic relative phrases are of great importance since they can have all grammatical functions that a noun has. In this section, we give an overview on the categorization of a linguistic sign and the concept of an Arabic relative sentence, and explain the various forms that can take.

4.1 Overview on Relative Sentences

A relative sentence (Srel) is defined as a subordinate clause fulfilling the various grammatical functions of a noun. It can play the role of a topic (منهدة), a predicate (خبر), a subject (فاعل), an object or a modifier in a given sentence. It should be noted that a relative sentence is built using a conjunctive noun and a relative clause:

\[
\text{Srel} = \text{conjunctive noun} + \text{relative clause}
\]

Example (1) illustrates an example of relative sentence.

1. أخذ الوالد الكتاب [الذي يريده]

‘akhadha ‘alwaladu ‘alkitaaba [‘allady yurydu]

The child takes the book [which he wants]

A conjunctive noun “اسم موصول” is a word which fulfills a grammatical function in the sentence. It occupies the functional head of the sentence and it is semantically co-referent with the antecedent. The conjunctive nouns are categorized as two kinds: nominal conjunctives and prepositional conjunctives.

Figure 5 shows the categorization of the nominal conjunctive nouns into two types: common conjunctive and special conjunctive. For the prepositional conjunctives, we subdivide them into two categories: conjunctives influencing the verbs and others influencing the nouns.
Any type of conjunctive nouns has a meaning only if it is followed by a relative clause “صلالة الموصول” This clause can be a verbal phrase (VP) or a nominal one (NP). In the following paragraph, we detail the different relative forms and give some examples.

4.2 Relative Forms

According to the nature of the relative clause which follows the conjunctive noun, we distinguish two forms of relatives:

Form 1: A conjunctive noun followed by a verbal phrase VP

This form regroups conjunctive nouns which require the existence of a verbal clause. For this form, we identify three types of relative’s nouns: special nominal conjunctives, common nominal conjunctives, except for the conjunctive “أي”, and prepositional conjunctives influencing the verbs. We define these various natures of conjunctive nouns as follows.

- Special conjunctives: they agree in gender (feminine, masculine) and in number (singular, plural) as الذين, الساذان, الساذان, الساذان. Thus, in examples (2) and (3), we can distinguish between a feminine special conjunctive and masculine one.

(2) al-bintan [lattan axnata al-katab]
‘albintaani [allataani akhadhataa alkitaaba]
The two girls [who took the book]

(3) yudhul-qulub [al-adh-dha akhadhataa alkitaaba]
‘alwaladu [alladhy akhadhataa alkitaaba]
The child [who took the book]

The special conjunctive “ذئان” is in a dual feminine form. So, it needs a dual feminine verb. However, in second example (3), the special conjunctive “ذئي” is in a singular masculine form. So, it must be followed by singular masculine verb. In both cases, we notice that the conjunctive nouns correspond with their antecedent in gender and in number.

- Neutral common conjunctives: they are independent from gender or number (من، ما، أي، أ). Except for “أي”， all neutral common conjunctives require a VP. For the conjunctive “ما”， it must be preceded by an interrogative conjunction “من” or “من”.

(4) qara’al-awlad maa kataba alabu fy ‘risaalata
The child read what the father wrote in the letter

Examples (4) and (5) illustrate the independence of the common conjunctive “ما” in gender and number.

- Prepositional conjunctives influencing verbs: prepositional conjunctives (ان، ذو، يعني) influence the verbs. They are followed by a VP. For the conjunctive noun “أي”， it’s preferable to be preceded by a desire verb (i.e., وزغ، ألمي). In example (6), we notice that the relative pronoun “أي” is preceded by the desire verb (ف). (وذت البنت لو تظهر)

(6) wadat albintu law tatir
The girl wants if it flies

Example 6 illustrates the first form of a relative sentence.

Form 2: A conjunctive noun followed by a nominal phrase NP

The second form covers conjunctive nouns which require the existence of a nominal clause. These conjunctives are represented by the common nominal pronoun “أي” and the prepositional conjunctives influencing the nouns. These various natures of conjunctive nouns are detailed as follows.

- The conjunctive “أي” is a declined common conjunctive which refers to all what is human.

(7) sayouqaffi ’u ‘al umaadhdu ‘ayyya mujahidin
The professor will reward any diligent

(8) sayyfizu ‘al umaadda ‘ayyuu mujahidinbijja’izati
any diligent will win a prize

Examples (7) and (8) show that the conjunctive noun “أي” can have in a sentence different grammatical functions. In example (7), the conjunctive noun “أي” is a part of the object. So, it is open ending. In example (8), the conjunctive noun “أي” is a part of a subject. It is then regular.

- Prepositional conjunctives influencing nouns: They require the existence of a NP after the conjunctive. The NP must be open ending. Example (9) illustrates the second form of relative sentences.

(9) qala ‘alabu [‘anna alwalada marydhun]
The father says [that the child is sick]

As we already mentioned, the relative phenomenon is complex. This complexity is due to the diversity of possible forms and the interaction with other linguistic phenomena such as ellipsis (حذف) and coordination (عطف). This interaction increases the complexity degree of this phenomenon. Sentence (10) illustrates this interaction.
In sentence (10), we can note that the phenomenon of ellipsis intervenes on the level of the verbs “يُريد” (to want) and “يُرغب” (to desire). Indeed, the objects of these two verbs (بَنْيَة) were elided. In order to analyze suitably the relative and the interaction with other phenomena, we have brought some modifications to the HPSG formality. In the following paragraph, we develop the modified HPSG grammar for relatives.

5. HPSG for the Arabic Language

HPSG (Head-driven Phrases Grammar Structure) is a unification grammar which was proposed in [18]. It is considered among best grammars for the modeling of the universal grammatical principles and a complete representation of the linguistic knowledge. Indeed, it represents in lexical entries phonological, morphological, syntactic and semantic information. This allows taking into account a great number of linguistic phenomena and describing linguistic constructions with a limited number of operators.

In fact, this grammar contains two essential components: a set of AVM (Attribute Value Matrix) and another of immediate domination schema. In fact, an AVM describes a set of features that can characterize a lexical entry. To each feature, a determined value was associated. Moreover, a schema represents a syntactic rule permitting to generate the derivation’s trees. Figure 6, represents the structure of an AVM:

The HPSG formalism is essentially based on a phrase hierarchy founded on the schemata of immediate dominance. In [18], we distinguish two types of phrases: those having a head branch (i.e., head-subject-phrase, head-complement-phrase, head-filler-phrase) and others having no head branch (non-head-phrase). We detail in figure 7 these different categories.

In figure 7, phrases are classified as either headed-phrases (hd-ph) or non-headed-phrases (non-hd-ph), each type exhibiting a variety of subtypes. Headed-phrases are broken down into five subtypes: head-adjective phrases (hd-adj-ph), head-subject phrases (hd-subj-ph), head-complement phrases (hd-comp-ph), and head-specifier phrases (hd-spr-ph).

5.1 Arabic Item Features

Referring to previous projects [1], [4], [10] and [15], we have kept some features and have added some others according to the proposed type’s hierarchy.

As we have already seen, a linguistic sign (word or phrase) can be characterized by its declension (الإعراب). Therefore a new feature: “DEC” is necessary to specify if it is a declined sign (مُعَرَّب) or not (غير مَعَرَّب).

According to figure 2, a triliteral or quadriliteral verb can be sound (مَسْلَم) or defective (مُعْتَل). Thus, the features, characterizing the verb type are gathered in the table 1 below:

<table>
<thead>
<tr>
<th>Features</th>
<th>Possible values</th>
</tr>
</thead>
<tbody>
<tr>
<td>RADICAL</td>
<td>- trilateral</td>
</tr>
<tr>
<td>VFORM</td>
<td>- sound</td>
</tr>
<tr>
<td>TYPE</td>
<td>- intact</td>
</tr>
<tr>
<td>VOICE</td>
<td>- Passive</td>
</tr>
<tr>
<td>ASPECT</td>
<td>- accomplished</td>
</tr>
<tr>
<td>ROOT</td>
<td>- the verb’s root</td>
</tr>
</tbody>
</table>

The exploitation of these features is presented in an example in figure 8:
In figure 8 above, we note that the verb « yachrab » (يشرب) is in an elided form. It indicates on the level of the valence’s feature the different complements. In fact, an elided verb (مجزم) must be preceded by an elision particle (حرف جزم), (referred by SPR feature) and followed by a masculine noun (referred by COMPS feature). The order of these two components is respected by the S-ARG feature.

According to figure 3, a declined noun can be variable (منحرف) as the common nouns or invariable (غير منحرف) as the proper nouns. For the indeclinable nouns, they regroup personal pronouns (الضمائر), conjunctive nouns (الדמות الموصلة) and demonstrative nouns (الإشارة). Thus, the features characterizing the noun type are gathered in table 2 below:

**Table 2: The Arabic noun features**

<table>
<thead>
<tr>
<th>Features</th>
<th>Possible values</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFORM</td>
<td>Declined, Indecinable</td>
</tr>
<tr>
<td>DEFINITE</td>
<td>yes if it is defined, no otherwise</td>
</tr>
<tr>
<td>NAT</td>
<td>demonstrative nouns, conjunctive nouns, no otherwise</td>
</tr>
<tr>
<td>ADJ</td>
<td>yes if it can be an adjective, no otherwise</td>
</tr>
</tbody>
</table>

In this context, conjunctive nouns are considered as insignificantly indeclinable nouns. In order to be able to formalize the typology mentioned in paragraph 4, the features represented in the table below are looked necessary (table3).

**Table 3: The Arabic conjunctive noun features**

<table>
<thead>
<tr>
<th>Features</th>
<th>Possible Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFORM</td>
<td>nominal, prepositional</td>
</tr>
<tr>
<td>RTYPE</td>
<td>common, specific</td>
</tr>
</tbody>
</table>

The conjunctive noun « 'alladhy » is not a significantly declined noun. This information is expressed by the features MAJ, NFORM and NAT. Besides, the feature INDEX shows that « الذي » is a singular masculine noun.

The Arabic particle, presented in figure 4, can be categorized in operative particles and inoperative ones. Thus, the features characterizing the particle type are gathered in the table below:

**Table 4: The Arabic particle features**

<table>
<thead>
<tr>
<th>Features</th>
<th>Possible values</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFORM</td>
<td>Non operative, Operative</td>
</tr>
<tr>
<td>NATP</td>
<td>elision particle, Subjunctive particle</td>
</tr>
</tbody>
</table>

The modifications brought to this formalism cover not only the features but also the different schemata of the HPSG grammar. In the following paragraph, we are going to present the different modifications brought to the schemata.

### 5.2 Arabic Schemata

As it’s indicated in the previous parts, the immediate domination schemata permit the generation of the derivation trees [6] and [18].

Our studies show that there are three types of Arabic phrases: The nominal, prepositional and verbal phrases and two types of sentences: nominal and verbal. In the following, we detail the exploitation of the different schemata.

We kept the schema 1 (rule of specification 1), to represent the nominal phrases whose the noun is the head-DTR that must be preceded by a demonstrative noun (demonstrative noun + noun). Thus, the HPSG representation of the schema 1 in the following sentence: *This boy* (هذا الولد) is as indicated below in the figure 10:

In the following figure, we present an example using these features.
Besides, we add two other schemata: one for the verbal phrases (rule of specification 2.1), whose verb must be preceded by a particle (particle + verb) such as "he will not go" (لا يذهب) and a second (rule of specification 2.2), to represent the verbal sentence of the form (VP + NP). The sentence "The child slept" (المولد) is an example.

In conclusion, the HPSG grammar designed and adapted to the Arabic language makes it possible to analyze the relative sentences by applying the rule of marking.

6. HPSG Grammar Implementation in TDL

In order to generate with the LKB a parser dealing with relative sentences, it is necessary to translate into TDL a HPSG lexicon, grammatical rules and a type hierarchy. The implementation in TDL requires knowledge about its syntax. The TDL language is a language syntactically very similar to the attributes-values structures which are the base of HPSG formalism. Thus, there are several similarities between HPSG and TDL syntax [14]. These similarities can easily specify HPSG grammars in TDL. Indeed, the addition of the constraints on types is done by the symbol "&". Besides, the co-indexations are preceded by the symbol "#". The comments are preceded by the symbol ";". Moreover, a new type definition is done with the assistance of the symbol "=". As in HPSG, the feature structures are delimited by brackets [ ].

The following figure 12 shows the HPSG representation of the AVM "that", (هذا) as well as its TDL implementation:

Figure 12: Implementation TDL of "ها "

Here is an example of a TDL implementation of a conjunctive noun (already represented in HPSG...
figure 9) using the majority of the instructions described previously.

\[ \text{'aladhy} := \text{lex-rel-specifique} \]
\[ \text{[PHON }<1 \text{ "alladhy" } >, \]
\[ \text{SS.LOC [CAT.TETE [RFORM nominal, Rtype agir_verbe],}
\[ \text{CONT [IND[NOMB sing, GEN masc]]]].} \]

As we already announced, the LKB platform can generate the syntactic tree of a given sentence only after the implementation of some files in TDL containing the syntactic rules. Indeed, these rules correspond to the translation of the immediate dominance schemata to a TDL implementation. Here is a TDL implementation of marking rule:

\[ \text{regle-marque} := \text{regle-bin-t-fin} \]
\[ \text{[SS.LOC.CAT [VAL #val, MARQUE #marque],}
\[ \text{BRS [BRS-NETETE}
\[ \text{<[SS.LOC.CAT[TETE.SPEC #tete,}
\[ \text{MARQUE #marque]>],}
\[ \text{BR-TETE [SS #tete &}
\[ \text{[LOC.CAT.VAL #val]]]}.} \]

Once the syntactic rules are implemented in TDL and gathered in a TDL file named “rsynt”, we pass to the experimentation of the grammar implemented in TDL.

7. Experimentation and Evaluation

The experimentation of the in TDL implemented grammar is realized with the linguistic development platform LKB [8]. So, we have created seven TDL files. These files contain the lexicon, the grammatical rules and the type hierarchy. The TDL files are the following: lexicon, type, type-lex, type-rules, rsynt, noeuds and roots. The file “noeuds.tdl” allows the labels specification to be posted during the LKB analysis. For the file “roots.tdl”, it delimits the structure to be analyzed by the parser. The other files are detailed later.

In the same way, we have used five files LISP in order to parameterize and to load the already mentioned files. LISP files cover the irregular forms as well as a script. The script file allows indicating the name and the repertory of each file which must be charged by LKB.

Once grammar is loaded successfully in LKB and the parser is generated, we pass to his evaluation on a corpus. The figure 12 show the LKB interface posted after loading successfully the grammar.

Figure 13 presents the LKB interface. This later is ergonomic and easy to use.

To analyze, for example, the relative sentence (12), the system checks that all words of this sentence are included in the lexicon file “lexique.tdl”. Then, the adapted rules already mentioned (i.e., the rule of marking) will be applied. The obtained result is a derivation tree represented in figure 14. This relative sentence (12) includes a special nominal conjunctive noun “« شرب الماء »” accompanied by the verbal phrase (VP) “« drank the water »”.

\[ \text{‘alwaladu ‘alladhy chariba ‘almaa naama}
\[ \text{The child who drank the water has slept} \]

The relative phrases, like all the Arabic phrases, can interact with other linguistic phenomena. In the same relative phrase, we can have prepositional, verbal phrase, etc.

The evaluation of the parser obtained is carried out on a sample of corpus. The sentences which form the corpus contain simple and composed sentences. This corpus deals with the analysis of various linguistic phenomena such as the elision “النامة”, the call “النامة”, the description “النامة”.

In addition, the corpus is extracted from the Arabic grammar books through literary texts for the pupils from the secondary first and second year and from daily newspapers. These sentences belong essentially to the two types of relative. The lexicon, that we use, contains approximately 3000 words. It is formed mainly of the words of the corpus sentences.

The table 5 gathers some types of relative sentences. In the same way, this table contains the number of trees for each example as well as the number of rules used for each one.
For the tested sentences, we note that the generated parser could correctly build their syntactic structures in a reasonable time. In addition, the correct analysis covers more than 80% of the corpus sentences. For the remaining sentences, the failure is due to the existence of two derivation trees for the same sentence. This problem is caused mainly by linguistic ambiguities found during relative sentences analysis. Indeed, in example (13), the relative clause “who gained in tournament” can refer to the noun “the neighbour” (the neighbour) or to the word group “The son of neighbour” which represents an annexed composite.

It should be noted that it is necessary to define a priority order of the schema application during analysis. With this priority order, unwanted readings are blocked and the order of schema’s application is enforced by using constraints. For example, schema 1 (of specification) which is more general than the others may have a minimal priority whereas the modification (schema 5) has a higher priority.

In order to increase the lexicon size, we have added an interface written in JAVA which can enrich the file lexique.tdl by new words automatically and without knowing the TDL syntax. We have also implemented a proper transliteration tool based on the Qalam’ system since the LKB Windows version does not support the Arabic letters.

8. Conclusion and Perspectives

In this article, we have studied the typology of the Arabic relative sentence. This study enabled us to propose an Arabic HPSG grammar. Then, we have specified an Arabic lexicon and the proposed grammar into TDL. Finally, we have experimented the specification with the LKB platform.

As perspectives of this work, we aim to test our parser on a larger corpus. We plan also to extend the HPSG description to cover other linguistic phenomena and deal with the majority of syntactic ambiguities of the Arabic language. Also, we plan to extend this work to cover semantic analysis. However, more work should be carried out to transform the system written under Windows into a compatible system under UNIX.

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1 The transliteration is realized according to Qalam: the morphological transliteration developed by A. Heddaya in contribution with W. Hamdy and Mr. H. Sherif, (1985-1992).
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