Use of NLP Tools in CALL System for Arabic

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This article focuses on the development of Natural Language Processing (NLP) tools for Computer Assisted Language Learning (CALL). First, we have developed some NLP tools: a labelled dictionary of Arabic (as complete as possible), a generator for morphological derivatives, a Conjugator and a morphological analyzer for Arabic. Second, we used these tools to create a number of educational applications for learning the Arabic language by using the proposed system SALA (an NLP-based authoring system, organized into three distinct layers: functions, scripts and activities).

Keywords: NLP (Natural Language Processing); CALL (Computer-Assisted Language Learning); Arabic.
1. Introduction

Computer environments for human learning are used in many fields, such as driving or training for fire-fighters, and also for teaching and learning of languages. However, the development in the field of language teaching is hampered by the fact that this tool does not take into account the specificity of the subject matter, which is the language. Natural Language Processing (NLP) is surely the missing field for a real qualitative evolution in the design of such systems. There are many examples of CALL software on the Internet, designed using authoring systems such as Course builder, Hot Potatoes or Netquiz. Such activities poses several problems [1] as the rigidity of software (the data used are predetermined and can’t be altered or enhanced) and the inadaptability of these courses to the language skills of the learners (the path is independent of its response to each step, they can’t evaluate). In order to permit learners to work independently, the activity must be able to detect, explain and automatically correct its mistakes. The current software does not allow a real customization and adaptation to the learner because the corrections are predetermined (compare the response of the learner with that in memory and in the best case display pre-recorded explanations). The only advantage that such exercises contribute to those written on paper is the interactivity of the computer. The use of NLP software is currently the only approach that can solve this problem [2].

But after more than two decades since the early work, the advanced research in the topic of CALL based on the NLP remains weak, due to two main factors: the lack of NLP from experts in language education or computer scientists, and the cost of resources and products of natural language processing. For this there are only a limited number of prototypes and experimental systems for languages that use the Roman alphabet [3–6]. The CALL work based on NLP for the Arabic language is practically nonexistent, in despite of a rich literature on the automatic processing of Arabic. In addition to factors mentioned above, the lack of CALL software for Arabic is due to that Arabic is a difficult language to treat automatically [7, 8].

In this situation, and hoping to enrich the possibilities for creating educational activities for Arabic we have: As a first step, developed a labelled dictionary of Arabic (as complete as possible), a morphological generator, a conjugator and a morphological analyzer of Arabic words [9–11]. In a second step, we used these tools to create a number of educational applications for learning Arabic as a foreign language for French learners by using our system SALA [12].
2. NLP Tools

The morphological analyzer forms the basis of the NLP applications, especially in the field of language learning because in this kind of applications, the output cannot be wrong: the application can’t give an approximate result to its users. For this reason we need an analyzer with a very high level of reliability, i.e., which gives answers fast and correctly, things which do not exist at the moment for the Arab language. The nonexistence of a tagged complete dictionary is one of causes of this failure. In fact, the dictionary serves as the knowledge base of the analyzer, so if it contains gaps, the analysis is defective. However, all the existing Arabic electronic dictionaries until now are: not labelled, incomplete or very specific to an application or a particular linguistic model [9].

To be reliable, Arabic CALL applications need a robust morphological analyzer, i.e. able to give at least a tag for a word which belongs to the language, whose core is a complete dictionary (which contains all the words of the Arab language and their corresponding tags). A complete dictionary of Arabic contains thousands of the words, and for implementing it manually we would need a lot of time. This explains the need for automatic treatment, especially because most of the Arabic lexicon can be easily derived. For this purpose, we began the generation of an automatically tagged dictionary, starting from the Arabic roots and by using their patterns and their meanings [10], using as basis the rules defining the morphemic structure of Arabic.

3. Arabic Electronic Dictionary

In Arabic, the majority of the verbs and the nouns are combinations of a root (generally with three radical consonants [16]) and a pattern. A word family can thus be generated automatically for the same semantic concept starting from only one root using various patterns. Moreover, even the Arabic roots can be generated automatically [17].
With an electronic dictionary, we can easily determine the roots of the words. Thereafter these roots can be used to assist learners of Arabic to know the synonyms and the meanings of words. In order to find a definition or a synonym of an Arab word, and in the absence of human help, the learners of Arabic can use the dictionary of synonyms (ordered alphabetically by roots for the derivable words) to face incomprehensible texts [8]. To identify a word in the dictionary we must know its root, which is not obvious for a person who learns Arabic.

In this study, we propose an electronic dictionary for Arabic, generated automatically at the request of the user, to avoid congestion in memory, using the rules for morphemic structure and the lexical matrix [11]. The complete dictionary is composed of several modules:

- tagging of roots,
- derivation and tagging of the nouns,
- derivation and tagging of the verbs,
- conjugation and tagging of the conjugated verbs

### 4. Level of NLP integration in SALA

For language learning, the way in which we use the NLP depends on the purpose of the tasks to be performed by learners. In our case, i.e., the Arabic language learning forms (morpho-lexical level), the NLP may occur in two levels:

- Creation of activities by the language teacher, based on scripts describing exercises and combining the NLP functions required to build these activities (morphological tagging, for example). The activities can be created according to scenarios created by the teacher as on the platform MIRTO (Multi-Interactive learning through research on texts and oral) [5].

- Expert analysis of exercises completed by learners in order to flag their lexical and morphological errors. This role is achieved through NLP tools dedicated to micro-tasks [13], and capable of solving issues of lexicon or morphology; the NLP tools provide a framework for analyzing the production of relatively predefined content. The language processing can be used to show grammatical errors directly to students in the system FreeText [14] or German Tutor [15]. The problems with these systems are the level of responses that we must give to the learner on his mistakes, especially in the case of multiple errors in a reply, the question being to know what mistakes we must resolve first.

In this study, we adopted the integration of NLP in the first level because it seems more interesting, with the possibility of later use of NLP tools in the level...
of responses as part of partial significant assistance for example on the word forms (indicating the pattern, the root, etc.) in order to facilitate inference and to guide the learner towards the correct solution.

5. SALA Architecture

The main goal of SALA is to offer to the language teacher the possibility of designing activities in their own set of pedagogical problems, taking advantage of NLP techniques. The approach of SALA is resolutely user-oriented because it is destined for language teachers who, a priori have little or no skill either in computing or in NLP. The technical nature of NLP has to be transparent to the language teacher and only the didactic aspects are to be visible and accessible to him. For this, the structure of SALA is composed of three levels (function or NLP tools, scripts and activities), as shown in Figure 2.

![Figure 2. SALA Architecture.](image)

5.1. Function level

Functions serve as the objects in the lowest level of SALA. They correspond to basic NLP tools such as a Conjugator or a morphological analyzer. Considering its technical nature and its independence of a didactic application, this level is not visible for any end users of SALA (i.e., teacher and learner).

5.2. Script level

This level corresponds to the application of NLP functions to language didactics. The scripts are modules that integrate resources or NLP treatment and which have a general educational goal. For example, automatic generation of conjugation exercises is regarded as a script, which must then be set by the
teacher as necessary to achieve a specific educational objective. The creation of scripts demands skills in NLP and computer science. NLP programs used here were written by us to support the SALA project. Given the technical nature of the scripts, the internal interface of this level is not visible to language teachers. Each script is created and identified by a name that suggests the potential pedagogical content.

5.3. Activity level

From a purely educational level, the design of activities is a task carried out by teachers of languages, through a specific interface. An activity corresponds to what is traditionally designated as an exercise given to learners to enable them to reach a goal. Generating activities involves the implementation of a didactic script. An activity is an instantiation of a didactic purpose that may be used by a learner in an autonomous manner.

The first step concerns the choice of a script to implement, in a list of available scripts. A script for the teacher is a black box; the only interface is a menu requesting a series of required parameters. Once the script chosen, the teacher must set up, according to parameters available in simplified form, through a panel, whose orders must be configured for use in teaching. For example, the teacher who wants to design a conjugation exercises must specify the person, tense, gender, number, aspect of conjugation, type of the root and/or type of pattern. Then the teacher must enter the command corresponding to the activity and indicate if the automatic evaluation is possible, any corrections based on the results of the evaluation.

Figure 3. Example of creation activity interface.
Each activity should be validated once it is created by its author, who must verify that no system errors are possible. The appearance of an error in an activity created has caused doubts about the quality (degree of accuracy) of the NLP results used in its preparation. Errors are possible, because the results of NLP treatment are not always 100% reliable especially for the Arabic language.

The setting and the automatic evaluation of an activity require special attention, and in case of a system error the teacher must make a correction manually.

Table 1. Operations and Users.

<table>
<thead>
<tr>
<th>Level</th>
<th>Operation</th>
<th>User</th>
</tr>
</thead>
<tbody>
<tr>
<td>NLP tools</td>
<td>Design</td>
<td>NLP computer scientist</td>
</tr>
<tr>
<td>Scripts</td>
<td>Design</td>
<td>NLP computer scientist</td>
</tr>
<tr>
<td></td>
<td>Utilization</td>
<td>Language teachers</td>
</tr>
<tr>
<td>Activities</td>
<td>Design</td>
<td>Language teachers</td>
</tr>
<tr>
<td></td>
<td>Utilization</td>
<td>Learners</td>
</tr>
</tbody>
</table>

6. The Interfaces

- The Computer Specialist allows access to all the NLP tools, language resources and the internal view of the scripts. It is useful for updating the tools, resources and scripts. It allows the integration of methods recently discovered by scientists (other than in the software design) for to be scalable and reusable.
• The language teacher interface is simple and easy to control (no computer knowledge is required), which provides access to the external view of scripts to create activities, and access to basic errors to improve the created activities. The parameters of each activity should be kept simple (too many parameters could discourage the user), and declarative parameter (user is not supposed to master a complex formalism, the definition of parameters should be intuitive) and friendly (important information should be readily understandable).
• The interface for language learners enables them to choose the level of difficulty and answer questions from the activities.

7. The Databases

• The Activity Database contains a suite of applications, which were designed by language teachers to achieve didactic goals, and which can be changed in response to the errors made by the learners.
• The Answer Database records all the tracks produced by learners including mistakes. It can be accessed by the teachers so that they can control the level of learners and enhance learning by offering other more appropriate activities.

8. Structuring Learning

The logical progression is normally one that goes from simple to complex, but the structuring of language learning does not imply that. The presentation of learning activities is determined only by the logic levels. If this were the case, education would be limited to situations and stereotypical content, artificial and poor. Progress through scheduled activities can be structured to provide all the communication needs of a learner at a given time. Since language learning must necessarily fall somewhere between a simulated interchange and an artifice, it is necessary to monitor situations and look for content that involves natural exchanges, so that learners can feel involved in what they write. A balance is always found between the desire to structure the learning and communication with the learner; otherwise the motivation of the latter can’t long be maintained. We must ensure that the structure responds to a need for language learning, made attractive by activities that allow as much communication as possible with the learner.
9. Examples of Activities

We have designed about twenty activities that continuously change with each call, eliminating the cases dealt with later. Most modules provide help that is displayed after a short delay to give students a chance to answer the question on their own. This aid is in the form of cues that depend on the activity such as the length of the word and the first letters, so as to guide the learner towards the correct solution.

The following example (see the figure below) asks the student to analyze a word chosen at random from our Arabic dictionary. The learner must make the choice of pattern for this word in a list box, enter the root and see if his or her answer is correct or not. This interface is used to assess learner knowledge.

![Image of activity](image-url)
The result reflects the activities of partially correct answers with the diagnosis according to adapt responses from the learner. Indeed, a response is not always completely false and can be broken down into several components, some of which are proven correct.

10. Experimental Results

The recording traces of the actions on which the learner can make a synthesis of system use. The traces are organized by session work and record any action done by the learner by date which enables them to calculate the time spent spent in each response in all activities and a saw to the teacher about how the system is used and assess whether, for example, an activity should be modified. In Table 2 an example of exploitation of these results:

<table>
<thead>
<tr>
<th>Time Spent</th>
<th>Learner 1</th>
<th>Learner 2</th>
<th>Learner 3</th>
<th>Learner 4</th>
<th>Learner 5</th>
<th>Learner 6</th>
<th>Average time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response 1</td>
<td></td>
<td>0.9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.9</td>
<td>0.97</td>
</tr>
<tr>
<td>Response 2</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Response 3</td>
<td>1</td>
<td>0.5</td>
<td>0.9</td>
<td>0.8</td>
<td>0.9</td>
<td>1</td>
<td>0.85</td>
</tr>
<tr>
<td>Response 4</td>
<td>1</td>
<td>0.9</td>
<td>0.8</td>
<td>0.6</td>
<td>1</td>
<td>0.9</td>
<td>0.87</td>
</tr>
<tr>
<td>Response 5</td>
<td>1</td>
<td>0.3</td>
<td>0.6</td>
<td>0.5</td>
<td>0.8</td>
<td>0.7</td>
<td>0.65</td>
</tr>
<tr>
<td>Response 6</td>
<td>1</td>
<td>0.3</td>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
<td>0.8</td>
<td>0.58</td>
</tr>
<tr>
<td>Response 7</td>
<td>1</td>
<td>0.5</td>
<td>0.7</td>
<td>0.7</td>
<td>0.9</td>
<td>0.6</td>
<td>0.73</td>
</tr>
<tr>
<td>Response 8</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Response 9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.9</td>
<td>0.98</td>
</tr>
<tr>
<td>Response10</td>
<td>1</td>
<td>0.9</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>activity 7</td>
<td>10</td>
<td>7.3</td>
<td>8.5</td>
<td>8.1</td>
<td>9</td>
<td>8.8</td>
<td>8.62</td>
</tr>
</tbody>
</table>

The evaluation of an activity can be done according to several parameters (number of correct responses, with time to reply, appreciation of the learner, ...). In our example, the assessment is made according to the time spent per learner per response.

\[
\text{Spent time} = \frac{\Delta t}{T}
\]

With \(\Delta t\): the difference between the time that the question was displayed on the screen and the moment in which the learner has responded or the end display, and \(T\): the maximum time allowed by the teacher.
The value 1 in learner’s table columns above shows that the learners could not answer. Thus the value 1 in the Average time column shows that no student could respond on this issue as was the case for question 2 and 8, which allows the teacher to recheck these issues and modify if is necessary.

Middle = \( \sum \) Spent time/N

With \( N \) is the number of learners in the analyzed sample. These evaluation results are used directly or through graphics such as:

![Figure 6. Graphics result of activity.](image)

This chart allows the teacher to conduct a comparative study at the level of capacity of understanding of each learner. So for our example, we note that the learner 2 is the best and the learner 1 is the lowest in this activity. This graph also shows that the goals of this activity have not been achieved, because we can see that the success rate of weaker responses to the latest issues, which is the opposite of what we expect when the goal of an activity is reached (more success towards the end of activity) and shows that the educational and pedagogical purpose of this activity has not been reached.

11. Conclusion and Future Work

The aim of our work was to design and implement a CALL system for the Arabic language, based on NLP tools with the goals of placing no limit on the vocabulary and making the system as simple to use as possible. This work will then become the starting point for new opportunities for improvement and
refinement on the basis of comparative tests and evaluations. To this end we have been led to make choices, to address a number of problems and to draw lessons, especially during the implementation of NLP tools.

The next step is to ensure that the system can make a more sophisticated diagnosis discerning typos or detecting answers that are almost correct. The system should also be capable of providing significant help on word forms (pattern, root etc.), in order to facilitate inference and to refer the student to the correct solution. Therefore, these exercises will be more than a simple tests, but a real educational activity promoting the learning of lexical and morphology of Arabic.

References


