

OVERVIEW OF COMPUTER-ASSISTED LANGUAGE LEARNING FOR EUROPEAN PORTUGUESE AT L²F

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Abstract: In this paper, we give an overview of our research in Computer-Assisted Language Learning for European Portuguese, to show how our long-time experience in spoken language processing allowed to propose multimedia documents as learning material. Web-based serious game were also introduced to cover aspects of listening, reading, and writing skills. One fundamental aspect of all our tools remains in the fully-automatic generation of the curriculum. This is very valuable for teachers, saving them time in search for motivating materials of appropriate quality, level and topic. A Web portal was recently created to make all our tools publicly available at <http://call.l2f.inesc-id.pt/reap.public>.

1 INTRODUCTION

Our research in Computer-Assisted Language Learning (CALL) began a few years ago in the context of a joint research program between Portuguese universities and the Carnegie Mellon University. The first effort was to port to Portuguese a vocabulary learning tutoring system, originally developed for American English. The system initially focused on vocabulary learning by presenting to students reading material with target vocabulary words in context (Heilman et al., 2006).

Once the text-based reading activity system was adapted, new functionalities were included, in particular Text-To-Speech (TTS) features, rich transcriptions provided by our Automatic Speech Recognition (ASR) engine and its post-processing modules, and Machine Translation (MT) within a game. The basic idea was to benefit from our long-time experience in spoken language processing to enhance the features of the system.

European Portuguese (EP) foreign learners often state that their listening skills cannot cope with spontaneous speech. In fact, one well-known characteristic of EP that distinguishes it from Brazilian Portuguese in particular, is the strong use of vowel re-

duction and simplification of consonantal clusters, both within words and across word boundaries (Cruz-Ferreira, 2009). Hence, the practice of listening comprehension appeared to be a very important feature to explore. With the growing interest in using serious games to motivate learners (Sørensen and Meyer, 2007), we decided to develop some games to be included in our platform.

This paper is organized as follows: Section 2 presents related work with some examples of CALL interfaces and educational games. Section 3 describes the main vocabulary learning platform based on texts retrieved from the Web. The introduction of multimedia documents, in particular broadcast news shows, is explained in Section 4, with the description of a BN browsing tool and the vocabulary perception serious games. Finally, other recent serious games are presented in Section 5.

2 RELATED WORK

Our CALL system is centered in Multimedia and Internet, resulting from the shift to globalization, where the teachers turn into facilitators instead of being the source of knowledge, and the students should

interpret and organize the information given in an active way. A number of recent projects have taken similar approaches to provide language learners with authentic texts. WERTi (Meurers et al., 2010) is an intelligent automatic workbook that uses texts from the Web to increase knowledge of English grammatical forms and functions. READ-X (Mitsakaki, 2009) is a tool for finding texts at specified reading levels that also performs a classification per area of interest. TAGARELA (Bailey and Meurers, 2008) is an intelligent computer-assisted language learning system that provides opportunities to practice reading, listening and writing skills.

Our CALL system takes a slightly different approach. Rather than teachers choosing texts, the tutor itself selects individualized practice readings from a digital library. The readings contain target vocabulary words shown in context. A given student needs to learn a set of words based on a student model. Beside the use of texts to develop reading skills, multimedia documents, and videos in particular, are a privileged medium to practice listening comprehension and vocabulary acquisition. Secules et al. (Secules et al., 1992) showed how listening comprehension skills improve when using video-based contents on French students. In (Brett, 1995), the author showed that authentic video materials with subtitles can increase the students' motivation to engage in these types of tasks.

Recently, games have gained strong interest in the CALL community to support L2 acquisition. These games are referred to as *serious games*, being characterized by an educational goal supported by entertainment features (Sørensen and Meyer, 2007). We believe that combining recent multimedia curriculum, broadcast news in this case, and serious games may render the tools more appealing and learning effective.

3 THE WEB AS AN OPEN CORPUS

At first login to the system, the student is given a pre-test, in which the interface shows a target word list extracted from the Portuguese Academic Word List (P-AWL) (Baptista et al., 2010), and they are asked to choose the ones they know, in order to assign one of the 12 school levels. The current version of P-AWL contains the inflections of about 2K different lemmas, totaling 33.3K words. Target words are assigned to each student according to their estimated level. Students may also define which topics they are interested in. Student-specific target word lists and preferred topics render the system more student-

adapted. Different students will have different interactions with the system.

The main reading activity component of the Web platform, which was also the first developed component, provides the students with real texts, which were automatically retrieved from the Web. The main document repository is the ClueWeb09 corpus. This is a collection of over 1 billion Web pages (5 TB compressed, 25 TB uncompressed), created by the Language Technologies Institute at Carnegie Mellon University¹. This corpus contains texts in 10 different languages (like Arabic, English, Portuguese or Spanish), compiled for research on speech and language technology. In the specific case of the Portuguese section of this corpus, it includes more than 37.5 million pages, all retrieved in 2009. This subset of documents (about 160 GB compressed) constitutes the corpus currently being used in our project. The average document size is 3,000 characters.

At each access to the individual reading activity platform, a list of five texts is presented. A search module is responsible for retrieving from the Web-based corpus the texts satisfying particular pedagogical constraints such as readability level and text length, and containing words from the target list that students should learn. It is also responsible for matching these documents with the student preferences in terms of topic. This filtering stage is a very valuable tool for teachers, saving them time in search for motivating materials of appropriate quality, readability and topic.

The list of topics includes ten labels, such as Economy, Education, Health, Politics, Sports, etc. We use the same topic indexer as the one used in our broadcast news processing pipeline (Amaral et al., 2007). A topic likelihood is compared to the corresponding non-topic likelihood, and given a threshold that was estimated for each topic, a classification decision is taken. With this method, several topic labels may be assigned to a single text. Concerning the readability level, Support Vector Machines (SVMs) are used to estimate the grade level of the texts with lexical features as input, such as statistics of word unigrams (Marujo et al., 2009).

During a reading session, the target words are highlighted in the texts and the student can search for the meaning of the words by clicking on them or by using the search field of the system. The reading session is followed by a series of multiple-choice definition questions and cloze (fill-in-the-blank) sentences about the words that were highlighted. These exercises are automatically generated based on a set

¹<http://boston.lti.cs.cmu.edu/Data/clueweb09> (last visited in December 2010)

of 6k sentences that were selected and adapted by linguists (Correia et al., 2010).

4 MULTIMEDIA DOCUMENTS AS LEARNING MATERIAL

We introduced broadcast news (BN) videos in the curriculum of the reading activity module. A large repository of BN shows has been daily stored and automatically transcribed since 2009. BN material allows to provide the learners with very recent curriculum, with a wide choice of short stories on different topics and with the added value of videos. Another early initiative consisted of integrating our real-time Text-To-Speech engine in the reading activity module described in the previous section. The reader may select words from the text to listen to a synthesized audio version.

So far, we developed two components that use BN shows: a listening/reading activity page, and several vocabulary perception games providing isolated sentences extracted from BN shows.

4.1 Enriched broadcast news videos panel

The BN videos need to be automatically segmented, transcribed and indexed in order to prepare and select relevant excerpts. The processing pipeline consists of removing the jingles that usually start and end the news shows, segmenting the audio stream into single-speaker homogeneous speech segments, transcribing the segments automatically with our in-house automatic speech recognition (ASR) system (Neto et al., 2008). Further modules are then applied to include punctuation, capitalization, and multiple topic labels. The topic classifier is the same tool as the one used with the Web texts of the main reading activity component described in Section 3.

The output of the BN pipeline is comprised of stories with about 300 words each on average. A further filter is applied to automatically estimate the readability level of the stories, from grade 5 to grade 12, with the same classifier as the one described in Section 3. It was found that the language level of the stories span over the 7th and the 11th grades, with an average corresponding to the 8th grade (Lopes et al., 2010). After the processing pipeline and the level classification, the filtered stories are displayed on a single Web page, showing the video excerpts with their automatic transcriptions.

4.2 Vocabulary perception serious games

As mentioned in the introduction, EP listening perception skills are hard to master for foreign learners. Attempting to combine the rich diversity of our BN repository with the motivating aspects of games, we developed “vocabulary perception” games. In these games, the learner is asked to listen to an utterance using only audio or along with a video clip, and then the sentence should be reconstructed by choosing words from lists containing the correct words and some distractors. Our main objective was to give realistic speech for the learners to get used to the sounds and the pronunciation of native speakers. Figure 1 shows one of the game interfaces.

All the exercises are generated in a fully-automatic way. A filtering is needed to discard sentences with probably misrecognized words. A sequence of five filters was designed to select the sentences: sentence length smaller than 10 words, high ASR confidence measures, syntactic completeness (at least one verb and one common name), large signal-to-noise ratio, descending pitch slope in the sentence boundaries (neutral declaratives). Finally, the distractors are also automatically generated, with two complementary techniques, either based on the confusion networks produced by the recognizer, or on phonetic distances (Pellegrini et al., 2011).

In (Correia et al., 2011), the best features for the games were explored by submitting a set of 18 exercises ending with a questionnaire to foreign EP learners. Preference was given to: audio and video in all the exercises, recent content and preferably anchor speech. A search feature was also proposed, allowing the player to search for a phrase into the BN repository. This feature was also appreciated, but some search suggestions should be provided. A *karaoke* feature also was well appreciated, allowing the user to watch the video with the corresponding transcription while the words are being highlighted as they are spoken.

5 OTHER SERIOUS GAMES

5.1 Vocabulary learning game

Lexical Mahjong proposes a set of exercises where the student has to establish a correspondence between a lemma and a definition. The list of target words came from P-AWL (Baptista et al., 2010) and the def-



Figure 1: Tick interface of the vocabulary perception game.

initions are taken from the Infopédia². A set of filters selects the definitions: (1) definitions containing cognates of the target word are discarded, since they are an obvious cue to the student; (2) only definitions of more than one word (to avoid similarities with synonyms' exercises) and less than 150 words (to avoid very long definitions) are considered; (3) characters that hinder the understanding of a given definition are removed (e.g. numbering of definitions, semicolon, cardinal, etc.); (4) the learning level of the words in the definition must be equal to or less than the level of the exercise and that of the target word it corresponds to (Lopes et al., 2010).

Definitions were also classified according to their difficulty level. Three levels were considered: beginners, intermediate and advanced. As the system is student-oriented, the word-definition pairs are chosen according to the student profile, taking into consideration: (i) the student's level, influencing the number of word-definition pairs that are presented to the student; it also determines the difficulty level of the definitions presented; (ii) the student's history, determining which words are presented to the student, by showing words that the student probably does not know yet. The automatic correction of the exercise locks only the correct answers, keeping the wrong answers still selectable for further tries.

The Lexical Mahjong exercises already require some knowledge of Portuguese as they call upon more advanced language contents. Due to the difficulties in gathering a test group with these features, evaluation of the game was conducted on a group of Portuguese native speakers in the 3rd and 4th grade (Group 1),

²<http://www.infopedia.pt> (last visited in December 2010)

who, in spite of their knowledge of Portuguese as mother language, still have limited vocabulary. The same test was also performed with a control group, comprised of native speakers with at least a college degree (Group 2). Thus, 45 subjects performed this exercise, 18 in Group 1 and 31 in Group 2. Each player was given three sets of words from each difficulty level. More than 77% of the users found the system easy to use, while only 39% needed to use the "Help" button. Group 2 obtained better results, with a performance of 84.0% (standard deviation = 6.6%), while the users from Group 1 made more errors and just attained a performance of 54.0% (sd = 12.4%). The error rate progression for each exercise showed that in both groups the more the difficulty level of exercises increases, more mistakes the players do. This result seems to confirm the adequacy of the strategy here followed for distinguishing the level of different definitions inside the dictionary entry of each target word. It may also contribute to devise automatic assessment strategies for second language learners.

5.2 Verbs and spatial prepositions 3D game

REAP Pictórico is a serious game which aims at teaching the verbs and prepositions used to describe the spatial relation of objects. Exercises are solved in a game environment making use of a 3D scenario in order to further capture the student's interest. The Unity 3D game engine³, was chosen to implement the game (Ribeiro et al., 2010).

In the game, the player controls an avatar through first-person perspective mainly. The scenario consists of an office composed of 5 different rooms, and in each room there are several exercises to be completed. The exercises consist of asking the student to move an object in the scenario to new positions with the use of the mouse, according to a given instruction. For example: *Coloque o objecto A em cima do objecto B* (Put the object A **on top of** the object B). Answers given by the students are automatically evaluated by our game (Silva et al., 2011).

When the player does not position an object in the right place, the game describes the action that was made and the one that should have been made. Figure 2 shows an example of informative feedback to explain to the player that he wrongly positioned the pen over the table and over the notepad instead of inside the pencil holder. Hence, the students may also learn from their mistakes by reading spatial verbs and

³<http://unity3d.com/> (last visited in November 2011)

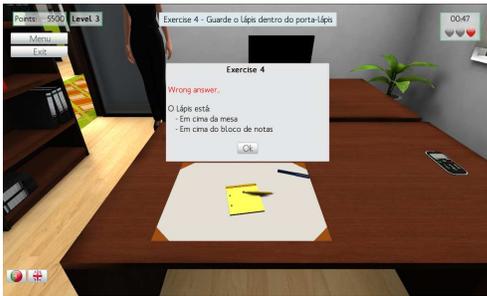


Figure 2: Screen shot of the 3D pictorial game. The player is asked to complete actions involving spatial verbs and prepositions.

prepositions that may be different from the ones used in the exercise instructions.

A first evaluation of the game was conducted. A total of 14 students from the Portuguese as Second Language (PSL) course of the University of Algarve played with the application and answered a survey. In terms of the interaction with the game – moving objects and controlling the avatar –, those who stated that the control of the avatar was easy, were also those who had less trouble moving objects around, and vice-versa. It appeared that learning how to play the game was not at all considered by most students as a barrier in their learning experience. The survey also asked the students to estimate how much they had learned. Their answers were very encouraging. 25% stated that they might have learned more with the game than with a traditional class, while 75% stated they might have learned the same. In general, students were satisfied (50%) or very satisfied (25%) with the game.

5.3 Translation game

This competitive language translation game aims at improving students vocabulary and writing skills. An automated agent is employed as an opponent in order to improve the user’s motivation and maintain the user focused. The game can currently be played with the language pairs English-French, English-Chinese, and Portuguese-Chinese, but it can easily be adapted to other language pairs for which one has a parallel corpus and an MT engine.

The exercises were created by processing the BTEC and DIALOG test corpus from the IWSLT 2010 evaluation. The Portuguese-Chinese language exercises were built by using the DIALOG English-Chinese dataset. A subset was manually translated from English to Portuguese since the corpus does not provide Portuguese-Chinese sentence pairs directly. The game only allows a single translation, selected



Figure 3: Screen shot of the translation game.

among a set of manually created references. The agent’s actions are based on the output of a statistical machine translation system. The agent has a representation of its current state, and a Markov process that determines how that state evolves for each action the agent or the player can perform. This resembles the process used in chess playing agents, where the agent has to think multiple moves ahead to determine the next action.

Each game is composed by a number of rounds. In each round the system presents a sentence in the source language (typically, the user’s native language), and the corresponding sentence in the target language with a number of hidden words (or characters, in the Chinese case), marked with an empty underlined space. Players take turns to guess the words that are hidden, proposing only one word at each turn. Players are rewarded 20 points when they get the right answer and penalized 5 points when they propose a wrong answer. In each round, the hardest word to find is marked in yellow, which is worth 40 points. Finally, the player who guesses the last word completing the sentence receives an additional 30 points.

Figure 3 shows a screen shot of this translation game where the sentence “Que queres dizer?” is to be translated into Mandarin. The target sentence shows words in green (answered by the student) and in red (answered by the agent). The bonus word has a yellow background.

An evaluation that was performed with 20 Portuguese learners of Mandarin suggested that the subjects were more focused and motivated when playing against the agent rather than playing alone. Furthermore, the majority of students said that the system helped them learn Mandarin and would like to use it in the future. The system has a web-based implementation and is easily accessible by language learners.

6 Conclusions and future work

In this paper, we presented our CALL platform, publicly available at url. The first developed tool was an individual reading activity module that gives access to a very large Web text corpus (about 37 million pages), presented according to automatically estimated readability levels and inferred topic labels. One of the most innovative aspects of our platform consists in the use of our speech and natural language processing technologies to propose real-life multimedia documents as learning material. ASR and subsequent processing modules are used to propose broadcast news videos together with enriched transcriptions. TTS is used to allow the learners to listen to any text segment of interest. Finally, our serious games were presented: a vocabulary perception game, a vocabulary learning game, a game to learn spatial verbs and prepositions, and a translation game. Hence, the platform covers three of the four major skills: listening, reading, and writing skills. Current research effort is devoted to further enhance our tools with pronunciation aid modules to cover the speaking skill.

Evaluations were carried out with real European Portuguese learners. These evaluations mainly concerned the features of the modules and the games, in order to help choosing the best ones. The user interest and satisfaction were also evaluated, and very positive feedback was given in general.

Further evaluations of learner performance are needed to establish whether our modules and games are conducive to actual learning. In particular, pre- and post-tests are envisaged to study the impact of our tools on the user's learning experience. Furthermore, future work will include the testing of new features in our modules and games. In the vocabulary perception game for instance, a TTS that would allow to listen to speech without co-articulation is expected to be very interesting to give hints to the learner.

REFERENCES

- Amaral, R., Meinedo, H., Caseiro, D., Trancoso, I., and Neto, J. (2007). A Prototype System for Selective Dissemination of Broadcast News in European Portuguese. *EURASIP Journal on Advances in Signal Processing*, page 11.
- Bailey, S. and Meurers, D. (2008). Diagnosing meaning errors in short answers to reading comprehension questions. In *Proc. of the Third Workshop on Innovative Use of NLP for Building Educational Applications*, pages 107–115, Morristown.
- Baptista, J., Costa, N., Guerra, J., Zampieri, M., de Lurdes Cabral, M., and Mamede, N. (2010). P-AWL: Academic Word List for Portuguese. In *Proc. PRO-POR*, pages 120–123, Porto Alegre.
- Brett, P. (1995). Multimedia for listening comprehension: The design of a multimedia-based resource for developing listening skills. *System*, 23(1):77–85.
- Correia, R., Baptista, J., Mamede, N., Trancoso, I., and Eskenazi, M. (2010). Automatic Generation of Cloze Question Distractors. In *Proc. SLaTE*, Tokyo.
- Correia, R., Pellegrini, T., Eskenazi, M., Trancoso, I., Baptista, J., and Mamede, N. (2011). Listening Comprehension Games for Portuguese: Exploring the Best Features. In *Proc. SLaTE*, Venice.
- Cruz-Ferreira, M. (2009). European Portuguese. *Journal of International Phonetic Association*, 25:02:90–94.
- Heilman, M., Collins-Thompson, K., Callan, J., and Eskenazi, M. (2006). Classroom Success of an Intelligent Tutoring System for Lexical Practice and Reading Comprehension. In *Proc. Interspeech*, pages 829–832, Pittsburgh.
- Lopes, J., Trancoso, I., Correia, R., Pellegrini, T., Meinedo, H., Mamede, N., and Eskenazi, M. (2010). Multimedia Learning Materials. In *Proc. IEEE Workshop on Spoken Language Technology SLT*, pages 109–114, Berkeley.
- Marujo, L., Lopes, J., Mamede, N., Trancoso, I., Pino, J., Eskenazi, M., Baptista, J., and Viana, C. (2009). Porting REAP to European Portuguese. In *Proc. SLaTE*, pages 69–72, Birmingham.
- Meurers, D., Ziai, R., Amaral, L., Boyd, A., Dimitrov, A., Metcalf, V., and Ott (2010). Enhancing Authentic Web Pages for Language Learners. In *Proc. of the 5th Workshop on Innovative Use of NLP for Building Educational Applications, NAACL-HLT*, Los Angeles.
- Miltsakaki, E. (2009). Matching readers preferences and reading skills with appropriate web texts. In *Proc. EACL*, Athens.
- Neto, J., Meinedo, H., Viveiros, M., Cassaca, R., Martins, C., and Caseiro, D. (2008). Broadcast news subtitling system in portuguese. In *Proc. ICASSP 2008*, Las Vegas, USA.
- Pellegrini, T., Correia, R., Trancoso, I., Baptista, J., and Mamede, N. (2011). Automatic generation of listening comprehension learning material in European Portuguese. In *Proc. Interspeech*, pages 1629–1632, Florence.
- Ribeiro, C., Jepp, P., Pereira, J., and Fradinho, M. (2010). Lessons Learnt in Building Serious Games and Virtual Worlds for Competence Development. In *Proc. Workshop on Experimental Learning on Sustainable Management, Economics and Industrial Engineering*, pages 52–62, Milano.
- Secules, T., Herron, C., and Tomasello, M. (1992). The effect of video context on foreign language learning. *Modern Language Journal*, 76(4):480–490.
- Silva, A., Mamede, N., Ferreira, A., Baptista, J., and Fernandes, J. (2011). Towards a serious game for portuguese learning. In *Proc. 2nd International Conference on Serious Games Development and Applications (SGDA 2011)*, volume 6944 of *Lecture Notes in Computer Science*, pages 83–94. Springer-Verlag.

Sørensen, B. and Meyer, B. (2007). Serious Games in language learning and teaching – a theoretical perspective. In *Proc. Digital Games Research Association Conference*, pages 559–566.