Dynamic Processing of Texts and Images for Contextualized Language Learning

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Abstract

In this paper we present methods for the dynamic processing of texts and images in the framework of contextualized learning. For that purpose we introduce Gymn@zilla, a browser-like application designed for intercultural and interlingual learning. Gymn@zilla combines annotated reading with the possibility to memorize and interactively practice unknown items by means of personal wordlists and dynamic exercises. Possible usage scenarios range from individual language learning over school and university classes to daily working scenarios in non-native speaking environments.

INTRODUCTION

World-wide, national and supra-national bodies promote the bi- and trilingualism of its citizens. In this endeavor, computer assisted language learning (CALL) will play a central role in supporting life-long learning, learner-centered learning, learning of languages for special purposes and learning of uncommon languages.

In order to reduce the usually high pedagogical and technical investment required for the development of CALL systems, more automatic approaches to CALL have being proposed. These approaches rely on Natural Language Processing (NLP) to transform an authentic document into a foreign language lesson. A text glosser, for example, links a target language document to an electronic dictionary to allow for annotated reading. This process of automatic annotation requires NLP modules for stemming (en: children → child), word-segmentation (de: Importdefizit → Import/Defizit), tagging (en: man → noun), and meaning disambiguation ("mouse" vs. "mouse pointer") to map words with high recall and precision onto dictionary entries (Nerbonne et al., 1998; Chen, 1998).

Text glossing for annotated reading is thus a show-case of automatic approaches to CALL. A closer look at the pedagogic aspects involved in annotated reading, quickly reveals that it also has the potential to implement those features which are considered important in up-to-date approaches to language learning, such as autonomy (Benson, 2001), personalized learning (Di Martino, 2003), contextualized language learning (Shrum & Glisan, 2004) and learning with authentic material (Rüschoff, 2003). In addition, a text glosser facilitates reading, lowers the emotional threshold to attack a foreign language text and supports the daily work in a foreign language environment through rapid vocabulary look-ups.

In order to maximize autonomy and authenticity in language learning, the automatic text glosser Gymn@zilla (Streiter et al., 2004) has been developed. This text glosser has been designed as a Web-browser which can visualize and gloss documents from the Internet, the local computer or the private mail-box.

Figure 1
Annotated reading of a web-page with Gymn@zilla

Under the hood of Gymn@zilla, a set of educational modules, language modules and web-technology modules have been assembled in a unique configuration. In a nutshell, Gymn@zilla allows to access Internet documents (maximal autonomy) and to convert them into a text glosser while preserving the original document layout (maximal authenticity). Translations of words and phrases are provided on user demand. By moving the mouse pointer onto unknown words (actively, autonomously, making a conscious choice) the user obtains helpful information (e.g. a translation and image), as well as further options to actively explore the unknown word, either in online (learner's) dictionaries, or with Google's text- and image search. In addition, the user can construct a personal wordlist: Similar to online shopping, words, translations, word contexts and images can be added into a shopping-basket. The resulting word-list is highly personalized: It reflects the personally chosen words and contains example sentences and images from the document the learner has consulted. Finally, the personal wordlist and the documents are merged automatically into a number of completion exercises.

Gymn@zilla, which has been available until recently only in a prototype implementation in a form of a unique web-application, currently undergoes a major re-implementation. This re-implementation not only tries to overcome minor problems with the first prototype, but aims at the conversion into a free CALL software which can be installed and configured at schools and universities to match the local language teaching requirements. A release of the new Gymn@zilla, which will be a free software under the GNU General Public License (GPL) is scheduled for May 2005. Our description of Gymn@zilla will cover the following topics: The language school, the learner, the teacher, the technical implementation of the browser and pedagogical aspects which lead to the design of the system.

THE LANGUAGE SCHOOL

Gymn@zilla is designed as a free software. Language schools, universities and other institutions are free to download Gymn@zilla and install it on one of the school's web-servers[1].

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[1]Currently, only Linux-based web-servers are supported

Gymn@zilla may be configured by each school, e.g. restricting the languages which can be used with Gymn@zilla, or refusing the access to the Gymn@zilla Web-service from outside the school[2].

A teacher in addition can define language classes, which further restrict the configuration made during the installation. The Teacher may restrict Gymn@zilla to one language pair only, e.g. in order not to distract learners by irrelevant options. He or she may limit Gymn@zilla to certain Internet domains (e.g. BBC news) or country codes (e.g. uk). The teacher may further define the layout of the personal wordlist and the content of the help box for unknown words. After the configuration, the language teacher chooses pages in the Internet which comply with the didactic concept of the language course and suit the needs of the learners in terms of interest, language level and the ratio of written to unwritten information. The teacher can add the selected pages to a bookmark folder to simplify the access to the page.

THE LEARNERS VIEW ON GYMN@ZILLA

Document Selection

The learner can install Gymn@zilla on his or her private computer or visit a running Gymn@zilla web-service at his or her school or university. Opening the Gymn@zilla home-page with the preferred web-browser[3], the learner can select the language pair, e.g. eng-deu, for reading English web-pages with support in German or eng-zho for reading English pages with support in Mandarin Chinese.

Then the learner freely enters the web-page to read. As an alternative, or for a first exploration of Gymn@zilla, each language disposes of pre-selected bookmarks, pointing to high-quality web-sites such as BBC News for English. Gymn@zilla's bookmarks include also the entire Project Gutenberg's Document RDF, covering about 15.000 documents in 30 languages. In addition, Gymn@zilla can browse the learner's computer, including the user's mail spool file for daily usage.

Annotated Reading

When browsing a page, Gymn@zilla returns the original page with recognized words annotated. The annotations are marked by a grey dashed underline. Moving the mouse pointer to an underlined word creates a help box appearing near the underlined word (cf. Fig. 1, right box). The standard help box contains:

1) The L2 lemma, recognized by stemming,
2) a image related to the L2 lemma,
3) the L1 equivalents drawn from associated dictionaries,
4) a link to entries in recommended learner's dictionaries,
5) a button which adds the L2 term to a personal wordlist and
6) links to GOOGLE image and document search.

Teachers may remove in their configuration elements from this list.

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[2] Although the developers of Gymn@zilla recognize the potential need to restrict the access to the Gymn@zilla Web-service, this restriction is not appreciated. Not only students working from outside the campus are excluded, but also students which otherwise have no access to Gymn@zilla. To promote the usage of Gymn@zilla in a free and unrestricted mode, Gymn@zilla provides a place to insert the school's logo into the Gymn@zilla Interface and thus to advertise for the language school in Gymn@zilla.

[3] The web-browser should support Unicode encoding, accept cookies and support Java-script, e.g. Mozilla, Firefox, Opera, Konqueror, Safari or Internet Explorer.

Additional Information

The learner reads the text and moves the mouse pointer on unknown words. He/she browses interesting links in the help box and explores word definitions and translations in online dictionaries. The Google image search may give important cues on possible polysemies, different denotational extensions in L1 and L2, cultural particularities and connotations. Due to the apparent complexity of phenomena, learners should discuss their findings with peers or the language teacher.

Creating a Personal Wordlist

Unknown words are added to the personal wordlist by clicking onto a specific button. Following the link "wordlist" in the menu bar, this personal wordlist is shown and can be edited. The personal wordlist can be copied into a private word processor for further editing or it can be printed out for root learning. Given the four components of a wordlist entry, i.e. L2 lemma, image, context and L1 equivalent, learners may be encouraged by the teacher to focus on specific relations (e.g. image - L2 relations). The format of the wordlist may be configured by the teacher as well.

Creating Exercises

The personal wordlist can be dynamically transformed into a series of exercises. These exercises may be used for training or testing. They are designed to not involve L1 and to reduce the interference of L1 in the processing of L2 (see our discussion below). Instead, the exercises train first the bonding of the image (representing the concept) and the L2 denomination on and, second, the lexical selection of the L2 context. The learner may repeat the exercises with rising degrees of difficulties, gaining self-confidence and experiencing rewards. These exercises are generated completely automatically for all languages.

UNDER THE HOOD OF GYMN@ZILLA

Gymn@zilla supports browsing a local document repository and Internet by dynamically creating and annotating HTML and pdf documents with open dictionaries resources. It is an online application running on every Linux computer under any web server with support for CGI (e.g. Apache). Gymn@zilla is written in Perl and uses GNU tools included in most Linux distributions. The main submodules of Gymn@zilla handle (1) the mirroring of web pages, (2) the linguistic processing, (3) the processing and selection of images and (4) the generation of exercises.

Mirroring of web pages

Mirroring of web pages is done by WGET, a powerful GNU-tool. This tool not only performs the download. It checks whether the web-page has been updated before downloading it, creates appropriate directory structures to store the page locally and transforms relative links into absolute links. Irrespective of how WGET manages to get the most up-to-date file, Gymn@zilla takes the file from the WGET directory. Character encodings other than utf-8 are converted to utf-8. Document formats other than html such as *.ps or *.pdf are converted to XHTML. Hyperlinks in a web page are transformed into CGI-parameters attached to Gymn@zilla's URL. This allows continuous browsing with Gymn@zilla. Links to multimedia documents such as audio, video and graphic files are preserved and can be fully integrated into the language learning scenario.

Linguistic Processing

The heart of Gymn@zilla is NLRDF (http://140.217.211.213/research/nlrdf.html), an XML-based description framework for natural languages, featuring the characterization of several hundred languages, their preferred encoding in the Internet, the countries or regions where a language is used and the URL of dictionaries and other language resources. This information pool is tapped by Gymn@zilla when processing documents in a specific language. On the basis of the specification for each language (segmentation rules, morpheme lists, word lists), the tokenization into words is performed. Further directives guide the stemming (currently implemented only for a

number of European languages). If the inflected form or the word lemma, or the concatenation of several words are found in a translation dictionary, the expression is annotated.

The annotation is done by insertion of tags with advanced link titles in JavaScript. These link titles, referred to as help boxes, will show up when the learner moves the mouse pointer onto the word. With the help of JavaScript, help boxes can be formatted like html-documents and may contain, in addition to the translation, images and links to further information sources. The button which allows inserting a word into the personal wordlist is generated here as well.

Image Processing

When learners solicit pages through Gymn@zilla, the addresses of images (the SRC-attribute) and the alternative text (the ALT-attribute) of images are compared to the text. If the string of a certain word (e.g. the word "Pakistan") appears in one of the attributes (e.g. ".../Pakistan/....jpg) and in the text on the page, Gymn@zilla stores the image's address with 'Pakistan' as a search key.

In this and future pages, Gymn@zilla is thus in state not only to provide a translation of foreign words, but to show a fairly up-to-date image related to that word. The shelf life of an image may be quite short as any newer image provided by this Web-domain and related to the same word will overwrite the older one. In this way Gymn@zilla silently builds up a visual dictionary of topical and user-driven images. In order to guarantee a thematic consistency of text and image, images have been limited to the domain from which they originated.

The relation between the image and the L2 term however is variable and full of surprises. In many cases it reflects the careful work of the web-designer. In other cases the relation draws its merits from the rhetoric figures it represents. Playful, dramatic or funny variants are not excluded.

Figure 2 Examples of terms associated in Gymn@zilla with images:
new, Pakistan, gay marriage

Image processing seems to be especially useful for proper nouns (persons, cities, plants, animals, etc.). Such words may not be included in any dictionary. Moreover, by reminding the student who a certain politician is, where a certain country is located (see the Pakistan map above), or to which city a certain sight may belong to, contextual clues are provided which facilitate the assimilation of new information. The images related to proper nouns share with the images related to concrete entities the power to explain the meaning of a word. For all other words, the learner has to understand the meaning of a word, e.g. scan through all possible meanings he or she hypotheses for a word, in order to understand why a given image has been selected. We hypothesize that finding a match between meaning hypothesis and the image requires a cognitively high demanding activity which becomes wonderfully rewarded when the match is found.

Figure 3: Annotation of proper names with images in Gymn@zilla

Creating Exercises

Each learner in Gymn@zilla is associated with a session identifier. This information is then used to make editable private wordlists in the form of simple XML documents. XSLT-transformations are then used to generate the exercises. The different levels of difficulties are generated by automatically scrambling characters in words or words in sentences. This feature has been introduced after first experiments showed that otherwise learners acquire only superficial knowledge of new words.

PEDAGOGICAL ASPECTS

The positive effect of glossed electronic texts on L2-acquisition has been repeatedly shown (Nerbonne et al, 1998; Laufer, 2000; Ridder, 2000). As a tendency, learners check more lexical entries with hyperlinked texts than when using paper dictionaries. Accordingly, they remembered more words. The experiments have been done with European languages only. One might expect even more significant differences with target languages such as Arabic, Chinese or Japanese, where a learner may occasionally need more than 1 hour to find a word in a paper dictionary compared to milliseconds in hyperlinked dictionaries. Additional advantages of this approach are the combination of incidental and intentional vocabulary acquisition, the learner-centered learning and the motivational surplus coming from authentic texts. The use of images drawn from the Internet is a new feature in this framework.

Images for L2-acquisition

Images have been widely used for L2 acquisition. We notice, however, that the fully automatic selection of images in Gymn@zilla contrasts with editorial habits in the elaboration of learner's dictionaries, encyclopedias, and children's books. While Gymn@zilla features colored photos of utmost contextualization, the traditional usage of images is based on (black and white) drawings which show a considerable degree of abstraction and de-contextualization. Even if photos are used, they may be de- contextualized by pruning off the background. Figure 4 illustrates this contrast by opposing images selected in Gymn@zilla to those we find for the French equivalents in Dubois (1987).

Figure 4 Automatically selected images (14.05.2004) and images in a paper dictionary for French as foreign language (Dubois, 1987).

to change   *to celebrate*
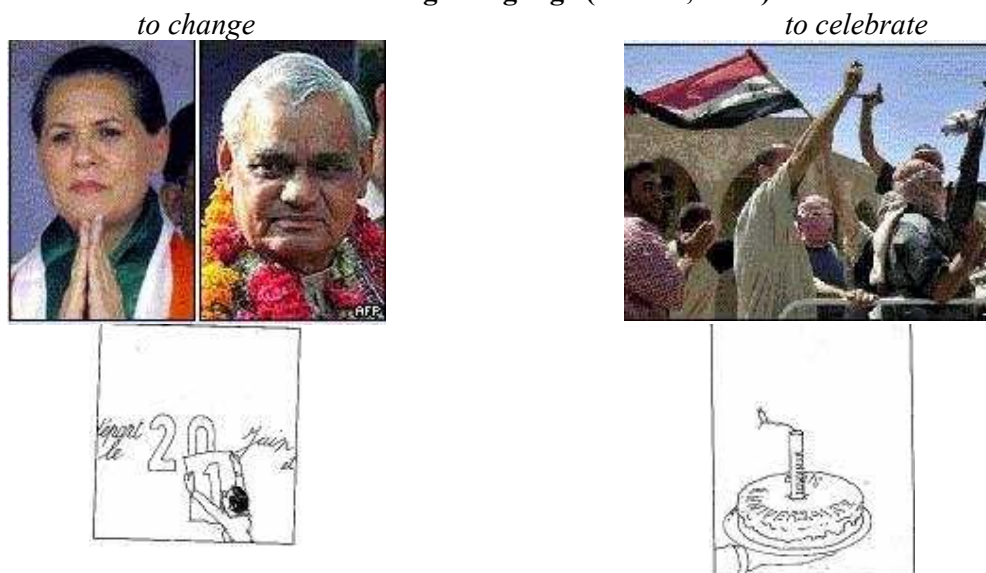
The difference is even more important if we consider the short period in which a contextualized image may be understandable. Therefore, images are constantly updated when newer images become available. The images in paper dictionary last for 40 years.

Figure 5 Image annotations for "to celebrate" as they are found on 3 consecutive days in Gymn@zilla.

13.5.2004   14.5.2004   15.5.2004

This difference in the usage of images requires an explanation. Can we identify besides the obviously different technical constraints in paper dictionaries and Gymn@zilla pedagogic motivations arguing in favor of the one or the other?

Although images are and have been widely used in the context of L2 acquisition, we rarely find the motivations for using images and for the choices which have been made. Some editors explain the inclusion of images with "clearness" and "efficient description of meanings" (Kempcke, 2000; Rozanova, 1987)[4], without discussing choices (photo vs. drawing, black vs. colored, de-contextualization vs. contextualization) more specifically.

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[4]E.g. Kempcke (2000) states that images that have been included in the dictionary to facilitate the recognition of the lemma defined. They make complex, encyclopedic verbal descriptions superfluous. Rozanova (1987) refers to the "clear comprehension" and uses drawings to explain real objects, verbs of movement and verbs of putting. Pexlivanova and Lebedeva (1991) go much further, using images for case, personal pronouns, diathesis, tense and aspect, without any explanation however.

When looking for psycholinguistic motivations we find that already more than 30 years ago Paivio showed that words with high imagery are more easily processed (Paivio and Rowe, 1970). According to his Dual Coding Theory, there are two cognitive subsystems. One is specialized for the representation and processing of nonverbal objects and the other is specialized for language. A word that symbolizes a concrete object can be encoded twice in memory. As a consequence, there should also be two ways the word can be retrieved from memory. An increasing body of research supports this conjecture, showing that learning is affected positively by presenting text and images together (Mayer and Sims, 1994). In addition, dynamic visualizations have been shown to be superior to static visualizations (Rieber, 1990). However, it has also been demonstrated that adding interesting but irrelevant material interfered with students' memory.

Another strand of research has shown that proficiency in L2 is related to the degree to which the L2 production is conceptually mediated and not L1 mediated: For beginners, the translation of words from L1 into L2 is faster than picture naming in L2. For proficient bilinguals however, these activities are almost equally fast, suggesting that both activities are conceptually mediated (Kroll and Curley, 1988; Potter et al., 1984).

A lexical mediation can still be found with proficient bilinguals in a L2 to L1 translation task. This disappears however, when words to be translated are preceded by a picture context (la Heji et al., 1996). The presence of images thus reduces the interference of L1 in the processing of L2. Interestingly, the effect is adverse when L1 is forbidden in classroom teaching (Stern, 1999).

What helps memorizing are "unique environmental cues for L2 or unique concepts of nuances of meaning that are distinctly associated with L2" (Kroll and Tokowicz, 2001). The function of these cues is to support L2 in its competition with L1. This is supported by experiments conducted by Kroll et al. 1998, who taught Dutch to three groups of American students. The first group learned with word translations only, the second with additional images, and the third group received non-canonical images as shown in Figure 6.

Figure 6 Canonical vs. non-canonical views of objects used in a vocabulary acquisition task, reproduced after Nicol 2000:67. L2-learning results were best with non-canonical images.

Learning results were best with non-canonical images. According to the authors, the unusual images attenuated the regress to L1 and privileged the bonding between L2 and the concept, identified with the non-canonical image. Focusing of particular features of L2-denoted entities may thus be particularly rewarding in L2-acquisition. While L1 learning is about learning prototypic representations, L2-acquisition has to slalom around the pitfalls of the L1 prototypes. French "Fromage blanc" is not German "Quark" and English "bread" is not Russian "xleb". These features of difference which can be represented in drawings to a limited extend only, are omnipresent in photos, even if they are due to incidental differences or the association with different events or episodes.

Incidental vs. Intentional Learning
Depending on the underlying learning resource, Gymn@zilla exposes learners abundantly to new vocabulary in personalized contexts and activates the mental lexicon in several steps and on several levels. On one hand, words are learned incidentally by reading a web-page annotated with

dictionary information. This, in general is considered a valuable feature in language learning (Chun, 20011; Laufer, 2000; Ridder, 2000). On the other hand, words are learned intentionally by editing and studying the personal wordlist and working through the completion exercises. Combining incidental and intentional learning, we hope to overcome the respective disadvantages of each approach.

Intentional vocabulary acquisition results from purposely learning words and their respective translations with the aid of wordlists. This method is usually appreciated by learners. It is fast and direct. The disadvantage is its superficiality. The learner encounters isolated words in their base form. Therefore, the learner may rapidly forget learned words or may not be able to use them in context. Instead, extensive word exposition is necessary to ensure a deep and solid embedding of vocabulary in the mental lexicon (Aitchison, 1994; Kielhöfer, 1996). Moreover, vocabulary acquisition should be personalized and should occur in context with authentic text (Groot, 2000; Jones, 1999; Müller and Wertenschlag, 1996; Shei, 2001). In Gymn@zilla word list thus consist of the lemma, the word form found in the context, the context, the image and the translation.

Incidental vocabulary acquisition refers to vocabulary acquisition by contextual deduction, e.g. when reading text in a foreign language. This method ensures that words are encountered in several semantic contexts and morphological forms. Hence new words are embedded much deeper within the mental lexicon. Through the patterns of syntactic contexts the right usage of a word is acquired together with the word.

However, as (Cobb, 1999) points out, this method is often not fast enough. It would require a considerable amount of time to master the vocabulary needed for fluent and correct conversations using this method in isolation. As a consequence of Zipf's law, about half of the words of a text occur only once, independent of the size of the text. Learning words from text thus would require infinite reading or learning from single-tone words with one example context. Example contexts of single tone words can be multiplied through a lexicon look-up or a Google document search.

Another problem with this approach comes from the possibly large amount of unknown words around the words to be learned (Groot, 2000). Thus learners at beginners' levels may be overwhelmed with this approach. A strategy according to which a learner switches between the two learning approaches thus seems to most promising. Many words may be learned quickly with intentional learning and then rooted deeper with further incidental learning.

CONCLUSION

In this paper we presented Gymn@zilla, an open source browser-like application designed for L2 acquisition. Gymn@zilla combines annotated reading with the possibility to memorize and interactively practice items by the means of personal wordlists and dynamic exercises. Possible usage scenarios range from individual language learning over school and university classes to daily work scenarios in a non-native speaking environment.

Generally speaking, Gymn@zilla is a learning tool that enhances text comprehension in a holistic way, rather than the learning of vocabulary for itself or out of context. Thus evaluations shall be designed to capture the learning progress on such a larger dimension. Buttaroni (1997) proposes self-evaluation methods that measure the self perception of Foreign Language Growth. She proposes such tests to accompany phases of "Global reading" which change with phases of "Detail-oriented reading" and "Controlled writing". Users of Gymn@zilla perform similar phases while just reading (global reading), reading with annotations (detail- oriented reading) and filling in cloze tests (controlled writing).

Since Gymn@zilla has been developed in an interdisciplinary research work between Linguists, Teachers, and Computer scientists a highly didactic learner's environment resulted. The creative exploration of electronic possibilities is used efficiently for foreign language acquisition: elementary needs of a learning person are considered, namely play instinct, curiosity, interest in communication and the enjoyment of new things.

Gymn@zilla blends traditional teaching by one human teacher with individual and autonomous multimedia learning: The teacher chooses text, subject, helps with problems and may at any time intervene to explain in more detail. The vocabulary, difficulty, progress and context can be manipulated by every learner individually.

Gymn@zilla follows a learner centered approach. In principle any Internet or Intranet page can be chosen. Still, teachers can restrict the choice to a certain type of pages, to a certain site or page. Nevertheless the learner will have options: read right through, read by help of the annotation, compile wordlists or not, print and study the words or work with quizzes. Difficulty and progress depend on the learner.

Gymn@zilla offers resource based learning because all online based knowledge resources can be tapped. While the use of Gymn@zilla remains the same, the resources can change from extremely technical text with content explanations by professors to rather simple texts for beginners, helped by a language teacher. With changing resources in the Internet, Gymn@zilla's resources will automatically be updated.

Gymn@zilla supports the constructivist approach, because users create their own knowledge. Learners are not limited to a certain prescribed behavior like following pre-elaborated content from lesson to lesson. Instead they can browse, read, practice, study intentionally and in after-hours. They organize their own learning environment, their own learning and their own language capacity.

Gymn@zilla means intercultural and interlingual learning. Authentic and up to date texts (and even images) provide precious information on the language, on the (technical) content and on the general setting where the information comes from. The cultural connection that traditional teaching materials tried to introduce artificially comes to Gymn@zilla most naturally through the cultural texture of the resources.

The combination of didactics, computational linguistics and network technologies promises to pave the way away from sterile laboratory systems to systems which pilot the learner through the cold shoal of foreign language texts.

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