

The Student-Computer Interface of an Intelligent Tutoring System for Japanese Language Instruction

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Abstract

This work describes the human-computer interaction of an intelligent tutoring system designed to mediate some of the difficulties of acquiring proficiency in reading technical Japanese material.

I. Introduction

In recent years, Japan has emerged as an acknowledged leader in several key areas of applied science and engineering. Japanese funding of R & D on a per capita basis equals that of U.S. civilian R & D expenditures [1] and its output of technical publications has steadily grown to 8% of the world total, second only to the United States [2]. Unfortunately, access to this wealth of information is denied to most Western scientists and engineers—of the approximately 10,000 technical journals that are published by the Japanese, only an estimated 6% are available in English [1].

The lack of Japanese language proficiency among American scientists and engineers is due to a number of factors including the inherent difficulty of the language and the scarcity of technical curricula and course materials [3]. The goal of this work is to mitigate some of these difficulties through the use of an intelligent computer tutoring system. The remainder of this paper first presents a brief summary of some of the unique characteristics of the Japanese language and is followed by a description of the student-computer interface of an intelligent tutoring system developed to accelerate the acquisition of technical Japanese reading proficiency.

II. The Japanese Language

The Japanese language is generally regarded as one of the most difficult languages for English-speaking people to learn. While the number of individuals studying Japanese is increasing there remains an extremely high attrition rate, estimated by some to be as high as 80% [3]. Much of this difficulty can be associated with the Japanese writing system. Japanese text consists of two distinct orthographies, a phonetic syllabary known as *kana* and a set of logographic characters, originally derived from the Chinese, known as *kanji*. The *kana* are divided into two phonetically equivalent but graphically distinct sets, *katakana* and

hiragana, both consisting of 46 symbols and two diacritic marks denoting changes in pronunciation. The *katakana* are used primarily for writing words of foreign origin that have been adapted to the Japanese phonetic system although they are also used for onomatopoeia, colloquialisms and emphasis. The *hiragana* are used to write all inflectional endings and some types of native Japanese words that are not currently represented by *kanji*. Due to the limited number of *kana*, their relatively low visual complexity, and their systematic arrangement they do not represent a significant barrier to the student of Japanese. In fact, the relatively small effort required to learn *katakana* yields significant returns to readers of technical Japanese due to the high incidence of terms derived from English and transliterated into *katakana*.

In contrast, the ability to read the much more visually complex *kanji*, which are used to write the vast majority of words functioning as nouns, verbs, or adjectives, presents a formidable task, even for native Japanese. A dictionary of all *kanji* ever used would contain on the order of 50,000 entries. Fortunately, 99% of all the currently used *kanji* can be found in the six to seven thousand entries specified under the Japanese Standard Association's JIS X 0208 standard. Though frequently considered to be graphical representations of objects or concepts, in actuality very few *kanji* belong to the category of pictographs or ideographs. The vast majority (over 90%) can be classified as phonologograms, characters composed from the combination of a phonetic component and a general meaning component. The phonetic component, however, does not uniquely specify the pronunciation of a character. This is due to the fact that *kanji* have multiple readings depending on the context. These readings are generally classified as either native Japanese (*kun*) or as being derived from the Chinese (*on*). The *kun* readings are generally used for single-character *kanji* or with inflected forms whereas *on* readings are more frequently used in multiple *kanji* words. Exceptions abound and phonologograms are frequently used for their phonetic component while disregarding the meaning or vice versa (such compounds are called *ateji*).

The difficulty of reading such a diverse and complicated character set is further magnified by the fact that Japanese text does not possess unique characters to specify lexical boundaries that correspond to the spaces used between words in Western languages. Thus a student has no idea whether a single *kanji* is to be interpreted as a com-

plete word or whether it is part of a compound. Likewise with *kana* one must know whether it is being used to represent an inflectional ending or a separate word. Additional difficulty is presented by the fact that Japanese sentence structure is basically Subject - Object - Verb (SOV) as opposed to the more common SVO structure of English.

III. Student-Computer Interaction

Many of the aspects of written Japanese discussed above present serious difficulties to the student, particularly with respect to the use of traditional study aids such as dictionaries and printed reference materials. Much of this is due to the fact that a significant amount of information must already be known about a Japanese "word" (number of characters, pronunciation, stroke counts, etc.) before it can even be accessed in such works. Thus even the use of phonetic conversion software of the type typically used in Japanese word processors [4,5] provides minimal assistance for identifying unknown passages of text. The tutor addresses this situation by not relying on any categorization scheme based on phonetic alphabetization or the pattern of strokes used to create the character. The interaction of the tutor with a student is presented in the following example of a typical session.

The tutor first addresses the issue of context by identifying the student and accessing their personal database which contains information about their technical interests as well as language proficiency. The keywords which define the student's area are used to search the electronic database of technical Japanese material. This database currently consists only of selected Japanese abstracts and their associated English translations. The database of language proficiency consists of the *kanji* and *kanji* compounds, along with their specific readings, to which the student has been exposed. These are divided into those which have been mastered and those which require further review. The database also includes a list of grammatical structures with which the student is familiar. The text which is chosen by the tutor for the student is thus designed to reinforce material which is not yet mastered and to introduce new material within a specific context. The order in which new *kanji* are presented is based on frequency counts within the desired discipline.

The tutor presents the actual Japanese text on the terminal screen in exactly the same format as it appears in the original Japanese publication. The addition of phonetic readings in *kana*, known as *furigana*, is avoided although this practice is common in language textbooks. This reduces the tendency of the student to rely on the *furigana* while reading thus preventing assimilation of the *kanji*. The text, while designed to maximize comprehension from context, will clearly have material which is not grasped by the student. When this occurs the student can highlight the difficult passage with a mouse and request a translation within this context. The tutor, detecting an input from the student, takes the highlighted Japanese text, matches it with its English translation, and displays this on the screen. At this point it takes all of the vocabulary and grammatical structures present in the highlighted

passage and updates the student's personal database to include these items in the material that is not currently mastered. Thus those items with which the student has difficulty will be repeated with greater frequency in subsequent sessions.

The manner in which the student highlights the unknown text is significant with respect to the information stored by the tutor. Any amount of text can be highlighted ranging from a single character to an entire sentence. Thus the tutor attempts to pinpoint the exact nature of the difficulty by determining whether the highlighted region is an inflectional ending, a single word, a clause, etc. There is particular interest in analyzing student responses that result in regions which do not occur at morphological or lexical boundaries. This is, of course, a common occurrence due to the lack of spacing between Japanese words. In the case that the student actually wants information on the sentence structure, the interface is designed to allow the student to click on the mouse while in a highlighted region in order to move one level up in the parse tree representing the sentence. Thus the student can trace the structure from a single morpheme to the entire sentence.

In addition to the above general scenario of a tutoring session, the tutor is being outfitted with electronic versions of supplementary materials such as examples of handwritten text and grammar references as well as general, technical, and character dictionaries. These are all linked to the graphical interface so that immediate access to all entries related to the highlighted region can be obtained. This environment should accelerate the rate at which scientists and engineers can acquire a reading knowledge of technical Japanese.

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