Interactive Phonetics, virtually!

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Abstract

This paper presents a set of phonetics teaching resources as modules in a more generic framework for web-based tutoring in the areas of phonetics, multimedia communication and spoken language research. Currently the toolkit consists of standalone interactive modules and lecture notes on a number of areas of phonetics, phonology and the lexicography of spoken language. The interactive presentation includes interactive Java and CGI tools for waveform generation and display, database access, phonetic alphabets, stylised articulatory phonetic animations with and without underlying phonological models, development and testing of syllable models, construction of web-based hyperlexica and basic techniques for visual and speech synthesis.

This paper will present the underlying motivation, the computational linguistic and phonetic modelling and demonstrate the actual use of these tools as phonetic teaching resources.

1. Introduction

This paper presents a set of phonetics teaching resources as modules in a more generic framework for web-based tutoring in the areas of phonetics, multimedia communication and spoken language research. These tools have been developed initially to supplement more traditional classroom teaching materials but experience has shown that students used these tools independently in their own study time, and indeed became interested in developing their own tool applications to help them understand the subject more clearly. For this reason, the materials are organised with respect to the notion of didactic depth starting with examples of illustrative materials and moving towards technical tools which can be developed further by the student. The tools are classified, therefore, with respect to different levels of granularity denoting the degree of technical detail. For each level of granularity some examples are provided together with a specification of the tool involved.

The main emphasis in connection with this toolkit development has been on interactivity and place and platform independent access for the student. The toolkit offers more flexibility than current CD-based tutorials in that it does not use canned examples (in the sense of stored video sequences, files and predefined frequency and amplitude specifications for waveform display). Displays are generated on-the-fly using the appropriate algorithms, based on acoustic and computational linguistic formal specifications. The toolkit is easily updated, maintained and extended in the web context, and permits additional interaction between student and tutor (via chat lounge and email).

2. Interactive Tutoring

The phonetic teaching resources are modules in a generic framework for web-based tutoring and can be classified according to content and method. With respect to content, the areas covered are phonetics, phonology, spoken language research (computational phonology, computational morphology, lexicology, lexicography) and elements of computing. With respect to method, the resources can be categorised in terms of interaction types and didactic depth or granularity.

In addition to lecture scripts as structured web documents such as that found in [4], the interactive presentation includes Java and CGI tools for waveform generation and display, database access, phonetic alphabets, stylised articulatory phonetic animations with and without underlying phonological models, development and testing of syllable models, construction of web-based hyperlexica and basic techniques for visual and speech synthesis (cf. [3]). The computational linguistic modelling of many of these tools have been described by the authors in [1], [2], and [5]. The forms of interaction which are provided for in this generic framework are the following:

- Student-Web
- Tutor-Web
- Student-Tutor

The tools themselves allow for interaction between either student or tutor and the web resources. Additional interactive tutorial support in the form of student-tutor interaction is provided by means of an *interactive help desk* (chat lounge), including a 'virtual office hour' and an *email help desk*.

The rest of this paper is concerned with the description of some of the tools from the generic framework. It is not possible in this context to present all the tools in

detail. A selection has been made, therefore, which provides example tools from each of the levels defined above. In each case a specification of the tool is given, together with example tasks corresponding to the degree of difficulty.

Section 3 presents illustrative materials of the sort which are used in an introduction to phonetics and phonology. The tasks associated with these tools correspond to the lowest degree of difficulty. Section 4 introduces tools with associated tasks corresponding to an intermediate degree of difficulty and section 5 introduces advanced tools for spoken language research.

3. Illustrative Phonetic Materials

This section is concerned with illustrative phonetic materials designed for use in an introductory course. These materials can be used directly by the tutor in the classroom context and also by the student for private study and practice. The interaction is restricted by the choice of possible parameters. The example tools described in this section are JavaWaves and SAMPAspeak.

3.1 JavaWaves

Goal: To demonstrate frequency, amplitude, phase shift and addition using simple sinusoids.

Topic: Acoustic Phonetics

Course Contexts:

- Terminology
- Waveform display

Tasks:

- Easy: Show how the waveform changes when amplitude and frequency values are altered

Comments: This tool calculates the sinusoid representations on-the-fly based on the values entered by the user.

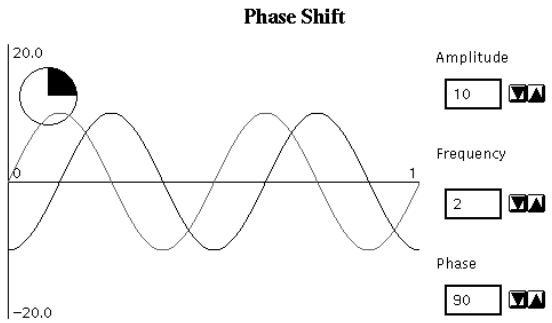

Figure 1: JavaWaves

3.2 SAMPAspeak

Goal: To demonstrate the relationship between SAMPA symbols and the sounds they represent.

Topic: Phonetic Alphabets

Course Contexts:

- Phonetic Transcription

Tasks:

- Easy: Listen to the sound individually and in context

Comments: This tool plays the audio file associated with a particular SAMPA symbol. The symbol can be played individually or in the context of a word.

4. Multimedia Communication

This section is concerned with materials which provide more interaction possibilities to both student and tutor. They are generally used in connection with a more intermediate level course and are associated with easy and hard tasks. The examples tools described in this section are the Animated Articulatory Synthesiser and the Phonotactic Toolbox.

4.1 Animated Articulatory Synthesiser

Goal: To demonstrate the main components of speech sound articulation using an abstract, stylised model.

Topic: Articulatory Phonetics

Course Contexts:

- Phoneme concatenation
- Articulatory correlates of distinctive features
- Structure of a basic synthesis system

Tasks:

- Easy: Given articulatory sequences, work out the underlying phonemes
- Hard: Reconstruct the synthesis procedure in general terms

Comments: This tool creates animated images on-the-fly based on the SAMPA representation entered by the user.

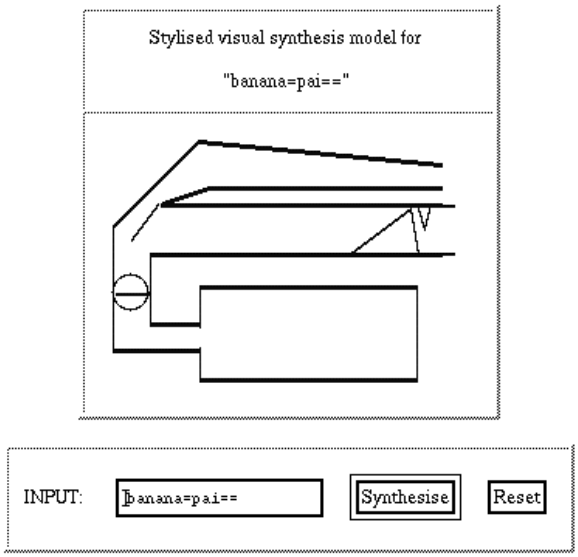

Figure 2: Animated Articulatory Synthesiser

4.2 Phonotactic Toolbox

Goal: To demonstrate and test syllable models for well-formedness using phonotactic and allophonic constraints.

Topic: Phonology

Course Contexts:

- Phonotactic description
- Computational phonology
- Finite state techniques

Tasks:

- Easy: Given a phonotactic description, test whether a particular combination is well-formed
- Hard: Develop and test a phonotactic description

Comments: This tool calculates all combinations represented in a finite state network, allows two networks to be compared and combinations to be tested for well-formedness.

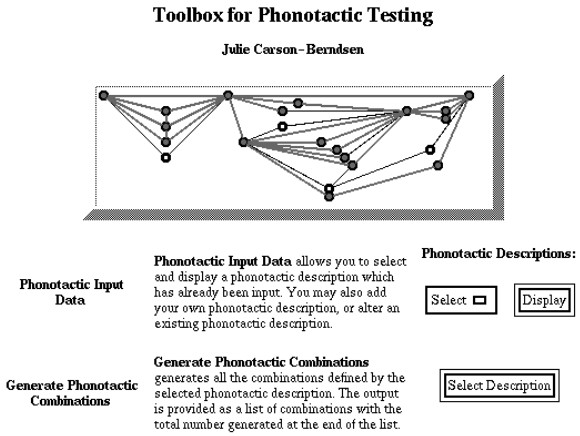

Figure 3: Phonotactic Toolbox

5. Spoken Language Research

This section presents advanced tools for spoken language research in the areas phonology, morphology, lexicology and lexicography. The advanced tasks specified at this level represent the greatest degree of difficulty. In addition to advanced tasks, it is assumed that a student who is working at this level and is interested in the computational modelling aspect of the tools, will also have the opportunity to examine the code of all tools in the generic framework and extend it to incorporate other features. Interaction with the tools provides access both to spoken language resources for research projects (e.g. for practical applications in term papers) and to basic techniques for computational linguistic modelling of spoken language data. Applications developed by the student are integrated into the resource catalogue when they have been checked by the tutor and are made freely available to other users. The resource catalogue is updated regularly to incorporate all relevant applications. The example tools described in this section are HyprLex and DFSA.

5.1 HyprLex

Goal: To introduce the lexicon theory and lexicographic applications.

Topic: Lexicology, lexical representations, lexicography.

Course Contexts:

- Lexicon theory
- Lexical databases
- Static and dynamic design

Tasks:

- Easy: Lookup entries in a lexical database
- Hard: Test queries for inheritance lexicon systems
- Advanced: Design a simple inheritance lexicon

Comments: The HyprLex idea covers a family of hierarchically structured inheritance lexica from basic interactive lexical databases with online hypertext help, through hypertext structured concordances to lexica containing generalisations expressed in inheritance hierarchies and implemented in DATR.

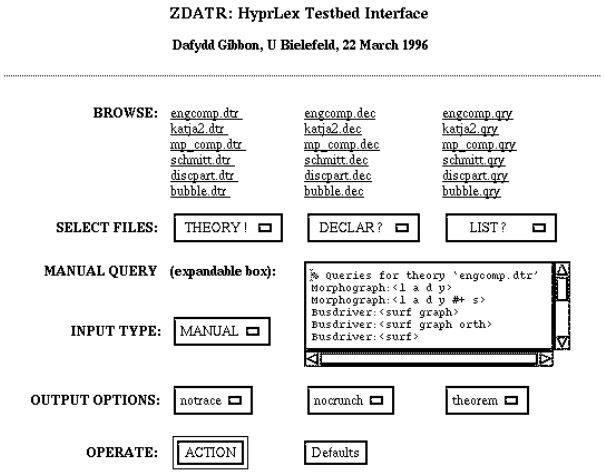

Figure 4: ZDATR: HyprLex Testbed Interface

5.2 DFSA

Goal: To demonstrate construction of deterministic finite automata.

Topic: Automata theory, finite state technologies

Course Contexts:

- Computational Phonology
- Computational Morphology
- Lexicography

Tasks:

- Easy: Design straightforward automata

- Hard: Model language constructions with automata and implement these
- Advanced: Inspect and extend the automaton code

Comments: This is a client-side interactive tool implemented in JavaScript which can be freely downloaded and adapted on a client browser.

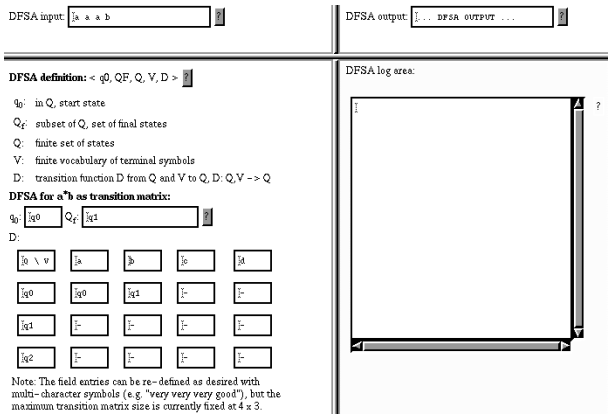

Figure 5: DFSA: Deterministic Finite State Automaton

6. Conclusion

This paper has presented teaching resources for phonetics, multimedia communication and spoken language research within a generic framework for interactive web-based tutoring. The resources consist of lecture scripts and computational tools which demonstrate different content areas and types of interaction. The resources are organised within the generic framework with respect to the notion of didactic depth and were discussed in this paper in the context of course levels with associated tasks of varying degrees of difficulty. Two example tools were presented in each case demonstrating the use of illustrative phonetic materials in introductory courses, multimedia communication materials in intermediate level courses and spoken language research materials in advanced courses.

The tools have been developed according to computational linguistic formal specifications and the code is available to students interested in developing the applications further. Since the main motivation for the development of these resources was place and platform independent access for the student, the resources are freely accessible via the authors' web sites.

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