Language Learning and Computational Linguistics

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Background reading:

- Detmar Meurers (2012) "Natural Language Processing and Language Learning". Encyclopedia of Applied Linguistics, edited by Carol A. Chapelle. Blackwell.
- "Language Tutoring Systems". Chapter 3 of "Language and Computers" by Markus Dickinson, Chris Brew and Detmar Meurers. Blackwell. 2013.

LEAD Graduate School
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Points of contact

- Computational Linguistics (CL) deals with the formal and computational modeling of human language.
  - This includes (but is not limited to) the development of tools for the automatic analysis of language.
    → Natural Language Processing (NLP)
- Where does language play a role in Education?
  - language is the most common medium of instruction, source of information, and basis of student assessment
  - in a (Second) Language Learning context, it also is the subject of learning
- Points of contact between CL and Language Learning: research questions and NLP applications based on
  I. analysis of *learner language*
  II. analysis of *(native) language* for learners

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I. Analyzing Learner Language

- There are several fields analyzing learner language:
  - Second Language Acquisition Research (SLA)
  - Foreign Language Teaching and Learning (FLTL)
  - Language Testing
- CL research and applications interfaces with all three

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Second Language Acquisition Research (SLA)

- SLA research is aimed at understanding how second languages are acquired (and how language works)
  - empirical basis: analysis of learner data, ...
- SLA research also studies *instructional interventions*
  - targeting different aspects of language,
  - in different types of tasks,
  - supporting different kinds of feedback, and
  - different sequencing of material
- interventions are tied to SLA theories and concepts, e.g.:
  - “monitor model” and “input hypothesis” (Krashen 1982)
  - “Zones of Proximal Development” (Vygotsky 1986)
  - “teachability” (Pienemann 1998)

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Foreign Language Teaching and Learning (FLT)

- adapts, advances, and tests effectiveness of intervention methods in teaching practice
- current FLTL typically is focused on the communicative abilities of the student
- analysis of learner language helps advance our understanding of student abilities and needs

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Language Testing

- generally focused on developing test items which are predictive for the constructs to be tested
  - i.e., limited interest in the linguistic modeling needed to predict and understand why certain items work
- Language testing theorists (Bachman, Palmer, etc.) have significantly enriched the models of language competence and language tasks (ignored in linguistics).
- analysis of learner language in tasks aimed at supporting valid inferences about the learner's knowledge

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CL and the analysis of learner language

- *Learner corpora*: analysis of learner language
  - to provide empirical evidence for SLA research (e.g., linguistic correlates of CEFR proficiency levels in MERLIN)
  - to provide insights into typical student needs in FLT

  CL helps represent & annotate data, to make it searchable
- *Intelligent Tutoring Systems*: analysis of learner language *aimed at supporting language acquisition*
  - provide immediate, individualized feedback, e.g.:
    - meta-linguistic feedback in a form-focused activity
    - incidental focus-on-form in a meaning-based activity
    - feedback on meaning (very rare in ITS)
  - determine progression through pedagogical material
- *Testing*: automate *assessment of learner abilities*
- *Writer's aid tools*: feedback *aimed at producing text*

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II. Analyzing language for learners

- *Searching for appropriate materials for learners*
  - materials on a particular topic
  - appropriate in readability, language forms to be learned
- *Generation of exercises and tests*
- *Enhanced presentation of materials*
  - texts with annotated vocabulary
  - visual input enhancement
- CL research and applications starts to target these, e.g.:
  - Language-Aware Search Engine (Ott & Meurers 2010)
  - Generation of exercises and visual input enhancement based on authentic materials

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A closer look at both types of CL analysis

I. Individualized feedback in Intelligent Tutoring Systems

TAGARELA: An intelligent, web-based workbook in support of ab-initio learning of Portuguese

(Amaral & Meurers 2008, 2009, 2011; Amaral, Meurers & Ziai 2011)

II. Enhancing authentic web pages for language learners

- Visual Input Enhancement of the Web (VIEW)
- Working with English Real-life Texts (WERTi)

(Meurers et al. 2010)

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Computers in Language Teaching and Learning

Introduction

- Computers widely used in foreign language teaching to help learners experience a foreign language & culture.
  - multimedia presentations, web-based TV/radio/news, email/chat with native speakers, . . .
- Apart from the undisputed role of such contextualized, communicative language use, which other aspects of language learning are relevant in this context?
- Research since the 90s has shown that **awareness of language forms and rules** is important for an adult learner to successfully acquire a foreign language.
  - (cf., e.g., Long 1991, 1996; Ellis 1994; Schmidt 1995; Lyster 1998; Lightbown & Spada 1999; Norris & Ortega 2000)

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Real-life teaching needs

- The time a student can spend with an instructor/tutor typically is very limited.
- In consequence, work on form and grammar is often deemphasized, confined to homework so that the time with the instructor can be used for communicative activities.
- The downside is that the learner has relatively few opportunities to gain awareness of forms and rules and receive individual feedback on errors.

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Real-life teaching needs

OSU practice confirming dilemma

A series of interviews with Spanish/Portuguese language instructors (cf., Amaral & Meurers 2005) finds that

- it can be difficult to achieve the communicative goal of an activity when students have problems using the appropriate language forms and sentence patterns.
- But class activities that focus on form or grammar patterns are perceived as problematic since
  - they reduce the pace of a lesson, and
  - individual differences make it impossible to have all students do the same tasks in exactly the same time.
- While instructors were sceptical of CALL tools aimed at replacing human interaction, they support tools that
  - practice receptive skills and reinforce acquisition of forms
  - raise linguistic awareness in general

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An opportunity for CALL

- The situation seems like an excellent opportunity for developing CALL tools to
  - provide individual feedback on learner errors and
  - foster learner awareness of relevant language categories.
- But existing CALL systems which offer exercises
  - typically are limited to uncontextualized multiple choice, point-and-click, or simple form filling, and
  - feedback usually is limited to yes/no or letter-by-letter matching of the string with a pre-stored answer.
    - Example: “Spanish Grammar Exercises” (B. K. Nelson)

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Making CALL tools aware of language: NLP

- String matching is the most common technique used in CALL to analyze student input. This works well when
  - correct answers & potential errors are predictable & listable
  - there is little grammatical variation
  - envisaged errors correspond directly to intended feedback
- But what if
  - possible correct answers are predictable but not (conveniently) listable for a given activity
  - errors can occur throughout a recursively built structure
  - individualized feedback is desired which requires linguistic analysis of the learner production

  $\Rightarrow$ Use NLP to analyze student input in such cases!

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Aspects of Linguistic Modeling

- A range of potentially relevant aspects of linguistic analysis
  - tokenization: identify words
  - morphological analysis: identify/interpret morphemes
  - syntactic analysis: identify selection, government and agreement relations and word order requirements
  - formal pragmatic analysis: identify coreference relations, information structure partitioning, . . .
- One can integrate NLP identifying such properties to obtain language-aware, “Intelligent” CALL (ICALL).
- What can the NLP analysis be integrated in?

  $\Rightarrow$ An Intelligent Tutoring System

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Intelligent Tutoring Systems

- An Intelligent Tutoring System (ITS) is a computer program that intelligently interacts with the learner. It
  - accurately diagnoses the knowledge/skills of a student,
  - adapts instruction accordingly, and
  - provide personalized feedback.
- Since Hartley & Sleeman (1973) an ITS is recognized as consisting of at least three components:
  - the expert model
  - the student model
  - the instruction model

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Components of an ITS

- Expert Model:
  - the knowledge that the ITS has of its subject domain, in our case the linguistic knowledge
- Student Model (= Learner Model)
  - the component of the system keeping track of the student's current state of knowledge
  - allows the ITS to infer student's understanding of subject matter and to adjust feedback to student's needs
- Instruction Model:
  - the component that stores pedagogical information, how to conduct instruction
  - It helps define strategies to deliver appropriate feedback.

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An example ILTS: TAGARELA

- A concrete example for an Intelligent Tutoring System:

  TAGARELA: Teaching Aid for Grammatical Awareness, Recognition and Enhancement of Linguistic Abilities

  - designed to satisfy the real-life FLT needs identified at OSU
    - regular classroom instruction
    - individualized instruction
    - long-distance courses (at UMass)
  - intelligent web-based workbook complementing instruction
  - targeting beginning learners of Portuguese

  The system is online at http://purl.org/icall/tagarela
  (send me email to obtain a login)

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TAGARELA

System role, Activity types, Interface

- What role does the system play in teaching?
  → Self-guided activities accompanying teaching
- What type of activities are appropriate and useful for fostering awareness (and fit into the FLT approach)?
  → Activities ideally involve both form and meaning, such as listening/reading comprehension questions.
  - TAGARELA offers six types of activities:
    - listening comprehension
    - reading comprehension
    - picture description
    - fill-in-the-blank
    - rephrasing
    - vocabulary

    Similar to traditional workbook exercises, plus audio.
- What should the system interfaces look like?
  → Use L2 as far as possible (needs careful interface design).

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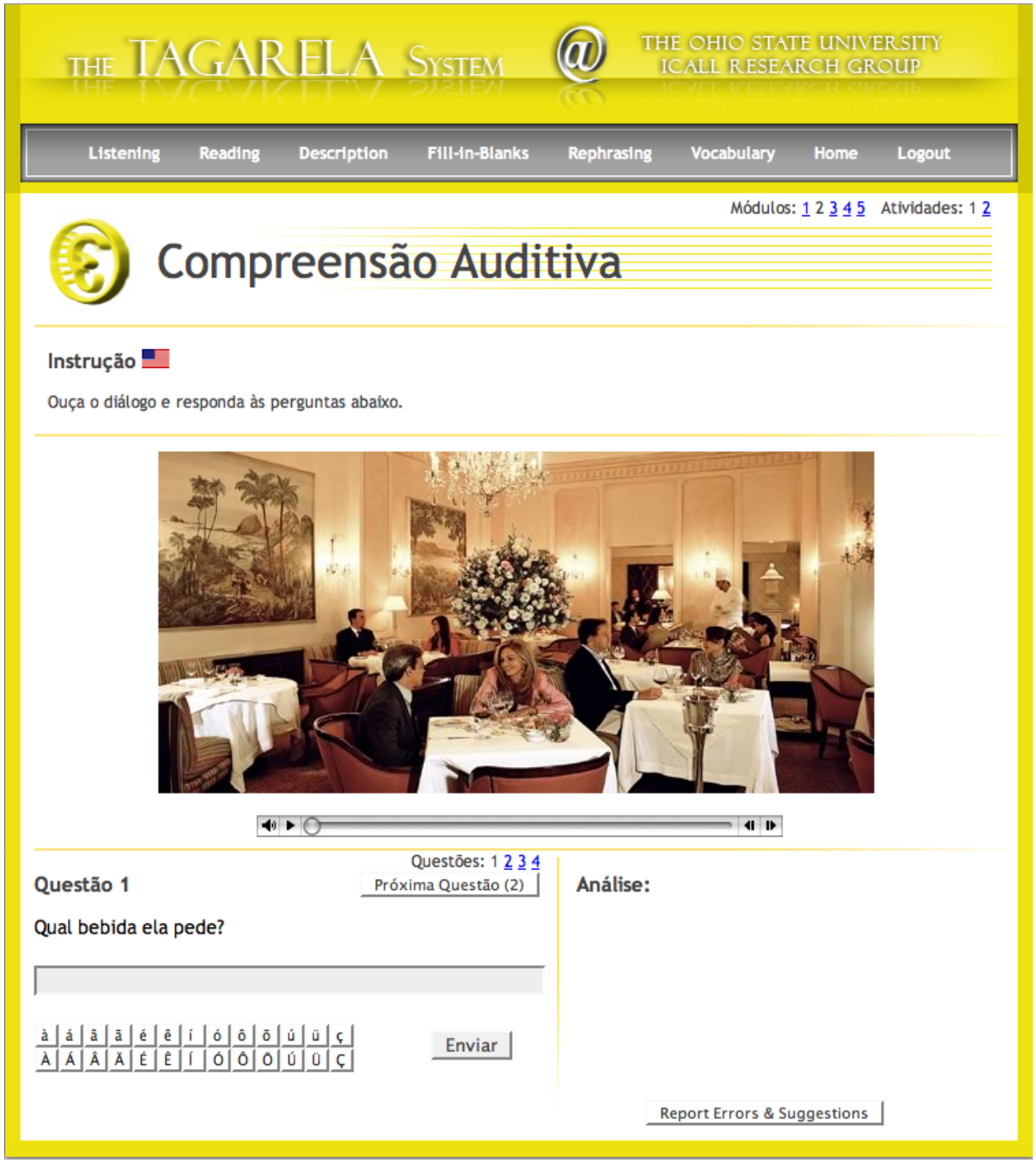

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Nature of the feedback

- Which forms of feedback are (most) successful in fostering awareness of forms/categories – and, ultimately, in influencing learning outcomes?
  - Meta-linguistic feedback, highlighting (cf. Heift 2004)
  - more research is needed into range of feedback types
    - what is appropriate for human-computer interaction/CMC (cf., e.g., Sachs & Suh 2007; Petersen 2010)

    including evaluation using
    - learning outcomes
    - online measures of noticing, e.g., using eye tracking, since no learning without noticing (Schmidt 1995)

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TAGARELA

What to provide feedback on?

- What can/should feedback be provided on?
  - TAGARELA provides on-the-spot feedback on
    - orthographic errors (non-words, spacing, capitalization, punctuation)
    - syntactic errors (nominal and verbal agreement)
    - semantic errors (missing or extra concepts, word choice)
  - Providing **feedback on meaning** becomes crucial for activities such as reading and listening comprehension.
    - automatic meaning analysis can be effective (→ CoMiC)

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THE TAGARELA SYSTEM @ THE OHIO STATE UNIVERSITY ICALL RESEARCH GROUP

Listening | Reading | Description | Fill-in-Blanks | Rephrasing | Vocabulary | Home | Logout

Módulos: 1 2 3 4 5 Atividades: 1 2

Leitura

Instrução

Leia o texto e responda às questões usando frases completas e o vocabulário apresentado no texto.

Quem é você?

Eu me chamo Patrícia Mattos, tenho quinze anos e moro em São Paulo. Eu estudo em uma escola pública e tenho muitos amigos.

Eu moro com minha mãe. Seu nome é Marta. Ela tem quarenta anos e é cozinheira em um restaurante de luxo.

Eu tenho um irmão. O nome dele é Claudio. Ele mora nos Estados Unidos e é músico. Ele toca Jazz e Blues. Ele é um excelente guitarrista.

Questões: 1 2 3 4 5 6 7 8

Questão 2 Próxima Questão (3)

Quantos anos ela tem?

Ela tens quinze anos.

à á â ã é ê í ó ô õ ú ü ç
À Á Â Ã É Ê Í Ó Ô Õ Ú Ü Ç

Enviar

Análise:

Input: **Ela tens quinze anos.**

There is an agreement error in **person** between the **subject** and the **verb** in the sequence ***ela tens*** from your answer.

To see a possible answer, click here.

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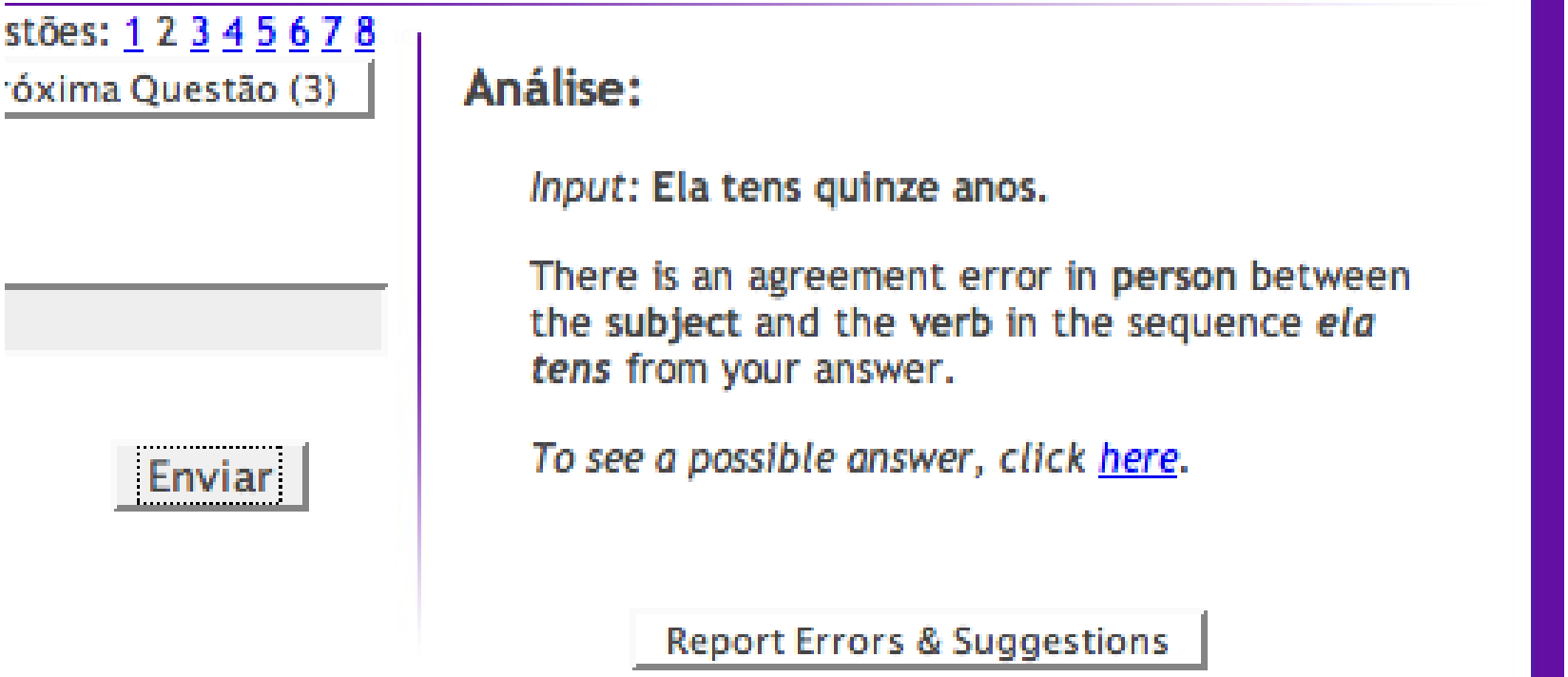
Feedback on Agreement



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Eu tenho um irmão. O nome dele é Claudio. Ele mora nos Estados Unidos e é músico. Ele toca Jazz e Blues. Ele é um excelente guitarrista.

Questões: 1 2 3 4 5 6 7 8

Questão 2 Próxima Questão (3)

Quantos anos ela tem?

Ela és quinze anos.

à á ã ā é ê í ó õ ō ú ü ç
À Á Â Ã É Ê Í Ó Ô Õ Ú Ü Ç

Enviar

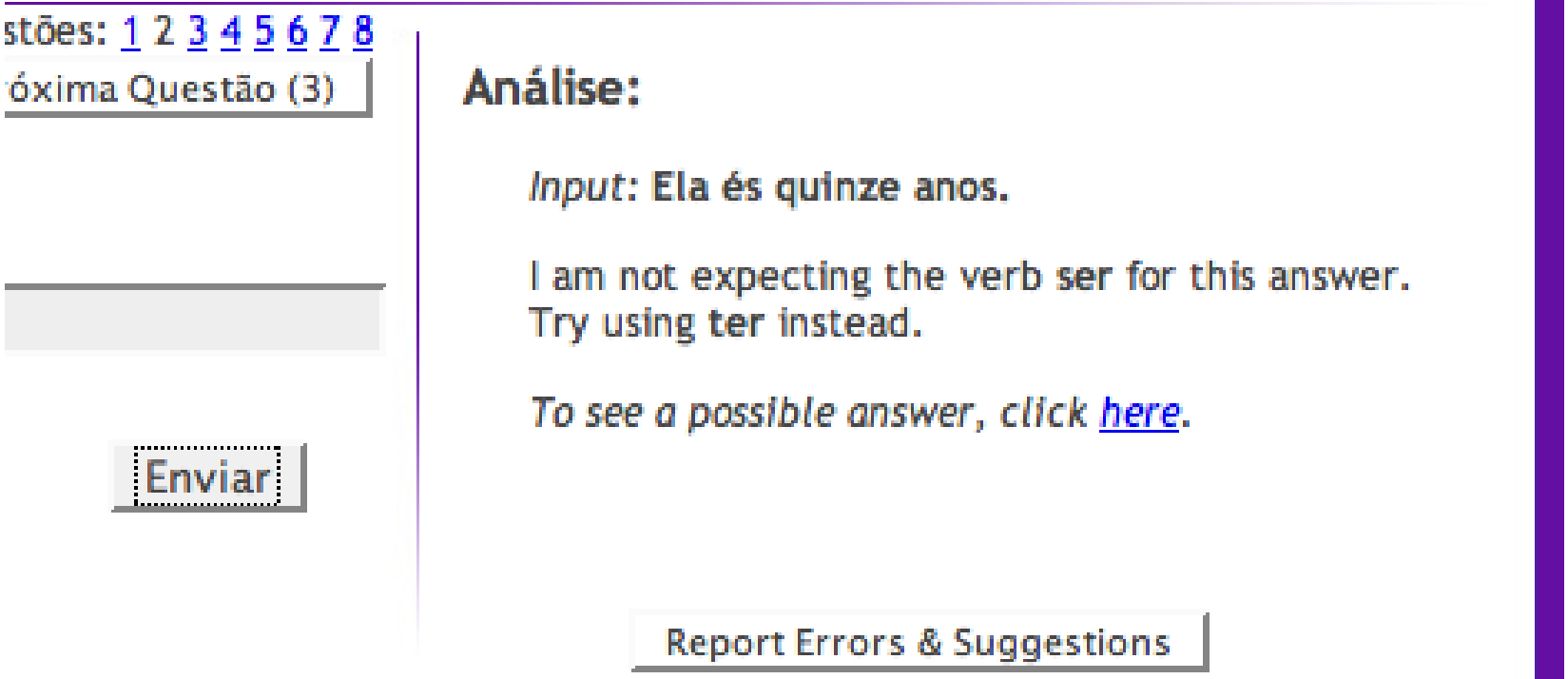
Análise:

Input: **Ela és quinze anos.**

I am not expecting the verb **ser** for this answer. Try using **ter** instead.

To see a possible answer, click here.

Feedback on Word Choice



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Descrição

Instrução

Excreva uma frase completa usando a informação apresentada pela gravura e as palavras entre parênteses.

Questões: 1 2 3 4

Questão 1 Próxima Questão (2)

chamar-se - Ana e Beatriz

Elas se chamam Ana e Maria.

à á â ã é ê í ó ô õ ú ü ç
À Á Â Ã É Ê Í Ó Ô Õ Ú Ü Ç

Enviar

Análise:

Input: **Elas se chamam Ana e Maria.**

I think there is a problem with the proper noun you have chosen.

Are you sure you want to use **Maria** instead of **Beatriz**?

To see a possible answer, click here.

Report Errors & Suggestions

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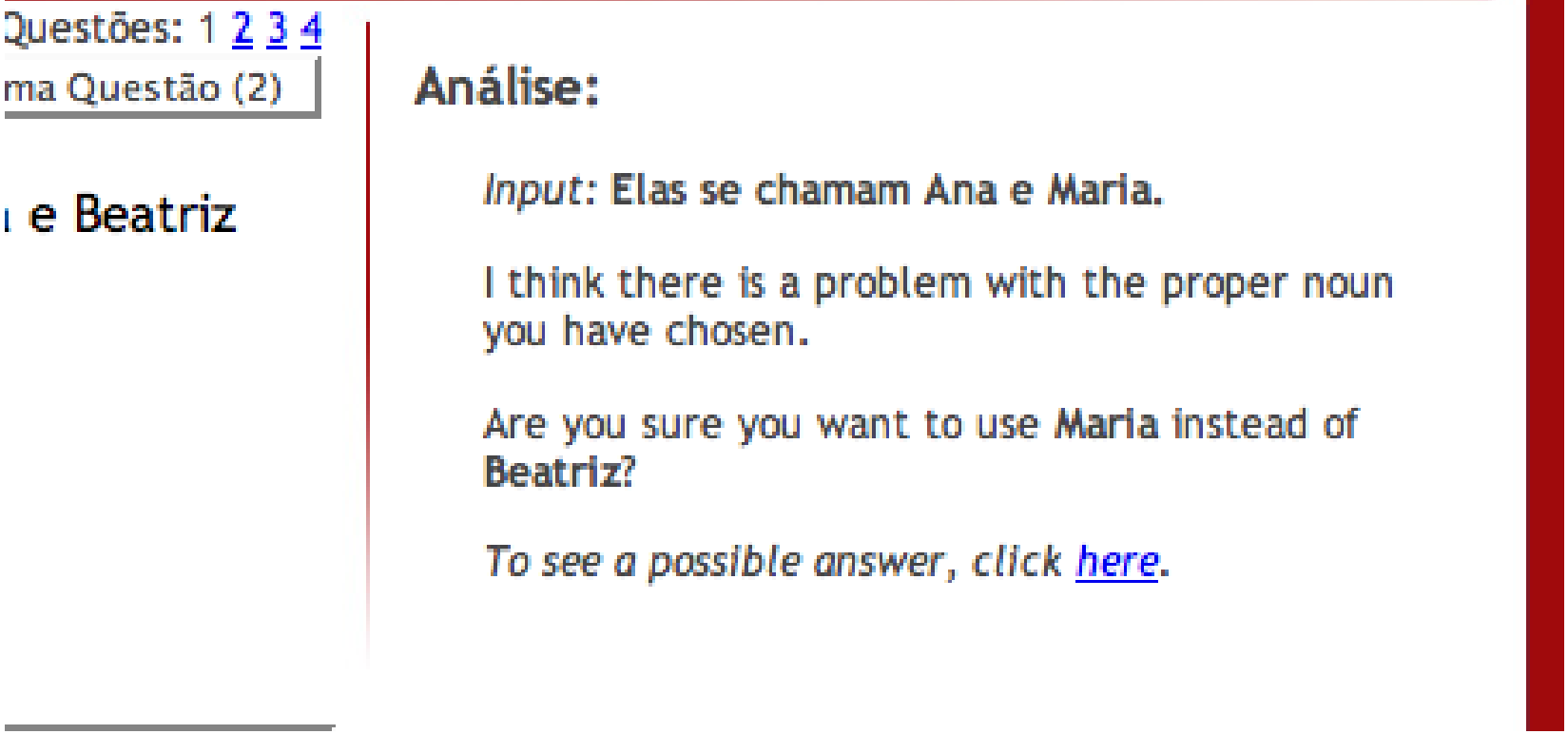
Feedback on Wrong Word



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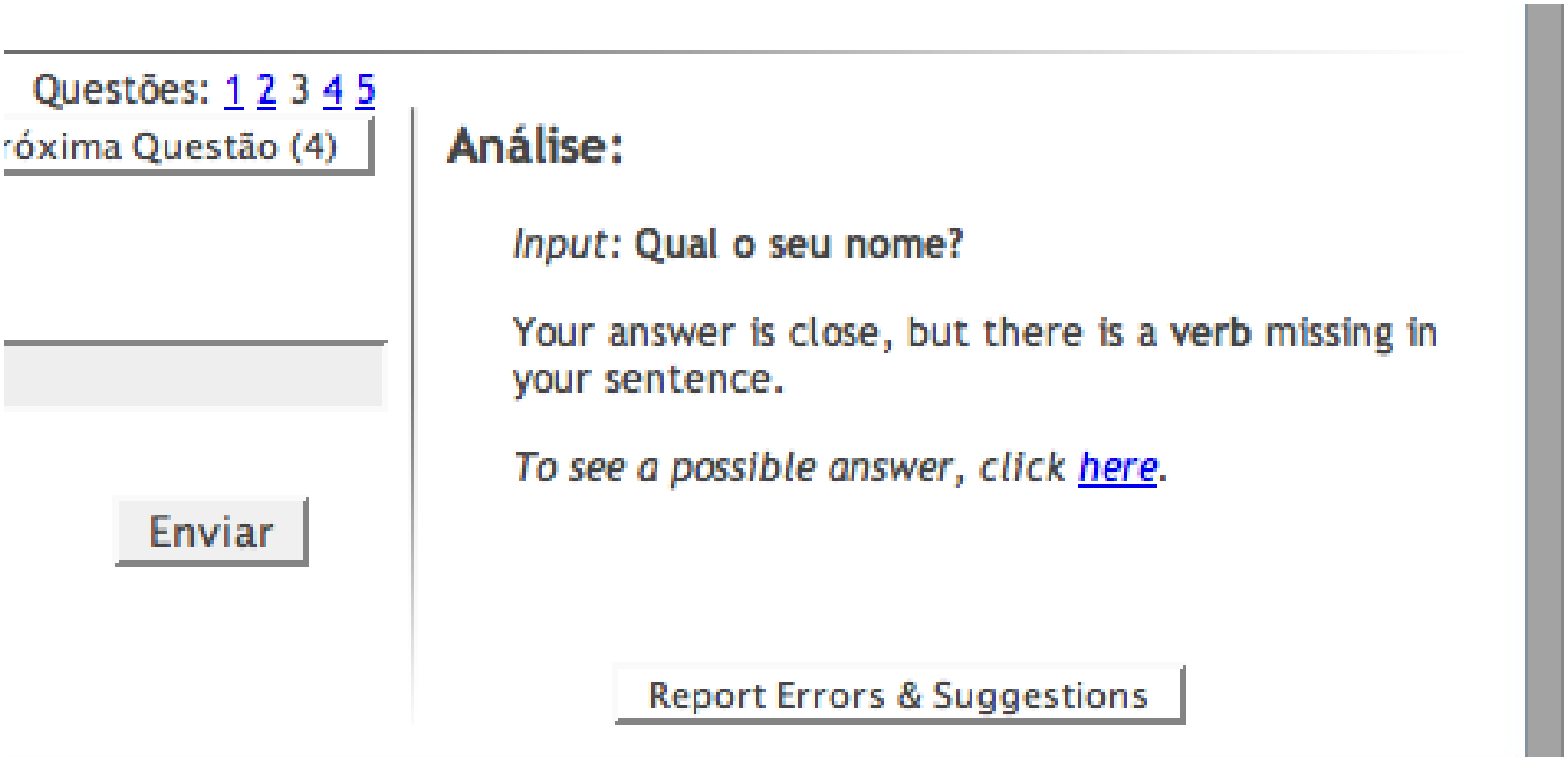
Feedback on Missing Verb



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ICALL summary

- NLP can be used in ICALL tools to
  - foster learner awareness of language forms & categories
  - provide individual feedback on learner errors
- 30 years of ICALL research (cf. Heift & Schulze 2007), but
  - very few ICALL systems used in FLT practice today
    (Heift 2010; Nagata 2010; Amaral & Meurers 2011)
- Problems to be overcome:
  - lack of interdisciplinary research combining computational, linguistic, SLA & education expertise
  - ICALL projects generally are not designed to address real-life needs, typically never tested with real users.

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Analyzing language for learners

Introduction

- NLP in language learning has primarily centered on analyzing learner language in Tutoring Systems.
- How about using NLP of authentic native language in support of language learning?
- Where does SLA research identify a corresponding need?

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SLA research on awareness

- Learners have to be exposed to linguistic features to acquire them and must **notice** them (Schmidt 1995).
- There is no learning without noticing, but developing awareness requires input.
- Strategies highlighting the salience of language forms and categories are referred to as *input enhancement* (Sharwood Smith 1993).

$\Rightarrow$ Let's use NLP to provide automatic input enhancement for language learners: WERTi (Meurers et al. 2010)

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WERTi: Working with English Real Text

- Provide learners of English (ESL) with input enhancement for any web pages they are interested in.
- good for learner motivation:
  - learners can choose material based on their interests
  - includes news, up-to-date information, hip stuff
  - pages remain fully contextualized (video, audio, links)
- wide range of potential learning contexts:
  - can supplement *regular classroom instruction*
  - can support voluntary, self-motivated pursuit of knowledge
    → *lifelong learning*
  - can foster *implicit learning*, e.g., for adult immigrants:
    - already functionally living in second language environment, but stagnating in acquisition
    - without access/motivation to engage in explicit learning, but browsing the web for information and entertainment

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What language properties should we enhance?

- A wide range of linguistic features can be relevant for *awareness*, incl. morphological, syntactic, semantic, and pragmatic information (cf. Schmidt 1995, p. 30).
- We focus on enhancing language patterns which are well-established difficulties for ESL learners:
  - determiner and preposition usage
  - use of gerunds vs. *to*-infinitives
  - *wh*-question formation
  - phrasal verbs

  NLP identifying other patterns can easily be integrated as part of a flexible architecture.

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How should the targeted forms be enhanced?

- WERTi currently offers three types of input enhancement:
  a) color *highlighting* of the pattern or selected parts thereof
  b) pages supporting *clicking*, with automatic color feedback
     - automatic feedback compares automatic annotation of clicked on form with targeted form
  c) pages supporting practice (e.g., *fill-in-the-blank*), with automatic color feedback
     - automatic feedback compares form entered by learner with form in original text
- This follows standard pedagogical practice (“PPP”):
  a) receptive presentation
  b) presentation supporting limited interaction
  c) controlled practice
  d) (free production)

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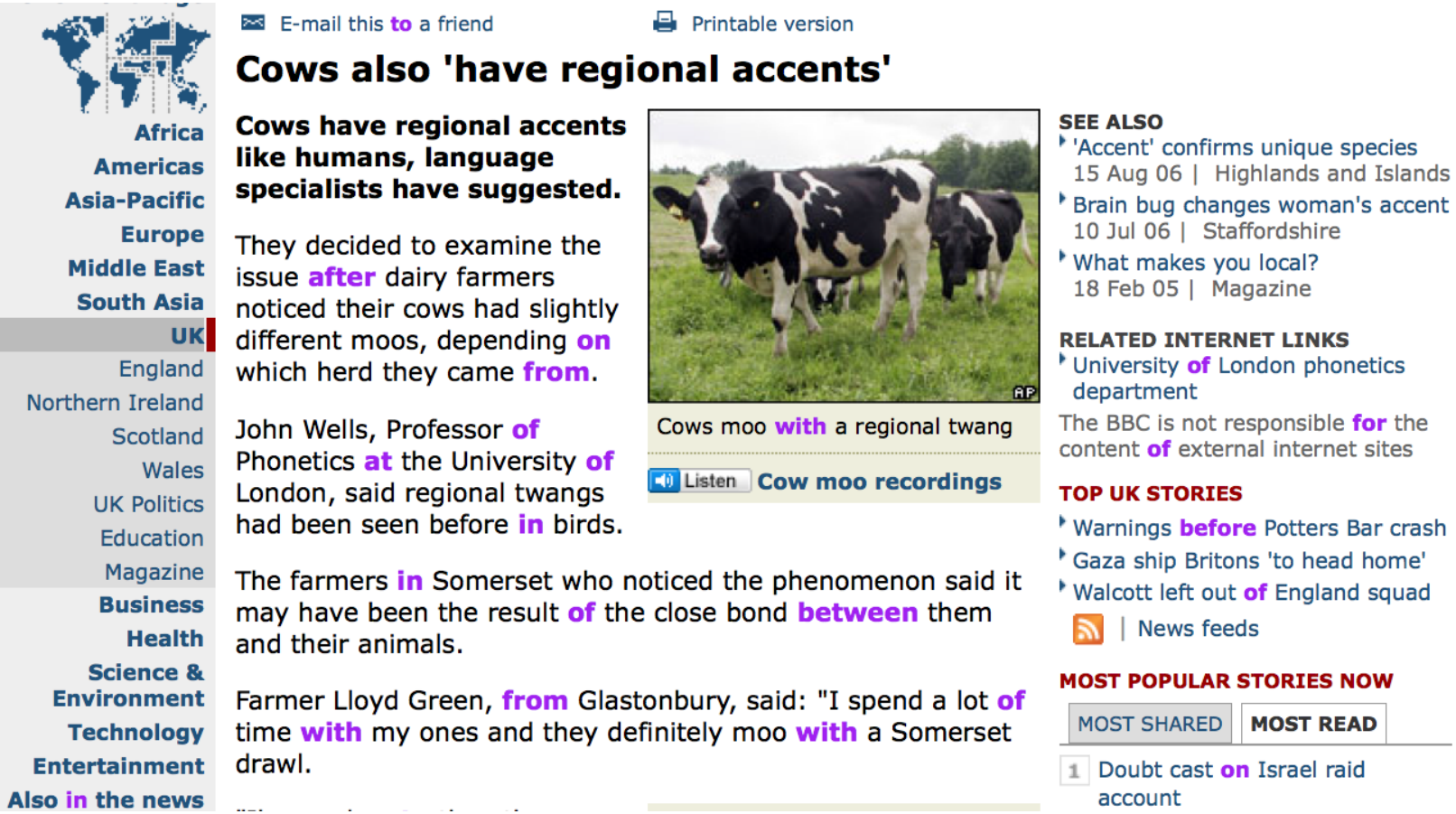
Prepositions: Presentation (Color)



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Cows also 'have regional accents'

Cows have regional accents like humans, language specialists have suggested.

They decided to examine the issue after dairy farmers noticed their cows had slightly different moos, depending on which herd they came from.

John Wells, Professor of Phonetics at the University of London, said regional twangs had been seen before in birds.

The farmers in Somerset who noticed the phenomenon said it may have been the result of the close bond between them and their animals.

Farmer Lloyd Green, from Glastonbury, said: "I spend a lot of time with my ones and they definitely moo with a Somerset drawl.

Cows moo with a regional twang

Listen Cow moo recordings

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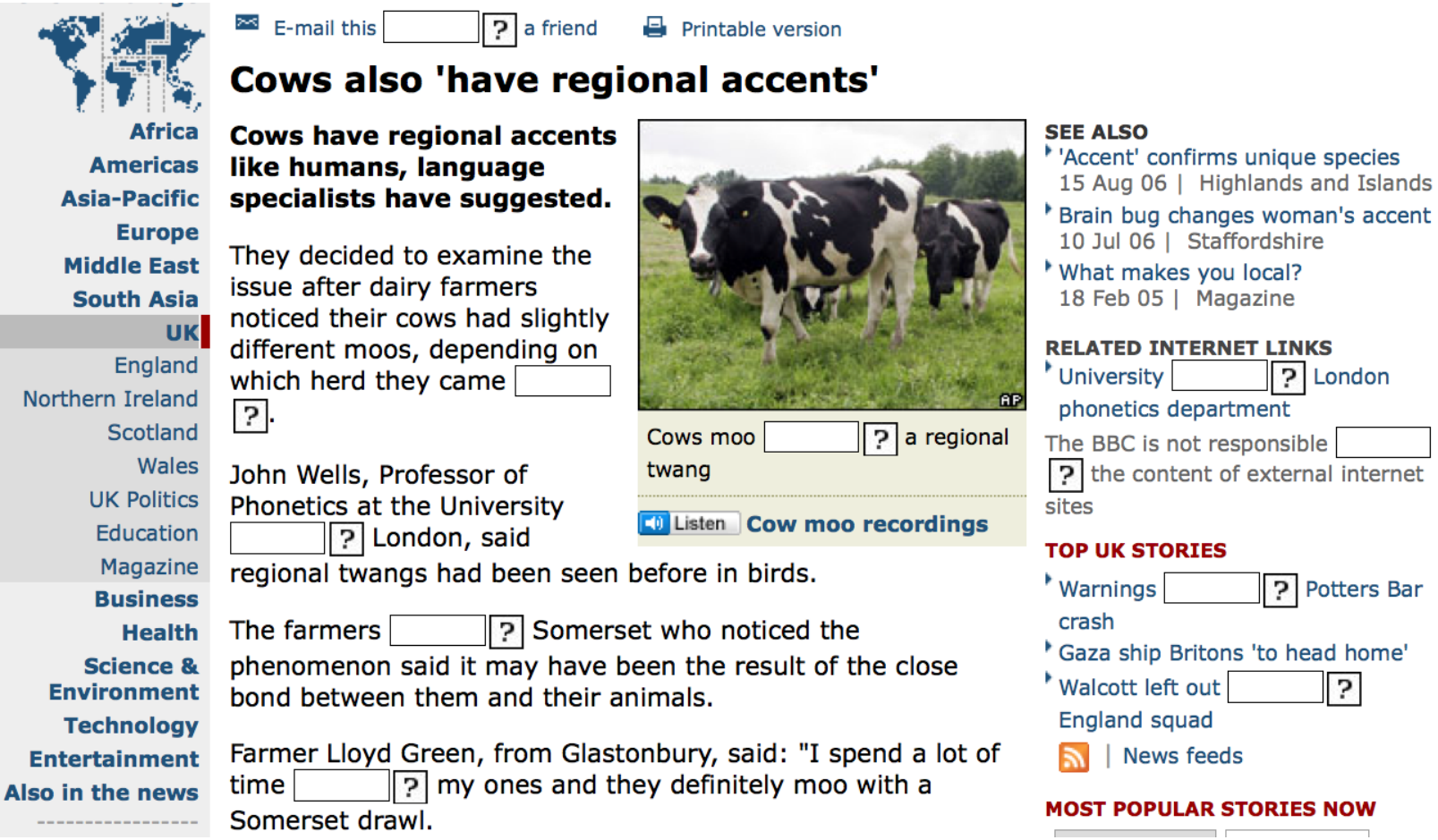
Prepositions: Practice (FIB)



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Cows also 'have regional accents'

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Cows moo [ ] [?] a regional twang

Listen **Cow moo recordings**

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Language Learning and Computational Linguistics

Detmar Meurers
Universität Tübingen

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Prepositions: Presentation + Interaction (Click)

Car-free cities: an idea with legs

Car-free neighbourhoods are no unrealistic utopia – they exist all over Europe

'Not anti-car, just pro-choice' ... a cyclist in Vauban, Germany. Photograph: Sipa Press/Rex Features

A quarter of households in Britain – more in the larger cities, and a majority in some inner cities – live without a car. Imagine how quality of life would improve for cyclists and everyone else if traffic were removed from areas where people could practically choose to live without cars. Does this sound unrealistic, utopian? Did you know many European cities are already doing it?

(55) (110)

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Posted by Steve Melia Thursday 29 October 2009 08.00 GMT
guardian.co.uk

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Source: http://www.guardian.co.uk/environment/green-living-blog/2009/oct/29/car-free-cities-neighbourhoods

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A

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More blogposts

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Phrasal verbs: Presentation (Color)

Laugh Lines

Funny Stuff From All Over

May 6, 2010, 11:14 AM

Letterman: 'They Don't Like Immigrants'

Monologue | *Wednesday night on "The Late Show With David Letterman" on CBS*: You folks been following the big British Petroleum oil spill in the Gulf of Mexico? I'm telling you, British Petroleum has **put** more birds **in** oil than Colonel Sanders.

I was thinking about this. Here's what I **came up** with. Now, in Arizona, you know about the new immigration law, where if you don't look like you belong there, they can **run** you **out of** the state? And they've got patrol cars driving around, **pulling up** to people, saying: "You don't look like you belong here. **Get out**!" So the deal is, in Arizona, they don't like immigrants. And I was thinking, well, that's odd, because right across the river there in California, they elected one governor.

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Phrasal verbs: Practice (Fill-in-the-blank)

Laugh Lines

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Gerunds vs. infinitives: Presentation (Color)

"The government says it is expanding access to university, but they are actually blocking people's aspirations and betraying a generation."

The government was forced to cap student numbers **after** **discovering** a £200m black hole in the university financing budget at the end of last year. Labour was accused **of** **abandoning** its pledge **to expand** higher education, addingpressure to a growing debate about how **to fund** the growing number of young people who **want to do** a degree. The government is due **to announce** a review of student finance.

The massive increase in applicants has put a strain on the university system this year, with one university forced **to convert** single bedrooms in halls into doubles, and others putting students up in hotels.

Source: http://www.guardian.co.uk/education/2009/oct/14/30000-miss-university-place

Gerunds vs. infinitives: Practice (FIB)

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Wh-questions: Presentation (Color)

If someone takes drugs, they can become addictive depending on the drug. Overdoses typically happen with cocaine, opioids, benzos, especially mixing benzos and opioids (Xanex, Valium, or Klonopin).

Why do people use illegal drugs? [change]

Most illegal drugs cause people to become intoxicated[*needs proving*]. The slang term for this experience is "getting stoned" or "getting high." When a drug user is intoxicated, they may feel strange, happy, dizzy, or weird. Some drugs such as marijuana and hashish often make users feel sleepy and relaxed. Some drug users have feelings that they are floating or dreaming. Drugs such as LSD make people feel intensely; they make one see and feel things like never before, and think things about the world they would normally not. Some say it increases knowledge and creates wisdom. Other drugs such as Crystal Meth make users feel excited and happy and full of energy.

Source: http://simple.wikipedia.org/wiki/Illegal_drugs

Wh-questions: Presentation + Interaction (Click)

If someone takes drugs, they can become addictive depending on the drug. Overdoses typically happen with cocaine, opioids, benzos, especially mixing benzos and opioids (Xanex, Valium, or Klonopin).

Why do people use illegal drugs? subject [change]

Most illegal drugs cause people to become intoxicated[*needs proving*]. The slang term for this experience is "getting stoned" or "getting high." When a drug user is intoxicated, they may feel strange, happy, dizzy, or weird. Some drugs such as marijuana and hashish often make users feel sleepy and relaxed. Some drug users have feelings that they are floating or dreaming. Drugs such as LSD make people feel intensely; they make one see and feel things like never before, and think things about the world they would normally not. Some say it increases knowledge and creates wisdom. Other drugs such as Crystal Meth make users feel excited and happy and full of energy.

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illegal drugs? do people Why use [change]

Why people do use illegal drugs? ✓ ✗ ?

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Source: http://simple.wikipedia.org/wiki/Illegal_drugs

Realizing WERTi/VIEW

- First WERTi prototype (Amaral/Meurers/Metcalf at CALICO 06, EUROCALL 06)
  - targets determiners, prepositions in Reuters news text
  - still available at http://purl.org/icall/werti-v1
- Second WERTi prototype (Dimitrov/Ott/Ziai)
  - flexibly support integration of a wider range of language patterns using heterogeneous set of NLP (using UIMA)
- Firefox Add-On (Boyd): http://purl.org/icall/werti
  - moves fetching of web page and text identification to client to better support sites requiring login, cookies, etc.
- Visual Input Enhancement of the Web (VIEW)
  - international version (English, German, Spanish)
  - Add-On available at: http://purl.org/icall/view

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Evaluating input enhancement techniques

- Improving learning outcomes is the overall goal of WERTi and visual input enhancement in general.
- While some studies show an improvement in learning outcomes, the study of visual input enhancement sorely needs more experimental studies (Lee & Huang 2008).
- WERTi can systematically produce visual input enhancement for a range of language properties
  - → Supports real-life intervention studies studying language learning under a wide range of parameters.
  - → Supports lab-based experiments to evaluate when input enhancement succeeds in making learners notice.
- Precision and recall of the NLP identifying the enhanced classes must also be tested (requires realistic test data).

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Related Work

Data-Driven Learning

- One can view automatic input enhancement as an enrichment of Data-Driven Learning (DDL).
  - DDL is an “attempt to cut out the middleman [the teacher] as far as possible and to give the learner direct access to the data” (Boulton 2009, p. 82, citing Tim Johns)
- WERTi: learner stays in control, but NLP uses ‘teacher knowledge’ about relevant language properties to make those more prominent to the learner.

Related Work

Reading Support Tools

- Glosser-RuG (Nerbonne et al. 1998): supports reading of French texts for Dutch learners
  - context-dependent dictionary, morphological analysis, and examples of word use in corpora
- COMPASS project (Breidt & Feldweg 1997): similar to Glosser-RUG, focusing on multi-word lexemes
- ALPHEIOS project (http://alpheios.net): supports lexicon lookup and provides aligned translations
- REAP project (http://reap.cs.cmu.edu) supports learners in searching for texts that are well-suited for providing vocabulary and reading practice (Heilman et al. 2008).

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Outlook: Questions to be addressed

- Which *language pattern types* should be input enhanced?
  - adverb placement, passive vs. active, ...
  - tense and aspect
    - effect is semantic, but there are identifiable lexical cues ("*usually* go" vs. "are going *tomorrow*")
- Which *aspect of the patterns* should be input enhanced?
  - lexical classes, morphemes
  - contextual clues (optional or obligatory)
- What is the *best input enhancement*, i.e., highlighting or interaction possibilities
  - for a particular linguistic pattern,
  - given a specific web page with its existing visual design features?

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Input enhancement summary

- We motivated and discussed an approach providing automatic input enhancement of authentic web pages.
- Automatic feedback for the practice activities is feasible since the original text is known.
- Web pages can be selected by learners based on interests.
  - But how can we ensure sufficient representation of pattern to be enhanced?
  - And is the text at the right level of readability for the individual learner?

  → Language Aware Search Engine

  (Ott & Meurers 2010; Vajjala & Meurers 2012)

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Conclusion

- NLP can be used to analyze
  - learner language or
  - language for learners.
- In tutoring systems it can address real-life needs, providing
  - contextualized activities integrating meaning & form,
  - opportunities for students to practice their listening, reading, and writing skills
  - with individualized feedback to learner
- It can support visual input enhancement fostering learner awareness of language categories.

$\Rightarrow$ Integration of computational, linguistic, FLT/SLA and education expertise opens up interesting opportunities.

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