Generating Modular Grammar Exercises with Finite-State Transducers

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Contents

Introduction

An ICALL system for learning complex inflection systems, based upon finite state transducers (FST).

- generates a virtually unlimited set of exercises
- processes both input and output according to a wide range of parameters
- anticipates common error types, and gives precise feedback
- makes it easy for a linguist or a teacher to model new language learning tasks
- in active use on the web for two Saami languages
- can be made to work for any inflectional language

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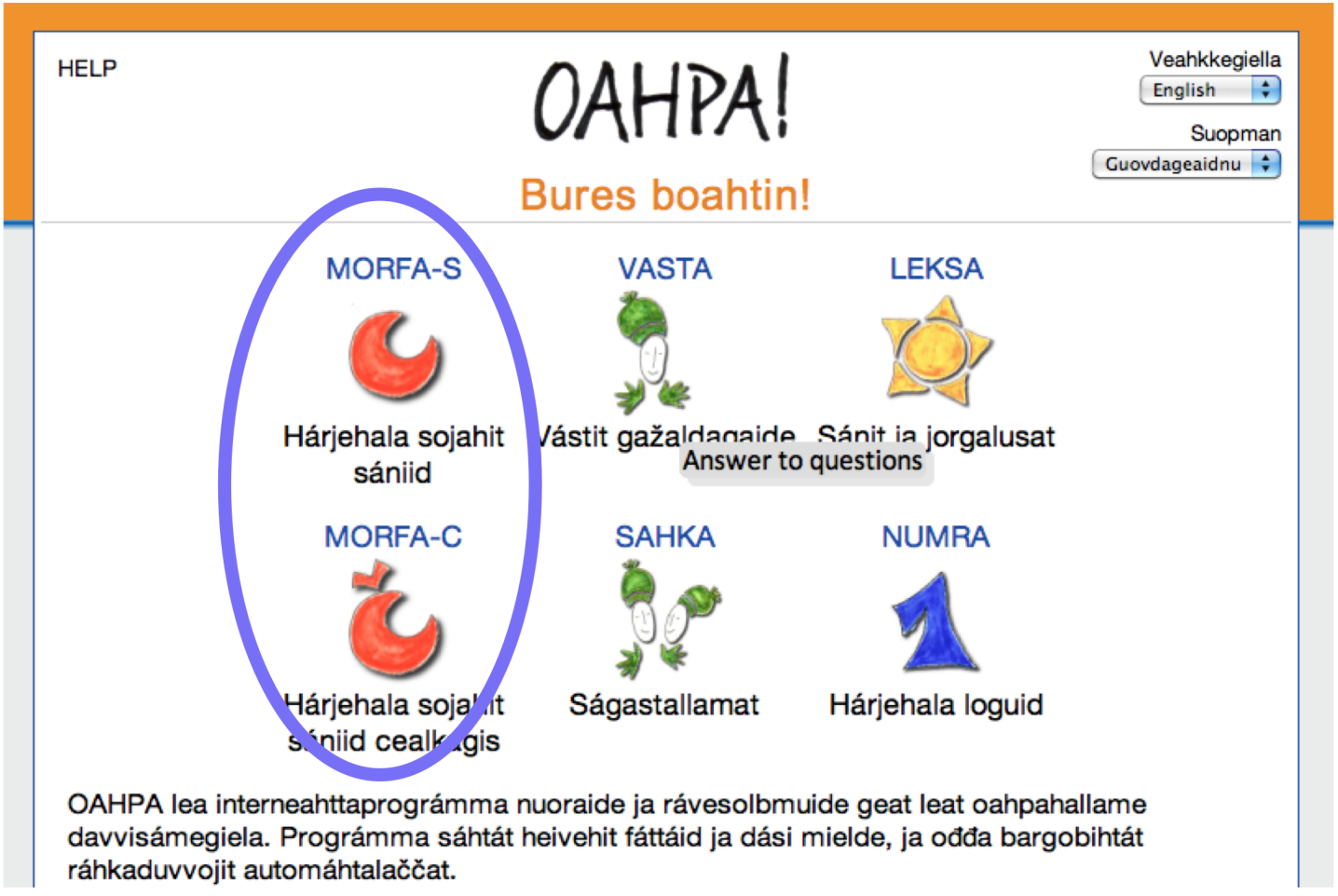
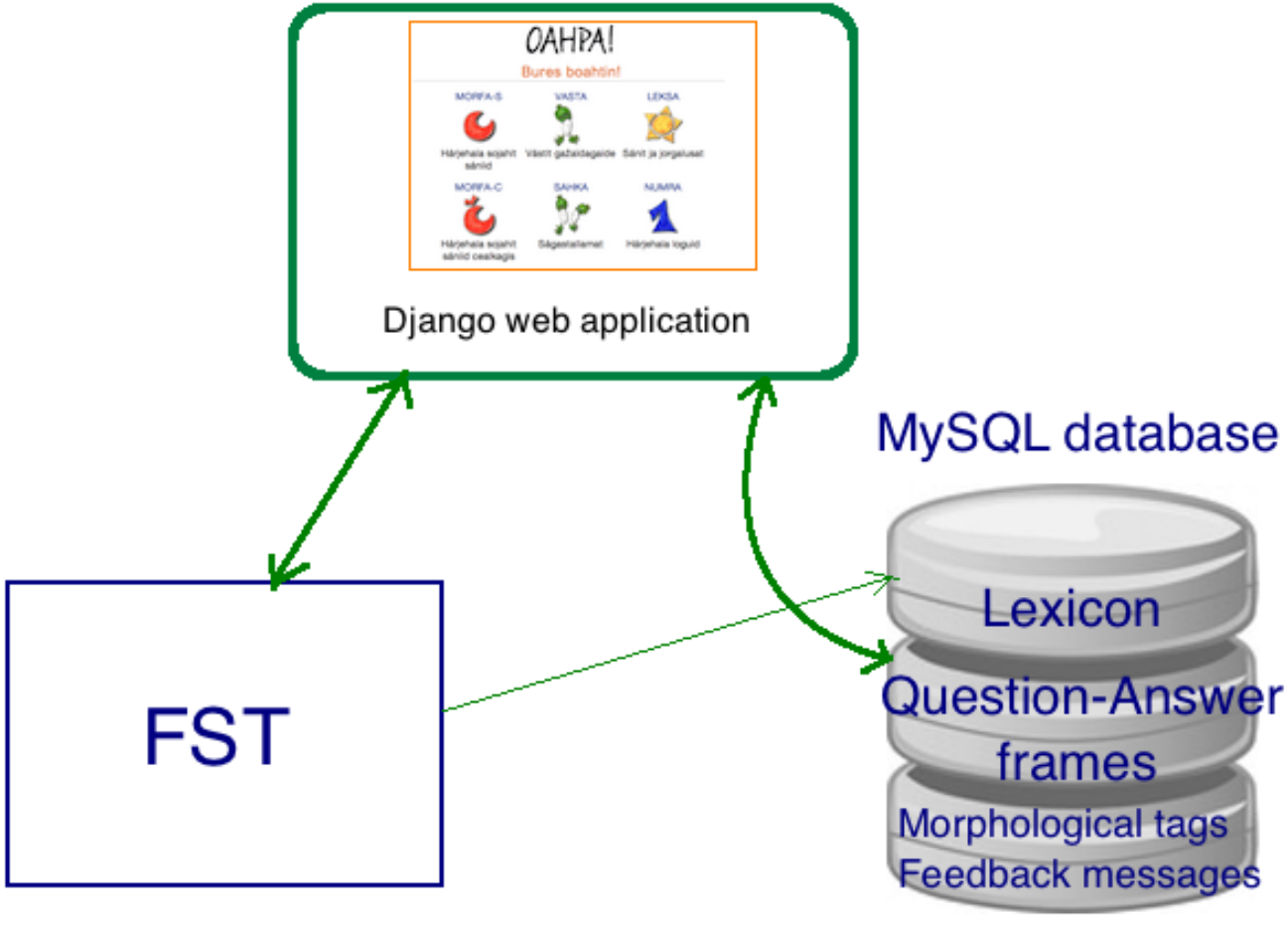
- Most of the available ICALL systems deal with English.
- There was no ICALL system usable for Saami languages.
- There existed an important resource – an FST (as the engine of a spell checker).

http://oahpa.no/index.eng.html



Overview of the System

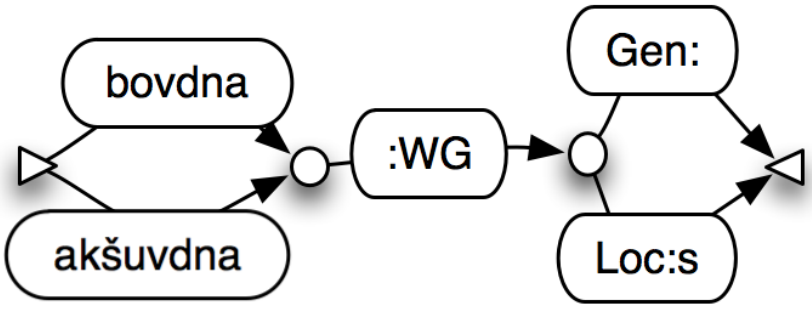


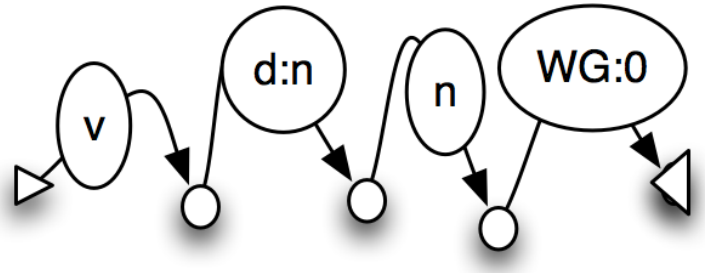
The history

- available on the Internet since 2009
- 2010-13:
  - started improving the structure for porting the system to new languages
  - made the programs for South Saami
  - experiments with other Saami languages
  - integrated the North Saami version into the university's introductory courses
  - expanded the lexicon, adjusted it for universities in Finland
  - added more task types, e.g. pronouns, derivations and possessive suffices
  - evaluation of the tasks

Antonsen, L., Huhmarniemi, S., and Trosterud, T. (2009). Interactive pedagogical programs based on constraint grammar. In Proceedings of the 17th Nordic Conference of Computational Linguistics. Nealt Proceedings 4.

Finite State-Transducers





bovdna+Loc:bovdnaWGs
bovdna+Gen:bovdnaWG
akšuvdna+Loc:akšuvdnaWGs
akšuvdna+Gen:akšuvdnaWG

vdnaWG:vnna0

bovdna+Loc:bovnnas ‘tussock’
bovdna+Gen:bovnna
akšuvdna+Loc:akšuvnnas ‘action’
akšuvdna+Gen:akšuvnna

The FSTs can be manipulated in different ways

- input (for acceptance of the student's input)
  - normative FST
  - tolerant FST
    - with spellrelax (ex. i = ï)
  - FST enriched with typical L2 errors marked with error tags
- output (for generating model answers)
  - normative FST
  - restricted FSTs
    - one for each dialect, without variants

Advantages of using FST

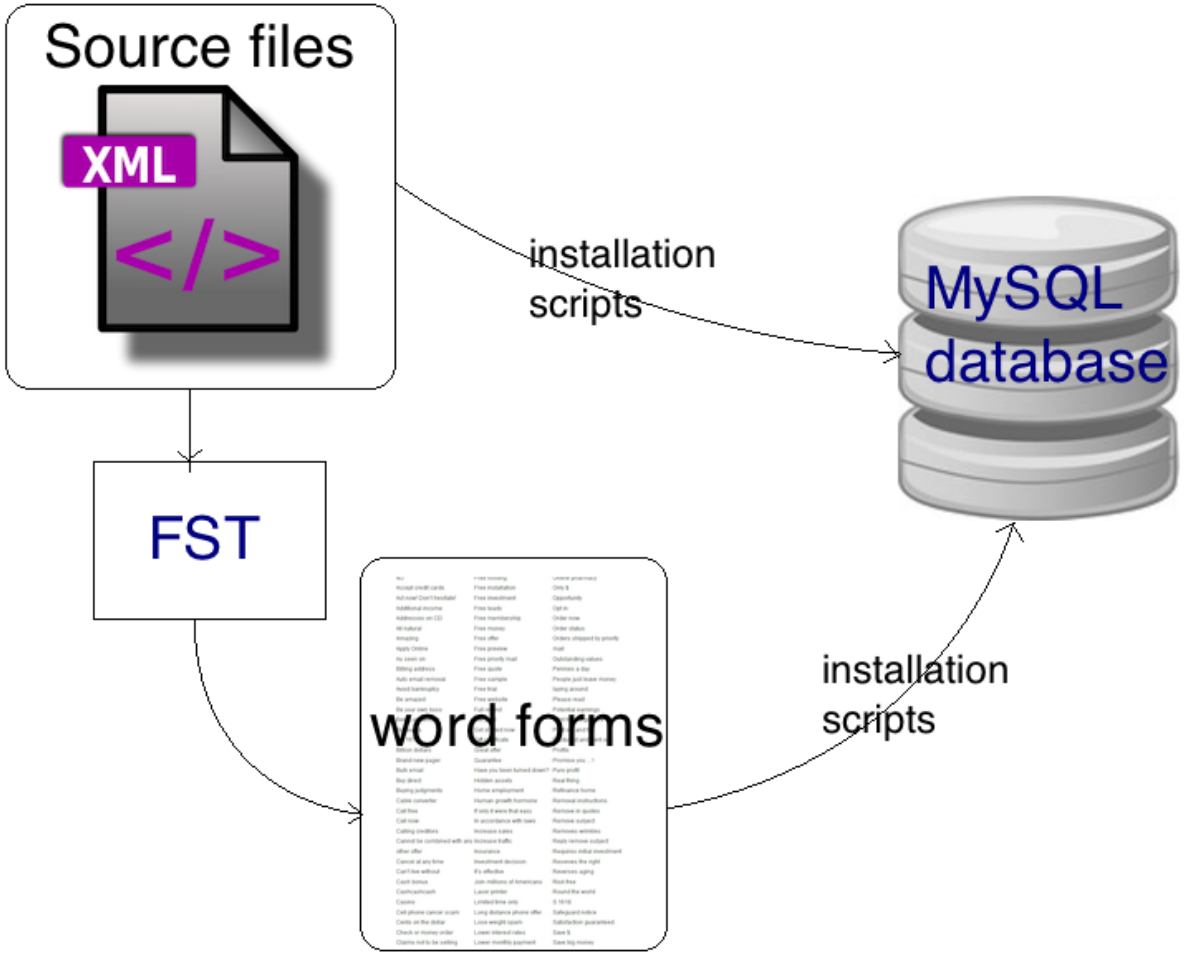
- generation of an "infinite amount" of exercises
- analysis and automatic evaluation of answers plus suggestions and comments on common error types
- flexibility with regard to language variation (dialects)
  - acceptance of several dialectal forms
  - ... but upon user request, suggest the normative form as a correct answer

Lexicon

Besides the FST, the lexicon is the other central resource for our language learning programs.

- A pedagogical lexicon containing the vocabulary of relevant textbooks
- Created from scratch, complemented in the course of development with data from (both electronic and non-electronic) textbooks and dictionaries

Lexicon – technical details



Lexicon Structure

```
<lg>
   <l diphthong="yes" gen_only="N+Sg,N+Ess" gradation="yes"
   pos="n" rime="0" soggi="a" stem="2syll">deadja</l>
</lg>
<dialect class="NOT-KJ"/>
<sources>
   <book name="sam1031_1"/>
</sources>
<mg>
   <semantics>
      <sem class="DRINK"/>
   </semantics>
   <tg xml:lang="nob">
      <t pos="n" stat="pref">te</t>
   </tg>
   <tg xml:lang="fin">
      <t pos="n" stat="pref">tee</t>
   </tg>
</mg>
```

Lexicon Structure

- The meta-information stored in the lexicon is there to select the appropriate words for the exercises.
- In addition, the morphophonological properties of words are used when providing detailed feedback on morphological errors.

Contextual Morphological Exercises

```
<question>
  <text>Maid SUBJ MAINV luomus</text>
<qtype>V-MIX</qtype>
  <element id="SUBJ">
<grammar pos="Pron"/>
  </element>
  <element id="MAINV">
<id>bargat</id>
<grammar tag="V+Cond+Prs+Person-Number"/>
  </element>
</question>
<answer>
  <text>Luomus SUBJ V-COND</text>
  <element game='morfa' id="V-COND" task="yes">
<sem class="ACTIVITY"/>
<grammar tag="V+Cond+Prs+Person-Number"/>
<agreement id="MAINV"/>
  </element>
</answer>
```

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ACTIVITY-set: 87 verbs

pronouns: 9 person-numbers → 783 tasks

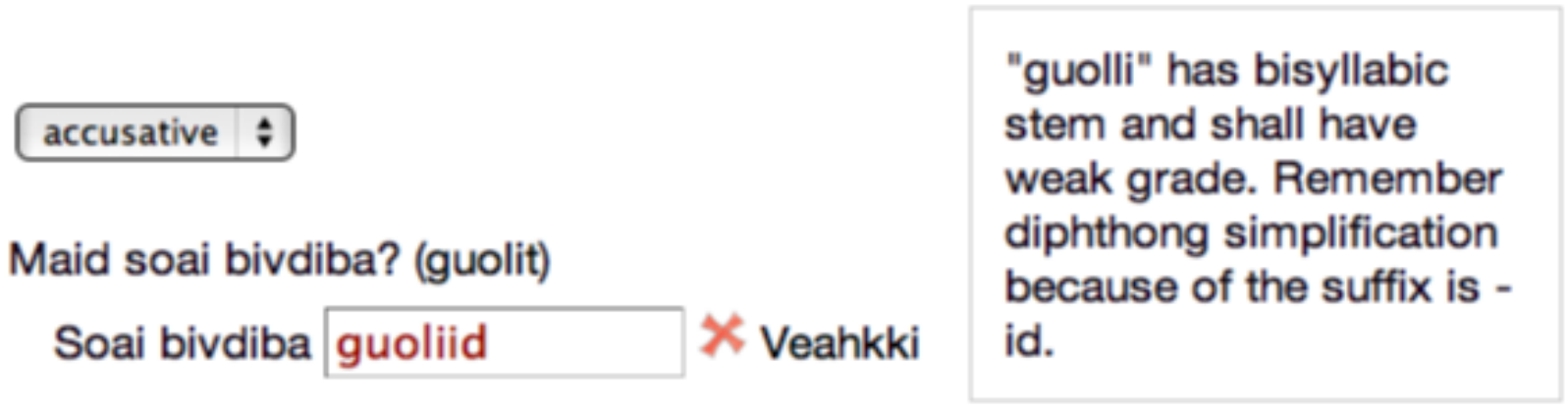
Generating exercises

- Morfa S: isolated words
  - 1200 nouns, 750 verbs, 300 adjectives, pronouns, numerals 1-12
  - → appr. 80,000 wordforms, drawn in sets of five at a time
- Morfa C: words in context
  - 330 templates for 34 different types of tasks with nouns, verbs, adjectives, pronouns, numerals and verb derivations
  - → 711,454 different exercises

Feedback

- Green if correct
- Metalinguistic help
- Unlimited self-correction

Metalinguistic feedback



Feedback is modular

1. "guolli" has bisyllabic stem
2. and shall have weak grade
3. Remember diphthong simplification
4. because of the suffix is -id

"3. Remember diphthong simplification"

Stem information in the lexicon:

```
<l diphthong="yes" gradation="yes" pos="n" finis="0"
stemvowel="i" stem="2syll">guolli</l>
```

Feedback message for this task:

```
<l stem="2syll" diphthong="yes" stemvowel="i">
<msg case="Acc" number="Pl">diphthongsimpl.</msg>
```

Evaluating the generated tasks

Three annotators gave scores to 340 randomly selected question-answer-pairs, from 34 different task types, for **grammaticality**, **meaningfulness** and **appropriateness**:

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Three annotators gave scores to 340 randomly selected question-answer-pairs, from 34 different task types, for **grammaticality**, **meaningfulness** and **appropriateness**:

- 1: wrong or very strange, would not have given it to the students → 'no'
- 2: acceptable, but not very good/natural, I wouldn't have made it myself → 'perhaps'
- 3: correct and natural, I could have made it myself for the students → 'yes'

Evaluating the generated tasks

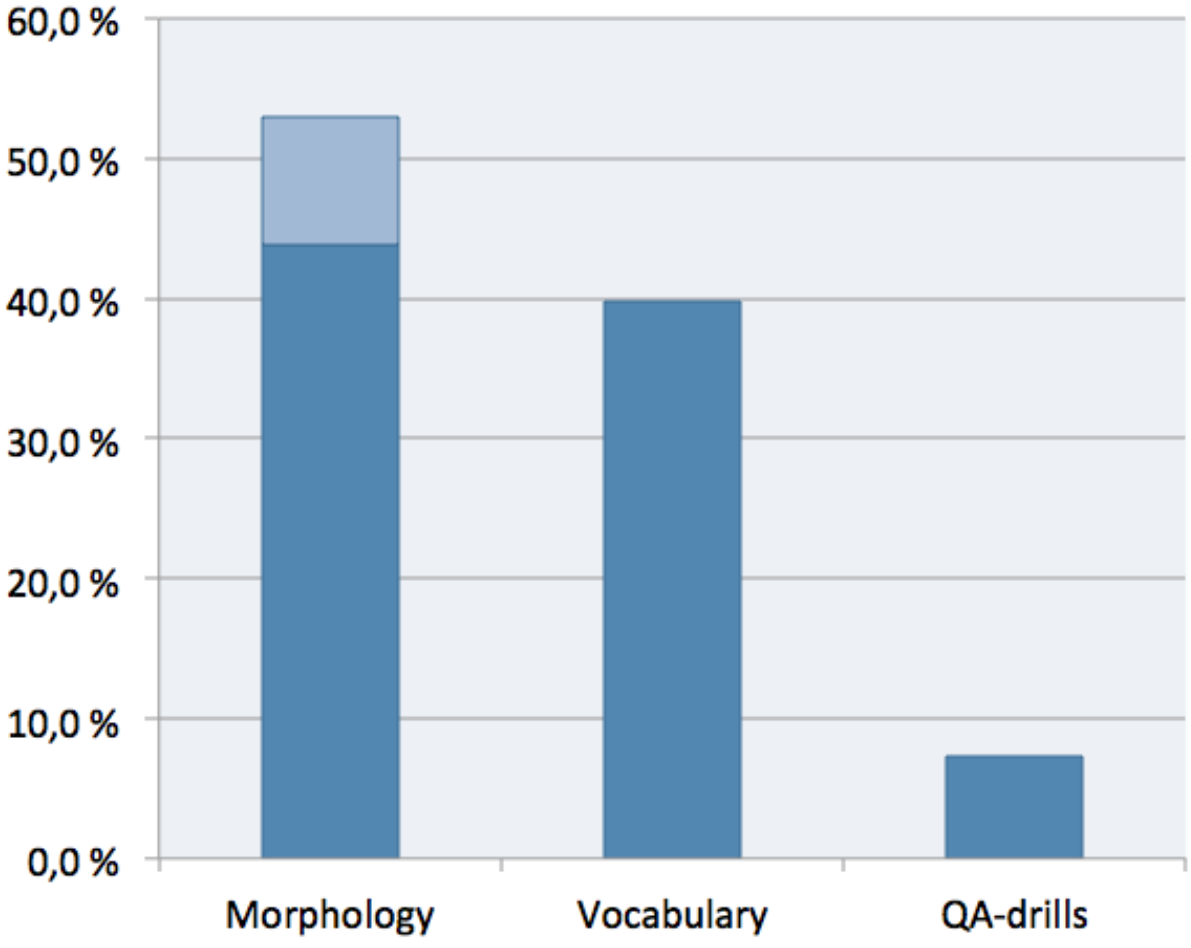
	Grammaticality			Meaningfulness			Appropriateness		
Scores	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
QA-pairs	30	17	308	31	33	281	23	42	295
Distrib. %	8.5	4.8	86.8	9.0	9.6	81.4	6.4	11.7	81.9
	average: 2.9			average: 2.8			average: 2.9		

Table: Evaluation of 340 randomly selected QA-pairs, from 34 different task types. The best score is 3 for each evaluation goal.

The bad ones

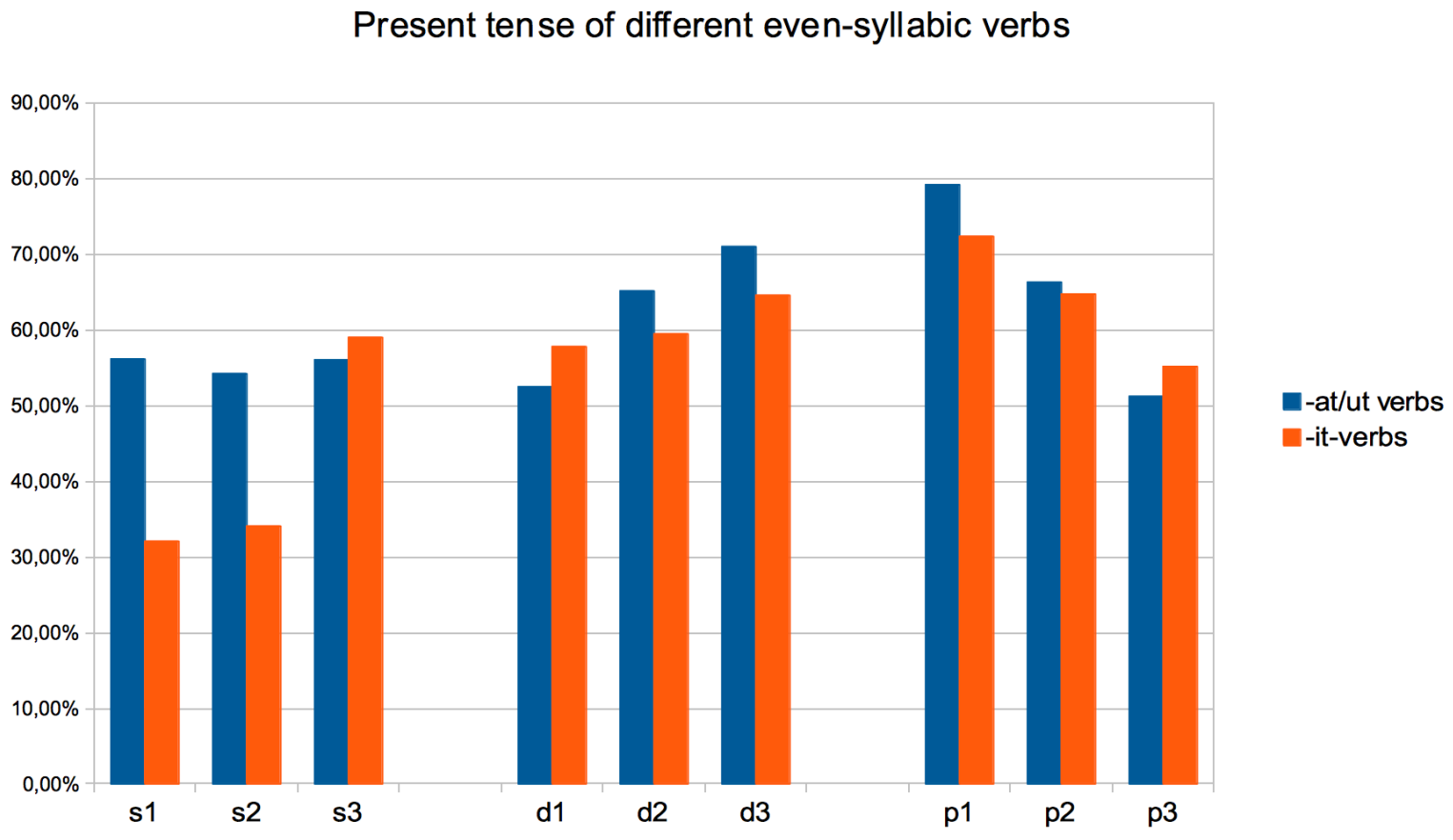
- not correct agreement between question and answer → fix the template
- noun requires modifier, e.g. 'her boyfriend' → make a new set with such nouns and make new tasks for them
- the subject doesn't match the verb for a natural meaning → delete the noun or the verb from the set
- some nouns would be more natural in plural than in singular, and vice versa → move them to other sets/make new sets

Logging User Activity



N=116,069

User data as basis for research

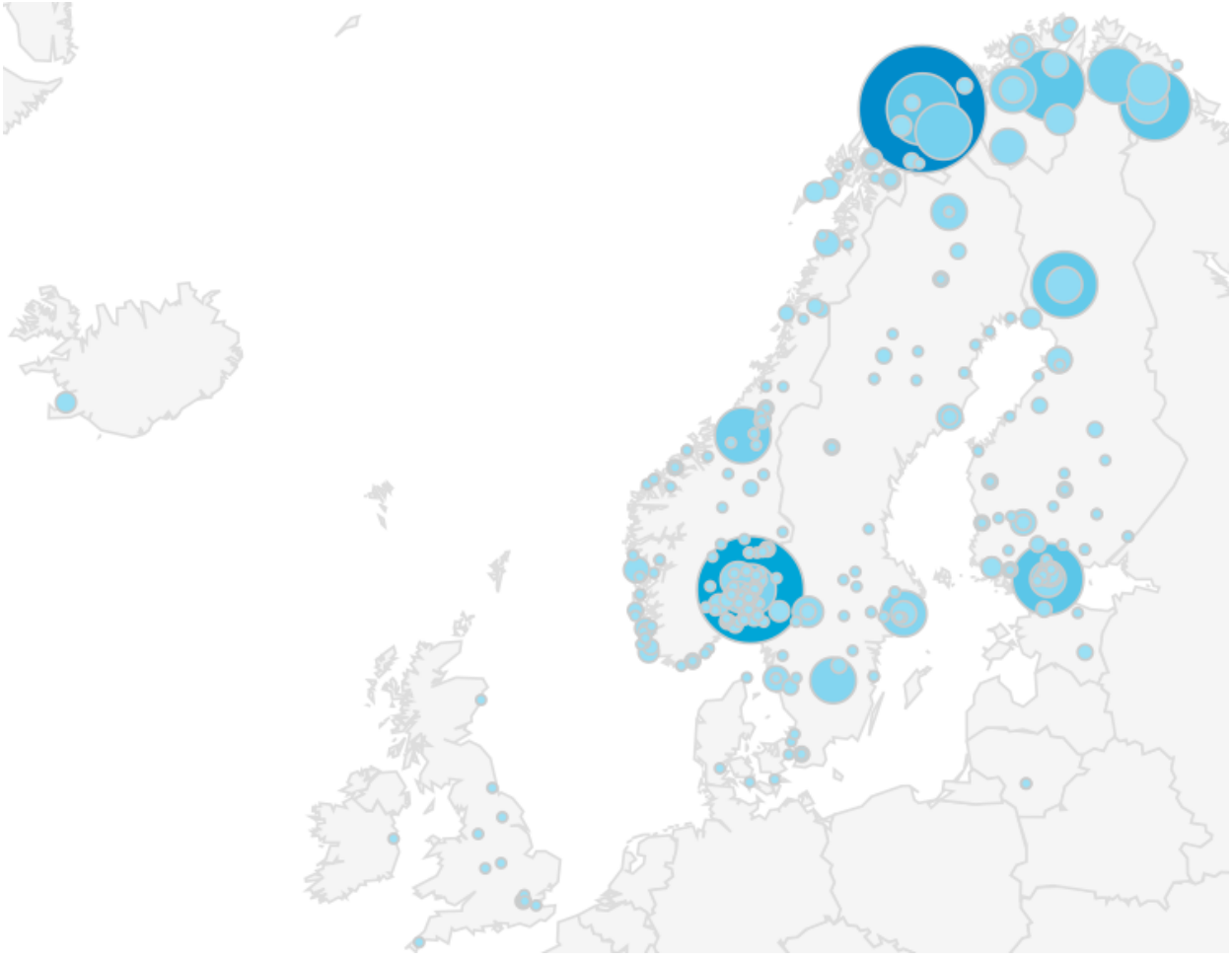


Logging User Activity – Google Analytics

During the time period from Oct. 22, 2012 to May 21 2013

- 7 017 visits
- 70 474 page views
- 10.04 pages per visit
- Power users: 883 of the visits (12.5 % of total visits) resulted in 48 636 page views (69.0 % of total page views)

Logging User Activity – Google Analytics



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*Thanks to **Norway Opening Universities** for funding the work, and to **Saara Huhmarniemi** for inspiring programming during the formative years of Oahpa.*