Improving feedback on L2 misspellings – an FST approach

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Introduction

Enriching the FST analyser with erroneous forms marked with error tags, as a way of improving feedback on L2 misspellings.

- What it can do:
  - isolated word error correction
  - detect real word errors in context-dependent word correction
  - give metalinguistic feedback on the nature of the errors
  - analyse the input despite misspellings
- How will it influence disambiguation?

Background

The computer should

- interpret learners' intentions as represented in their interlanguage forms
- give metalinguistic response → heighten the learner's awareness of morphological processes
- be able to overlook the misspelling

What is a misspelling?

a written form that deviates from the conventions in the written language

- non-word
- real word
  - an unintended word form of the same lemma
  - an unintended word form of another lemma

North Saami

- morphologically complex – a suffixing language with much suprasegmental morphology
- the vowels have the same sound values as in German ([u, o] as <u, o> etc.), different from the Norwegian
- Latin alphabet extended by means of diacritical marks (*á*, *š*, *č*, *ž*, *đ*, *ŋ*), whereas Norwegian uses letter combinations (*skj*, *tsj*, *ng*)
- all diphthongs are different from Norwegian diphthongs
- little exposure of written Saami

Misspellings

- errors of performance
- errors of competence

Corder 1967. Errors in language learning and use: exploring error analysis. Longman. 129pp

- Substance errors (errors in encoding/decoding)
  - a vs. á, special letters: š č ž đ ŋ
- Text errors (usage)
  - suprasegmental processes like vowel harmony and consonant gradation:
    (*viessu* Sg Ill → *vissui* vs *viessui*)

James C. 1998. Errors in language learning and use: exploring error analysis. Longman. 129pp

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- Substance errors (errors in encoding/decoding)
  - a vs. á, special letters: š č ž đ ŋ
    morphologically irrelevant, but still systematic
- Text errors (usage)
  - suprasegmental processes like vowel harmony and consonant gradation
    morphologically relevant, and systematic

Feedback

Many kinds of feedback

1. something is wrong in the sentence
2. highlightening
3. provide the target word or a list of possible words
4. metalinguistic feedback → understand the reason for the misconception

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error of performance or competence?
Real word errors are a challenge for the computer for giving good feedback

Looking at L2 misspellings

Annotated L2 sentences with 739 misspellings
(corpus of sentences from the ICALL-program log and from student texts)

North Saami spellchecker (`http://divvun.no`)
– dictionary lookup (FST) and dynamic compounding
– designed for native speakers

L2-texts:

- precision 0.92, recall 0.74

The problems of the spellchecker and L2 misspellings

- False negatives – real word errors
- Generating and ranking of candidates

Generating and ranking of candidates

error model based on edit distance –
These operations give an edit distance of 1:

- deletion of a character
- insertion of a character
- change of a character
- transposition of two characters

Damerau 1964/Levenstein 1965.

Average error distance: L2=1.54 vs. L1=1.23

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In addition phonetic rules, which rank errors based upon phonetic likelihood, and can to some extent override the edit distance.

L2: Ranking of candidates

true positives	correct cand. among top 3	correct cand. but not among top 3	no correct candidate
563 = 99.9%	67.7% (85%)	12.3%	19.9%
aver. edit distance	1.39	1.59	2.74

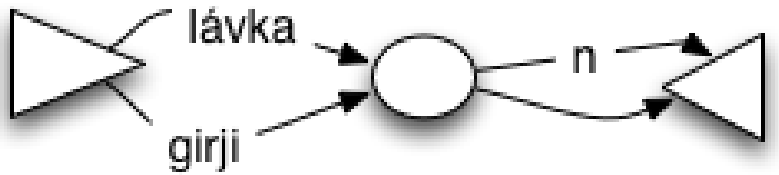
The order which the words appear in the suggestion list, seems to be an influencing factor for selecting one word over another Rimrott and Heift (2008b).

→ L2 student is probably not able to choose between a large number of candidates

→ appropriate help for 52% of the misspellings

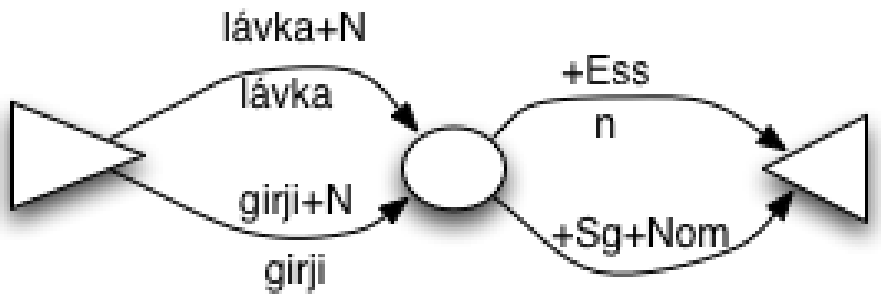
Modeling the morphology of the language

Finite-state automaton



lávka
girji
lávkan
girjin

Finite-state transducer



lávka+N+Sg lávka
girji+N+Sg girji
lávka+N+Ess lávkan
girji+N+Ess girjin

FST with erroneous forms

- ranking of suggestion candidates despite for big edit distance
- easier to detect real word errors in context-dependent word correcting
- possible to give metalinguistic comments about the morphological nature of the misspellings, both for non-word and real word errors.

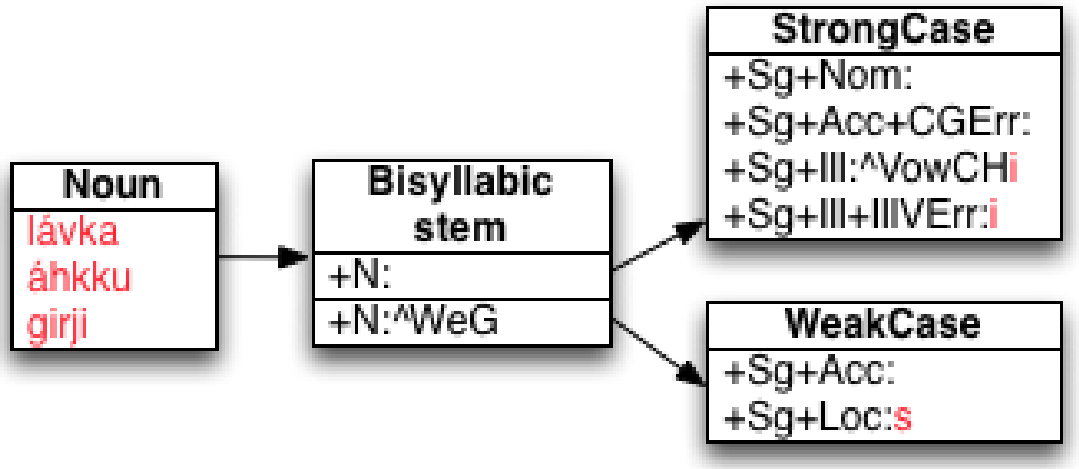
Systematic erroneous forms with errortags

1. to the lexical transducer: giving extra paths marked with errortags, e.g. CGErr
2. to the phonological transducer: change letters generally or under special conditions, e.g. á → a AErr
3. by concatenating transducers: all placenames with lowercase initial letter LowercaseErr

Extra paths to lexc

"<hivssegi>" "hivsset" N Sg Ill IllErr
"<hivssegii>" "hivsset" N Sg Ill
'to the toilet.N'

Extra paths to lexc



"<áhkku>" "áhkku" N Sg Acc CGErr
"<áhku>" "áhkku" N Sg Acc
"<girjái>" "girji" N Sg Ill
"<girjii>" "girji" N Sg Ill IllVErr

Phonological transducer (twolc)

ss → s, rj → rjj, ... || _ Vow* WeG ;
i → á || _ VowCH ;

Extra paths to twolc

Add tag to both sides in the Lexc.
Change á => a if there is a tag.
Remove the tag in the lower side if á => a.

"From longA to shortA"
á:a => _ :* %+AErr:0 ;

"Only if A is changed"
%+AErr:0 => á:a :* _ ;

Concatenating transducers

Placenames with lowercase initial letter

[A -> a ,
B -> b , ...

[%+Prop %+LowercaseErr <- %+Prop] ;

Error tags for systematical misspellings

"<áhkku>" "áhkku" N Sg Nom
"<áhkku>" "áhkku" CGErr N Sg Acc
áhku ‘grandmother.Acc’

"<barru>" "bárru" N Sg Nom AErr
bárru ‘wave’
"<viessui>" "viessu" N Sg Ill DiphErr
vissui ‘to the house’

"<londonis>" "London" N Prop LowercaseErr Plc Sg Loc
Londonis ‘in London’

Disambiguation with Constraint Grammar

```
"<Gos>"
    "gos" Adv
"<du>"
    "don" Pron Pers Sg2 Gen
"<áhkku>"
    "áhkku" N Sg Nom
"<orru>"
    "orrut" V IV Ind Prs Sg3
"<qdl>"
    "qdl" QDL
```

```
"<Mu>"
    "mun" Pron Pers Sg1 Gen
"<ahkku>"
    "áhkku" CGErr Sg Acc AErr
    "áhkku" CGErr Sg Gen AErr
→   "áhkku" N Sg Nom AErr ←
"<orru>"
    "orrut" V IV Ind Prs Sg3
"<chicagos>"
    "Chicago" N Prop LowercaseErr Sg Loc
```

‘Where does your grandmother live? My grandmother lives in Chicago.’

Recognized misspellings

error tag	erronous form	targetform	
Lowercase	"<londonis>"	Londonis	'London.SgLoc'
AErr	"<manna>"	mánná	'child.SgNom'
AiErr	"<boahtan>"	boahtán	'come.V.PrfPrc'
CGErr	"<skuvlas>"	skuvllas	'school.SgLoc'
DiphErr	"<viessui>"	vissui	'house.SgIll'
IllVErr	"<skuvlai>"	skuvlii	'school.SgIll'
IllErr	"<hivssegi>"	hivssegii	'toilet.SgIll'

and also the combination of these:
"<fallejohkas>" "Fállejohka" N Prop LowercaseErr CGErr Sg Loc AErr
Fállejogas placename.Loc
edit distance: 4

Erroneous forms in the student's input.

```
"<Ahkku>"
 "Ahkku" ?
"<manná>"
 "mannat" V IV Ind Prs Sg3
"<lundii>"
 "lundii" ?
"<odne>"
 "odne" Adv
```

Figure 5: 'Grandmother goes to Lund today.' analysed with the regular FST.

Erroneous forms in the student's input.

```
"<Ahkku>"
 "áhkku"  CGErr Sg Acc AErr
 "áhkku"  CGErr Sg Gen AErr
 "áhkku" N Sg Nom AErr        <- correct
"<manná>"
 "mannat" V IV Ind Prs Sg3    <- correct
 "mánná" Hum N Sg Nom AErr
 "mánná" Hum N CGErr Sg Acc AErr
 "mánná" Hum N CGErr Sg Gen AErr
"<lundii>"
 "Lund" N Prop LowercaseErr Plc Sg Ill
"<odne>"
 "odne" Adv
```

Analysed with an FST enriched with erroneous forms.

Testing a part of the log: Erroneous forms in word analyses

Testing with 2705 qa-pairs from the log.

errortag	before disambiguation	after disambiguation
CGErr in nouns	1786	113
AErr	1395	524
Lowercase	534	65
AiErr in verbs	214	95
IIIVErr	74	27
IIIErr	28	28
DiphErr in nouns	22	16

Analyses: 74,517 $\rightarrow$ 83,582 (12.1%), per wordform: 2.26 $\rightarrow$ 2.54.
The disambiguation is not complete, constraint grammar rules decide if there will be given an error feedback to the student.

Testing a part of the log: Looking at word analyses

"recognized" = the system knows the target form

Errors The target form was	**Reg.FST.**		**Err.FST**	
not recognised	871	91.9%	563	56.0%
recognized	77	8.1%	443	44.0%
Total	948	100%	1006	100%

Table: Parsing 2705 qa-pairs. Comparing the regular FST with the error-FST.

Testing a part of the log: Feedback to answers

	Reg.FST	**Err.FST**
Misspellings	751	804
Syntactic errors	1181	1071
Comments on semantics	599	527
Altogether	2531	2402
Number of sentences giving feedback on errors	1560	1561

Table: Parsing 2705 qa-pairs. Some sentences have more than one error feedback. Prec=0.96 Rec=0.99 for both FSTs

Finite verb or not

"<vuolggan>"
"vuolgga" N Ess ‘departure’
"vuolgit" V IV Ind Prs AiErr Sg1 ‘I leave’

System-student interaction

1. Mun manan hoteallii
   'I go to the hotel.Ill.misspelled.'
   - "hoteallii" misses diphthong simplification
2. Mun manan hotellii

The size of the FSTs

	Reg.FST	**Err.FST**
size	41.5 Mb	398.8 Mb
	100%	959%
states	497,632	4,739,590
arcs	1,062,995	10,297,121

Table: The size of the regular FST and the error-FST.

The compilation time increases with 570 %, e.g. on a MacBook Pro (OS 10.6.8) from 3.5 minutes to 23.5 minutes.
It is possible to remove very marginal compoundings and derivations.

Conclusion

Adding grammatical misspellings to the finite state transducer

- Recognizes both non-word and real word errors
  - Recognizes 47.7 % of the misspellings (increasing from 9.1 %)
  - Handles big edit distances better than the spell checker
- Even if the number of analysis increases from 2.26 to 2.54 per wordform, it does not ruin the disambiguation
- Makes it possible to give tutorial feedback to the student (or even to ignore the misspelling)
- We will look more into the system-student interaction

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