Constraints in Free-input Question-Answering Drills

Lene Antonsen
Centre for Saami Language Technology
http://giellatekno.uit.no/

Contents

Background

- Our Question-Answering drills have been available on the Internet since 2009
- 2011: We started improving the system
- 2012: We started integrating it into the university's introductory courses

Antonsen, L., Huhmarniemi, S., and Trosterud, T. (2009). Constraint grammar in dialogue systems. In Proc. of the 17th Nordic Conference of Computational Linguistics, volume 8 of NEALT Proceeding Series.

Motivation

- ► Language tutoring system with error analysis
- ► Immediate metalinguistic feedback
- ► Focus on Form (Long, 1991)
- ► Formal rule teaching is necessary for adult language learners (Keyser 1995, 2000)

Challenges

- avoid long instructions in the learners' L1 but still constrain the learner input so that it can be analysed well enough
- give appropriate feedback to the learner
- make it interesting for the learner
- overcome the learners' avoidance of complex constructions
- overcome the problem with the learners' misspellings that make the human-computer interaction more difficult and less interesting for them
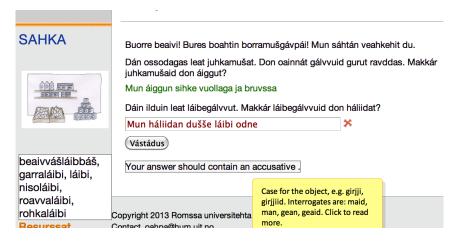
Oahpa

The Question-Answering drills

- ▶ Dialogue QA-drill: 6 dialogues with ready-made questions
  - ▶ getting acquainted (usual small talk)
  - ▶ car talk (small talk for fun)
  - ▶ visit: having coffee or tea together (accusative vs. nominative)
  - ▶ visit: helping a friend moving furniture (illative vs. locative + dualis)
  - ▶ shopping: buying groceries (accusative vs. nominative)
  - ▶ shopping: comparing prices (adjective comparison)
- ▶ Generated QA-drill
  - ▶ Questions are generated and come randomly
  - ▶ Questions are grouped according to level
- ▶ Constraints for both types
  - ▶ answer with a full sentence, use the same verb as in the question

Dialogue QA-drill

SAHKA

Buorre beaivi! Bures boahtin borramušgávpái! Mun sáhtán veahkehit du.

Dán ossodagas leat juhkamušat. Don oainnát gálvvuid gurut ravddas. Makkár juhkamušaid don áiggut?

Mun áiggun sihke vuollaga ja bruvssa

Dáin ilduin leat láibegálvvut. Makkár láibegálvvuid don háliidat?

Mun háliidan dušše láibi odne ✖

[Vástádus]

Your answer should contain an accusative .

beaivvášláibbáš,
garraláibi, láibi,
nisoláibi,
roavvaláibi,
rohkaláibi

Case for the object, e.g. girjji, girjjiid. Interrogates are: maid, man, gean, geaid. Click to read more.

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Generating questions

```
<question>
  <text>Maid SUBJ MAINV oastit</text>
  <element id="SUBJ">
<grammar pos="N"/>
<sem class="PROFESSION"/>
  </element>
  <element id="MAINV">
<id>áigut</id>
<grammar tag="V+Ind+Person-Number"/>
  </element>
</question>
```
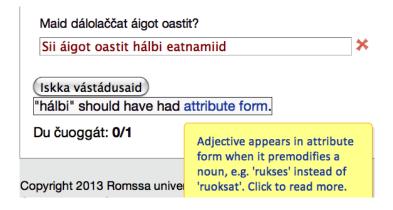
Maid x áigut-INFL oastit? 'What x want-INFL to buy?'

Generated QA-drill

Maid dálolaččat áigot oastit?

Sii áigot oastit hálbi eatnamiid ✖

(Iskka vástádusaid)
"hálbi" should have had attribute form.

Du čuoggát: **0/1**

Adjective appears in attribute
form when it premodifies a
noun, e.g. 'rukses' instead of
'ruoksat'. Click to read more.

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'What the farmers want to buy? They want to buy cheap land.'

Problems

The logs reveal, however, that the students will not write more complex language than they have to.

The solution: Constrained generated QA-drill

Gean deivet gáffádagas? Mun deaivat suohtas skibir .

Mun deivet suohtas skihpára ✖

Iskka vástádusaid

Remember agreement between subject and verbal.

Du čuoggát

The verb is conjugated to correlate for person and number of the subject, e.g. Mun boađán. Click to read more.

'Who did you meet at the cafe?' 'I meet, funny, friend'

Possible answers

- Gean deivet gáffádagas? Mun deaivat suohtas skibir
- Mun deiven suohtas skihpára.
  'I met a funny friend.'
- Mun han deiven iežan suohtas skihpára.
  'I (emph) met my funny friend.'
- Ikte mun vuot deiven iežan suohtas skihpára.
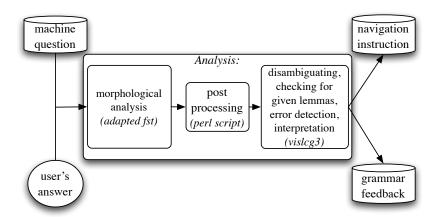 'Yesterday I again met my funny friend.'

Generating tasks

*<text>*Gean MAINV gáffadagas*</text>*
*<text>*Mun MAINV ADJ NOUN*</text>*

- MAINV: \<grammar tag="V+Inf"/\> \<id\>deaivat\</id\>
- ADJ: \<grammar tag="A+Sg+Nom"/\>
  \<sem class="HUMAN-ADJ"/\> (45)
- NOUN: \<grammar tag="N+Sg+Nom"/\>
  \<sem class="HUMAN"/\>: (44)

1980 different exercises

The system and the analysers

Morphological analyser

- finite state transducers (FST)
- Xerox compilation tools
- 110.000 lemmas (almost half of them are proper nouns)

Constraint grammar

- vislcg3
- North Saami: F-score of 0.99 for PoS disambiguation, 0.94 for disambiguation of inflection and derivation, and 0.93 for assignment of grammatical functions
- in the same rule set
  - 872 rules disambiguate the QA-pair to a certain extent
  - 247 rules for grammar errors and navigating

Implicit feedback

Buorre beaivi! Bures boahtin mu geahčai! Suohtas oaidnit du!

Dál moai gáfestalle. Manne go stohpui?

Juo, moai manne dohko

De manne stohpui.
Mun lean okto ruovttus odne.

Háliidat go gáfe vai deaja?

Mun háliidan deaja

Háliidat go honnega?

[   ]

(Vástádus)

Navigating with Constraint Grammar

```
"<Háliidat>"
    "háliidit" V TV Ind Prs Sg2
"<go>"
    "go" Qst Pcle
"<gáfe>"
    "gáffe" Plant N Sg Acc
"<vai>"
    "vai" CS
    "vai" CC
"<deaja>"
    "deadja" N Sg Acc
"<^sahka>"
    "^sahka" QDL Haliidat_go_gafe_vai_deaja &dia-pos
"<Mun>"
    "mun" Pron Pers Sg1 Nom
"<háliidan>"
    "háliidit" V TV Ind Prs Sg1
"<deaja>"
    "deadja" N Sg Acc &dia-target &dia-tea
"<.>"
    "." CLB
```

Rules for navigating

```
ADD (&dia-target) TARGET NP-HEAD + Acc
IF (*−1 QDL BARRIER Neg
LINK *−1 TARGETQUESTION-ACC)
(NEGATE 0 Gen LINK 1 N) ;


ADD (&dia-tea) TARGET N
(0 ("deadja") OR ("teadja")
LINK 0 (&dia-target)) ;
```

Navigating to the relevant next question

```
<text>Háliidat go gáfe vai deaja?</text>
<alt target="coffee" link="sugar_question"/>
<alt target="tea" link="honey_question"/>
<alt target="negative"
link="drink_something_else_question"/>
<alt target="default"> link="next_topic"/>
```

Feedback on grammar error with Constraint Grammar

Gean deivet gáffádagas? Mun deaivat suohtas skibir .

Mun deivet suohtas skihpára ✖

(Iskka vástádusaid)

Remember agreement between subject and verbal.

Du čuoggát

The verb is conjugated to correlate for person and number of the subject, e.g. Mun boađán. Click to read more.

'Who did you meet at the cafe?' 'I meet, funny, friend'

Analysis

```
"<Gean>"
    "gii" Pron Interr Sg Acc
"<deivet>"
    "deaivat" V TV Imprt Pl2
    "deaivat" V TV Ind Prt Sg2
"<gáffádagas>"
    "gáffádat" Org N Sg Loc
"<^vastas>"
    "^vastas" QDL
    "deaivat" V
    "suohtas" A
    "skibir" N
"<Mun>"
    "mun" Pron Pers Sg1 Nom
"<deivet>"
    "deaivat" V TV Ind Prt Sg2 &grm-non-agr-subj-v
"<suohtas>"
    "suohtas" A Attr
"<skihpára>"
    "skibir" Hum N Sg Acc
"<.>"
```

Rule for detecting grammar errors

```
MAP (&grm-non-agr-subj-v) TARGET VFIN IF
(0 $$PERSON-NUMBER-TAG
LINK -1 (Pers Nom) - $$PERSON-NUMBER-TAG
LINK *-1 QDL) ;
```

Grammar errors for which we have rules

- ▶ verbs: finite, infinite, negative form, correct person/tense according to the question
- ▶ agreement: subject/verbal, NP-internal
- ▶ case of argument and PP based upon the interrogative and valency
- ▶ time expressions, some special adverbs, particles according to word order
- ▶ comparison of adjectives

Analysis

```
"<Gean>"
    "gii" Pron Interr Sg Acc
"<deivet>"
    "deaivat" V TV Imprt Pl2
    "deaivat" V TV Ind Prt Sg2
"<gáffádagas>"
    "gáffádat" Org N Sg Loc
"<^vastas>"
    "^vastas" QDL
    "deaivat" V
    "suohtas" A
    "skibir" N
"<Mun>"
    "mun" Pron Pers Sg1 Nom
"<deivet>"
    "deaivat" V TV Ind Prt Sg2 &grm-non-agr-subj-v
"<suohtas>"
    "suohtas" A Attr
"<skihpára>"
    "skibir" Hum N Sg Acc
"<.>"
```

Meta comments with Constraint Grammar

```
LIST ADJ-LEMMA = (".*"r A) ;

MAP (&not-same-adj) TARGET $$ADJ-LEMMA
(0 ("^vastas") LINK NOT *1 $$ADJ-LEMMA) ;
```

→ "You must use the given adjective."

Better handling of misspellings

Geasa don attát gáffaliid?

Mun attan daid dálueamidii

(Iskka vástádusaid)
You might have forgotten to write á in "attan"

'To whom do you give the forks? I give them to the housewife.'

Erroneous forms in FST: typical L2 misspellings

"<attan>" "addit" V TV Ind Prs Sg1 AiErr 'to give'
        (targetform: attán)
"<attan>" "atta" N Ess 'something given'

Human-Computer interaction

Boađát go odne? ('Do you come today?')		
user's input		**System's feedback**
In sáhtte boahtit odne. 'I don't "can" come today.'	0	"sáhtte" has wrong form. It comes after the negation verb and should have negation form.
In sáhte boahtit odne. 'I cannot come today.'	1	

Human-Computer interaction

Lea go dus heasta? ('Do you have a horse?')		
user's input		**System's feedback**
*mus **in** leat heasta* 'I don't.Sg1 have a horse'	0	Are you confident that you answer in correct person?
*mus **in** lean heasta* 'I don't.Sg1 have.Sg1=PrtConNeg a horse'	0	Are you confident that you answer in correct tense?
*mus **in** lea heasta* 'I don't.Sg1 have.Sg3 a horse'	0	The verb should have negation form.
mus ii leat heasta 'I don't.Sg3 have.Sg3 a horse'	1	

Evaluation

- ▶ What rules are in use
- ▶ Precision and recall for feedback
- ▶ Students' responses

Evaluation: The rules

	Other QA-drills		Constrained QA-drill	
CG rule type	N	%	N	%
misspellings	307	37.5 %	329	43.7 %
no finite verb	145	17.7 %	10	1.3 %
wrong case/number	102	12.5 %	133	17.7 %
verbal-subject agreement	94	11.5 %	75	10.0 %
metacomments	89	10.9 %	119	15.8 %
wrong verb form	35	4.3 %	36	4.8 %
NumP internal agreement	27	3.3 %	22	2.9 %
other	12	1.5 %	3	0.4 %
NP internal agreement	7	0.9 %	26	3.5 %
altogether	818	100.1 %	753	100.1 %

Table: Rules in use for a corpus of logged 2834 question-answer pairs.

Evaluation: The rules

- ▶ the Constrained QA-drill makes the users form more complex sentences, with finite verb and more complex NPs, than the unconstrained QA-drills

Evaluation: Precision and recall

	True pos.	True pos. but not correct feedback	False pos.	True neg.	False neg.	Prec.	Rec.
Not constr. QA-drills N=982	493	44 = 8.9 %	36	439	12	0.932	0.976
Constr. QA-drill N=1114	749	72 = 9.6 %	3	352	9	0.996	0.988

Lessons from the log

- ▶ Mismatch between metalinguistic information and the user
- ▶ Dialogue length: 28 questions are too long → 8–14 questions

Students' responses

- ▶ Key for answers?
    - ▶ Dialogue-QA: example answer after second time
    - ▶ Generated QAs: Key has to be generated
- ▶ Audio files?
    - ▶ Dialogue-QA: Questions can be recorded
    - ▶ Generated QAs: Text-to-speech
- ▶ Mismatch between users and meta-linguistic feedback
    - ▶ Individualized feedback?
    - ▶ Require login? or ask for age?

Conclusion

- ▶ CG is very flexible – the same rule set can disambiguate, add tags for navigation, find grammar errors and also cope with different kinds of generated exercises
- ▶ CG can analyse the student's free input with very good precision and recall
- ▶ Constraining the input with given lemmas to build their answer is a way of getting the learners to write more complex language
- ▶ Constraints can be good, instead of trying to give the impression of a real-life conversation

Thanks to Heli Uibo and Trond Trosterud, and Norway Opening Universities
Giitu! – Thank you for listening!