A Pilot Study on three Germanic Languages

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Introduction

- Grammar Matrix Word Order Library
  - Going towards bottom-up approach
  - What analyses to add?
- Alternative Analyses
  - When there is more than one way to analyze a phenomenon, which do you pick?

Criteria to choose among analyses

- Ability to account for the data
- Interaction with other phenomena
  - Predictions
  - Necessary adaptations of present implementation
  - Extendability
- Efficiency
- Simplicity/elegance
- Theoretical soundness

When looking at Library Analyses

Primary criteria

- Ability to account for data
- Interaction with present implementations

Also important

- Extendability (simplicity, accomodating for known phenomena)
- Efficiency

Theoretical soundness

- Important that the grammar creates correct MRS representations
- Linguistic theory may provide good analyses for phenomena

$\Rightarrow$ it is important for inspiration

- Analyses are more likely to be known by the grammar engineer
- Interaction with other (non-implemented) phenomena may be investigated (in theory)

$\Rightarrow$ it can be advantageous for extendability

But theoretical motivations can differ from engineering motivations

Comparing Analyses

- Can they account for the data?
- Can they be added to the customization system without breaking other libraries?
- Parsing efficiency
  - CPU time (of possible)
  - Space
  - Edges
  - Tasks
- Generation efficiency
  - Number of edges necessary to generate from a given string
- Can they easily be fine-tuned or extended to account for new phenoma?

$\Rightarrow$ Problem: how to evaluate?

The overall idea

1. Create several threads of the matrix customization system
2. Threads provide alternative analyses that can account for the same data
3. Evaluate efficiency of grammar with the same phenomena
   - Evaluation of test-data
   - Corpus evaluation (or simulation of relative frequency)
4. Extend the grammars to account for additional phenomena
5. Evaluate the extended grammars

The pilot study

- Verb-secondness is handled using the feature $\left[\text{MC } na\right]$ to register the position of the verb
- Two analyses for auxiliaries
- Toy grammars for Danish, German and Dutch
- Evaluation of parsing efficiency for clauses with upto four auxiliaries
- Generation evaluation with upto four auxiliaries for Danish and German, and upto three auxiliaries for Dutch

Alternative analyses (simplified): analysis 1

- Similar to the “standard” HPSG analysis: the auxiliary raises all complements of its verbal complement:
  - Auxiliary lexical entry:

$$\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SUBJ} & \langle \boxed{1} \rangle \\ \text{COMPS} & \langle \boxed{2} \oplus \boxed{3} \rangle \end{bmatrix} \\ \text{ARG-STR} & \langle \boxed{1}, \boxed{2} \begin{bmatrix} \text{VAL}|\text{COMPS} & \boxed{3} \end{bmatrix} \rangle \end{bmatrix}$$

- Problem: the complement list of the auxiliary is underspecified until the auxiliary combines with its complement

Alternative analyses (simplified): analysis 2

- Alternative proposal from Dan: the auxiliary only selects for its verbal complement, a rule makes sure complements are raised if necessary
  - Auxiliary lexical entry:

$$\begin{bmatrix} \text{VAL} & \begin{bmatrix} \text{SUBJ} & \langle\,\rangle \\ \text{COMPS} & \langle \begin{bmatrix} \text{HEAD} & \textit{verb} \end{bmatrix} \rangle \end{bmatrix} \end{bmatrix}$$

  - Auxiliary+verb syntax rule:

$$\begin{bmatrix} \text{VAL} & \boxed{1} \\ \text{HEAD-DTR} & \begin{bmatrix} \text{HEAD} & \textit{verb} \begin{bmatrix} \text{AUX} & + \end{bmatrix} \\ \text{VAL} & \begin{bmatrix} \text{COMPS} & \langle \begin{bmatrix} \text{HEAD} & \textit{verb} \end{bmatrix} \rangle \end{bmatrix} \end{bmatrix} \\ \text{NONHEAD-DTR} & \begin{bmatrix} \text{HEAD} & \textit{verb} \\ \text{VAL} & \boxed{1} \end{bmatrix} \end{bmatrix}$$

The data

- Main clauses with intransitive and transitive verbs
- All three languages are verb-second languages with verbal complements appearing clause-final
- All allow VP-fronting (VP appearing in first position)
- Word order constraints within the verbal group vary

Danish

- Verbal cluster is pre-objectival
- Verbs precede their complement in the verbal group
- No partial VP fronting allowed

1st constituent	fin-verb	'mittelfeld'	verbal group
Subj	Aux1		Aux2 MainVerb Obj
Obj	Aux1	Subj	Aux2 MainVerb
Aux2 MainVerb Obj	Aux1	Subj	
MainVerb Obj	Aux1	Subj	Aux2

German

- Verbal cluster is really final
- Verbs follow their complement in the verbal group
- Partial VP fronting allowed

1st constituent	fin-verb	'mittelfeld'	verbal group
Subj	Aux1	Obj	MainVerb Aux2
Obj	Aux1	Subj	MainVerb Aux2
Obj MainVerb Aux2	Aux1	Subj	
MainVerb Aux2	Aux1	Subj Obj	
Obj MainVerb	Aux1	Subj	Aux2
MainVerb Aux1	Subj Obj	Aux2	

Dutch

- Verbal cluster is really final
- Partial VP fronting allowed
- Four types of 'auxiliaries':
  - Verbs that appear on either side of their vcomp
  - Verbs that must precede their vcomp when infinitive, but else may appear on either side
  - Verbs that must follow their vcomp when participle, but else may appear on either side
  - Verbs that must precede their vcomp

Evaluation: step 1

Can both analyses handle all data?

- The argument-raising analysis can
- The auxiliary+verb-rule analysis has problems with examples such as the following:

bezoeken	zou	hij	ze	nog wel	kunnen
visit	would	he	them	still indeed	can

“he’d still be able to visit them, though”

Extending the auxiliary+verb-rule analysis

- To account for these examples, we add two rules to the grammar:
  1. A rule that allows the auxiliary in second position to combine with a (partial) VP even if the main verb is not in the correct form
  2. A rule that inserts the auxiliary at the end of the clause at the correct position in the MRS-representation
- This works, but does not score well on simplicity (and possibly extendability)

Four grammars for each language

- All grammars use $\begin{bmatrix} \text{MC} & na \end{bmatrix}$ for verb secondness
- Two grammars for both auxiliary analyses:
  - One that excludes auxiliaries at three locations
  - One that covers all data

Evaluation: parsing

- Testdata, intransitive and transitive main verbs with different numbers of auxiliaries:
  - Danish: 1022 (24 positive)
  - German: 1022 (36 positive)
  - Dutch: 2990 (153 positive)
- Evaluation criteria:
  - Space
  - Tasks
  - Edges

Observations

- For German, the auxiliary+verb rule outperforms argument compositionality
- For negative examples, auxiliary+verb outperforms argument compositionality
- For Danish and Dutch, space and tasks outperform in argument compositionality for positive examples
- Auxiliary+verb is catching up when sentence length increases

Results on Generation

	num of aux	Required edges aux-verb	aux-verb-ext	arg comp
Da	2	1,000	1,000	2,500
	3	2,000	3,500	10,500
	4	7,000	19,000	fail
Ge	2	1,000	2,000	3,000
	3	3,500	8,000	15,000
	4	14,000	fail	fail
Du	2	2,000	3,000	1,000
	3	15,000	fail	7,000

Table: Performance on Generation

Observations on Generation

- For Danish and German, the auxiliary+verb analysis outperforms argument compositionality
- For Dutch, it's the other way around $\rightarrow$ probably due to a difference in handling word order
- Dutch sentences where the verb enforces cross-serial dependencies are most efficient in generation (from an additional evaluation)

Next steps

- Make threads of the customization system with different analyses
- Add threads with head-filler analysis (following theoretical HPSG) for verb-secondness (include filler-release)
- Create bigger grammars and 'real' grammars:
  - 'test' extendability
  - investigate effects of bigger grammar and ambiguity
- Look at other (verb-second and free word order) languages
- Design an appropriate interface...

Feedback?

THANK YOU!