Evaluating a German Sketch Grammar:  
A Case Study on Noun Phrase Case

Kremena Ivanova*, Ulrich Heid*, Sabine Schulte im Walde*,  
Adam Kilgarriff○, Jan Pomikálek○▷

*Institute for Natural Language Processing, University of Stuttgart, Germany  
○Lexical Computing Ltd, Brighton, UK  
▷Masaryk University, Brno, Czech Republic

{ivanovka, heid, schulte}@ims.uni-stuttgart.de,  
adam@lexmasterclass.com, xpomikal@fi.muni.cz

Marrakech, Morocco, May 28, 2008
The Sketch Engine (Kilgarriff et al. 2004)
A system for corpus exploration

• Input: preprocessed corpora, e.g. tokenized, POS-tagged, lemmatized, ...

• Functions:
  – concordancing
  – collocation extraction with a sketch grammar, i.e. a set of regular expression search patterns over the corpus

• Output: Word sketches
  Sets of significant word pairs, grouped by grammatical relations, e.g. adjective + noun, verb + subject noun, coordinated elements, etc.
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The Sketch Engine – word sketches
A sample word sketch: collection of cooccurrence data

Node word + ‘collocates’:
Word sketch for verb *öffnen* ‘open’:
Lemma of cooccurrence partner – frequency (in BNC) – significance

<table>
<thead>
<tr>
<th>subj</th>
<th>subj</th>
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<td>10</td>
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<td>Tor</td>
<td>4</td>
<td>11.7</td>
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<td></td>
<td></td>
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</tbody>
</table>

Source: *DeWaC*, 10 million words
Sketch Grammars

Regular expression-based: sequence patterns

Example:

• Adjective + Noun combination:
  2:[tag="ADJA"] 1:[tag="NN"]

– finds sequences adjective + noun
– counts frequency, calculates significance
– allows for display of pair in list of adjective collocates of a given noun (1:...), e.g.

  klein
  'small'
  274
  37.68

• Modified nouns

  Ausschnitt
  'extract'
  188
  37.49

  Junge
  'boy'
  325
  33.91

  Dorf
  'village'
  274
  32.80

  Meerjungfrau
  'mermaid'
  46
  31.19

Simple model of a noun phrase as a POS sequence:

DET? ADV* ADJA* NOUN

Ivanova et al. (LREC 2008)
Sketch Grammars
Regular expression-based: sequence patterns

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* list of noun nodes of a given adjective (2:...), e.g. *klein*

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Identifying grammatical relations, e.g. verb + object noun
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• EN (configurational): by position wrt the verb:
  Subject < Verb < Object  
  (Kilgarriff et al. 2004)
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Identifying grammatical relations, e.g. verb + object noun

- EN (configurational): by position wrt the verb: Subject < Verb < Object  (Kilgarriff et al. 2004)
- CHI: by position and particles  (Kilgarriff 2005)

- CZ, SLO (inflecting): by inflectional affixes:
  - SLO l´ epa h ´ ıˇ sa  (NOM-SG)
  - l´ epi h ´ ıˇ si  (DAT-SG | LOC-SG (+ Prep.) (Kilgarriff et al. 2004, Krek/Kilgarriff 2006)

Ivanova et al. (LREC 2008)  German Sketch Grammar
Sketch Grammars
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- CZ, SLO (inflecting): by inflectional affixes:
  SLO lépa híša (“beautiful house”): NOM-SG
  lépi híši: DAT-SG | LOC-SG (+ Prep.)
  (Kilgarriff et al. 2004, Krek/Kilgarriff 2006)
Sketch Grammars
Identifying grammatical relations in German texts

• not via word order:
  den Mitarbeiter Acc
  lobt der Chef Nom
  ("the boss speaks highly of the collaborator")

• not often via inflection:
  Hans Nom/Acc
  lobt Maria Nom/Acc
  weil der Chef Acc
der Firma Gen/Dat
  in Berlin PP
  empfahl, . . . zu . . .

Only ca. 21% of all NPs are unambiguous wrt case (Evert 2004)

⇒ harder than in other languages
Sketch Grammars
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A Sketch Grammar for German
Knowledge for the identification of grammatical relations

1 \{gender, number, case\} of nouns $\leftrightarrow$ inflectional affixes
A Sketch Grammar for German
Knowledge for the identification of grammatical relations

1. \{gender, number, case\} of nouns $\leftrightarrow$ inflectional affixes
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A Sketch Grammar for German
Knowledge for the identification of grammatical relations

1. \{gender, number, case\} of nouns $\leftrightarrow$ inflectional affixes
2. Preferential constituent ordering:
   verb-final constituent order model is more regular than others
3. Constraints on subcategorization patterns, e.g.
   ‘No two identical grammatical functions in one sentence’
   (cf. ‘coherence’ in LFG)
A Sketch Grammar for German
Proportion between preprocessing (offline) and query (online)

1. Gender, number, case:
   not annotated: STTS: "NN" (UPenn: "NNS" – "NNP")
   → Need to identify these within the sketch grammar

2. Preferential constituent ordering under V-final:
   → Search in a subset of the corpus sentences

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⇒ To assess usefulness of these types of information: Different versions of the sketch grammar which include the different types of information
A Sketch Grammar for German
Versions of the grammar with different types of information (1/2)
Conditions for the evaluation

Morphological restrictions: alternatives
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- **inflection:**
  case guessing from the form of affixes (affix sequences)

  \[
  \text{dem}_{\text{Dat}} \ \text{kleine}_n_{\text{Dat}} \ \text{Haus}_{\text{Nom/Dat/Acc}}
  \]
Morphological restrictions: alternatives

- **inflection:**
  case guessing from the form of affixes (affix sequences)
  \[dem_{Dat} \textit{kleine}n_{Dat} \textit{Haus}_{Nom/Dat/Acc}\]

- **affix-gender:**
  case and gender guessing
  from derivational affixes and inflectional affixes
  \[den_{ACC-SG-MASC/DAT-PL-FEM} \textit{Schwierigkeiten}_{ANY-PL-FEM}\]
  \[\Rightarrow\] subset of nouns with known agreement properties
A Sketch Grammar for German

Versions of the grammar with different types of information (2/2)

Conditions for the evaluation

Structural restrictions: alternatives
A Sketch Grammar for German

Versions of the grammar with different types of information (2/2)

Conditions for the evaluation

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A Sketch Grammar for German
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  extraction only from verb-final sentences (≡ subclauses),
  according to constraints on subcategorization patterns
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Conditions for the evaluation

Structural restrictions: alternatives

- **no-structure(-constraints):**
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- **verb-final:**
  extraction only from verb-final sentences (= subclauses),
  according to constraints on subcategorization patterns

- **all-clauses:**
  extraction from an explicit model of all verb position models
  (V1, V2, Vlast), according to subcategorization patterns
Evaluation: comparing versions of the Sketch Grammar
Combining the restrictions

<table>
<thead>
<tr>
<th>no affix-gender</th>
<th>no structure</th>
<th>verb-final (R)</th>
<th>all-clauses (R)</th>
</tr>
</thead>
</table>

inflection = minimum knowledge

(1) inflection + no-structure
(2) inflection + affix-gender + no-structure
(3) inflection + verb-final
(4) inflection + affix-gender + verb-final
(5) inflection + all-clauses
(6) inflection + affix-gender + all-clauses

- fewest restrictions (R)
- structural restrictions (R)
- most restr. (R)
Evaluation: comparing versions of the Sketch Grammar

Gold standard corpus

- 1000 randomly selected sentences from DeWaC

Example:

Ich musste meine Arbeit schon sehr gut machen, um anerkannt zu werden. 'I had to do my work really well to be approved.'
Evaluation: comparing versions of the Sketch Grammar
Gold standard corpus

- 1000 randomly selected sentences from DeWaC
- Manual annotation for NP (one annotator):
  - start and end point
  - case
- Example:
  \[
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  ‘I had to do my work really well to be approved.’
• Figures: NPs in the 1000 sentences

<table>
<thead>
<tr>
<th>Case</th>
<th>Count</th>
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<tbody>
<tr>
<td>Nominative</td>
<td>1,709</td>
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<tr>
<td>Genitive</td>
<td>437</td>
</tr>
<tr>
<td>Dative</td>
<td>149</td>
</tr>
<tr>
<td>Accusative</td>
<td>618</td>
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</tbody>
</table>
Evaluation: comparing versions of the Sketch Grammar
Results: recall and precision

Evaluated per case and per condition:
Exception: Genitive not implemented under conditions 3 + 4:
No verb with genitive object in the corpus, we only consider genitives in NPs

<table>
<thead>
<tr>
<th>Case</th>
<th>N</th>
<th>Conditions incl. <em>inflection</em></th>
<th>Conditions incl. <em>inflection</em> + affix-gender</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
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<tr>
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Ivanova et al. (LREC 2008)  German Sketch Grammar  5/28/2008
Evaluation: comparing versions of the Sketch Grammar
Recall vs. precision

<table>
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<tr>
<th>Case</th>
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- Condition 1 vs. condition 2: ⊕ precision ⊖ recall
  Adding derivation-based gender-guessing
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Recall vs. precision

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<tr>
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<td>Genitive</td>
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<td></td>
<td></td>
<td>60</td>
<td>82</td>
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</tbody>
</table>

- Condition 1 vs. condition 2: $\oplus$ precision $\ominus$ recall
  Adding derivation-based gender-guessing
- Condition 1 vs. 3, 2 vs. 4: $\oplus$ precision $\ominus$ recall
  Verb-final clauses: ca. 20% of all corpus sentences
  Stronger changes than in condition 1 vs. 2
Evaluation: comparing versions of the Sketch Grammar
Recall vs. precision

<table>
<thead>
<tr>
<th>Case</th>
<th>$N$</th>
<th>incl. inflection</th>
<th>incl. inflection + affix-gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>P</td>
<td>R</td>
</tr>
</tbody>
</table>
| Nominative| 1,709| 85               | 28          | 7    | 76   | 26   | 65   | 43   | 53   | 9    | 81   | 28   | 60
| Accusative| 618  | 64               | 24          | 6    | 37   | 18   | 41   | 51   | 30   | 6    | 35   | 14   | 45
| Dative    | 149  | 62               | 9           | 21   | 34   | 41   | 35   | 55   | 13   | 25   | 59   | 40   | 74
| Genitive  | 437  | 78               | 34          | 65   | 79   | 57   | 44   | 60   | 82   |

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- Cond. 4 vs. 6: better precision (!) and increased recall
  - recall: all-clauses is less restrictive than verb-final
  - precision: usefulness of explicit modelling?
Evaluation: comparing versions of the Sketch Grammar

Which German sketch grammar to choose?

So far: developer evaluation:

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- Best recall: condition 1: least constrained
- Best precision: condition 6: morph. + structural constraints
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User evaluation: “Clients” would have to decide (ongoing work)

- Lexicographers: need high-precision data (→ condition 6)
- NLP researchers: may prefer large amounts of candidates (→ cond. 1)

But: decision to be taken on Word Sketches, not on precision/recall
### Word sketch for noun *Pflanze* ‘plant’

<table>
<thead>
<tr>
<th>attr-adj</th>
<th>1566</th>
<th>2.0</th>
<th>subj-of</th>
<th>905</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>gentechnisch</em></td>
<td>94</td>
<td>47.14</td>
<td><em>wachsen</em></td>
<td>26</td>
<td>24.45</td>
</tr>
<tr>
<td><em>verändert</em></td>
<td>100</td>
<td>42.3</td>
<td><em>gedeihen</em></td>
<td>6</td>
<td>18.46</td>
</tr>
<tr>
<td><em>genmanipuliert</em></td>
<td>30</td>
<td>39.44</td>
<td><em>anbauen</em></td>
<td>5</td>
<td>18.30</td>
</tr>
<tr>
<td><em>fleischfressend</em></td>
<td>16</td>
<td>35.93</td>
<td><em>werden</em></td>
<td>73</td>
<td>15.91</td>
</tr>
<tr>
<td><em>transgenen</em></td>
<td>16</td>
<td>34.59</td>
<td><em>können</em></td>
<td>44</td>
<td>15.15</td>
</tr>
<tr>
<td><em>exotisch</em></td>
<td>24</td>
<td>30.00</td>
<td><em>sollen</em></td>
<td>30</td>
<td>15.03</td>
</tr>
<tr>
<td><em>transgener</em></td>
<td>8</td>
<td>28.45</td>
<td><em>gießen</em></td>
<td>4</td>
<td>14.52</td>
</tr>
</tbody>
</table>
Beyond the current state

We have presented

- a methodology for testing and evaluating (sketch) grammars for data extraction from corpora: applicable also to other languages
- a draft sketch grammar for German with different types and portions of linguistic knowledge

Ivanova et al. (LREC 2008)
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