Language Technologies

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Lecture III.
Computer Corpora

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Overview of the lecture

1. Background
2. Corpus compilation and markup
3. Morphosyntactic tagging

Background

- What is a corpus?
- Using corpora
- Characteristics of a corpus
- Typology of corpora
- History
- Slovene language corpora

A corpus is ~

- a large collection of texts
- in digital format
- language "as it is"
- a sample of the language it is meant to represent
- used for describing language (descriptive/empirical linguistics)

A more precise definition

- ***Corpus*** (plural ***corpora***) is Latin for *body*
- Guidelines of the Expert Advisory Group on Language Engineering Standards, EAGLES:
  - ***Corpus*** *: A collection of pieces of language that are selected and ordered according to explicit linguistic criteria in order to be used as a sample of the language.*
  - ***Computer corpus*** *: a corpus which is encoded in a standardised and homogeneous way for open-ended retrieval tasks. Its constituent pieces of language are documented as to their origins and provenance.*
- For computer scientists: a dataset

Using corpora

- Applied linguistics:
  - *Lexicography*: making dictionaries (first users of corpora)
  - *Translation studies*: translation equivalents with contexts translation memories, machine aided translations
  - *Language learning*: real-life examples, curriculum development
- Corpus linguistics:
  - linguistics based not on introspection, but on observation of real data
- *Language technology*:
  - testing set for developed methods;
  - *training set* for inductive learning (statistical Natural Language Processing)

Characteristics of a (good) corpus

- *Quantity*:
  the bigger, the better
- *Quality* :
  the texts are authentic; the mark-up is validated
- *Simplicity*:
  the computer representation is understandable, with the markup easily separated from the text
- *Documented*:
  the corpus contains bibliographic and other meta-data

Typology of corpora I.

- Medium:
  - *written language*
  - *spoken language* (spoken, but in writing / transcription)
  - *speech corpora* (actual speech signal)
- Content:
  - *reference* corpora (representative), e.g. BNC
  - *sub-language corpora* (specialised), e.g. COLT
- Structure:
  - corpora with *integral* texts
  - corpora or of text *samples* (historical and legal reasons) e.g. Brown

Typology of corpora II

- Time:
  - *static* corpora
  - *monitor* corpora (language change)
- Languages:
  - *monolingual* corpora
  - multilingual *parallel* corpora (e.g. Hansard, Europarl)
  - multilingual *comparable* corpora
- Annotation:
  - *plain text* corpora
  - *annotated* corpora

Reference corpora

- Characteristics:
  - a sample of the "complete" language
  - large, expensive, detailed and explicit design criteria
  - typically of contemporary language
  - documented and annotated
  - legaly clean, available
- Criteria for including texts:
  - representativeness:
    corpus includes "all" text types
  - balance:
    the sizes of text type samples are in proportion to their "importance" for the speakers of the language
- metodhodology v.s. practical constraints

History

History of Computational linguistics:

- 1950 -- 1960: empiricism
  weak computers:
  frequency lists
- 1970 -- 1980: cognitive modeling (generative approaches, artificial intelligence)
  deep analysis / "basic science": computational linguistics
- 1990 -- ...: empiricist revival, also combined approaches
  quantity / usefulness:
  language technologies
- 2000 -- ...: The Web

History of computer corpora:

- First milestones: Brown (1 million words) 1964; LOB (also 1M) 1974
- The spread of reference corpora: Cobuild Bank of English (monitor, 100..200..M) 1980; BNC (100M) 1995; Czech CNC (100M) 1998; Croatian HNK (100M) 1999...
- Slovene language reference corpora: FIDA (100M), Nova Beseda (100M...) 1998; FIDA+ (600M) 2006.
- EU corpus oriented projects in the '90: NERC, MULTEXT-East,...
- Language resources brokers: LDC 1992, ELRA 1995
- Web as Corpus (2000)
- more, larger, for more languages, with diverse annotations

Slovene language corpora

Monolingual reference corpora:

- ZRC SAZU: Beseda, 1998; Nova beseda, 2000-
- DZS, Amebis, FF, IJS: FIDA, 1998, FidaPlus, 2006

Parallel corpora:

- IJS: MULTEXT-East 1998--, IJS-ELAN 1999--, SVEZ-IJS, 2004, JRC-ACQUIS, 2006
- SVEZ: EuroKorpus
- FF: TRANS, 2002
- UP: Turist Corpus, 2008

Speech corpora:

- Laboratory for Digital Signal Processing, University of Maribor: SpeechDat, ONOMASTICA...
- Laboratory of Articifical Perception, Systems and Cybernetics, University of Ljubljana: SQEL, GOPOLIS,...

II. Compilation and markup of corpora

- Steps in the preparation of a corpus
- What annotation can be added to the text
- Computer coding of corpora
- Markup Methods

Before making your own corpus

check if an appropriate corpus is already available

- google
- corpora@lists.uib.no
- LDC, ELRA

Steps in the preparation of a corpus

1. Choosing the component texts and acquiring digital originals
2. Up-translation to standard format
3. Linguistic annotation
4. Documentation
5. Use and Dissemination

Getting the text

1. Choosing the component texts:
   linguistic and non-linguistic criteria; availability; simplicity; size
2. Copyright
   sensitivity of source (financial and privacy considerations); agreement with providers; usage, publication
3. Acquiring digital originals
   OCR; digital originals; Web
   - BootCat

Processing

1. Conversion to common format
   consistency; character set encodings; structure
   - Web as Corpus: Wacky tools
2. Documentation
   e.g. TEI header; Open Archives etc.
3. Linguistic annotation
   language dependent methods; errors

Use and dissemination

- Using the corpus:
  - concordancer (linguists)
    e.g. NovaBeseda, FidaPLUS, SKE, iKorpus
  - statistics extraction
  - development of new methods for analysis
- Dissemination:
  - legalities (source copyright, corpus use agreement)
  - mode: concordancer or dataset

Computer coding of corpora

- Encoding must ensure
  - durability
  - interchange between computer platforms
  - interchange between applications
- Basic standard: *Extended Markup Language*, XML
  - a number of companion standards and technologies: XSLT, XML Schema, ISO Relax NG, XPath, XQuery, ...
- The vocabulary of annotations for corpora and other language resources are defined by the *Text Encoding Initiative*, TEI
- XML/TEI used much wider than just for corpora:
  - annotation of dictionaries: English-Slovene, Japanese-Slovene (from jaSlo)
  - for annotating text-critical editions

Corpus annotation

Annotation = interpretation

- Documentation about the corpus (example)
- Document structure (example)
- Basic linguistic markup: sentences, words (example), punctuation, abbreviations (example)
- Lemmas and morphosyntactic descriptions (example)
- Syntax (example)
- Alignment (example)
- Terms, semantics, anaphora, pragmatics, intonation,...

Example: TEI header

```
<teiHeader id="ecmr.H" type="text" lang="sl-en" creator=ET status="update"
    date.created="1999-04-13" date.updated="1999-06-22" >
 <fileDesc>
  <titleStmt>
   <title lang="sl">Ekonomsko ogledalo; 13 &scaron;tevilk 98/99</title>
   <title lang="en">Slovenian Economic Mirror; 13 issues, 98/99</title>
   <respstmt>
    <name>Andrej Skubic, FF</name>
    <resp lang="sl">Zagotovitev digitalnega originala, poravnava</resp>
    <resp lang="en">Provision of digital original, alignment</resp>
    <name>Toma&zcaron; Erjavec, IJS</name>
    <resp lang="sl">Tokenizacija, pretvorba v TEI</resp>
    <resp lang="en">Tokenisation, conversion to TEI</resp>
   </respStmt>
  </titleStmt> ...
```

Example: text structure

```
<quote id="Osl.1.8.18" rend="center;it">
 <lg id="Osl.1.8.18.1">
  <l id="Osl.1.8.18.1.1">Tam pod kostanjevim drevesom</l>
  <l id="Osl.1.8.18.1.2">izdala si me,</l>
  <l id="Osl.1.8.18.1.3">izdal sem te,</l>
  <l id="Osl.1.8.18.1.4">ne da bi trenila z očesom.</l>
 </lg>
</quote>
<p id="Osl.1.8.19">
  <s id="Osl.1.8.19.1">Trije možje se niso niti ganili.</s>
  <s id="Osl.1.8.19.2">Toda ko je <name>Winston</name>
  znova pogledal v Rutherfordov propadli obraz, je opazil, da so
  njegove oči polne solz.</s> ...
```

Example: morphosyntactic tagging

```
<s id="Osl.1.2.2.1">
  <w lemma="biti" ana="Vcps-sma">Bil</w>
  <w lemma="biti" ana="Vcip3s--n">je</w>
  <w lemma="jasen‟ ana="Afpmsnn">jasen</w><c>,</c>
  <w lemma="mrzel" ana="Afpmsnn">mrzel</w>
  <w lemma="aprilski" ana="Aopmsn">aprilski</w>
  <w lemma="dan" ana="Ncmsn">dan</w>
  <w lemma="in" ana="Ccs">in</w>
  <w lemma="ura" ana="Ncfpn">ure</w>
  <w lemma="biti" ana="Vcip3p--n">so</w>
  <w lemma="biti" ana="Vmps-pfa">bile</w>
  <w lemma="trinajst" ana="Mcnpnl">trinajst</w><c>.</c>
</s>
```

Example: alignment

```
<linkGrp id="Oslen.1" type="body" targtype="s"
   domains="Oen Osl">
  <link xtargets="Osl.1.2.2.1 ; Oen.1.1.1.1">
  <link xtargets="Osl.1.2.2.2 ; Oen.1.1.1.2">
  <link xtargets="Osl.1.2.3.1 ; Oen.1.1.2.1">
  <link xtargets="Osl.1.2.3.2 ; Oen.1.1.2.2">
   ...
  <link xtargets="Osl.1.2.6.5 ; Oen.1.1.5.5">
  <link xtargets="Osl.1.2.6.6 ; Oen.1.1.5.6 Oen.1.1.5.7">
  <link xtargets="Osl.1.2.6.7 ; Oen.1.1.5.8">
   ...
```

Methods for linguistic markup

- *hand annotation*: documentation, first steps
  generic (XML, spreadsheet) editors or specialised editors
- *semi-automatic*: morphosyntactic and other linguistic annotation
  cyclic approach: machine, hand, validate, correct, machine, ...
- *machine, with hand-written rules*: tokenisation
  regular expression
- *machine, with inductively built models from annotated data*: "supervised learning"; HMMs, decision trees, inductive logic programming,...
- *machine, with inductivelly built models from un-annotated data*:
  "unsupervised leaning"; clustering technigues
- overview of the field

III. Morphosyntactic tagging

- Better known as part-of-speech (PoS) tagging
- Tagging is the task of labeling each word in a sequence of words with its appropriate part-of-speech
- Words are often ambiguous with respect to their POS:
  - *saw* → singular noun
  - *saw* → past tense of verb *see*
- Purposes and applications (examples):
  - pre-processing step for further analyses:
    - lemmatisation
    - syntactic structure, etc.
  - text indexing, e.g. nouns are more useful than verbs
  - pronunciation in speech processing

Steps in tagging

- for each word token in text the tagger needs to know all its possible tags --> a morphological lexicon
- given the context in which the word appears in, the tagger must decide in the correct tag:
  - he saw/V a man carrying a saw/N
- so, tagging performs a limited syntactic disambiguation

Example: Penn Treebank

Under/IN the/DT proposal/NN ,/, Delmed/NNP would/MD issue/VB about/IN 123.5/CD million/CD additional/JJ Delmed/NNP common/JJ shares/NNS to/TO Fresenius/NNP at/IN an/DT average/JJ price/NN of/IN about/IN 65/CD cents/NNS a/DT share/NN ,/, though/IN under/IN no/DT circumstances/NNS more/JJR than/IN 75/CD cents/NNS a/DT share/NN ./.

PoS taggers

- Most taggers induce the language model from a hand-annotated corpus
- Typically, two resources are induced:
  - lexicon, giving the possible tags of a word and their frequencies in the training corpus
  - how the tag of a word depends on its local context

Tagging with Markov Models

- Sequence of tags in a text is regarded a Markov chain
- Limited horizon: A word's tag only depends on the previous tag: $p(X_{i+1} = t^i \mid X_1, \ldots, X_i) = p(X_{i+1} = t^i \mid X_i)$
- Time invariant: This dependency does not change over time: $p(X_{i+1} = t^i \mid X_i) = p(X_2 = t^i \mid X_1)$
- Task: Find the most probable tag sequence for a sequence of words
- Maximum likelihood estimate of tag t^k following t^i: $p(t^k \mid t^i) = f(t^i, t^k) / f(t^i)$
- Optimal tags for a sentence: $t'_{1,n} = \arg\max p(t_{1,n} \mid w_{1,n}) = \prod p(w_i \mid t_i)\, p(t_i \mid t_{i-1})$

Most popular Markov model tagger

- TnT (Trigrams 'n Tags)
- induces lexicon and tag trigrams from the training corpus
- has heuristics to tag unknown words
- has no problem with large tagsets
- fast in training and tagging
- freely available for non-commercial use: http://www.coli.uni-saarland.de/~thorsten/tnt/
- but only as a Linux executable

TreeTagger

- uses decision trees
- relatively fast
- comes with lots of models for various languages
- executables freely available http://www.ims.uni-stuttgart.de/projekte/corplex/TreeTagger/

Transformation-based Tagging (TbT)

- Basic idea: transform an imperfect tagging into one with fewer errors by changing wrong tags
- Features that trigger changes can be conditioned on words and on more context and are user specified
- Components:
  - specification of transformations
  - learning algorithm: constructs a ranked list of transformations
- A transformation consists of two parts:
  - triggering environment + rewrite rule
- Examples:
  - if previous tag is TO and current tag is NN then change it to VB
  - if one of previous two words is *n't* and current tag is VBP then change it to VB
  - if next tag is JJ and current tag is JJR then change it to RBR
  - if one of previous three tags is MD and current tag is VBP then change it to VB

Yet another Tagger

For a while, trying out new approaches to tagging was in fashion

- Maximum Entropy taggers
- Support Vector Machine taggers
- Memory based taggers
- …

Tagsets

- A tagset is a set of part-of-speech tags
- Classical 8 classes (Thrax, 100 BC): noun, verb, article, participle, pronoun, preposition, adverb, conjunction
- But all tagset use more tags than that!
- Criteria:
  - specifiability: degree to which humans use the tagset uniformly on the same text
  - accuracy: evaluation of output on tagged text
  - suitability for intended application

Tagsets for English

- For English, there exist several tagsets: Brown, CLAWS, Penn, …
- English tagsets include PoS + some other morphological (inflectional) properties: 30-80 tags
- Penn Treebank Tagset for English: 37 tags, e.g.
  - JJ adjective, positive
  - JJR adjective, comparative
  - JJS adjective, superlative
  - NN non-plural common noun
  - NNS plural common noun
  - NNP non-plural proper name
  - NNPS plural proper name
  - IN preposition
  - …

Morphosyntactic tagsets

- For inflectionaly rich languages (such as Slavic languages), tagsets contain much more information than just PoS
- Slovene, Czech, etc. > 1000 different morphosyntactic tags
  - gendar, number, case, animacy, definiteness, …
- Efforts to standardise tagsets across languages:
  - Eagles
  - MULTEXT
  - MULTEXT-East

MULTEXT-East

- EU project in '90s: development of language resources for Central and East-European languages
- also development of morphosyntactic specifications, lexica and annotated corpus
- Parallel annotated corpus: Orwell's 1984
- Several later releases, V3 in 2004
- Project Web site: http://nl.ijs.si/ME/

MULTEXT-East morphosyntactic specifications

- Specify
  - what morphosyntactic features particular languages distinguish,
  - what their names and values are,
  - how they can be mapped to tags (morphosyntactic descriptions, MSDs)
- e.g. that *Ncms* is:
  - a valid for Slovene
  - is equivalent to *PoS:Noun, Type:common, Gender:masculine, Number:singular*
- http://nl.ijs.si/ME/V3/msd/html/

JOS morphosyntactic specifications

- only for Slovene
- based on MULTEXT-East
  but changed some features and lexical assignments
- also moved to 100% XML/TEI encoding
- bi-lingual (Slovene and English)
- also made annotated corpora:
  - jos100k (hand validated)
  - jos1M (partially hand validated)
- http://nl.ijs.si/jos/ - still work in progress!