Annotating language data

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Lecture 4: Lexical Semantics
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Overview

1. Word senses
2. Word sense disambiguation
3. Semantic lexica

Word Senses

- Lexical semantics is the study of how and what the words of a language denote.
- Lexical semantics involves the meaning of each individual word
- A word sense is one of the meanings of a word
- A word is called ambiguous if it can be interpreted in more than one way, i.e., if it has multiple senses.
- Disambiguation determines a specific sense of an ambiguous word.

Homonymy and Polysemy

- A homonym is a word with multiple, unrelated meanings.
  A homonym is a word that is spelled and pronounced the same as another but with a different meaning.
  bank → financial institution
  → slope of land alongside a river
- A polyseme is a word with multiple, related meanings.
  school → I *go to school every day.* (institution)
  → *The school has a blue facade*. (building)
  → *The school is on strike.* (teacher)
- Regular polysemy performs a regular induction of a word sense on the basis of another, e.g. *school / office.*

Human Beings and Ambiguity

- What seems perfectly obvious to a human being is deeply ambiguous to the computer, and there is no easy way of resolving ambiguity.
  - *I paid the money on my bank account.*
  - *I watched the ducks on the river bank.*
- Semantic priming (psycholinguistics):
  The response time for a word is reduced when it is presented with a semantically related word.
  doctor → nurse / butter
- If an ambiguous prime such as *bank* is given, it turns out that all word senses are primed for
  bank → money / river

Disambiguation Cues

- Probability and prototypicality → default interpretation:
  corpus-related importance of word senses
- Internal text evidence: context, in particular collocations
- One sense per discourse
- Domain
- Real-world knowledge

Word Sense Disambiguation (WSD)

- WSD: associating a word in a text with a meaning (sense) which can be distinguished from other meanings the word potentially has.
- Intermediate task: not an end in itself, but (arguably) necessary in most NLP tasks, such as machine translation, information retrieval, speech processing
- Problems:
  1. Which are the senses?
  2. Which is the correct sense?
- Sources of information:
  1. Context of the word to be disambiguated (local, global)
  2. External knowledge sources (e.g. dictionary definitions)

Sense Inventory

- Word Sense Disambiguation needs a set of word senses to disambiguate between.
  - Word Sense Discrimination doesn't
- Sense inventories are found in dictionaries, thesauri or similar.
- The granularity and criteria for the set of senses differ (lumpers vs. splitters).
- There is no reason to expect a single set of word senses to be appropriate for different NLP applications.

Lexical Semantic Resources

- Sense inventory and organisation:
  - WordNet
- Sense annotation and semantic role annotation:
  - Prague Dependency Treebank
  - FrameNet
  - PropBank
  - OntoBank / OntoNotes

WordNet

- Online lexical reference system, freely available also for downloading
- The design is inspired by current psycholinguistic theories of human lexical memory.
- English nouns, verbs, adjectives and adverbs are organised into synonym sets (synsets).
- Each synset represents one underlying lexical concept.
- Different (paradigmatic) relations link the synonym sets.
- WordNet was developed by the Cognitive Science Laboratory at Princeton University under the direction of George A. Miller.
- WordNets now exist for many languages.

WordNet Synsets

- Synsets are sets of synonymous words ("literals").
- Polysemous words appear in multiple synsets.
- Examples:
- noun example:
  {coffee, java}
  {coffee, coffee tree}
  {coffee bean, coffee berry, coffee}
  adjective : {chocolate, coffee, deep brown, umber, burnt umber}
- adjective example:
  {cold}
  {aloof, cold}
  {cold, dry, uncordial}
  {cold, unaffectionate, uncaring}
  {cold, old}

More about synsets

Synsets also include:

- glosses (definitions)
- examples of usage
- e.g.
  (n) **glass** (glassware collectively) *"She collected old glass"*
- recently added by ITC, Italy: semantic domains
  e.g.

Example: Bank

Sense Number	Synset and Gloss	Domains
1	depository financial institution, bank, banking concern, banking company (a financial institution ...)	**Economy**
2	bank (sloping land ...)	**Geography, Geology**
3	bank (a supply or stock held in reserve...)	**Economy**
4	bank, bank building (a building...)	**Architecture, Economy**

WordNet Relations

- Within synsets:
  - Synonymy, such as {coffee, java}
- Between synsets / parts of synsets:
  - Antonymy: opposition, e.g. {cold} - {hot}
  - Hypernymy / Hyponymy: is-a relation, e.g. {coffee, java} - {beverage, drink, potable}
  - Meronymy / Holonymy: part-of relation, e.g. {coffee bean, coffee berry, coffee} - {coffee, coffee tree}
- Morphology:
  - Derivations: appealing - appealingness

WordNet Hierarchy

- Depending on the part-of-speech, different relations are defined for a word. For example, the core relation for nouns is hypernymy, the core relation for adjectives is antonymy.
- Hypernymy imposes a hierarchical structure on the
- synsets.
- The most general synsets in the hierarchy consists of a number of pre-defined disjunctive top-level synsets:
  - nouns → {entity}, {abstraction}, {psychological}, …
  - verbs → {move}, {change}, {get}, {feel}, …

WordNet Hierarchy: Examples

{entity}
|
{object, inanimate object, physical object}
|
{substance, matter}
{food, nutrient}
|
{beverage, drink, potable}
{coffee, java}

{abstraction}
|
{attribute}
|
{property}
|
{visual property}
|
{color, coloring}
|
{brown, brownness}
|
{chocolate, coffee, deep brown, umber, burnt umber}

WordNet Family

- Current status: WordNets for 38 languages
- WordNets in the world:
- http://www.globalwordnet.org/gwa/wordnet_table.htm
- Integration of WordNets into multi-lingual resources:
  - EuroWordNet: English, Dutch, Italian, Spanish, German, French, Czech and Estonian
  - BalkaNet: Bulgarian, Czech, Greek, Romanian, Turkish, Serbian
- An inter-lingual index connects the synsets of the WordNets
- ~ multilingual lexicon; machine translation

WordNet annotated corpora

- SemCor: created at Princeton University, a subset Brown corpus (700,000 words). 200,000 content words are WordNet sense-tagged
- MultiSemCor: created at ITC, Italy, consists of SemCor + translation into Italian, which is also sense-tagged http://multisemcor.itc.it/
- DSO Corpus of Sense-Tagged English (National University of Singapore)
- etc.

Prague Dependency Treebank

- Three-level annotation scenario:
  - 1. morphological level
  - 2. syntactic annotation at the analytical level
  - 3. linguistic meaning at the tectogrammatical level
- Corpus data: newspaper articles (60%), economic news and analyses (20%), popular science magazines (20%)
- 1 million tokens are annotated on the tectogrammatical level.

Tectogrammatical Level of the PDT

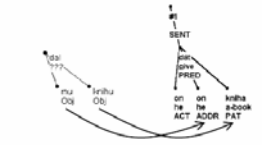
- Annotation: dependency, functor, ellipsis resolution, coreference, …
- 39 attributes
- Similar to the surface (analytical) level, but:
  - certain nodes deleted
    (auxiliaries, non-autosemantic words, punctuation)
  - some nodes added
    (based on word - mostly verb, noun - valency)
  - some ellipsis resolution
    (detailed dependency relation labels: functors)

Tectogrammatical Functors

- General functors, e.g.:
  actor/bearer, addressee, patient, origin, effect, cause, regard, concession, aim, manner, extent, substitution, accompaniment, locative, means, temporal, attitude, cause, regard, directional, benefactive, comparison
- Specific functors for dependents on nouns, e.g.:
  material, appurtenance, restrictive, descriptive, identity
- Subtle differentiation of syntactic relations, e.g.:
  temporal (before, after, on), accompaniment, regard, benefactive (for/against)

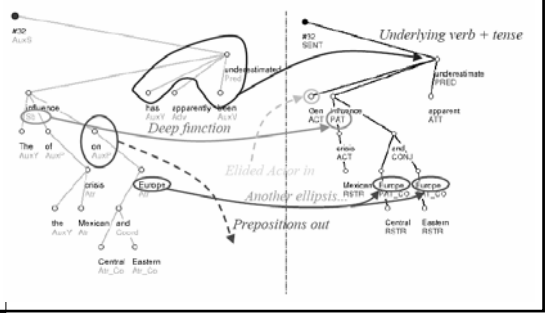
Tectogrammatical Example

- Example: *(he) gave him a book*
  dal mu knihu



The "Obj" goes into ACT, PAT, ADDR, EFF or ORIG, as based on the governor's valency frame.

Analytical vs. Tectogrammatical Level



Other semantic lexica/corpora

- FrameNet
- PropBank
- OntoNotes
- …