Ontology for Literary Text

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March 20, 2018

Outline

1. My Starting Point
   - My past research
   - Why and when are Ontology Projects Successful
2. Ontology for GIS
3. Computational Reading
   - My current interest
   - Layers of Natural Language Processing
4. Representation of Meaning
   - AMR Abstract Meaning Representation
   - Extracting Ontology from Text

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GIS Research

- Professor at TU Wien for Geoinformation for 25 years.
  NCGIA (University of Maine branch) before.
- Spatial relations, especially spatial reasoning with distances and directions.
- "Semantics of spatial data" (part of the title of my Ph.D. thesis in 1982).
  Connection between
  - datastructures for databases
  - object oriented programming
    using the functional, second order, programming language Haskell
  - visualization of data
  - economic value of data and data quality
- Extend ontologies beyond taxonomy:
  add actions and operations (verbs) to the ontology

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Example Successful Projects

- Bio- or Medical and similar:
  of interest to pharma and health industry
- Manufacturing: description of parts for order processing
- Accounting and banking
- Law: managing the documents relevant for large cases.

Factors for Success

- Substantive commercial interest
- An authority can fix the ontology ("fiat" ontologies)
- Seldom: factual or scientific justification
- Issue: Reistance to the structure imposed by the ontology
  a modern form of imperialism

Example

The political discussion on bank accounting rules (US vs. Europe)

Ontologies for GIS cannot be "fiat"

- Classification of real world (geographic) objects depend on the point of vie,i.e. the intended use of the information
- Efforts to describe object properties "objectively" (Werner Kuhn and his students)

Tiers of ontology

Group data on the "objectiv" to "subjective" spectrum
i.e. the amount of expected intersubject agreement

Tier 0: human independent reality (unknown)
Tier 1: observation of physical world (quantitative, Partial Differential Equations)
Tier 2: physical objects with properties
Tier 3: social reality
Tier 4: subjective knowledge

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Computational Comparative Literature

- Computational analysis of literary text
- Intelligent search in a literary text:

Example Task: Find all sentences in a collection of text where Animals think or talk.
E.g. fables and fairy tales.

- Analysis with Natural Language Processing and Semantic Tools required

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NLP analysis adds gradually information to a text

tokenization breaking text in words
Information added: the readers knowledge of word formation and word boundary markers

lemmatization identification of base word forms
Information added: the readers knowledge of the lexicon

POS tagging determination of Part of Speech
Information added: the readers knowledge of grammar

NLP analysis adds gradually information to a text

dependencies grouping words into meaningful units
Information added: knowledge of grammar

co-references resolve references
(e.g. what is "it" or "they" referring to?)
Information added: the readers knowledge of semantics

action patterns marked
Information added: knowledge of semantics and real world processes

Gradual analysis comparable to Tiers of Ontology?

- results of initially analysis steps are comparable between subjects
- research focus on: "Information contributed by the reader to the reading process"
- what is the "objective meaning" of a text?

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"Not an interlingua, but close" (Xue et al 2014)

- The representation of the meaning of a sentence should be independent of the language used.
- Demonstration: a text and two translations (English, Chinese and Czech) result in the same AMR representation.
- AMR is much influence by English language structures and semantics, but:
- various other research efforts to extract more semantics from text, AMR is probably the most ambitous one

Example: Where is Homer Simpson when you need him?

c. Kde je Homer Simpson, když ho potřebujete?

```
(b / byt_umisten
    :ARG0 (p / person
                :name ( h / name
                          :op1 "Homer"
                          :op2 "Simpson"))
    :ARG1 (a / amr-unknown)
    :time (p2 / potřebovat-1|need-01
                :ARG0 (v / vy|you)
                :ARG1 p))
```

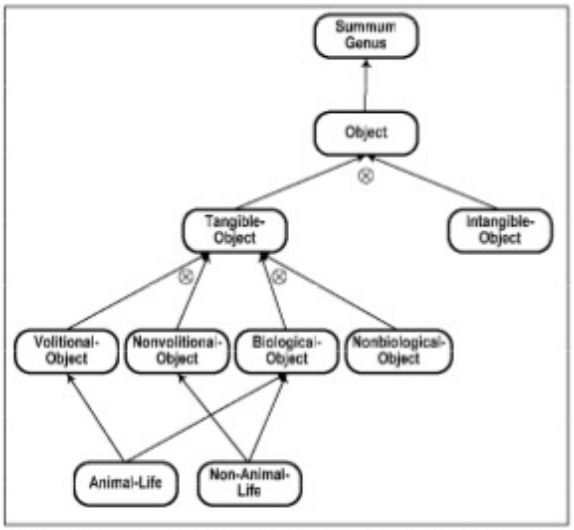
b. 当你需要他时, 霍默　辛普森在哪里?

```
(b / be-located-at
    :ARG0 (p / person
                :name (n / name
                          :op1 " 霍默　辛普森|Homer Simpson"))
    :ARG1 (a / amr-unknown)
    :time (n2 / 需要|need
                :ARG0 (y / 你|you)
                :ARG1 p))
```

(1) a. Where is Homer Simpson when you n

```
(b / be-located-at-91
    :ARG0 (p / person
                :name ( h / name
                          :op1 "Homer"
                          :op2 "Simpso
    :ARG1 (a / amr-unknown)
    :time (n / need-01
                :ARG0 (y / you)
                :ARG1 p))
```

Ontology?

- Semantic annotations for nouns are elements of a taxonomy
- Major component: Wordnet synsets
- Plans to merge with other upper level ontologies
- AMR uses the Omega Ontology (Philpot et al, 2005) a shallow, lexically oriented, term taxonomy
- Construct as a lattice over mutually disjoint concepts
- 

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Probability and Ontology

- NLP is fundamentally probabilistic because human language is polysemous, imprecise and context dependent
- Influence of context is captured with probability
- Construct ontology with probability (Ding and Peng, 2004)

Example

Trivial: Probability 50% of "x is male" if "x is an animal", but not when "x is a cow" or "x is a chicken".

A Literary Text creates a Reality

- The imaginary "reality" constructed by the author is the only reality of a fictional text.
- The ontology of the text may be different from everyday ontology as we experience it.
- The difference in the ontology may signal to the user that this is a work of fiction.
- Research question: how does the ontology represented change in time or between countires?

Large amount of Text

- Large amounts of text available.

Example

About 9000 English novels of the 19th century are in the Project Gutenberg.

- How much of a probabilistic "ontology" can be extracted automatically?

Achieved so far:

- Automatic processing to construct multi-language corpora of analyzed literary text.
- Storage of annotated text in RDF triplestore
- Query with SPARQL
- Challenges:
  - Construction of probabilistic ontology useful for NLP
  - Extraction of ontology from text
  - AMR or similar "interlingua" annotation systems.

Summary

- New research in NLP use ontologies
- NLP methods can be routinely used to process large amounts of text.
- Literary text (e.g. novels) contain much information about cultural and social situation. Computational comparative analysis can reveal important trends in time and difference between societies.
- Ontologies used for NLP and extracted from text are probabilistic (fuzzy, or rough set) based

References:

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