Data Intensive Linguistics — Lecture 13
Semantics and discourse

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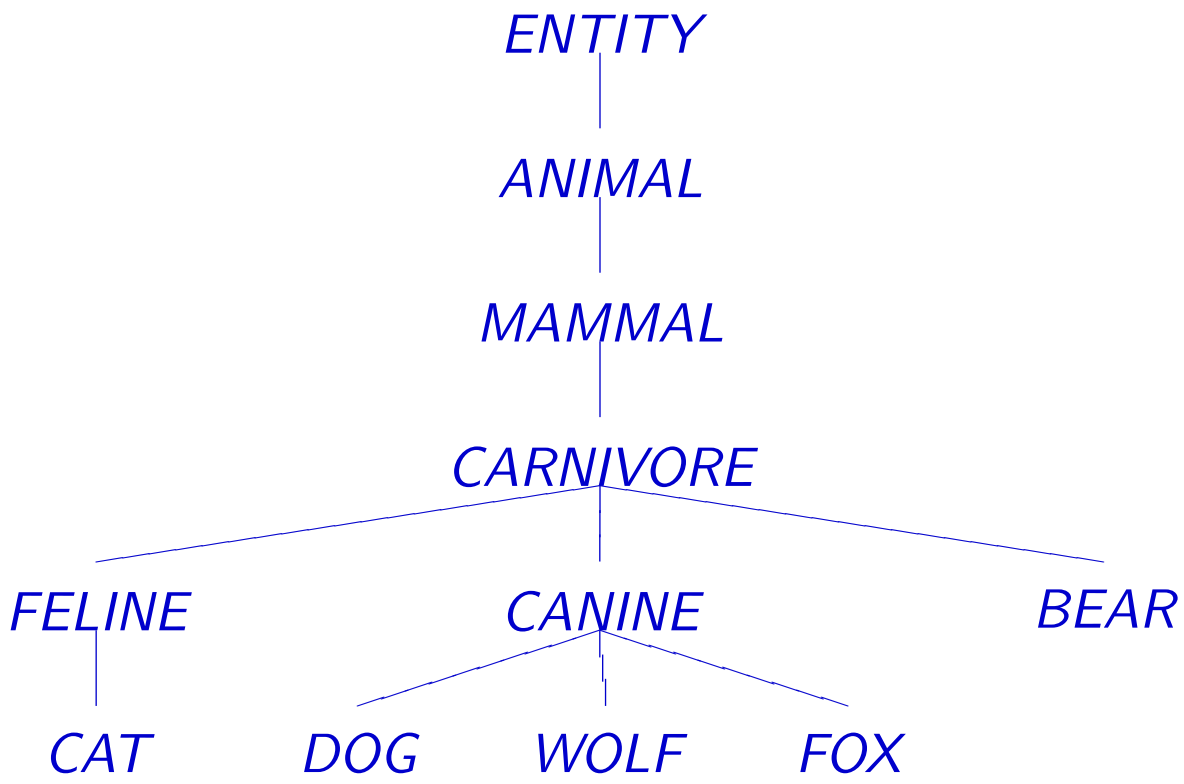
Semantics

- What is **meaning**?
- What is the meaning of the word *cat*?
  - not a specific cat
  - not all cats

  $\rightarrow$ abstract notion of any cat
- Atomic semantic units: **concepts**
  - example: *cat* $\rightarrow$ *CAT*

WordNet: an ontology of concepts



Semantic relationships

- **Hypernym** / **hyponym**
  - *CAT is-a FELINE*
  - basis of hierarchical relationships in WordNet
- **Part** / **whole**
  - *CAT has-part PAW*
  - *PAW is-part-of CAT*
- **Membership**
  - *FACULTY has-member PROFESSOR*
  - *PROFESSOR is-member-of FACULTY*
- **Antonym** / **opposite**
  - *LEADER is-opposite-of FOLLOWER*

Thematic roles

- Words play **semantic roles** in a sentence

$$\underbrace{I}_{AGENT} \; see \; \underbrace{the\ woman}_{THEME} \; \underbrace{with\ the\ telescope}_{INSTRUMENT} \; .$$

- Specific verbs typically require **arguments** with specific thematic roles and allow **adjuncts** with specific thematic roles.

Semantic frames

- Complex concepts can be defined by **semantic frames**, whose **slots** are filled by concrete information

- *SOCCER-GAME*
  - *HOME-TEAM: Heart of Midlothian*
  - *AWAY-TEAM: FC Motherwell*
  - *SCORE: 3-0*
  - *TIME-STARTED: 2006-02-18 16:00 GMT*
  - *LOCATION: Tynecastle Stadium, Edinburgh*

- **Information extraction**: can we fill semantic frames from text?

Source of semantic knowledge

- Semantic knowledge is not directly observable
- Building semantic knowledge bases
  - for instance WordNet, an ontology
  - labor intensive
  - may not contain all information we want, e.g.
    - *pigeon* is a **typical** *bird*
    - *penguin* is not a typical *bird*
- Can we automatically learn semantics?

Learning semantics

The meaning of a word is its use.
Ludwig Wittgenstein, Aphorism 43

- Represent context of a word in a vector
  → Similar words have similar **context vectors**

- Example: **Google sets** `http://labs.google.com/sets`
  - one meaning of *cat*
    - enter: *cat, dog*
    - return: *cat, dog, horse, fish, bird, rabbit, cattle, ...*
  - another meaning of *cat*
    - enter: *cat, more*
    - return: *more, cat, ls, rm, mv, cd, cp, ...*

Learning prejudices

- Detecting national stereotypes with Google
- Enter: *Scots are known to be **
  ⇒ *frugal, friendly, generous, thrifty, ...*
- Enter: *Englishmen are known to be **
  ⇒ *prudish, great sports-lovers, people with manners, courteous, cold, ...*
- Enter: *Germans are known to be **
  ⇒ *pathetic, hard-nosed, arrogant, very punctual, fanatical, hard-working, ...*

Discourse

- Beyond the sentence level, we are interested in how texts are structured
  - central message of text
  - supporting arguments
  - introduction, conclusion
- **Elementary discourse units (EDU)** ($\sim$ clauses) are related to each other
- Texts shift in focus $\rightarrow$ **text segmentation**

Text segmentation

- Some text types have very pronounced **topic shifts**
  - news broadcasts cover different stories
- Also other long texts may cover multiple topics
  - lectures
  - speeches
  - essays
- Task text segmentation
  - *given:* text
  - *wanted:* segmentation into smaller units with different topics

Segmentation by vocabulary change

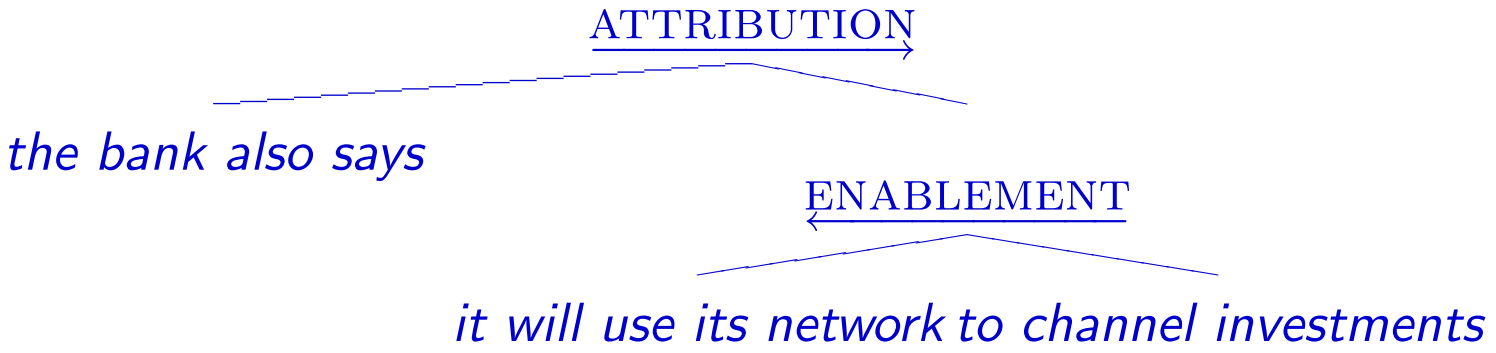
- At a **topic boundary**, use of vocabulary changes
- By comparing vocabulary of neighboring text parts, boundaries can be detected
- Example: *Stargazers text* from Hearst [1994]
  - intro: the search for life in space
  - the moons chemical composition
  - how early proximity of the moon shaped it
  - how the moon helped life evolve on earth
  - improbability of the earth-moon system

next slide from MIT class *6.864: Natural Language Processing*

```
Sentence:        05   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80   85   90   95|
-----------------------------------------------------------------------------------------------------------+
14       form    1     111 1   1                              1 1     1   1       1     1     1    1        |
 8  scientist                  11           1   1               1          1      1  1                       |
 5      space 11    1     1                                                      1                        |
25       star    1           1                                  11 22  111112  1 1  1   11 1111     1 |
 5     binary                                                   11  1          1                      1|
 4    trinary                                                    1   1         1                      1|
 8 astronomer 1               1                                1 1           1   1    1  1           |
 7      orbit   1                    1                             12    1 1                           |
 6       pull                       2     1 1                        1  1                             |
16     planet   1    1       11               1           1           21  11111                 1     1|
 7     galaxy    1                                                1               1  11     1          1|
 4      lunar           1  1     1       1                                                            |
19       life 1  1  1                          1    11 1  11  1      1                1 1    1 111  1 1 |
27       moon        13  1111   1 1 22 21  21    21          11 1                                      |
 3       move                                  1   1   1                                             |
 7  continent                                  2 1 1 2 1                                             |
 3  shoreline                                      12                                                |
 6       time                   1              1  1  1     1                                      1   |
 3      water                           11            1                                              |
 6        say                           1 1       1       11              1                          |
 3    species                                 1  1  1                                                |
-----------------------------------------------------------------------------------------------------------+
Sentence:        05   10   15   20   25   30   35   40   45   50   55   60   65   70   75   80   85   90   95|
```

Rhetorical relations

- **Rhetorical Structure Theory (RST)**: relations between spans of EDUs
- Example:



Types of rhetorical relations

- **Mono-nuclear**: **Nucleus** is more salient than **satellite**, which contains supporting information
- **Multi-nuclear**: joining spans have equal importance
- 78 types of relations in 16 classes
  attribution, background, cause, comparison, condition, contrast, elaboration, enablement, evaluation, explanation, joint, manner-means, topic-comment, summary, temporal, topic-change
- More detail, see: *Building a discourse-tagged corpus in the framework of rhetorical structure theory* by Lynn Carlson, Daniel Marcu, and Mary Ellen Okurowski [SIGDIAL 2001]

Discourse parsing

- **Human annotator agreement** on rhetorical relations is not very high
  - 71.9% if 18 relation types are used
  - 77.0% if 110 relation types are used
- *Probabilistic parsing model* [Soricut and Marcu, NAACL 2003]
  - probabilistic chart parser
  - achieves similar performance
- Experiments done on the sentence level.
- Discourse parsing should be useful for, e.g., **summarization**

Anaphora

Violent protests broke out again in Happyland. According to the country's department of peace, flowers will be handed out tomorrow. A spokesman of the department announced that they will be blue and green. This will demonstrates the country's commitment to alleviate the situation.

- A text contains often multiple **references** to the same objects:
  - *flowers — they*
  - *Happyland — the country*
  - *department of peace — the department*
  - *violent protests — the situation*
  - *handing out flowers — this*

- **Anaphora resolution** (matching the references) is a hard problem

Sentiment detection

- What is the overall **sentiment** of a text
- Example: *movie review*
  - is it a recommendation or a negative review?
  - can be framed as a text classification problem
  - see *Seeing stars: exploiting class relationships for sentiment categorization with respect to rating scales* by Bo Pang and Lillian Lee [ACL 2005]
- Similar questions
  - is a text critical of a person?
  - does the text have a bias (political, etc.)?