Computational Lexical Semantics

Lexical Semantics – Pustejovsky (2016)

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HHU Düsseldorf

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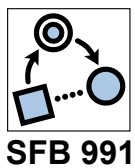

Outline

Worum geht's?

Aus der Kursbeschreibung:

> *Das Lexikon enthält diejenigen semantischen Informationen, die für die Bedeutungskomposition notwendig sind.*

1. Welche Einheiten enthält das Lexikon?
   - ⇒ Morpheme, **Worte** (Wortformen, Lexeme), Phrasen, …
2. Was ist "die Bedeutung"?
   - ⇒ Problem: Mehrdeutigkeit, Abstraktheit
3. Wie repräsentieren wir (lexikalische) Bedeutung?
   - ⇒ Paraphrasen, logische Formeln, Merkmalsstrukturen, Typenhierarchien, Vektoren, …

In diesem Seminar

eine **Auswahl** (2 SWS!) computerlinguistischer "Antworten"

Stationen des Seminars

1. Theorie: Lexikon & lexikalische Semantik
2. Lexikalische Ressourcen: WordNet, FrameNet, VerbNet
3. Semantisch annotierte Korpora: SemCor, PropBank, OntoNotes
4. Anwendungen:
   - Word Sense Disambiguation
   - Semantic Role Labeling
   - …

Letzte Woche: Cruse (2001)

1. Welche Einheiten enthält das Lexikon?

- lexicon = "basic units" = "words" ("no succinct definition")
- words = word forms | lexemes | lexical units
- lexeme = "a set of **related** meanings associated with a set of **related** word forms", "units listed in a lexicon"

⇒ **Wann sind die Bedeutungen so unterschiedlich, dass man separate Lexeme annehmen muss?**

- Unterspezifikation versus Ambiguität (***teacher*** versus ***position***)
  - ⇒ unterschiedliche Bedeutungen?
- Ambiguität: Polysemie versus Homonymie (***position*** versus ***bank***)
  - ⇒ unterschiedliche Lexeme?

⇒ **Wann wird eine Bedeutung ins Lexikon aufgenommen?**

- wörtliche versus übertragene Bedeutung (Metonymie, Metapher)
- etablierte versus Spontanbedeutungen

(Beispiel ***bank*** in Merriam-Webster)

Letzte Woche: Cruse (2001)

2. Was ist “die Bedeutung”?

1. Contextual/holistic approach (sense relations)
2. Componential/localist approach (semantic decomposition)
3. Conceptual approach

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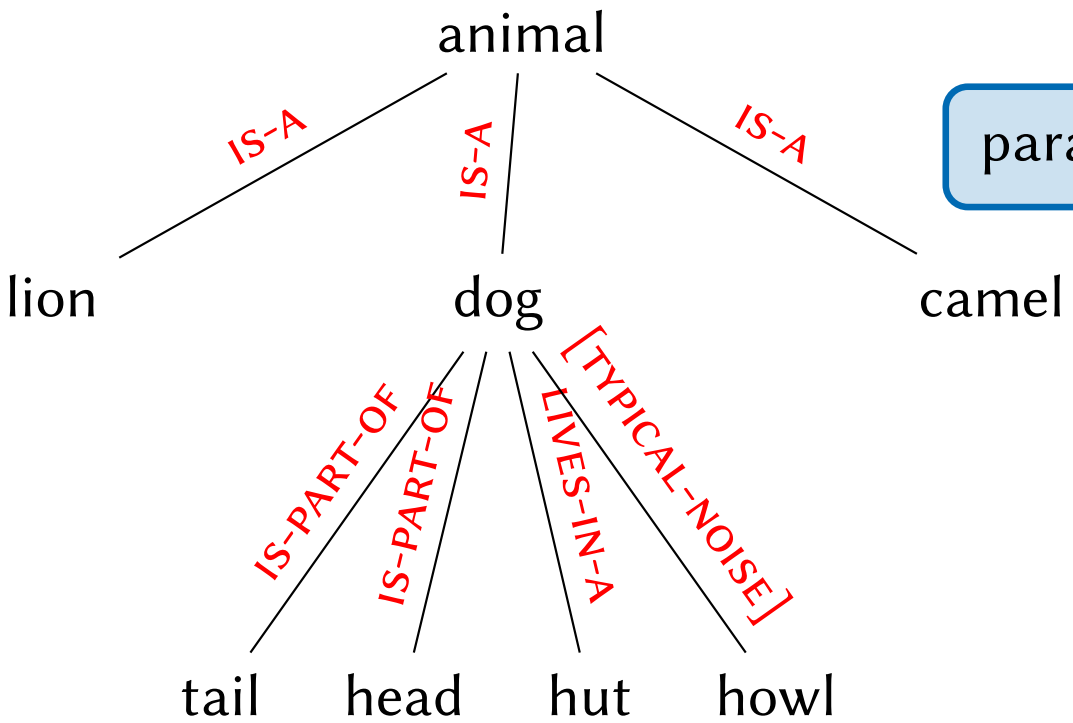

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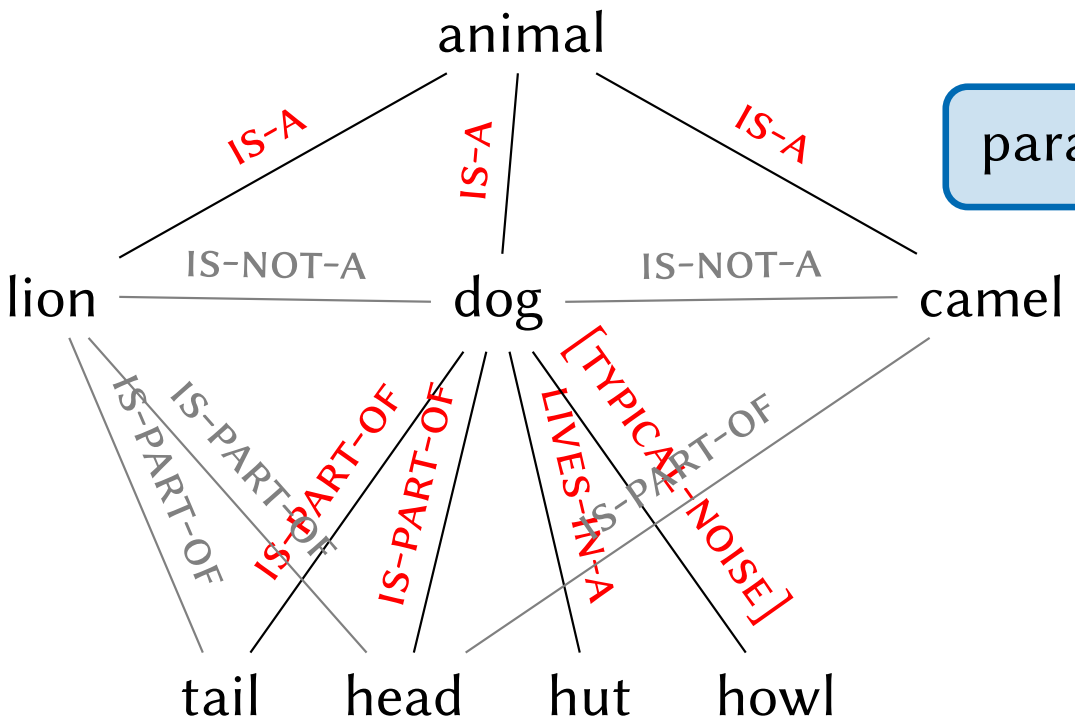

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   (1) The Prime Minster attended the White House reception accompanied by his Dad/father.
   (2) John drank the wine / filing cabinet.
   (3) a male/female aunt

   syntagmatic relations

2. Componential/localist approach (semantic decomposition)
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filly	=	[HORSE] [FEMALE] [YOUNG]
boy	=	[HUMAN] [MALE] [YOUNG]
kill	=	[CAUSE] [BECOME] [NOT] [ALIVE]
chair	=	[OBJECT] [FURNITURE] [FOR SITTING] [FOR ONE PERSON] [WITH BACK]

3. Conceptual approach

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???

Pustejovsky (2016)

Pustejovsky, James. 2016. Lexical Semantics. In Maria Aloni & Paul Dekker (eds.), The Cambridge Handbook of Formal Semantics (Cambridge Handbooks in Language and Linguistics), 33–64. Cambridge, UK: Cambridge University Press.

wieder ein Handbuch-Artikel ⇒ Terminologie, Grundbegriffe, Beispiele

Leseaufgabe:
Geben Sie für jede der “strategies to lexical specification” (S.34) je ein Beispiel aus dem Text.

Pustejovsky (2016): Outline

- Introduction
- The history of lexical semantics
- Issues in lexical semantics
- Event semantics
- Lexical decomposition
- Semantic roles
- Qualia structure
- Type theory and the lexicon
- Open issues in lexical semantics

Pustejovsky (2016): Introduction

> *Lexical semantics is the study of what words mean and how their meanings contribute to the compositional interpretation of natural language utterances. The lexicon can be seen as that component of the grammar that encodes both* ***the information required for composition*** *in the syntax and the knowledge for multiple levels and types of semantic interpretation.*

Key questions:

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4. When is a component of word meaning considered "lexical" rather than "world" knowledge?

Pustejovsky (2016): Introduction

Theoretical assumptions:

- Lexical meaning involves a kind of **componential analysis**, either through predicative primitives or a system of types.
- The **selectional properties** of words must be explained in terms of the lexical semantics of predication.
- An understanding of the semantics of nouns and the contribution that verbal arguments play in composition is crucial for an adequate model of how lexical semantics contributes to compositionality.

Pustejovsky (2016): Introduction

Four strategies to lexical specification of the “interface”:

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4. **Structural decomposition:** Component-based features are organized as a graph structure, with associated compositional interpretations in the model.

Pustejovsky (2016): Introduction

Atomic predication

- non-decompositional approaches to lexical semantic interpretation
- as many lexical entries as there are senses for it in the object language

$\Rightarrow$ type-theoretic semantics (Montague 1974)

$\Rightarrow$ language of thought (Fodor 1975)

Pustejovsky (2016): Introduction

Relational models

- words are treated as primitives
- arbitrarily complex relational structures that facilitate semantic inferences

$\Rightarrow$ Davidson's addition of the event variable to action predicates (Davidson 1967)

Pustejovsky (2016): Introduction

Feature-based decomposition

All expressions in the object language are decomposed into sets of binary-valued features, distinguishing concepts such as gender, number, age, marital status, and so on.

$\Rightarrow$ distributional semantic models

Pustejovsky (2016): Introduction

Structural decomposition

Words are defined as restricted algebraic structures, with **primitive predicates as atomic elements**.

- ⇒ Dowty (1979)
- ⇒ Generative Semantics
- ⇒ Jackendoff's Conceptual Structure
- ⇒ Generative Lexicon (Pustejovsky 1995)
- ⇒ HPSG

The history of lexical semantics

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- Montague Semantics: structural decomposition; synthesis of lexicon and syntax

Issues in lexical semantics: Ambiguity vs. polysemy [sic!]

Ambiguity is unavoidable: size of lexicon < number of objects and relations in the world

- **homonymy** ("unrelated senses")

  (1) a. Mary strolled along the ***bank*** of the river.
  b. This company is the largest ***bank*** in the city.

  ⇒ "represented as separate lexical entries"

- **polysemy** ("related senses")

  (2) a. Mary carried the ***book*** home.
  b. Mary doesn't agree with the ***book***.

  ⇒ [represented in one lexical entry?]

"It is the role of the lexicon to distinguish such ambiguities, and to establish what this logical relation is."

"simply listing the senses of these words [nouns and adjectives] will not always account for their **creative use** in novel contexts in language"

Issues in lexical semantics: Selectional constraints

Lexical information impacting the grammar:

- **argument structure**: number of associated co-phrases
- **syntactic category**: “ identifies the actual syntactic phrase associated with the argument”
- **selectional constraints**: grammatical and semantic features

(3) laugh(arg 1 [cat=NP,animacy=+])
  a. *The man laughed the ball.
  b. The man / *the rock laughed.

Issues in lexical semantics: Verb meaning and mapping to syntax

Verbal polysemy ⇒ alternation

(4) a. The glass ***broke***.
    b. Mary ***broke*** the glass.
(5) a. The ball ***rolled*** down the slide.
    b. The boy ***rolled*** the ball down the slide.
(6) a. The ship ***sank***.
    b. The torpedo ***sank*** the ship.

Not all verbs have alternations such as this (***die***, ***arrive***).
Where is it stored? In the lexicon? "Clear" cases: ***eat***, ***devour***[, ***dine***]
[How does this reflect the meaning of the verb?]

Event semantics

Two characterizations of events in lexical semantics:

1. **Event variable** in FOL: $\lambda y \lambda x \lambda e[\text{eat}(e, x, y)]$

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   - achievement

Lexical decomposition

*Lexical decomposition is concerned with the **internal semantic structure** of lexical items within a lexicon. The focus of lexical decomposition is on how the lexical items are semantically similar and distinct by virtue of shared knowledge structures or **semantic primitives**.*

kill: (CAUSE(x,(BECOME(NOT(ALIVE y)))))[1]

Inventory of primitve categories?
Complete and exhaustive description of the meaning?
Status of decomposition?

[1] Following Dowty (1979).

Semantic roles

"partial decomposition" with respect to argument structure
(aka theta role assignment)

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(8) a. put⟨agent,theme,location⟩
    b. borrow⟨recipient,theme,source⟩

⇒ Case Grammar, Frame Theory

Qualia structure

Qualia structure in Generative Lexicon Theory

1. **formal role**: the basic category that distinguishes the object within a larger domain

Example: ***rock*** versus ***chair***

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3. **telic role**: purpose and function
4. **agentive role**: origin or "coming into being"

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Type theory and the lexicon

Richer type system than Montague Grammar, with type composition:

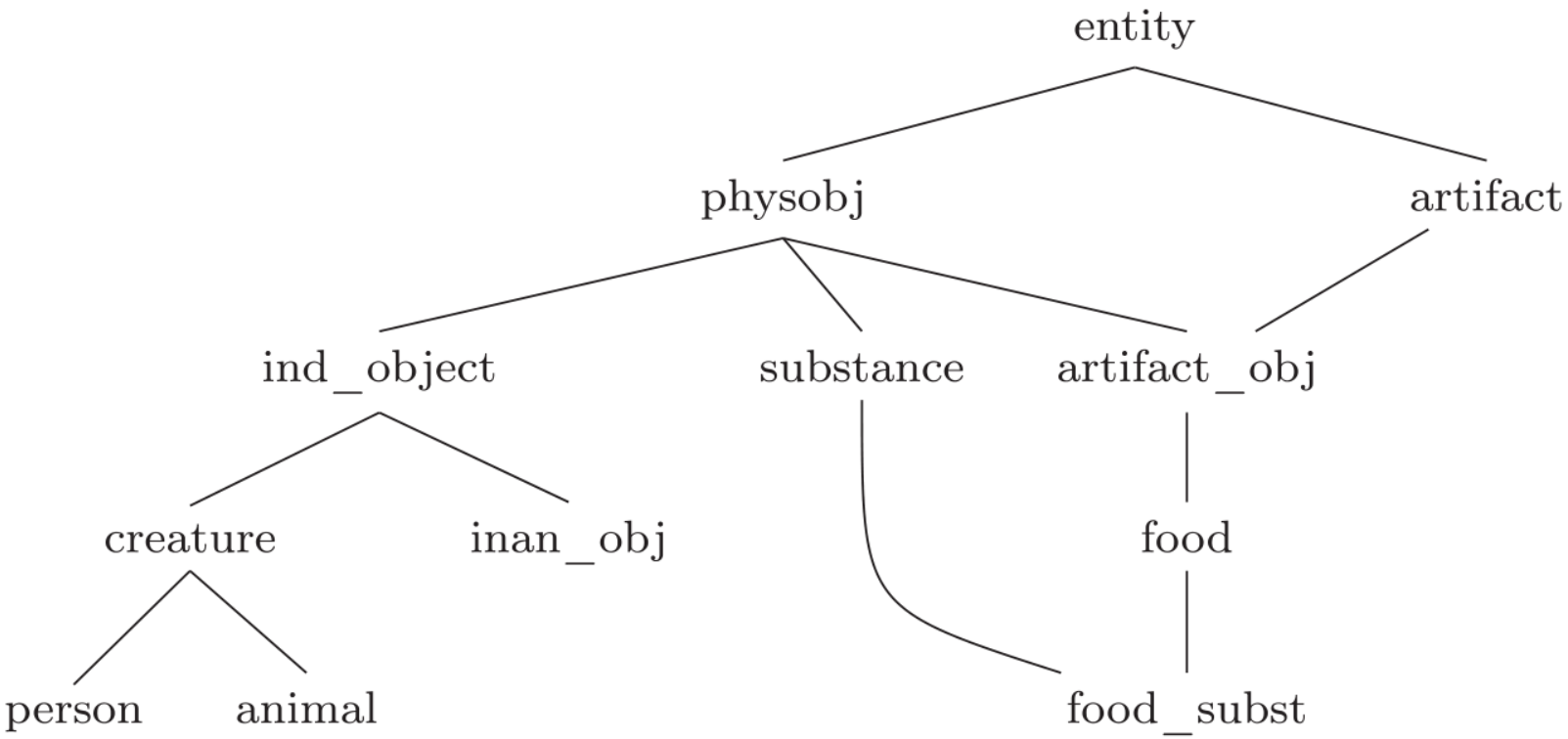

Figure 2.1 *Fragment of a type hierarchy*

Benefits: “explaining” selectional constraints; type coercion

References

[1] Davidson, Donald. 1967. The logical form of action sentences. In Nicholas Rescher (ed.), *The logic of decision and action*. University of Pittsburgh Press.

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