Introduction

The course will look into aspects of natural language meaning over and above compositional semantics at the sentence level.

There will be two parts dealing with distinct aspects of meaning:

• In the first part of the course, we will zoom in to explore the meaning of words, paying special attention to "Distributional Semantic Models".

• In the second part, we will zoom out to look into how meaning arises in interactive language use, as combinations of utterances are contributed by different interlocutors.

N.B.: The course is NOT meant to be an exhaustive introduction to lexical semantics nor dialogue modelling. It is rather an advance course on a selection of (interesting) issues within these disciplines.
Practical Matters

• **Lecturer:** Raquel Fernández (raquel.fernandez@uva.nl) C3.132
• **Timetable:** Mondays 13-15 in G2.04 until 18 Oct, then D1.160
• **Evaluation:** There will be some homework assignments, specially during the first part of the course; required readings to be done before the lectures; and reading presentations. At the end, a short essay on a topic of the course will have to be submitted and presented in a talk. *[more details shortly]*
• **Website:** Slides, homework exercises, references, and other important information will be posted on the course website: [http://staff.science.uva.nl/~raquel/teaching/mom2010/](http://staff.science.uva.nl/~raquel/teaching/mom2010/)
• **Seminars:** There may be talks at the ILLC that are relevant to the course and that you are welcome (and occasionally even required!) to attend, e.g. at the Computational Linguistics Seminar.
Prerequisites

No formal prerequisites are required to follow the course. Nevertheless, some basic things are expected from you:

- an interest in natural language, particularly in language use (in semantics and pragmatics)
- an empirical orientation: an interest in the empirical evidence (or lack thereof) behind theoretical claims
- an interest in what psycholinguistics has to say about language use
- a formal/computational inclination: an interest in computational methods of enquiry and evaluation

You don’t have to like everything we cover in the course. You can choose to focus on those aspects that interest you most.
Related Courses


• This is a course at the interface of the Logic & Language and the Language & Computation groups at the ILLC.

• (Mildly) related courses:
  ∗ Structures for Semantics (Robert van Rooij)
  ∗ Semantics and Pragmatics (Jeroen Groenendijk)
  ∗ Philosophy of Semantics (Martin Stkhof)
  ∗ Meaning, Reference and Modality (Paul Dekker)
  ∗ Elements of Language Processing and Learning (Khalil Sima’an)
  ∗ Cognitive Models of Language and Beyond (Rens Bod)
  ∗ Knowledge Representation (Bert Bredeweg)
  ∗ Information Retrieval (Maarten de Rijke)
Plan for today

1. Overview of the main topics of the course
2. Introduction to the first block: how to represent word meaning
Overview of Course Topics
• In linguistics, the term *formal semantics* is typically used to refer to *compositional semantics* \(\approx\) the computation of propositional meaning at the sentence level.

\[
[S] = [VP]([NP])
\]

\[
[S] = ([\text{NP}]) = ([\text{Ann}]) = a
\]

\[
[\text{NP}] = [\text{Ann}]
\]

\[
[\text{VP}] = [V][\text{NP}]
\]

\[
[V] = [\text{love}]
\]

\[
[\text{NP}] = [\text{Jan}]
\]

\[
\text{VP} = \lambda xy.\text{Love}(x, y)
\]

\[
\text{S}
\]

\[
\text{NP}
\]

\[
\text{VP}
\]

\[
\text{V}
\]

\[
\text{NP}
\]

\[
\text{Jan}
\]

\[
\text{Ann}
\]

Raquel Fernández

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Meaning, however, is present at different levels of interpretation:

- lexical semantics
- compositional semantics
- discourse structure
- dialogue

The course will cover aspects of meaning related to the two end-points of this interpretation ladder.
Part 1: Word Meaning

• In classic compositional semantics, words are considered basic expressions — nothing insightful is said about their meaning.

• During the first part of the course, we’ll look into different proposals to represent *word meaning*.

• Some of the issues we will discuss are the following:
  * What are the building blocks of word meaning? Can we decompose word meanings into finer-grained semantic components?
  * What’s the structure of the lexicon (speakers’ inventory of words)? What kind of relationships hold between word meanings?
  * What is the relationship between word meaning and concepts?
Words and Concepts

• What is the relationship between word meaning and concepts?
• The relation between word form and word meaning is not one-to-one:
  * Several words can have the same meaning → synonymy
    ▶ ‘buy’ / ‘purchase’
    ▶ ‘car’ / ‘automobile’
  * One word can mean different things → lexical ambiguity
    ▶ ‘bank’₁: the slope of land adjoining a body of water
    ▶ ‘bank’₂: a business establishment in which money is kept

• Certainly, words do not correspond to concepts.
• Word senses (lexems) might be better candidates.

⇒ We will spend one or two classes discussing psychological theories of human concepts and word meaning.

Distributional Semantic Models

After these introductory topics, the second half of the first part of the course will be dedicated to Distributional Semantic Models.

- DSM take a decidedly usage-based view of word meaning.
- The basic idea behind distributional or context-theoretical semantics is that word meaning depends on the contexts in which words are used.
- An example by Stefan Evert: what’s the meaning of ‘bardiwac’?

* He handed her her glass of bardiwac.
* Beef dishes are made to complement the bardiwacs.
* Nigel staggered to his feet, face flushed from too much bardiwac.
* Malbec, one of the lesser-known bardiwac grapes, responds well to Australia’s sunshine.
* I dined oïñĀ bread and cheese and this excellent bardiwac.
* The drinks were delicious: blood-red bardiwac as well as light, sweet Rhenish.

⇒ ‘bardiwac’ is a heavy red alcoholic beverage made from grapes
The Distributional Hypothesis

- DH: The degree of semantic similarity between two linguistic expressions A and B is a function of the similarity of the linguistic contexts in which A and B can appear (Harris, 1954).

- The distributional perspective has led to an innovative methodology for investigating lexical meaning based on the statistical analysis of context in large corpora.

- DSMs make use of mathematical and computational techniques to turn the informal DH into empirically testable semantic models.

- They build contextual semantic representations from data about language usage.

- These representations are defined as an abstraction over the linguistic contexts in which a word is encountered.

⇒ We will study several approaches and formal techniques currently used to characterise a word distributional behaviour.
Part 2: Meaning in Dialogue

- Traditional (compositional) semantics focusses on analysing isolated sentences or written text.
- Dialogue is a form of interaction and hence brings in additional challenges.
- Crucially, it involves multiple participants and it unfolds in time.
- Participants are autonomous rational agents with their own intentions and interests. This shapes the interaction, introduces room for misunderstanding, and hence requires coordination.
- **Timing** matters: it also requires coordination, for instance of turn-taking (who speaks when).
During the second part of the course we will cover issues that are typically studied within the area of **Dialogue Modelling**.

- **Dialogue Modelling** is a fairly new research area at the interface of (computational) linguistics, artificial intelligence, psychology...
- It is concerned with designing formal systems that model aspects of **dialogue interaction**. Some general research questions are:
  
  * What kind of skills (linguistic and otherwise) are required to participate in conversation?
  * What kind of information does a participant need to keep track of?
  * What makes a dialogue coherent? How is dialogue structured?
  * How can we design artificial conversational agents that allow natural human-computer interaction?
Grounding and Meta-communication

• A key aspect of meaning in dialogue is the process of *grounding*.
• During conversation, participants need to coordinate their interaction and make sure they understand each other.
• Grounding is the process by which participants reach mutual understanding (Clark & Schaefer 1989, Clark 1996).
• Participants need to *signal understanding* or else *request repair*.
A Dialogue Transcript


B: I ordered some paint from you uh a couple of weeks ago some vermilion
A: Yuh
B: And I wanted to order some more the name is Boyd
A: Yes // how many tubes would you like sir
B: U:hm (. ) What’s the price now eh with V.A.T. do you know eh
A: Er I’ll just work that out for you =
B: = Thanks
   (10.0)
A: Three pounds nineteen a tube sir
B: Three nineteen is it =
A: = Yeah
B: E::hm (1.0) That’s for the large tube isn’t it
A: Well yeah it’s the thirty-seven c.c.s.
B: Er, I’ll tell you what I’ll just eh eh ring you back I have to work
   out how many I’ll need. Sorry I did- wasn’t sure of the price you see
A: Okay.

Grounding and Meta-communication

- A key aspect of meaning in dialogue is the process of *grounding*.
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- Grounding is the process by which participants reach mutual understanding (Clark & Schaefer 1989, Clark 1996).
- Participants need to signal understanding or else request repair.
- Grounding takes place at a meta-level (a *collateral track*):

<table>
<thead>
<tr>
<th>communicative acts</th>
<th>meta-communicative acts</th>
</tr>
</thead>
<tbody>
<tr>
<td>B: I ordered some paint from you...</td>
<td>A: Yuh</td>
</tr>
<tr>
<td>B: And I wanted to order...</td>
<td></td>
</tr>
<tr>
<td>A: Bill is around.</td>
<td>B: Bill Johnston?</td>
</tr>
<tr>
<td></td>
<td>A: Yes.</td>
</tr>
<tr>
<td></td>
<td>eh, I mean, John</td>
</tr>
<tr>
<td>A: Bill...</td>
<td></td>
</tr>
<tr>
<td>...is around.</td>
<td></td>
</tr>
</tbody>
</table>

Some of the topics we will cover (time permitting) are:

- **Grounding and meta-communication**
  - psycholinguistic foundations
  - how is *word meaning* acquired and coordinated through interaction?

- **Communication management**: *turn-taking*
  - not directly about *meaning*, but about the mechanisms required for its coordination

- **Rudiments of dialogue systems**
  - computational models of dialogue-capable agents – putting it all together
Introduction to the First Block of the Course: How to Represent Word Meaning
• **Credits**: Bits and pieces of the materials for this first part of the course are based on resources (slides, exercises, tutorials) prepared by colleagues in the field:

  * Course by Manfred Pinkal on Semantics (U. Saarbrücken, 2007)
  * Course by Gemma Boleda and Stefan Evert on Computational Lexical Semantics (ESSLLI 2009)
  * Course by Katrin Erk on Word Meaning and Concepts (U. Texas, 2009)
  * Course by Stefan Evert and Alessandro Lenci on Distributional Semantic Models (ESSLLI 2009)
  * Tutorial by Stefan Evert on DSMs (NAACL 2010)
Montague tradition: application of semantics used for systems of formal logic to natural language.

- **Truth-conditional semantics:**
  - to know the meaning of a (declarative) sentence is to know what the world would have to be like for the sentence to be true \(\Rightarrow\) to know its *truth conditions*
  - truth-conditional semantics attempts to specify the relationship between linguistic expressions (sentences) and the world.

- **Focus of formal semantics:** how the truth-conditional meaning of sentences is *compositionally* built from the semantic value of basic expressions.

- Words are considered “basic expressions” associated with an entity, a property, or a relation in the world.
Dolphins are mammals, not fish. They are warm blooded like man, and give birth to one calf at a time. At birth a bottlenose dolphin calf is about 90-130 cms long and will grow to approx. 4 metres, living up to 40 years.

**Function words** (closed class)
- connectives and quantifiers
- copula, auxiliary and modal verbs
- temporal and modal adverbials
- pronouns, articles, degree modifiers...

**Content words** (open class)
- nouns
- adjectives
- verbs

∀\(d\) (dolphin\(d\) → mammal\(d\) ∧ ¬fish\(d\))
∀\(d\) (dolphin\(d\) → ∀\(x\)∀\(y\)∀\(t\) (givebirth\(d, x, t\) ∧ givebirth\(d, y, t\) → \(x = y\)))

- Compositional semantics focuses on those function words that constitute the *glue* required for composition.
- But not a lot of emphasis is put on content words...
• Content words are defined in terms of set-theoretical notions (sets/relations) that assign them an extensional meaning:

\[
[dolphin] = \{x \mid x \text{ is a dolphin}\} \quad f : D \rightarrow \{1, 0\} \quad \langle e, t \rangle
\]

\[
[envy] = \{\langle x, y \rangle \mid x \text{ envies } y\} \quad f : D \rightarrow (D \rightarrow \{1, 0\}) \quad \langle e, \langle e, t \rangle \rangle
\]

• What matters for composition is their categorial or type information, which determines their denotation and their syntactic behaviour.

• But this is a rather crude notion of lexical meaning....
  * What are dolphins?
  * How do we know whether an entity belongs to the set of dolphins or not?
  * This is what truth conditions are meant to tell us, but most set-theoretical formalisations abstract away from this.
Reference vs. Sense

• Among other problems, this coarse-grained view of lexical meaning does not make justice to Frege’s distinction between *sense* and *reference* ("Sinn und Bedeutung"):  

(1) a. The dean of the UvA’s FNWI is my neighbour  
    b. My neighbour is my neighbour  
(2) a. Sue thinks that my neighbour is rude  
    b. Sue thinks that the dean of the UvA’s FNWI is rude

* The two sentences in (1) have the same extensional semantics; yet the first one seems more informative.  
* The two sentences in (2) are assigned the same truth value in each possible world; yet intuitively one may be true and the other false.

⇒ There is more to the meaning of words than their extension: co-extensional expressions may have different *senses*. 
Lexical Meaning

• Lexical semantics is about *word senses* – but, what are they?
• For Frege the *sense* of an expression is the manner in which we determine its reference; a mode of presentation: a particular way of determining its extension.
• We can think of this as a way of fleshing out the interpretation function that determines the extension of each word.
  * when does an entity belong to the extension of, say, ‘*dolphin*’?
• During the first part of the course we will look into different proposals for characterising and representing lexical meaning:
  * **Decompositional** approaches: the Generative Lexicon proposed by Pustejovsky
  * **Psychological** theories of word meaning:
  * **Distributional** Semantic Models

*but recall that this is not meant to be an exhaustive course on lexical semantics!*
Semantic Relations

- Lexical semantic theories are also interested in accounting for semantic relations that hold between senses.
- The most common sense relation are the following:
  - **Hyponymy and Hypernymy**: relation of semantic inclusion that holds between a more general term such as ‘bird’ and a more specific term such as ‘robin’
  - **Synonymy**: relation of semantic identity between senses, e.g. ‘aurora/dawn/sunrise’, ‘whore/prostitute’
  - **Antonymy**: relation of semantic oppositeness between senses, e.g. ‘tall/short’, ‘dead/alive’
  - **Meronymy**: part-whole relation between senses, e.g. ‘elbow/arm’, ‘keyboard/computer’
- However, sense relations seem to be “metalinguistic”:
  - they do not lie at the basis of our knowledge of the meaning of words, but our knowledge of the meaning of words lies at the basis of our ability to identify or attribute sense relations.
- Different theories of word senses will explain sense relations differently.
Next Week

Next week we will introduce componential approaches to word meaning, paying special attention to the *Generative Lexicon* framework.

**Homework:** Readings to be done *before* the lecture next week:


You can find links to these papers on the course website: [http://staff.science.uva.nl/~raquel/teaching/mom2010/](http://staff.science.uva.nl/~raquel/teaching/mom2010/)