

# Semantics: An Introduction

week2

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- ① Background
- ② Mathematics for Linguists
- ③ Semantic Theory and Linguistic Complexity
- ④ Bibliography

# Semantics, Why

- Semantics is the study of meaning (communicated through language).
- Linguistic description is an attempt to reflect a speaker's linguistic knowledge, the semanticist is committed to describing **semantic knowledge**.
- Why it's hard and not popular?
- Key of cognition, communication and culture.

# Semantic Knowledge

## Example

- Synonymous
- Contradictory
- Ambiguous
- Entailment
- . . . . .

# Semantic Knowledge Processing

- To show how people communicate meanings with pieces of language, knowing what we know is not enough.
- (Linguistic) **meaning processing** is a special subset of the more general human ability to use **signs** to process **signals**.

# How do you do that?

## Example

- ① Happiness *means* 'the state of being happy'. → can be defined as
- ② Happiness *means* never having to frown. → results in
- ③ Happiness *means* gladness. → is a synonym of
- ④ Happiness *means* what I'm feeling right now. → refers to
- ⑤ Glädje *means* happiness in Swedish. → can be translated as
- ⑥ Happiness *means* something more ordinary than ecstasy. → connotes,  
[or, is associated with]

What is Meaning? | What kinds of semantic theory do we need?

# Challenges in Doing Semantics

- Problem of **circularity** by adopting a naive **definitions theory**
- Distinction between **linguistic knowledge** and **non-linguistic knowledge** (e.g., encyclopedic knowledge, conceptual knowledge).
- Role of **context** to meaning.



# Representational Approach

*A guess is that meanings are something in the mind: concepts, thoughts or ideas. This approach to meanings is known as the representational approach or the idea theory of meaning.*

# Meanings are Social Games/Practices

# Meanings are out in the world

- Meanings are not internal to language, are not in the mind, and are not merely social practices.
- Rather, they are based in language- and mind-external reality.

## Meanings in terms of Truth Conditions

- If the meanings of some nouns are language- and mind-external realities, what is the *meaning* of a sentence? e.g., what does "The circle is inside the square" mean?
- If you understand the meaning of the sentence above, you will be able to tell us **what scenario is true and what scenario is false**, i.e., the knowledge of meaning involves (at least) the knowledge of the conditions under which a sentence is true, and those under which it's false.

Note that knowing the meaning of a sentence amounts to knowing its truth conditions, not whether it is true or false (what semanticists call its truth value).

# Semantic Meaning vs. Speaker's Meaning

- The semantic meaning of a sentence is its literal meaning, based on what words individually mean and the grammar of the language.
- The speaker's meaning of a sentence is what the speaker intends to communicate by uttering it.

☆ ⓧ hsiao-wen to me

我把鑰匙留在機車上，在寶雅走廊

↩ Reply   ➡ Forward   ⓧ 小文 is not available to chat

# Philosophers have a say

## meaning holism

- Proposed by the philosopher Quine, the theory of holism claims that the meaning of a word or phrase or sentence depends on its relationship with other words, phrases and sentences. For example, the meaning of tall is that it's opposed to the meaning of short.
- More precisely, holist theories tend to be **functional** in the sense that it is some aspect of the use of a piece of language which makes for that if you call something tall, you should not at the same time call it short, and if you call something tall you should be willing to also call it not short.

So what do we do to construct a theory of semantics?

- ① have to set out the criteria that we expect **minimally** to be met by any part-way reasonable explication of interpretation for natural language expressions.
- ② then turn to putative models of language to see how well they can meet the target of satisfying those criteria.



What would be these minimal criteria?

- needs to tackle with the problem of the compositionality of meaning  
→ An adequate semantic theory must provide an account of how the meanings assigned to words are put together in a systematic way by the syntactic constructions of a language to yield interpretations.
- and this process, whatever it is, must allow for recursive complexity in order to account for the multiple-embedding properties of natural languages.

# Keep updating yourself

- Semantics is the articulation of the relation between natural language expressions and the world around which language enables humans to talk about.
- Yet, in the research that has been developing over the last twenty years, the assumptions on which semantics has been grounded have been progressively shifting;
- in consequence, **earlier disputes over the relation between semantics and the cognitive enterprise in general can be seen in an entirely different light.**

# Recent Developments in Semantics

## Example

Developing theories on a broader basis of empirical evidence, taking into account *cross-linguistically data*, *diachronic data*, *psycho- and neurolinguistic data* as well as *corpus and computational linguistic resources*.

# Recent Developments in Semantics

## EMERGENT SEMANTICS

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### SYNONYMS

Bottom-Up Semantics; Evolutionary Semantics

### DEFINITION

*Emergent semantics* refers to a set of principles and techniques analyzing the evolution of decentralized semantic structures in large scale distributed information systems. Emergent semantics approaches model the semantics of a distributed system as an ensemble of relationships between syntactic structures. They consider both the representation of semantics and the discovery of the proper interpretation of symbols as the result of a self-organizing process performed by distributed agents exchanging symbols and having utilities dependent on the proper interpretation of the symbols. This is a complex systems perspective on the problem of dealing with semantics.

# In a Nutshell

**Natural Language Semantics** classically concerns a triadic structure comprising a **symbol** (how some idea is expressed), an **idea** (what is abstracted from reality), and a **referent** (the particular object in reality).

# Your Motivation Shapes How you Gain and Grow



## MODERN DATA SCIENTIST

Data Scientist, the sexiest job of the 21st century, requires a mixture of multidisciplinary skills ranging from an intersection of mathematics, statistics, computer science, communication and business. Finding a data scientist is hard. Finding people who understand who a data scientist is, is equally hard. So here is a little cheat sheet on who the modern data scientist really is.

### MATH & STATISTICS

- ☆ Machine learning
- ☆ Statistical modeling
- ☆ Experiment design
- ☆ Bayesian inference
- ☆ Supervised learning: decision trees, random forests, logistic regression
- ☆ Unsupervised learning: clustering, dimensionality reduction
- ☆ Optimization: gradient descent and variants

### DOMAIN KNOWLEDGE & SOFT SKILLS

- ☆ Passionate about the business
- ☆ Curious about data
- ☆ Influence without authority
- ☆ Hacker mindset
- ☆ Problem solver
- ☆ Strategic, proactive, creative, innovative and collaborative

### PROGRAMMING & DATABASE

- ☆ Computer science fundamentals
- ☆ Scripting language e.g. Python
- ☆ Statistical computing packages, e.g., R
- ☆ Databases: SQL and NoSQL
- ☆ Relational algebra
- ☆ Parallel databases and parallel query processing
- ☆ MapReduce concepts
- ☆ Hadoop and Hive/Pig
- ☆ Custom reducers
- ☆ Experience with xaaS like AWS

### COMMUNICATION & VISUALIZATION

- ☆ Able to engage with senior management
- ☆ Story telling skills
- ☆ Translate data-driven insights into decisions and actions
- ☆ Visual art design
- ☆ R packages like ggplot or lattice
- ☆ Knowledge of any of visualization tools e.g. Flare, D3.js, Tableau



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## Why Formal Introduction (First)?

- Formalization allows the construction of very precise theories, and precise theories are better because they do not allow the theorists to fudge the data quite so easily as less precise theories do.
- good for implementation in computational settings, and for exploring the relations between semantics and the other sub-disciplines of linguistics which have a formal flavor, like syntax, as well the interdisciplinary field known as cognitive science, in particular computer science, psychology, philosophy and neuroscience.



- **natural deduction: a syntactic mode of inference**
- conditional elimination: *Modus Ponens*  
$$\frac{\phi \rightarrow \psi, \phi}{\psi}$$
- conditional introduction: conditional proof

## Logic and other formal requirements

Provide a formal model of meaning in natural language means: Providing a formal basis for the mapping of strings of a given language onto some assigned content in a way that reflects the general principles within the language for mapping the meaning of the individual words onto the meaning of all more complex expressions that can be formed from them.

- propositional and predicate logic (together constitute the so-called *classic logic*)
- proof theory and model theory
- feature structure representation (e.g, attribute-value matrix)

# Other Mathematical Methods

- Calculus
- Linear Algebra
- Graph theory
- . . . . .

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## Starting from words(?)

In making a first stab at the problem of compositionality, one might assume that one should first look at word meanings, and then define a process of combining those meanings together.

- word senses and sense relations

- Words are **protean** in nature. i.e., they can shift meanings in different **contexts** of use.
- For example, Conventional meanings for *zero* includes 'naught', 'freezing temperature', and 'nonentity'. BUT,

### Example

Clark et al, 1983 a. You'll have to ask a zero. ('people you can reach on a telephone by dialing zero')

b. All the zeros must redo their papers. ('people with a grade of zero on a paper')

## Example

Clark et al. 1983

- a. A crab scuttled along the beach.
- b. I like crab. ('crab meat')
- c. There's crab on the menu. ('a dish with crab meat')
- d. How many crabs do you have there? ('said by a grocery clerk, 'cans of crab meat')
- e. I stopped in Perry's for a quick crab. ('meal of crab meat')
- f. ....

## Example

- a. France is a country of outstanding natural beauty. (geographical landmass)
- b. France is one of the leading nations in the European Union. (political nation state)
- c. France beat New Zealand in the 2007 Rugby World Cup. (rugby team)
- d. France voted against the EU constitution in the 2005 referendum. (French electorate)



**Polysemy:** Theoretical approaches to polysemy fall into two schools of thought:

- **The monosemy position:** there is no need to represent multiple senses of lexemes in the mind (e.g., **The Generative Lexicon**), the senses of a word can be derived by predicable processes from a single semantic representation;
- **The polysemy network position:** the senses of a word have separate, albeit connected representations.(e.g., **Radial Network of Senses**)

Example: What can be opened? (Searle, 1983)

Example

- a. John opened the window.
- b. John opened his mouth.
- c. John opened his book.
- d. John opened his briefcase.
- e. John opened the curtains.
- f. The carpenter opened the wall.
- g. The surgeon opened the wound.
- h. The sapper opened the dam.

## More figurative examples ... (Evans, 2009)

### Example

- a. The discussant opened the conversation.
- b. John opened a bank account.
- c. John opened the meeting.
- d. John opened a dialogue.
- e. John opened the curtains.
- f. The Germans opened hostilities against the Allies in 1940.
- g. The skies opened.
- h. He opened his mind to a new way of thinking.
- g. He finally opened up to her.

**Regular Polysemy:** A variety of polysemy that gets a fair amount of linguistic attention is **regular (or systematic)** polysemy. This refers to word senses that are distinct, but which follow a general pattern or rule in the language.

- *container/contents:*

I put some sand into a box/bottle/tin/canister.

I dumped the whole box/bottle/tin/canister onto the floor.

- location/government/inhabitants:city

- physical object/information: book

- . . . . .

## Meaning Underspecification: Challenges to Polysemy

Within lexical semantics, polysemy is the issue that has received the most attention. At least three distinct approaches to handle it:

**Lexical rules** They deduce secondary readings of a word from a presumed "primary" reading.

**Underspecification** Represent the "kernel meaning" underlying all the word's readings, formulate rules for spelling it out in a particular context

**Spreading activation** either in a neural network or in a (symbolically represented) semantic network.

## Underspecified Meanings: 1 (Pustejovsky, 1995)

**begin** is *syntactically polymorphic*:

### Example

- a. Mary **began** *[to eat her breakfast]*.
- b. Mary **began** *[eating her breakfast]*.
- c. Mary **began** *[her breakfast]*.

but *semantically underspecified*:

### Example

- a. Mary **began**  
her beer/thesis/dinner/class/homework/bath
- b. John **enjoyed**  
his coffee/movie/cigar/discussion/appointment

## Underspecified Meanings: 2

How many meanings for **good**?

### Example

- (a) a *good* car
- (b). a *good* meal
- (c). a *good* knife

What does *noisy* select for?

### Example

- (a). a *noisy*<sub>1</sub> car
- (b). a *noisy*<sub>1</sub> dog
- (c). a *noisy*<sub>2</sub> room
- (d). a *noisy*<sub>2</sub> cafeteria

## Underspecified Meanings: 3

What about distinct but overlapping word senses?

### Example

- a. John *baked* the potatoes.
- b. Mary *baked* a cake.
- a. Mary *cooked* a meal.
- b. Mary *cooked* the carrots.
- a. John *fried* an omelet.
- b. John *fried* an egg.



# Delimit the realm of Lexical Semantics: Semantics or Pragmatics

## Cinderella's shoe

Cinderella was going to be late for the ball because she couldn't find her other **shoe**.



## Cinderella's shoe

The mare was almost ready to pull the carriage, but Cinderella was going to be late for the ball because she couldn't find her other shoe. She had three of them piled on the table in the blacksmith's shop, but where was that fourth one?

- We make **pragmatic inferences**, which is **defeasible** (i.e., able to be cancelled out by providing further information)
- What help you with that?
  - **context**: the rest of the linguistic material surrounding the word.
  - **background knowledge = word knowledge = encyclopedic knowledge**
  - and more, e.g., knowledge about the discourse situation at hand.

# Compositionality

The general principle is called "compositionality". But the rules of semantic combinatorics respect the rule of syntax. So, there are two parts to the process of semantic interpretation: (a) the meaning of the words, and (b) their mode of combination.

The relation between form and meaning is stated in the principle of compositoinality, due originally to the German logician Gottlob Frege:

*The meaning of a larger expression is a function of the meanings of its parts, and the syntactic rules that are used to combine them.*

Though we can use words to successively build up a composite whole, this process has also to be sensitive to how the context contribute to such a process.

## Challenges to simple Compositionality

- Assumptions: Language meaning is compositional. → **Compositionality** is a desirable property of a semantic model.
- The (weak version) of **the principle of compositionality** doesn't work well:
  - (German): Damenschuh (lady's shoes) ✓, Schnürschuh (sneakers) ?
  - (Chinese):
  - (English) : a beautiful dancer; a criminal lawyer
  - so, where do these differences originate?

# Semantics and Semantic Theory

**A semantic theory must** (revised from Kempson (1977); Cann(1993))

- Capture for any language the nature of **meaning composition**;
- Be able to predict the **ambiguities** and **polymorphism** in the expression of language;
- Characterize and explain the systematic relations between syntax and semantics.
- Give an account of the relation between linguistic expressions and **extra-linguistic objects** (denotation).

## The Generative Lexicon (as a Testbed)

[Pustejovsky, 1991]

- Explain the *polymorphic nature* of language;
- Capture the *creative use of words* in novel contexts;
- Develop a richer, *co-compositional* semantic representation. (Unlike purely verb-based approaches to compositionality, GL attempts to spread the semantic load across all constituents of the utterance.)

*Methodologically*, GL has been trying to promote a research *paradigm shift* in lexical semantics (i.e., from **Sense Enumeration Lexicon** to **Sense Generative Lexicon**).





Pustejovsky, J. (1991).

The generative lexicon.

*Computational linguistics*, 17(4):409–441.