Semantics I, Rutgers University
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Week 1
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Preliminaries

1. What is formal semantics?

Semantics is the branch of linguistics devoted to the investigation of **linguistic/literal meaning**, i.e, the interpretation of expressions in a language system. Formal Semantics seeks to constructing precise **mathematical models (e.g., formal logic)** of the semantic principles.

2. The framework we'll work with: compositional semantics

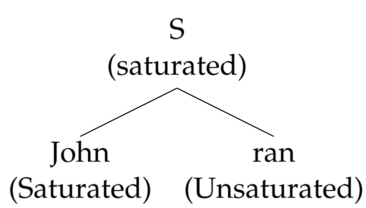
- Any natural language has infinitely many sentences, but the brain is finite. So, for **syntax**, linguistic competence must involve some finitely describable means for specifying an infinite class of sentences.

  In analogous, a speaker of a language knows the meanings of those infinitely many sentences, and is able to understand a sentence she hears for the first time. So, for **semantics**, there must also be finite means for specifying the meanings of the infinite set of sentences of any natural language.

- In generative grammar, a central principle of formal semantics is that the relation between syntax and semantics is *compositional*.

  (1) **The principle of compositionality (Fregean Principle):**
  The meaning of a complex expression is determined by the meanings of its parts and the way they are syntactically combined.

  (2) John ran.

  a. ran is a *function* that mapping each individual x to the sentence 'x ran'.
  b. John is an *argument* of the function ran.
  c. The meaning of these two words combine via the composition rule *functional application*, i.e., applying the function run to John: $[\![\text{John ran}]\!] = [\![\text{ran}]\!]([\![\text{John}]\!]) = \mathsf{ran}(\mathsf{j})$

- As such, the (literal) meaning of a complex expression is determined by:

  1. the lexical meaning of each word/idom
  2. the syntactic structure (esp. logical form) of this expression
  3. the composition rules

- **Semantic ambiguities** can arise from any of the above three factors

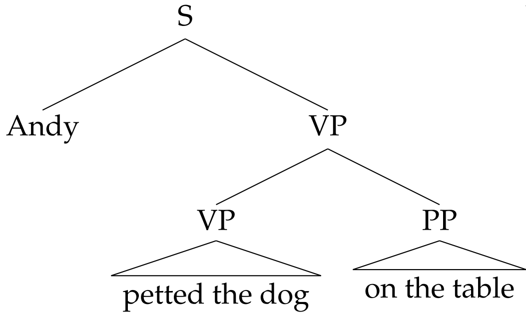
  1. Lexical ambiguity

     (3) Jimmy's house is near the bank.

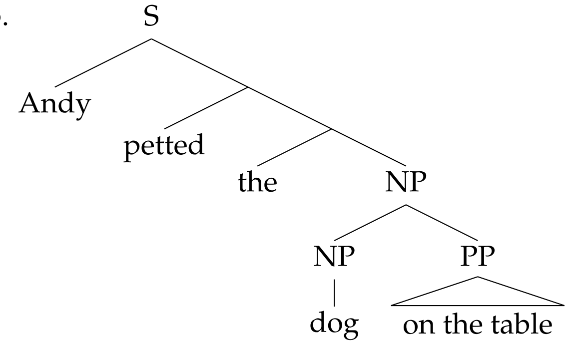
  2. Structural ambiguity
     Case 1: Modification (labels for non-terminal nodes are omitted)

(4) Andy petted to the dog on the shelf.

a.



b.



Case 2: Scope ambiguity of quantificational expressions[1]:

(5) Every shark attacked a pirate.

√ Every shark attacked a (different) pirate.

√ Every shark attacked the same pirate.

3. Selection of composition rules:

(6) Andy is a funny dancer.

a. Functional application: *Andy is funny when he dances.*

b. Predicate modification: *Andy is funny (in general), and he is a dancer.*

3. What is meaning?

3.1. Meaning as truth conditions

- **Truth conditions**

Heim & Kratzer (1998): To know the literal meaning of a sentence is to know its **truth conditions**, namely, the conditions under which a sentence is true, and those under which it's false.

(7) *Schema for truth conditions*
The sentence "________________" is true if and only if ________________.

(8) "Andy lives in Highland Park" is true iff Andy lives in Highland Park.

If an expression is substituted by another one while leaving the rest of the sentence as it was and the truth-conditions of the sentence change, the two expressions differ in semantic meaning. Compare:

(9) a. A **turtle** sleeps under the couch.

[1] Pictures are taken from Benjamin Bruening's Scope Fieldwork Project (http://udel.edu/bruening/scopeproject/scopeproject.html).

b. A **cat** sleeps under the couch.

(10) a. The cat sleeps under the **couch**.
b. The cat sleeps under the **sofa**.

- **Interpretation, extension, intension**

  The literal meaning of a syntactic expression X is $[\![X]\!]$. $[\![\bullet]\!]$ is called **interpretation function**; it maps a syntactic expression to the interpretation/denotation/(literal) meaning of this expression.

  – The **extension** of an expression is dependent on the evaluation world. We add an *evaluation world* to the interpretation function. The extension of a sentence is a truth value. For example, if Andy and Billy both live in Highland Park in w, then:

  (11) a. $[\![\text{Andy lives in Highland Park}]\!]^w = \text{TRUE}$
  b. $[\![\text{Billy lives in Highland Park}]\!]^w = \text{TRUE}$

  These two sentences have the same extension in w. However:

  (12) Andy and Billy live in HP, and Mary believes that Andy lives in HP.
  $\not\Rightarrow$ Mary believes that Billy lives in HP.

  – The **intension** of an expression is a function that maps a possible world to the extension of this expression in that world. The intension of a sentence is a function from worlds to truth values, called *proposition*. For example, the above two sentences have the same extension in w but different intension:

  (13) a. $[\![\text{Andy lives in Highland Park}]\!] = \lambda w : [\![\text{Andy lives in Highland Park}]\!]^w = \text{TRUE}$
  b. $[\![\text{Billy lives in Highland Park}]\!] = \lambda w : [\![\text{Billy lives in Highland Park}]\!]^w = \text{TRUE}$

- **Definedness conditions**

  We can assign the extension of a sentence in w to TRUE/FALSE only when this sentence is defined in w. **Presuppositions** are modeled as definedness conditions.

(14) *Schema for definedness conditions*
The sentence "________________" is defined only if ________________.

(15) "Andy's daughter lives in Highland Park" is defined only if Andy has a daughter; when defined, this sentence is true iff Andy's daughter lives in Highland Park.

3.2. Meaning beyond truth conditions

- **Sentences not defined in terms of truth conditions**

  – Questions *per se* don't have truth conditions — you don't say a question is true or false. But, interpretations of question-embeddings involve world-dependency: knowing a question (roughly) means knowing the complete true answer of that question.

  (16) a. Is it raining?
  b. Judy knows whether it is raining.
  = *if it is raining, Judy knows that it is raining; otherwise, Judy knows that it isn't raining.*

  – Imperatives

  (17) a. Give me a pen!

b. Get out of here or I call the police.

– Biscuits-conditionals

(18) If you are hungry, there are some biscuits in the fridge.
$\neq$ *If it is true that you are hungry, then it is true that there are some biscuits in the fridge.*

- **Complexities of truth-condition-based meaning**

– "Meaningful" contradictions

(19) a. Is John smart? He is and he isn't. [implicit context dependence]
b. Is it raining? It is and it isn't. [vagueness]
c. John is in that room. But for me in that room there is nobody. John is not a person.

- **Problems with synonymy**

Sameness of truth conditions doesn't warrant universal substitutivity.

– Binding

(20) The Riddler has scattered five clues around and ...
a. Batman has found all but one of the five clues.
b. Batman has found four of the five clues.

(21) a. John believes that [Batman has found all of the five clues but one].
b. John believes that [Batman has found four of the five clues].

However: (After Partee)

(22) a. [Batman has found all of the five clues but one], which is pinned on his back.
b. ?? [Batman has found four of the five clues], which is pinned on his back.

– Answer focus and *it*-clefts

(23) Who did Mary invite?
a. Mary invited JOHN.
b. # MARY invited John.

(24) Mary baked the cake.
a. No, it was Sue who baked the cake.
b. # No, it was the cake that Sue baked.

4. Inferences: Entailments, presuppositions, and implicatures

- Truth is intimately related to inference and reasoning: a sound way of reasoning takes you from a premise A to a conclusion B in a truth preserving way. We may not know whether A is true or not, but we may know that if A is true, B must also be true.

- **Entailments**

A **entails** B ('$A \Rightarrow B$') iff B is true whenever A is true.

In natural languages, a commonly proposed test for entailments is as follows: ϕ entails ψ iff "ϕ but not ψ" is intuitively contradictory. For example:

(25) a. John and Mary left, but Suzi didn't leave.
(Not contradictory. Hence "John and Mary left" $\not\Rightarrow$ "Suzi left".)

b. # John and Mary left, but John didn't leave.
(Contradictory. Hence "John and Mary left" $\Rightarrow$ "John left".)

Nevertheless, this test doesn't always work:

(26) # John or Mary left, but both John and Mary left.
(Sounds odd. But "John or Mary left" $\not\Rightarrow$ "John and Mary didn't both leave".)

Discussion: Why does this test fail?

– The following contradiction test in the form of a question-answer pair is more reliable:

(27) a. Q: Did John and Mary leave?
A: Yes. # Actually, John didn't leave.

b. Q: Did John or Mary leave?
A: Yes. Actually, they both left.

- **Presuppositions**

Presuppositions are inferences taken for granted (i.e., being part of the conversational background). Presupposition **projects** over a family of sentences: If ϕ presupposes p, the presupposition p is inherited by "$\neg\phi$", "if ϕ, then ψ", "perhaps ϕ" and "ϕ?".

(28) a. John's daughter is coming.
b. John's daughter is not coming.
c. If John's daughter is coming, then we will have a party tonight.
d. Perhaps John's daughter is coming.
e. Is John's daughter coming?
Presupposition: John has a daughter.

Presuppositions are also entailments. If A presupposes B, then B is an entailment of both A and not-A.

(29) a. # Andy's daughter lives in HP, but he doesn't have a daughter.
b. # Andy's daughter doesn't live in HP, but he doesn't have a daughter.
c. Q: Does Andy's daughter live in HP?
A: Yes. # Actually, he doesn't have a daughter.
d. Q: Andy's daughter doesn't live in HP, right?
A: Yes. # Actually, he doesn't have a daughter.

However, the above contradiction test doesn't always work in complex sentences:

(30) a. If my daughter lives in HP, I will move to there too. But, I don't have a daughter.
b. Q: If Andy's daughter lives in HP, he will move to HP, right?
A: Yes, he always wants to stay with family. But, actually, he doesn't have a daughter.

- **Implicatures**

Unlike entailments, implicatures can be easily cancelled. It is standardly assumed that implicatures are not part of literal meaning; instead, they arise from conversational norms.

(31) a. Some of my students live in Highland Park.
$\rightsquigarrow$ *Not all of my students live in Highland Park.*
b. Do some of my students live in Highland Park?
Yes. Actually, all of my students live in Highland Park.

- **Questionnaire**

(32) a. What is your previous exposure to semantics and logic?
  b. What is your previous exposure to linguistics outside of semantics?
  c. How would you rate the level of your interests in learning symbolic models? (1 for extremely uninterested, 7 for extremely interested)
  d. How would you rate your current ability of using/learning symbols models? (1 for extremely bad, 7 for extremely good)
  e. What do you hope to learn in this class?
  f. Do you have any concerns/questions about this class?