Semantik, Modul 1003

Truth-conditional meaning, compositionality, functions and predicates

Heim & Kratzer (1998), ch. 1

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Course topics

1. truth-conditional meaning, compositionality, sets vs. functions, predicate logic
2. composition rules, functional application, semantic types, schönfinkalization
3. λ-calculus, more predicates, interpretation function
4. modification: predicate modification vs. functional application
5. definite determiners: presuppositions
6. relative clauses: predicate abstraction, interpreting traces
7. pronouns: co-indexation, variable binding
8. quantifiers: semantic type, quantifier binding
9. quantifiers in object position, quantifier raising

Truth-conditional semantics

Semantics is the study of meaning. There are various kinds of meaning, and they can be examined from several different perspectives, but this course is about:

Linguistic semantics: The study of meaning in natural language

Here we'll mainly follow the approach known as **formal semantics**.

We understand meaning in terms of **truth-conditions**. So knowing the meaning of a sentence is knowing the conditions under which it would be true. Example:

(1) Barack Obama is the 43rd President of the United States.

A competent speaker of English might not know whether (1) is true, but he knows what the world would have to be like for it to be true.

Truth-conditional semantics

Another example:

(2) The elephant is to the left of the turtle.

Which scenarios make the sentence true? Which scenarios make it false?

(3) a. 
b. 
c. 

(4) a. 
b. 
c. 

The scenarios on the left each make sentence true, the scenarios on the right make the sentence false. So by understanding the sentence, we know what's necessary for it to be true.

Truth-conditional semantics

Sentences can convey all kinds of information. Imagine the following dialogue:

(5) A: Do you want to have lunch with me today?
B: I have to fix my laptop.

There are at least three inferences B's answer conveys:

(6) a. B has to fix her laptop. *truth conditions*
b. B owns a laptop. *presupposition*
c. B doesn't have time to have lunch with A. *implicature*

We will mostly be concerned with inference (6a) in this course!

We will briefly touch on inferences like (6b) when we talk about definite determiners. We will, however, not have time to discuss inferences like (6c), mainly because it belongs to the field of *pragmatics*.

The merits of formalism

Formal semantics can be rather difficult in the beginning. We will employ tools from formal logic to model natural language meanings.

(7) $[\![\textit{every}]\!] = \lambda P_{\langle e,t \rangle} \lambda Q_{\langle e,t \rangle} . \forall x [P(x) \rightarrow Q(x)]$

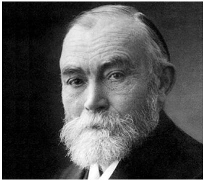
Why so complicated?

- the formalism requires precision and clarity because of the use of well-understood systems of logic
- the implications of a particular analysis are easy to determine and test
- we avoid a potential circularity, because the symbols are themselves independently defined
- the properties of logical languages can provide insight into the nature of the semantics of natural languages

What is meaning?

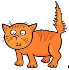
Gottlob Frege (1848-1925), mathematician and philosopher, distinguishes *sense (= Sinn)* and *reference (= Bedeutung)* in his essay *Über Sinn und Bedeutung*.

1. Sinn: *Art des Gegebenseins des Bezeichneten* (also idea, concept, etc.)
2. Bedeutung: *Gegenstand, auf die sich das Zeichen bezieht*



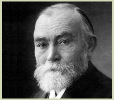
Sinn is also called **intension**, whereas *Bedeutung* is called **extension**.

An example:

Katze: extension/Bedeutung ⇒ , ,  , ...

intension/Sinn ⇒ [+tier,+weiblich,+fellhabend,...]

What is meaning?



Frege's motivation for differentiating between *Sinn* and *Bedeutung* came from thinking about identity statements like *a*=*a* and *a*=*b* and why only the latter is informative. The famous example:

(8) a. Der Morgenstern ist der Morgenstern. *a*=*a*

b. Der Morgenstern ist der Abendstern. *a*=*b*

The planet Venus can be referred to either with *Morgenstern* or *Abendstern*.

$\text{Sinn}_{Morgenstern}$: last star occuring in the morning $\Rightarrow$

$\Leftarrow$ $\text{Sinn}_{Abendstern}$: first star occuring in the evening

The cognitive significance of *a*=*b* is not based on the difference in signs. The relation between signs and what they refer to is arbitrary (Saussure). It is not based on *Bedeutung* either since  =  is not informative. What makes the identity statement (8b) informative is the difference in senses!

What is meaning?

Sinn$_{Morgenstern}$: last star occuring in the morning ⇒

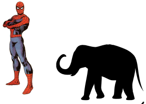
meaning!

⇐ Sinn$_{Abendstern}$: first star occuring in the evening

For this course, we're going to adopt the idea that meanings are anchored outside of language and outside the mind in the real world.

Frege calls the *Sinn* of a sentence a *thought (= Gedanke).* The *Bedeutung* is a truth value (or rather its truth conditions).

Gedanke$_1$: Spiderman is to the left of the elephant. ⇒

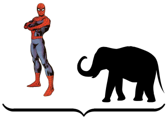


meaning!

⇐ Gedanke$_2$: Peter Parker is to the left of the elephant.

What is meaning?

Gedanke$_1$: Spiderman is to the left of the elephant. $\Rightarrow$



extension

$\Leftarrow$ Gedanke$_2$: Peter Parker is to the left of the elephant.

Thoughts/concepts/intensions of sentences are important for **intensional semantics**. They deal with sentences whose truth value depend on hypothetical scenarios. Examples:

(9) a. Imke might golf. *modals*

b. Jelena believes that Imke golfs. *attitude predicates*

c. If Jelena golfed, then Imke wouldn't be alone. *conditionals*

We, however, will only have time to talk about **extensional semantics**. Truth-conditions are conditions on how the actual world must be. A sentence is true iff it is an accurate description of the world.

How to approach sentence meaning

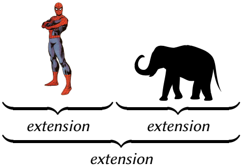
We've adopted the idea that the meaning of a sentence is its truth-conditions.
But how do we take a given sentence and figure out what its truth-conditions are?

For words it's reasonable to think that there's just something like a mental lexicon where we look up the meanings.

But this clearly isn't right for sentences. The sentences of a language are infinite and unlistable. We would never be able to put together the complete dictionary of sentence meanings, because there would always be more sentences.

Fortunately, sentential semantics seems to have a very convenient property that makes all of this manageable. It is **compositional**.

(10) Spiderman is to the left of the elephant.



Compositionality

As long as we know the meanings of the individual words and can figure out (with the help of the syntax) how they are put together, we can reliably figure out the meaning of the whole thing.

This is one of the most important ideas of linguistic semantics, and the central principle on which this course will be built.

And, again, this idea comes from **?**)][49-50]Frege1892.

> **Compositionality**
>
> The meaning of an expression is determined by the meaning of its component parts and the way in which they are combined and nothing else.

This means that our rules for connecting expressions of natural language to formal language must include not only a way of assigning meanings to simple words, but also a way of combining these meanings together to assign meanings to complex units. The way we do this is using **compositional rules**.

Syntax and Semantics

Compositionality

The meaning of an expression is determined by the meaning of its component parts and **the way in which they are combined** and nothing else.

Compositional semantics will always be closely tied to syntax. Specifically, semantic interpretation will be at least partly guided by syntactic structure in figuring out how to combine together the pieces it's presented with.

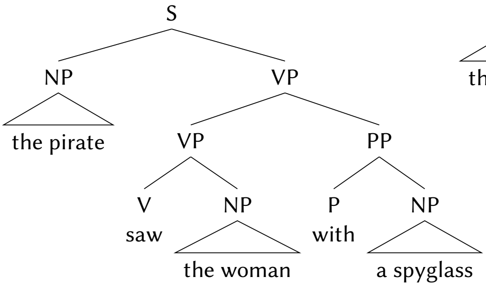
Let us look at an example again: The following sentence can have two different readings. Which are they?

(11) The pirate saw the woman with a spyglass.

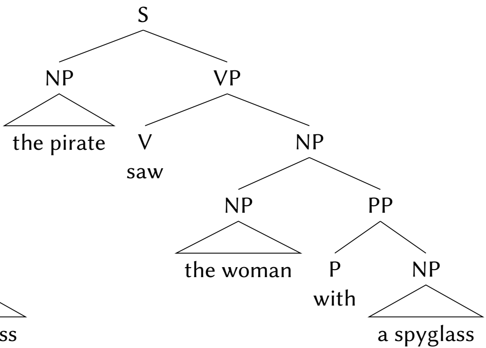
$\leadsto$ The pirate used a spyglass to see the woman.
$\leadsto$ The pirate saw the woman, who had a spyglass.

Syntax and Semantics

(12) The pirate saw the woman with a spyglass.



The pirate used a spyglass to see the woman.



The pirate saw the woman, who had a spyglass.

Predicates and Saturation

The way that Frege thought about composition specifically involved the saturation of one meaning component by another. This corresponds closely to what you learned about *predicates* and *terms* within *predicate logic.*

(13) Spiderman is sleeping.

Composition brings together...

... a complete meaning component

... and an unsaturated meaning component

$\hookrightarrow$ also known as predicates, properties

The complete meaning component *Spiderman* saturates the predicate *is sleeping*, yielding a proposition with a truth condition.

Predicates and Saturation

In other words, the argument *Spiderman* fills the gap of the open slot of the predicate *is sleeping*, yielding a proposition with a truth condition. ($[\![\ ]\!]$ = interpretation function)

(14) $[\![$Spiderman$]\!]$ =

(15) $[\![$is sleeping$]\!]$ = $\left(\quad \right)$

$\mapsto$ TRUE

(16) $[\![$Spiderman is sleeping$]\!]$ = (

)

$\mapsto$ TRUE

We know the meaning of the sentence (truth conditions) and the meaning of *Spiderman* (by pointing to the thing in the world). So we are able to figure out the meaning of *is sleeping* by taking the sentence and substracting the meaning of *Spiderman*.

Transitive verbs (two-place predicates)

Until now, all of our examples have involved just a subject and a predicate, i.e. they've been intransitive. Let's try out a transitive, i.e. a sentence with two arguments: a subject and a direct object.

(17) Spiderman beschimpft Hulk.

(18) $[\![\text{Spiderman}]\!] =$ 

(19) $[\![\text{Hulk}]\!] =$ 

(20) $[\![\text{beschimpft}]\!] = \left(\quad \right)$ 

$\left(\quad \right) \mapsto \text{TRUE}$

(21) $[\![\text{beschimpft Hulk}]\!] =$????

Transitive verbs (two-place predicates)

A two-place predicate becomes a one-place predicate (a property in other words), after the first argument slot has been filled.

(22) $[\![$beschimpft Hulk$]\!] = \big(\quad\big)$ Du Holzkopf! $\Bigg($  $\Bigg) \mapsto$ TRUE

After filling the second slot, we get a proposition (an atomic statement in predicate logic).

(23) $[\![$Spiderman beschimpft Hulk$]\!] = \Bigg($  $\Bigg)$ Du Holzkopf! $\Bigg($  $\Bigg) \mapsto$ TRUE

Let us assume that whether the argument is to the right or to the left of the speech bubble determiners who is the one getting scolded and who is doing the scolding. But how do we determine which argument goes where?

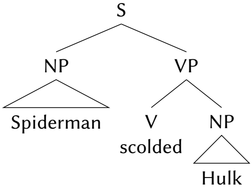
Transitive verbs (two-place predicates)

How do we determine which argument goes where?

(24) ⟦Spiderman scolded Hulk⟧ = 

$\mapsto$ TRUE

We will make use of syntax again!



Syntactically, it is clear that the verb first combines with the direct object to form the verb phrase, and only later with the subject. So the meaning of *scolded* needs to somehow say that the first argument it combines with goes in the slot on the right.

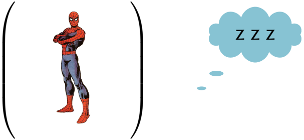
Object language, metalanguage

With our notation, we have so far tried to come as close as we can to extensions. From now on, we will make use of notation which is closer to our object language.

Object language is what write in ⟦ ⟧.

Metalanguage can look like what's on the right of "=":

(25) ⟦Spiderman is sleeping⟧ =



$\mapsto$ TRUE

From now on, however, metalanguage will rather look like this:

(26) *is.sleeping(spiderman)* = 1 iff *Spiderman is sleeping*

In fact, most of the time, it will look like this:

(27) *is.sleeping(spiderman)*

Predicates and Functions

We can understand a predicate as a special kind of function:

(28) **Predicate:** a function whose range is restricted to the set of truth values, i.e. true and false or 1 and 0.

What are functions again?

(29) **Function:** a relation between objects in two sets A and B such that:

a. for a given object in A, there is a unique second object in B, i.e. every member in A is mapped onto a unique member in B

b. every member in A is used in the relation, i.e. no member of A is “left out”

Examples:

(30) a. $\textit{square.number}(12) = 144$

b. $\textit{capital}(\textit{Sachsen}) = \textit{Dresden}$

c. $\textit{father}(\textit{Luke Skywalker}) = \textit{Darth Vader}$

Convince yourselves that the examples above are functions!

Predicates and Functions

We can understand a predicate as a special kind of function:

(31) **Predicate:** a function whose range is restricted to the set of truth values, i.e. true and false or 1 and 0.

(32) *is.sleeping(spiderman)* = 1 iff *Spiderman is sleeping*

Let's think about what this means and how it works:

A predicate attributes a property of some sort to the argument it applies to. If that argument has that property, we end up with a true statement, and if it doesn't, we end up with a false statement.

So *is.sleeping* returns 1 when applied to a person or animal who is currently sleeping and 0 otherwise.

Predicates, functions, sets

We can understand a predicate as a special kind of function:

(33) **Predicate:** a function whose range is restricted to the set of truth values, i.e. true and false or 1 and 0.

We can translate functions into sets:

(34) ⟦sleep⟧:=

a. function-talk: *sleep(x)* = 1 iff *x sleeps*

b. set-talk: {x | x is a sleeper} *(the set of all x such that x sleeps)*

Sometimes, it will be useful to define semantic denotations in terms of sets; other times, it will be easier to define them in terms of functions.

References

Frege, G. (1892). Über Sinn und Bedeutung. In Patzig, G., editor, *Funktion, Begriff, Bedeutung*, pages 40–65. Vandenhoeck and Ruprecht, Göttingen.