Session I:
Compositionality and Saturation

1. Truth-Conditions & Compositionality

- **The Meaning of Sentences**

(1) a. The capital of Burkina Faso is Ouagadougou.
b. The capital of Burkina Faso is Niamey.

→ Part of the meaning of sentences is whether they are true or false when interpreted relative to particular situations or utterance contexts.

→ We say that a sentence is true ('1') or false ('2') relative to a situation S. For the examples in (1ab), we can write this as follows, if we take 'S1' to stand for our actual world as evaluation world/situation.

(2) a. $[[(1a)]]^{S1} = 1$
b. $[[(1b)]]^{S1} = 0$

BUT: This cannot be all since…

i. The truth value of sentences can change over time / or situations:

(3) a. Malte is in Ghana → may be true or not depending on the circumstances
b. The cat is on the mat. → is true when interpreted relative to situation S35:

S35: 

ii. We can grasp the meaning of a clause without knowing whether it is true or not.

(4) a. Ouagadougou has more than 1 Mio. inhabitants.
b. The river Nile is longer than 1500 kms.
c. The French president is in Paris right now.

iii. Sentences with identical truth value mean different things nonetheless:

(5) a. Water boils at 100°C temperature under normal conditions ≠
b. Cats are mammals.

- Cresswell (1978): "What I want to put forward as the semantic competence of a speaker is *nothing more or less than his ability, when presented with a sentence and a situation, to tell whether the sentence, in that situation is true or false*."

→ A sentence α is true relative to a given evaluation situation S if and only if the ***truth conditions*** of α are satisfied in S

→ To know the meaning of a sentence is to know its ***truth conditions*** (Tarski 1944)

- **Productivity/Creativity and Compositionality**

i. *Observation I:*

As native speakers of a language, we can produce and interpret utterances of arbitrary length and complexity even if we have never uttered or heard them before:

(6) Ezeulu rose from his goatskin and moved to the household shrine on a flat board behind the central dwarf wall at the entrance.

ii. *Observation II:*

The interpretation of a sentence depends on its syntactic structure.

(7) a. Cats eat mice.
b. Mice eat cats.

(8) a. Audu yaa ga Musa. (HAUSA, CHADIC)
'Audu sees/saw Musa.'

b. Musa yaa ga Audu.
'Musa sees/saw Audu.'

Principle of Compositionality (Frege 1879, Heim & Kratzer 1998: ch.1):

The meaning of a clause, i.e. its truth conditions, depends in a systematic way on the meaning of its parts and the way in which they are syntactically combined

→ ***truth-conditional compositional semantics***

2. Saturation by Functional Application: Functions and Arguments

Q: How to determine the truth conditions of clauses in compositional fashion ?

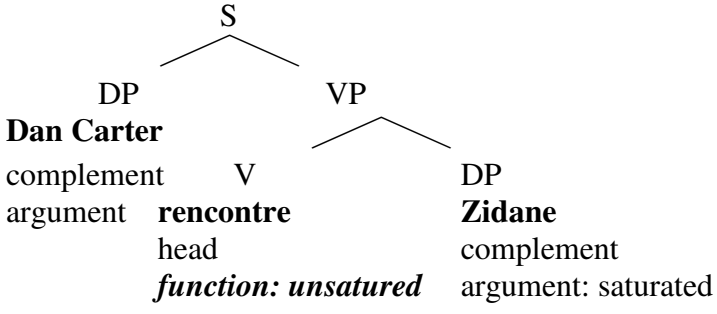
- *Frege's Central Insight:*
Different parts of a sentence play different roles in the derivation of its meaning.

(9) a. predicative expressions (V, A, P, bare Ns): ***unsaturated, semantic functions***
b. nominal arguments (DPs): ***saturated, semantic arguments***

→ Typically, though not obligatorily, there is a tight connection between syntactic *head-complement* structure and semantic *function-argument* structure.

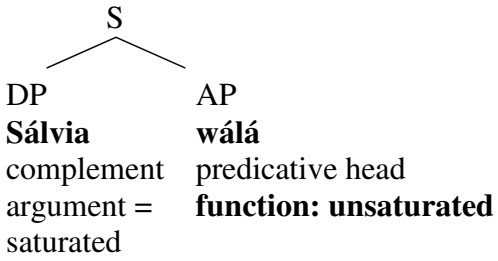
(10) a. Dan Carter *rencontre* Zidane.
Dan Carter met Zidane

b.



(11) a. Sálvía wálá. (BURA, CENTRAL CHADIC)
Sálvía big/important
'Sálvía is big/important.'

b.



→ the same combinatory logic applies to head-complement combinations of P+DP → PP (*in the house*), Det+NP → DP (*the house*), etc.

- *Conclusion:*

  A major mechanism of deriving sentence interpretations in a compositional way consists in applying the meaning of unsaturated, or ***function-denoting***, expressions to the meaning of their saturated arguments, until all argument positions are saturated.

  = ***Function Application***

(12) [[Dan Carter *rencontre* Zidane]] = [[S]]
= [[VP]] ([[DP_{Subj}]])
= ([[V]]([[DP_{Obj}]])) ([[DP_{Subj}]])
= ([[rencontre]])(zidane)(dan carter)

→ The interpretation of a sentence with a transitive verbs and its two syntactic complements involves two instances of function application where the order of semantic arguments is determined by syntactic structure.

Ex.1 How is the meaning of the predicative construction in (11) derived?

3. Technicalities: λ-Calculus (Heim & Kratzer 1998: 34-40)

Q: How can we formally represent the unsatured function meaning of predicative expressions in natural language?

- the λ-calculus allows for a short and concise formal notation of the meaning of function-denoting expressions and of the applicationof these function-denoting expressions to their saturated semantic arguments:

(13) a. [[laugh]] = $\lambda x \in D_e$. x laughs
READ:the meaning of *laugh* is a function that takes individuals x of type e (=entity) as its sole argument and maps them to the truth value '1' if and only if x has the property of laughing in the relevant situation

b. [[important]] = $\lambda x \in D_e$. x is important

c. [[rencontrer]] = $\lambda x \in D_e$. $\lambda y \in D_e$. y meets x

- ***Conventions of the λ-calculus***

(14) i. each ‚.' stands for a function that applies to arguments in its domain and maps them onto function value.

ii. Any variables (x, y, P, ...) bound by a λ-operator to the left of the full Stopp stand for argument positions to be satisfied by arguments from within the fucntion domain.

iii. the expression to the right of the full stop stands for the function value after function application to the argument

iv. if function application yields a truth value (i.t. at the sentence-level), we do not write ‚1' or ‚0', but specify the relevant truth conditions instead.

→ RULE OF THUMB: λ-terms stand for the meaning of unsaturated, function-denoting expressions.

- ***Function application as λ-conversion***

→ We have already seen that the semantic intepretation of many sentences proceeds in a compositional fashion by function application of unsaturated expressions (predicates → functions) to saturated arguments of appropriate kind.

→ the λ-calculus provides an easy technical measn of modelling the semantic composition procedure of function application: *λ-conversion*

(15) λ-conversion (schematically):

i. combine the λ-term (a function) and its argument(s) by writing the argument in round brackets behind the λ-term in square brackets:

a. [λx. P(x)] **(z)**

ii. The result of function application is obtained by deleting the λ-operator and the variable to the left of the full stopp (here: λx) and by replacing the variable in the function value (here: *x*) by the concrete value of the argument (here: z)

b. P(**z**)

(16) *general scheme of λ-conversion:*

[λx. P(x)] (z) ⇔ P(z)

iii. in case of multiply unsaturated functions, the arguments appear in left-to-right order in the order of application, i.e. inner arguments before outer arguments, and the λ-operators are deleted from left to right:

(17) [**λx**. λy. R(y)(x)] (**u**)(v)
⇔ [λy. R(y)(**u**)] (**v**)
⇔ R(**v**)(u)

- **Sample derivation:**

(18) [[Dan Carter *rencontre* Zidane]] = ?

(19) a. [[Dan Carter rencontre Zidane]] = ([[rencontre]])(zidane)(dan carter)

b. = [λx∈ D_e. λy∈ D_e. y meets x] (zidane)(dan carter)

c. = [λy∈ D_e. y meets Zidane] (dan carter)

d. = 1 iff Dan Carter meets Zidane.

Ex.2 How is the meaning of the predicative construction in (11) derived by means of λ-calculus and λ-conversion?

4. An apparent problem & two solutions

- *Observation:* In many agglutinating languages (including some Romance languages, Bantu languages, North American languages, and possibly more), it appears that pronominal arguments need not be realized overtly:

→ In such cases, the sentence seems to consist of a verb plus agreement morphology

(20) a. T-a-híy-u-‘ (LAKHOTA, Baker 1995)
cis-fact-1sI/MsII-give-punc
I give it to him

b. a-ná-mwáápey-átsa (MAKHUWA-ENAHARA, van der Wal 2009)
2-pres.dj-cook-plur
‘They are cooking.’

Q1: Do these verb-based expressions constitute full-fledged saturated sentences with truth conditions and truth values?

Q2: Is this a case of cross-linguistic variation?

TYPE A-LANGUAGES: fully surface compositional = directly compositional

→ functions (head) and arguments (complements): Function Application
→ functions apply in the same way to pronominal and full noun arguments

TYPE B-LANGUAGES: different semantics for *V+pronoun* and *V+full noun*

→ functional meaning plus agreement morphology: **???**
→ functions plus arguments with full nominal expressions: Function Application

- *Two possible solutions:*

i. PRO DROP:

- Agreement markers in some B-type languages are indeed agreement markers, but pronominal arguments are not realized overtly, but covertly as *pro*. The overt agreement marker allows for correct resolution of the covert pronoun, cf. (21a).

(21) a. pro ha comprato una macchina. [ITALIAN]
3sg bought a car
‘He/she bought a car.’

- Full nominal arguments function as ordinary arguments and provide the verb meaning with an explicit semantic argument, cf. (21b).

(21) b. Giovanni ha comprato una macchina. [ITALIAN]
John 3sg bought a car
'John bought a car.'

ii. PRO-ARG:

- Many North American languages (Lakhota, Mohawk, Strait Salish) have been analysed as *proarg*-languages. The alleged agreement markers on the verb are not agreement markers , but pronominal arguments that incorporate into the verb stem.

(22) t'əm'-t-∅ = lə' = **sən** (→ *t'əm'tlə'sən*) [STRAIT SALISH, Jelinek 1995]
hit-TRAN-3ABS PAST 1sNOM
'I hit him.'

- Additional full NPs do not function as semantic arguments, but are left-dislocated topics that are coreferential with the respective pronouns under co-indexation

(23) a. Shawátis shako-núhwe'-s Uwári
John MsI/FsII-like-hab Mary
'John likes Mary.'

b. [$_S$ John [$_S$ **pro**-likes-**pro**] Mary]

c. ≈ John$_1$, he$_1$ likes her$_2$, Mary$_2$

- CORRECT PREDICTION: Genuine quantificational NPs, such as *everybody* and *nobody*, are categorically ruled out in *proarg*-languages, presumably for the same reason that blocks the construal of pronouns with left-dislocated quantifiers in Italian or English:

(24) *Nessuno, lo conosco in questa citta.
nobody, him know.1sg in this city
*'Nobody, I know him in this city.'

5. Homework Assignment

i. Check whether your own language has predicative and transitive structures parallel to (10a) and (11a) above. Give examples.

ii. Are such sentences interpretable by means of function application? If so, give a sample derivation for a simple clause. If not, what might be possible reasons?

iii. What is the semantic function, if any, of the copula element *is* in English (25):

(25) The cat *is* black.

iv. Does your own language have copular elements? If so, check whether they behave like English *is*, or whether they have additional semantic functions.

v. Consider the following Hausa sentence with an optional full subject NP:

(26) (Musa) ya-a tàfi
Musa 3SG-PERFleave
'Musa / He left.'

- Give two alternative syntactic analyses of (26), treating Hausa (i.) as a *prodrop*-language; and (ii.) as a *proarg*-language.

- How would the semantic derivation proceed on either syntactic analysis (ignore the semantic contribution of the perfective marker *-a*)? In particular, which syntactic expression would provide the verb with its unique argument?

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