PREDICATION, MODIFICATION, PRESUPPOSITION

LECTURE 4

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The HU Lectures on Formal Semantics

RECAP, REVISION, CONSOLIDATION

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THE λ-CALCULUS

WHAT λ DOES: MAKING THE WEIRD INTUITIVE

(1) Kermit sneezes

Our life BEFORE λ

⟦(1)⟧ = SNEEZE(k)

⟦Kermit⟧ — k

⟦sneezes⟧ — SNEEZE( ) SNEEZE(???) SNEE

Our life AFTER λ

⟦(1)⟧ = SNEEZE(k)

⟦Kermit⟧ — k

⟦sneezes⟧ — SNEEZE(x) λx [SNEEZE(x)] $\lambda x \in D_e$ [S

Q ⟦sneeze⟧ needs saturation, so is its argument position empty?

A We can't have it empty! We need to signify the placeholder with a **variable**. Of the correct type. We need λ to encode this.

Q Why **appropriate** argument? What's wrong with $\lambda x \in D_t$ [SNEEZE(x)]? What's wrong with

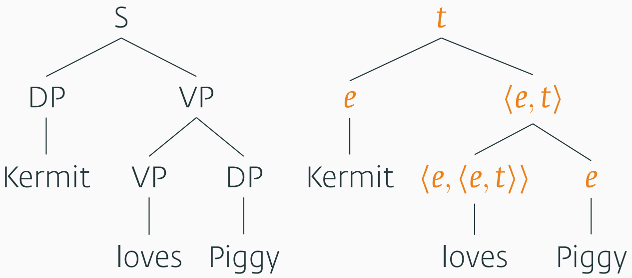
Q $\lambda x \in D$... [SNEEZE(x)] So what can we do with λ? **NB:** UNSATURATED MEANINGS HAVE TO BE λ-WRAPPED!

WHAT ABOUT TRANSITIVES?

- SNEEZE takes one argument
- What about verbs (predicates/functions) like GREET or LOVE?

WHAT ABOUT TRANSITIVES?

DEMO



EX Write down the lexical entry for (or the formal semantic makeup of) the verb *love*!

TERMINOLOGY lexical entry of a word = the formal semantic makeup of that word

WHAT IS THE MEANING OF LIFE?

(2) $[\![$life$]\!]$ =

(Facetiously left for online discussion.)

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EXERCISES

Let j = ⟦Jason⟧

(3) $\lambda x[\textsc{cat}(x)](j)$

(4) $\lambda P[P(j)](\textsc{cat})$

(5) $\lambda x[\lambda P[P(j)]](\textsc{cat})(j)$

(6) $\lambda P[P(j)](\lambda x[\textsc{cat}(x)])$

FINALLY: WHAT ABOUT DITRANSITIVES?

- Consider ditransitive verbs like GIVE, which takes three arguments.
- What's its type? To get its type:
  - think of it as a relation, three-place relation (how do we represent this?)
  - and then schönfinkelise it

1 Follow Frege

- **A** Split the sentence (S) into two parts, so that one part is saturated and another unsaturated.
- **B** Repeat the process for the unsaturated part until the entire S is chopped up.

2 Look at the tree structure and ensure that your dissection attempt corresponds to mother nodes: each pair of saturated-unsaturated (chunks of) words you split up should also map onto the way the syntactic tree is split up.

3 List all terminal nodes and get ready to give them a lexical entry[2]—a formal semantic signature, a logical translation of their meaning. Listing and ultimately spelling out these lexical entries is half of the job. The other half is composing the non-terminal nodes.

4 All non-terminal nodes will have to result from compositional principles—we know function application (FA) that turns unsaturated meanings into saturated ones.

5 A mother node having a saturated and an unsaturated daughter should result from FA, where the unsaturated daughter is a function whose argument is provided by its saturated sister.

6 Keep track of types!

- a S is of type t, proper names[3] are individuals of type e.
- Everything else is of a derived type, notated in ⟨angular braces⟩. This way, the bottom-up type-driven composition, following FA, converges on/toward the ultimate t-type, yielding a truth value.

7 That's it! Done.

UPGRADING λ-TERMS: PRESUPPOSITION

(7) $\lambda\alpha : \gamma \,.\, \varphi$

- The colon here provides the **domain condition** and the full stop the **value description**.
- For instance, this applies to (9a), which we can reduce to (9b).

(8) a. $\lambda x : x \in D_e \,.\, x$ SMOKES

b. $\lambda x \in D_e \,.\, x$ SMOKES

(9) a. $\lambda x : x \in D_e \,.\, x$ SMOKES
"the function which maps every x, such that x is an individual, to 1 if x smokes, and to 0 otherwise."
"any x, such that x is an individual, is suitable to make the function SMOKES true if x smokes and untrue if x does not smoke."
"find an x, such that x is an individual, which can make the function SMOKE true if x smokes and untrue if x does not smoke..

b. $\lambda x \in D_e \,.\, x$ SMOKES
"map any x which is an individual to 1 if x smokes, and to 0 otherwise."

- So far, we've dealt with examples where a λ is needed to 'meet the condition' of a truth-value denoting predicate (like **smoke**).
- It doesn't have to.

(10) Read $[\lambda\alpha : \gamma \,.\, \varphi]$ as either (i) or (ii), whichever makes (more) sense.

i. "the function which maps every α, such that γ, to 1, if φ, and to 0 otherwise."

e.g. intransitive verbs . . . . actual ex.?

ii. "the function which maps every α, such that γ, to φ."

e.g. transitive verbs . . . . actual ex.?

FUNCTIONS CAN BE λ-ARGUMENT TOO

(11) $[\lambda f : f \in D_{\langle \mathbf{e},\mathbf{t} \rangle}$. there is some $x \in D_{\mathbf{e}}$ such that $f(x) = 1]$

- Can you think of an example that would work with (11)?

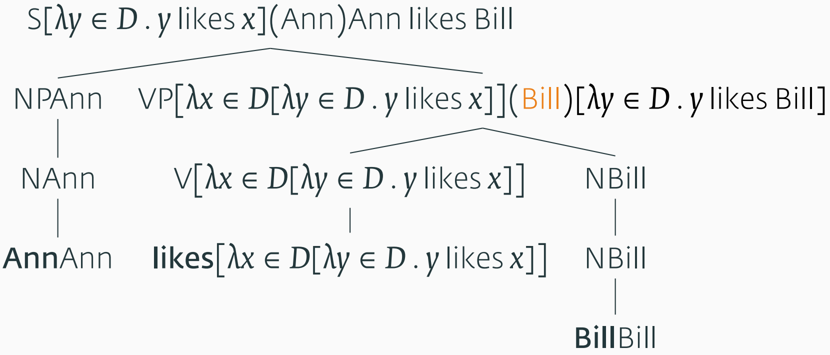
upgrading λ-terms: presupposition

λs in trees

- A transitive verb like ⟦**likes**⟧ takes **two arguments**, hence is a **2-place function**.
- In λ-abstracted form, it looks something like (12)

(12) ⟦**likes**⟧ = $[\lambda x \in D[\lambda y \in D\,.\, y \text{ likes } x]]$

- We know both x, y are in D so we could drop "$\in D$". Since want to be precise, we are not going to.


S[λy ∈ D . y likes x](Ann)Ann likes Bill
NPAnn
VP[λx ∈ D[λy ∈ D . y likes x]](Bill)[λy ∈ D . y likes Bill]
NAnn
V[λx ∈ D[λy ∈ D . y likes x]]
NBill
AnnAnn
likes[λx ∈ D[λy ∈ D . y likes x]]
NBill
BillBill

- So far, the left-most λ-term combined with the right-most argument (in brackets).
- When drawing trees, this is much easier, since a λ-term will apply **only to its syntactic sister** (locally).
- Think of the problem with the example below.

(13) $\lambda x \in D \,.\, [\lambda y \in D \,.\, y \text{ loves } x](\text{Sue})$

a. $[\lambda x \in D \,.\, [\lambda y \in D \,.\, y \text{ loves } x](\text{Sue})]$
$= \lambda x \in D \,.\, \text{Sue loves } y$

b. $[\lambda x \in D \,.\, [\lambda y \in D \,.\, y \text{ loves } x]](\text{Sue})$
$= \lambda y \in D \,.\, y \text{ loves Sue}$

SOME MORE EXERCISES

(14) $\Big[\lambda x \in D\,.\,[\lambda y \in D\,.\,[\lambda z \in D\,.\,z \text{ introduced } x \text{ to } y]]\Big](\text{Ann})(\text{Sue})$

(15) $\Big[\lambda x \in D\,.\,[\lambda y \in D\,.\,[\lambda z \in D\,.\,z \text{ introduced } x \text{ to } y](\text{Ann})](\text{Sue})\Big]$

(16) $\Big[\lambda x \in D\,.\,[\lambda y \in D\,.\,[\lambda z \in D\,.\,z \text{ introduced } x \text{ to } y](\text{Ann})]\Big](\text{Sue})$

(17) $\Big[\lambda x \in D\,.\,[\lambda y \in D\,.\,[\lambda z \in D\,.\,z \text{ introduced } x \text{ to } y]](\text{Ann})\Big](\text{Sue})$

(18) $[\lambda f \in D_{\langle e,t\rangle}\,.\,[\lambda x \in D_e\,.\,f(x) = 1 \text{ and } x \text{ is grey}]]$
$(\lambda y \in D_e\,.\,y \text{ is a cat})$

(19) $[\lambda f \in D_{\langle e,\langle e,t\rangle\rangle}\,.\,[\lambda x \in D_e\,.\,f(x)(\text{Ann}) = 1]]$
$([\lambda y \in D_e\,.\,[\lambda z \in D_e\,.\,z \text{ saw } y]])$

(20) $[\lambda x \in \mathbb{N}\,.\,[\lambda y \in \mathbb{N}\,.\,y > 3 \text{ and } y < 7](x)]$

(21) $\Big[\lambda z \in \mathbb{N}\,.\,[\lambda y \in \mathbb{N}\,.[\lambda x \in \mathbb{N}\,.\,x > 3 \text{ and } x < 7](y)](z)\Big]$

SEMANTIC VACUITY

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- Some lexical items make no semantic contribution to the structures in which they occur.
- Can you think of some?

(22) a. ⟦of John⟧ = ⟦John⟧
b. ⟦be rich⟧ = ⟦rich⟧
c. ⟦a cat⟧ = ⟦cat⟧

- What is the meaning of items **of**, **be**, and **a** above so that the equivalences hold? (3mins)

Nonverbal predication

- Not only verbs are functions.
- So are predicates (we discussed this yesterday).
  - Can you think of any 1-place (**monadic**) non-verbal predicates?
  - Can you think of any 2-place (**dyadic**) non-verbal predicates?

Monadic:

a. cat
b. student
c. bored
d. gray

Dyadic:

a. part
b. fond
c. in
d. from

- What are the meanings of each of these? . . . . 5′

- What is the denotation of **in Texas**?
- Let's calculate the truth-conditions of the following:

(23)
a. Joe is in Texas.
b. Joe is fond of Kaline.
c. Kaline is a cat.

- What about the meaning of **a grey cat**?
- Try composing it. . . . . 2′

PREDICATE MODIFICATION

- We need a new rule that can handle cases where Functional Application (FA) cannot apply.

Predicate Modification (PM)

If α is a branching node, $\{\beta, \gamma\}$ is the set of α's daughters, and $[\![\beta]\!]$ and $[\![\gamma]\!]$ are both in $D_{\langle \mathbf{e},\mathbf{t}\rangle}$, then

$[\![\alpha]\!] = \lambda x \in D_{\mathbf{e}} . [\![\beta]\!](x) = [\![\gamma]\!](x) = 1$
(= $\lambda x \in D_{\mathbf{e}}$. x is $[\![\beta]\!]$ <u>and</u> x is $[\![\gamma]\!]$)

- We can now calculate the truth conditions of (24).

(24) ⟦**city in Texas**⟧=

(25) Denver is a city in Texas.

PRESUPPOSITIONS & THE DEFINITE ARTICLE

- Common nouns, like 'cat', denote the characteristic functions of sets of individuals. (What type are they, again?)
- What does this imply for the semantic analysis of determiners? Let's just focus on **the** for now.

- Basic intuition: "the NP" denotes individuals, just like proper names.
- **student** denotes a ($\textsc{char}_f$ of a) set of students.
- **the student** denotes a unique individual. (Russell, cf. Frege who thought so too.)

(26) a. ⟦**the**⟧(⟦**German chancellor**⟧) =Angela Merkel

b. ⟦**the**⟧(⟦**opera by Beethoven**⟧) =Fidelio

c. ⟦**the**⟧(⟦**negative square root of 4**⟧) = −2

- What, then, does **the** denote?
- **The** is a **function**.
- What is its domain? Its range?

(27) For any $f \in D_{\langle \mathbf{e},\mathbf{t} \rangle}$ such that there is exactly one x for which $f(x) = 1$,
$[\![\textbf{the}]\!](f)$ = the unique x for which $f(x) = 1$.

- What about fs that do not maps exactly one individual to 1? What would ⟦**the**⟧ yield?

(28) **the escalator in South College**

(29) **the stairway in South College**

NB There are no escalators in South College and there is more than one stairway.

- What objects do (30) and (31) denote?

(30) **the escalator in South College**

(31) **the stairway in South College**

NB There are no escalators in South College and there is more than one stairway.

- No objects are denoted. The function cannot apply since ⟦**the escalator in South College**⟧ and ⟦**the stairway in South College**⟧ **are not in the domain of** ⟦**the**⟧.
- If they are not in the domain of ⟦**the**⟧, then ⟦**the**⟧ cannot apply to them – we cannot apply FA to calculate a semantic value for (30) and (31).

A GENERALISATION ON DEFINITE DESCRIPTIONS

- The generalisation that emerges regarding the domain of $[\![\textbf{the}]\!]$ is the following:

(32) The domain of $[\![\textbf{the}]\!]$ contains just those functions $f \in D_{\langle \mathbf{e,t} \rangle}$ which satisfy the condition that there is exactly one x for which $f(x)$.

- The semantics of $[\![\textbf{the}]\!]$ is then the following (recall the colon in λ-terms):

(33) $[\![\textbf{the}]\!] = \lambda f : f \in D_{\langle \mathbf{e,t} \rangle}$ and there is exactly one x such that $f(x)$.
the unique y such that $f(y) = 1$.

- What, then, is the type of ⟦**the**⟧?
- Does it map totally? Are all $x \in D_{\langle \mathbf{e,t} \rangle}$ in the domain of ⟦**the**⟧?

(34) A **partial** function from A to B is a function from a **subset** of A to B.