IA165
Combinatory Logic for Computational Semantics

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Summing up: last lecture

- How to apply the combinators to natural language analysis

  1) using introduction and elimination rules by beta-reduction of combinators: control heurstic of combinatorial application and bracketing

  2) using a syntactic tool for controlling the application of combinators

  : CCG assumes the preliminary steps to find a well-structured normal form, that is, a formal semantic structure

Remind...

- Combinator W

$$\mathbf{W}fx \longrightarrow_{\beta} fxx$$

: The combinator W takes one functor f and applies the functor f to the argument x by duplicating the argument x. → duplication

Intro. and Elim. Rules of the combinator W

$$\frac{(\mathbf{W}f)(x)}{(f(x))(x)} \qquad \frac{(f(x))(x)}{(\mathbf{W}f)(x)}$$

Short introduction to "Reflexivization"–1

- In binding theory (P.Schlenker, UCLA, presented in ESSLLI04')

"Conditions of acceptance of the reflexivization"

Condition A: A reflexive (or reciprocal) pronoun must be bound within its local domain.

a. $John_1$ likes $himself_1$

b. *[$John_1$'s $mother]_2$ likes $himself_1$

c. *$John_1$ thinks that $Mary_2$ likes $himself_1$

Condition B: A non-reflexive pronoun must be free (cannot be bound) within its local domain.

a. *John$_1$ likes him$_1$

b. [John's mother]$_2$ likes him$_1$

c. John$_1$ thinks that Mary$_2$ likes him$_1$

Condition C: An R-expression (=proper noun) must be free.

a. ??John$_1$ likes John$_1$ (*He$_1$ likes John$_1$)

b. [John$_1$'s mother]$_2$ likes John$_1$

c. ??John$_1$ thinks that Mary$_2$ likes John$_1$

Mary thinks that Mary is clever is "interpretable"

however it is ruled out on pragmatic ground because there is a 'better' logical form to express the same meaning, namely

Mary thinks that she is clever

- Counter-example of the condition A

English reflexives have logophoric homonyms that are pronominal

example:

Albert$_i$ was upset that Mary had endangered Gordon and himself$_i$ on the climbing trip.

Formal semantic analysis of the "Reflexivization"

- the pronoun itself, like all noun phrases, is type-raised

  ==> (operator SELF).

- Unlike most arguments, it is a clitic, like French (and Czech) *se*, which means that it is specialized to apply only to lexical verbal categories. The natural way to capture this specialization is to define it as a "lexicon-internal morphological operator"

(sentences given by Johan van Benthem, Computational Linguistics and Formal Semantics)

- Example : *Reflexives I*

1. Mary despised herself
2. ?Mary$_i$ despised Mary$_i$
3. John despised Anna

1'. DESPISE(ONESELF)(MARY)
2'. DESPISE (MARY)(MARY)
3'. DESPISE (ANNA)(JOHN)

- Mary despised herself

Definition of the operator "**SELF**"

: is an operator which operates on the binary predicate ***despise*** to form the unary predicate "**SELF-despise**"

$$\textbf{herself} =_{def} \textbf{SELF}$$

Important remark:

The paraphrase of the *Mary despised herself* is *Mary despise Mary*, that is, "one has an acitivity to despise and it is Mary who is this person".

$$P_2 \text{ SELF} =_{def} \text{SELF } P_1$$

1/ Mary despised herself	
2/C*Mary despised herself	Hypothesis 1 [C*Mary=Mary]
3/C*Mary SELF $despised_1$	Hypothesis 2 [P_2 SELF $=_{def}$ SELF P_1]
4/C*Mary W $despised_1$	Hypothesis 3 [SELF=W]
4/B(C*Mary W)$despised_1$	Intro. of B
5/(C*Mary) (W $despised_1$)	Elim. of B
6/(W $despised_1$)Mary	Elim. of C*
7/ ($despised_1$)Mary Mary	Elim. of W

$SELF =_{def} W$

1/ ((herself)despisedP_1)Mary

2/((SELF)despised)Mary	Hypothesis 1 [herself=SELF]
3/(W despised)Mary	Hypothesis 2 [SELF=W]
4/(despised (Mary))Mary	Elim. of W

Reflexive-marked predicate: *'seem'* and *'believe'*

- Condition A: A reflexive-marked predicate must be semantically reflexive.
- Condition B: A semantically reflexive predicate must be reflexive-marked.

Conditions A and B effect beyond the domain of the predicate.

a. John seems to himself to be sick.

a'. seems to himself [John to be sick]

b. John believes himself to be sick

b'. John believes [himself to be sick]

a′. seems to himself [John to be sick]

b′. John believes [himself to be sick]

there appears to be a relation of "reflexivization" between a semantic argument of the embedded clause and a semantic argument of the matrix verb.

John believes himself to be sick

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C*John REF believes to-be-sick

==> [C*John'=John] [himself=SELF] [SELF=REF]

B(B(C*John' REF)believes)to-be-sick

(C*John')(W(believes(to-be-sick)))

==> [REF=W]

(believes(to-be-sick)John) John
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Multilingual examples of Reflexives-1

- French

1. Jean se rase (John SE shaves)
2. Jean rase lui-meme (John shaves HIMSELF)
3. ?Jean$_i$ rase Jean$_i$ (John shaves JOHN)
4. Le coiffeur rase Pierre (The barber shaves Pierre)

1′. (SE RASE)JEAN
2′. RASE(LUI-MEME)JEAN
3′. RASE (JEAN)(JEAN)
4′. RASE PIERRE (LE COIFFEUR)

- Jean se rase ≈ Jean rase Jean

  <u>Definition of the operator "**REF**"</u>

  : is an operator which operates on the binary predicate *rase* to form a unary predicate "**REF–rase**"

<u>**Question.**</u>

How to explain the paraphrastic relation between *Jean se rase* and **Jean rase Jean*?

Possibility: consider the reflexive **se** as the linguistic trace of the combinator **W**

- Law of the reflexivization

[REF] [REF $=_{def}$ W]

1/Jean se rase	
2/C*Jean se rase	Hypothesis 1 [Jean=C*Jean]
3/C*Jean REF rase	Hypothesis 2 [REF=se]
4/C*Jean W rase	Law of Reflex. [REF=W]
5/B(C*Jean W) rase	Intro. of B
6/ (C*Jean) (W rase)	Elim. of B
7/ (W rase)Jean	Elim. of C*
8/ (rase(Jean)) Jean	Elim. of W

Multilingual examples of Reflexives-2

- Czech

Marie slyšela Petra mluvit.

Mary heard Peter-Acc speak-Inf.

‘Mary heard Peter speaking.’

≈ *Mary heard that Peter is speaking*

(Slyšela (Petra(mluvit)))Marie

Marie se slyšela mluvit (v rádiu).

Mary SE heard speak-Inf (in a radio).

‘Mary heard herself speaking (in a radio)’

≈ *Mary heard that Mary is speaking*

(Slyšela (Marie(mluvit)))Marie

- Definition of the operator "REF"

: is an operator which operates on the binary predicate ***slyšela*** to form a unary predicate REF–**slyšela**

Definition1
[REF=se]

Definition 2
[REF] [REF $=_{def}$ **W**]

The reflexive "*se*" is a linguistic trace of the combinator W

Marie slyšela Petra mluvit

1/Marie slyšela Petra mluvit	
2/**C***Marie slyšela Petra mluvit	Intro of C*
3/(**B**(**C***Marie) slyšela) Petra mluvit	Intro of B
4/(**B**(**B**(**C***Marie) slyšela) Petra) mluvit	Intro of B
5/((**B**(**C***Marie) slyšela) (Petra mluvit))	Elim. Of B
6/(**C***Marie) (slyšela (Petra mluvit))	Elim. Of B
7/(slyšela (Petra mluvit))(Marie)	Elim. Of C*

Marie se slyšela mluvit (v rádiu)

1/Marie se slyšela mluvit	
2/**C***Marie se slyšela mluvit	Hypothesis 1 [**C***Marie=Marie]
3/**C***Marie REF slyšela mluvit	Hypothesis 2 [REF=se]
4/**B**((**C***Marie) REF) slyšela mluvit	Intro of **B**
5/**B**(**B**((**C***Marie) REF) slyšela) mluvit	Intro of **B**
6/**B**(**B**((**C***Marie) **W**) slyšela) mluvit	Hypothesis 3 [REF=**W**]
7/**B**((**C***Marie) **W**) (slyšela mluvit)	Elim of **B**
8/(**C***Marie) (**W** (slyšela mluvit))	Elim of **B**
9/ (**W** (slyšela mluvit))(Marie)	Elim of **C***
10/ ((slyšela mluvit)(Marie))(Marie)	Elim of **W**

Next week...

- Continue about the application of the combinators to natural language analysis: passivization