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...1

- The combinator C

  : expresses the conversion, that is, the permutation of two arguments of an binary operator.

  : takes one functor f and two arguments x and y. The elimination of the combinator C by β-reduction allows to converse the position of the arguement x with y.

$$Cfxy \longrightarrow_{\beta} fyx$$

The introduction and elimination rule of the combiantor C

$$\frac{((Cf)(x))(y)}{(f(y))(x)} \qquad \frac{(f(y))(x)}{(Cf)(x))(y)}$$

Remind...2

Associativity of the combinatory logic

$$x(yz)=xyz$$

$$Bxyz= (Bxy)z$$

Proof

$((X \cdot Y) \cdot Z)x \geq B(BXY)Zx \geq BXY(Zx) \geq X(Y(Zx)) \leq X(BYZx)$

$\leq BX(BYZx) = X(Y \cdot Z)$

Short introduction to "Passivization"

- Consider the following sentences

a. The man has been killed.

b. One has killed him.

→ Invariant of meaning

→ Relation between two sentences

a'. unary passive predicate (has-been-killed)

b'. active transitive predicate (have-killed)

- active agent corresponds optional *by* phrase in passive; passivization is a form of 'intransitivation';
  - same semantic role (e.g. agent) – (1)
  - some differences (e.g. case) – (2)
  - other complements are unaffected;
  - changes to morphosyntax of verb (aux **be** plus passive participle)

(1) Kim stole the most expensive picture.
(1') The most expensive picture was stolen by Kim
(2) He saw her.
(2') She was seen by him.

- Definition of the operator of passivisation 'PASS'

$$[\text{PASS} = \text{B}\ \Sigma\ \text{C}\ ]$$

where B and C are the combinator of composition and of conversion and where Σ is the existential quantificator which, by applying to a binary predicate, transforms it into the unary predicate.

$$\Sigma(\text{E}^1\ \text{E}^2) \rightarrow (\text{E}^1\ \text{x}\ \text{E}^2)$$

Formal semantic analysis of the "Passivization"

1/ has-been-killed (the-man)	hypothesis
2/ [has-been-killed=PASS(has killed)]	passive lexical predicate
3/ PASS (has-killed)(the-man)	repl.2.,1.
4/ **[PASS = B Σ C]**	definition of 'PASS'
5/ B Σ C (has-killed)(the-man)	repl.4.,3.
6/ Σ (C(has-killed))(the-man)	[e-B]
7/ (C(has-killed)) x (the-man)	[e-Σ]
8/ (has-killed)(the-main) x	[e-C]
9/ [x in the agentive subject position = one]	definition of 'one'
10/ (has-killed)(the-man)one	repl.9.,8., normal form

We establish the paraphrastic relation between the passive sentence with expressed agent and its active counterpart:

The man has been killed by the enemy

↓

The enemy has killed the man

Relation between *give-to* and *receive-from*

z gives y to x

↕

x receives y from z

The lexical predicate "*give-to*" has a predicate converse associated to "*receive-from*";

[receive-from z y x = give-to x y z]

Anna gave a DVD to Nancy

Nancy received a DVD from Anna

z gave y to x → `(gave_to x y z)`

x received y from z → `(received_from z y x)`

Prove the following relation

[((receive-from) z) y x = give-to x y z]

1/ ((receive-from) z) y x

2/ C((receive-from) z) x y

3/ BC(receive-from) z x y

4/ C(BC(receive-from)) x z y

5/ C(C(BC(receive-from)) x) y z

6/ BC(C(BC(receive-from))) x y z

7/ [give-to=BC(C(BC(receive-from)))]

8/ give-to x y z

x: Anna
y: a DVD
z: Nancy

x lead y → (lead y) x

y follow x → (follow x) y

x chase y → (chase y) x

y flee x → (flee x) y

Combinator **C** of conversion

(f(x)) y → (**C**f) y x

What is the semantic relations between these couples of sentences? (Show in the classwork)

Multilingual examples of Passives–1

- Passive transformation In Czech

Transformation T1

(a) $[NP^1]_{NOM} - [V^1{}_{lex}]_{fin} - [NP^2]_{ACC} \Rightarrow$ (b)

(b) $[NP^2]_{NOM} - [V^2 be]_{fin} - [V^1 lex]_{part} - [NP^1]_{INSTR}$

Examples

(a) Petr sliboval Pavlovi, že přijde ⇒ (b)

PeterNOM promised PaulDAT that arrives3SM ⇒ (b)

'Peter promised to Paul that he arrives.'

(b) Pavlovi bylo slibováno (Petrem), že přijde

PaulDAT was promised (PeterINSTR) that arrives3SN

'It was promised to Peter (by Paul) that he arrives.'

Multilingual examples of Passive-2

Consider the following relation:

bylo-slibováno and sliboval

x sliboval y

→ ((sliboval y) x)

⇓

y bylo-slibovano (by x)

→ (bylo-slibovano) y

We need to define the operator of the passivisation

[PASS=B Σ C = Σ • C]

- Formal analysis of the passivisation in Czech

1/ bylo-slibováno y (by x=Petrem)

2/ **[bylo-slibováno=PASS (sliboval)]**

3/ PASS (sliboval) y

4/ B Σ C (sliboval) y

5/ Σ (C sliboval) y

6/ (C sliboval) x' y

7/ [x'= agentive subject]

8/ sliboval y x'

[bylo-slibováno Pavlovi] =
Passivisation of [sliboval Pavlovi Petr]

Next week...

- Continue about the application of the combinators to natural language analysis: **aspecto-temporal operators**