1 Type theory: Semantics

Let U is a non-empty set of entities. For every type τ, the domain of possible denotations D_τ is given by:

- $D_e = U$
- $D_t = \{0, 1\}$
- $D_{\langle\sigma,\tau\rangle}$ is the set of functions from D_σ to D_τ.

A model structure is a pair $M = \langle U_M, V_M\rangle$ such that

- U_M is a non-empty set of individuals
- V_M is a function assigning every non-logical constant of type τ a member of D_τ.

Interpretation:

- $[\![\alpha]\!]^{M,g} = V_M(\alpha)$ if α is a constant
- $[\![\alpha]\!]^{M,g} = g(\alpha)$ if α is a variable
- $[\![\alpha(\beta)]\!]^{M,g} = [\![\alpha]\!]^{M,g}([\![\beta]\!]^{M,g})$
- $[\![\lambda v\alpha]\!]^{M,g} =$ that function $f : D_\sigma \to D_\tau$ such that for all $a \in D_\sigma$, $f(a) = [\![\alpha]\!]^{M,g[v/a]}$ (for v a variable of type σ)
- $[\![\alpha = \beta]\!]^{M,g} = 1$ iff $[\![\alpha]\!]^{M,g} = [\![\beta]\!]^{M,g}$
- $[\![\neg\phi]\!]^{M,g} = 1$ iff $[\![\phi]\!]^{M,g} = 0$
- $[\![\phi \wedge \psi]\!]^{M,g} = 1$ iff $[\![\phi]\!]^{M,g} = 1$ and $[\![\psi]\!]^{M,g} = 1$
- $[\![\phi \vee \psi]\!]^{M,g} = 1$ iff $[\![\phi]\!]^{M,g} = 1$ or $[\![\psi]\!]^{M,g} = 1$
- $[\![\phi \to \psi]\!]^{M,g} = 1$ iff $[\![\phi]\!]^{M,g} = 0$ or $[\![\psi]\!]^{M,g} = 1$
- $[\![\exists v\phi]\!]^{M,g} = 1$ iff there is an $a \in U_\tau$ such that $[\![\phi]\!]^{M,g[v/a]} = 1$ (for v a variable of type τ)
- $[\![\forall v\phi]\!]^{M,g} = 1$ iff for all $a \in U_\tau$, $[\![\phi]\!]^{M,g[x/a]} = 1$ (for v a variable of type τ)

2 Type theory: Lexicon

(a) Proper names:
John $\Rightarrow \lambda F.F(j^*)$

(b) Determiners:
every $\Rightarrow \lambda F\lambda G\forall x.(F(x) \to G(x))$
a $\Rightarrow \lambda F\lambda G\exists x.(F(x) \wedge G(x))$
no $\Rightarrow \lambda F\lambda G\neg\exists x.(F(x) \wedge G(x))$

(c) Most content words are simply analysed as constants, but somtimes the the semantics of a word can be represented more precisely by a complex term (e.g., transitive verbs or adjectives).

3 Nested Cooper Storage

Transitive verbs are analysed as constants of type $\langle\langle\langle e,t\rangle,t\rangle,\langle e,t\rangle\rangle$.

(a) Storage:

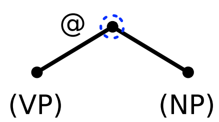
$$\frac{B \;\Rightarrow\; \langle\gamma,\Gamma\rangle \qquad B \text{ is an NP node}}{B \;\Rightarrow\; \langle\lambda P.P(x_i),\{\langle\gamma,\Gamma\rangle_i\}\rangle \qquad i\in\mathbf{N} \text{ is a new index}}$$

(b) Retrieval:

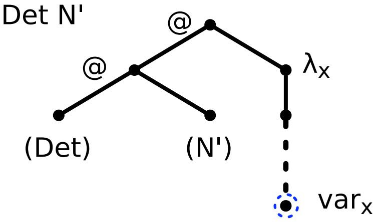
$$\frac{A \;\Rightarrow\; \langle\alpha,\Delta\cup\{\langle\gamma,\Gamma\rangle_i\}\rangle \qquad A \text{ is any sentence node}}{A \;\Rightarrow\; \langle\gamma(\lambda x_i.\alpha),\Delta\cup\Gamma\rangle}$$

4 Dominance graphs: Semantics construction

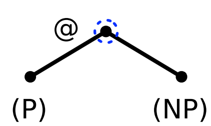
S → NP VP



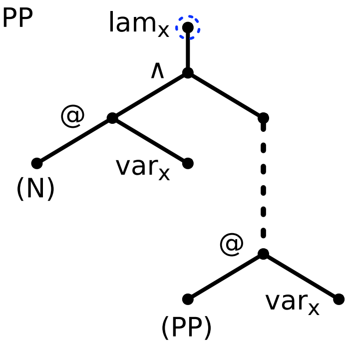
NP → Det N'



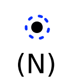
PP → P NP



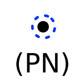
N' → N PP



N' → N



NP → PN



5 DRT: Syntax and Semantics

A discourse representation structure (DRS) K is a pair $\langle U_K, C_K\rangle$ where

- U_K is a set of discourse referents
- C_K is a set of conditions.

Conditions:

$R(u_1,\ldots,u_n)$	R is an n-place relation, $u_i \in U_K$
$u = v$	$u, v \in U_K$
$u = a$	$u \in U_K$, a a proper name
$K_1 \Rightarrow K_2$	K_1 and K_2 DRSs
$K_1 \vee K_2$	K_1 and K_2 DRSs
$\neg K_1$	K_1 is a DRS

6 DRT: Embedding, verifying embedding

Let U_D be a set of discourse referents, $K = \langle U_K, C_K \rangle$ a DRS with $U_K \subseteq U_D$, $M = \langle U_M, V_M \rangle$ a model structure of first-order predicate logic that is suitable for K. An *embedding* of U_D into M is a (partial) function from U_D to U_M that assigns individuals from U_M to discourse referents.

An embedding f *verifies* the DRS K in M ($f \models_M K$) iff

(a) $U_K \subseteq \mathrm{Dom}(f)$ and

(b) f verifies each condition $\alpha \in C_K$.

f verifies a condition α in M ($f \models_M \alpha$) in the following cases:

$f \models_M R(u_1, \ldots, u_n)$	iff $\langle f(u_1), \ldots, f(u_n) \rangle \in V_M(R)$
$f \models_M u = v$	iff $f(u) = f(v)$
$f \models_M u = a$	iff $f(u) = V_M(a)$
$f \models_M K_1 \Rightarrow K_2$	iff for all $g \supseteq_{U_{K_1}} f$ such that $g \models_M K_1$, there is $h \supseteq_{U_{K_2}} g$ such that $h \models_M K_2$
$f \models_M \neg K_1$	iff there is no $g \supseteq_{U_{K_1}} f$ such that $g \models_M K_1$
$f \models_M K_1 \vee K_2$	iff there is a $g_1 \supseteq_{U_{K_1}} f$ such that $g_1 \models_M K_1$, or there is a $g_2 \supseteq_{U_{K_2}} f$ such that $g_2 \models_M K_2$.

7 Presuppositions (van der Sandt)

A proto-DRS is a triple $\langle U_K, C_K, A_K \rangle$, where

- U_K is a set of discourse referents
- C_K is a set of conditions
- A_K is a set of “anaphoric” (alpha-) DRSs.

8 Resolution of α-DRSs

Let K and K' be proto-DRSs such that K' is a sub-DRS of K. Let $\gamma = \alpha x K_s$ be an alpha-free alpha-DRS in K', and let K_t be a sub-DRS of K that is accessible for γ.

(a) Accommodation: Remove γ from K', and extend K_t with U_{K_s} and C_{K_s}.

(b) Binding: Let further $y \in U_{K_t}$ be a discourse referent that is suitable for γ. Then remove γ from K', and extend K_t with U_{K_s} and C_{K_s} and the condition $x = y$.