Enriching Contexts for Type-Theoretic Dynamics

CAuLD Workshop on Logical Methods for Discourse

Scott Martin and Carl Pollard

Ohio State University

December 14, 2009

Dynamic Categorial Grammar

- An interdisciplinary research project/seminar at Ohio State University
- Initiated in Spring 2009 by Scott Martin, Carl Pollard, Craige Roberts, and Elizabeth Smith
- Seeks to develop a syntax/semantics/pragmatics interface which is
  - formally explicit
  - computationally implemented
  - pedagogically sound (comprehensible to linguists)
  - equipped to handle projective meaning

DyCG Integrates Two Research Traditions

- the 'Curryesque' tradition within categorial grammar
  - Curry 1961, Oehrle 1994, ACG, λG, GF, HOG, etc.
  - λ-calculi for concrete syntax (phenogrammar) and semantics, mediated by abstract syntax (tectogrammar)
  - Montague's 'quantifying in' implemented as β-reduction at the pheno level (Oehrle 1994)
- the dynamic semantics tradition
  - pioneered by Kamp, Heim, Barwise, Rooth, etc.
  - utterance meaning as context change
  - formulated type-theoretically by Muskens, de Groote, Barker and Shan
  - our approach builds on Roberts' modeling of information structure of discourse

This Talk

- builds on de Groote's type-theoretic dynamics
- elaborates the notion of (left) context, drawing inspiration from Heim, Roberts, and Muskens
- application: resolution of definiteness presuppositions

Names

(1) A: I saw John.
B: John who?
A: #Just some guy. His girlfriend called him John.

(2) A: I saw Mary.
B: Mary who?
A: #Susan Smith.

(3) A: In our department, it just so happens every committee has a different guy named Kim on it.
B: And so?
A: So every committee meeting, #Kim falls asleep!

Definite Descriptions

(4) A: In our department, it just so happens every committee has a different guy named Kim on it.
B: And so?
A: So every committee meeting, the guy named Kim falls asleep!

(5) A: I saw the donkey.
B: What donkey?
A: #Oh, just some donkey out in a field on the way to Upper Sandusky.

(6) A: I saw the donkey.
B: What donkey?
A: #That llama we always see on the way to Findlay.

Pronouns

(7) #It brayed. [out of the blue]

(8) Every donkey denies that it brays.

(9)
- a. A donkey had a red blanket.
- b. A mule had a blue blanket.
- c. The donkey/#it snorted.

(10)
- a. A donkey had a red blanket.
- b. Another donkey had a blue blanket.
- c. The donkey with the blue blanket/#the donkey/#it snorted.

(11)
1. A donkey walked in.
2. A cat walked in too.
3. The donkey was sad.
4. It meowed. [it = the donkey!]

Type-ography

x, y	variables
e, t	static types
α, κ	dynamic types
suc	non-linguistic constants
donkey	static (hyper-)intensional predicates
DONKEY	dynamic predicates

Basic Types

Type	Variables	Description
e	x, y	entities
t	(not used)	truth values
p	p, q	static (hyper-)intensional propositions
ω	n, m	natural numbers (*qua* discourse referents)

Type Constructors

$\rightarrow$	exponential
$\times, +$	product, coproduct
$\{x \in A \mid \varphi[x]\}$	separation-style subtyping
$\amalg_n A_n$	dependent coproduct

Some Defined Types

First n natural numbers: $\omega_n =_{\text{def}} \{i \in \omega \mid i < n\}$

n-ary assignments: $\alpha_n =_{\text{def}} \omega_n \rightarrow \text{e}$

Assignments: $\alpha =_{\text{def}} \amalg_n \alpha_n$

n-ary resolutions: $\rho_n =_{\text{def}} \{r \in \omega_n \rightarrow \omega_n \rightarrow \text{t} \mid r \text{ is a preorder}\}$

n-ary (information) structures: $\sigma_n =_{\text{def}} (\alpha_n \times \rho_n \times \text{p})$

Structures: $\sigma =_{\text{def}} \amalg_n \sigma_n$

About Structures I

- Structures are a simplified version of Roberts' (1996, 2004) information structures (aka discourse contexts).
- Here much is omitted (moves, domain goals, QUD)
- The type σ plays a role analogous to that of γ (left contexts) in de Groote's type-theoretic dynamics.

- Discourse referents (dr's) are modelled as natural numbers.
- Domains of assignments are natural number types ω_n.
- To handle propositional anaphora, we could allow dr's for propositions too. Two possibilities:

  define α_n to be $\omega_n \rightarrow (\mathrm{e} + \mathrm{p})$ rather than $\omega_n \rightarrow \mathrm{e}$; or
  a separate set of dr's expressly for propositions (cf. Portner's (2007) **common propositional space**)

About Structures II

- The **resolution** of a structure is a preorder on the domain of the structure's assignment.
- 'Higher' dr's are 'better' antecedents for definites.
- The **common ground** of a structure is the conjunction of the 'established' (static) propositions.
- Both the resolution and the common ground are used to resolve definiteness presuppositions.

Some Helpful Functions

$\mathbf{suc} : \omega \to \omega$: successor of a natural number

$\mathbf{l} : \alpha \to \omega$: length of an assignment (and the 'next' dr)

$\mathbf{a} : \sigma \to \alpha$, $\mathbf{r} : \sigma \to \rho$, $\mathbf{c} : \sigma \to \mathrm{p}$: the projections from a structure to its three components.

More Helpful Functions

$\bullet_n : \alpha_n \rightarrow \mathrm{e} \rightarrow \alpha_{\mathbf{suc}(n)}$: extends an assignment with a new entity (cf. de Groote's ::)

$*_n : \rho_n \rightarrow \rho_{\mathbf{suc}(n)}$: 'noncommittally' adds the next dr n to a resolution (i.e. $n \sqsubseteq n$ but is incomparable to all $m < n$)

$\mathbf{intro} =_{\text{def}} \lambda_{xs}.\langle \mathbf{a}s \bullet x, *(\mathbf{r}s), \mathbf{c}s\rangle : \mathrm{e} \rightarrow \sigma \rightarrow \sigma$: adds an entity to a structure's assignment and adds the new dr to its resolution

Continuations

- A **continuation** (type κ) is a function from a structure to a (static) proposition:

$$\kappa =_{\mathrm{def}} \sigma \rightarrow \mathrm{p}$$

- Modulo replacement of de Groote's γ (left contexts) and o (truth values) by σ and p respectively, these are direct analogs of his **right contexts** ($\gamma \rightarrow \mathrm{o}$).
- The **null** continuation is λ_s.true, where true is a greatest proposition relative to entailment (a necessary truth).

Dynamic Propositions

- A **dynamic proposition** (type π) maps a structure and a continuation to a (static) proposition:

$$\pi =_{\text{def}} \sigma \rightarrow \kappa \rightarrow \text{p}$$

- This is a direct analog of de Groote's type Ω.
- Example (weather predicate): $\text{RAIN} =_{\text{def}} \lambda_{sk}.\mathsf{rain} \wedge ks$

More Type-ography

Variables for dynamic types:

α	a, b
ρ	r, u
σ	s
κ	k
π	P, Q
δ	D, E

Dynamic Relations

Extending Muskens (1994), for each $n \in \omega$, we define the type of n-ary **dynamic relations** as follows:

$$\delta_0 =_{\text{def}} \pi$$
$$\delta_{\mathbf{suc}(n)} =_{\text{def}} \omega \rightarrow \delta_n (n \in \omega)$$

We abbreviate δ_1 to δ (dynamic properties).

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- Examples:

$$\text{DONKEY} =_{\text{def}} \lambda_{nsk}.\mathsf{donkey}\ (\mathbf{a}sn) \wedge ks : \delta$$
$$\text{BRAY} =_{\text{def}} \lambda_{nsk}.\mathsf{bray}\ (\mathbf{a}sn) \wedge ks : \delta$$
$$\text{OWN} =_{\text{def}} \lambda_{mnsk}.\mathsf{own}\ (\mathbf{a}sm)(\mathbf{a}sn) \wedge ks : \delta_2$$

- Unlike de Groote's, the arguments of our dynamic relations do not have raised types.
- Instead, dynamic GQs will be quantified into them.

(Static) Propositional Connectives

$\wedge$	and
$\vee$	or
$\neg$	not
$\rightarrow$	implies
$\exists$	exists
$\forall$	for all

Dynamic Negation

- $\text{NOT} =_{\text{def}} \lambda_{Psk}.\neg(Ps(\lambda_s.\mathsf{true})) \wedge ks : \pi \rightarrow \pi$
- This is a direct analog of de Groote's dynamic negation.
- So the null continuation freezes the scope of negation.
- But here, the occurrence of s in the scope of the static negation makes NOT a hole for projecting definiteness presuppositions, since they depend on the resolution preorder and the common ground.

Dynamic Conjunction

- Direct analog of de Groote's dynamic conjunction would be

$$\textsc{and} =_{\text{def}} \lambda_{PQsk}.Ps(\lambda_s.Qsk)$$

- Instead we use

$$\lambda_{PQsk}.P\langle \mathbf{a}s, \mathbf{r}s, \mathbf{c}s \wedge Ps(\lambda_s.\mathsf{true})\rangle(\lambda_s.Qsk) : \pi \to \pi \to \pi$$

for dynamic AND.

- This makes the 'staticization' of the left conjunct become the input common ground to the right conjunct.
- Example:

$$\textsc{and}(\textsc{rain}) = \lambda_{Qsk}.\mathsf{rain} \wedge Q\langle \mathbf{a}s, \mathbf{r}s, \mathbf{c}s \wedge \mathsf{rain}\rangle k : \pi \to \pi$$

Dynamic Existential Quantification

- Our replacement for de Groote's Σ is
  $\text{EXISTS} =_{\text{def}} \lambda_{Dsk}.\exists(\lambda_x.D(\mathbf{l}(\mathbf{a}s))(\mathbf{intro}xs)k)$
- This updates both assignments and resolutions.
- Whereas dynamic conjunction updates the common ground.

The Dynamic Indefinite Article

- $\text{A} =_{\text{def}} \lambda_{DE}.\text{EXISTS}(\lambda_n.Dn \text{ AND } En) : \delta \to \delta \to \pi$
- Note the division of the updating labor between the EXISTS (assignment and resolution) and the AND (common ground).
- As a result, a definiteness presupposition of the scope can be satisfied in the restriction.

A Dynamic Indefinite GQ

$$\text{A DONKEY} = \lambda_E.\text{EXISTS}(\lambda_n.\text{AND}\ (\lambda_{sk}.\mathsf{donkey}(\mathbf{a}sn) \wedge ks)(En)) =$$

$$\lambda_{Esk}.\exists(\lambda_x.\mathsf{donkey}\ x \wedge E(\mathbf{l}(\mathbf{a}s))\langle \mathbf{a}s \bullet x, *(\mathbf{r}s), \mathbf{c}s \wedge \mathsf{donkey}\ x\rangle k) : \delta \rightarrow \pi$$

Note that the sortal restriction imposed by the noun on the new dr is part of the common ground passed to the scope.

A Dynamic Pronoun Meaning

The direct analog of de Groote's meaning for *it* would be

$$\text{IT} =_{\text{def}} \lambda_{Ds}.D(\mathbf{sel}(\lambda_i.i < \mathbf{l}(\mathbf{a}s))s$$

which magically selects the "right" dr. Instead we use:

$$\text{IT} =_{\text{def}} \lambda_{Ds}.D(\mathbf{def}\ s\ \textsf{nonhuman})s : \delta \rightarrow \pi$$

where $\mathbf{def} : \sigma \rightarrow (\mathrm{e} \rightarrow \mathrm{p}) \rightarrow \omega$ is a *definiteness* operator.

The Definiteness Operator

$$\mathbf{def}_n =_{\text{def}} \lambda_{sS}.\bigsqcup_{\mathbf{r}s}(\lambda_{i:\omega_n}.\mathbf{c}s \to S(\mathbf{a}si)) : \sigma_n \to (\text{e} \to \text{p}) \to \omega_n$$

takes a structure and a static property and returns the highest dr in the structure's resolution whose value can be inferred from the structure's common ground to have that property.

It is also used in the dynamic meaning of the definite article:

$$\text{THE} =_{\text{def}} \lambda_{DEs}.E(\mathbf{def}\ s\ Ds(\lambda_s.\mathsf{true}))s : \delta \to \delta \to \pi$$

$$\text{THE DONKEY} = \lambda_{Ds}.D(\mathbf{def}\ s\ \mathsf{donkey})s : \delta \to \pi$$

To Do Next

A pronoun or definite description must also update the resolution by boosting its dr to a higher position in the preorder.