A Higher-Order Theory of Presupposition

Scott Martin

Department of Linguistics
Ohio State University

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Separate Traditions

- Sentence (or **static**) meaning (Montague, 1973):
  - distinction between sense and reference (cf. Frege, 1892)
  - well-understood formal foundations
  - compositional derivation of sentence meanings from their subparts
  - unified treatment of NP meanings, quantification, coordination

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  - compositional derivation of sentence meanings from their subparts
  - unified treatment of NP meanings, quantification, coordination
- Discourse (or **dynamic**) meaning (Kamp's (1981) DRT, Heim's (1982) FCS):
  - ability to handle cross-sentential and 'donkey' anaphora
  - account of the novelty condition on indefinites
  - characterization of natural language meaning as utterance use in context
  - ability to model presuppositions

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Pros
- no formal resources beyond standard higher-order logic (HOL: Church, 1940)
- ability to characterize static (sentence) meaning as well as discourse anaphora

Cons
- no way to model presuppositions more general than extremely simplified cases of definite anaphora

Compositionality Revisited

- Frege not only noted that sentence meaning is compositional, but also that presuppositions ‘project’ through e.g. negation:

  Kepler died in misery.

  Kepler did not die in misery.

  (both sentences presuppose that the name *Kepler* has a reference)

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  (both sentences presuppose that the name *Kepler* has a reference)
- Frege called the phenomenon of presupposition an "imperfection" of language.
- But given that they project, we could think of the task of stating an utterance's presuppositions as one of the aspects of compositionally determining meaning (separate from truth conditions).

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What This Talk is About

- In this talk, I discuss my ongoing work with Carl Pollard to develop a more general theory of presupposition.
- Main idea: take inspiration from Muskens and de Groote to build a theory equipped to handle presuppositions as well as static and dynamic meaning.
- First I lay out some preliminaries, then show how our theory accounts for some selected kinds of presupposition (definite anaphora, factivity, ‘donkey’ anaphora).

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Goal a natural language semantics that combines the advances in both static and dynamic semantics with a mechanism to capture presuppositions more generally.

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Strategy
1. Enrich the discourse context to include **discourse referents (DRs)** preordered by relative **salience** and a **common ground (CG)** of mutually accepted content (following Stalnaker (1973), Lewis (1979), and Roberts (1996)).

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Strategy

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2. Model presuppositions (following Stalnaker, 1973; Heim, 1983a) as the conditions a discourse context must meet for an utterance's felicitous interpretation.

Point of Departure

- Start with Pollard's (2008) static hyperintensional semantics, which is built on classical higher-order logic (HOL: Church, 1940; Henkin, 1950).
  - A finer-grained alternative to Montague semantics that fixes some foundational problems with it.
  - Assumes, following Thomason (1980), that propositions (type p) are basic and worlds defined in terms of them (instead of the other way around, as for Montague).

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- Then add
  - following Lambek and Scott (1986), separation subtyping and a natural number type ω as the type of DRs (following Heim) in addition to the other basic types p, t (of truth values), and e (of entities), and
  - dependent coproduct types parameterized by ω

Discourse Contexts

- For each $n : \omega$, an n-context c_n is a triple of type

$$\mathrm{c}_n =_{\mathrm{def}} \mathrm{a}_n \times \mathrm{r}_n \times \mathrm{p}$$

  where

  1. a_n is an n-**anchor** mapping the first n DRs to entities,
  2. r_n is an n-**resolution** (a preorder on the first n DRs that encodes their relative salience), and
  3. p is a proposition (the CG).

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- The umbrella type c is the dependent coproduct of all the c_n.

Manipulating Contexts

For an n-context c:

- The functions $\mathbf{a} : \mathrm{c} \to \mathrm{a}$, $\mathbf{r} : \mathrm{c} \to \mathrm{r}$, and $\mathbf{p} : \mathrm{c} \to \mathrm{p}$ abbreviate the projections from c to its three components.

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- DRs are added to c's anchor and resolution by $::_n$, so that $(c ::_n x)$ is just like c except that
  - its anchor $(\mathbf{a}\, c)$ maps n to the entity x, and
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- The notation $[m]_c$ abbreviates $(\mathbf{a}\, c\, m)$, the entity c anchors to the DR m (usually the subscript c is omitted).
- $+$ extends a CG. For any proposition p, the CG of $c + p$ is $(\mathbf{p}\, c)$ and p (where and is propositional conjunction).

Context-Dependent Propositions

- The type $\mathrm{k} =_{\mathrm{def}} \mathrm{c} \rightharpoonup \mathrm{p}$ is the type of **context-dependent propositions (CDPs)**, partial functions from contexts to propositions. (This type is an analog of de Groote's **right contexts**.)

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- The function $\downarrow$ says which contexts are in the domain of a CDP. For a CDP k, if $k \downarrow c$ then we say
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  - c satisfies the presuppositions of k, or equivalently
  - k is **felicitous** in c.
- Dynamic (declarative) sentence meanings are functions from CDPs to CDPs. Their type is

$$\mathrm{u} =_{\mathrm{def}} \mathrm{k} \rightarrow \mathrm{k}$$

(mnemonic for **update** or **utterance**).

Dynamic Properties

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$$(\mathbf{dyn}_0\ \mathsf{rain}) = \lambda_{kc}.\mathsf{rain}\ \mathsf{and}\ (k\ (c + \mathsf{rain}))$$

$$(\mathbf{dyn}_1\ \mathsf{donkey}) = \lambda_{nkc}.(\mathsf{donkey}\ [n])\ \mathsf{and}\ (k\ (c + (\mathsf{donkey}\ [n])))$$

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- Dynamic properties are written using smallcaps versions of their static counterparts, e.g. $\textsc{rain} = (\mathbf{dyn}_0\ \mathsf{rain})$, etc.
- The type d_1 of unary dynamic properties is abbreviated to d.

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- Example (here ≡ is propositional equivalence):

$$\begin{aligned}(\mathbf{stat}\ c\ \text{RAIN}) &= (\lambda_{kc}(\mathsf{rain\ and}\ (k\ (c + \mathsf{rain})))\ \lambda_c \mathsf{true}\ c) \\ &= \mathsf{rain\ and}\ (\lambda_c \mathsf{true}\ (c + \mathsf{rain})) \\ &= \mathsf{rain\ and\ true} \\ &\equiv \mathsf{rain}\end{aligned}$$

Dynamic Conjunction

Conjunction is designed to allow the first conjunct to satisfy the presuppositions of the second:

$$\text{AND} =_{\text{def}} \lambda_{uvk}.u\,(v\,k) : \mathrm{u} \to \mathrm{u} \to \mathrm{u}$$

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- For example, the discourse *It rains. It pours.* is analyzed as the following update:

$$\begin{aligned} &\text{RAIN AND POUR} : \mathrm{u} \\ =&\lambda_{kc}.(\lambda_{kc}(\mathsf{rain\ and}\ k\ (c + \mathsf{rain}))\ \lambda_c(\mathsf{pour\ and}\ (k\ (c + \mathsf{pour})))) \ c \\ =&\lambda_{kc}.\mathsf{rain\ and\ pour\ and}\ k\ (c + \mathsf{rain} + \mathsf{pour}) \end{aligned}$$

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- Note that rain is available in the CG of the context passed to POUR

Dynamic Existential Quantifier

The **dynamic existential** introduces DRs:

$$\textsc{exists} =_{\text{def}} \lambda_{Dkc}.\textsf{exists}\ \lambda_x.D\ (\textsf{next}\ c)\ k\ (c :: x) : \mathrm{d} \rightarrow \mathrm{u}$$

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- The dynamic indefinite article uses EXISTS to pass a newly introduced DR to its restrictor and scope (both dynamic properties):

$$\textsc{a} =_{\text{def}} \lambda_{DE}.\textsc{exists}\ \lambda_n.(D\ n)\ \textsc{and}\ (E\ n) : \mathrm{d} \to \mathrm{d} \to \mathrm{u}$$

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$$\text{A} =_{\text{def}} \lambda_{DE}.\text{EXISTS}\, \lambda_n.(D\, n)\ \text{AND}\ (E\, n) : \mathrm{d} \to \mathrm{d} \to \mathrm{u}$$

- Since EXISTS introduces an as-yet-unused DR, this definition of the dynamic indefinite captures Heim's novelty condition on indefinites.

Dynamic Indefinite Example

Example for *A donkey brays*, where $\textsc{bray} = (\mathbf{dyn}_1\ \mathsf{bray})$:

$$\begin{aligned}
&\textsc{a donkey bray} : \mathrm{u} \\
=&\textsc{exists}\ \lambda_n.(\textsc{donkey}\ n)\ \textsc{and}\ (\textsc{bray}\ n) \\
=&\lambda_{kc}.\mathsf{exists}\ \lambda_x.((\textsc{donkey}\ (\mathsf{next}\ c))\ \textsc{and}\ (\textsc{bray}\ (\mathsf{next}\ c)))\ k\ (c :: x) \\
=&\lambda_{kc}.\mathsf{exists}\ \lambda_x.(\mathsf{donkey}\ x)\ \mathsf{and}\ (\mathsf{bray}\ x) \\
&\qquad \mathsf{and}\ (k\ (c :: x + (\mathsf{donkey}\ x) + (\mathsf{bray}\ x)))
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$$\begin{aligned} & \text{A DONKEY BRAY} : \mathsf{u} \\ = & \text{EXISTS } \lambda_n.(\text{DONKEY } n) \text{ AND } (\text{BRAY } n) \\ = & \lambda_{kc}.\mathsf{exists}\ \lambda_x.((\text{DONKEY } (\mathsf{next}\ c)) \text{ AND } (\text{BRAY } (\mathsf{next}\ c)))\ k\ (c :: x) \\ = & \lambda_{kc}.\mathsf{exists}\ \lambda_x.(\mathsf{donkey}\ x) \mathsf{\ and\ } (\mathsf{bray}\ x) \\ & \qquad \mathsf{and}\ (k\ (c :: x + (\mathsf{donkey}\ x) + (\mathsf{bray}\ x))) \end{aligned}$$

- Not only is the newly introduced DR (mapped to x) available to the rest of the discourse, but so is the information that x is a braying donkey.

Dynamic Negation

The **dynamic negation** NOT : u → u 'traps' modifications made to the context under its scope using the staticizer:

$$\text{NOT} =_{\text{def}} \lambda_{uk}\lambda_{c\,|\,(u\,k)\downarrow c}.(\mathsf{not}\ (\mathbf{stat}\ c\, u))\ \mathsf{and}\ (k\ (c + \mathsf{not}\ (\mathbf{stat}\ c\, u)))$$

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- Note the condition on c: it says that dynamic negation is a presupposition 'hole' because the presuppositions of its argument are preserved.

Example for the discourse *It is not raining*:

$$\begin{aligned} &\text{NOT RAIN} : \mathrm{u} \\ =&\lambda_k\lambda_{c \mid (\text{RAIN}\,k)\downarrow c}.(\mathsf{not}\,(\mathbf{stat}\,c\,\text{RAIN}))\ \mathsf{and}\ (k\,(c + (\mathsf{not}\,(\mathbf{stat}\,c\,\text{RAIN})))) \\ =&\lambda_k\lambda_{c \mid (\text{RAIN}\,k)\downarrow c}.(\mathsf{not\ rain})\ \mathsf{and}\ (k\,(c + (\mathsf{not\ rain}))) \end{aligned}$$

Negation and Accessibility

The dynamic univeral EVERY : d → d → u is built on NOT:

$$\text{EVERY} =_{\text{def}} \lambda_{DE}.\text{NOT}\,(\text{EXISTS}\,\lambda_n.(D\,n)\ \text{AND}\ (\text{NOT}\,(E\,n)))$$

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where $\varpi = \mathsf{not}\ (\mathsf{exists}\ \lambda_x.(\mathsf{donkey}\ x)\ \mathsf{and}\ (\mathsf{not}\ (\mathsf{bray}\ x)))$ is the proposition added to the CG.

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The dynamic univeral $\textsc{every} : \mathrm{d} \to \mathrm{d} \to \mathrm{u}$ is built on $\textsc{not}$:

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- Note that no new DR is available to the subsequent discourse.
- So $\textsc{and}$ and $\textsc{not}$ together represent this theory's couterpart of DRT accessibility.

Sucky Weather

(1) a. Pedro thinks it's raining.
b. But it's not raining.

(2) a. It sucks that it's raining.
b. # But it's not raining.

(3) a. It doesn't suck that it's raining.
b. # But it's not raining.

- The difference in felicity between (1) and (2-3) has to do with the **factivity** of the verb *suck*: it presupposes the proposition expressed by its complement sentence.
- Since (in 3) these presuppositions project through negation, we can't simply say *It sucks that it's raining* entails that it's raining.

Modeling Factivity

The dynamic meaning of the factive *suck* is $\textsc{suck} : \mathrm{u} \to \mathrm{u}$:

$$\textsc{suck} =_{\text{def}} \lambda_{uk}\lambda_{c \mid (\mathbf{p}\ c)\ \mathsf{entails}\ (\mathbf{stat}\ c\ u)}.(\mathsf{suck}\ (\mathbf{stat}\ c\ u))\ \mathsf{and}\ (k\ (c + (\mathsf{suck}\ (\mathbf{stat}\ c\ u))))$$

Note the condition on c: it requires that the CG entails the staticization of SUCK's complement.

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$$\textsc{suck} =_{\text{def}} \lambda_{uk}\lambda_{c \mid (\mathbf{p}\ c)\ \mathsf{entails}\ (\mathbf{stat}\ c\ u)}.(\mathsf{suck}\ (\mathbf{stat}\ c\ u))$$
$$\mathsf{and}\ (k\ (c + (\mathsf{suck}\ (\mathbf{stat}\ c\ u))))$$

Note the condition on c: it requires that the CG entails the staticization of SUCK's complement. Example for *It sucks that it rains*:

$$\textsc{suck}\ \textsc{rain} = \lambda_k\lambda_{c \mid (\mathbf{p}\ c)\ \mathsf{entails\ rain}}.(\mathsf{suck\ rain})\ \mathsf{and}\ (k\ (c + (\mathsf{suck\ rain}))) : \mathrm{u}$$

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Suck's factive presuppositions also project through negation:

$$\textsc{not}\ (\textsc{suck rain}) : \mathrm{u}$$
$$= \lambda_k\lambda_{c \mid (\textsc{suck rain}\ k)\downarrow c}.(\mathsf{not}\ (\mathsf{suck\ rain}))\ \mathsf{and}\ (k\ (c + \mathsf{not}\ (\mathsf{suck\ rain})))$$

So the infelicity in both (2b) and (3b) is accounted for.

Definiteness

(4) # He thinks it's raining.

(5) a. A farmer bought the donkey.

b. What donkey?

c. # Just some donkey I saw when we passed through Findlay.

(6) a. A farmer bought a donkey and a mule.

b. { The donkey / # It } brayed.

- Example (4), uttered out of the blue, shows the **familiarity** presupposition of definiteness (Heim, 1983b).
- But (5) and (6) show that familiarity isn't enough: the antecedent must be uniquely maximally **salient** (Roberts, 2005).

Modeling the Definiteness of *It*

The dynamic definite pronoun meaning $\textsc{it} : \mathrm{d} \rightarrow \mathrm{u}$ is as follows (here $\textsc{nonhuman} = (\mathbf{dyn}_1\ \mathsf{nonhuman})$):

$$\textsc{it} =_{\mathrm{def}} \lambda_{Dkc}.D\,(\mathbf{def}\ c\ \textsc{nonhuman})\ k\ c$$

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where $\mathbf{def}_n : \mathrm{c}_n \to \mathrm{d} \to \omega_n$ picks out the most salient DR in a context c that is entailed by c's CG to have the property D:

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- This means that $\textsc{it}$ selects the uniquely most salient $\textsc{nonhuman}$ DR in the discourse context, accounting for both the presupposition of familiarity and of unique greatest salience.

Example of IT in Action

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It brays is analyzed as follows:

$$
\begin{aligned}
& \text{IT BRAY} : \mathrm{u} \\
= \; & \lambda_{kc}.\text{BRAY}\; (\mathbf{def}\; c\; \text{NONHUMAN})\; k\; c \\
= \; & \lambda_{kc}.(\mathsf{bray}\; [(\mathbf{def}\; c\; \text{NONHUMAN})])\; \mathsf{and}\; (k\; (c + (\mathsf{bray}\; [(\mathbf{def}\; c\; \text{NONHUMAN})])))
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- Provided that the CG contains the information that donkeys are nonhuman, and no inferrably nonhuman DR more salient than $(\mathsf{next}\ c)$, we can reduce $(\mathbf{def}\ c\ \text{NONHUMAN})$ to x.

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- Provided that the CG contains the information that donkeys are nonhuman, and no inferrably nonhuman DR more salient than ($\mathsf{next}\ c$), we can reduce ($\mathbf{def}\ c$ NONHUMAN) to x.
- Then the analysis of *A donkey enters. It brays.* is

$$
\begin{aligned}
& (\text{A DONKEY ENTER})\ \text{AND}\ (\text{IT BRAY}) : \mathrm{u} \\
= {} & \lambda_{kc}.\mathsf{exists}\ \lambda_x.(\mathsf{donkey}\ x)\ \mathsf{and}\ (\mathsf{enter}\ x)\ \mathsf{and}\ (\mathsf{bray}\ x) \\
& \quad \mathsf{and}\ (k\ (c :: x + (\mathsf{donkey}\ x) + (\mathsf{enter}\ x) + (\mathsf{bray}\ x)))
\end{aligned}
$$

Modeling *The*

The dynamic meaning THE : d → d → u is similar to IT:

$$\vdash \textsc{the} = \lambda_{DEkc}.(\lambda_n((D\,n)\ \textsc{and}\ (E\,n))\ (\mathbf{def}\ c\ D))\ k\ c$$

Modeling *The*

The dynamic meaning $\textsc{the} : \mathrm{d} \rightarrow \mathrm{d} \rightarrow \mathrm{u}$ is similar to $\textsc{it}$:

$$\vdash \textsc{the} = \lambda_{DEkc}.(\lambda_n((D\,n)\ \textsc{and}\ (E\,n))\,(\mathbf{def}\ c\,D))\,k\,c$$

- $\textsc{the}$ also resembles the dynamic indefinite $\textsc{a}$, except that it selects an antecedent based on D rather than introducing a new DR.

Modeling *The*

The dynamic meaning THE : d → d → u is similar to IT:

$$\vdash \textsc{the} = \lambda_{DEkc}.(\lambda_n((D\ n)\ \textsc{and}\ (E\ n))\ (\mathbf{def}\ c\ D))\ k\ c$$

- THE also resembles the dynamic indefinite A, except that it selects an antecedent based on D rather than introducing a new DR.
- Unlike IT, the two properties D and E are conjoined to make sure any DRs introduced by the first are available to the second (as in *The donkey with the red blanket chews it.*).

The in Action

The analysis of *The donkey brays* is:

$$
\begin{aligned}
& (\textsc{the donkey bray}) : \mathrm{u} \\
= {} & \lambda_{kc}.(\lambda_n((\textsc{donkey}\; n) \;\; \textsc{and} \;\; (\textsc{bray}\; n))\; (\mathbf{def}\; s\; \textsc{donkey}))\; k\; c \\
= {} & \lambda_{kc}.(\textsf{donkey}\; [(\mathbf{def}\; c\; \textsc{donkey})])\; \textsf{and}\; (\textsf{bray}\; [(\mathbf{def}\; c\; \textsc{donkey})]) \\
& \quad \textsf{and}\; (k\; (c + (\textsf{donkey}\; [(\mathbf{def}\; c\; \textsc{donkey})]) + (\textsf{bray}\; [(\mathbf{def}\; c\; \textsc{donkey})])))
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- The upshot is that, in a discourse like *A donkey enters. A mule enters. The donkey brays.*, THE DONKEY is able to select the 'right' antecedent (the one that is a donkey).

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$$= \lambda_{kc}.(\mathsf{donkey}\ [(\mathbf{def}\ c\ \text{DONKEY})])\ \mathsf{and}\ (\mathsf{bray}\ [(\mathbf{def}\ c\ \text{DONKEY})])$$
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- The upshot is that, in a discourse like *A donkey enters. A mule enters. The donkey brays.*, THE DONKEY is able to select the 'right' antecedent (the one that is a donkey).
- The discourse *A donkey enters. A mule enters. #It brays.* is correctly predicted to be infelicitous, because IT has no way of deciding which of the two nonhuman DRs to select.

Speaking of Donkeys ...

The notorious ‘donkey sentences’ pose problems for semantic interpretation:

(7) a. Every farmer who owns a donkey beats it.

b. # It’s named “Chiquita.”

- For (7a), we have to say how the DR introduced in the restriction can antecede the pronoun *it* in the scope.
- But we can’t just say that indefinites make a DR ‘globally’ available (7b)!

Handling Donkey Anaphora I

- To analyze (7), we first need

$$\textsc{farmer} = (\mathbf{dyn}_1\ \mathsf{farmer})$$
$$\textsc{own} = (\mathbf{dyn}_2\ \mathsf{own})$$
$$\textsc{donkey} = (\mathbf{dyn}_1\ \mathsf{donkey})$$
$$\textsc{beat} = (\mathbf{dyn}_2\ \mathsf{beat})$$

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$$\text{FARMER} = (\mathbf{dyn}_1\ \mathsf{farmer})$$
$$\text{OWN} = (\mathbf{dyn}_2\ \mathsf{own})$$
$$\text{DONKEY} = (\mathbf{dyn}_1\ \mathsf{donkey})$$
$$\text{BEAT} = (\mathbf{dyn}_2\ \mathsf{beat})$$

- Next, we define the dynamic meaning of WHO : $\mathrm{d} \to \mathrm{d} \to \mathrm{d}$ as the conjunction of two (dynamic) properties:

$$\text{WHO} =_{\text{def}} \lambda_{DEn}.(E\ n)\ \text{AND}\ (D\ n)$$

Handling Donkey Anaphora II

We use the HOL rules Hypothesis and Abstraction (in addition to Application) to get the dynamic meaning of (7):

$$(\textsc{every}\ (\textsc{who}\ \lambda_j(\textsc{a donkey}\ \lambda_i(\textsc{own}\ i\ j))\ \textsc{farmer})\ \lambda_j.\textsc{it}\ \lambda_i.\textsc{beat}\ i\ j) : \mathrm{u}$$
$$= \lambda_{kc}.(\mathsf{not}\ (\mathsf{exists}\ \lambda_x((\mathsf{farmer}\ x)\ \mathsf{and}\ (\mathsf{exists}\ \lambda_y((\mathsf{donkey}\ y)\ \mathsf{and}\ (\mathsf{own}\ y\ x)\ \mathsf{and}\ (\mathsf{not}\ (\mathsf{beat}\ y\ x)))))))\ \mathsf{and}\ k\ (c + \varpi)$$

(note that this is the ‘strong donkey’ reading). Here the context passed to the subsequent discourse is extended with the proposition

$$\varpi = \mathsf{not}\ (\mathsf{exists}\ \lambda_x.(\mathsf{farmer}\ x)\ \mathsf{and}\ (\mathsf{exists}\ \lambda_y.(\mathsf{donkey}\ y)\ \mathsf{and}\ (\mathsf{own}\ y\ x)\ \mathsf{and}\ (\mathsf{not}\ (\mathsf{beat}\ y\ x))))$$

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$$\mathsf{and}\ (\mathsf{not}\ (\mathsf{beat}\ y\ x))))$$

- So IT is able to select its nonhuman antecedent, but no DR remains in the resulting discourse context.

Taking Stock

- This new theory combines Montague's static compositionality with DRT innovations like the ability to characterize cross-sentential and 'donkey' anaphora, using no formal resources beyond classical HOL.
- But unlike earlier attempts to do this, it also has a more general way to capture an utterance's presuppositions by stating them as conditions on the discourse context.
- The payoff is a better handling of definite anaphora and a way to characterize other presuppositional phenomena like projection and factivity.

What's Next

- Make the theory *truly* compositional by hooking it up with a grammar.
- Figure out how to model the "proportion problem" (a.k.a. "farmer-donkey asymmetry") associated with e.g. *most* in this setup. This will likely involve going beyond the 'strong donkey' reading we currently get.
- Find a way to say how the relative salience of DRs gets adjusted as the discourse unfolds.
- Give a computational implementation of a fragment of English using this theory.
- Model more kinds of presuppositions: e.g., those associated with proper names, *too*, etc.

Thanks

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