It all depends:
A modern, type-theoretic, compositional dynamic semantics for projection and beyond

Scott Martin
http://coffeeblack.org/

Natural Language Understanding and Artificial Intelligence Laboratory
Nuance Communications

Dynamic Semantics: Modern Type Theoretic and Category Theoretic Approaches
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This talk

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- This semantics continues the tradition of dynamic semantics due to Muskens (1996), Beaver (2001) and de Groote (2006), and somewhat more distantly Heim (1982), Groenendijk and Stokhof (1991), and Chierchia (1995)
- I’ll discuss the formal specifics of the framework, which is encoded in dependent type theory
- I’ll also show how it can be straightforwardly hooked up to many grammar formalisms, and how it performs empirically on a range of phenomena of interest: anaphora, iterative adverbs, supplements, VP ellipsis, (pseudo)gapping
What do you mean “It all depends”?

- The framework incorporates the most central intuition of dynamic semantics: utterances are dependent on a context for their interpretation.
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- But it also uses dependent types to enforce certain aspects of the formalization, although in a completely different way than the propositions-as-types perspective used in Dependent Type Semantics (which Daisuke and Ribeka will talk about tomorrow)
What do you mean “It all depends”? 

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- But it also uses dependent types to enforce certain aspects of the formalization, although in a completely different way than the propositions-as-types perspective used in Dependent Type Semantics (which Daisuke and Ribeka will talk about tomorrow).
- I’ll explain both of these notions of dependency in a minute.
Dynamic Agnostic Semantics

Talk outline

Dynamic Agnostic Semantics
- Agnostic Semantics
- Going dynamic
- Connecting it to a grammar

Road testing
- Projective meaning
  - Anaphora
  - Supplements
- VP ellipsis and related phenomena

Conclusions and future directions
Dynamic Agnostic Semantics (DAS) has been under development in various guises since 2009 (Martin, 2012, 2013, 2015, in press; Kierstead and Martin, 2012; Martin and Pollard, 2012a,b, 2014)

- Dynamic intuitions
  1. Utterances both depend upon and update their context of interpretation
  2. Indefinites don’t quantify, but rather introduce discourse referents for later discussion

Compositionality dynamicism extends down to the lexical level; semantic composition occurs in a way familiar to those acquainted with the Montagovian tradition

Agnosticism the semantic underpinnings are not necessarily the Montagovian interpretation of possible worlds semantics, but may be hyperintensional
The framework in brief

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Agnostic Semantics

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The underlying static semantics is the Agnostic Hyperintensional Semantics (AHS) of Pollard (2008, 2015). In this semantics,

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  - Some other way
Senses and their extensions

- The *sense types* are the types that can be formed from e and p using the constructors \(\rightarrow\) and \(\times\).
Senses and their extensions

- The *sense types* are the types that can be formed from \( e \) and \( p \) using the constructors \( \to \) and \( \times \)
- The *extension types* associated with senses are
  
  \[
  \begin{align*}
  \text{Ext}(e) & \overset{\text{def}}{=} e \\
  \text{Ext}(p) & \overset{\text{def}}{=} t \\
  \text{Ext}(A \to B) & \overset{\text{def}}{=} A \to \text{Ext}(B) \\
  \text{Ext}(A \times B) & \overset{\text{def}}{=} \text{Ext}(A) \times \text{Ext}(B)
  \end{align*}
  \]

- For example, the extension type of \( e \to p \) (the sense of unary properties) is \( e \to t \) (sets of entities)
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- For example, the extension type of e → p (the sense of unary properties) is e → t (sets of entities)
- Then the agnosticism is maintained by adding an abstraction layer, the extension functions @A : A → w → Ext(A), for every sense type A
- So for any proposition p and world w, (p @p w) in principle gives the truth value of p at w
Entailment and equivalence

- Entailment is encoded by \( \text{entails} : p \rightarrow p \rightarrow t \), so that \( p \) entails \( q \) iff for every world \( w \), \( q \) is true at \( w \) provided \( p \) is.
- Propositional equivalence is defined so that \( p \equiv q \) iff \( p \) and \( q \) have the same extension at every world.
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- However, mutual entailment between \( p \) and \( q \) does not require that \( p = q \)!

We can opt for Montagovian intensionality by defining the type \( p \) as \( w \rightarrow t \) (sets of worlds), and the extension function \( \lambda \) \( p \) \( \lambda w. (p w) \).

But then equivalence and equality collapse together, and several unsavory, recalcitrant problems reappear (see Pollard, 2008, 2015; Plummer and Pollard, 2012).

We could also opt for hyperintensionality, and define worlds as maximal consistent sets of propositions.
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- However, mutual entailment between p and q does not require that p = q!
- We can opt for Montagovian intensionality by defining the type p as w \rightarrow t (sets of worlds), and the extension function @p as set membership, i.e. as \lambda p \lambda w.(p w).
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- All the usual relations needed to model natural language can be encoded as AHS senses

  **Unary properties**  
  cyclist : $e \to p$

  **Binary relations**  
  love : $e \to e \to p$

  **Ternary relations**  
  give : $e \to e \to e \to p$

  **Propositional attitudes**  
  believe : $p \to e \to p$
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  - Binary relations: love : e → e → p
  - Ternary relations: give : e → e → e → p
  - Propositional attitudes: believe : p → e → p

- Standard treatments of modality can also be developed inside AHS, but I won’t bother with the details here.
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- The goal was to build a better mousetrap that could model projective meaning: anaphora, Potts’s (2005) “CIs”, etc.
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- The goal was to build a better mousetrap that could model projective meaning: anaphora, Potts’s (2005) “CIs”, etc.
- Everything on the market at that time seemed overly laden with definitions, too complicated at the type level, out of touch with the core intuitions, or too reliant on aspects of the model theory.
- We wanted to mix the nice features of various dynamic semantics:
  - Contexts as first-class objects that can be extended (de Groote, 2006)
  - Meanings explicitly modeled as functions that both consume and output contexts (Heim, 1982; Groenendijk and Stokhof, 1991; Muskens, 1996; Beaver, 2001; de Groote, 2006)
  - Fully compositional, with all the semantic work handled by lambdas (Muskens, 1996; Beaver, 2001; de Groote, 2006)
  - Systematic ‘lifting’ from static to dynamic semantics (Groenendijk and Stokhof, 1990; Chierchia, 1995)
Contexts

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\[ \lambda_{x,y}.(\text{cyclist } x) \text{ and } (\text{wheel } y) \text{ and } (\text{break } y x) : c_2 \]

would correspond to an utterance of \textit{Some cyclist broke a wheel}. 

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Another subtlety: dynamic properties will need to take natural numbers (discourse referents) as arguments, but how can we ensure that the context of interpretation actually has such a referent?
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Enter dependent types

- To handle these issues, the type theory is extended to use *dependent types* parameterized by the natural numbers (type n).
- Here, *products* $\Pi_{x:A}.B$ generalize simple type-theoretic functions, and *sums* $\Sigma_{x:A}.B$ generalize simply-typed cartesian products.
- So $\Pi_{x:A}.B$ is a function from $A$ to $B$ where the type $B$ may depend on the value of $x$, and $\Sigma_{x:A}.B$ is a pair where the second component’s type $B$ may depend on the first component $x$. 
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Then the simple type-theoretic constructors represent the special case where no dependency is present:

$$A \to B \overset{\text{def}}{=} \Pi_{x:A}.B \quad (x \text{ not free in } B)$$

$$A \times B \overset{\text{def}}{=} \Sigma_{x:A}.B \quad (x \text{ not free in } B)$$
Dependently-typed contexts and contents

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- But the type of contents is
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But the type of contents is $k_n = \text{def } \Pi_{c:c_m} c_{m+n}$.

So $k_n$ is the type of contents that introduce $n$ referents (the degree).

The types of contexts with arity at least $n$ is encoded as $c_{\geq n} = \text{def } \Sigma_{m:n} c_{m+n}$, and $c_{> n} = \text{def } c_{\geq n+1}$ the type of contexts whose arity is strictly greater than $n$. 
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  and \( c_{> n} = \text{def } c_{\geq n + 1} \) the type of contexts whose arity is strictly greater than \( n \)
- We also write the types of contexts of any arity and contents of any degree as follows:
  \[ c = \text{def } \Sigma_{n : n \cdot c_n} \]
  \[ k = \text{def } \Sigma_{n : n \cdot k_n} \]
Dynamic properties with dependent types

- Defining \( n \)-ary static properties is straightforward:

\[
\begin{align*}
  p_0 & \overset{\text{def}}{=} p \\
  p_{n+1} & \overset{\text{def}}{=} e \rightarrow p_n
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- With dependent types, we can state the required constraint:

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\begin{align*}
 d_{0,i,j} &= \text{def } \Pi_{c : c > i} \cdot c_{|c|+j} \\
d_{n+1,i,j} &= \text{def } \Pi_{m : n} \cdot d_{n,(\max i m),j}
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- For each \( n \), there is also the disjoint union type \( d_n = \text{def } \Sigma_{i:n} \Sigma_{j:n}.d_{n,i,j} \) over all the types \( d_{n,i,j} \).
Dynamic Agnostic Semantics

Going dynamic

Dynamicization

- The *dynamicizer* functions $\text{dyn}_{n,i} : p_n \rightarrow d_{n,i,0}$ lift static properties to dynamic ones:

  $$\text{dyn}_{0,i} = \text{def} \lambda p : p_0 \lambda c : c > i \lambda x : |c| \cdot p$$

  $$\text{dyn}_{n+1,i} = \text{def} \lambda R : p_{n+1} \lambda m : n \cdot \text{dyn}_{n,(\max i m)} (R x_m)$$
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- Some examples:

$$(\text{dyn}_{0,0} \text{ rain}) = \lambda_{c:c > 0} \lambda_{x:|c|} \cdot \text{rain}$$

$$(\text{dyn}_{1,0} \text{ cyclist}) = \lambda_{n:n} \lambda_{c:c > n} \lambda_{x:|c|} \cdot (\text{cyclist } x_n)$$

$$(\text{dyn}_{2,0} \text{ break}) = \lambda_{m:n} \lambda_{n:n} \lambda_{c:c > (\max m n)} \lambda_{x:|c|} \cdot (\text{break } x_m x_n)$$

$$(\text{dyn}_{3,0} \text{ give}) = \lambda_{k:n} \lambda_{m:n} \lambda_{n:n} \lambda_{c:c > (\max k m n)} \lambda_{x:|c|} \cdot (\text{give } x_k x_m x_n)$$
Contents are distinguished from *updates*, which have the same type:
\[ u_n = \text{def} \ k_n \]
Updates and context change

- Contents are distinguished from *updates*, which have the same type: $u_n = \text{def } k_n$

- A content $k$ is promoted to an update by the *context change* function $cc : k_n \to u_n$:

  $$cc = \text{def } \lambda_k : k \lambda_c : c \lambda_{x|c|,y|k|} (c \, x) \text{ and } (k \, c \, x, y)$$

- That is, the update $(cc \, k)$ has the same content as $k$, but also incorporates the information from the input context
Updates and context change

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- For example, defining *RAIN* as the content $(\text{dyn}_{0,0} \text{ rain})$,

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(cc \text{ RAIN}) = \lambda c: c. (\lambda x|c|. (c x) \text{ and } \text{rain})
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- For example, defining RAIN as the content $(\text{dyn}_{0,0} \ \text{rain})$,

$$\text{(cc RAIN)} = \lambda_{c : c} \lambda_{x \mid c}. (c \ x) \text{ and } \text{rain}$$

- The $cc$ function models the process of making an at-issue proposal, i.e., proffering a content (cf. Roberts, 2012b)
Existential ‘quantifier’

- A prerequisite for the dynamic existential is the context extension function, which extends a context with a new coordinate $y$:

$$(\cdot)^+ \overset{\text{def}}{=} \lambda c : c \cdot \lambda _{x \in c}. y . c x \quad (y \text{ not in } x \text{ or free in } (c x))$$
Existential ‘quantifier’

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- Then the existential \( \text{EXISTS} : \Pi_{D:d_1,i,j,k_{j+1}} \) just adds a new discourse referent using \((\cdot)^+\), and passes it to its argument property:

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Existential ‘quantifier’

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$$(\cdot)^+ = \text{def} \; \lambda c: c. \lambda x|c|, y. c \cdot x \quad (y \; \text{not in} \; x \; \text{or free in} \; (c \cdot x))$$

Then the existential $\text{EXISTS} : \Pi_{D:d_{1,i,j}.k_{j+1}}$ just adds a new discourse referent using $(\cdot)^+$, and passes it to its argument property:

$\text{EXISTS} = \text{def} \; \lambda D:d_{1,i,j}. \lambda c: c. D | c | c^+$

For example, letting $\text{WHEEL} = \text{def} \; (\text{dyn}_{1,0} \; \text{wheel})$, the meaning of There’s a wheel would be

$\text{EXISTS WHEEL} = \lambda c: c. \text{WHEEL} | c | c^+$

$= \lambda c: c. \lambda x|c|, y. (\text{wheel} (x, y)|c|)$

$= \lambda c: c. \lambda x|c|, y. (\text{wheel} y)$
Dynamic conjunction

As usual in dynamic semantics, conjunction is asymmetric, with the second conjunct interpreted ‘after’ the first conjunct has a chance to modify the input context.

\[
\text{AND} = \text{def} \lambda_{h:k} \lambda_{k:k} \lambda_{c:c} \lambda_{x|c, y|h, z|k} \cdot (h \ c \ x, \ y) \ \text{and} \ (k \ (cc \ h \ c) \ x, \ y, \ z)
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\[
\text{AND} \equiv_{\text{def}} \lambda h : k . \lambda k : k . \lambda c : c . \lambda x | c |, y | h |, z | k | . (h c x, y) \text{ and } (k (cc h c) x, y, z)
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- The first conjunct \( h \) is interpreted with respect to the input context
- But the second is interpreted in the context \((cc \ h \ c)\) that results from updating the input context with \( h \)'s content
- So generating CYCLIST via \((\text{dyn}_{1,0} \ \text{cyclist})\), we get a model of There's a cyclist and there's a wheel as

\[
\exists \text{ CYCLIST AND EXISTS WHEEL} \equiv \lambda c:c.\lambda x|c|,y,z.(\text{cyclist} \ y) \ \text{and} \ (\text{wheel} \ z)
\]
Dynamic negation

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Famously, dynamic negation traps discourse referents introduced in its scope, making them unavailable for future reference. This is achieved by existentially binding the referents in the content passed to $\text{NOT} : k_n \rightarrow k_0$, reminiscent of Heim’s (1982) “existential closure”:

$$\text{NOT} = \text{def } \lambda_k : k \lambda_c : c \lambda_x : |c|. \text{not exists}_{y : |k|}. (k \cdot c \cdot x, y)$$
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- So for *It’s not raining*, we get

$$\text{NOT RAIN} = \lambda_{c:c} \lambda_{x|c|}. \text{not rain}$$

- But the model of *There’s no wheel* is

$$\text{NOT (EXISTS WHEEL)} = \lambda_{c:c} \lambda_{x|c|}. \text{not exists}_{y}. (\text{wheel} \ y)$$
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- The importance of this definition will become apparent when we get to anaphoric accessibility.
Other dynamic connectives, quantifiers, and determiners

- With AND, EXISTS, and NOT, we can define other connectives:

  \[
  \text{THAT} = \text{def} \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{n:n} \cdot (D \, n) \ \text{AND} \ (E \, n)
  \]

  \[
  \text{OR} = \text{def} \lambda_{h:k} \lambda_{k:k} \cdot \text{NOT} \ ((\text{NOT} \, h) \ \text{AND} \ (\text{NOT} \, k))
  \]

  \[
  \text{IMPLIES} = \text{def} \lambda_{h:k} \lambda_{k:k} \cdot (\text{NOT} \, h) \ \text{OR} \ (h \ \text{AND} \ k)
  \]
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  \text{THAT} \overset{\text{def}}{=} \lambda D:d_1 \lambda E:d_1 \lambda n:n. (D n) \text{ AND } (E n)
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- Other quantifiers:

  \[
  \text{FORALL} \overset{\text{def}}{=} \lambda D:d_1. \text{NOT EXISTS}_n. \text{NOT} \ (D n)
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Other dynamic connectives, quantifiers, and determiners

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  \]
  \[
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  \[
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  \]

- Other quantifiers:

  \[
  \text{FORALL} = \text{def } \lambda_{D:d_1}. \text{NOT EXISTS}_{n}. \text{NOT } (D n)
  \]

- And, in turn, dynamic versions of the static determiners:

  \[
  \text{A} = \text{def } \lambda_{D:d_1} \lambda_{E:d_1}. \text{EXISTS}_{n}. (D n) \text{ AND } (E n)
  \]
  \[
  \text{NO} = \text{def } \lambda_{D:d_1} \lambda_{E:d_1}. \text{NOT } (\text{A } D E)
  \]
  \[
  \text{EVERY} = \text{def } \lambda_{D:d_1} \lambda_{E:d_1}. \text{FORALL}_{n}. (D n) \text{ IMPLIES } (E n)
  \]
Weak readings and the proportion problem

The definition of dynamic implication IMPLIES may seem a bit roundabout, but it is an implementation of Chierchia’s (1995) dynamic conservativity, since the antecedent’s content is copied into the consequent

\[ \text{IMPLIES} = \text{def} \lambda_h:k \lambda_k:k. (\text{NOT } h) \lor (h \land k) \]

The effect of this definition is that donkey sentences get the so-called weak reading by default, avoiding the proportion problem (which Ribeka will also talk about tomorrow)
Dynamic Agnostic Semantics

Going dynamic

Weak readings and the proportion problem

The definition of dynamic implication \textsc{implies} may seem a bit roundabout, but it is an implementation of Chierchia’s (1995) \textit{dynamic conservativity}, since the antecedent’s content is copied into the consequent

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\textsc{implies} \overset{\text{def}}{=} \lambda h:k. \lambda k:k. (\text{NOT } h) \text{ OR } (h \text{ AND } k)
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The effect of this definition is that donkey sentences get the so-called \textit{weak} reading by default, avoiding the \textit{proportion problem} (which Ribeka will also talk about tomorrow)

For example, the weak reading of

(1) Everyone with a quarter in their pocket put it in the meter. does not require that everyone deposited all their change into the meter, only that everyone put \textit{at least one} quarter into the meter
Going beyond the utterance level, updates are combined by the *parataxis* operation, which is just function composition written in the other order:

\[ \circ \overset{\text{def}}{=} \lambda u:u \lambda v:u \lambda c:c. v (u \ c) \]
Going beyond the utterance level, updates are combined by the \textit{parataxis} operation, which is just function composition written in the other order:

\[
\circ = \text{def } \lambda_u : u \lambda_v : u \lambda_c : c. v (u c)
\]

So the model of the mini-discourse \textit{It was raining. A cyclist left.} is the composed update

\[
(cc \text{ RAIN}) \circ cc (A \text{ CYCLIST LEAVE})
\]

\[
= \lambda_c : c \lambda_x : c \lambda_x : c \lambda_y (c \ x) \text{ and rain and (cyclist y) and (leave y)}
\]
Some connections

- Modulo type constraints, this semantics shares with many others the idea of treating the meanings of declaratives as functions from contexts to contexts.
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- Modulo type constraints, this semantics shares with many others the idea of treating the meanings of declaratives as functions from contexts to contexts.
- It can be seen as a rational reconstruction of Heim 1982, similarly to Beaver 2001 and Muskens 1996.
- It is also similar to de Groote’s (2006) dynamic semantics; the type of contexts is essentially the type of de Groote’s continuations.
- Also, as Carl Pollard once noted, de Groote’s declaratives get the type
  \[ \gamma \rightarrow (\gamma \rightarrow t) \rightarrow t, \]
  where \( \gamma \) is the type of sets of entities.
- But with \( \gamma \) analogous to \( e^n \) and \( t \) analogous to \( p \), this is just a permutation of
  \[ (e^n \rightarrow p) \rightarrow (e^m \rightarrow p), \]
  which is the type of contents.
Talk outline

**Dynamic Agnostic Semantics**
- Agnostic Semantics
- Going dynamic
- Connecting it to a grammar

**Road testing**
- Projective meaning
  - Anaphora
  - Supplements
- VP ellipsis and related phenomena

**Conclusions and future directions**
Hooking DAS up to HTLCG

- Connecting DAS to a formalism like Hybrid Type-Logical Categorial Grammar (Kubota and Levine, to appear) is straightforward, and mostly consists of modifying the lexicon.

  - First, all \( n \)-ary static properties need to be replaced by the dynamic counterparts, obtained by the lifting functions \( \text{dyn} \).
  - For example, letting \( \text{GIVE} = \text{def}(\text{dyn}3,0\text{give}) \), one lexical entry for \( \text{gave} \) becomes \( \text{gave};\text{GIVE};\text{VP/NP/NP} \).
  - Then the semantic component of the determiner lexical entries need to be replaced by their dynamic counterparts, e.g., the lexical entry for \( \text{every} \) becomes \( \lambda \tau \lambda \sigma.\sigma(\text{every} \circ \tau);\text{EVERY};(\text{S} | (\text{S} | \text{NP})) / \text{N} \).
  - None of the inference rules need to change, although the semantic variable in NP hypotheses now has type \( n \), of discourse referents.
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Dynamic Agnostic Semantics
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Basic dynamic HTLCG analysis

- The analysis of *A cyclist broke every wheel* just requires adding some more lexical entries:

\[ \lambda_\tau \lambda_\sigma.\sigma (a \circ \tau) ; A ; (S|(S|NP))/N \]

*cyclist* ; CYCLIST ; N

*wheel* ; WHEEL ; N

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wheel ; WHEEL ; N \\
\lambda_\varphi_1 \lambda_\varphi_2. \varphi_2 \circ \text{broke} \circ \varphi_1 ; \text{BREAK} ; (NP \backslash S) / NP
\]

- From these (along with the entry for *every*), we can derive both of the following:

\[
a \circ \text{cyclist} \circ \text{broke} \circ \text{every} \circ \text{wheel} ; \\
(A \text{ CYCLIST})_n.(\text{EVERY WHEEL})_m.\text{BREAK} \, m \, n \, ; \, S \\
a \circ \text{cyclist} \circ \text{broke} \circ \text{every} \circ \text{wheel} ; \\
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\]
HTLCG, like many frameworks, has been aimed primarily at sentence-level phenomena.
Discourse-level rules

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- Extending it to model discourse requires the addition of a new type D (of discourses), and a new inference rule

\[
\frac{\varphi_1; u; D \quad \varphi_2; k; S}{\varphi_1 \circ \varphi_2; u \circ (cck); D}
\]

- Continue

- This just says that you can concatenate the result of proffering a content \( k \) to an ongoing discourse to create a new discourse.
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  \]
  This just says that you can concatenate the result of proffering a content k to an ongoing discourse to create a new discourse.
- Positing the empty discourse \( \epsilon ; \lambda_{c.c} . c ; D \), the Continue rule gives the following derived rule:
  \[
  \frac{\varphi ; k ; S}{\varphi ; (cc \, k) ; D} \text{ Start}
  \]
  This rule allows any dynamic sentence meaning \( \varphi ; k ; S \) to be promoted to a discourse, proffering its content along the way.
Talk outline

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Road testing
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Conclusions and future directions
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**Projective meaning (Simons et al., 2010; Tonhauser et al., 2013)**

- **Anaphora** must find its antecedent in prior discourse, modulo accessibility constraints and salience
- **Supplements** sometimes constitute a separate discourse update, in addition to participating in anaphora
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**Projective meaning (Simons et al., 2010; Tonhauser et al., 2013)**

- **Anaphora** must find its antecedent in prior discourse, modulo accessibility constraints and salience.
- **Supplements** sometimes constitute a separate discourse update, in addition to participating in anaphora.

**VP ellipsis and (pseudo)gapping (Kubota and Levine, 2014)** needs to find a suitable antecedent property in order to get the meaning right.
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Projective meaning

Just projecting?

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- Anaphora is projective because the requirement that the utterance context contain a suitable antecedent doesn’t go away when embedded:

(2) There was a big pothole around one of the corners on the descent. One cyclist in the group didn’t see the pothole.
Just projecting?

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- For supplements, projection occurs when the supplemental content doesn’t interact with the operators targeting the main clause content.

(3) It’s not true that Lance, a cheating doper, won the Tour de France in 2011.
Invoking the prior context

- Though minimally simplified, the example below shows how the semantics needs to be extended to handle anaphora:

(4) A cyclist$_i$ arrived. The cyclist$_i$ left.
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▶ In order for the anaphoric link indicated by the subscripts to be established, the dynamic meaning of *The cyclist* needs to

1. know which discourse referents in the input context are entailed to be cyclists, and
2. select the most salient one from among them.

▶ So we need a notion of dynamic entailment
Context entailment

Dynamic entailment is based on entailment between contexts, which is encoded by

\[ c\text{-entails} = \text{def} \lambda c: c \lambda d: c \geq |c| \forall x: |c| . (c x) \text{ entails exists } y: |d| - |c| . (d x, y) \]
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\[ \text{c-entails} \overset{\text{def}}{=} \lambda c : c \geq |c| \forall x : |c| \cdot (c \ x) \text{ entails exists } y : |d| - |c| \cdot (d \ x, y) \]

- In words, context entailment between \( c \) and some context \( d \) of at least \( c \)'s arity holds if every way of instantiating \( c \)'s discourse referents yields a proposition that entails the proposition obtained by instantiating \( d \) with those same referents, plus any extras.
Context entailment

- Dynamic entailment is based on entailment between contexts, which is encoded by

\[ c\text{-entails = } \lambda c: c. \lambda d: c \geq |c| \forall x: |c| . \left( c \ x \right) \text{ entails exists}_{y: |d| - |c|} . \left( d \ x, y \right) \]

- In words, context entailment between \( c \) and some context \( d \) of at least \( c \)'s arity holds if every way of instantiating \( c \)'s discourse referents yields a proposition that entails the proposition obtained by instantiating \( d \) with those same referents, plus any extras.

- For example, instantiate the contexts \( c \) and \( d \) as follows:

\[ c = \lambda x. \text{person } x \]
\[ d = \lambda x, y. (\text{name } y) \text{ and } (\text{have } y \ x) \]

Then assuming people always have names, we have \( \vdash c \text{-entails } d \), because

\[ \vdash \forall x. (\text{person } x) \text{ entails exists}_{y} . (\text{name } y) \text{ and } (\text{have } y \ x) \]
But for anaphora, we need to know when a context entails some content, e.g., when a context entails that one of its discourse referents is a cyclist.

Entailment between a context and a content can be checked via

\[ k\text{-entails} = \text{def} \lambda_c : c \lambda_{k:k}.c \text{ c-entails } (cc \ k \ c) \]
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\[ k\text{-entails} =_{\text{def}} \lambda_c: \lambda_k: k. c\text{-entails } (cc k c) \]

That is, a context \( c \) entails a content \( k \) if \( c \) contextually entails the context we get by updating \( c \) with \( (cc k) \).
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Entailment between a context and a content can be checked via

\[
\text{k-entails} \equiv \lambda c. \lambda k. k \cdot c \text{-entails} (cc k c)
\]

That is, a context \(c\) entails a content \(k\) if \(c\) contextually entails the context we get by updating \(c\) with \((cc k)\).

Example: letting \(\text{PERSON} \equiv \text{def} (\text{dyn}_{1,0} \text{person})\), then

\[
\vdash \lambda x. (\text{cyclist } x) \text{-entails } (\text{PERSON } 0)
\]

because \(\vdash \lambda x. (\text{cyclist } x) \text{-entails } \lambda x. (\text{person } x)\)
Generalized definiteness

- With a notion of dynamic entailment, we can define an operator that selects the discourse referent with a certain property.
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- With a notion of dynamic entailment, we can define an operator that selects the discourse referent with a certain property.
- The *generalized definiteness* operator \( \text{the} : d_1 \rightarrow c \rightarrow n \) does this:

\[
\text{the} \equiv \lambda D : d_1 \lambda c : c \lambda n : n. (n < |c|) \land c \text{ k-entails } (D n)
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- So the returns the discourse referent \( n \) known to \( c \) such that \( c \) content-entails \( (D n) \)
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- Here, \( \iota : (n \rightarrow t) \rightarrow n \) is one of the definite description operators that come with the logic (cf. Henkin, 1963).
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- So the returns the discourse referent \( n \) known to \( c \) such that \( c \) content-entails \( (D n) \).
- Here, \( \iota : (n \rightarrow t) \rightarrow n \) is one of the definite description operators that come with the logic (cf. Henkin, 1963).
- Caveat: a large component of \( \iota \) is simply assumed, namely the requirement of greatest salience.
- For example, it’s not enough to select the unique cowboy in the following:

(5) A cowboy walked in and sat down. Another cowboy came in, and that cowboy ordered a Mai Tai.
The definite determiner

- The definite determiner is then based on the:

\[ \text{THE} = \text{def} \ \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{c:c} \ E \ (\text{the} \ D \ c) \ c \]

- This just takes two properties \( D \) and \( E \), passing to \( E \) the uniquely most salient discourse referent in \( c \) with the property \( D \)
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- For example, the model of \textit{The cyclist left} is

\[
\begin{align*}
\text{THE CYCLIST LEAVE} \\
= \lambda_c:c.\text{LEAVE} \ (\text{the CYCLIST} \ c) \ c \\
= \lambda_c:c \lambda_{x|c}.\text{leave} \ x(\text{the CYCLIST} \ c)
\end{align*}
\]
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\end{align*}
\]

- This content takes a context \( c \) to return another context in which whichever discourse referent \( c \) has at the index (the CYCLIST \( c \)) is asserted to have left
Resolving a definite

- Returning to our previous example
  
  (4) A cyclist\textsubscript{i} arrived. The cyclist\textsubscript{i} left.

- With $\textsc{ARRIVE} =_{\text{def}} (\text{dyn}_{1,0} \text{arrive})$, the model of (4) is

  (6) $\left( \text{cc} \left( \text{A CYCLIST ARRIVE} \right) \right) \circ \text{cc} \left( \text{THE CYCLIST LEAVE} \right)$
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- The context passed to \(\text{THE CYCLIST LEAVE}\) is

\[(((\text{cc} (\text{A CYCLIST ARRIVE})) \lambda_x.\text{true})\]

\[= \lambda_x.\text{true and (cyclist }x\text{) and (arrive }x\text{)}\]
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- The context passed to THE CYCLIST LEAVE is
  
  $((\text{cc} (\text{A CYCLIST ARRIVE})) \lambda_{x_1}.\text{true})$

  $= \lambda_x.\text{true}$ and $(\text{cyclist } x)$ and $(\text{arrive } x)$

- And so THE CYCLIST is able to select the intended referent, giving

  $\lambda_x.\text{true}$ and $(\text{cyclist } x)$ and $(\text{arrive } x)$ and $(\text{leave } x)$

  as the context output by (4) interpreted in the empty context
Proper names

In this framework, proper names are not modeled by constants, as they are in some others.
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- Here, NAMED-KIM is the dynamic property of being named “Kim”, derived from its static counterpart named-kim via \( \text{dyn}_{1,0} \).
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\text{KIM} = \text{def THE NAMED-KIM}
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- Here, *NAMED-KIM* is the dynamic property of being named “Kim”, derived from its static counterpart *named-kim* via \(\text{dyn}_{1,0}\).
- In other words, *Kim* is treated on a par with the definite *the one named Kim*. 
Definitely general

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A model of (7), in this framework, would be

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Because it is sensitive to entailments, THE can be extended to handle bridging anaphora by implementing Roberts’s (2005) “weak familiarity”, but I omit the details here (see Martin 2012, 2013).
What about pronouns?

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- But empirically, pronouns are different:

  (8) A cop$_i$ pulled me over, and she$_i$ wrote me a ticket!
  (9) # Some guy$_i$ pulled me over, and she$_i$ wrote me a ticket!
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- The generalization is that pronouns don’t require their antecedents to strictly entail their descriptive content, just that the antecedent is consistent with their content.

- So we also need a notion of contextual consistency.
Content consistency and pronominal definiteness

- Fortunately, consistency between a context and a content is easy to define in terms of $k$-entails:

$$k\text{-cons} = \text{def } \lambda c : c \lambda k : k. \neg (c \text{ k-entails } (\text{NOT } k))$$

- As the definition shows, $k$-cons only requires that the context does not entail the negation of the content
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- Then there is a modified version of the for pronouns that uses k-cons instead of k-entails:

\[ \text{pro} = \text{def} \lambda D: d_1 \lambda c: c \lambda n: n. (n < |c|) \land c \text{k-cons} (D n) \]

- Similarly to the, this function selects the uniquely most salient discourse referent in the context that is consistent with the dynamic property \( D \).
Generalized pronouns

- Pronouns are defined by a ‘determiner’ that works in a parallel way to THE but using pro:

$$\text{PRO} =_{\text{def}} \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{c:c}.E(\text{pro} \ D \ c) \ c$$
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- So the and pro can be seen as analogous to de Groote’s (2006) sel function, except that sel doesn’t take entailments into account

- Note that, in contrast to the, this ‘determiner’ is never pronounced in English!
Pronouns defined

- It does figure in the definitions of pronouns, however:

  HE $=_{\text{def}}$ PRO MALE
  HIM $=_{\text{def}}$ PRO MALE
  SHE $=_{\text{def}}$ PRO FEMALE
  HER $=_{\text{def}}$ PRO FEMALE
  IT $=_{\text{def}}$ PRO NONHUMAN

Here MALE, FEMALE, and NONHUMAN are unary dynamic properties derived from their counterparts male, female, and nonhuman by $\text{dyn}_{1,0}$.
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- For example, the content S\text{HE A}RR\text{IVE} expands to

  \[
  \begin{align*}
  \text{SHE ARRIVE} & = \lambda_{c:c}. \text{ARRIVE} \left( \text{pro FEMALE} c \right) c \\
  & = \lambda_{c:c} \lambda_{x|c|}. \text{ARRIVE} \ x \left( \text{pro FEMALE} c \right)
  \end{align*}
  \]
Possessives

- We can also define possessive pronouns based on the definite and pronoun determiners
- For example, the dynamic meaning of his can be modeled as
  \[
  \text{HIS} = \text{def } \lambda_D:d_1 \lambda_E:d_1 \cdot \text{THE} (D \text{ THAT } \lambda_n \cdot \text{HE} (\text{HAVE } n)) \cdot E
  \]
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\]

(Here *HAVE* is generated by \( \text{dyn}_{2,0} \) from *have*)
- For example, the meaning of *his wheel*, under this treatment, is

\[
\text{HIS WHEEL} = \lambda_{E:d_1} \cdot \text{THE} \left( \text{WHEEL} \quad \text{THAT} \quad \lambda_n \cdot \text{HE} \left( \text{HAVE} \; n \right) \right) \; E
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  \]
- A similar treatment can be given to the possessives \text{HER} and \text{ITS}, by replacing \text{HE} with \text{SHE} or \text{IT}, respectively, and analogously for other possessives.
The obligatory donkey sentence

- Defining BIKE via $\text{dyn}_{1,0}$ and OWN and RIDE via $\text{dyn}_{2,0}$, we can get a meaning for

(10) Every cyclist who owns a bike$_i$ rides it$_i$.

that does the right thing
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\[(10) \quad \text{Every cyclist who owns a bike}\_i \text{ rides it}\_i.\]

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- The semantics is

\[
\text{EVERY (CYCLIST THAT } \lambda_n.(A \text{ BIKE})_m.\text{OWN } m n ) \lambda_n.(\text{IT}_m.\text{RIDE } m n)
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\]

- The anaphora works because the restrictor property generates the following:

\[
\lambda_{n:n} \lambda_{c:c} \lambda_{x|c|_y}.(\text{cyclist } x_n) \text{ and (bike } y \text{) and (own } y \; x_n)
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\]

- The pronoun in the scope can pick up the uniquely most salient nonhuman antecedent from its input context, namely, the bike $y$
Anaphoric accessibility in discourse

However, the bike referent in (10) isn’t accessible outside the scope of EVERY, since EVERY is defined in terms of FORALL, which is in turn defined in terms of NOT
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- To illustrate this, we take the even simpler example
  (11) # No cyclist\(_i\) arrives. She\(_i\) leaves.
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\[(11) \quad \# \text{ No cyclist}_i \text{ arrives. She}_i \text{ leaves.} \]

- The dynamic meaning of the first utterance of (11) is

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\text{NO CYCLIST ARRIVE} = \lambda_c : \lambda_{x|c|}. \text{not exists}_y.(\text{cyclist } y) \text{ and (arrive } y) \]
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  \[ \text{NO CYCLIST ARRIVE} = \lambda c : c \lambda x |c| \text{.not exists}_y (\text{cyclist } y) \text{ and (arrive } y) \]
- Since the cyclist referent \( y \) is existentially bound, it is trapped—no reference to it in subsequent discourse is possible
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Since the cyclist referent $y$ is existentially bound, it is trapped—no reference to it in subsequent discourse is possible.

And this inaccessibility is inherited by all the connectives, quantifiers, and determiners defined in terms of dynamic negation: EVERY, FORALL, IMPLIES, NO, OR.
Iterative adverbs

- Iterative adverbs like *too* can also be analyzed under the rubric of anaphora:

\[
\text{TOO} \overset{\text{def}}{=} \lambda n \colon n . \lambda c \colon c > n . \lambda x \colon |c| .
\]
\[
D (m \colon n . m = n \land \exists k : n . (c k \text{-entails} (D k)) \land \neg (k = m)) c x
\]

- This definition effectively requires the discourse referent passed to \( D \) to be distinct from one the context already knows about with that property.
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\text{TOO} \overset{\text{def}}{=} \lambda D : d_1 \lambda n : n \lambda c : c > n \lambda x \mid c . \\
D (\iota_{m : n} . m = n \land \exists k : n . (c \ k \text{-entails} (D k)) \land \neg (k = m)) \ c \ x
\]

This definition effectively requires the discourse referent passed to \( D \) to be distinct from one the context already knows about with that property.

For example, a model of *Kim owns a bike, too* would be

\[
\text{KIM} \ (\text{TOO} \ \lambda n . (\text{A BIKE})_m . \text{OWN} \ m \ n)
\]
Iterative adverbs

Iterative adverbs like *too* can also be analyzed under the rubric of anaphora:

\[ \text{TOO} =_{\text{def}} \lambda_D \, \lambda_n \, \lambda_c \, \lambda_x \, \lambda_c \times |c| \cdot \]
\[ D \, (\lambda_m \, \lambda_m = n \, \land \, \exists_k \, (c \, k \text{-entails} \, (D \, m)) \, \land \, \neg (k = m)) \, c \, x \]

This definition effectively requires the discourse referent passed to \( D \) to be distinct from one the context already knows about with that property.

For example, a model of *Kim owns a bike, too* would be

\[ \text{KIM} \, (\text{TOO} \, \lambda_n \, (\text{A BIKE})_m \, \text{OWN} \, m \, n) \]

Supposing \( k \) is selected as the discourse referent entailed to be named “Kim”, the definition of TOO requires that there be some other referent besides \( k \) that is also entailed to own a bike.
The conventional (implicature) view of supplements

- Potts (2005) and many others have characterized supplements like the one in (3) as contributing to a separate meaning “dimension”

(3) It’s not true that Lance, a cheating doper, won the Tour de France in 2011.
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► Potts (2005) and many others have characterized supplements like the one in (3) as contributing to a separate meaning “dimension”

(3) It’s not true that Lance, a cheating doper, won the Tour de France in 2011.

► Multidimensionality has been touted as giving a nice model for (3), because it allows the implication that Lance doped to survive even when the implication of winning is negated.
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(12) Kim’s bike, which used to have reflectors on it, was safe to ride until she took them off.
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- In my dissertation (Martin, 2013), I tried to reconcile anaphora and multidimensionality, but more recently I became unsure that a multidimensional semantics is right for supplements
Problems with multidimensionality for supplements

The main reason is that, contrary to claims often made about them, supplements can participate in scope interactions.

(13) In each class, several students failed the midterm exam, which they had to retake later. (Amaral et al., 2007)

(14) It’s not the case that a boxer, a famous one, lives in this street. (Nouwen, 2014)

(15) If tomorrow I call the chair, who in turn calls the dean, then we will be in deep trouble. (Schlenker, ms)

(16) Every famous boxer I know has a devoted brother, who he completely relied on back when he was just an amateur.

(17) But there would always be some student, a photographer or a glassblower, who would simply have taken a piece of newspaper and folded it once and propped it up like a tent and let it go at that.
Further problems with multidimensionality

- Potts and others have often claimed that supplements are not deniable because they can’t ever be *at-issue*, since their content ends up in the non-at-issue dimension

(18)  
  a. Edna, who is a fearless leader, started the descent.  
  b. # No, she isn’t. She is a coward.  
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▶ But this pattern isn’t general, because supplements get easier to deny when they’re closer to the end of an utterance

(19) a. He told her about Luke, who loved to have his picture taken.

b. No, he didn’t like that at all.

c. No, he told her about Noah.

(AnderBois et al., 2010)
More dimensions, more problems

- Baked into the multidimensional program is the idea that inhabiting the non-at-issue dimension is an inherent property of supplements.
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More dimensions, more problems

- Baked into the multidimensional program is the idea that inhabiting the non-at-issue dimension is an inherent property of supplements.
- But this means that all supplement anchors are treated on a par, so that current multidimensional approaches don’t distinguish between proper name and indefinite anchors.
- And so they don’t explain the apparent difference between the following:

  (20) It’s not true that some cyclist, a cheating doper, won the Tour de France in 1918. There was no Tour that year.

  (21) It’s not true that Henri Pélissier, a cheating doper, won the Tour de France in 1918. There was no Tour that year.

- It is much easier to interpret the supplement in the scope of negation for (20) than it is for (21).
A new, unidimensional account

- The core idea is to get rid of the extra dimensions and model supplements as quantifier phrase modifiers.
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- Since the framework already handles anaphora, we also get anaphoric interactions between supplements and other content with no extra effort.

As I’ll discuss in a minute, the account also gives a nice model of how a supplement’s deniability increases with its utterance-finality.

This account is discussed in detail in Martin 2015 and Martin in press.
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- For example, a component of the meaning of *Lance is a cyclist* is the predicativized GQ *a cyclist*, derived as follows:

\[
PRED \text{ A CYCLIST} \\
= \lambda n: n. (A \text{ CYCLIST})_m.m \text{ EQUALS } n \\
= \lambda n: n. \text{ EXISTS}_m. (\text{CYCLIST } m) \text{ AND } (m \text{ EQUALS } n)
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\[= \lambda n : n. \exists m. (\text{CYCLIST } m) \text{ AND } (m \text{ EQUALS } n)\]

- Here \(\text{EQUALS} = \text{def} \lambda m : n. \lambda n : n. \lambda c : c. \lambda x : c. x_m \text{ equals } x_n\), and equals is the intensional equality function
The entire analysis of supplements on one slide

- All the work of the analysis is handled by the *comma intonation*, defined as

\[
\text{COMMA} = \text{def } \lambda_{Q:d_1 \rightarrow k} \lambda_{D:d_1} \lambda_{E:d_1} \cdot (Q \ D) \ \text{AND} \ (\text{THE} \ D \ E)
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- The result is conjoined into a GQ in which the appositive does double duty, effectively adding its content into the GQ’s restrictor
- And that’s all, folks
A simple example of a supplement that projects:

(22) Lance, a doper, won the Tour de France.
A projecting supplement

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- We get the analysis

\[
\text{COMMA LANCE (PRED A DOPER) WIN-TDF} = (\text{LANCE (PRED A DOPER)}) \text{ AND THE (PRED A DOPER) WIN-TDF}
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- A simple example of a supplement that projects:

  \[(22) \quad \text{Lance, a doper, won the Tour de France.}\]

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  \text{COMMA LANCE (PRED A DOPER) WIN-TDF} \\
  \quad = (\text{LANCE (PRED A DOPER)}) \text{ AND THE (PRED A DOPER) WIN-TDF}
  \]

- So (22) is treated on a par with *Lance is a doper, and the one who's a doper won the Tour de France*
Projection as conjoined update

Projection arises for (22) because the supplement constitutes a separate update when (22) gets proffered.
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- Projection arises for (22) because the supplement constitutes a separate update when (22) gets proffered
- That’s because of a formal theorem linking conjoined update and parataxis (see Martin in press for proof):

\[
\vdash \forall h: k \forall k: k. \text{cc} (h \text{ AND } k) = (\text{cc } h) \circ (\text{cc } k)
\]

(Recall that the context change function cc transforms a content into an update (i.e., an at-issue proposal), and represents the process of proffering a content for acceptance or rejection)
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(Recall that the context change function $cc$ transforms a content into an update (i.e., an at-issue proposal), and represents the process of proffering a content for acceptance or rejection.)

And so, when proffered, the analysis of (22) is equivalent to

$$(cc \ \text{LANCE} \ (PRED \ A \ DOPER)) \circ (cc \ \text{THE} \ (PRED \ A \ DOPER) \ \text{WIN-TDF})$$

This amounts to a two-utterance discourse with (1) the update that Lance dopes followed by (2) the update that he won.
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- This amounts to a two-utterance discourse with (1) the update that Lance dopes followed by (2) the update that he won
- More generally, this implies that whenever a supplement outscopes all other operators, it projects because it constitutes its own discourse update
Projection from under negation

- This account models projection for the negated simplification of (21) below:

  (23) It’s not true that Henri, a doper, won the Tour de France.
Projection from under negation

- This account models projection for the negated simplification of (21) below:

(23) It’s not true that Henri, a doper, won the Tour de France.

- The system generates the following two representations of (23)

  \[
  \text{COMMA HENRI (PRED A DOPER) } \lambda_n.\text{NOT (WIN-TDF } n) \\
  \text{NOT (COMMA HENRI (PRED A DOPER) WIN-TDF)}
  \]
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- The first of these is the projective one, because it is equivalent, under proffering, to the two-update discourse

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  (23)   It’s not true that Henri, a doper, won the Tour de France.

- The system generates the following two representations of (23)

  \[
  \text{COMMA HENRI (PRED A DOPER) } \lambda_n \cdot \text{NOT (WIN-TDF } n) \\
  \text{NOT (COMMA HENRI (PRED A DOPER) WIN-TDF)}
  \]

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  \[
  (\text{cc HENRI (PRED A DOPER)}) \circ \\
  (\text{cc THE (PRED A DOPER) } \lambda_n \cdot \text{NOT (WIN-TDF } n))
  \]

- This reading is preferred, as desired, because of the general preference for proper names to scope widest (Kamp and Reyle, 1993; Bos, 2003)
Non-projection from under negation

- Things are different for indefinites, however:
  
  (24) It’s not true that some cyclist, a doper, won the Tour de France.

- For this simplified variant of (20), two scopings are generated, as before

  \[
  \text{COMMA (A CYCLIST) (PRED A DOPER) } \lambda_n.\text{NOT (WIN-TDF } n) \\
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\text{NOT} (\text{COMMA} (\text{A CYCLIST}) (\text{PRED A DOPER}) \text{WIN-TDF})
\]

In this case, there is no default preference for the indefinite to scope wide, and so we get a genuine ambiguity between the projective and non-projective readings.
Quantifier scope ambiguity and projection ambiguity

For Nouwen’s (2014) example

(25) Every boxer has a coach, who is famous.
the system also gives two analyses:

\[(\text{EVERY BOXER})_n. (\text{COMMA (A COACH)} \lambda_m. (\text{HAVE } m \ n \ \text{FAMOUS}))\]
\[(\text{COMMA (A COACH)} \lambda_m. (\text{EVERY BOXER})_n. (\text{HAVE } m \ n \ \text{FAMOUS}))\]
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- The first, non-projective, reading of (25) is preferred because of the independent preference for surface scope
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The first, non-projective, reading of (25) is preferred because of the independent preference for surface scope.

But just as with normal quantifier scope ambiguity, the second, projective, reading is also available by selecting the inverse scope reading instead.
Ruling out quantificational anchors

> A pervasive pattern is that quantificational anchors are disallowed, as in

(26)  # Every cyclist, a doper, won the Tour de France.
Ruling out quantificational anchors

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▶ In this account, quantificational anchors are ruled out by the familiar mechanism of anaphoric accessibility
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  (26)  # Every cyclist, a doper, won the Tour de France.

- In this account, quantificational anchors are ruled out by the familiar mechanism of anaphoric accessibility

- That’s because the analysis of (26), when proffered, is

  \[
  (\text{cc } \text{EVERY CYCLIST} (\text{PRED A DOPER})) \circ \\
  (\text{cc } \text{THE} (\text{PRED A DOPER}) \text{WIN-TDF})
  \]

- Since the doping cyclist referent is trapped in the scope of every, it cannot be accessed by \text{THE} (\text{PRED A DOPER}) in the next update, as desired
Carl Pollard (p.c.) once pointed out this example to me:

(27) No Tibetan Buddhist\textsubscript{i} thinks the Dalai Lama, his\textsubscript{i} spiritual mentor, would ever cave to Chinese pressure tactics.

To see how the system analyzes (27), we first have to define a meaning for \textit{think}

\[
\text{THINK} \triangleq \lambda_{k:k} \lambda_{n:n} \lambda_{c:c} \lambda_{x|x|}.\text{think} \ (k \ c \ x) \ x_n,
\]
Exceptional binding and supplements I

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\]

► Then the preferred reading generated for (27) is

\[
\text{COMMA } (\text{THE D-L}) (\text{PRED HIS MENTOR}) \lambda_m.(\text{NO T-B})_n.\text{THINK } (\text{CAVE } m)\ n \\
= (\text{THE D-L } (\text{PRED HIS MENTOR})) \text{ AND } (\text{THE (PRED HIS MENTOR)})_m.(\text{NO T-B})_n.\text{THINK } (\text{CAVE } m)\ n
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This reading, repeated below, is *almost* the right one

\[(\text{THE D-L (PRED HIS MENTOR)}) \text{ AND} \]
\[(\text{THE (PRED HIS MENTOR)})_m.(\text{NO T-B})_n.\text{THINK (CAVE }m) n\]
Exceptional binding and supplements II

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\[(\text{THE D-L (PRED HIS MENTOR)}) \text{ AND} \]
\[(\text{THE (PRED HIS MENTOR)})_m \cdot (\text{NO T-B})_n . \text{THINK (CAVE m)}_n\]

- In addition to cataphora, HIS can’t access its antecedent, the Tibetan Buddhist, because it’s in the scope of NO
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- But note the similarity between (27) and this example, an instance of Roberts's (1989) telescoping:

(28) Each degree candidate \(i\) walked to the stage. He \(i\) took his \(i\) diploma from the dean and returned to his \(i\) seat. (Roberts, 1989)
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  \[(\text{THE D-L (PRED HIS MENTOR)}) \text{ AND} \]
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- An analysis of exceptional binding like (28) has been implemented by Wang et al. (2006) via discourse relations, and could be here too
Salience and supplement deniability

- The supplement in (30) is easier to deny than the one in (29):

  (29)  Some cyclist, a doper, met Lance.
  
  (30)  Some cyclist met Lance, a doper.
Salience and supplement deniability

- The supplement in (30) is easier to deny than the one in (29):

  (29) Some cyclist, a doper, met Lance.
  (30) Some cyclist met Lance, a doper.

- In this account, supplement deniability is related to the fact that more recent utterances are more salient (Ginzburg, 2012)
Salience and supplement deniability

- The supplement in (30) is easier to deny than the one in (29):

  (29) Some cyclist, a doper, met Lance.
  (30) Some cyclist met Lance, a doper.

- In this account, supplement deniability is related to the fact that more recent utterances are more salient (Ginzburg, 2012)

- In the analysis of (30), the supplement updates the discourse last, and is therefore more salient:

\[
\text{COMMA LANCE } \lambda_m. (\text{A CYCLIST})_n. (\text{MEET } m \ n) (\text{PRED A DOPER}) \\
= (\text{LANCE}_m. (\text{A CYCLIST})_n. \text{MEET } m \ n) \text{ AND} \\
\text{THE } \lambda_m. (\text{A CYCLIST})_n. (\text{MEET } m \ n) (\text{PRED A DOPER})
\]

- Under proffering, this is equivalent to the two-utterance discourse Some cyclist met Lance. The one that some cyclist met is a doper.
This account follows Simons et al. (2010), Martin (2013) and Tonhauser et al. (2013) in not lumping factives, aspectuals, and achievements in with anaphora.
Anaphora and presupposition I

- This account follows Simons et al. (2010), Martin (2013) and Tonhauser et al. (2013) in not lumping factives, aspectuals, and achievements in with anaphora.

- That’s because they don’t seem to constrain the context the way anaphora does:

  (31) It can’t be that Kim is worried because she *regrets* leaving the stove on. Her stove is currently broken.

  (32) Sandy can’t participate in that smoking cessation program because she didn’t *quit* smoking—actually, she never smoked in her life.

  (33) Lance didn’t *win* the Tour de France in 2011. He didn’t even enter that year.
Anaphora and presupposition I

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- That’s because they don’t seem to constrain the context the way anaphora does:

  (31) It can’t be that Kim is worried because she regrets leaving the stove on. Her stove is currently broken.

  (32) Sandy can’t participate in that smoking cessation program because she didn’t quit smoking—actually, she never smoked in her life.

  (33) Lance didn’t win the Tour de France in 2011. He didn’t even enter that year.

- Contrast with the completely bizarre

  (34) # She might be here, but there’s no suitable antecedent to resolve she to.
This approach’s stance:
- Factives, aspectuals, achievements, etc., sometimes strongly suggest an inference on the part of the hearer
- But it would be incorrect for the semantics to force the inference
Anaphora and presupposition II

- This approach’s stance:
  - Factivs, aspectuals, achievements, etc., sometimes strongly suggest an inference on the part of the hearer
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- And so this approach can be seen as strengthening van der Sandt’s (1992) slogan that presupposition is [an instance of] anaphora to the claim that presupposition and anaphora are synonyms
Anaphora and presupposition II

- This approach’s stance:
  - Factivs, aspectuals, achievements, etc., sometimes strongly suggest an inference on the part of the hearer
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- And so this approach can be seen as strengthening van der Sandt’s (1992) slogan that presupposition is [an instance of] anaphora to the claim that presupposition and anaphora are synonyms
- In other words, the job of the semantics should be to say which entailments the contextual interpretation gives rise to, but factives, aspectuals, achievements, etc., don’t have the same force as true entailments
Talk outline

Dynamic Agnostic Semantics
  Agnostic Semantics
  Going dynamic
  Connecting it to a grammar

Road testing
  Projective meaning
    Anaphora
    Supplements
  VP ellipsis and related phenomena

Conclusions and future directions
An anaphoric analysis of VP ellipsis, etc.

▶ Our workshop organizers have a really cool analysis of VP ellipsis and numerous instances of (pseudo)gapping (Kubota and Levine, 2014, ms)
An anaphoric analysis of VP ellipsis, etc.

- Our workshop organizers have a really cool analysis of VP ellipsis and numerous instances of (pseudo)gapping (Kubota and Levine, 2014, ms).

- Its central feature is that it gets correct analyses for a whole bunch of related phenomena via a single operator (VP abbreviates NP\S):

  \[
  \lambda \varphi. \varphi ; \lambda \mathcal{F}. (\mathcal{F} P) ; (VP/\$) \| ((VP/\$)/(VP/\$))
  \]

- The occurrence of \( P \) is anaphoric to a previously mentioned property, with some constraints on its suitability that I’ll discuss in a minute.
Our workshop organizers have a really cool analysis of VP ellipsis and numerous instances of (pseudo)gapping (Kubota and Levine, 2014, ms)

Its central feature is that it gets correct analyses for a whole bunch of related phenomena via a single operator (VP abbreviates NP\S):

$$\lambda \varphi . \varphi ; \lambda F . (F P) ; (VP/$$)$|((VP/$$)/(VP/$$))$$

The occurrence of $P$ is anaphoric to a previously mentioned property, with some constraints on its suitability that I’ll discuss in a minute

Kubota and Levine’s account is static, but here we’ll fill in the dynamic details, point out some problems, and make some suggestions for improvement
Some data

- The analysis is targeted at data like the following

  (35)  
  a. Kim sneezed. Sandy did (too).
  b. Kim thought she sneezed. Sandy did (too).
  c. Kim read every book before Sandy did.

  (VP ellipsis)

  (36)  
  Kim can eat pizza and Sandy tacos. (Gapping)

  (37)  
  a. Kim should eat the banana. Sandy should the apple
  b. You can’t take the lining out of that coat. You can this one.
  c. Although I didn’t give Kim the book, I did Sandy.

  (Pseudogapping)
Redefining contexts

» The basic idea is to store dynamic properties in the context as they’re used, so they’re available for later anaphoric reference
Redefining contexts

- The basic idea is to store dynamic properties in the context as they’re used, so they’re available for later anaphoric reference.
- So we need to redefine the type of contexts to be

\[ c_n = \text{def } e^n \rightarrow (p \times (\sum_m d_m) \rightarrow t) \]

- This is the type of functions from an \( n \)-ary entity vector to a pair consisting of (1) a proposition and (2) a set of dynamic properties (of any arity).
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- This is the type of functions from an \( n \)-ary entity vector to a pair consisting of (1) a proposition and (2) a set of dynamic properties (of any arity).
- The new second component of the context will store the dynamic properties as they are encountered.
- Two new functions give mnemonic access to the two components:

\[
\text{cont} = \text{def } \lambda_{c:c}.\pi_1 c \\
\text{rels} = \text{def } \lambda_{c:c}.\pi_2 c
\]
Sets in type theory

- We also need to define some functions for accessing and extending the dynamic property sets in the context

\[
\emptyset = \text{def } \lambda D : d_n . F \\
\{ \cdot \} = \text{def } \lambda D : d_n \lambda Q : \Sigma_m . d_m . Q = \langle n, D \rangle \\
\in = \text{def } \lambda D : d_n \lambda S : (\Sigma_m . d_m) \rightarrow t . (S \langle n, D \rangle) \\
\cup = \text{def } \lambda S : (\Sigma_n . d_n) \rightarrow t \lambda T : (\Sigma_n . d_n) \rightarrow t \lambda D : d_k . D \in S \lor D \in T
\]

- Also, \( \{ D, E \} \) is shorthand for \( \{ D \} \cup \{ E \} \), and outer brackets are often dropped
Redefining the connectives, quantifiers, and entailment

The dynamic connectives and quantifiers also need redefining, so that they keep track of the properties they inherit.

\[
\text{cc} = \lambda_k \lambda_c \lambda_x [c|] \cdot \lambda_y [k|] \cdot \langle \text{cont} (c \ x) \text{ and cont} (k \ c \ x, y), \\
\text{rels} (c \ x) \cup \text{rels} (k \ c \ x, y) \rangle
\]

\[
\text{EXISTS} = \lambda_D \lambda_c \cdot \langle \text{cont} (D \ |c| \ c^+), \text{rels} (D \ |c| \ c^+) \rangle
\]

\[
\text{AND} = \lambda_h \lambda_k \lambda_c \lambda_x [c|] \cdot \lambda_y [h|] \cdot \lambda_z [k|] \cdot \langle \text{cont} (h \ c \ x, y) \text{ and cont} (k \ (\text{cc} \ h \ c) \ x, y, z), \\
\text{rels} (h \ c \ x, y) \cup \text{rels} (k \ (\text{cc} \ h \ c) \ x, y, z) \rangle
\]

\[
\text{NOT} = \lambda_k \lambda_c \lambda_x [c|] \cdot \langle \not \exists y [k|] \cdot \text{cont} (k \ c \ x, y), \\
\lambda_D \cdot \exists z [k|] \cdot D \in \text{rels} (k \ c \ y, z) \rangle
\]
Redefining the connectives, quantifiers, and entailment

- The dynamic connectives and quantifiers also need redefining, so that they keep track of the properties they inherit

\[
\text{cc} \ = \ \lambda_k \lambda_c \lambda x |c|. y |k|. \langle \text{cont} (c \ x) \ 	ext{and cont} (k \ c \ x, y), \\
\text{rels} (c \ x) \cup \text{rels} (k \ c \ x, y) \rangle
\]

\[
\text{EXISTS} \ = \ \lambda D \lambda c. \langle \text{cont} (D \ |c| \ c^+), \text{rels} (D \ |c| \ c^+) \rangle
\]

\[
\text{AND} \ = \ \lambda_h \lambda_k \lambda_c \lambda x |c|. y |h|. z |k|. \langle \text{cont} (h \ c \ x, y) \ 	ext{and cont} (k (cc \ h \ c) \ x, y, z), \\
\text{rels} (h \ c \ x, y) \cup \text{rels} (k (cc \ h \ c) \ x, y, z) \rangle
\]

\[
\text{NOT} \ = \ \lambda_k \lambda_c \lambda x |c|. \langle \text{not exists}_{y |k|} . \text{cont} (k \ c \ x, y), \\
\lambda D. \exists z |k|. D \in \text{rels} (k \ c \ y, z) \rangle
\]

- We (trivially) redefine contextual entailment as follows:

\[
c\text{-entails} \ = \ \lambda c:\lambda d: c \geq |c| . \forall x |c|. \langle \text{cont} (c \ x) \ 	ext{entails exists}_{y |d| - |c|} . (d \ x, y) \rangle
\]
We also need to redefine the dynamicizer functions

\[ \text{dyn}_{0,i} = \text{def} \lambda p:p_0 \lambda c:c_{>i} \lambda x|c| \cdot \langle p, \emptyset \rangle \]

\[ \text{dyn}_{n+1,i} = \text{def} \lambda R:p_{n+1} \lambda m:n \lambda c:c_{>(\text{max } m)} \lambda x|c| \cdot \right\langle \right. \text{cont} \left( \text{dyn}_{n,(\text{max } m)} (R x_m) c x \right), \]

\[ \left\{ \lambda_k \text{dyn}_{n,k} (R x_k) \right\} \cup \text{rels} \left( \text{dyn}_{n,(\text{max } m)} (R x_m) c x \right) \left\rangle \right. \]
Redefining dynamicization

- We also need to redefine the dynamicizer functions

\[
\begin{align*}
\text{dyn}_{0,i} &= \text{def} \lambda p : p_0 \lambda c : c > i \lambda x |c| \cdot \langle p, \emptyset \rangle \\
\text{dyn}_{n+1,i} &= \text{def} \lambda R : p_{n+1} \lambda m : n \lambda c : c > (\text{max } i m) \lambda x |c| \cdot \\
 & \quad \langle \text{cont} \ (\text{dyn}_{n, (\text{max } i m)} \ (R x_m) \ c \ x), \\
 & \quad \{ \lambda_k . \text{dyn}_{n,k} (R x_k) \} \cup \text{rels} \ (\text{dyn}_{n, (\text{max } i m)} \ (R x_m) \ c \ x) \rangle
\end{align*}
\]

- For example, these give dynamic properties that store themselves and any sub-properties

\[
\begin{align*}
(\text{dyn}_{1,0} \text{ sneeze}) &= \lambda n \lambda c \lambda x |c| . \langle \text{sneeze } x_n \rangle, \\
\lambda_k \lambda c \lambda x |c| . \langle \text{sneeze } x_k , \emptyset \rangle \rangle \\
(\text{dyn}_{2,0} \text{ eat}) &= \lambda m \lambda n \lambda c \lambda x |c| . \langle \text{eat } x_m x_n \rangle, \\
\{ \lambda_k \lambda j \lambda c \lambda x |c| . \langle \text{eat } x_k x_j, \ldots \rangle, \lambda j \lambda c \lambda x |c| . \langle \text{eat } x_m x_j, \ldots \rangle \} \rangle
\end{align*}
\]
Redefining the anaphoric determiners

Lastly, we need to redefine the anaphoric determiners THE and PRO to store their scope property

\[
\text{THE } =_{\text{def}} \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{c:c} \lambda_{x|c|}. \langle \text{cont} (E \text{ (the } D \text{ c) } c \text{ x}), \\
\{E\} \cup \text{rels} (E \text{ (the } D \text{ c) } c \text{ x}) \rangle
\]

\[
\text{PRO } =_{\text{def}} \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{c:c} \lambda_{x|c|}. \langle \text{cont} (E \text{ (pro } D \text{ c) } c \text{ x}), \\
\{E\} \cup \text{rels} (E \text{ (pro } D \text{ c) } c \text{ x}) \rangle
\]
Redefining the anaphoric determiners

- Lastly, we need to redefine the anaphoric determiners *THE* and *PRO* to store their scope property

\[
\begin{align*}
\text{THE} &= \text{def } \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{c:c} \lambda_{x|c|}. \langle \text{cont } (E (\text{the } D\ c\ c)\ x), \{E\} \cup \text{rels } (E (\text{the } D\ c\ c)\ x) \rangle \\
\text{PRO} &= \text{def } \lambda_{D:d_1} \lambda_{E:d_1} \lambda_{c:c} \lambda_{x|c|}. \langle \text{cont } (E (\text{pro } D\ c\ c)\ x), \{E\} \cup \text{rels } (E (\text{pro } D\ c\ c)\ x) \rangle
\end{align*}
\]

- For example, *The cyclist leaves* gets the meaning

\[
\begin{align*}
\text{THE CYCLIST LEAVE} &= \lambda_{c:c} \lambda_{x|c|}. \langle \text{leave } x_{(\text{the CYCLIST } c)}, \{\text{LEAVE}\} \rangle
\end{align*}
\]
New ellipsis/gapping operator

- For $n > 0$, we define the ellipsis operators $vpe$

  $vpe_1 = \text{def } \lambda_{F:d_1 \to d_1} \lambda_{n:n} \lambda_{c:c} \lambda_{x:\|c\|}.F(\iota_{D:d_1}.D \in \text{rels}(c\ x))\ n\ c\ x$

  $vpe_2 = \text{def } \lambda_{F:d_2 \to d_2} \lambda_{m:n} \lambda_{n:n} \lambda_{c:c} \lambda_{x:\|c\|}.F(\iota_{D:d_2}.D \in \text{rels}(c\ x))\ m\ n\ c\ x$

  $vpe_3 = \text{def } \lambda_{F:d_3 \to d_3} \lambda_{k:n} \lambda_{m:n} \lambda_{n:n} \lambda_{c:c} \lambda_{x:\|c\|}.F(\iota_{D:d_3}.D \in \text{rels}(c\ x))\ k\ m\ n\ c\ x$

  ...$

- These operators all select the uniquely most salient property in the context with the matching arity
New ellipsis/gapping operator

- For $n > 0$, we define the ellipsis operators $vpe$

  \[
  vpe_1 = \text{def } \lambda F:d_1 \rightarrow d_1 \lambda n:n \lambda c:c \lambda x[c].F(\iota_D:d_1.D \in \text{rels}(c \ x)) \ n \ c \ x
  \]

  \[
  vpe_2 = \text{def } \lambda F:d_2 \rightarrow d_2 \lambda m:n \lambda n:n \lambda c:c \lambda x[c].F(\iota_D:d_2.D \in \text{rels}(c \ x)) \ m \ n \ c \ x
  \]

  \[
  vpe_3 = \text{def } \lambda F:d_3 \rightarrow d_3 \lambda k:n \lambda m:n \lambda n:n \lambda c:c \lambda x[c].F(\iota_D:d_3.D \in \text{rels}(c \ x)) \ k \ m \ n \ c \ x
  \]

  \vdots

- These operators all select the uniquely most salient property in the context with the matching arity

- We can now redefine Kubota and Levine’s operator for VP ellipsis and gapping as follows:

  \[
  \lambda \varphi.\varphi;vpe_{\text{|$|+1}};(\text{VP/$})\|(\text{VP/$})/(\text{VP/$})
  \]

Here $|$ is the number of argument categories in $\text{(NP, PP, ...)}$
VP ellipsis 1

With the lexical entry for *did*

\[ \text{did} ; \lambda_{D:d_1} D ; \text{VP/VP} \]

we can now analyze the following VP ellipsis example:

(38) Kim read every book and then Sandy did.

The semantics gives two readings for (38)

\[
(\text{EVERY BOOK})_m. (\text{KIM}_n. (\text{READ } m n) \text{ AND SANDY } (\text{vpe}_1 \text{ DID})) \\
(\text{KIM}_n. (\text{EVERY BOOK})_m. (\text{READ } m n)) \text{ AND SANDY } (\text{vpe}_1 \text{ DID})
\]
With the lexical entry for *did*

\[
did; \lambda_{D:d_1}.D; VP/VP
\]

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(\text{KIM}_n.(\text{EVERY BOOK})_m.(\text{READ } m n)) \text{ AND SANDY (vpe}_1 \text{ DID)}
\]

For the first, vpe\(_1\) selects the property \(\lambda_k.\text{READ } m k\), but for the second, it selects the property \(\lambda_k.(\text{EVERY BOOK})_m.\text{READ } m k\)
To analyze

(35b) Kim thought she sneezed. Sandy did (too).

we redefine the meaning of *thinks* as

\[
\text{THINK} = \text{def} \lambda_k:k \lambda_n:n \lambda_c:c \lambda_{x|c|}. \langle (\text{think} \ (\text{cont} \ (k \ c \ x)) \ x_n), \text{rels} \ (k \ c \ x) \rangle
\]

Then the meaning of (35b) is the discourse

\[
(\text{cc KIM} \ (\text{THINK} \ (\text{SHE SNEEZE}))) \circ (\text{cc SANDY} \ (\text{vpe}_1 \ \text{DID}))
\]
To analyze

(35b) Kim thought she sneezed. Sandy did (too).

we redefine the meaning of *thinks* as

\[
\text{THINK} = \lambda_{k:k} \lambda_{n:n} \lambda_{c:c} \lambda_{|c|} \langle \text{think} \left( \text{cont} \left( k \ c \ x \right) \right) x_n, \text{rels} \left( k \ c \ x \right) \rangle
\]

Then the meaning of (35b) is the discourse

\[
\left( \text{cc KIM} \left( \text{THINK} \left( \text{SHE SNEEZE} \right) \right) \circ \left( \text{cc SANDY} \left( \text{vpe}_1 \text{ DID} \right) \right) \right)
\]

Since the context passed to the second utterance contains the properties

\{ \text{THINK (SHE SNEEZE), SNEEZE} \}

the \text{vpe}_1 \text{ operator needs to select the most salient one}
To analyze

(35b) Kim thought she sneezed. Sandy did (too).

we redefine the meaning of \textit{thinks} as

\[
\text{THINK} = \lambda_k \lambda_n \lambda_c \lambda_x \langle \text{think} (\text{cont} (k c x)) x_n, \text{rels} (k c x) \rangle
\]

Then the meaning of (35b) is the discourse

\[
(\text{cc KIM (THINK (SHE SNEEZE))) \circ (cc SANDY (vpe_1 DID))}
\]

Since the context passed to the second utterance contains the properties

\[
\{ \text{THINK (SHE SNEEZE), SNEEZE} \}
\]

the \textit{vpe}_1 operator needs to select the most salient one

(Is there really an ambiguity? Or not?)
Assuming the vpe\(_1\) operator selects THINK (SHE SNEEZE) as the more salient property, we’re still left with an ambiguity.

\[(39) \quad \text{Kim}_i \text{ thought she}_i/j \text{ sneezed. Sandy}_k \text{ thought she}_i/j/k \text{ sneezed too.}\]
VP ellipsis and salience I

- Assuming the \( \text{vpe}_1 \) operator selects \( \text{THINK} (\text{SHE SNEEZE}) \) as the more salient property, we’re still left with an ambiguity.

\[(39) \quad \text{Kim}_i \text{ thought she}_i/j \text{ sneezed. Sandy}_k \text{ thought she}_i/j/k \text{ sneezed too.}\]

- We can use various devices to force one of the readings over the other, such as binding the first occurrence of the pronoun at the VP level.
Assuming the \( vpe_1 \) operator selects \( \text{THINK} \ (\text{SHE SNEEZE}) \) as the more salient property, we’re still left with an ambiguity

(39) \( \text{Kim}_i \) thought she\(_{i/j} \) sneezed. \( \text{Sandy}_k \) thought she\(_{i/j/k} \) sneezed too.

We can use various devices to force one of the readings over the other, such as binding the first occurrence of the pronoun at the VP level.

As an alternative, I simply leave it up to the (unimplemented) salience mechanism to decide which antecedent is right for which occurrence.
VP ellipsis and salience II

As justification, consider (39) in the following contexts:

**Context**

Kim and Sandy are wondering whether Megyn Kelly sneezed on air after Donald Trump assailed her with misogynistic comments.  
(Kim / Megyn Kelly; Sandy / Megyn Kelly)
VP ellipsis and salience II

As justification, consider (39) in the following contexts:

**Context**
Kim and Sandy are wondering whether Megyn Kelly sneezed on air after Donald Trump assailed her with misogynistic comments. (Kim / Megyn Kelly; Sandy / Megyn Kelly)

**Context**
Kim and Sandy are discussing whether or not Kim sneezed during her testimony about Chelsea Clinton’s potential ties to Hezbollah in the 37th House select committee on Benghazi. (Kim / Kim; Sandy / Kim)
VP ellipsis and salience II

As justification, consider (39) in the following contexts:

Context
Kim and Sandy are wondering whether Megyn Kelly sneezed on air after Donald Trump assailed her with misogynistic comments. (Kim / Megyn Kelly; Sandy / Megyn Kelly)

Context
Kim and Sandy are discussing whether or not Kim sneezed during her testimony about Chelsea Clinton’s potential ties to Hezbollah in the 37th House select committee on Benghazi. (Kim / Kim; Sandy / Kim)

Context
Kim and Sandy are arguing over which one of them had the worse time during last year’s exceptionally tortuous allergy season. (Kim / Kim; Sandy / Sandy)
Pseudogapping

- We can analyze the pseudogapping example
  (37a) Kim ate the banana. Sandy should the apple.

- Giving a definition for the transitive verb version of *should* as

  \[
  \text{SHOULD} \equiv \lambda D : d_2 \lambda m : n \lambda n : n \lambda c : c \lambda x : |c| \cdot \langle \text{should cont} (D m n c x), \{D\} \cup \text{rels} (D m n c x) \rangle
  \]

  allows an analysis of (37a):

  \[
  (\text{cc KIM}_n \cdot (\text{THE BANANA})_m \cdot \text{EAT} m n) \circ
  (\text{cc SANDY}_k \cdot (\text{THE APPLE})_j \cdot (\text{vpe}_2 \text{SHOULD}) j k)
  \]
Pseudogapping

We can analyze the pseudogapping example

(37a) Kim ate the banana. Sandy should the apple.

Giving a definition for the transitive verb version of *should* as

$$\text{SHOULD} = \text{def} \; \lambda_{D:d_2} \lambda_{m:n} \lambda_{n:n} \lambda_{c:c} \lambda_{x:|c|}. \langle \text{should cont} \; (D \; m \; n \; c \; x), \{D\} \cup \text{rels} \; (D \; m \; n \; c \; x) \rangle$$

allows an analysis of (37a):

$$\left( \text{cc} \; \text{KIM}_n. (\text{THE BANANA})_m. \text{EAT} \; m \; n \right) \circ \left( \text{cc} \; \text{SANDY}_k. (\text{THE APPLE})_j. (\text{vpe}_2 \; \text{SHOULD}) \; j \; k \right)$$

Since the input context to *Sandy should the apple* contains

$$\{ (\text{THE BANANA})_m. (\text{EAT} \; m), \text{EAT} \}$$

\text{vpe}_2 selects the only available binary dynamic property \text{EAT}, as desired
The syntactic identity (meta)constraint

- So the arity requirement built into the vpe operators partially constrains which antecedent property can be chosen.

But as Kubota and Levine point out, this can’t be the whole story, since sometimes a syntactic match is required too.

(43) * John spoke to Mary more often than Peter did for Anne.

To rule out (43), Kubota and Levine constrain the anaphora resolution for their VP ellipsis / gapping operator so that anaphora isn’t possible.

The reason is that the category VP/PP of spoke to doesn’t match the category VP/PP for of spoke for.

However, this constraint probably can’t be encoded in the logic, since judgments like $\phi; s; C$ are metalanguage statements.

So we may have to content ourselves with the syntactic match being a metaconstraint.
The syntactic identity (meta)constraint

- So the arity requirement built into the vpe operators partially constrains which antecedent property can be chosen.
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- The reason is that the category $VP_{to}$ of $spoke \, to$ doesn’t match the category $VP_{for}$ of $spoke \, for$.
- However, this constraint probably can’t be encoded in the logic, since judgments like $\varphi; s; C$ are metalanguage statements.
- So we may have to content ourselves with the syntactic match being a metaconstraint.
Talk outline

Dynamic Agnostic Semantics
  Agnostic Semantics
  Going dynamic
  Connecting it to a grammar

Road testing
  Projective meaning
    Anaphora
    Supplements
  VP ellipsis and related phenomena

Conclusions and future directions
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Via dependent types, it accomplishes what other frameworks do in the metalanguage, namely making sure the context has enough discourse referents for the purported interpretation.
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Some loose ends remain:

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▶ A comparison with the approaches using monads, which seem increasingly popular, is in order—I’m hoping Carl and Simon will provide some clues


References VII


