A Dynamic Context Model for Questions

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Martin 2013; Martin and Pollard 2014, and Martin 2015 present a fully compositional model of dynamic semantics.
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Despite the desirable characteristics of the framework, previous work on DyCG did not concern itself with the analysis of questions and answers in discourse. An adequate model of context, however, should include a way to keep track of questions that are uttered in discourse and capture the interpretation of their answers (among others, Ginzburg, 1994, 1995a,b; Roberts, 1996/2012, 2004; Zeevat, 2007; Farkas and Bruce, 2009).
Introduction

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- An adequate model of context, however, should include a way to keep track of questions that are uttered in discourse and capture the interpretation of their answers (among others, Ginzburg, 1994, 1995a,b; Roberts, 1996/2012, 2004; Zeevat, 2007; Farkas and Bruce, 2009).
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As a case study, I illustrate how the enriched context model captures the interpretations of constituent questions and their answers.
Extending the DyCG context model

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  1. whose first component is a (static) proposition, the common ground (CG), and
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  1. whose first component is a (static) proposition, the **common ground** (CG), and
  2. whose second component is a stack of (some of) the semantic objects in the $n$-tuple.
- The semantic objects in the $n$-tuple are indexed by what are commonly called **discourse referents** (DRs).
- DRs are modeled as natural numbers.
The TUD-stack

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- The second component of a context is called the **topics under discussion (TUD)** stack.
- The TUD-stack is similar to the QUD-stack (Ginzburg, 1994; Roberts, 1996/2012) in the sense of keeping track of accepted questions in discourse.
- However, such questions are not stored as sets of propositions as in the QUD-stack but rather push onto the TUD-stack a DR for which further identification is sought (more on this later).
An example context

(1) \( \lambda x_1. \langle (\text{donkey } x_0) \text{ and } (\text{bray } x_0), [ ] \rangle \)
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Extending Martin’s (2013) DyCG

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4. there are no topics under discussion (which is indicated by \[ \]).
Context update in the extended system

Once an utterance is accepted, its context update is obtained by applying to its dynamic meaning the cc function.

\[ \text{cc} = \text{def } \lambda k : k . \lambda c : c . \lambda x | c | , y | k | . \langle \pi_1(c x), \pi_1(k c x, y), \text{append}(\pi_2(c x), \pi_2(k c x, y)) \rangle \]

Here, the first component of the ordered pair in the body of the abstract is obtained by conjoining the carryover from the input context \(c\) with the conjunct which is jointly determined by \(c\) and the proffered content \(k\).

The second component adds to the TUDs of the input context the TUDs coming from updating the context with the accepted utterance.
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- The dynamic meaning of *A farmer danced* is given in (2).

\[(2) \quad \lambda_c. \lambda_{y|c|} x^1. \langle (\text{farmer } x_0) \text{ and } (\text{danced } x_0), [ ] \rangle\]
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- The context update of (2) is given in (3).

\[(3) \quad \lambda_c \cdot \lambda_{y\mid c\}, x^1 \cdot \langle \pi_1(c \cdot y) \text{ and (farmer } x_0) \text{ and (danced } x_0), \text{ append (}\pi_2(c \cdot y), [])\rangle\]
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\]

- Applying this update to the context in (1) yields (4).

\[
(4) \quad \lambda_{x^2}.\langle(donkey\ x_0)\ \text{and}\ (bray\ x_0)\ \text{and}\ (farmer\ x_1)\ \text{and}\ (danced\ x_1),\ [\ ]\rangle
\]
The type of $n$-ary contexts is defined as follows:

$$c_n = \text{def } \Pi_\nu : s_n \times (\text{subvect } \nu)$$

This is a dependent product type, a generalization of function types, where the type of the value depends on the argument. $(\text{subvect } \nu)$ stands for the type of subvectors of $\nu$. A subsequence is to a sequence as a subvector is to a vector. $s$ is the disjoint union of all types of semantic objects to which anaphoric reference is possible (left open).
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- The type $c$ of contexts should subsume all the $n$-ary contexts, for every natural number $n$.
- Thus, $c$ is defined as follows:

$$c = \text{def } \Sigma_{n:n} \cdot c_n$$

This is the dependent sum of the $c_n$ as $n$ ranges over natural numbers. It denotes a disjoint union of a family of sets which is itself indexed by the members of another set (here, the natural numbers).
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  1. how Hamblin originally defined questions, and
  2. his notion of the **presumption** of a question.
Hamblin’s earlier work

Although Hamblin is always cited as claiming that a question denotes the set of its possible (propositional) answers, he also defined such answers in a certain way.
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- Thus, such answers are complete in the sense that each possible alternative precludes all of the others.
What’s the meaning of a *who*-question?

For a *who*-question, we obtain an alternative for each particular choice of a maximal plurality with the property in question.
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- For a *who*-question, we obtain an alternative for each particular choice of a maximal plurality with the property in question.
- Thus, a *who*-question is taken as asking for the maximal plurality with the property in question.
The meaning of *Who passed the exam?*

- The question *Who passed the exam?* has the meaning in (5).

(5) \[ \text{who passed-the-exam\#} = \lambda_p. \text{exists}_X. \ p \text{ equals (maximize } X (\lambda_Y. (\text{person\# } Y) \text{ and (passed-the-exam\# } Y))) \]
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- I distinguish between types \( e \) (entities) and \( e\# \) (pluralities); \( X \) and \( Y \) range over pluralities.
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- person\# and passed-the-exam\# are distributive properties of pluralities; Z ranges over properties of pluralities.
- (maximize \ X \ Z) is the proposition that the plurality X is the maximal plurality with property Z.
- Thus, the question is asking for the maximal plurality that passed the exam.
Hamblin (1971, p.134) defines the **presumption** of a question as “equivalent to the disjunction of its answers.”
Hamblin presumption

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Since possible answers are complete and mutually exclusive, the presumption of a question requires not only existence but the unique existence of a true complete answer.
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- Since possible answers are complete and mutually exclusive, the presumption of a question requires not only existence but the unique existence of a true complete answer.
- In other words, the Hamblin presumption of a question $q$ is the proposition that exactly one of $q$’s alternatives is true.
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- Since possible answers are complete and mutually exclusive, the presumption of a question requires not only existence but the unique existence of a true complete answer.
- In other words, the Hamblin presumption of a question \( q \) is the proposition that exactly one of \( q \)’s alternatives is true.
- With Hamblin (1971), I assume that the asker of a question (and in case of acceptance, all the interlocutors) are committed to the truth of the presumption of the question.
The Hamblin presumption of *Who passed the exam?*

- The Hamblin presumption of *Who passed the exam?* is given in (6).

(6) \( \exists !_p \cdot p \) and \( \exists_\lambda X \cdot (p \text{ equals } \maximize X (\lambda_Y. (\text{person} \# Y) \text{ and } (\text{passed-the-exam} \# Y))) \)
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(7) \( \exists_x. \text{maximize } X (\lambda_Y.(\text{person}_# \ Y) \text{ and } (\text{passed-the-exam}_# \ Y)) \)

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- However,…
Dynamic Hamblin presumption

(7) \( \exists X. \max X (\lambda Y. (\text{person} \# Y) \land (\text{passed-the-exam} \# Y)) \)

- The dynamic counterpart of (7), the **dynamic Hamblin presumption** of the question, introduces a new DR corresponding to \( X \).
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The dynamic Hamblin presumption expresses that $X$ is the maximal satisfier of the property in question.
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1. conjoins the dynamic Hamblin presumption to the CG of the input context, and

This encodes the commitment of the discourse participants to (sufficiently) identify this DR.

This is analogous to resolving a question in the QUD-stack-based approaches (e.g., Ginzburg, 1995a,b; Roberts, 1996/2012).
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1. The context update of an accepted *wh*-question is an update function which
   - conjoins the dynamic Hamblin presumption to the CG of the input context, and
   - pushes the corresponding DR on top of the TUD-stack so that it becomes the current topic.
   - This encodes the commitment of the discourse participants to (sufficiently) identify this DR.
   - This is analogous to resolving a question in the QUD-stack-based approaches (e.g., Ginzburg, 1995a,b; Roberts, 1996/2012).
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- The update function of *Who passed the exam?* is given in (8).

\[
\lambda_c \cdot \lambda_{x|c} \cdot X \cdot (\pi_1(c \cdot x) \text{ and } (\text{maximize } X (\lambda_Y . (\text{person# } Y) \text{ and } (\text{passed-the-exam# } Y))), \text{append } (\pi_2(c \cdot x), [X]))
\]
The context update of *Who passed the exam?* is given in (8).

(8) \[ \lambda_c \cdot \lambda_{x|c}, X. (\pi_1(c \cdot x) \text{ and } \text{maximize } X (\lambda_Y . (\text{person}_# Y) \text{ and } \text{(passed-the-exam}_# Y))) \text{, append } (\pi_2(c \cdot x), [X]) \]

Applying this update to a context \( c \) yields the new context in (9).

(9) \[ \lambda_{x|c}, X. (\pi_1(c \cdot x) \text{ and } \text{maximize } X (\lambda_Y . (\text{person}_# Y) \text{ and } \text{(passed-the-exam}_# Y))) \text{, append } (\pi_2(c \cdot x), [X]) \]
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A dynamic analysis of answers

- Given the context update of a question, answers are modeled to pick up the DR introduced by the dynamic Hamblin presumption.
- We keep track of such DRs by pushing them onto the TUD-stack.
- The descriptive content of a DR on the TUD-stack is recoverable from the CG (thanks to the Hamblin presumption).
The meaning of long answers

(10) A: Who passed the exam?
B: JOHN passed the exam.
The meaning of long answers

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- By a long answer, I mean an answer where the continuation of the focused expression in the answer is overtly provided.
The meaning of long answers

(10) A: Who passed the exam?
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- By a long answer, I mean an answer where the continuation of the focused expression in the answer is overtly provided.
- In (10), John is the focused expression and the post-focal part of the sentence is its continuation.
The meaning of long answers (cont’d)

The dynamic meaning of a long answer is defined as follows:
The meaning of long answers (cont’d)

The dynamic meaning of a long answer is defined as follows:

\[ \text{la} \overset{\text{def}}{=} \lambda Z. \lambda Y. Z (\lambda n. \lambda c. \lambda x |c| \cdot \langle x_n \sqsubseteq_{\text{nn}} (\max Y (c x)), [ ] \rangle) \]

Here, \( Z \) stands for the focused expression and \( Y \) for its continuation. \( n \) and \( c \) are variables for a DR and a context, respectively.

1. The set of pluralities forms a join-semi lattice such that \( A \sqsubseteq B \) if and only if the atoms of \( A \) is a subset of the atoms of \( B \).
2. The partial order \( \sqsubseteq_{\text{nn}} \), where the subscript ‘nn’ abbreviates non-null, requires that both \( A \) and \( B \) are non-null pluralities.
3. \( (\max Y (c x)) \) is used to pick up the DR from among the DRs that are on the TUD-stack. This is the way in which \( \text{la} \) encodes the anaphoricity of the answer to the accepted question.
The meaning of long answers (cont’d)

- The dynamic meaning of a long answer is defined as follows:
  \[ \text{la} =_{\text{def}} \lambda Z. \lambda Y. Z (\lambda n. \lambda c. \lambda x|c|.(x_n \sqsubseteq_{\text{nn}} (\max Y (c x)), [])) \]

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The meaning of long answers (cont’d)

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Here, $Z$ stands for the focused expression and $Y$ for its continuation.

- $n$ and $c$ are variables for a DR and a context, respectively.
- The interpretation of $x_n \sqsubseteq \text{nn} (\max Y (c x))$ relies on the following:

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  \[ \text{la} =_{\text{def}} \lambda Z. \lambda Y. \ Z (\lambda n. \lambda c. \lambda x|c|. \langle x_n \sqsubseteq_{\text{nn}} (\max Y (c \ x)), [\ ] \rangle) \]
- Here, Z stands for the focused expression and Y for its continuation.
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- The interpretation of \( x_n \sqsubseteq_{\text{nn}} (\max Y (c \ x)) \) relies on the following:
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The meaning of long answers (cont’d)

- The dynamic meaning of a long answer is defined as follows:
  \[ la = \text{def } \vdash \lambda Z. \lambda Y. Z (\lambda n. \lambda c. \lambda x. |c| \cdot \langle x_n \sqsubseteq_{nn} \left( \max Y (c \cdot x) \right), [\ ] \rangle) \]

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The meaning of long answers (cont’d)

- The dynamic meaning of a long answer is defined as follows:

\[ \text{la} \xrightarrow{\text{def}} \lambda Z. \lambda Y. Z (\lambda n. \lambda c. \lambda x |c| . \langle x_n \sqsubseteq_{\text{nn}} (\max Y (c \ x)), [ ] \rangle) \]

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The meaning of long answers (cont’d)

- The dynamic meaning of a long answer is defined as follows:
  \[ \text{la} = \text{def } \vdash \lambda Z.\lambda Y. Z (\lambda_n.\lambda_c.\lambda_x|c|. \langle x_n \sqsubseteq_{nn} (\max Y (c \ x)), [ ] \rangle) \]

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  3. \( (\max Y (c \ x)) \) is used to pick up the DR from among the DRs that are on the TUD-stack.

- This is the way in which \( \text{la} \) encodes the anaphoricity of the answer to the accepted question.
A long answer answer example

In Martin 2013, the dynamic meaning of a proper name like John is analyzed as follows:

\[(11)\] A: Who passed the exam?  
B: JOHN passed the exam.
A long answer answer example

(11) A: Who passed the exam?
    B: JOHN passed the exam.

- In Martin 2013, the dynamic meaning of a proper name like *John* is analyzed as follows:

  \[
  \text{JOHN} = \lambda_D.\lambda_c. D \left( \text{the NAMED-JOHN} \ c \right) \ c
  \]
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- Here, the maps a dynamic property and a context to a DR.
- The DR (the NAMED-JOHN c) is the unique DR that is entailed by the context to have the property of being named John.
A dynamic analysis of questions and answers

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- Here, the maps a dynamic property and a context to a DR.
- The DR (the NAMED-JOHN c) is the unique DR that is entailed by the context to have the property of being named John.
- This DR is then passed to a specified dynamic property.
A long answer example (cont’d)

- The dynamic property PASSED-THE-EXAM is defined as follows:
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PASSED-THE-EXAM = \text{def } \lambda_n.\lambda_{c:c>n}.\lambda_{x|x|}.\langle\text{passed-the-exam } x_n, [ ]\rangle
\]

Intuitively, this is saying that \( x_j \), which corresponds to the entity denoted by the focused expression John, is a non-null member of the maximal plurality that passed the exam.
A long answer example (cont’d)

- The dynamic property PASSED-THE-EXAM is defined as follows:
  \[ \text{PASSED-THE-EXAM} = \text{def } \lambda_n \lambda_{c:c>n} \lambda_{x|c} (\text{passed-the-exam } x_n, [ ]) \]

- The meaning of the long answer *John passed the exam* comes out as:
A long answer example (cont’d)

- The dynamic property \textsc{PASSED-THE-EXAM} is defined as follows: \textsc{PASSED-THE-EXAM} =_{\text{def}} \lambda n. \lambda c: c > n. \lambda x |c|. \left< \text{passed-the-exam } x_n, [\ ] \right>

- The meaning of the long answer \textit{John passed the exam} comes out as:

\[
\text{la JOHN PASSED-THE-EXAM} = \lambda c: c > j. \lambda x |c|. \left< x_j \sqsubseteq \text{nn} \left( \text{max \textsc{PASSED-THE-EXAM} } (c \ x) \right), [\ ] \right>
\]
A long answer example (cont’d)

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- Intuitively, this is saying that \( x_j \), which corresponds to the entity denoted by the focused expression *John*, is a non-null member of the maximal plurality that passed the exam.
The meaning of short answers

(12) A: Who passed the exam?
    B: JOHN.
The meaning of short answers

(12) A: Who passed the exam?
    B: JOHN.

By a short answer, I mean an answer where the continuation of the focused expression in the answer is omitted.
A dynamic analysis of questions and answers

The meaning of short answers

(12)  A: Who passed the exam?
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- By a short answer, I mean an answer where the continuation of the focused expression in the answer is omitted.
- The dynamic meaning of a short answer is defined as follows:
The meaning of short answers

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  the focused expression in the answer is omitted.
- The dynamic meaning of a short answer is defined as follows:

\[
\text{sa} = \text{def } \lambda Z. Z (\lambda_n. \lambda_c. \lambda_x |c| \cdot \langle x_n \sqsubseteq_{nn} \text{top} (\pi_2 (c \ x)), [ ] \rangle)
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The meaning of short answers

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Here, \( Z \) stands for the focused expression.
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- Here, Z stands for the focused expression.
- \(n\) and \(c\) are variables for a DR and a context, respectively.
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Here, $Z$ stands for the focused expression.

$n$ and $c$ are variables for a DR and a context, respectively.

The fact that the short answer is anaphoric to the topmost DR on the TUD-stack is captured by saying $x_n \sqsubseteq_{nn} \text{top } (\pi_2(c\ x))$. 
A short answer example

- The meaning of the short answer *John* comes out as:
A dynamic analysis of questions and answers

A short answer example

- The meaning of the short answer *John* comes out as:

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\text{sa } \text{JOHN} = \lambda_{c:c > j} \lambda_{x|c|} \cdot \langle x_j \sqsubseteq_{\text{nn}} \text{top} (\pi_2(c \times)), [ ] \rangle
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Intuitively, this is saying that that $x_j$, which corresponds to the entity denoted by the focused expression *John*, is a non-null member of the topmost DR on the TUD-stack.
Discussion: TUD-stack vs QUD-stack

The DR introduced by a question is concomitantly made into a topic and pushed onto the TUD-stack.

There is independent evidence to assume that question words, e.g., wh-expressions, introduce DRs. Cross-linguistically, such expressions are closely related to indefinites (Baker, 1968; Haspelmath, 1997; Bhat, 2000), and the latter are dynamically analyzed as introducing DRs. wh-expressions can antecede anaphora similar to indefinites.

Thus, an advantage of the TUD-stack is that the DRs that are pushed onto it are already independently needed.
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  2. *wh*-expressions can antecede anaphora similar to indefinites.

(13)  
  a. Who went to Mary’s party? and what did *they* bring?  
  b. A: Who went to Mary’s party? B: John was one of *them*.
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  - Cross-linguistically, such expressions are closely related to indefinites (Baker, 1968; Haspelmath, 1997; Bhat, 2000), and the latter are dynamically analyzed as introducing DRs.
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  (13) a. Who went to Mary’s party? and what did they bring?
      b. A: Who went to Mary’s party? B: John was one of them.

- Thus, an advantage of the TUD-stack is that the DRs that are pushed onto it are already independently needed.
Analyzing answers as anaphoric to the DRs on the TUD-stack automatically enables access to the continuation of the question word—thanks to the presumption of the question—which a short answer needs to have access to for its interpretation.
Analyzing answers as anaphoric to the DRs on the TUD-stack automatically enables access to the continuation of the question word—thanks to the presumption of the question—which a short answer needs to have access to for its interpretation.

This is another advantage of the TUD-stack over the QUD-stack since in the latter approach, the answer needs to ‘look inside’ the current QUD, which is stored as a set of propositions, and figure out the continuation.
The need to have access to the continuation of the question word is the reason why some scholars (e.g., Ginzburg, 1995a; Krifka, 2001, 2004; van Rooy, 1997; Ginzburg, to appear) adopt the so-called *categorial approach* (Hausser and Zaefferer, 1979).
Discussion: TUD-stack vs the ‘categorial’ approach

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In the categorial approach the meaning of a question is represented as an ordered pair and the continuation of the question word is explicitly provided.

\[ \langle \lambda_x. (\text{passed-the-exam } x), \text{person} \rangle \]

Since questions receive functional interpretations, different questions are assigned different types.
Discussion: TUD-stack vs the ‘categorial’ approach

However, assigning different types to different questions results in problems with embedding and coordination (Aloni et al., 2007).

- Verbs that take complements which denote questions would receive different types depending on what type of question they can embed, compare (14a) and (14b).

(14) a. Mary wonders who will come to the party.
   b. Mary wonders whether Bill will come to the party.
   c. Mary wonders whether she should throw a party and who she would invite.

At the same time, the fact that different questions can be conjoined as in (14c) is not accounted for.
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Future work

- Developing an analysis of polar questions and their answers.
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  - How to analyze the dynamic Hamblin presumption of polar questions?
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  1. How to analyze the dynamic Hamblin presumption of polar questions?
  2. How to capture the different kinds of answers to polar questions, e.g., ‘yes/no’ answers in English; repeat answers in Finnish, Mayan languages, etc.?
Future work (cont’d)

- Developing an analysis of alternative questions and their answers.
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    1. How to analyze the dynamic Hamblin presumption of alternative questions?
Future work (cont’d)

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  1. How to analyze the dynamic Hamblin presumption of alternative questions?
  2. The disjunctive coordinate structure in an alternative question can consist of different kinds of syntactic material.
Future work (cont’d)

- Developing an analysis of alternative questions and their answers.
  1. How to analyze the dynamic Hamblin presumption of alternative questions?
  2. The disjunctive coordinate structure in an alternative question can consist of different kinds of syntactic material.

(15) a. Did John↑ or Mary pass the exam↓?
Future work (cont’d)

- Developing an analysis of alternative questions and their answers.

1. How to analyze the dynamic Hamblin presumption of alternative questions?
2. The disjunctive coordinate structure in an alternative question can consist of different kinds of syntactic material.

(15) a. Did John↑ or Mary pass the exam↓?
    b. Did John pass the exam↑ or fail it↓?
Future work (cont’d)

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    b. Did John pass the exam↑ or fail it↓?
    c. Did John pass↑ or fail the exam↓?
Future work (cont’d)

- Developing an analysis of alternative questions and their answers.

1. How to analyze the dynamic Hamblin presumption of alternative questions?
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(15) a. Did John↑ or Mary pass the exam↓?
   b. Did John pass the exam↑ or fail it↓?
   c. Did John pass↑ or fail the exam↓?
   d. Did John give flowers to Mary↑ or cookies to Sue?↓ etc.
When does a question get resolved?
Future work (cont’d)

- When does a question get resolved? (When does the DR introduced by a question count as sufficiently identified?)
Future work (cont’d)

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- What counts as a *resolving* answer (Ginzburg, 1995a), i.e., an answer that is sufficient to terminate an inquiry, depends on several factors, e.g.,
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Future work (cont’d)

- When does a question get resolved? (When does the DR introduced by a question count as sufficiently identified?)
- What counts as a *resolving* answer (Ginzburg, 1995a), i.e., an answer that is sufficient to terminate an inquiry, depends on several factors, e.g.,
  1. what kind of answer the addressee thinks the asker is looking for based on the goals and the knowledge of the asker,
  2. what the addressee can provide given what she knows.
  3. Thus, what counts as a resolving answer is contextually parametrized.
Future work (cont’d)

(16) Context: A needs a ride to the workshop dinner and wants to find out which grad students are going.
(16) Context: A needs a ride to the workshop dinner and wants to find out which grad students are going.

A: Who’s going to the workshop dinner?
Future work

(16) Context: A needs a ride to the workshop dinner and wants to find out which grad students are going.
A: Who’s going to the workshop dinner?
B: JOHN is H% (perhaps there are others).
Future work (cont’d)

(16) Context: A needs a ride to the workshop dinner and wants to find out which grad students are going.

A: Who’s going to the workshop dinner?

B: JOHN is H% (perhaps there are others).

B’: JOHN is L% (perhaps he’s the only one, or B thought that knowing one driver would be enough for A).
Future work (cont’d)

(16) Context: A needs a ride to the workshop dinner and wants to find out which grad students are going.

A: Who’s going to the workshop dinner?

B: JOHN is H% (perhaps there are others).

B’: JOHN is L% (perhaps he’s the only one, or B thought that knowing one driver would be enough for A).

A: Who else?
(16) Context: A needs a ride to the workshop dinner and wants to find out which grad students are going.

A: Who’s going to the workshop dinner?

B: JOHN is H% (perhaps there are others).

B’: JOHN is L% (perhaps he’s the only one, or B thought that knowing one driver would be enough for A).

A: Who else?

- Is this something that can be/needs to be captured in a formal theory of context?
(16) **Context:** A needs a ride to the workshop dinner and wants to find out which grad students are going.

A: Who’s going to the workshop dinner?

B: JOHN is H% (perhaps there are others).

B’: JOHN is L% (perhaps he’s the only one, or B thought that knowing one driver would be enough for A).

A: Who else?

- Is this something that can be/needs to be captured in a formal theory of context?
- Or is it something that potentially involve extralinguistic parameters to fully account for?
(17) Context: A and B are in the barn.
A: Where’s Burrita?
(17) Context: A and B are in the barn.
A: Where’s Burrita?
B: ...(Burrita walks into the barn.)
Many thanks to Carl Pollard and Judith Tonhauser for helpful discussions.
Thank you!


References II


