Dynamic inquisitive semantics

Jakub Dotlačil & Floris Roelofsen

JUNE 27, 2019, InqBnB3
To develop a logical framework that combines insights from:

- Dynamic semantics
- Inquisitive semantics

To highlight some of the advantages that such a framework has w.r.t. frameworks that are non-dynamic or non-inquisitive in the analyses of questions.
1 Motivating dynamic inquisitive semantics

2 Dynamic inquisitive semantics

3 Explaining the motivating data
1 Motivating dynamic inquisitive semantics

2 Dynamic inquisitive semantics

3 Explaining the motivating data
A dynamic semantics of questions is needed to capture certain types of anaphora.

(Groenendijk, 1998; van Rooij, 1998; Haida, 2007)

It also provides an attractive account of certain kinds of intervention effects.

(Haida, 2007)
In dynamic semantics, meaning is not equated with truth-conditions but rather with context change potential. This includes the potential to introduce discourse referents. Dynamic semantics has been motivated by contrasts like:

(1) a. [One of my ten marbles]$^x$ is not here. It$_x$ is probably under the sofa.
   b. Nine of my ten marbles are here. #It is probably under the sofa.

The first sentence in (1-a) introduces a discourse referent picked up by the anaphoric pronoun.

The first sentence in (1-b) is truth-conditionally equivalent but does not introduce a suitable discourse referent.
Dynamic semantics for questions is motivated by examples like:

(2)  
   a. Which\(x\) one of your three sons is living in Paris? And is he\(x\) happy there?
   b. Which\(x\) two of your three sons are not living in Paris? #And is he\(x\) happy there?

The initial questions in (2-a) and (2-b) are equivalent in terms of resolution/answerhood conditions.

But they differ in their potential to license pronominal anaphora.
Anaphora in questions

- The fact that wh-questions license anaphora has been the primary piece of motivation for dynamic approaches to question semantics. (Groenendijk, 1998; van Rooij, 1998; Haida, 2007)

- Wh-words are taken to introduce discourse referents, just like plain existential indefinites, which can be picked up by anaphoric pronouns.
Certain operators appearing between a wh-word and the interrogative complementizer lead to ungrammaticality.
Example from Beck (2006):

(3)  
   a. Wer hat Luise wo angetroffen?
       who-Nom has Luise where met
       ‘Who met Luise where?’

   b. ??Wer hat niemandem wo angetroffen?
       who-Nom has nobody-Dat where met
       ‘Who didn’t meet anybody where?’

   c. Wer hat wo niemandem angetroffen?
       who-Nom has where nobody-Dat met
       ‘Who didn’t meet anybody where?’
Intervention effects: possible interveners

• Possible interveners (Beck, 2006):
  • Focus sensitive operators: *only, even,*…
  • Nominal quantifiers: *every, no, most, few,*…
  • Adverbial quantifiers: *always, often, never,*…
  • Negation: *not*
How to understand the licensing relation between the wh-word and the complementizer?

Two prominent approaches (among others):

- **Focus approach** (Beck, 2006) – wh-words introduce focus alternatives. Intervention effects arise when C cannot access these focus alternatives because they are consumed by a focus sensitive intervener.

- **Dynamic approach** (Haida, 2007) – wh-words introduce discourse referents that C has to access. Intervention effects arise if such access is blocked by operators that do not let discourse referents project from their scope.
The focus approach works well for only and even, which are without doubt focus sensitive.

However, nominal quantifiers every, no, and most are more problematic because they are not necessarily focus sensitive. Beck (2006, Section 4), and Haida (2007, Chapter 8)

Experimental data suggest that the focus-sensitive particle also is not an intervener in German. Haida and Repp (2013)
The dynamic approach works well for quantifiers and negation, which are known to block discourse referents from projecting:

(4) a. John didn’t consider buying [a car]i.
   *Iti was too expensive.
 b. Most students considered buying [a car]i.
   *Iti was very cheap.
 c. John often considered buying [a car]i.
   *Iti was very cheap.

Focus sensitive particles do not block discourse referents from projecting, so require a different explanation (Haida, 2007)

Cross-linguistic variation as to which operators act as interveners is largely an open issue for both approaches.
Dynamic theories of questions are based on partition semantics (Groenendijk, 1998; van Rooij, 1998; Haida, 2007)

Partition semantics is suitable to model exhaustive interpretations of questions:

(5) Which of the guests are vegetarian?
• However, non-exhaustive question interpretations are difficult to capture in partition semantics

(6) Who has a bike that I could borrow for 15 minutes?

• In inquisitive semantics both exhaustive and non-exhaustive question interpretations can be captured straightforwardly.

• Moreover, dynamic inquisitive semantics allows us to relate exhaustive and non-exhaustive questions to another contrast, strong and weak readings of donkey anaphora.
<table>
<thead>
<tr>
<th></th>
<th>Anaphora</th>
<th>Intervention</th>
<th>Non-exhaustive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static inquisitive</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Dynamic partition</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Dynamic inquisitive</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- There are other potential advantages to dynamic inquisitive semantics which we do not explicitly discuss here
Motivating dynamic inquisitive semantics

Dynamic inquisitive semantics

Explaining the motivating data
Our compositional dynamic inquisitive semantics ($\text{Inq}_D$) integrates the basic static inquisitive system, $\text{Inq}_B$, with

- the dynamic system GSV (Groenendijk et al., 1996), and
- the compositional dynamic system CDRT (Muskens, 1996)

The system presented here simplified.

$\text{Inq}_D$ for a first-order language:
to appear in Dotlačil and Roelofsen, Proceedings of SuB.
Contexts in GSV encapsulate:

1. information about the world
2. information about the discourse referents
3. information about dependencies between the world and the discourse referents
Formally, a context in GSV is a set $s$ of $\langle w, g \rangle$ pairs (possibilities), such that $w$ is a possible world and $g$ a (partial) assignment function.

This encodes:

- Information about the world:
  
  $$\text{worlds}(s) := \{ w \mid \langle w, g \rangle \in s \text{ for some } g \}$$

- Information about the discourse referents:
  
  $$\text{assigns}(s) := \{ g \mid \langle w, g \rangle \in s \text{ for some } w \}$$

- Information about dependencies between the world and the discourse referents.
Limits on the notion of context in GSV:

- Contexts represent information, but not contextual issues
- Contexts in GSV are not rich enough to analyze questions
Contexts in inquisitive semantics encapsulate:

1. information about the world
2. issues raised about the world
Contexts in inquisitive semantics

Context $C$ – a set of information states, each a set of possible worlds

Conditions on $C$:

- each information state contains enough information to resolve the raised issues
- no information state contains any worlds that have been ruled out by the available information
- set of information states is downward closed and non-empty
- the information available in a context, $\text{INFO}(c) := \bigcup c.$
- A context $c$ is inquisitive just in case $\text{INFO}(c) \notin c.$
Limits on the notion of context in Inq_B:

- Contexts represent information and issues about the world.
- They do not model information and issues about discourse referents.
- They do not model dependencies between the world and the discourse referents.
Context $C$ – a set of information states, each a set of possibilities ($\langle w, g \rangle$ pairs) ($w$ – world; $g$ – dref assignment function)

Conditions on $C$:

- each information state contains enough information to resolve the raised issues
- no information state contains any possibilities that have been ruled out by contextual information
- set of information states is downward closed and non-empty
InqD has four basic types: $e$ for individuals, $s$ for possible worlds, $t$ for truth values, and $r$ for discourse referents.

<table>
<thead>
<tr>
<th>Object</th>
<th>Type</th>
<th>Type abbreviation</th>
<th>Variable convention</th>
</tr>
</thead>
<tbody>
<tr>
<td>dref assignment f.</td>
<td>(re)</td>
<td>$a$</td>
<td>-</td>
</tr>
<tr>
<td>possibility</td>
<td>($s \times a$)</td>
<td>-</td>
<td>$p$</td>
</tr>
<tr>
<td>information state</td>
<td>(($s \times a)t$)</td>
<td>$i$</td>
<td>$s$</td>
</tr>
<tr>
<td>context</td>
<td>(it)</td>
<td>$k$</td>
<td>$c, c'$</td>
</tr>
<tr>
<td>update function</td>
<td>(kk)</td>
<td>$T$</td>
<td>$A, B$</td>
</tr>
</tbody>
</table>

**Table:** Types and abbreviation conventions
Contexts in dynamic inquisitive semantics – graphical representation

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & w_b & w_{\emptyset} \\
 u/a & \bullet & \bullet & \bullet & \\
u/b & \bullet & \bullet & \bullet & \\
\end{array}
\]
Contexts in dynamic inquisitive semantics – graphical representation

\[
\begin{array}{cccc}
    & w_a & w_{a,b} & w_b & w_{\emptyset} \\
\hline
u/a & \cdot & \cdot & \cdot & \cdot \\
u/b & \cdot & \cdot & \cdot & \cdot \\
\end{array}
\]
Contexts in dynamic inquisitive semantics – graphical representation

<table>
<thead>
<tr>
<th></th>
<th>$w_a$</th>
<th>$w_{a,b}$</th>
<th>$w_b$</th>
<th>$w_\emptyset$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u/a$</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>$u/b$</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>
Contexts in dynamic inquisitive semantics – graphical representation
Contexts in dynamic inquisitive semantics – graphical representation

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & w_b & w_\emptyset \\
  u/a & \bullet & \bullet & \bullet & \bullet \\
  u/b & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & w_b & w_\emptyset \\
  u/a & \bullet & \bullet & \bullet & \bullet \\
  u/b & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & w_b & w_\emptyset \\
  u/a & \bullet & \bullet & \bullet & \bullet \\
  u/b & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & w_b & w_\emptyset \\
  u/a & \bullet & \bullet & \bullet & \bullet \\
  u/b & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]
A state $s'$ extends a state $s$, $s' \geq s$, iff $s' = s$ or:

- $s'$ extends the information about the world provided in $s$ (by excluding some possibilities), and/or
- $s'$ extends the information about the discourse referents provided in $s$ (by adding new discourse referents)

A state $s$ subsists in a state $s'$ iff:

- $s' \geq s$, and
- every possibility in $s$ is in $s'$, modulo the addition of new discourse referents

A state $s$ subsists in a context $C$ iff there is some $s' \in C$ such that $s$ subsists in $s'$. In this case, $s'$ is called a descendant of $s$. 
Semantics: relations and conjunction

(7) \[ R\{u_1, \ldots, u_n\} := \lambda c_k \lambda s_i. \quad s \in c \land \forall p \in s \]
\[ (R(w_p)(g_p(u_1)) \cdots (g_p(u_n))) \]

(8) \[ A_{(kk)}; B_{(kk)} := \lambda c_k. B(A(c)) \]
If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and $\text{assigns}(s') = \text{assigns}(s) \cup \{u\}$. 
If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and 
\[ \text{assigns}(s') = \text{assigns}(s) \cup \{ u \}. \]

- \[ [g[u]g']^{F,I,\theta} = 1 \text{ iff } \]
  - \[ [\text{dom}(g')]^{F,I,\theta} = [\text{dom}(g)]^{F,I,\theta} \cup \{ [u]^{F,I,\theta} \} \text{ and } \]
  - \[ [\forall v_r((v \neq u \land v \in \text{dom}(g)) \rightarrow g(v) = g'(v))]^{F,I,\theta} = 1 \]

- \[ [p[u]p']^{F,I,\theta} = 1 \text{ iff } [w_p = w_{p'}]^{F,I,\theta} = 1 \text{ and } [g_p[u]g_{p'}]^{F,I,\theta} = 1 \]

- \[ [u] := \lambda c_k \lambda s_i. \left\{ \begin{array}{l}
  \exists s' \in c. \\
  \forall p \in s. \ \exists p' \in s'. \ (p'[u]p) \wedge \\
  \forall p' \in s'. \ \exists p \in s. \ (p'[u]p)
\end{array} \right\} \]
Semantics: dref introduction

\[
\emptyset \quad w_a \quad w_{a,b} \quad w_b \quad w_\emptyset
\]

\[
\begin{array}{cccc}
\text{sing}\{u\} & w_a & w_{a,b} & w_b & w_\emptyset \\
u/a & \bullet & \bullet & \bullet & \bullet \\
u/b & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]
Semantics: disjunction

\[(9) \quad A_{(kk)} \sqcup B_{(kk)} := \lambda c_k. A(c) \cup B(c)\]
(9) \[ A_{(kk)} \sqcup B_{(kk)} := \lambda c_k . A(c) \cup B(c) \]

---

\[
\begin{array}{cccc}
\text{\(w_{\text{sing}}\)} & \text{\(w_{\text{sing,dance}}\)} & \text{\(w_{\text{dance}}\)} & \text{\(w_{\emptyset}\)} \\
\text{\(u_1/a\)} & \bullet & \bullet & \bullet & \bullet
\end{array}
\]

\[
\begin{array}{cccc}
\text{\(w_{\text{sing}}\)} & \text{\(w_{\text{sing,dance}}\)} & \text{\(w_{\text{dance}}\)} & \text{\(w_{\emptyset}\)} \\
\text{\(u_1/a, u_2/a\)} & \bullet & \bullet & \bullet & \bullet
\end{array}
\]

\[
\begin{array}{cccc}
\text{\(w_{\text{sing}}\)} & \text{\(w_{\text{sing,dance}}\)} & \text{\(w_{\text{dance}}\)} & \text{\(w_{\emptyset}\)} \\
\text{\(u_1/a\)} & \bullet & \bullet & \bullet & \bullet
\end{array}
\]

\[
\begin{array}{cccc}
\text{\(w_{\text{sing}}\)} & \text{\(w_{\text{sing,dance}}\)} & \text{\(w_{\text{dance}}\)} & \text{\(w_{\emptyset}\)} \\
\text{\(u_1/a, u_2/a\)} & \bullet & \bullet & \bullet & \bullet
\end{array}
\]
(10)  Bill either rented a\textsuperscript{u} car or hitchhiked.  
\*It\textsubscript{u} was probably a cabriolet. 

(11)  Bill either rented a\textsuperscript{u} blue car or a\textsuperscript{u} red car.  
It\textsubscript{u} was probably a cabriolet. 

cf. Stone (1992)
Semantics: disjunction

(10) Bill either rented an\textsuperscript{u} car or hitchhiked.
    *It\textsubscript{u} was probably a cabriolet.

(11) Bill either rented an\textsuperscript{u} blue car or an\textsuperscript{u} red car.
    It\textsubscript{u} was probably a cabriolet.

cf. Stone (1992)

(12) \textbf{A:} Bill either rented an\textsuperscript{u} car or hitchhiked.
    \textbf{B:} The former, of course. It\textsubscript{u} was a cabriolet.

(13) \textbf{A:} Did Bill rent an\textsuperscript{u} car\textsuperscript{\uparrow} or did he hitchhike?\textsuperscript{\downarrow}
    \textbf{B:} The former, of course. It\textsubscript{u} was a cabriolet.
(14) \[ \neg A_{(kk)} := \lambda c_k \lambda s_i. s \in c \land \neg \exists t \subseteq s (t \neq \emptyset \land t \text{ subsists in } A(c)) \]
Semantics: discharging inquisitiveness

(15) \( !A_{(kk)} := \lambda c_k \lambda s_I.s \in !(A(c)) \land \exists s' \in c (s \text{ is an extension of } s') \)

• For any context \( C \):

\( !C := \{ \bigcup C \} \downarrow \) is the non-inquisitive projection of \( C \)

• \( !A \) discharges any inquisitiveness introduced by \( A \)
Semantics: negation and exclamation operator (graphical comparison)
Semantics: negation and exclamation operator (graphical comparison)
Semantics: negation and exclamation operator (graphical comparison)

\[ u_1/a, u_2/b \]

\[ u_1/a, u_2/b, u_3/a \]

\[ u_1/a, u_2/b, u_3/b \]
Semantics: negation and exclamation operator (graphical comparison)
Semantics: ensuring inquisitiveness

(16) \( ?A_{(kk)} := A \sqcup \neg A \)

(17) \( \langle ? \rangle A := \begin{cases} ?A & \text{if } A \text{ is not inquisitive} \\ A & \text{otherwise} \end{cases} \)

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & w_b & w_{\emptyset} \\
u_1/a & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]

\( ?\text{sing}\{u_1\} \)

\[
\begin{array}{cccc}
  & w_a & w_{a,b} & & \\
u_1/a & \bullet & \bullet & \bullet & \bullet \\
\end{array}
\]

\[
\begin{array}{cccc}
  & & w_b & w_{\emptyset} & \\
\end{array}
\]
(18)  \( ?u := \lambda c_k \lambda s_i. s \in c \land \exists x_e. \forall p \in s. g_p(u) = x \)
Semantics: identity of drefs

(18) \( ?u := \lambda c_k \lambda s_i. s \in c \land \exists x_e. \forall p \in s. g_p(u) = x \)

(19) \( ?u_1, \ldots u_j, u_n := \lambda c_k \lambda s_i. \) 

\[
\left\{ 
  \begin{align*}
    s & \in c \land \\
    \exists f. \forall p \in s. g_p(u_n) & = f(g_p(u_1), \ldots g_p(u_j))
  \end{align*}
\right\}
Translation of declaratives

\[
\begin{align*}
\text{[Foc]} &= \lambda A_{(kk)}!(A) \\
\text{removes inquisitiveness of complement} \\
\text{[leave]} &= \lambda v_r.\text{leave}\{v\} \\
\text{[somebody}^u\text{]} &= \lambda P_{rT}.\{u\}; P(u)
\end{align*}
\]

\[(20) \quad \llbracket [FocP \text{Somebody}^u \text{ left}] \rrbracket = !(\llbracket [u]; \text{left}\{u\} \rrbracket)\]
Translation of declaratives

\[ \text{Type} \]

\[ \text{FocP} \]

\[ \text{Foc} \]

\[ \text{TP} \]

\[ \text{NP} \]

\[ \text{VP} \]

\[ \text{somebody}^{u} \]

\[ \text{V} \]

\[ \text{left} \]

\[ [\text{Type}] = \lambda A_{(kk)} ! (A) \] removes inquisitiveness of complement

\[ (21) \quad [\text{Somebody}^{u} \; \text{left}] = !! ([u]; \text{left}\{u\}) \]

- (21) introduces a dref that left but (21) does not raise issues
Translation of wh examples

\[
[Foc_u] = \lambda A_{kk}(A); ?u
\]
removes inquisitiveness of complement
raises an issue about the identity of drefs
introduced by wh-words

\[
[\text{who}^u] = \lambda P_{rT}.[u]; P(u)
\]

(22) \[ [[FocP \text{Who}^u \text{left}]] = !(\{u; \text{left}\{u\})); ?u \]
Translation of wh examples

\[ [\text{Type}] = \lambda A_{(kk)} \langle ? \rangle (A) \] ensures inquisitiveness of complement

(23) \[ [\text{Who}^u \text{ left}] = !([u]; \text{left}\{u\}); ?u \]

- (23) introduces a dref that left and (23) raises an issue about the identity of the dref
Translating 'wh' examples

(24) \([\text{Who left}] = !([u]; \text{left}\{u\}); ?u\)
Translations of wh examples

(25) \[[\text{Who saw what}] = !([u_1]; [u_2]; \text{saw}\{u_1, u_2\}); ?u_1; ?u_1u_2\]
Explaining anaphora

(26) $[\text{Someone}^u \text{ left. He}_u \text{ was furious.}]$
$= !([u]; \text{left}\{u\}); !(\text{furious}\{u\})$

(27) $[\text{Who}^u \text{ left? (I don’t know but) he}_u \text{ was furious.}]$
$= !([u]; \text{left}\{u\}); ?u; !(\text{furious}\{u\})$

- Wh-words are indefinites.
- Their inquisitiveness is introduced by the Foc head that they agree with.
- This does not affect their binding possibilities.
- Their licensing of anaphora is captured.
Explaining anaphora

(26) \([\text{Someone}^u \text{ left. He}_u \text{ was furious.}]\)
    = !(\{u; left\}; !(\text{furious}\{u\}))

(27) \([\text{Who}^u \text{ left? (I don’t know but) he}_u \text{ was furious.}]\)
    = !(\{u; left\}; \text{?u}; !(\text{furious}\{u\}))

- Wh-words are indefinites.
- Their inquisitiveness is introduced by the Foc head that they agree with.
- This does not affect their binding possibilities.
- Their licensing of anaphora is captured.

(28) \([\text{Who}^u \text{ left? Was he}_u \text{ furious?}]\)
    = !(\{u; left\}; \text{?u}; \text{?!(furious}\{u\}))
• Baseline: a grammatical example

(29) \[
[ \text{Who met Luise where? (German)} ]
\]

\[= !([u_1]; [u_2] \wedge \text{meet}(u_1, L, u_2)) ; ?u_1 ; ?u_1 u_2 \]
Intervention effects

\[ (30) \quad [\text{Who met nobody where? (German)}] \]
\[ = !([u_1]; \neg([u_3] \land [u_2] \land M(u_1, u_3, u_2))); ?u_1; ?u_1 u_2 \]

- Negation blocks discourse referents from projecting
Mayr (2014): plural quantifiers intervene only when interpreted distributively

(31)  

a. Wo haben sich mehr als drei Maler wann eine Pizza geteilt?  
   ‘Where did more than three painters share a pizza when?’

b. *Wo haben sich mehr als drei Maler wann eine Arbeitshose angezogen?  
   ‘Where did more than three painters wear dungarees when?’
Mayr (2014): plural quantifiers intervene only when interpreted distributively

This contrast is predicted in our account because only distributive readings of quantifiers block the projection of dynamic information (cf. Kamp and Reyle 1993):

(32) a. More than three students shared a pizza. It was tasty.
b. More than three students sipped a coffee. #It was cold.
Q-particles are ?u

- words that can function both as indefinites and as wh-words (quexistentials)
- a separate morpheme (a Q(uestion)-particle) obligatorily accompanies quexistentials and its syntactic position can disambiguate the reading

(33) a. Daa *(sá) aawaxáa i éesh?
what Q he.ate.it your father
‘What did your father eat?’

b. Tlél goodéi *(sá) xwagoot.
not where.to Q I.went
‘I didn’t go anywhere.’

Cable (2010)
Q-particle – overt realization of the identity operator

- Q-particles can be separated from quexistentials
- Whenever a Q-particle can appear in two structurally different positions and the two positions differentiate between indefinite and wh-interrogative interpretations, then the low position must be the indefinite interpretation and the high position must be the wh-question interpretation.

Correct for Japanese, Sinhala, Tlingit

Non-exhaustive readings straightforwardly captured:

(34) Who has a bike that I could borrow for 15 minutes?

<table>
<thead>
<tr>
<th></th>
<th>$w_a$</th>
<th>$w_{a,b}$</th>
<th>$w_b$</th>
<th>$w_\emptyset$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$u/a$</td>
<td><img src="dot.png" alt="Dot" /></td>
<td><img src="dot.png" alt="Dot" /></td>
<td><img src="dot.png" alt="Dot" /></td>
<td><img src="dot.png" alt="Dot" /></td>
</tr>
<tr>
<td>$u/b$</td>
<td><img src="dot.png" alt="Dot" /></td>
<td><img src="dot.png" alt="Dot" /></td>
<td><img src="dot.png" alt="Dot" /></td>
<td><img src="dot.png" alt="Dot" /></td>
</tr>
</tbody>
</table>
(35)  If a farmer owns a donkey, does he beat it?

\[ A_{(kk)} \rightarrow B_{(kk)} := \lambda c_k \lambda s_i. \quad s \in c \land \forall t \subseteq s \]

(36)  \[ (t \text{ subsists in } A(c) \rightarrow t \text{ subsists in } B(A(c)))) \]

\[ \llbracket (35) \rrbracket = ([u_1]; [u_2]; farmer\{u_1\}; donkey\{u_2\}; own\{u_1, u_2\}) \]

\[ \rightarrow \ ?!beat\{u_1, u_2\} \]
To derive exhaustive readings, a **max** operator can be added to $\lnq_{\text{ID}}$

\[(37) \quad \text{max}\{u\} := \lambda c_k \lambda s_i. s \in c \land \forall p \in s \forall p' \in \bigcup c (w_p = w_{p'} \rightarrow g_{p'}(u) \leq g_p(u))\]

\[(38) \quad \text{Who did not register yet?}\]

\[(39) \quad !([u]; \text{notregistered}\{u\}; \text{max}\{u\}); ?u\]
Brasoveanu (2008) derives weak / strong readings of donkey anaphora by postulating an ambiguity of indefinites \( \text{max} \Rightarrow \text{strong reading} \)

(40)  a. If a farmer owns a donkey, he beats it.
     b. If Bill has a dime, he puts it in the parking meter.

While singular indefinites are compatible with both readings, plural indefinites force strong readings:

(41)   If Bill has dimes, he puts them in the parking meter.

The same effect is observed with exhaustive/non-exhaustive questions:

(42)   Which students have a bike that I could borrow?
Inq$_D$ integrates insights from dynamic and inquisitive semantics in a single, compositional framework.

- It is well-suited to capture both exhaustive and non-exhaustive question interpretations.
- It can capture the anaphoric potential of wh-words.
- It can be used to derive anaphora-related intervention effects.
- It can connect the existence of exhaustive and non-exhaustive readings of questions to the existence of strong and weak readings of donkey anaphora.
THANK YOU


Appendix – lifting $\ln q_D$ working with sets of assignments
Dependencies between assignments within one possibility:
express quantificational dependency

(43) Each boy saw a movie. They liked it.
(44) Which boy saw which movie? Did they like it?
Dependencies

• Dependencies between assignments within one possibility:
  • express quantificational dependency

  (43) Each boy saw a movie. They liked it.
  (44) Which boy saw which movie? Did they like it?

• Dependencies between world and assignments:
  • express uncertainty with respect to the value of the dref

  (45) Someone dances.
Extension and subsistence

A possibility $\langle w', G' \rangle$ is an extension of another possibility $\langle w, G \rangle$, $\langle w', G' \rangle \geq \langle w, G \rangle$, iff $w' = w$ and $G' \geq G$.

(46) Dref matrix extension:

$$G' \geq G := \left\{ \begin{array}{l} \forall g \in G. \exists g' \in G'. g \subseteq g' \land \\
\forall g' \in G'. \exists g \in G. g \subseteq g' \end{array} \right. $$
A possibility $\langle w', G' \rangle$ is an extension of another possibility $\langle w, G \rangle$, $\langle w', G' \rangle \geq \langle w, G \rangle$, iff $w' = w$ and $G' \geq G$.

(46) Dref matrix extension:
$$ G' \geq G := \left\{ \begin{array}{l} \forall g \in G. \exists g' \in G'. g \subseteq g' \land \\ \forall g' \in G'. \exists g \in G. g \subseteq g' \end{array} \right. $$

(47) State extension: $s' \geq s := \forall p' \in s'. \exists p \in s. p' \geq p$
A possibility \( \langle w', G' \rangle \) is an extension of another possibility \( \langle w, G \rangle \), \( \langle w', G' \rangle \succeq \langle w, G \rangle \), iff \( w' = w \) and \( G' \succeq G \).

(46) Dref matrix extension:

\[
G' \succeq G := \begin{cases} 
\forall g \in G. \exists g' \in G'. g \subseteq g' \land \\
\exists g' \in G'. \forall g \in G. g \subseteq g'
\end{cases}
\]

(47) State extension: \( s' \succeq s := \forall p' \in s'. \exists p \in s. p' \succeq p \)

A state \( s \) subsists in a state \( s' \) iff:

- \( s' \succeq s \), and
- \( \forall p \in s. \exists p' \in s'. p' \succeq p \)
Semantics: relations and conjunction

\[
R\{u_1, \ldots, u_n\} := \lambda c \lambda s_i. \quad s \in c \land \forall p \in s(\forall g \in G_p (R(w_p)(g(u_1)) \ldots (g(u_n))))
\]
Semantics: relations and conjunction

\[(48)\]
\[R\{u_1, \ldots, u_n\} := \lambda c_k \lambda s_i. \quad s \in c \land \forall p \in s(\forall g \in G_p (R(w_p)(g(u_1)) \ldots (g(u_n))))\]

\[(49)\]
\[A_{(kk)}; B_{(kk)} := \lambda c_k. B(A(c))\]
If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and $u \in \text{assigns}(s')$. 
Semantics: dref introduction

- If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and $u \in \text{assigns}(s')$.

- $\llbracket g[u]g' \rrbracket_{F,I,\theta}^F = 1$ iff
  - $\llbracket \text{dom}(g') \rrbracket_{F,I,\theta}^F = \llbracket \text{dom}(g) \rrbracket_{F,I,\theta}^F \cup \{\llbracket u \rrbracket_{F,I,\theta}^F\}$ and
  - $\llbracket \forall v_r((v \neq u \land v \in \text{dom}(g)) \rightarrow g(v) = g'(v)) \rrbracket_{F,I,\theta}^F = 1$
If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and $u \in \text{assigns}(s')$.

- $\left\langle g[u]g' \right\rangle_{F,I,\theta} = 1$ iff
  - $\left\langle \text{dom}(g') \right\rangle_{F,I,\theta} = \left\langle \text{dom}(g) \right\rangle_{F,I,\theta} \cup \{ \left\langle u \right\rangle_{F,I,\theta} \}$ and
  - $\left\langle \forall v_r((v \neq u \land v \in \text{dom}(g)) \rightarrow g(v) = g'(v)) \right\rangle_{F,I,\theta} = 1$

- $\left\langle G[u]G' \right\rangle_{F,I,\theta} = 1$ iff
  - $\left\langle \forall g \in G. \ \exists g' \in G'. g[u]g' \right\rangle_{F,I,\theta} = 1$ and
  - $\left\langle \forall g' \in G'. \exists g \in G. \ g[u]g' \right\rangle_{F,I,\theta} = 1$
• If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and $u \in \text{assigns}(s')$.

• $\langle g[u]g' \rangle_{F,I,\theta} = 1$ iff
  - $\langle \text{dom}(g') \rangle_{F,I,\theta} = \langle \text{dom}(g) \rangle_{F,I,\theta} \cup \{[u]_{F,I,\theta}\}$ and
  - $\forall v_r((v \neq u \land v \in \text{dom}(g)) \rightarrow g(v) = g'(v))_{F,I,\theta} = 1$

• $\langle G[u]G' \rangle_{F,I,\theta} = 1$ iff
  - $\forall g \in G. \exists g' \in G'. g[u]g'_{F,I,\theta} = 1$ and
  - $\forall g' \in G'. \exists g \in G. g[u]g'_{F,I,\theta} = 1$

• $\langle p[u]p' \rangle_{F,I,\theta} = 1$ iff $\langle w_p = w_{p'} \rangle_{F,I,\theta} = 1$ and $\langle G_p[u]G_{p'} \rangle_{F,I,\theta} = 1$
Semantics: dref introduction

- If $C$ is a context and $u$ not in assignments in $C$, then introducing the dref $u$ creates the largest context $C'$ such that every $s' \in C'$ has some $s \in C$ s.t. $s$ subsists in $s'$ and $u \in \text{assigns}(s')$.

- $\left[ [g[u]g'] \right]_{F,I,\theta} = 1$ iff
  - $\left[ \text{dom}(g') \right]_{F,I,\theta} = \left[ \text{dom}(g) \right]_{F,I,\theta} \cup \{ \left[ u \right]_{F,I,\theta} \}$ and
  - $\left[ \forall v_r ((v \neq u \land v \in \text{dom}(g)) \rightarrow g(v) = g'(v)) \right]_{F,I,\theta} = 1$

- $\left[ [G[u]G'] \right]_{F,I,\theta} = 1$ iff
  - $\left[ \forall g \in G. \ \exists g' \in G'. g[u]g' \right]_{F,I,\theta} = 1$ and
  - $\left[ \forall g' \in G'. \exists g \in G. \ g[u]g' \right]_{F,I,\theta} = 1$

- $\left[ [p[u]p'] \right]_{F,I,\theta} = 1$ iff $\left[ w_p = w_{p'} \right]_{F,I,\theta} = 1$ and $\left[ G_p[u]G_{p'} \right]_{F,I,\theta} = 1$

- $[u] := \lambda c_k \lambda s_i. \begin{cases} \forall s' \in c. \\ \forall p \in s. \ \exists p' \in s'. (p'[u]p) \land \\ \forall p' \in s'. \exists p \in s. (p'[u]p) \end{cases}$
Semantics: dref introduction
(50) \[ ?u := \lambda c_k \lambda s_I. s \in c \land \exists x_e. \forall p \in s. \forall g \in G_p. x = g(u) \]
Semantics: identity of drefs

(50) \[ ?u := \lambda c_k \lambda s_I.s \in c \land \exists x_e. \forall p \in s. \forall g \in G_p. x = g(u) \]

(51) \[ ?u_1, \ldots, u_{n-1}, u_n := \lambda c_k \lambda s_I. \ s \in c \land \exists f_{\epsilon^m,e}. \forall p \in s. \forall g \in G_p. \ f(g(u_1), \ldots, g(u_{n-1})) = g(u_n) \]
Translations of wh examples

\[ [\text{Who saw what}] = \lambda A_{(kk)}!(A); \ ?u_1 u_2 \]

\[(52) \quad [\text{Who saw what}] = ![\{u_1, u_2\}; \text{saw}(u_1, u_2)]; \ ?u_1 u_2 \]
Multiple wh-questions

(53)  \[ [\text{Who saw what}] =!([u_1]; [u_2]; \text{saw}\{u_1, u_2\}); ?u_1u_2 \]

- The identification operator derives that pair-list reading is functional
  (Higginbotham and May, 1981; Dayal, 1996)

(54)  Which student talked to which professor?
  a.  Alice and Bill both talked to Prof. Carl.
  b.  #Alice talked to Prof. Carl and Prof. Dan.