# Questions and beyond: day 3

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# Plan of today: dynamics of questions

- A short intro to dynamic semantics;
- Jeroen Groenendijk (2007): The logic of interrogations. In M. Aloni, P. Dekker and A. Butler (eds). *Questions in Dynamic Semantics*. CRiSPI series, Elsevier.
- Aloni, Beaver, Clark and van Rooij (2007): The dynamics of topic and focus. In M. Aloni, P. Dekker and A. Butler (eds). *Questions in Dynamic Semantics*. CRiSPI series, Elsevier.

# Dynamic semantics (Kamp, Heim, G&S)

- Classical view:

  meanings $\mapsto$ truth conditions
  answerhood conditions
  compliance conditions
  ...

- Dynamic view:

  meanings $\mapsto$ **context change potentials**

# Original linguistic motivation: anaphora

- Cross-sentential and donkey anaphora (Geach'62):

(1) a. A man came in. He was pushing a bike. Was he happy?
b. $\exists x \phi(x) \ \wedge \psi(x) \wedge ?\chi(x)$
c. $\exists x(\phi(x) \wedge \psi(x)) \wedge ?\chi(x)$
d. $\exists x(\phi(x) \wedge \psi(x) \wedge ?\chi(x))$

(2) a. If a farmer owns a donkey, he is rich.
b. $\exists x \phi(x) \rightarrow \psi(x)$
c. $\exists x(\phi(x) \rightarrow \psi(x))$
d. $\forall x(\phi(x) \rightarrow \psi(x))$

- In dynamic semantics, the following equivalence hold:

(3) a. $\exists x \phi \wedge \psi \ \equiv \ \exists x(\phi \wedge \psi)$
b. $\exists x \phi \rightarrow \psi \ \equiv \ \forall x(\phi \rightarrow \psi)$

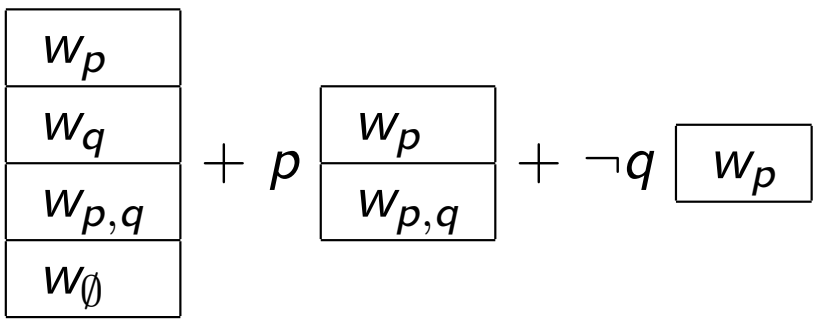
# Dynamic semantics: contexts

- Meanings $\mapsto$ functions from contexts to contexts;
- Contexts represent speakers' presupposition, what is taken for granted by conversationalists;
- Formally, sets of possibilities:
  - Possible worlds (Stalnaker's context set)
  - World-assignment pairs (Heim's files, dynamic info states)
  - ...

# A toy example

- Context = set of possible worlds [world knowledge]
- Comparable to partial models, wrt $C$ some propositions $p$ are satisfied, some are falsified, and others are neither.
  - (i) $C \subseteq p$ — it is presupposed that $p$
  - (ii) $C \cap p = \emptyset$ — it is presupposed that not $p$
  - (iii) Otherwise — it is not known whether $p$
- Contexts change as conversation proceeds: $C + \phi = C \cap ||\phi||$

(4)




- Applications: presuppositions, epistemic modals, ...

# Another toy example

- C = set of world-assignment pairs [world + discourse]

(5) a. [A fat man]$_i$ came in. He$_i$ was smoking.
b. $\exists x(\mathbf{F}x \wedge \mathbf{C}x) \wedge \mathbf{S}x$

- An indefinite set up a discourse marker $\mathrm{DM}_x$
- Anaphor$_x$ interpreted with respect to $C$ + [*indefinite*] refers back to $\mathrm{DM}_x$
- Suppose $a, b$ and $c$ are the fat men coming in in $w$. Only $b$ is smoking.

(6) $\boxed{w} + \exists x(\mathbf{F}x \wedge \mathbf{C}x)$

| | **x** |
|---|---|
| w | a |
| w | b |
| w | c |

$+ \mathbf{S}x$

| | **x** |
|---|---|
| w | b |

# Today's question: what is the CCP of a question?

Two answers:

- The logic of interrogation;
- The dynamics of topic and focus.

In both cases:

$$\text{context} = \text{what is known} + \text{what is under discussion}$$

# The logic of interrogation: motivation

- Standard logic deals with reasoning
- Goal: formalize the notion of valid conclusion
- But, reasoning is just one of many things we can do with language
- G tries to extend the domain of logic to cooperative information exchange (more basic than reasoning)
- His goal: formalize the notion of pertinent move in a dialogue game
- Logic meets pragmatics

- **Standard logic**: *valid conclusion* in reasoning

(7) a. All men are mortals, Socrates is a man. Thus Socrates is mortal. (valid)
b. Some men are mortal, Socrates is a man. Thus Socrates is mortal. (invalid)

- **Logic of interrogation**: *pertinent move* in a dialogue

(8) a. Who smokes? Mary smokes. (pertinent)
b. Who smokes? Mary is blond. (impertinent)

# Overview

- The game of interrogation
- A query language
- Semantics for the language
- Logical notions to arbitrate the game
- Answerhood
- An application

# Game of Interrogation

- Two players: the interrogator and the witness
- The interrogator may only raise issues by asking the witness non-superfluous questions
- The witness may only make credible (Quality), non-redundant (Quantity) statements which exclusively address the issues raised by the interrogator (Relation)
- **Goal:** Define logical notions that arbitrate whether an interrogation proceeds in accordance with the rules

# Query Language

- Let *PL* be a language of predicate logic.
- The *Query Language QL* is the smallest set such that:
  - i. If $\phi \in PL$, then $\phi \in QL$ (indicatives $\phi$!)
  - ii. If $\phi \in PL$, $\vec{x}$ a sequence of $n$ variables, then $?\vec{x}\,\phi \in QL$ (interrogatives $\phi$?)

# Examples of interrogatives

| | | |
|---|---|---|
| a. | $?Pm$ | Did Mary call? |
| b. | $?\exists xPx$ | Did anyone call? |
| c. | $?x\ Px$ | Who called? |
| d. | $?xy\ Rxy$ | Who ate what? |
| e. | $\#\ \neg ?x\ Px,\ \exists x ?x\ Px$ | |

# Denotational semantics

- Standard truth definition for indicatives:

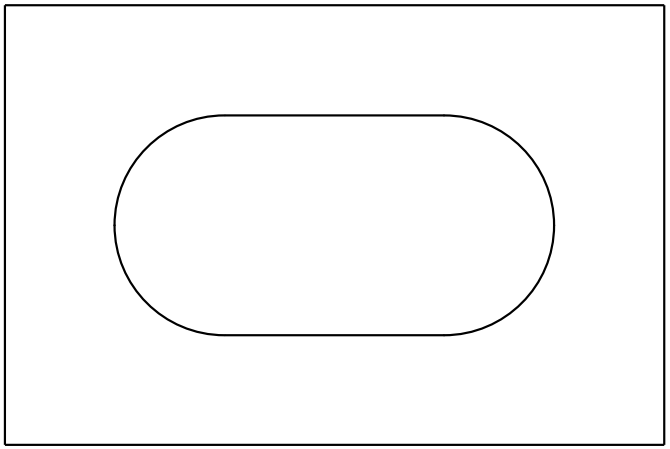
  (9) $\|\phi!\|_{M,w,g} \in \{0,1\}$

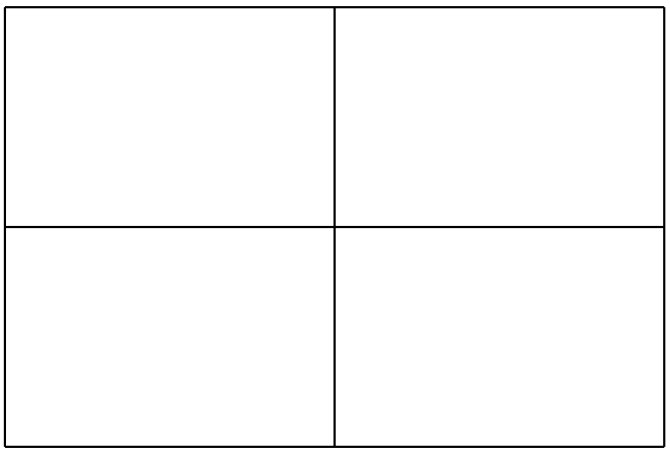
- Partition semantics for interrogatives:

  (10) $\|?\vec{x}\,\phi\|_{M,w,g} =$
  $\{v \in W \mid \forall \vec{e} \in D^n : \|\phi\|_{v,g[\vec{x}/\vec{e}]} = \|\phi\|_{w,g[\vec{x}/\vec{e}]}\}$

- An indicative $\phi!$ *selects* a subset of the set of worlds: the worlds where $\phi!$ is true
- An interrogative $\phi?$ *divides* the set of worlds into a number of (mutually exclusive) *alternatives*.

# Pictures: propositions and questions





# Dynamic semantics

- An update semantics for QL defined in terms of the denotational semantics
- The notion $C[\phi]$, the effect of updating a context C, defined for indicative and interrogative sentences $\phi$
- A context consists of **data** (provided by the witness) and **issues** (raised by the interrogator)

# Data and Issues

- If we only considered data, a context could be a subset of the set of possible worlds (Stalnaker's context set)

  (11) $C[!\phi] = C \cap [\phi]$

- Interrogatives provide no data, they may only raise issues
- Issues modeled by structuring the context ...

# Structured contexts

- A structured context $C$ is a symmetric and transitive relation on the set of possible worlds $W$
- I.e. $C$ is an equivalence relation on a subset of $W$
- If two worlds $w$ and $v$ are related in $C$, $\langle w, v \rangle \in C$, the difference between $w$ and $v$ is not an issue
- Notation: $w \in C$ means $\langle w, w \rangle \in C$

# Examples of structured contexts

# Updating contexts

1. $C[\phi!] = \{\langle w, v\rangle \in C \mid \|\phi!\|_w = \|\phi!\|_v = 1\}$;
2. $C[\phi?] = \{\langle w, v\rangle \in C \mid \|\phi?\|_w = \|\phi?\|_v\}$;
3. For $\tau = \phi_1; \ldots; \phi_n$, $C[\tau] = C[\phi_1] \ldots [\phi_n]$.

- An indicative $\phi!$ eliminates a pair of worlds from the context as soon as $\phi!$ is false in one of the worlds of the pair
- An interrogative $\phi?$ disconnects those worlds where the question would receive different answers
- Interpreting an interrogation, a sequence of a mix of interrogatives and indicatives, is just interpreting the sentences in the sequence one by one

# Examples of updates

1. $C[\phi!] = \{\langle w, v\rangle \in C \mid \|\phi!\|_w = \|\phi!\|_v = 1\}$;
2. $C[\phi?] = \{\langle w, v\rangle \in C \mid \|\phi?\|_w = \|\phi?\|_v\}$;

# The rules of the game

- Basic intuition:
  - The interrogator may only raise issues by asking the witness non-superfluous questions (Quantity)
  - The witness may only make credible (Quality), non-redundant (Quantity) statements which exclusively address the issues raised by the interrogator (Relation)
- Groenendijk defines three logical notions:
  - **Consistency** $\mapsto$ Quality
  - **Informativeness** $\mapsto$ Quantity
  - **Licensing** $\mapsto$ Relation

# Consistency

- $\phi$ is *consistent* with $\tau$ iff $\exists C : C[\tau][\phi] \neq \emptyset$
- Only indicatives can be inconsistent with the context
- Consistency is the logical notion used to arbitrate credibility of the witness [Quality]
- The witness is judged credible as long as she doesn't contradict herself

# Informativeness

- $\tau$ entails $\phi$ iff $\forall C\colon C[\tau] = C[\tau][\phi]$
- $\phi$ *informative* after $\tau$ iff $\tau$ does not entail $\phi$
- Both indicatives and interrogatives can be uninformative
- Informativeness is the logical notion used to arbitrate whether statements are non-redundant, and questions are not superflous [Quantity]

# Entailment: example

- Uniform for indicatives and interrogatives
- Between indicatives: as in predicate logic
- Between interrogatives: as in partition semantics

  (12) $?xPx$ entails $?Pm$ and $?\exists xPx$

- Mixed cases:

  (13) $\phi!$ entails $\psi?$ iff $\phi!$ is an exhaustive answer to $\psi?$

  (14) $\phi?$ entails $\psi!$ iff $\psi!$ is a tautology

# Licensing

- $\tau$ *licenses* $\phi$ iff
  $\forall C, w, v : \langle w, v \rangle \in C[\tau]$ & $w \notin C[\tau][\phi] \Rightarrow v \notin C[\tau][\phi]$
- If $\phi$ eliminates a world from the context, it should eliminate the whole alternative to which that world belongs
- Licensing is the logical notion used to arbitrate whether the witness exclusively addresses the issues raised by the interrogator [Relevance]

# Fact about licensing

- $\tau$ licenses $\phi$! iff $\tau$ entails $\phi$?
- An indicative is licensed by the context iff the corresponding polar interrogative is part of the issues raised in the context
- Interrogatives are always licensed
- Tautologies and contradictions are always licensed

# Pertinence

- $\phi$ is *pertinent after* $\tau$ iff
  i. $\phi$ is consistent with $\tau$ (*Quality*)
  ii. $\phi$ is informative after $\tau$ (*Quantity*)
  iii. $\phi$ is licensed after $\tau$ (*Relation*)
- The logical notion of pertinence arbitrates whether an interrogation is in accordance with the rules of the game

# Answerhood

- Answers as pertinent moves:

  (15) $\phi!$ is a (pertinent) answer to $\psi?$ iff $\phi!$ is pertinent after $\psi?$

- Allows for partial answers, but not for over-informative answers
- Cf. complete answers in terms of entailment:

  (16) $\phi!$ is a complete answer to $\psi?$ iff $\phi!$ entails $\psi?$

- Correspond to exhaustive answers in partition semantics
- Allows for over-informative answers

# Examples answers

- Pertinent answers to $?xPx$ (who called?)

(17)

| | | |
|---|---|---|
| a. | $Pa$ | (a called) |
| b. | $\neg Pa$ | (a didn't call) |
| c. | $(Pa \wedge Pb)$ | (a and b called) |
| d. | $\forall xPx$ | (everybody called) |
| e. | $\forall x(Px \leftrightarrow x = a)$ | (only a called) |

- Answers (d) and (e) also complete:

(18)

a. $\forall xPx$ entails $?xPx$

b. $\forall x(Px \leftrightarrow x = a)$ entails $?xPx$

# Resolving an ambiguity with an issue

- An ambiguous sentence:

(19) Alf rescued Bea. And no-one else.

a. $Rab;\ \neg\exists x(Rxb \wedge x \neq a)$ (only Alf rescued Bea)
b. $Rab;\ \neg\exists x(Rax \wedge x \neq b)$ (Alf rescued only Bea)

- Disambiguation by a preceding interrogative:

(20) Who rescued Bea? Alf rescued Bea. And no-one else.

a. $?x\,Rxb;\ Rab;\ \neg\exists x(Rxb \wedge x \neq a)$ (pertinent)
b. $?x\,Rxb;\ Rab;\ \neg\exists x(Rax \wedge x \neq b)$ (impertinent)

(21) Whom did Alf rescue? Alf rescued Bea. And no-one else.

a. $?x\,Rax;\ Rab;\ \neg\exists x(Rxb \wedge x \neq a)$ (impertinent)
b. $?x\,Rax;\ Rab;\ \neg\exists x(Rax \wedge x \neq b)$ (pertinent)

# Conclusion

- A formally precise characterization of the notion of pertinent move in a dialogue game;
- Correct predictions in many cases:

(22) Who smokes?

a. Mary smokes. (pertinent)
b. Mary is blond. (impertinent)

(23) Who rescued Bea?

a. Only Alf rescued Bea. (pertinent)
b. Alf rescued only Bea. (impertinent)

- But ...

- Problems with other over-informative answers:

(24) a. Did someone rescue Bea?
b. Yes, Alf rescued Bea. (impertinent)

- And with question strategies (cf. Roberts 1996):

(25) a. Who smokes? Does M smoke? (impertinent)
b. Who smokes? Does M swim? (pertinent)

- Next: *The dynamics of topic and focus* (handout)