Dynamics in Language

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Slides:
https://www.marialoni.org/resources/DynTutorial2022.pdf

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Logic, Language, and Meaning
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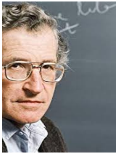
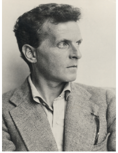
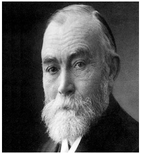
Logic, Language and Meaning

- **Formal semantics** uses logic to analyze linguistic meaning
  - Roots in philosophy of language (Frege, Russell, Wittgenstein) and theoretical linguistics (Chomsky);
  - Richard Montague (1930–1971, mathematician and philosopher) pioneered a logical approach to natural language meaning;
  - Barbara H. Partee (born 1940, linguist and philosopher) established formal semantics as independent (interdisciplinary) field of research.

- Indirect method: semantic datas explained via translation

$$\text{Natural Language} \mapsto \text{Logical Language} \Rightarrow \text{Models}$$

- Many challenges: (i) How to collect semantic datas in a reliable way? (ii) How to translate natural language expressions into a logical language in a systematic and compositional way? But also (iii) which logic? which logical language? which interpretation?

Static vs dynamic view on meaning

- Static view: meanings are truth conditions
  - To understand the meaning of a sentence is to understand what has to be the case for the sentence to be true
- In static semantics, sentences are true or false wrt to models:

$$[\![\phi]\!]_M \in \{0, 1\}$$

- Dynamic view: meanings are context change potentials
  - The meaning of any linguistic expression is dependent on the context of interpretation.
  - The meaning of any linguistic expression is its ability to change the context of interpretation.
- In dynamic semantics, sentences denote relations over contexts:

$$\begin{array}{ccc} & \nearrow & c_1 \\ c_0[\![\phi]\!]_M & \rightarrow & c_2 \\ & \searrow & c_3 \end{array}$$

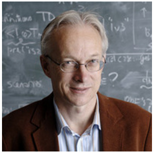
- Dynamic semantics is a generalization of static truth-conditional semantics rather than a radically different alternative.

Dynamic Semantics for Natural Language

Core ideas due independently to Kamp (1981) and Heim (1982)


Developed in the 1990's by Groenendijk & Stokhof, Veltman, van Benthem, Chierchia, Dekker, and more




Still a popular conception of meaning with applications in linguistics and philosophy (Beaver, Bittner, Brasoveanu, Charlow, Cheng, Dotlacil, Huang, Kuang, Nouwen, Pan, Rothschild, Willer, and many more)

Overview of tutorial

Goal: discuss linguistic motivation for dynamic turn and present examples of dynamic semantics for natural language

1. Anaphora
   - Linguistic data: Cross-sentential and donkey anaphora
   - Dynamic system: Dynamic Predicate Logic (DPL - Groenendijk and Stokhof 1991)
2. Presupposition
   - Linguistic data: Presupposition, presupposition projection
   - Dynamic system: Update Semantics for Presupposition (USP - based on Heim 1988)
3. Concluding Remarks
   - What makes a system truly dynamic?
   - Do we need dynamic semantics?

Literature

- Jeroen Groenendijk and Martin Stokhof (1991): Dynamic Predicate Logic. *Linguistics and Philosophy* 14, pp. 39–100.
- Irene Heim (1988): On the Projection Problem for Presuppositions. In D. Flickinger et al. (eds) *Proceedings of the Second West Coast Conference on Formal Linguistics* Stanford University Press.

Anaphora

The use of an expression (anaphor) whose interpretation depends upon another expression in context (its antecedent).

- **Cross-sentential or discourse anaphora**:

  (1) A man is walking in the park. He is smiling.

  Anaphoric connection between indefinite NP "a man" (antecedent) and the subsequent pronoun "He" (anaphor)

- Anaphoric connections within the same sentence:

  (2) Mary saw a man who had bought a Harry Potter book and who had read it in a day.

  (3) **Donkey anaphora**

  a. If John owns a donkey, he feeds it.
  b. Every farmer who owns a donkey feeds it.
  c. Ruguo ni kanjian shei, jiao ta lai jian wo. (Huang Pan)

- Anaphora outside of the nominal domain:

  (4) The weather in the Netherlands is terrible and this upsets everyone.

  (5) Fenrong was angry, and so was I.

Anaphora: not anything goes

- Indefinite NPs cannot act as anaphors:

(6) A man^x is walking in the park. John likes him$_x$/# a man$_x$.

- Universal and negative quantifiers cannot act as antecedents:

(7) Every/No man is walking in the park. # He is smiling.

- Antecedent potential of indefinite NPs blocked under some operators:

(8) I do**n't** own a mobile phone. # It's red.

(9) **If** I buy a mobile phone, I will give it to you. # It's red.

(10) I bought a mobile phone **and** I will give it to you. It's red.

Cross-sentential and donkey anaphora: the challenge

- Compositional translations for (11-a) and (12-a):

(11) Cross-sentential anaphora

a. A man^x is walking in the park. He$_x$ is smiling.
b. *What we get*: $\exists x(Mx \wedge Wx) \wedge Sx$
c. *What we want*: $\exists x((Mx \wedge Wx) \wedge Sx)$

(12) Donkey anaphora

a. If John owns a donkey^x, he feeds it$_x$.
b. *What we get*: $\exists x(Dx \wedge Ojx) \rightarrow Fjx$
c. *What we want*: $\forall x((Dx \wedge Ojx) \rightarrow Fjx)$

Problem of compositional translations: in both cases, the final x is not in the scope of $\exists x$

- Dynamic solution: interpret (11-b) and (12-b) in a semantics satisfying the following equivalences:

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

- Standard compositional $\mapsto$ combined with non-classical $\Rightarrow$:

Natural Language $\mapsto$ Logical Language $\Rightarrow$ Models

Dynamic semantics for anaphora

- Dynamic semantics: meanings are context change potentials, i.e., 'updates' that take in a context, and give back a context
  - $\mapsto$ Indefinite descriptions change the context by introducing *discourse referents*
  - $\mapsto$ Anaphors interpreted relative to this context refer back to these discourse referents
- Illustration: Suppose John owns three donkeys, a, b and c

$$
C \; [\![\text{John owns a donkey}^x]\!] \begin{array}{lll} \nearrow & C + [x \mapsto a] & [\![\text{John feeds it}_x]\!] \\ \rightarrow & C + [x \mapsto b] & [\![\text{John feeds it}_x]\!] \\ \searrow & C + [x \mapsto c] & [\![\text{John feeds it}_x]\!] \end{array}
$$

- In Dynamic Predicate Logic (DPL), anaphoric connections captured by modelling meanings as binary relations on variable assignment functions
- Comparison with other systems we will present today:

	context	**update**
DPL	variable assignment	relational
USP	set of possible worlds	functional
qUSP	set of world-assignment pairs	functional

DPL: definitions

- Language of first-order predicate logic (with identity)
- Classical first-order models $M = \langle D, I \rangle$, where
  - D is a non-empty set of individuals
  - I is an interpretation function which assigns to each n-place predicate R a subset of D^n
- Formulas denote sets of assignment pairs, relations between input output assignments, viewed as modelling context transitions in an evaluation process:

$$
\begin{aligned}
[\![Rx_1, ..., x_n]\!]_M &= \{\langle h, g\rangle \mid h = g \ \& \ \langle h(x_1), \ldots, h(x_n)\rangle \in I_M(R)\} \\
[\![\phi \wedge \psi]\!]_M &= \{\langle h, g\rangle \mid \exists k : \langle h, k\rangle \in [\![\phi]\!]_M \ \& \ \langle k, g\rangle \in [\![\psi]\!]_M\} \\
[\![\neg\phi]\!]_M &= \{\langle h, g\rangle \mid h = g \ \& \ \neg\exists k : \langle h, k\rangle \in [\![\phi]\!]_M\} \\
[\![\exists x\phi]\!]_M &= \{\langle h, g\rangle \mid \exists k : h[x]k \ \& \ \langle k, g\rangle \in [\![\phi]\!]_M\}
\end{aligned}
$$

  where $h[x]k$ means that k differs from h at most wrt the value it assigns to x
- Dynamic entailment:
  $\phi \models \psi$ iff for every $h, g, M : \langle h, g\rangle \in [\![\phi]\!]_M \ \Rightarrow \ \exists k : \langle g, k\rangle \in [\![\psi]\!]_M$
- Truth: ϕ true in M wrt h iff there is g such that $\langle h, g\rangle \in [\![\phi]\!]_M$

DPL: results

- We derive the following equivalences:

(14) Egli's equivalences:

a. $\exists x\phi \wedge \psi \;\equiv\; \exists x(\phi \wedge \psi)$

b. $\exists x\phi \rightarrow \psi \;\equiv\; \forall x(\phi \rightarrow \psi)$

where $\phi \equiv \psi$ iff for all $M : [\![\phi]\!]_M = [\![\psi]\!]_M$

- Proof of (14-a):
  - $[\![\exists x\phi \wedge \psi]\!] =$
    $\{\langle g, h\rangle \mid \exists l : \langle g, l\rangle \in [\![\exists x\phi]\!] \;\&\; \langle l, h\rangle \in [\![\psi]\!]\} =$ [def. of $\wedge$]
    $\{\langle g, h\rangle \mid \exists k\text{: } \exists l\text{: } g[x]k \;\&\; \langle k, l\rangle \in [\![\phi]\!] \;\&\; \langle l, h\rangle \in [\![\psi]\!]\}$ [def. of $\exists x$]
  - $[\![\exists x(\phi \wedge \psi)]\!] =$
    $\{\langle g, h\rangle \mid \exists k\text{: } g[x]k \;\&\; \langle k, h\rangle \in [\![\phi \wedge \psi]\!]\} =$ [def. of $\exists x$]
    $\{\langle g, h\rangle \mid \exists k\text{: } \exists l\text{: } g[x]k \;\&\; \langle k, l\rangle \in [\![\phi]\!] \;\&\; \langle l, h\rangle \in [\![\psi]\!]\}$ [defi. of $\wedge$]

  $\Rightarrow$ $[\![\exists x\phi \wedge \psi]\!] = [\![\exists x(\phi \wedge \psi)]\!]$
- Prove (14-b) as exercise, define $\forall x\phi = \neg\exists x\neg\phi$ and $\phi \rightarrow \psi = \neg(\phi \wedge \neg\psi)$ to obtain:

$$[\![\phi \rightarrow \psi]\!]_M = \{\langle h, g\rangle \mid h = g \;\&\; \forall k : \langle h, k\rangle \in [\![\phi]\!]_M \;\Rightarrow\; \exists j : \langle k, j\rangle \in [\![\psi]\!]_M\}$$

$$[\![\forall x\phi]\!]_M = \{\langle h, g\rangle \mid h = g \;\&\; \forall k : h[x]k \;\Rightarrow\; \exists j : \langle k, j\rangle \in [\![\phi]\!]_M\}$$

DPL: results

- We have proven the equivalence of the following two sentences:

(15) John owns a donkey. He feeds it. $\mapsto \exists x D_j x \wedge F_j x$

(16) John has a donkey, which he feeds. $\mapsto \exists x(D_j x \wedge F_j x)$

- And we also capture their truth conditions:
  - (15)-(16) true in M wrt g iff there is an h s.t. $g[x]h$ & $h(x) \in I_M(D_j)$ & $h(x) \in I_M(F_j)$ iff there is a $d \in D_M$ s.t. d is a donkey that John owns and feeds in M.
- Suppose we have three individuals in our domain, a, b and c. And a and c are donkeys John owns, but he feeds only a. $[M_1]$

$$\begin{array}{lll} & \nearrow & g[x/a] \quad [\![D_j x]\!]_{M_1} \rightarrow g[x/a]\ [\![F_j x]\!]_{M_1} \rightarrow g[x/a] \\ g\ [x] & \rightarrow & g[x/b] \quad [\![D_j x]\!]_{M_1} \rightarrow \bot \\ & \searrow & g[x/c] \quad [\![D_j x]\!]_{M_1} \rightarrow g[x/c]\ [\![F_j x]\!]_{M_1} \rightarrow \bot \end{array}$$

Sentences predicted to be true in M_1

- Suppose now John feeds none of them: $[M_2]$

$$\begin{array}{lll} & \nearrow & g[x/a] \quad [\![D_j x]\!]_{M_2} \rightarrow g[x/a]\ [\![F_j x]\!]_{M_2} \rightarrow \bot \\ g\ [x] & \rightarrow & g[x/b] \quad [\![D_j x]\!]_{M_2} \rightarrow \bot \\ & \searrow & g[x/c] \quad [\![D_j x]\!]_{M_2} \rightarrow g[x/c]\ [\![F_j x]\!]_{M_2} \rightarrow \bot \end{array}$$

Sentences predicted to be false in M_2

DPL: results

- Dynamic binding isn't anything-goes:

(17) Every/No man is walking in the park. # He is smiling.

(18) I do**n't** own a mobile phone. # It's red.

(19) **If** I buy a mobile phone, I will give it to you. # It's red.

(20) I bought a mobile phone **and** I will give it to you. It's red.

- **Negation** is externally static:

$$[\![\neg\phi]\!]_M = \{\langle h, g\rangle \mid h = g \;\&\; \neg\exists k : \langle h, k\rangle \in [\![\phi]\!]_M\}$$

- Negative and universal quantifiers, too:

$$[\![\forall x\phi]\!]_M = \{\langle h, g\rangle \mid h = g \;\&\; \forall k : h[x]k \;\Rightarrow\; \exists j : \langle k, j\rangle \in [\![\phi]\!]_M\}$$

- **Implication** is internally dynamic but externally static:

$$[\![\phi \to \psi]\!]_M = \{\langle h, g\rangle \mid h = g \;\&\; \forall k : \langle h, k\rangle \in [\![\phi]\!]_M \;\Rightarrow\; \exists j : \langle k, j\rangle \in [\![\psi]\!]_M\}$$

- **Conjunction** instead is externally and internally dynamic:

$$[\![\phi \wedge \psi]\!]_M = \{\langle h, g\rangle \mid \exists k : \langle h, k\rangle \in [\![\phi]\!]_M \;\&\; \langle k, g\rangle \in [\![\psi]\!]_M\}$$

Some open issues and further readings

- DPL only accounts for strong readings of donkey sentences:

(21) Usually, if a man has a garage with a window, ...
  a. he keeps it open while he is away. [weak]
  b. he keeps it closed while he is away. [strong]
  (Yoon 1996 / Champollion 2019)

- Other classical examples where strong readings are less prominent:

(22)
  a. Every person who has a credit card, will pay her bill with it (Cooper)
  b. Every person who has a dime will put it in the meter (Pelletier and Schubert 1989)

- This and other problems discussed in: (see H. Pan's talk)
  - Gennaro Chierchia, 1992, Anaphora and Dynamic Binding. *Linguistics and Philosophy* 15(2), pp. 111–83
- A recent overview with solutions:
  - Adrian Brasoveanu & Jakub Dotlacil, 2018, Donkey Anaphora: Farmers and Bishops. To appear in: *Linguistics Companion.* Wiley.
- Dekker's monograph:
  - Paul Dekker, 2012, *Dynamic Semantics*. Springer.

Exercise on DPL

Of the following pairs of formulas ϕ and ψ some are equivalent (<u>eq</u>), some are only s-equivalent (<u>s-eq</u>), and some stand in the entailment relation. Which? Fill in your findings with "+"s and "−"s in the following table.

ϕ	ψ	<u>eq</u>	<u>s-eq</u>	$\phi \models \psi$	$\psi \models \phi$
$Fx \wedge \exists yGy$	$\exists yGy \wedge Fx$				
$\exists xGx \wedge Fx$	$Fx \wedge \exists xGx$				
$Fx \wedge \exists xGx$	$Fx \wedge \exists xGx$				
Fx	$\exists xFx$				
$Gx \wedge \exists xFx$	$\exists yFy \wedge Gx$				

Definitions

- Equivalence: $\phi \equiv \psi$ iff $\forall M : [\![\phi]\!]_M = [\![\psi]\!]_M$ (same denotation)
- s-Equivalence: $\phi \equiv_s \psi$ iff $\forall M : |\phi|_M = |\psi|_M$ (same satisfaction set)
- Satisfaction set: $|\phi|_M = \{h \mid \exists g : \langle h, g\rangle \in [\![\phi]\!]_M\}$
- Dynamic entailment:
  $\phi \models \psi$ iff $\forall h, g, M : \langle h, g\rangle \in [\![\phi]\!]_M \Rightarrow \exists k : \langle g, k\rangle \in [\![\psi]\!]$

Questions?

Presupposition

- The phenomenon whereby speakers mark linguistically information as being taken for granted, rather than being part of the main propositional content of a speech act. (from SEP entry, Beaver & Geurts)
- A diagnostic test: presuppositions typically 'project under negation', i.e. follow from both a sentence/utterance and its denial:

(23) Some girls stopped buying Danish products.

a. Some people stopped buying Danish products. [entailment]

b. Some girls used to buy Danish products. [presupposition]

- Both (a) and (b) follow from (23). Only (b) also follows from (24):

(24) No girls stopped buying Danish products.

- Definition of presupposition remains controversial. Some examples:
- A presupposes B iff
  - A entails B and not A entails B;
  - B is a necessary condition for the interpretability of A;
  - If A is true or false in a model then B must be true in that model;
  - Speaker uttering A take for granted the truth of B;
  - A is only felicitous if B is in the common ground (i.e. the mutual beliefs of conversational participants).

Presupposition triggers

Presuppositions tend to be associated with particular lexical items or grammatical constructions, known as *presupposition triggers/inducers*.

(25) a. John *stopped* smoking. (aspectual verbs)
     b. John used to smoke.

(26) a. Fred *regrets* that he cheated at the exam. (factives)
     b. Fred cheated at the exam.

(27) a. *It was John who* solved the problem. (clefts)
     b. Someone solved the problem.

(28) a. *The president of Mali* is bald. (definites)
     b. Mali has a (unique) president.

Prehistory of presupposition

The old Greek already knew about presupposition (from Karttunen 2016)

- Eubulides (4th C. BCE)

(29) a. Have you lost your horns?
b. You had horns.

- Frege (1892)

(30) a. Kepler died misery.
b. The name 'Kepler' has a referent.

- Russell (1905)

(31) The present king of France is bald. (FALSE)

- Strawson (1950)

(32) The present king of France is bald. (neither TRUE nor FALSE)

- Karttunen (1973). Presuppositions of Compound Sentences. *Linguistic Inquiry*, Vol. 4, No. 2 (Spring, 1973), pp. 169-193

Property of presupposition: projection (1)

- Let S be a sentence that induces the presupposition P, $S_{[P]}$, then the following will also normally imply P:

(33) a. Not $S_{[P]}$ b. It is possible that $S_{[P]}$
c. If $S_{[P]}$, then T ...

- Example:

(34) (i) John stopped smoking. $\rightsquigarrow_p$ (ii) John used to smoke.
a. John didn't stop smoking. $\rightsquigarrow_p$ (ii)
b. It is possible that John stopped smoking. $\rightsquigarrow_p$ (ii)
c. If John stopped smoking, he must be stressed. $\rightsquigarrow_p$ (ii)

- According to Karttunen's (1973) taxonomy, such operators which preserve presupposition are called **holes**.

Properties of presupposition: projection (2)

- Not all complex sentences however inherit the presuppositions of their parts.
- Sentences like the following '**filter**' the presupposition that P is true:

(35) a. If A, then $S_{[P]}$, b. A and $S_{[P]}$

- Examples:

(36) a. If John used to smoke, then he stopped smoking.
b. If John moved to the US, then he stopped smoking.
c. John used to smoke.

(37) a. John used to smoke and he stopped smoking.
b. John moved to the US and he stopped smoking.
c. John used to smoke.

In both, only (b) variants presuppose (c). In (a), the presupposition that John used to smoke is filtered (since entailed by preceding sentence).

Properties of presupposition: Cancellation/defeasibility

It is often possible to construct special presupposition blocking instances of the schemata that otherwise preserve presupposition:

(38) A: The king of Buganda is bald. (David Beaver)
B: Come now A, Buganda is not even a monarchy.
A: Ok, I was wrong then. The king of Buganda is not bald. Perhaps it was the president I was thinking of?

(39) Fred didn't kiss Betty, and therefore he doesn't regret that he kissed her either. (Bart Geurt)

According to many theorists such cases of cancellation/defeasibility are exceptional/deviant. But others (e.g. Gazdar) take cancellation/defeasibility as characteristic property of presupposition.

Kinds of explanations

- Two challenges for a theory of presupposition:
  - explain triggering
  - explain projection (and cancellation/defeasibility)
- Two kinds of explanations for triggering:
  - Conventionalist/Lexicalist accounts: almost all theorists;
  - (Semi)Conversationalist account: Stalnaker, Simons, Schlenker
- Kinds of explanation for projection:
  - Semantic accounts: Frege, Strawson, Peters, Rothschild, ...
  - Pragmatic accounts: Stalnaker, Simons, Schlenker, ...
  - **Dynamic accounts**: Heim, Beaver, van der Sandt, Geurts, ...
- Another option: Living *without* presupposition (Russell)

Living without presupposition (Russell)

- No notion of presupposition needed, so no triggering to be explained.
- Projection and cancellation reading explained in terms of underlying **scope ambiguity**:

(40) The king of France is not bald

a. $\iota x[\text{king-of-france}(x)] : \neg B(x)$ (projection)

b. $\neg \iota x[\text{king-of-france}(x)] : B(x)$ (cancellation)

- Problem: hard to extend to other triggers. But maybe we should not aim at a uniform account of all triggers

> *Separate cages should have built for different types of 'presupposition triggers'. The quest of an all- encompassing theoretical account of presupposition was doomed to failure from the very beginning. [Karttunen 2016]*

Presupposition in dynamic semantics

- A dynamic account of presupposition projection (Heim 1988):
  - The semantic value of an expression = its context change potential;
  - Presupposition projection = side effect of the rules governing context change.
- Overview:
  - Contexts in dynamic semantics
  - Heim's solution to the projection problem:[1]
    - Update Semantics for Presupposition (USP)
    - Quantified Update Semantics for Presupposition (qUSP)
  - One remaining problem: the tall man with the bycicle

[1] These systems differs from original Heim (1988), but in inessential ways.

Dynamic semantics: contexts

- Contexts in different dynamic systems can encode different information
  - DPL: discourse information (possible antecedents for anaphora);
    - Context $\mapsto$ variable assignment
  - USP: factual information (speakers' presupposition, what is taken for granted by conversationalists, their common ground);
    - Context $\mapsto$ set of possible worlds (Stalnaker's context set)
  - qUSP: both discourse and factual information.
    - Context $\mapsto$ set of world-assignment pairs (cf. Heim's files)
- USP: contexts defined as sets of worlds comparable to partial models
- Both contexts c and propositions p identified with sets of possible worlds: in a context some propositions are satisfied, some are falsified, and others are neither.

(41)
a. $c \subseteq p$ — it is known/presupposed that p
b. $c \cap p = \emptyset$ — it is known/presupposed that not p
c. Otherwise — it is not known/presupposed whether p

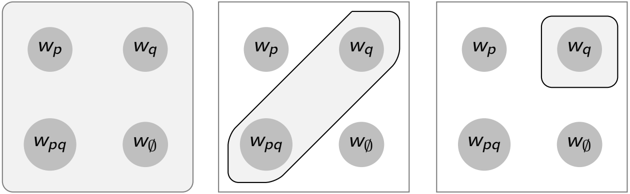
A toy example

- Consider a language of propositional logic with two atomic propositions: p, q
- Logical space: $W = \{w_p, w_q, w_{pq}, w_\emptyset\}$

(42) a. $c_1 = W$ — nothing is presupposed
b. $c_2 = \{w_q, w_{pq}\}$ — q is presupposed
c. $c_3 = \{w_q\}$ — q and not(p) is presupposed

- Contexts change as conversation proceeds:

(43) a. $c_1 + q = c_2$
b. $c_2 + \neg p = c_3$
c. $c_1 + (q \wedge \neg p) = c_3$



(a) c_1 (b) c_2 (c) c_3

Update Semantics for Presupposition (USP)

- Language: $\phi := p \mid \neg\phi \mid \phi \wedge \phi \mid \phi_{[\psi]}$, with $p \in A$

  ($\phi_{[\psi]}$ means ϕ presupposes ψ)
- Models: $M = \langle W, V \rangle$, where W is a set of possible worlds and V is a valuation function assigning truth values to atoms wrt worlds
- Contexts: $c \subseteq W$, sets of possible worlds
- CCP are partial functions from contexts to contexts:

(44) a. $c[p] = c \cap \{w \in W \mid V(p, w) = 1\}$
b. $c[\neg\phi] = c - c[\phi]$
c. $c[\phi \wedge \psi] = c[\phi][\psi]$

- Other connectives as derived notion:

(45) a. $c[\phi \rightarrow \psi] = c[\neg(\phi \wedge \neg\psi)] = c - (c[\phi] - c[\phi][\psi])$
b. $c[\phi \vee \psi] = c[\neg(\neg\phi \wedge \neg\psi)] = c - (c[\neg\phi] - c[\neg\phi][\psi])$

- For complex sentences, distinction global vs local context. E.g.
  - for $c[\phi \wedge \psi]$, local context of $\psi \mapsto c[\phi]$; global $\mapsto c$.
  - for $c[\phi \vee \psi]$, local context of $\psi \mapsto c[\neg\phi]$; global $\mapsto c$.
- Crucial idea: presupposition must be satisfied at the level of the local context.

Presupposition in USP

- Lexicon assigns pres to their trigger (not explicit in Heim):

(46) a. s: John stopped smoking $\rightsquigarrow$ p: J used to smoke
b. $s_{[p]}$

- Updates undefined if presupposition is not satisfied:

(47) $c[\phi_{[\psi]}] = c[\phi]$, if $c[\psi] = c$ (i.e., if c **entails** ψ)
undefined, otherwise.

- Terminology: A context c **admits** ϕ iff $c[\phi]$ is defined.
- Definition of presupposition:

(48) ϕ **presupposes** ψ iff every c that admits ϕ entails ψ.

Application: holes

Presupposition must be satisfied at the level of the local context

(49)
  a. John did not stop smoking
  b. $\neg s_{[p]}$
  c. $c[\neg s_{[p]}] = c - c[s_{[p]}]$

- The local context for $s_{[p]}$ is c itself
- c admits $\neg s_{[p]}$ iff c entails p, therefore $\neg s_{[p]}$ presupposes p, i.e. (49-a) predicted to presuppose that John used to smoke.

Application: filters

(50) a. John used to smoke and he stopped smoking.
b. $p \wedge s_{[p]}$
c. $c[p \wedge s_{[p]}] = c[p][s_{[p]}]$

(51) a. If John used to smoke, then he stopped smoking.
b. $p \rightarrow s_{[p]}$
c. $c[p \rightarrow s_{[p]}] = c - (c[p] - c[p][s_{[p]}])$

- The local context for $s_{[p]}$ in both cases is $c[p]$ which always entails p, therefore any c admits (50-b) and (51-b), thus the sentences presuppose nothing.

(52) a. If John moved to the US then he stopped smoking.
b. $q \rightarrow s_{[p]}$
c. $c[q \rightarrow s_{[p]}] = c - (c[q] - c[q][s_{[p]}])$

- c admits (52-b) iff $c[q]$ entails p iff c entails $q \rightarrow p$, therefore (52-b) presupposes $q \rightarrow p$, i.e. if John moved to the US then he used to smoke.

What about disjunction?

Exercise: Which presupposition predicted for the following sentences by USP? And are these predictions correct?

(53) Either the king of France is bald or the king of France is not bald.

(54) Either there is no king of France or the king of France is bald.

(55) Either the king of France is bald or there is no king of France.

The interpretation of variables: from context sets to files

- So far, no predictions for presupposition which contain free variables:

(56) a. [A tall man]$_i$ was pushing his$_i$ bicycle $\rightsquigarrow_p$ x_i has a bicycle
b. [Every nation]$_i$ cherishes its$_i$ king $\rightsquigarrow_p$ x_i has a king
c. $\mathcal{Q}x_i\phi_{[\psi(x_i)]}$

- In Heim, such presupposition captured by defining contexts as files (sets of sequence-world pairs):
  - USP: contexts = set of possible worlds
  - qUSP: contexts = sets of world-assignment pairs (≈ Heim's files)
- Independent motivation: cross-sentential and donkey anaphora

(57) a. [A tall man]$_i$ came in. He$_i$ was pushing a bicycle.
b. If [a farmer]$_i$ owns a donkey, he$_i$ is rich.

qUSP: free variables and existential quantifier

- Language of f-o predicate logic $+ \phi_{[\psi]}$
- Models: $M = \{W, D, I\}$, with W a set of worlds, D a set of individuals and I a world-dependent interpretation function
- Contexts: sets of world-assignment pairs
- The CCP of sentences with free variables in qUSP:

(58) $c[Rx_1, ..., x_n] = \{\langle w, g\rangle \in c \mid \langle g(x_1), \ldots, g(x_n)\rangle \in I(w, R)\}$

- Heim treats indefinites as free variables, in qUSP they are existential quantifiers as in DPL:

(59) $c[\exists x \phi] = c[x][\phi]$

where $c[x] = \{\langle w, g[x/d]\rangle \mid d \in D \,\&\langle w, g\rangle \in c\}$

- As in DPL, indefinites introduce new discourse referents which can be referred back by subsequent anaphors.

The 'tall man' problem

- Logical rendering of the example:

(60) a. [A tall man]$_i$ was pushing his$_i$ bicycle.
b. $\exists x(Mx \wedge \phi(x)_{[Bx]})$ [Bx: x has a bicycle]
c. $c[x][Mx][\phi(x)_{[Bx]}]$

- For c to admit (60), $c[x][Mx]$ must entail Bx:

(61) $c[x][Mx] = c[x] \cap \{\langle w, g \rangle \mid g(x) \text{ is a tall man in } w\}$

- This holds only if in every world compatible with c every tall man has a bicycle.
- Thus (60) wrongly predicted to carry the universal presupposition: every tall man has a bicycle.

A graphical representation of the problem

(62) a. [A tall man]$_i$ was pushing his$_i$ bicycle.

b. $\exists x(Mx \wedge \phi(x)_{[Bx]})$ [Bx: x has a bicycle]

c. $c[x][Mx][\phi(x)_{[Bx]}]$

- Suppose a, b and c are the only tall men in w. Then all three are required to have a bicycle for the sentence to be defined in $c = \{\langle w, g\rangle\}$.

$$c[x] \begin{array}{|cc|} \hline & x \\ \hline w & a \\ \hline w & b \\ \hline w & c \\ \hline w & d \\ \hline w & e \\ \hline \end{array} [Mx] \begin{array}{|cc|} \hline & x \\ \hline w & a \\ \hline w & b \\ \hline w & c \\ \hline \end{array} [\phi(x)_{[Bx]}]$$

- Solutions of this problem within dynamic semantics in Beaver (1994), and Aloni (2001).

(63) $c[\exists x \phi] = \bigcup_{d \in D}(c[x/d][\phi])$ (Beaver 1994)

What makes a system truly dynamic?

- Let US be USP without $\phi_{[\psi]}$ (i.e., USP without presuppositions).

(64) a. $c[p] = C \cap \{w \in W \mid V(p, w) = 1\}$
b. $c[\neg\phi] = c - c[\phi]$
c. $c[\phi \wedge \psi] = c[\phi][\psi]$

(65) $\phi \models_{US} \psi$ iff for all c: $c[\phi] \models \psi$

- US looks dynamic, but is it truly dynamic?
- US not truly dynamic. It can be reformulated in a static semantics:

(66) a. $[\![p]\!] = W \cap \{w \in W \mid V(p, w) = 1\}$
b. $[\![\neg\phi]\!] = W - [\![\phi]\!]$
c. $[\![\phi \wedge \psi]\!] = [\![\phi]\!] \cap [\![\psi]\!]$

(67) $\phi \models_{CL} \psi$ iff $[\![\phi]\!] \subseteq [\![\psi]\!]$

- US-validity is equivalent to CL-validity:

$$\phi \models_{US} \psi \;\Leftrightarrow\; \phi \models_{CL} \psi$$

- US updates can be defined ito static truth-conditional content:

(68) for all $\phi \in L$: $c[\phi] = c \cap [\![\phi]\!]$ (⇒ US is **intersective**)

What makes a system truly dynamic?

- van Benthem's (1986) result:

(69) A system is intersective just in case for all $\phi \in L$ and $c \in C$

(i) $c[\phi] \subseteq c$ (eliminativity)

(ii) $c[\phi] = \cup_{i \in c}\{i\}[\phi]$ (distributivity)

- The failure of one or both of these properties is claimed to be a key hallmark of truly dynamicness:
  1. DPL: distributive, but not eliminative
  2. USP: eliminative, but not distributive
  3. qUSP: neither distributive nor eliminative
  4. US: both eliminative and distributive
- All systems considered today are truly dynamic with the exception of US.

Do we need dynamic semantics?

- Do we really need truly dynamic systems?
- Can't we account for all phenomena just combining a static semantics with a smart pragmatics?
- Some[2][3] argued that we do not need dynamic semantics and therefore we should maintain a static view on meaning;
- A possible reply:[4] why should a dynamic semantics be given only when it is unavoidable?
  - Smart pragmatics which can account for dynamic phenomena are very complex (if possible at all). So why should static semantic represent some kind of austere, minimal starting point as compared to dynamic approaches?

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[2] Robert Stalnaker, 1996, On the Representation of Context. SALT VI

[3] Karen Lewis, 2014, Do We Need Dynamic Semantics? In: Burgess & Sherman (eds.) Metasemantics: New Essays on the Foundations of Meaning.

[4] Rothschild & Yalcin, 2016, Three Notions of Dynamicness in Language. Linguistics and Philosophy 39(4), pp. 333–355.

Questions?