Situations in and out of relations

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Carnap-Montague intension of a formula $\varphi$

$$\llbracket \varphi \rrbracket_{i_1...i_n} = \begin{cases} 1 & \text{if } i_1...i_n \models \varphi \\ 0 & \text{otherwise} \end{cases}$$

Inputs: indices $i_1...i_n$ — e.g. possible world, time
Output: extension/denotation $\llbracket \varphi \rrbracket_{i_1...i_n}$

Barwise & Perry 1983: use situations in a relation $R[\varphi]$ refining $\llbracket \varphi \rrbracket$

More relations associated with $\varphi$

1. Kaplan $i_1...i_n \rightsquigarrow u,i$ (2-dimensions: use, truth)
   - character: $u \mapsto$ content (context $u$ of use)
   - content: $i \mapsto$ truth value $\approx \llbracket \varphi \rrbracket_i$ (fixed context $u$)

2. Dynamic semantics: meaning as context change
   - context $\approx$ set of possible worlds (e.g. Veltman)
     + normality (V 1996), laws (V 2005)
   - Kamp $(M,f) \approx$ world-sequence pair (Heim)

3. Relations between denotations
   - a proof of $\varphi_1 \supset \varphi_2$ maps proofs of $\varphi_1$ to proofs of $\varphi_2$
   - links (e.g. causation) underlying rhetorical relations

PLAN. Start with refinement $R[\varphi]$ of $\llbracket \varphi \rrbracket$ with $u$

About what?

Truthmakers as
(i) pairs for $\varphi \land \psi$ (propositions-as-types)
(ii) functions for $\varphi \supset \psi$ (propositions-as-types)
(iii) events for "action sentences" $\varphi$ (Davidson 1967)
(iv) main eventualities behind discourse relations (SDRT)
   - special case of causation: Schubert
(v) relevant bits of an index, for "simple" $\varphi$ (with $n=1$)
   $$s \ R[\varphi] \ s' \iff s' \subseteq s \text{ and } s' \in A[\varphi]$$
   - records and frames: Cooper
   - temporal structure: strings (finite-state methods)
**Introduction**

1. **Denotations versus indices**
   - From ordered pairs to records and strings
   - Conditionals and entailments

### Denotations versus indices

- **From ordered pairs to records and strings**
  - Conditionals and entailments

#### Description versus Modal Logics

<table>
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<th>Description Logic</th>
<th>Modal Logic</th>
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<td>extensions</td>
<td>possible worlds ...</td>
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<tr>
<td>noun phrase</td>
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<td>role</td>
<td>accessibility relation</td>
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*Description logic* - popular for ontologies and semantic web
- shift complexity from sentences (truth values) to noun phrases
  
  - Every daughter of a farmer owns a pony.
    - (parent) → (own) → (pony)
  - decontextualized?
  - **Proposal.** Situate (context, not just denotations)

#### Relations between sentences and situations

<table>
<thead>
<tr>
<th>object level</th>
<th>predication</th>
<th>index</th>
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</thead>
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<tr>
<td>Schubert</td>
<td>true of</td>
<td></td>
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<tr>
<td>Kratzer</td>
<td>exemplify A[ϕ]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>true in support T[ϕ]</td>
<td></td>
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- Schubert
  - John’s driving while phoning caused an accident.
- Kratzer
  - Whenever a man rides a donkey, the man gives a treat to the donkey.

#### Flesh out denotations to (non-maximal) indices

- \( \varphi \vdash \psi \) if \( (\forall i \in C) i \models \varphi \) implies \( i \models \psi \)
  - if \( C \cap T[\varphi] \subseteq T[\psi] \)

For “simple” \( \varphi \),

\[
s \mathcal{R}[\varphi] s' \text{ if } s' \in A[\varphi] \text{ and } s' \subseteq s
\]

\[
T[\varphi] = \{ s | (\exists s' \in A[\varphi]) s' \subseteq s \}
\]

for suitable “part-of” relation \( \subseteq \).

Add constraints \( (C) \) above on \( s \) but allow \( s \) to be non-maximal
- logical omniscience
  - Pat believes 1+1=2 but not Fermat’s Last Theorem.
- vagueness (overprecision)
John fell.

\[ \varphi \land \psi \]

Mary pushed him.

\[ \text{fall } f \land \text{push } p \]

Order in \((f, p) \in A[\varphi \land \psi]\) from \(\varphi\) preceding \(\psi\) in \(\varphi \land \psi\).

But expect:

- \(p\) happens before \(f\) (temporal structure)
- \(p\) causes \(f\) (conceptual structure?)

Records trade tuple order for un-ordered labels (attributes)
- HPSC, DRT, SDRT (Asher and Lascarides)

Strings of chronologically ordered snapshots (cartoon/film strip)

\[ A \text{ dog appears to be approaching.} \]

\[ x : \text{Ind} \]

\[ c_0 : \text{dog}(x) \]

\[ c_2 : \text{appear}(c_0 : \text{approach}(x)) \]

A record type \(T\) is closed under \(\sqsubseteq\) (subject to modification)

\[ r \in T \text{ and } r \sqsubseteq r' \implies r' \in T. \]

\[ \begin{bmatrix} x = a \\ c_0 = p \\ c_1 = q \end{bmatrix} \sqsubseteq \begin{bmatrix} x = a \\ c_0 = p \\ c_1 = q \end{bmatrix} \]

Build \(T\) from its \(\sqsubseteq\)-minimal elements — \(A[\varphi]\) before \(T[\varphi]\)

Labels as attributes or discourse referents or clutter — in which case anonymize (as Prolog singleton variables)

### Beyond Cartesian products

\(\text{π} : "\text{no time without change}"\)

\[ \pi(e, e', e, e', e', e', e', e') = e, e', e' \]

For maximality, add pre- and post-events

\[ e, e', e' \leadsto e, \text{pre}(e'), e, e', e', \text{post}(e) \]

**Moral.** Base temporal granularity on alphabet (box fillers)
Entailments relative to a set $C$ of indices

Equate $\models_C \varphi \supset \psi$ with $\varphi \models_C \psi$ where

$$\varphi \models_C \psi \iff \forall i \in C \ i \models \varphi \implies i \models \psi$$

$$\varphi \models_C \psi \iff C \cap T[\varphi] \subseteq T[\psi]$$

context change from $C$ to $C \cap T[\varphi] —$ purely eliminative

Defeasible variants revise $C \cap T[\varphi]$ to $update(C, \varphi)$

$$\varphi \models_C \psi \iff update(C, \varphi) \subseteq T[\psi]$$

Non-eliminative update for counterfactuals - Veltman 2005:

*The crucial trick is that actual retraction takes place at the level of the bases of the worlds.*

... combining some of the ideas put forward here with the event based semantics put forward in Condoravdi (2002).

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### Functions for implications, in context

A proof of $\varphi \supset \psi$ maps proofs of $\varphi$ to proofs of $\psi$

$$A[\varphi \supset \psi] = A[\varphi] \to A[\psi]$$

or contextualizing, let $\llbracket x \rrbracket_i = \{s \mid i \ R[\chi] s\}$ and

$$\llbracket \varphi \supset \psi \rrbracket_i = \llbracket \varphi \rrbracket_i \to \llbracket \psi \rrbracket_i.$$

For fixed $i$, proofs-as-functions and truth conditions converge

$$\llbracket \varphi \supset \psi \rrbracket_i \neq \emptyset \iff i \models \psi \text{ or not } i \models \varphi.$$ 

Let $i$ range over some set $C$, and allow changes from left to right.

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### Link $\varphi$ to $\psi$

If John fell, [that’s because] Mary pushed him.

Whenever a man rides a donkey, the man gives a treat to the donkey [for the ride].

- make links explicit in semantic representation
  - construction versus interpretation
- relations between denotations versus relations between indices/events/situations versus worlds
- constraints rather than preference relation on possible worlds

V&B 2010 $\varphi \rightsquigarrow \psi$ as $\varphi \wedge \neg Ab_{\varphi} \supset \psi$

V 1996 $\varphi \rightsquigarrow \psi$ refines expectations $\approx$ binary relation on possible worlds comparing normality

Cooper: similar records (denotations) versus possible worlds (Lewis)
Case study: inertia

From inertia worlds (Dowty) to inertial fluents with forces as abnormalities, \( f^\varphi \approx Ab_{\varphi, \text{next }} \varphi \)

\[
\varphi, f^\varphi \implies \square \varphi
\]

- persist forward \( \varphi \implies \square \varphi \implies f^\varphi \)
- persist backward \( \square \varphi \implies \varphi \implies f^\varphi \)
- succeed unless opposed \( f^\varphi \implies \varphi \implies f^\varphi \)

resolve by weighing forces --- rank constraints!

Forces from actions \( \alpha \)

\[
\text{try}(\alpha) \implies f^\varphi \quad \text{for } \varphi \in \text{add-list}(\alpha)
\]

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