Partiality, situations and branching time

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Overview

1. I want to talk about a notion of partiality and show its relevance to a number of phenomena from the domain of modality.

2. A Kratzerian view on situations as parts of possible worlds.

3. An Austinian view on situations as the stuff we talk about (topic situations). Time is an abstraction and need not be assumed as a separate ontological category.

4. A view of situations as branching to the future.
1. Tarski, States of Affairs, Possible Worlds
\((\alpha)\)  The mug is on the desk.
  [Uttered in actual context \(c_1\).]

☐ Tarski (in context):

\[(T)\]  Sentence \((\alpha)\) (as uttered in \(c_1\)) is true
  \( if \ and \ only \ if \)
  the mug (referred to by the speaker of \(c_1\)) is on the desk (referred to by the speaker of \(c_1\)).

The condition in boldface in \((T)\) stands in for a particular (possible) **state of affairs**—call it ‘MoD’.

Picture 1. The state of affairs \(M(ug)o(n)D esk)\.)
\((\alpha)\) The mug is on the desk.

- Standard Truth Conditions in formal semantics:

\[(TC)\quad [[ (\alpha) ]]^{c, g, \@} = 1 \text{ iff } \@ \in [[ (\alpha) ]]^{c, g}.
\]
\[\text{iff } \@ \in \{w: [[ \text{the mug } ]]^{c, g, w} \text{ is on } [[ \text{the desk } ]]^{c, g, w} \text{ in } w\}.\]

- How does the Tarski story fit with \((TC)\)?

- \((TC)\) makes explicit reference to an **evaluation index** \@ (a possible world), thus relativizing truth to such an index.

- I prefer however to understand \((TC)\) as introducing a **world as subject of a predication**: the subject \@ is a world \(w\) such that the mug is on the desk in \(w\).
In formal semantics, states of affairs like MoD are modelled as *a possible world being member of a set of possible worlds / having a certain property (of possible worlds)*;

MoD is modelled as the world @ being member of the set of those possible worlds in which the mug in question is on the desk in question—call this set ‘$X_{\text{MoD}}$’.

- Tarski (Possible Worlds jargon):

$(T_{\text{PW}})$ Sentence $(\alpha)$ (as uttered in $c_1$) is true *iff* the actual world is a member of $X_{\text{MoD}}$. 

*Picture 1. The state of affairs MoD.*
• A problem. This approach does not distinguish between (α) and (β)-(γ):

(α) (At this moment) The mug is on the desk.
(β) (#At this moment) The mug is made of ceramics.
(γ) (#At this moment) Water is H₂O.

➤ (α) concerns a “temporally small” situation;
➤ (β) and (γ) cannot possibly concern a small situation: (β) concerns a situation (containing the mug and the property of being made of ceramics) co-extensive with the mug’s life span, and (γ) concerns the maximal actual situation, i.e. the actual world @. (Maybe not the whole actual world but only a temporally maximal situation that includes all the water there is and nothing else. I will put this issue aside.)
• Only generics such as (γ) involve properties of whole worlds (and so, only generics make the classical formal semantics representation of truth conditions fully appropriate).

• A historical note. Lewis (1979) made a close point in his article on De Se attitudes: attitudes such as belief, traditionally conceived as propositional (i.e., their objects would be classical propositions—sets of possible worlds), sometimes take properties as their objects, where properties need not be homogeneously true (or false) throughout a whole world and are rather instantiated “locally”.

• Here we think of Lewis’ properties as nothing more and nothing less than propositions in the generalized sense of properties of possible situations.
2. Kratzerian Situations, Austinian Topic Situations, Fully Specific Propositions
• Kratzerian situations are partial worlds (i.e., parts of possible worlds).

(α) The mug is on the desk.

• M(inimal)-truth (Kratzer 2019)
  The proposition (of the $c_1$-utterance of) (α) is M(inimally)-true in a situation $s_1$ that only contains:
  i. the mug,
  ii. the desk,
  iii. information regarding the spatial relation between the desk and the mug.

• We will also say that $s_1$ is the “minimal situation” in which (α) is true and that $s_1$ is the situation that (α) concerns.
• Kratzer (1989) assumes a principle of Persistence:

**Persistence**

If \((\alpha)\) is true in a situation \(s\) and \(s\) is a part of a situation \(s'\) (\(s \subseteq s'\)), then \((\alpha)\) is true in \(s'\).

- Kratzer abstracts away from time: in her statement of Persistence, \(s \subseteq s'\) means that \(s'\) is an extension of \(s\) *that is synchronous with \(s*.

- By Persistence, since \((\alpha)\) (as uttered in \(c_1\)) is true in the (actual) situation \(s_1\) depicted in Picture 1, it is also true in the maximal situation \(@\) that is our world (since \(s_1 \subseteq @\)).
Given what we said about the difference between (α) *(The mug is on the desk)* and (γ) *(Water is H₂O)*, what would it mean that (α) (as uttered in c₁) is true in @?

Aren’t we falling back onto the problem raised by the classical possible worlds picture of propositions?
• **Persistence (time added).** If \((\alpha)\) is true in a situation \(s\) and \(s\) is a part of a situation \(s'\) that extends \(s\) in time/space, then \((\alpha)\) is true in \(s'\).

• **M-truth** corresponds to the concept of a proposition concerning a situation and does not satisfy Persistence.
  
  (Except possibly for generics: if generics are M-true in worlds, then M-truth of generics satisfies Persistence in a trivial way.)

• The notion of truth that does satisfy Persistence (call it **P-truth**) corresponds to a concept of **a-temporal / a-locational truth**: since the proposition of \((\alpha)\)'s utterance in \(c_1\) is M-true somewhere (i.e., in \(s_1\)), it is P-true in every situation that has \(s_1\) as a part (in particular, it is P-true in the possible world @).

➢“P-true in a situation \(s\)” means “M-true somewhere within \(s\)”.
• Persistence only works *upward* (not downward!) on the part-of structure. So, from the fact that \((\alpha)\) (as uttered in \(c_1\)) is P-true in our world \(@\), it does not follow that it is P-true in the situation \(s_2 \leq @\) depicted in Picture 2.

• Notice that in \(s_2 (\alpha)\) (as uttered in a context \(c_2 \neq c_1\)) is true. But in this case we have a different proposition!

- In \(c_1 (\alpha)\) was addressed to my office-mate to instruct her on the whereabouts of the mug I had borrowed from her.
- In \(c_2 (\alpha)\) was addressed to my daughter to let her know where in our apartment I saw her favourite mug.

**Picture 2. MoD2**
Different mugs, different desks, different moments in the temporal flow ...

Different situations!

Picture 1. “The mug is on the desk” in $c_1$.

Picture 2. “The mug is on the desk” in $c_2$. 
• I am in a context $c_3$, one year after $c_2$. I tell my daughter “the mug is on the desk”, referring to the same mug and to the same desk as in $c_2$.

• Is the proposition expressed by my $c_3$-utterance true in the old situation $s_2$?

• This time the identity of the mug and the desk does not pose a problem—the mug and the desk I am referring to in $c_3$ are the same mug and the same desk contained in $s_2$.

• However, while $s_2$ was in 2018, the minimal situation $s_3$ in which (α) (as uttered in $c_3$) is true is a situation in 2019.
• Minimal situation $s_3$ in 2019 verifying the proposition of my $c_3$-utterance of ($\alpha$)

• Situations are particulars:

a situation in which the mug is on the desk one year ago is not the same as a situation in which the mug is on the desk today.

Picture 3. “The mug is on the desk” in $c_3$. 
• A triviality. In the new context $c_3$, to say something true of the old situation $s_2$ I should use a different sentence:

$$(\alpha') \quad \text{The mug is on the desk and it was on the desk that time too.}$$

The boldfaced part of $(\alpha')$ (as uttered in $c_3$) expresses the same proposition as $(\alpha)$ (as was uttered in $c_2$).

(The parts “that time” and “too” do not contribute anything to this proposition and their only role is to contribute to discourse coherence.)
• **A question/objection.** Why are you going so particular? Propositions (like concepts) are *general*: they typically apply to different situations. Your situations $s_2$, $s_3$ are *both* correctly described by the proposition *that the mug is on the desk*.

• **Reply.** Propositions are M-true in situations and those situations in which they are M-true are what they concern—those situations are *constituents* of the propositions, if you like.

(To say that ($\alpha$) as-uttered-in-$c_2$ and ($\alpha$) as-uttered-in-$c_3$ express the same proposition would be like saying that *John is tall* and *Bill is tall* express the same proposition because they involve the ascription of the same property to an individual.)

• ($\alpha$) as-uttered-in-$c_2$ and ($\alpha$) as-uttered-in-$c_3$ concern different situations and so they are different propositions.
In conclusion: the propositions are different since they encompass different (though resembling) situations:

\[ s_2 \text{ is such that the mug is on the desk} = p \]
\[ s_3 \text{ is such that the mug is on the desk} = p' \]
• I give an example of propositional identity from Amaral & Del Prete (2016) study on Portuguese *afinal* and Italian *alla fine* (‘in the end’) as markers of “truth unpersistance”:

(A)  [Uttered on Friday:] *I will go to the theatre on Sunday.*

(B)  [Uttered on the following Monday:] *In the end I did not go to the theatre.*

• Operators like “in the end” mark the unpersistance of the truth of a backgrounded proposition:

“This notion [of truth unpersistance] captures a basic fact concerning felicitous and truthful utterances of [sentences as in (B)]: they require that the truth of a proposition $p^*$ fail to persist through a temporal succession of epistemic states, where $p^*$ is incompatible with the proposition modified by *in the end* (hereafter, the “prejacent”).” [Amaral & Del Prete (2016)]
(A) [Uttered on Friday] I will go to the theatre on Sunday.
(B) [Uttered on the following Monday] In the end I did not go to the theatre.

• For the utterance in (B) to make sense, the prejacent of “in the end” must be factually incompatible with the same proposition that was previously entertained—the proposition of the utterance in (A).

• In spite of (A) being future tensed and (B) past tensed, the proposition in (A) and the proposition with which the prejacent of “in the end” in (B) is factually incompatible are the same proposition.
(F) \( [[ \text{will}(p) ]]_{c,g,s} = 1 \iff (c < s) \) and \( p \) is M-true in \( s \)
\( \iff (c < s) \) and \( s \in [[p]]_{c,g} \)

(P) \( [[ \text{past}(p) ]]_{c,g,s} = 1 \iff (s < c) \) and \( p \) is M-true in \( s \)
\( \iff (s < c) \) and \( s \in [[p]]_{c,g} \)

- The underlined conditions in (F) and (P) (i.e., the temporal relations between topic situation and utterance situation marked by the tense) do not contribute to the pure propositions expressed by an utterance of “will(p)” / “past(p)”.

- As far as their propositional content is concerned, “will(p)” and “past(p)” do not differ from one another (provided that they concern the same situation).

- “will(p)” and “past(p)” only differ in their use-conditions (the place of the speaker with respect to the topic situation has changed in passing from one context to the other).

(NOTE. If you are not happy with this “flat” analysis of past vs. future, I’ll be back to the future later later on.)
• **Question.** What sort of semantic object is the one obtained via abstraction over the situation?

\[ \lambda s. s \text{ is such that the mug is on the desk} \]

- It is the sort of compositional object we need to compute the meaning of sentences like (\(\delta\)) and (\(\varepsilon\)):

(\(\delta\)) The mug is **always** on the desk
  (you always forget to put it back in the kitchen!)

(\(\varepsilon\)) The mug **must** be on the desk
  (1. I saw it there this morning. / 2. The house rules dictate so.)
3. Open Propositions, Intra-World vs. Cross-World

Relations Between Situations
• We must distinguish between:

i. propositions as the semantic objects that get transmitted in communication and are built and identified in concrete utterances,

ii. “proposition-like” entities (*propositional functions*, if you like) that are needed for compositional semantics purposes (see Rabern 2012).
(δ) The mug is always on the desk
(you always forget to put it back in the kitchen!)

• The intuition about (δ): it concerns a temporally large situation $s_{\text{big}}$.

• “Always” quantifies over situations (from a context set C) that are parts of the situation $s_{\text{big}}$:

\[
[[ \text{Always}_C ]^{\text{the mug is on the desk}}]^{c, g, s_{\text{big}}} = \lambda s. (s' \subseteq s_{\text{big}} \rightarrow s' \text{ is such that mug is on desk})
\]

\[
[[ \text{Always}_C \hspace{0.5cm} ^{\text{the mug is on the desk}} ]^{\text{the mug is on the desk}}]^{c, g, s_{\text{big}}} = 1 \iff \forall s' \in C (s' \subseteq s_{\text{big}} \rightarrow s' \text{ is such that mug is on desk})
\]
(ε) The mug must be on the desk
   (Context 1. I saw it there this morning. / Context 2. The house rules dictate so.)

• The intuition about (ε): in Context 1 it concerns a small situation but in Context 2 it concerns a large situation.

• “Must” quantifies over situations that are related to the concerned (topic) situation via some intra- or cross-world relation f:

\[ [[\text{must}]]_{c,g,s} = \lambda p_{<s,t>}. \forall s' (s' \in f(s) \rightarrow p(s') = 1) \]

\[ [[\text{^[the mug is on the desk]}]]_{c,g,s} = \lambda s. (s \text{ is such that the mug is on the desk}) \]

\[ [[[[\text{Must ^[the mug is on the desk]}]]]]_{c,g,s} = 1 \text{ iff } \forall s' (s' \in f(s) \rightarrow s' \text{ is such that the mug is on the desk}) \]
(ε₁) The mug must be on the desk. (I saw it there this morning.)

The situation concerned is a small evidential situation \( s_0 \) containing the speaker and relevant information accessible to her from which she infers that the mug is on the desk.

In (ε₁)’s truth condition:

\[ \forall s' (s' \in f(s_0) \rightarrow s' \text{ is such that the mug is on the desk}) \]

\( f(s_0) \) is a set of situations that, in light of the evidence in \( s_0 \), might be the actual situation; \textbf{f is not a cross-world relation because the situations in } f(s_0) \textbf{ are candidates for an actual situation in } @. \textbf{ (See Santorio 2012.)}
(ε₂) The mug must be on the desk. (The house rules dictate so.)

The situation concerned is a large normative situation $s_0$ consisting of certain rules that provide that the mug be on the desk.

In (ε₂)’s truth condition:

$$\forall s' \ (s' \in f(s_0) \rightarrow s' \text{ is such that the mug is on the desk})$$

$f(s_0)$ is a set of situations that comply with the relevant rules; $f$ is a cross-world relation because the situations in $f(s_0)$ are (also) situations from non-actual worlds (cf. “The mug must be on the desk, but you never put it back there!”).
4. SITUATIONS IN BRANCHING TIME
Branching Time (BT): many futures, one past
(Prior 1967, Thomason 1984, Belnap et al. 2001)

• Our world, considered at any moment $m$, has a unique fixed past and present (the past and the present at $m$) and many open futures (the possible futures at $m$).

A suitable representation of our world, as it is at a moment $m$, depicts it as the cluster of all histories passing through $m$. 

![Diagram showing branching time with past and future branches at moment $m$.]
Branching Situations (Partial BT)

• A variant of Branching Time based on situations (called Partial Branching Time in Del Prete 2012): every situation comes with a unique past history but may evolve into a number of alternative situations.

• For any situations $s_1, s_2$, the formula `$s_1 \mathcal{E}_s s_2$’ means that $s_1$ did occur from the perspective of $s_2$, while $s_2$ might occur from the perspective of $s_1$ (Belnap 1992), the occurrence of $s_2$ being expected given some relevant facts in $s_1$ and its past.

• Histories are maximal chains of causally connected situations.

• A world is always a world at a particular situation: the world at $s$, world($s$), is the set of all histories passing through $s$. 
Future tense in PBT: “Peircean” approach (Prior 1967)

- \([ \text{will}(p)]^{c, g, c_s = 1} \iff \forall h (c_s \in h \rightarrow \exists s' \in h (s' > c_s \& \text{[[p]]}^{c, g, s' = 1})) \]

- On this approach, future tensed sentences are essentially **necessity modal sentences** \(\Box p\) (Condoravdi 2003): they make a claim about the present and require to check the truth of their open prejacent \(p\) relative to a number of alternative world-histories accessible from the present situation.
Future tense in PBT: “Ockhamist” approach (Prior 1967)

- $[[\text{will}(p)]^{c, g, cs} = 1 \iff \exists s' \in TRL(cs) (s' > cs \& [[p]^{c, g, s'} = 1))$

([[will(p)]^{c, g} is true in cs if and only if p is true at an s' following cs on the history $h^*$ that will be actual after cs – the Thin Red Line of cs]

➢ Although there are many possible futures, only one will be actual. A future tensed statement concerns this only future.
• The Peircean approach makes justice to the modal uses of the future (Condoravdi 2003), but it faces some problems with negation and indefinites:

(in the following I will make use of parameterized choice functions $\varepsilon$ to analyse indefinites; a choice-function term "$\varepsilon(N, w)$" picks out an individual that is $N$ in $w"
Modals/Future and indefinites (Stalnaker’s asymmetry)

(\phi)  
President Carter has to appoint a woman to the Supreme Court, but he doesn't have to appoint any particular woman; he just has to appoint some woman or other. [from Stalnaker 1981]

(\phi')  
(\forall s_1 \in f(s_0)) (s_1 \text{ is such that Carter appoints } \varepsilon(\text{woman, world}(s_1)))

BUT \neg \exists \varepsilon' (\forall s_1 \in f(s_0)) (s_1 \text{ is such that Carter appoints } \varepsilon'(\text{woman, world}(s_0)))

(\gamma)  
President Carter will appoint a woman to the Supreme Court, #but he won't appoint any particular woman; he just will appoint some woman or other. [from Stalnaker 1981]

(\gamma')  
(\forall h_1 s_0 \in h_1) (\exists s_1 > s_0 \& s_1 \in h_1) (s_1 \text{ is such that Carter appoints } \varepsilon(\text{woman, world}(s_1)))

BUT (\forall h_1 s_0 \in h_1) \neg \exists \varepsilon' (\exists s_1 > s_0 \& s_1 \in h_1) (s_1 \text{ is such that Carter appoints } \varepsilon'(\text{woman, world}(s_0)))
Modals/Future and negation

• The \( \forall \) lexically introduced by *must* can scopally interact with negation, as in (\( \sigma \)-b), (\( \sigma \)-c):

\[
(\sigma) \quad a. \quad \text{He must not come to the party.} \\
    b. \quad (\forall s_1 \in f(s_0)) (s_1 \text{ is such that } \neg(\text{he comes to the party})) \\
    c. \quad \neg(\forall s_1 \in f(s_0)) (s_1 \text{ is such that he comes to the party})
\]

• On the other hand, the \( \forall \) over histories in the “Peircean” interpretation of *will* cannot scopally interact with negation (see the unavailability of narrow scope in (\( \tau \)-c)):

\[
(\tau) \quad a. \quad \text{He will not come to the party.} \\
    b. \quad (\forall h \ s_0 \in h) \neg(\exists s_1 > s_0 \& s_1 \in h) (s_1 \text{ is such that he comes to the party}) \\
    c. \quad \neg(\forall h \ s_0 \in h) (\exists s_1 > s_0 \& s_1 \in h) (s_1 \text{ is such that he comes to the party})
\]
• Universal quantification underlying the “will” future does not seem to be able to enter scope relations with other scope bearing elements.

• In the past, I took this behaviour as evidence that this quantification is not contributed by any element overtly realized in the sentence and is due to a pragmatic strategy: a supervaluation to overcome the plurality of possible future histories that are relevant to evaluate the utterance (Del Prete 2014).
• “Modal Forcing” – not just with future tensed sentences! (Spolaore & Del Prete 2019):

(a) Now Yohan Blake will win. [Uttered after Usain Bolt has been disqualified.]
(b) Now you committed a crime last year. [Uttered after the new *ex post facto* law.]
(c) Now Pluto is not a planet anymore. [Uttered after the relevant conceptual shift has occurred.]
(d) Now it was an asteroid and not climate change that killed dinosaurs. [Uttered after the relevant theory-change has occurred.]

Modal interpretations of *will* as a particular case of Modal Forcing? (Context-situation forces the topic situation.)

• Narrative contexts in the “historical present”:

(e) 1941 - Richard Cheney is born in Lincoln, Nebraska, on January 30th. He will grow up in Casper, Wyoming, and earn his bachelor's and master's of arts degrees from the University of Wyoming.

The purely temporal (“Ockhamist”) *will* appears from examples like (e), where the narrated events are located in the past (in spite of being reported in the present tense) and the narrator has complete information about the relevant sequence of events. (Transposition in the past tense of (e) would show a parallel purely temporal *would*.)
Conclusion

• A partial semantics based on situations and a relation of minimal truth between propositions and situations capturing the intuition that a proposition concerns a situation (its topic situation).

• Propositions in actual communication are completely specific (they are not open propositions that are evaluated relative to times or worlds).

• Open propositions are needed for compositional semantics purposes – we need them in order to compute the meaning of sentences containing modals and other quantificational operators.

• Situation semantics allows a simple take on propositional contents of our utterances (ultimately there might be no semantic difference between the past tense “I went to the theatre on Sunday” and the future tense “I will go to the theatre on Sunday”, when the two utterances refer to the same situation).
Thank you! Here, now


