BEYOND EXTENSIONS

1. Times, events, worlds

1.1. Natural languages contain expressions that seem to refer to times (e.g. 'yesterday', 'last Monday', etc.) and expressions that seem to quantify over them (e.g. 'most Thursdays', 'every second', etc.). It would thus be hard to construct a semantics for natural language without entities representing times in our models. The question is whether we need to treat times in a special way or they can be just objects. The main reason for special treatment is tense:

(1) Trump was corrupt.
(2) Some billionaire was corrupt.

There is a sense in which (1) and (2) are about the past. On many standard semantic theories, this is assimilated either to the sense in which (1) is about Trump or to the sense in which (2) is about all billionaires. That is, many standard semantic theories take it that (1) and (2) contain a referring expression whose semantic value is a time:

(1′) Trump be corrupt at *t*
(2′) Some billionaire be corrupt at *t*

(1″) For some *t* in the past, Trump be corrupt at *t*
(2″) Some billionaire *b* is such that for some *t* in the past, *b* be corrupt at *t*

Many philosophers felt that neither of these models does justice to the sense in which (1) and (2) are about the past. They suggested, instead, that times should be added to the indices relative to which these sentences are evaluated.

1.2. What can be said of times can be said of events as well: we have expressions that seems to refer to them (e.g. 'World War II', 'the death of Alexander', etc.) and others that seem to quantify over them (e.g. 'every funeral', 'no inauguration', etc.), so we should probably include entities representing them in or models. Again, the main question is whether events should receive special treatment in semantics. The main reason to think so are manner adverbs:

(3) Trump tweeted recklessly.
(4) Some billionaire tweets recklessly.

(3′) Trump did *e* and *e* was reckless
(4′) Some billionaire *b* is such that *b* did *e* and *e* was reckless

(3″) For some *e* that be a tweeting, Trump did *e* and *e* was reckless
(4″) Some billionaire *b* is such that for some *e* that be a tweeting, *b* did *e* and *e* was reckless

While one may reasonably worry that (3) and (4) are not about events in quite the same sense in which (3) is about Trump and (4) about all billionaires, philosophers have not explored the possibility of adding events to indices relative to which sentences are semantically evaluated.

1.3. It is less clear that semantic theories need to posit possible worlds – there are no non-technical examples of expressions *obviously* referring to or quantifying over possible worlds. It is often said that 'actual' in an indexical that refers to the actual world. Arguably, this is a technical use of the word. Modal adverbs, like 'possibly', 'probably', etc. do seem to have quantificational force but it is not clear that they quantify over maximal possibilities. It is standard to assume that possible worlds should be added to the indices relative to which these sentences are evaluated.

2. The simplest framework

2.1. The observation that tenses display all the characteristic behavior of pronouns is due to Barbara Partee. Matthew Stone has stressed the exact analogy with moods.

Deictic	He is a fraud. I left the stove on. You would make me feel loved.
Anaphoric	He is a fraud and he doesn't care. I left a stove on and you did not warn me. Had you bought me flowers you would have made me feel loved.
Bound	No president will admit that he is a fraud. When I go to work I leave the stove on. If you give a man flowers you make him feel loved.

2.2. The simplest way to introduce times, events, and worlds to our semantic theories is to allow them to be the semantic values of referring expressions including variables. That way, our semantics remains wholly extensional.

(5) $[\![\text{win}]\!]^c = \lambda w \lambda e \lambda t \lambda x.\, e \textit{ is a winning by } x \textit{ at } t \textit{ in } w$

Some of the variables can be bound (overtly or covertly), others cannot. For example, 'She could have won' has the reading (6a) but does not have the reading (6b):

(6) She could have won.

(6a) $[\![\text{She could have won}]\!]^c = \exists w \exists t.\, [\![\emptyset_e]\!]^c \textit{ is a winning by } [\![she]\!]^c \textit{ at } t \textit{ in } w$
(6b) $[\![\text{She could have won}]\!]^c = \exists w \exists e \exists t \exists x.\, e \textit{ is a winning by } x \textit{ at } t \textit{ in } w$

(The fact that *w* must be accessible from the world of the context and that *t* must be in the past of the time of the context can be captured via some mechanism of domain restriction.)

2.3. Why abandon the simplest framework? The interpretation of formal languages with tense or mood uses operators and their semantics is not extensional.

Syntax: If S is a sentence then P S, $\Diamond S$ are also a sentences

Semantics: $[\![\text{P}\, S]\!]^{\boldsymbol{t}} = 1$ iff there is a $\boldsymbol{t'}$ before $\boldsymbol{t}$ such that $[\![S]\!]^{\boldsymbol{t'}}$
$[\![\Diamond S]\!]^{\boldsymbol{w}} = 1$ iff there is a $\boldsymbol{w'}$ accessible from $\boldsymbol{w}$ such that $[\![S]\!]^{\boldsymbol{w'}}$

(Boldface letters are meta-linguistic variables whose values are members of the domain of the model. They are supposed to represent something.) Of course, the same truth-conditions can be generated in a different way, using quantificational clauses:

Syntax: If S is a sentence then $\exists t.S$, $\exists w.S$ are also a sentences

Semantics: $[\![\exists t.\, S]\!]^{g} = 1$ iff there is a $\boldsymbol{t'}$ before g(t) such that $[\![S]\!]^{\text{g}[\text{t: } \boldsymbol{t'}]} = 1$
$[\![\exists w.\, S]\!]^{g} = 1$ iff there is a $\boldsymbol{w'}$ accessible from g(w) such that $[\![S]\!]^{\text{g}[\text{w: } \boldsymbol{w'}]} = 1$

The reason we favor formal languages where tense and mood introduce intensional contexts is that operators (unlike variable-binding devices) can be added to a language without changing the basic syntactic and semantic clauses. Compare: if you have propositional logic, you can straightforwardly add modal or temporal operators to it but if you want to introduce quantifiers, you need new expressions in the lexicon – predicates and variables.

This is a reason to treat tense and mood as operators in natural languages only if (i) tense and mood are extra layers over bare clauses, (ii) bare clauses have truth-conditions, and (iii) they are interpretable without movement. However, (i) – (iii) are all open empirical hypotheses.

2.4. But there are also good reasons one might want to go beyond extensional semantic values in the semantics of natural languages.

First, there are some reasonable metaphysical scruples. Suppose you think possible orthodontists are not real (i.e. that they are not orthodontists, either because they do not exist or because they are something other than orthodontists). Then (assuming you want semantic values that compositionally determine truth-conditions) you have no choice but to add something to your indices. Possible worlds are a reasonable option.

Second, there is the expectation to deliver reasonable empirical predictions. It is clearly the job of a semantic theory to go some way in predicting what sorts of readings belong to sentences. It may well be too complicated to design a theory that does not massively over-generate (e.g. predicts that (6b) is not a possible reading for (6)) within an extensional framework.

Third, one should try to build a semantics that smoothly connects with other theories. For example, the theory of communication presumably needs contents that are more fine-grained than extensions. It might be desirable if semantics assigned these more fine-grained contents (e.g. sets of possible worlds, sets of centered worlds, structured propositions) to declarative sentences.