COMIC RELIEF FOR ANANKASTIC CONDITIONALS

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Abstract. Anankastic conditionals are analyzed in terms of events conceived as sequences of snapshots – roughly, comics. Quantification is applied not to worlds (sets of which are customarily identified with propositions) but to strings that record observations of actions. The account generalizes to other types of conditionals, sidestepping certain well-known problems that beset possible worlds treatments, such as logical omniscience and irrelevance. A refinement for anankastic conditionals is considered, incorporating action relations.

1. Introduction: over-generating means

Sentences such as (1) have recently attracted the attention of semanticists interested in the challenge they pose for the approach to modality described in Kratzer 1991.

(1) If you want to go to Harlem, you must take the A train. (Sæbø 2001)

(2) If you want to go to Harlem, you must take the A train to do that.

(3) To go to Harlem, you must take the A train.

Read as an *anankastic conditional*, (1) associates, according to von Fintel and Iatridou 2005, a goal with *must*, expressed in (2) and (3). Hence, (4) is deviant as an anankastic conditional; seeing the Apollo theatre is a "must" for visitors *already in* Harlem, *not* part of a means for getting to Harlem.

(4) If you want to go to Harlem, you must see the Apollo theatre.

"Being a means for" has, as noted in von Stechow et al. 2005, proved difficult for semantic accounts of anankastic conditionals based on possible worlds. Both von Stechow et al. 2005 and Huitink 2005 acknowledge problems with overgeneration; the former traces this to a lack of "understanding of the semantics of purpose clauses" while the latter argues that this is a job for pragmatics. Elaborating on what (2) adds to (1), Nissenbaum 2005 and von Fintel and Iatridou 2005 propose specific remedies, reviewed below. I claim that these works, taken together, suggest (albeit unwittingly perhaps) stepping from propositions down to actions, relations between which are employed in Balkanski 1992 and Di Eugenio and Webber 1996 to analyze "being a means for." The "relief" offered in the present paper draws on all the aforementioned accounts, plus Fernando 2004, where events (recording actions) are strung out as comics.

2. From propositions to actions

Let us, as usual, identify a proposition with the set of possible worlds where it is true, and agree that a modal base $m(w)$ of a world w is a set of worlds accessible from w. A simple semantics for sentences such as (3) is (5).

(5) *to* p*, must* q is true in world w relative to modal base $m(w)$ iff all worlds in $m(w)$ that belong to p belong to q — i.e. $m(w) \cap p \subseteq q$

If we set $m(w)$ to the intersection $\bigcap f(w)$ given by the conversational background function f of Kratzer 1991, (5) becomes line (24b) in von Fintel and Iatridou 2005. (5) over-generates because it fails to link q causally with p. Accordingly, von Fintel and Iatridou add to the right hand side of (5) the requirement that q *be an essential part of a way of achieving* p, formalized relative to a world w with modal base $m(w)$ as (6).

(6) for some set P of propositions, $m(w) \cap q \cap \bigcap P \subseteq p$ but $m(w) \cap \bigcap P \not\subseteq p$

Unpacking (6), we can think of the set P as a partial plan that lacks only q to bring about p. But can we assume that time takes care of itself in (6)? Suppose, for the sake of the argument, that noone who goes to Harlem can leave Harlem — that is, $m(w)$ includes the proposition that everyone who goes to Harlem dies in Harlem. Would it be fair to say then that dying in Harlem is part of a way of getting to Harlem? As an anankastic conditional, (7) should be no truer than (4).

(7) If you want to go to Harlem, you must die in Harlem.

In general, if (6) holds for q, then it holds for $q \cap r$, for any r. Combined with (5), this may not be a problem if r is not necessary given p. (Take seeing the Apollo theatre for r.) But who can rule out pesky conditions such as those supposed above for (7)? Or setting $q = p$ in (6), can we really construe (8) anankastically?

(8) If you want to go to Harlem, then you must go to Harlem.

And what about satisfying (6) with q equal to $r \rightarrow p$, for r in $P \cup f(w)$?

The brute fact is that a sentence such as (3) does not come so readily with propositional constituents p and q. Its constituents p and q are arguably actions that combine temporally, not atemporally (as in $\cap$). While it is easy enough to express the performance of an action at a particular time as a proposition, it is not trivial to recover an action from a set of possible worlds. Nor is it clear that a set q of worlds can meaningfully be part of a means for any set of worlds, unless we can associate an action with q.

But what is an action? One answer, not fully satisfactory but instructive nonetheless, is that an action is a program — something a programmer writes that is meant to be executed. A program π for a commuter at train station X wishing to get to Harlem might consist of the 4 steps below.

$$\pi \;=\; \textit{walk to platform 2; board A train; ride A train; get off at 4th stop}$$

As with any description, the degree of detail in π is bounded; we might introduce intermediate steps such as *wait at platform*, or perhaps concurrent actions such as *stay awake*. Exactly what instructions to state is a difficult matter that certainly calls for pragmatic reasoning (and more). This aside, there are two questions to ask about π or indeed any program: whether we can carry it out (e.g. does the A train stop at platform 2?), and if we do, whether it would have the desired effect (i.e. is Harlem the A train's fourth stop from X?). For (1)-(3), what counts is not a program in paper (or in some mind), but a (complete) run of a program that transports us to Harlem.

3. Events as observations of actions

Let us fix a set Φ of temporal propositions, called *fluents* (McCarthy and Hayes 1969), such as *walk-to-platform2* saying that some agent (we leave implicit, for brevity) walks to platform 2. We hyphenate fluents to distinguish them from instructions that, for instance, appear in the 4-step program π from the previous section. We can picture a run of π as the string

$$\hat{s} \quad = \quad \fbox{\textit{walk-to-platform2}}\fbox{\textit{board-Atrain}}\fbox{\textit{ride-Atrain}}\fbox{\textit{get-off-at-4th-stop-from-X}}$$

with substring $\fbox{\textit{board-Atrain}}\fbox{\textit{ride-Atrain}}$ describing an event of taking the A train.[1] In general, we construe a string $\alpha_1 \cdots \alpha_n \in \textit{Power}(\Phi)^+$ as an event of n successive moments, with every fluent in α_i asserted to hold at the ith moment (for $1 \leq i \leq n$).[2] We extend inclusion $\supseteq$ between sets to strings in $\textit{Power}(\Phi)^+$, defining *subsumption* $\trianglerighteq$ to hold between strings of the same length when $\supseteq$ holds componentwise

$$\alpha_1 \cdots \alpha_n \;\trianglerighteq\; \beta_1 \cdots \beta_m \quad \text{iff} \quad n = m \;\; \textit{and} \;\; \alpha_i \supseteq \beta_i \;\; \textit{for} \; 1 \leq i \leq n \; .$$

For instance, $\hat{s} \;\trianglerighteq\; \Box\fbox{\textit{board-Atrain}}\fbox{\textit{ride-Atrain}}\Box$ (for $\hat{s}$ as above). Next, just as we form sets of possible worlds for propositions, we collect strings in languages

[1]Hence, $\hat{s}$ is a run also of the 3-step program *walk to platform 2; take A train; get off at 4th stop* . (No hyphens.)

[2]*Power*(Φ) is the set of subsets of Φ. To reinforce the intuition of a string as a comic-strip, boxes are used to enclose sets, understood as symbols from which strings are formed. Thus, the empty set is written as $\Box$, when it is meant as a symbol, as opposed say, to the empty language $\emptyset$ containing no strings. Following the practice of regular expressions, we conflate a string a with the singleton language $\{a\}$, lift concatenation to languages, and write Kleene star * for iteration (with $L^+ = LL^*$).

$L, L', \ldots$ over the alphabet *Power*(Φ) for event-types, and define L to *subsume* L' if every string in L subsumes some string in L'

$$L \trianglerighteq L' \quad \text{iff} \quad (\forall s \in L)(\exists s' \in L')\, s \trianglerighteq s'$$

(Fernando 2004). We say L *explicitly entails* L' and write $L \vdash L'$ if $L \trianglerighteq \Box^* L' \Box^*$ (padding L' with $\Box$'s to undo the requirement of equal length in $\trianglerighteq$). Identifying a string s with the language $\{s\}$, we have $\hat{s} \vdash$ | *board-Atrain* | *ride-Atrain* |. Languages with any number of strings allow us to formulate an alternative to (5) simply as (9), where $\mathcal{W}_c(p)$ is a set of ways to *get to* p from a starting point supplied by context c, while $\mathcal{L}(q)$ is the set of events of type q.

(9) *to p, must q* is true in context c iff $\mathcal{W}_c(p) \vdash \mathcal{L}(q)$

The right hand side of (9) says every way to get to p includes a q-event from a language $\mathcal{L}(q) \subseteq$ *Power*$(\Phi)^+$, which we may assume is given by linguistic knowledge (assembled, for instance, from a lexicon specifying the meanings of words in q). As for $\mathcal{W}_c(p)$, the necessity for going beyond $\mathcal{L}(p)$ is illustrated by (10), uttered in a context where speaker and addressee find themselves in a deserted island off Dublin with no food or drink or boat.

(10) To drink Guinness, you must swim to Dublin.

As no lexical semantics for drink can be expected to involve swimming, we must turn to context c for a starting point for the actions in $\mathcal{W}_c(p)$, drawing on world knowledge along the way. But isn't (9) a bit ad hoc?

Far from it, I claim (9) generalizes to conditionals *if* p *then* q, provided $\mathcal{W}_c$ is allowed to vary according to the kind of conditional (reading) involved. This is because it is natural to generate entailments by enriching explicit entailment $\vdash$ with maps $\mathcal{E}$ on languages L as follows

$$L \vdash_{\mathcal{E}} L' \quad \text{iff} \quad \mathcal{E}(L) \vdash L' .$$

If, as one may expect, $\mathcal{E}$ elaborates on L in that $\mathcal{E}(L) \vdash L$ then $\vdash$ is a subset of $\vdash_{\mathcal{E}}$. We might form $\mathcal{W}_c(p)$ as $\mathcal{E}_c(\mathcal{L}(p))$ for an $\mathcal{E}_c$ such that $\mathcal{E}_c(L) \vdash L$. For anankastic conditionals, the temporal span of $\mathcal{E}_c(L)$ may extend backward from L to its past/left (as specified by c), but *not* forward, into the future/right.[3] This accounts for the oddness of (4) and (7) as anankastic conditionals; neither a visit to the Apollo theatre nor death in Harlem falls within the temporal span of $\mathcal{W}_c$(go to Harlem). Tailoring $\mathcal{E}$ according to the type of conditional of interest, we have a flexible handle on inference, with temporal matters strung out in full view. Since a string in $\mathcal{E}(L)$ falls short of a possible world, we may sidestep problems such as logical omniscience and irrelevance that plague possible worlds treatments. For instance, we may assume kissing Pedro Martinez (Nissenbaum 2005) does not appear in $\mathcal{W}_c$(go to Harlem).[4]

[3]That is, for *no* $s \in \mathcal{E}_c(L)$ do we have $s \trianglerighteq L\Box^+$. Hence, we can require q to precede p if we replace $\mathcal{L}(q)$ in (9) by $\mathcal{L}(q)\Box$, falsifying (8), where $p = q$.

[4]The obvious existential version of (9) is (9)$'$.

4. A refinement

Instead of sharpening a set of possible worlds where p is achieved to some language $\mathcal{W}_c(p) \subseteq \mathit{Power}(\Phi)^+$, we might follow Nissenbaum 2005 and re-analyze q as *q with the goal to p*. This proposal, however, is flawed; as pointed out in von Fintel and Iatridou 2005 for the A train in (1), "it doesn't matter whether you take it with the goal of going to Harlem (as long as you get off at the right stop)" [p 19].

That said, we may nevertheless analyze q alongside p, replacing $\mathcal{L}(q)$ in (9) by a set $\mathcal{R}(q,p)$ of runs of q that lead to p in that

$$\mathcal{R}(q,p) \trianglerighteq \mathcal{L}(q)\Box^* \quad \text{and} \quad \mathcal{R}(q,p) \trianglerighteq \Box^*\mathcal{L}(p) \ .$$

(11) *to p, must q* is true in context c iff $\mathcal{W}_c(p) \vdash \mathcal{R}(q,p)$

Some support for changing $\mathcal{L}(q)$ in (9) to $\mathcal{R}(q,p)$ in (11) is to be found in the observation from Di Eugenio and Webber 1996 that in the phrase *q to p*, the goal p constrains q (presumably under minimal rationality assumptions). These constraints can be imposed through action relations linking q to p, which Balkanski 1992 argues are (among other things) irreflexive, marking *p to p* as odd. Thus, if (8) is indeed deviant as an anankastic conditional, we have a ready explanation from (11) and the constraint $\mathcal{R}(p,p) = \emptyset$.[5] In Di Eugenio and Webber 1996, action relations bind actions to form *plan graphs*, representing intentions. The aforementioned problem with Nissenbaum's proposal suggests we should be careful about reducing these intentions to claims entirely about mental states. Both (9) and (11) focus on what can be observed from the outside as strings over the alphabet $\mathit{Power}(\Phi)$. But action relations may well call for greater boldness in speculating about what lies inside the black box, so as to understand how black boxes might interact to produce, for example, $\mathcal{R}(q,p)$.

5. Conclusion: from worlds to strings

Proposals (9) and (11) above reduce the semantic over-generation of previous accounts based on possible worlds that are arguably too crude to capture what "being a means for" means. The step from worlds down to strings recording observations of a computational/cognitive mechanism is an attempt to stake out some middle ground between what Jackendoff 1996 calls E[xternalized]-semantics and I[nternalized]-semantics — between on the one hand, propositions and truth (against some external world), and on the other hand, actions and computation/cognition.

(9)′ *to p, may q* is true in context c iff $(\exists s \in \mathcal{W}_c(p))\ s \vdash \mathcal{L}(q)$

To interpret *ought* relative to a preference relation $\leq_c$ on strings, let $(Q^{\leq_c} s \in L)\ A(s)$ abbreviate $(\forall s \in L)\ (\exists s' \leq^L_c s)(\forall s'' \leq^L_c s')\ A(s'')$, where $s \leq^L_c s'$ abbreviates $s \leq_c s'$ *and* $s \in L$.

(9)′′ *to p, ought q* is true in context c iff $(Q^{\leq_c} s \in \mathcal{W}_c(p))\ s \vdash \mathcal{L}(q)$

[5] See also footnote 3 for an explanation covering the case where the action relation is enablement.

Pragmatic input to $\mathcal{W}_c(p)$ and, in the case of (11), to $\mathcal{R}(q,p)$ breaks the traditional semantics-pragmatics pipeline that places semantic matters of truth strictly ahead of pragmatic considerations of use.[6]

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[6]**Post Script**: (12) and (13) pose problems for (9)/(11), brought to my attention by Magdalena Schwager.

(12) If you want to go to Harlem, you must not take the B train.

(13) If you want to go to Harlem, you must stay awake.

For (12) and (13), it is unfortunate that the temporal force of q in (9)/(11) should be made existential by the step from $\unrhd$ to $\vdash$. While I cannot claim to have a fully worked out proposal at the moment, I am, for the case of (9), inclined to put into $\mathcal{L}(q)$ a fluent that, for (12) and (13), has effects beyond the box that encloses it — as is the case for inertia and fluents with temporal operators (discussed in my SALT 2004 and FG/MOL 2005 papers, available in `www.cs.tcd.ie/Tim.Fernando`). The q's in (12) and (13) are, after all, stative. Whether this approach can be pulled off cleanly, I regret I cannot say.