Conditional truth and future reference

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Overview

- the interpretation of tenses in indicative conditionals
- interactions between modal and temporal expressions
- consequences for semantic theory

Two classes of indicative conditionals

I will call conditionals like (1a) and (1b) *predictive* and *non-predictive*, respectively.

(1) a. If he <u>submits</u> his paper to a journal, we won't include it in our book.
b. If he <u>submitted</u> his paper to a journal, we won't include it in our book.

Two questions

I. What are the antecedents of (1a) and (1b)?

My claim: The antecedents of (1a,b) are (2a,b), respectively.

(2) a. He submits his paper to a journal.
b. He submitted his paper to a journal.

- BUT the antecedent of (1a) does not have the same interpretation as (2a).
- (2a) is only felicitous with a reading that includes "certainty" or "scheduling":

(2a') *[According to his agenda,]* he submits his paper to a journal *[tomorrow]*.

I call this the <u>"Certainty Condition"</u> (CC). Notice that it is absent from (1a).

⇒ Some claim that the antecedent of (1a) is:

- not really a tensed clause (Dudman, 1984; Crouch, 1993, etc.);
- or (3a) (McCawley, 1971; Comrie, 1985; Dancygier, 1998, etc.).

(3) a. He will submit his paper to a journal.
b. ?If he will submit his paper to a journal, we won't include it in our book.

Related claim: (3b) is infelicitous unless '*will*' has a volitional reading ('*If he is willing to submit his paper. . .* ').

II. What is the semantic difference between the sentences in (1a) and (2b)?

My claim: There is no significant difference.

- BUT there is a clear intuitive difference between (1a) and (1b), concerning the status of the antecedent. Funk (1985):[1]

  (1a): the relevant state of affairs is still subject to manifestation and not verifiable.

  (1b): the relevant state of affairs is 'manifested' and could (in principle) be verified.

  In general, in (1b), but not in (1a), the truth of the antecedent is known to someone other than the speaker, or knowable in principle, or in any case somehow "out there."

- But this difference is not an appropriate basis for classifying conditional *sentences*!

  The same sentences can have the opposite reading:

  (4) a. *[We'll check what was decided about these manuscripts at yesterday's meeting.]*
  If he submits his paper to a journal, we won't include it in our book.

  b. *[We'll contact potential contributors next month to see which of these manuscripts are still available then.]*
  If he submitted his paper to a journal, we won't include it in our book.

  - (4a) shares with (1b) the "verifiability" of the antecedent at speech time.
  - (4b), on this "past-in-the-future" interpretation, shares with (1a) the "non-verifiability" at speech time.

  ⇒ If the criterion were to distinguish *sentences*, then (1a) and (4a) would be distinct, homophonous sentences; likewise for (1b) and (4b).

- Instead, I assume that (1a/4a) are the same sentence; likewise for (1b/4b).

  Funk's distinction arises from variation in a (pragmatic) parameter of interpretation.

- Funk's criterion distinguishes *readings*, not sentences.

Terminology (for now):

- Predictive reading (1a/4b): the antecedent (i) carries the Certainty Condition when used in isolation, but not in the conditional; and (ii) refers to a state of affairs that is "manifested" at speech time.
- Non-predictive reading (1b/4a): The ones that are not predictive.
- (i) and (ii) are reflexes of the same semantic property, hence not independent (so there are no more than two cases).

[1] Funk (1985): "In the case of [1b] the uncertainty is largely due to the fact that the state-of-affairs described and predicated does not yet exist, i.e., is still subject to manifestation (so that it cannot be affirmed or denied—it is unverifiable) at the moment of the sentence being uttered. In [1a], however, the state-of-affairs *does* exist at the time of speaking (either in the positive or negative sense—it is 'manifested' and could thus be verified), but the speaker has not got enough information (or is otherwise not disposed) to be sure about it and hence to affirm or deny it. Accordingly, the meaning of the conditioning frame can be said to vary from 'if it happens that ...' to 'if it is true that ...' " (375–376)

1 Time, truth, and knowledge[2]

1.1 Two kinds of uncertainty

What is the relevant difference between (1a) and (1b)?

- Both are used under uncertainty as to the truth of the antecedent.
- But the uncertainty has different sources:

Objective: (1a) If he submits his paper...

  - He may or may not submit his paper.
  - The uncertainty is *objective*—the matter is not yet settled.
  - "The relevant state of affairs is still subject to manifestation and as yet not verifiable."

Subjective: (1b) If he submitted his paper...

  - He either did or didn't submit his paper.
  - The uncertainty is *subjective*—due to ignorance alone.
  - "The relevant state of affairs is 'manifested' and could (in principle) be verified."

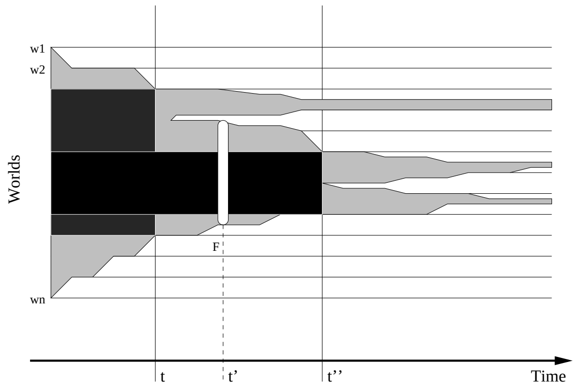
Interdependence:

- Objective uncertainty implies subjective uncertainty.
  (What is not yet "manifested" cannot already be known.)
- But not vice versa.

[2] For detailed definitions, see the Appendix.

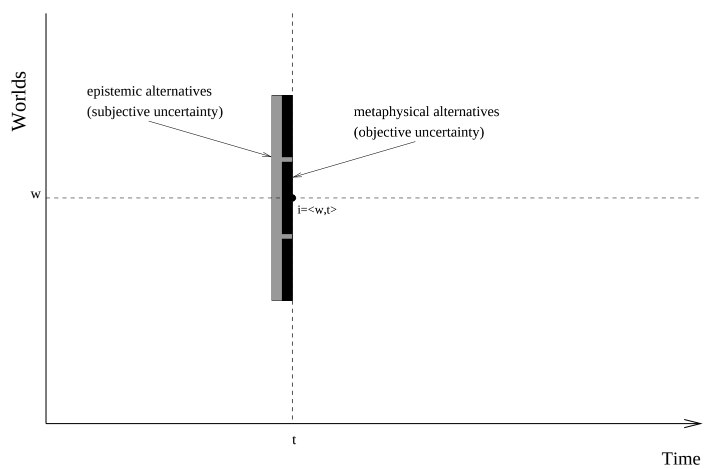
1.2 Objective uncertainty and historical necessity

- The past is "fixed," the future is "open."
- History proceeds by shedding alternative continuations.
- The grey areas in the figure indicate possible histories.
- The worlds included in the black rectangles are indistinguishable at times up to t and t', respectively.



1.3 Subjective uncertainty and "verifiability"

- The past is not open: There may be subjective uncertainty about the past.
- Beliefs change over time by eliminating alternatives. (No revisions in this model.)
- Doxastic histories lack foreknowledge: Belief states cannot at any point "cut across" classes of historical alternatives.



1.4 Formalities: Accessibility relations

Relations R between indices (world-time pairs) are:

- *temporal* if they are "horizontal": $iRj \Longrightarrow w_i = w_j$
  - Temporal precedence: $<$
- *modal* if they are "vertical": $iRj \Longrightarrow t_i = t_j$
  - *Metaphysical* accessibility (historical alternatives): $\approx$
    - $\approx$ is an equivalence relation.
    - If two worlds are historical alternatives at one time, they are historical alternatives at all earlier times.
    - If $i \approx j$, then i and j agree on the truth values of all atomic sentences.
  - *Doxastic* accessibility (doxastic alternatives): $\sim$
    - $\sim$ is serial, transitive and euclidean (i.e., consistent and introspective)
    - The agent's beliefs are subject to historical necessity: If $i \sim j$ and $i \approx k$, then $k \sim j$.
    - Lack of foreknowledge: If $i \sim j$ and $j \approx k$, then $i \sim k$.

1.5 A sentence is:

settled at i iff it is true at all of i's historical alternatives.

known at i iff it is true at all of i's doxastic alternatives.

presumed decided at i iff either it or its negation is settled at all of i's doxastic alternatives.

➧ Truth and settledness coincide for sentences which depend for their truth entirely on past or present facts.

➧ Only what is settled can (already) be known.

2 Interpretation

Goals of the analysis:

- Compositionality in a strict sense: give the constituents of conditionals the same interpretation as in isolation;
- Derive the interpretive possibilities of conditionals from the interplay between modal and temporal elements (and the structure of the model)

➨ The formulas here are slightly simplified. The "official" version is Kaufmann (2005b).

2.1 Basics

Two basic types: s for indices (world-time pairs) and t for truth values.

Sentence radicals

'he come, she leave, ...'

- the smallest units of interpretation.
- a valuation function V assigns truth values to them pointwise at world-time pairs.
- Type: $\langle\langle s,t\rangle,t\rangle$.

(5) $$[\![Rad]\!] = \lambda x.\exists i[x(i) \wedge V(Rad)(i)]$$

- Example: $[\![\mathit{he\ arrive}]\!] = \lambda x_0.\exists k[x_0(k) \wedge V(\mathit{he\ arrive})(k)]$

Frame adverbials

'tomorrow, yesterday, ...'

- relations between indices. The first argument may be:
  - (i) the speech time (*deictic*: *'tomorrow, now, ...'*)
  - (ii) the reference time of the local context (*anaphoric*: *'then, the following day, ...'*)
  - (iii) irrelevant (*referential*: *'on February 10, 2005'*)
    (the terminology is due to Smith, 1991)
- I only deal with deictic ones; for simplicity, I leave the speech time as a free variable s. Technically, this does not really work. See Kaufmann (2005b) for a better solution.
- TOM_s is the set of indices that are "tomorrow" from the perspective of s.
- Type: $\langle\langle\langle s,t\rangle,t\rangle,\langle\langle s,t\rangle,t\rangle\rangle$.

(6) $$[\![Adv]\!] = \lambda\varphi\lambda x.\varphi(\lambda i.x(i) \wedge \textsc{adv}_s(i))$$

- φ is of type $\langle\langle s,t\rangle,t\rangle$, like (5).
- $[\![tomorrow(he\ arrive)]\!]$
  $= \lambda\varphi\lambda x_1.\varphi(\lambda i.x_1(i) \wedge \textsc{tom}_s(i))\ (\lambda x_0.\exists k[x_0(k) \wedge V(he\ arrive)(k)])$
  $= \lambda x_1[\lambda x_0.\exists k[x_0(k) \wedge V(he\ arrive)(k)]\ (\lambda i.x_1(i) \wedge \textsc{tom}_s(i))]$
  $= \lambda x_1.\exists k[\lambda i[x_1(i) \wedge \textsc{tom}_s(i)](k) \wedge V(he\ arrive)(k)]$
  $= \lambda x_1.\exists k[x_1(k) \wedge \textsc{tom}_s(k) \wedge V(he\ arrive)(k)]$

2.2 The tenses: Some general considerations

How many tenses are there in English?

i. past, present, future; *'will'* marks future tense (Wekker, 1976; Bennett and Partee, 1978)

ii. past, present, future; Present ambiguous between present and future (Steedman, 2002)

iii. past and non-past; Present underspecified (Joos, 1964; Huddleston and Pullum, 2002)

- Arguments for (iii): *'will'* is neither necessary nor sufficient for future reference; bare Present can realize future reference:

  (7) a. He submits his paper to a journal.
  b. He will be in her office right now.

- Potential problem for (iii): The Certainty Condition arises with the bare Present, but *only* with future reference time (8a; cf. also 7a); *not* with present reference time (8b):

  (8) a. He is in his office tomorrow.
  b. He is in his office (now).
  c. He was in his office (yesterday).

Q: Is this a problem for a unified analysis of the Present?

A: No. First, notice that the CC never arises with Past tense either (9c).

Then generalize: The CC is felt whenever the reference time follws the evaluation time.

But that does not mean that it is otherwise absent.

- Leech (1971): The futurate Present "attributes to the future the same degree of certainty that we normally accord to present and past events."

➨ *All* bare tenses (Past and Present) contain a covert epistemic necessity modal and are evaluated against metaphysical or doxastic modal bases.[3]

Given the structure of the model, it is only with future reference that this modal adds something over and above the condition that the sentence be true.

Sources of certainty about the future

1. Certainty that the sentence is true.

   (9) The sun sets at 8:39 tomorrow. [Goodman, 1973]

   This is only available for assertions about the outcomes of processes that are deemed deterministic.

2. Deducibility from a currently fixed (though possibly misleading) body of information, such as a timetable:

   (10) Your plane leaves at 4pm…
   a. but I doubt that it will.
   b. #but I doubt that it does.

   (10) conveys certainty about the timetable (thus (10b) is infelicitous) but not about the *actual* departure time (thus (10a) is felicitous, if interpreted w.r.t. two different modal bases).

   Cf. also the following, due to Lakoff (1971):

   (11) a. The Yankees play the Red Sox tomorrow.
   b. ?The Yankees play well tomorrow.

   (11a) is (plausibly) about the schedule.

   (11b) is bad because it is harder (though not impossible!) to think of reading under which it is already settled.

3. Omniscience:

   (12) a. ?It rains tomorrow.
   b. It will rain tomorrow.

   (12a) only felicitous if uttered by the "Almighty" (Edgington, 1997). (12b) shows that '*will*' makes a weaker assertion.

➨ There are three elements to the tenses: Modal force, temporal relation, and modal base. The are represented separately and enter the derivation at different points.

[3] "Epistemic" here in the linguistic sense, as opposed to "root" — not in the logical sense, as opposed to deontic etc.

Back to compositional semantics...

Modal forces

Some assumptions:

- $\textsc{will}(\varphi) = \textsc{pres}(\textsc{woll}(\varphi))$

  The contribution of PRES is purely temporal; WOLL contributes a *modal force.*

- Analogously, bare Present is decomposed into $\textsc{pres}(\varnothing(\varphi))$; $\varnothing$ contributes modal force.

- The modal force of WOLL is weaker than that of $\varnothing$:

  (13) a. #It rains tomorrow.
  b. It will rain tomorrow.

  (14) a. #The coin comes up heads (eventually).
  b. The coin will come up heads (eventually).

- $\varnothing$ expresses necessity;

  WOLL conveys something weaker; for simplicity, I assume it is necessity relative to an ordering source (Kratzer, 1981).

- Modal forces are relations between propositions, or generalized quantifiers over indices. Notation: Dyadic operators $\Box$, $\boxed{O}$; two constituents correspond to *restrictor* and *scope.*

Type: $\langle\langle\langle s,t\rangle,t\rangle,\langle\langle\langle s,\langle s,t\rangle\rangle,\langle\langle s,\langle s,t\rangle\rangle,\langle s,t\rangle\rangle\rangle\rangle\rangle$

(15) $$[\![\varnothing]\!] = \lambda\varphi\lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\varphi(\lambda k.jTk))$$

(16) $$[\![\textsc{woll}]\!] = \lambda\varphi\lambda T\lambda R\lambda i.\boxed{\preccurlyeq_s}(\lambda j.iRj)(\lambda j.\varphi(\lambda k.jTk))$$

- T and R are accessibility relations (temporal and modal, respectively).

- The expressions produced by these translations are then evaluated in the model:

  - $\Box(\Phi)(\Psi)(i) = 1$ iff for all j such that $\Phi(j)$ is true, $\Psi(j)$ is true.
  - $\boxed{O}(\Phi)(\Psi)(i) = 1$ iff for all j such that $\Phi(j)$, there is some k such that $\Phi(k)$ and jO_ik and $\Psi(k)$ is true.

- $[\![\varnothing(\mathit{tomorrow}(\mathit{he\ arrive}))]\!]$
  $= \lambda\varphi\lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\varphi(\lambda l.jTl))\ (\lambda x_1.\exists k[x_1(k) \wedge \textsc{tom}_s(k) \wedge V(\mathit{he\ arrive})(k)])$
  $= \lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j[\lambda x_1.\exists k[x_1(k) \wedge \textsc{tom}_s(k) \wedge V(\mathit{he\ arrive})(k)]\ (\lambda l.jTl)])$
  $= \lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\exists k[\lambda l[jTl](k) \wedge \textsc{tom}_s(k) \wedge V(\mathit{he\ arrive})(k)])$
  $= \lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\exists k[jTk \wedge \textsc{tom}_s(k) \wedge V(\mathit{he\ arrive})(k)])$

Tenses

PRES and PAST denote non-past and past, respectively.
Type: $\langle s, \langle s, t\rangle\rangle$

(17) $$[\![\text{PRES}]\!] = \lambda i \lambda j. i \leq j$$

(18) $$[\![\text{PAST}]\!] = \lambda i \lambda j. j < i$$

- $[\![\varnothing(tomorrow(he\ arrive))(\text{PRES})]\!]$
  $= \lambda T \lambda R \lambda i[\Box(\lambda j. iRj)(\lambda j. \exists k[jTk \wedge \text{TOM}_s(k) \wedge V(he\ arrive)(k)])]\ (\lambda l \lambda m. l \leq m)$
  $= \lambda R \lambda i. \Box(\lambda j. iRj)(\lambda j. \exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(he\ arrive)(k)])$

Modal bases

Modal bases are modal accessibility relations.
Type: $\langle s, \langle s, t\rangle\rangle$

(19) $$\lambda i \lambda j. i \approx j$$

(20) $$\lambda i \lambda j. i \sim j$$

- $[\![\varnothing(tomorrow(he\ arrive))(\text{PRES})(\sim)]\!]$
  $= \lambda R \lambda i[\Box(\lambda j. iRj)(\lambda j. \exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(he\ arrive)(k)])]\ (\lambda l \lambda m. l \sim m)$
  $= \lambda i. \Box(\lambda j. i \sim j)(\lambda j. \exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(he\ arrive)(k)])$

- Finally, and "magically," we bind i and s together. This is worked out in Kaufmann (2005b); here, I will just stipulate that the final result is the following:

- $= \lambda s. \Box(\lambda j. s \sim j)(\lambda j. \exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(he\ arrive)(k)])$

  $= 1$ iff for all j such that $s \sim j$, there is a k such that $j \leq k$ and $\text{TOM}_s(k) = 1$ and $V(he\ arrive)(k) = 1$.

2.3 Conditionals

'*If*'-clauses modify sentences that are tensed but not yet supplied with a modal base (for motivation, see below). Their semantic contribution is a restriction on the modal base.

Type of IF: $\langle\langle s,t\rangle,\langle\langle\langle s,\langle s,t\rangle\rangle,\langle s,t\rangle\rangle,\langle\langle s,\langle s,t\rangle\rangle,\langle s,t\rangle\rangle\rangle\rangle$

Non-predictive conditionals

(21) $$[\![\text{IF}]\!] = \lambda\Phi\lambda\zeta\lambda R\lambda i.\zeta(\lambda l\lambda m.lRm \wedge \Phi(m))(i)$$

- ζ is of type $\langle\langle s,\langle s,t\rangle\rangle,\langle s,t\rangle\rangle$. For example, this is the type of the output under (17).
- For readability (yeah right), let the antecedent be represented by $\mathcal{A}$ of type $\langle s,t\rangle$. Let the consequent be '*he arrives tomorrow*'.
- $[\![\text{IF}(\mathcal{A})]\!]$
  $= \lambda\Phi\lambda\zeta\lambda R\lambda i[\zeta(\lambda l\lambda m.lRm\Phi(m))(i)]\ (\mathcal{A})$
  $= \lambda\zeta\lambda R\lambda i.\zeta(\lambda l\lambda m.lRm \wedge \mathcal{A}(m))(i)$
- $[\![\text{IF}(\mathcal{A})(\varnothing(\mathit{tomorrow}(\mathit{he\ arrive}))(\text{PRES}))]\!]$
  $= \lambda\zeta\lambda R\lambda i[\zeta(\lambda l\lambda m.lRm\wedge\mathcal{A}(m))(i)]\ (\lambda R_0\lambda i_0.\Box(\lambda j.i_0R_0j)(\lambda j.\exists k[j \leq k\wedge\text{TOM}_s(k)\wedge V(\mathit{he\ arrive})(k)]))$
  $= \lambda R\lambda i[\lambda R_0\lambda i_0[\Box(\lambda j.i_0R_0j)(\lambda j.\exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(\mathit{he\ arrive})(k)])]\ (\lambda l\lambda m.lRm \wedge \mathcal{A}(m))(i)]$
  $= \lambda R\lambda i[\lambda i_0[\Box(\lambda j[\lambda l\lambda m[lRm \wedge \mathcal{A}(m)](i_0)(j)])(\lambda j.\exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(\mathit{he\ arrive})(k)])](i)]$
  $= \lambda R\lambda i[\lambda i_0[\Box(\lambda j[\lambda m[i_0Rm \wedge \mathcal{A}(m)](j)])(\lambda j.\exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(\mathit{he\ arrive})(k)])](i)]$
  $= \lambda R\lambda i[\lambda i_0[\Box(\lambda j.i_0Rj \wedge \mathcal{A}(j))(\lambda j.\exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(\mathit{he\ arrive})(k)])](i)]$
  $= \lambda R\lambda i.\Box(\underline{\lambda j.iRj \wedge \mathcal{A}(j)})(\lambda j.\exists k[j \leq k \wedge \text{TOM}_s(k) \wedge V(\mathit{he\ arrive})(k)])$

  $= 1$ iff for all j s.t. iRj and $\mathcal{A}(j) = 1$, there is a k s.t. $j \leq k$ and $V(\mathit{he\ arrive})(k) = 1$.
- The underlined part is where the '*if*'-clause has made its contribution. Compare this to the last line in the example under (17) above.

➨ Under this reading, the conditional quantifies over the set of indices accessible via the modal relation R (hence cotemporal with the speech time.
Recall that $\mathcal{A}$ has its own modal force. Paraphrase: '*If $\mathcal{A}$ is settled (now) ...*'.)

Predictive conditionals

Predictive conditionals are the general case. *'If $\mathcal{A}$'* means *'If and when $\mathcal{A}$'*; $\mathcal{A}$ is interpreted at times later than the speech time.

- Forward extension of a modal base:

  $R^* = R \circ \leq$, the composition of R with temporal precedence: iR^*j iff for some k, iRk and $k \leq j$.

(22) $$[\![\text{IF}]\!] = \lambda\Phi\lambda\zeta\lambda R\lambda i.\zeta(\lambda l\lambda m.lR^*m \wedge \Phi(m))(i)$$

- Consider the above example, now with R^*:

  $\lambda R\lambda i.\Box(\underline{\lambda j.iR^*j \wedge \mathcal{A}(j)})(\lambda j.\exists k[j \leq k \wedge \textsc{tom}_s(k) \wedge V(\textit{he arrive})(k)])$

- Let $\mathcal{A}$ be *'he leaves today'*, interpreted with respect to $\approx$.

  (23) If he leaves today, he arrives tomorrow.

> – With R^*, the reading is "predictive":
>
>   *'If it is settled (now or in the future) that he leaves today...'*
>
> – Intuitively: With R^*, the quantification ranges over a "rectangular area", rather than just a vertical line, in the world-time space.
>
> – But this domain is restricted by various elements:
>
>   * The Present tense in the antecedent restricts R^* to indices no earlier than speech time
>   * The adverbial restricts R^* to the day of speech time.

3 Discussion

3.1 Temporal interpretation

Let us simplify the picture by adopting a Reichenbachian caricature of the above account.

- S, R, E as usual;
- for indicative conditionals, there is an additional time S', the "perspective" from which antecedent and consequent are evaluated.
- In general: $S \leq S'$.
  non-predictive: $S = S'$
  predictive: $S < S'$

Past-in-the-future readings

Consequent:

(24) If I smile when I get out, the interview went well. [Crouch (1993)]

(25) Where a 45-win season would have seemed like a terrific accomplishment before the season began, now there's a feeling that if they don't win 55 games, something went wrong. [NYT 01/24/95]

Note that these examples show that the shift of perspective into the future cannot be attributed to the modal *'will'* in the consequent, along the lines of Abusch (1997, 1998); for there is no *'will'* in these examples.
Antecedent:

(26) If she arrived in the morning, she left the night before.

The (hypothetical) arrival may lie in the future from the perspective of S; it only has to be before S'.

Settledness readings with futurate antecedents

- The reference time of the antecedent may follow that of the consequent: $R_C < R_A$

  (27) If you leave tomorrow, I will give you call tonight.

  But in this case, the antecedent *must* receive a "scheduling" reading: *'We'll decide on your trip at today's meeting. If it is (then) decided that you leave tomorrow...'*

  - R_C is restricted to *'tonight'*
  - S' must be no later than R_C (due to the non-past in the consquent)
  - R_A must be no later than S' (due to the non-past in the antecedent)
  - R_A is restricted to *'tomorrow'*
  - ➡ R_A is later than S', which explains the scheduling reading.

- Such examples also motivate the decision to include the necessity (settledness) modal into the truth conditions for the Present tense
  - rather than treating it as a pragmatic side effect of asserting the sentence;
  - absent in conditional antecedents because they are not asserted.
  - The problem with this account: The antecedent automatically receives a scheduling reading whenever its reference time follow S'.

(28) a. If I come out smiling, the interview went well.
b. If I come out smiling, the interview goes well.
c. If I come out smiling, the interview will go well.

  - In (28a), S' may follow the interview; hence no scheduling reading.
  - In (28b,c), S' must not follow the interview (due to the non-past in the consequent); hence $S' < R_A$ and the antecedent receives a scheduling reading.
  - This would not fall out if the necessity modal were not built into the truth conditions of the antecedent.

Predictive '*will*' in the antecedent

Conditionals with predictive (non-volitional) '*will*' are plentiful:

(29) *If your nanny will need money in each of the next four years,* she should predict her annual cash flow and invest so that money will be available as required to pay tuition bills and other costs. [NYT 08/07/94]

(30) *If it will take 18 months to develop a product*—a software package or high-tech device, for example—the carrying costs would be too high to use plastic, Scullin said. [NYT 09/20/94]

(31) "I really said to God: 'I am willing to have an abortion. I don't think I'll ever get over it, but *if I won't be a great parent for a kid to be born to under current circumstances* maybe it's better if You recycle this one." [NYT 11/30/94]

(32) *If the delay will be up to 30 days*, the purchaser can cancel the order and *if it is more than 30 days*, the order is automatically canceled unless the consumer agrees to a longer delay. [WSJ 10/12/89]

(33) *If the worker will be running errands,* ask to see driver's license and proof of insurance. [NYT 08/08/94]

(34) *If you will be installing the hardware,* remember that the system will come unmonitored; hooking it up to a monitoring station can be difficult. [NYT 08/17/94]

(35) *If you will be teaching a course* in summer session 2002 or next academic year in which such a service might be useful, you are most welcome to contact me (as the administrator) to be enrolled. [university service announcement]

These can be paraphrased as *'If it is (or becomes) predictable (now or some future time) that . . . '*;
in line with my interpretation of '*will*' as a predictability modal.

A side note on '*will be V-ing*'

- For the antecedents of (29) through (32) '*will*' is perfectly acceptable.
- In contrast, (33) through (35) *require* the progressive; without it, their antecedents would be much less acceptable unless they receive a volitional interpretation:

(33') If the worker will run errands, ask to see driver's license and proof of insurance.

(34') If you will install the hardware, remember that the system will come unmonitored...

(35') If you will teach a course in summer session 2002 or next academic year in which such a service might be useful, remember to contact me...

- Leech (1971): "It is tempting to speculate that this usage has grown up through the need to have a way of referring to the future uncontaminated by factors of volition, plan, and intention which enter into the future meanings of '*will/shall*' + Infinitive, the Present Progressive, and *be going to* + Infinitive." (p. 62–63)
- Open questions:

  1. Which predicates are subject to such "contamination"?
     Aspectual properties? Agentive proto-roles in their argument structure?
  2. Why does the Progressive eliminate this reading?
  3. Why does the conditional antecedent makes the volitional reading, where it is available, more prominent than it is in isolation?
     Non-veridicality? Cf. (36) from Palmer (1979):

     (36) a. Will you come to the party? c. Will you be coming to the party?
          b. Shall I come to the party? d. Shall I be coming to the party?

     Similarly, it seems, for negation:

     (37) a. I/you/she won't come to the party.
          b. I/you/she won't be coming to the party.

     In each of these, the progressive prevents the modal from receiving a volitional reading. It's not clear to me why that is.

3.2 Modal interpretation

Modal bases

- Recall that the antecedent enters the derivation "fully modalized" — i.e., with their own modal force *and* modal base.
- This is unlike other accounts, such as Data Semantics (Veltman, 1986; Crouch, 1993), where *all* sentences are interpreted relative to $\sim$. Those accounts cannot adequately deal with examples like these:

  (38) a. If Reagon works for the KGB, I'll never believe it. [Lewis, 1986]
  b. If he will be alone on Christmas Day, he will let us know. [Leech, 1971]

  Here, the antecedent is be evaluated with respect to a modal base other than the speaker's beliefs.

Epistemic conditionals

Kaufmann (2005a) and others have called non-predictive conditionals like (39b) "epistemic."

(39) a. If he submits his paper to a journal, we won't include it in our book.
b. If he submitted his paper to a journal, we won't include it in our book.

What is the connection between non-predictive and epistemic readings?

- First, nothing prevents (39a) from being interpreted relative to an epistemic modal base

  $\Rightarrow$ predictive conditionals can be epistemic.

- However, non-predictive conditionals *have to* be epistemic for pragmatic reasons.
  - Suppose (39b), on its non-predictive reading, is evaluated against the "metaphysical" modal base $\approx$.
  - By historical necessity, the truth value of the antecedent is constant across all accessible worlds.
  - If the antecedent is true, the conditional is equivalent to its consequent.

    If the antecedent is false, the truth value of the conditional is undefined due to presupposition failure (or the conditional is vacuously true, depending on what is assumed about the consequences of quantifying universally over an empty domain).
  - Either way, interpreting a non-predictive conditional with respect to $\approx$ results in a degenerate reading.
- Hence the preference for epistemic readings. But this is really a modal side effect of their temporal interpretation.

4 Conclusion

- Fully compositional treatment of simple and conditional sentences
- Explanation of the range of available readings of indicative conditionals in terms of the interplay between modal and temporal semantic ingredients
- In particular: The Present tense is the antecedent receives it usual interpretation
- Some further issues:
  - What about counterfactuals?
    (How to interpret the apparently extraneous “layer of Past morphology”?)
  - What about root modals?
    (E.g., are deontic modals in the consequent embedded under wide-scope epistemic modals?)

5 Some derivations

(40) He left in the morning.

- $\varnothing(\textit{morning}(\textit{he leave}))(\textsc{past})(\approx)$
 $\lambda i.\Box(\lambda j.i \approx j)(\lambda j.\exists k[k < j \wedge \textsc{morn}(k) \wedge V(\textit{he leave})(k)])$
  - $\lambda i_3 \lambda j_3.i_3 \approx j_3$
  - $\varnothing(\textit{morning}(\textit{he leave}))(\textsc{past})$
 $\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\exists k[k < j \wedge \textsc{morn}(k) \wedge V(\textit{he leave})(k)])$
    - $\textsc{past}$
 $\lambda i_2 \lambda j_2.j_2 < i_2$
    - $\varnothing(\textit{morning}(\textit{he leave}))$
 $\lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\exists k[jTk \wedge \textsc{morn}(k) \wedge V(\textit{he leave})(k)])$
      - $\varnothing$
 $\lambda\varphi\lambda T\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\varphi(\lambda i_1.jTi_1))$
      - $\textit{morning}(\textit{he leave})$
 $\lambda x_1.\exists k[x_1(k) \wedge \textsc{morn}(k) \wedge V(\textit{he leave})(k)]$
        - $\textit{morning}$
 $\lambda\varphi\lambda x_1.\varphi(\lambda i_0.x_1(i_0) \wedge \textsc{morn}(i_0))$
        - $\textit{he leave}$
 $\lambda x_0.\exists k[x_0(k) \wedge V(\textit{he leave})(k)]$

(41) If he arrives in the evening, he left in the morning.

$$\textsc{if}(\mathcal{A})(\varnothing(\mathit{morning}(\mathit{he\ leave})))(\textsc{past})(\sim)$$
$$\lambda i.\Box(\lambda j.i \sim^{*} j \wedge [\![\mathcal{A}]\!](j))(\lambda j.\exists k[k < j \wedge \textsc{morn}(k) \wedge V(\mathit{he\ leave})(k)])$$

$$\sim$$

$$\textsc{if}(\mathcal{A})(\varnothing(\mathit{morning}(\mathit{he\ leave})))(\textsc{past})$$
$$\lambda R\lambda i.\Box(\lambda j.iR^{*}j \wedge [\![\mathcal{A}]\!](j))(\lambda j.\exists k[k < j \wedge \textsc{morn}(k) \wedge V(\mathit{he\ leave})(k)])$$

$$\textsc{if}(\mathcal{A})$$
$$\lambda\zeta\lambda R\lambda i.\zeta(\lambda j.iR^{*}j \wedge [\![\mathcal{A}]\!](j))(i)$$

$$\textsc{if}$$
$$\lambda\Phi\lambda\zeta\lambda R\lambda i.\zeta(\lambda j.iR^{*}j \wedge \Phi(j))(i)$$

$$\mathcal{A} = \varnothing(\mathit{evening}(\mathit{he\ arrive}))(\textsc{pres})$$
$$[\![\mathcal{A}]\!] = \lambda i.\Box(\lambda j.i \approx j)(\lambda j.\exists k[j \leq k \wedge \textsc{eve}(k) \wedge V(\mathit{he\ arrive})(k)])$$

$$\varnothing(\mathit{morning}(\mathit{he\ leave}))(\textsc{past})$$
$$\lambda R\lambda i.\Box(\lambda j.iRj)(\lambda j.\exists k[k < j \wedge \textsc{morn}(k) \wedge V(\mathit{he\ leave})(k)])$$

6 Appendix: Definitions

Definition 1 (T $\times$ W-frame—Thomason, 1984)
A $T \times W$-frame is a structure $\langle W, T, <, \approx\rangle$, where W and T are disjoint nonempty sets; $<$ is a transitive relation on T which is also irreflexive and linear; and $\approx$ is a relation in $T \times W \times W$ such that (i) for all $t \in T$, $\approx_t$ is an equivalence relation; (ii) for all $t, t' \in T$ and $w, w' \in W$, if $w \approx_t w'$ and $t' < t$ then $w \approx_{t'} w'$.

Definition 2
Given a $T \times W$-frame $\langle W, T, <, \approx\rangle$, let $I = W \times T$. The relations $<$ and $\approx$ are extended to $I \times I$ as follows:
a. $\langle w, t\rangle \approx \langle w', t'\rangle$ if and only if $w \approx_t w'$ and $t = t'$;
b. $\langle w, t\rangle < \langle w', t'\rangle$ if and only if $w = w'$ and $t < t'$.

Definition 3 (History model)
Let $\mathcal{A}$ be a set of propositional variables. A history model *for $\mathcal{A}$ is a structure $\mathcal{M} = \langle W, T, <, \approx, V\rangle$, where $\langle W, T, <, \approx\rangle$ is a $T \times W$-frame and $V : \mathcal{A} \mapsto (I \mapsto \{0, 1\})$ is a truth assignment for $\mathcal{A}$ such that for all $A \in \mathcal{A}$ and $i, j \in I$, if $i \approx j$ then $V(A)(i) = V(A)(j)$.*

Definition 4 (Historicity and lack of foreknowledge)
An accessibility relation R in $I \times I$ is
a. modal *if and only if $\langle w, t\rangle R\langle w', t'\rangle$ implies $t = t'$;*
b. temporal *if and only if $\langle w, t\rangle R\langle w', t'\rangle$ implies $w = w'$.*
A modal accessibility relation R
a. is historical *if and only if iRj and $i \approx k$ jointly imply kRj;*
b. lacks foreknowledge *if and only if iRj and $j \approx k$ jointly imply iRk.*

Definition 5 (Doxastic history)
Given a history model $\langle W, T, <, \approx, V\rangle$, a doxastic history *is a modal relation $\sim$ in $I \times I$ that is historical and lacks foreknowledge, and such that*
a. $\sim$ is transitive, serial and euclidean;[4]
b. if $i \sim j$, $i' < i$ and $j' < j$, then $i' \sim j'$.

Definition 6 (Modal base)
A modal accessibility relation $R \subseteq I \times I$ is a modal base *if and only if it is historical.*

Remark 1
For any accessibility relation R:
a. $\Box_{\approx}\Box_R\varphi \Longrightarrow \Box_R\varphi$;
b. $\Box_R\Box_{\approx}\varphi \Longrightarrow \Box_R\varphi$.

Remark 2
An accessibility relation R
a. is historical if and only if $\Box_R\varphi \Longrightarrow \Box_{\approx}\Box_R\varphi$;
b. lacks foreknowledge if and only if $\Box_R\varphi \Longrightarrow \Box_R\Box_{\approx}\varphi$.

Definition 7 (Presumption of decidedness)
A sentence φ is presumed decided *by an agent a at $i \in I$ if and only if $\Box_{\sim^a}(\varphi \to \Box_{\approx}\varphi)$ is true at i.*

[4] Transitive: if $i \sim j$ and $j \sim k$ then $i \sim k$. Serial: For all i there is a j such that $i \sim j$. Euclidean: if $i \sim j$ and $i \sim k$ then $j \sim k$. See Fagin et al. (1995); Stalnaker (2002).

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