

Abandoning Linear Time

On a Priorian model, the model is branching. The past and the present are tenses, while the future is a tense and a modal.

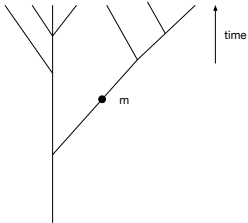


Figure: Branching time.

What the branching account gets right?

- In a unified manner, BT can account for the real, historical, past.
 - (1) I had coffee for breakfast.
- And also counterfactuals involving real past choices, a.k.a historical counterfactuals.
 - (2) I had coffee for breakfast, if I had had tea, it would have been better.

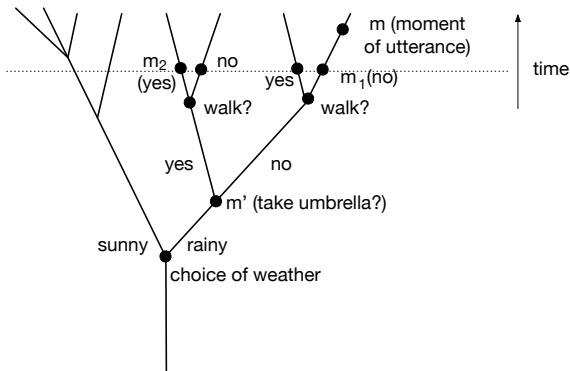
→ historical connectedness assumption is a virtue here – because, the examples involve before now choices or events.

What the branching account gets right?

After all, a counterfactual past could be something that was possible (open) in the real past, but did not actualise.

A tree-like representation of counterfactuals, supports the view that the past is fixed (and hence linear) while the future may be open (branching into multiple possible futures).

What the branching account gets right?



(3) If I had an umbrella yesterday, I would have gone for a walk in the rain.

What the branching account gets wrong?

- non-real epistemic possibilities
 (real counterfactuals, counterlegals, ...)
 - (4) If kangaroos had no tails, they would topple over. (Lewis 1973)
 - (5) If water froze at 7 degrees, we would have had more snow.
- Try to consider these examples, in light of the rationale above:
 “There is a line that takes one back . . . , there is an alternative branch that would then be taken” You can’t, can you?

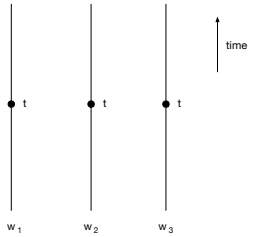
What the branching account gets wrong?

The problem here is that there is no reaching back in the linear past where it was possible that kangaroos had no tails, i.e. the issue whether there was a past choice does not arise.

→ BT fails because it relies on a notion of historical connectedness – i.e., historical connectedness is a vice here.

What the possible worlds gets right?

- To account for counterfactual conditionals that appeal to possibilities that were never open in the real world, the PW is the right way to go – as it goes against having one connected set of temporal courses of events (and in favor of several linear time lines).



What the possible worlds gets right?

- atemporal counterfactuals
- the kangaroo
- counterlegals
 - You can always hop to a different world, and say of that one that so and so is (would have been) the case.

What the possible worlds gets wrong?

- (6) Humphrey cares about whether he could have won the elections. (Kripke 1980)

→ Spatio-temporal separation gets the wrong results.

What the possible worlds gets wrong?

- The example is not about a counterpart of Humphrey – he couldn't care less about other guys who look like him.
- Humphrey_i in world w_1 cares that he_i could have won the elections, really. It is about Humphrey himself, his feelings, and the fact that an emotional reaction is warranted for what would have been the case *for him* in case he had won.
- This is not understandable on this model, in which a Humphrey-look alike wins the elections in the completely separate world w_2 .
 → PW approach mistakes the Humphrey case.

What the possible worlds gets wrong?

- It helps to think of this example within a connected past framework with an element of reality.
- The branching account does that well, because it helps here that the histories are predicted to intersect.
 - Distinct linear lines is not always justified, because it means that one would be losing the real possibilities in their specificity.
 - Another problem is the appeal to miracles (when intuitively we can appeal to choices).

What the possible worlds gets wrong?

- The open future: worlds contain full histories that reach well into the future – making each world individually deterministic.
- The branching account does that well – after all, this is what it was designed to do.

What both accounts don't get quite right?

Future conditionals

- (7) FNVs (non "subjunctive"): If they invade Laos tomorrow, they will . . .
- (8) FLVs (singly marked "subjunctive"): If they **were** to invade Laos tomorrow, they would . . .
- (9) FCF (doubly marked "subjunctive"): If they had invaded Laos tomorrow, instead of yesterday/ some other country, they would've . . .

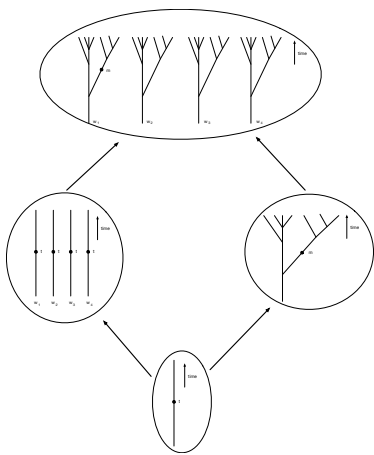
What both accounts don't get quite right?

Future conditionals

- The PW framework fails, even on accounts that take the contribution of past tense seriously (getting rid of miracles and defining similarity locally): (Arregui 2009)
- Relying on past similarity misses the counterfactuality inference of FLVs: since there are no de re facts about a future event, identifying the actual-world facts that matter is not possible.
- So here the possible worlds account mistakes what the future will be: disregarding a prominent reading of such examples where the speaker expresses something about self location with respect to a set of possible worlds.

Enter the forest

From linear time to the modal forest, in two steps: a commuting diagram.



Enter the forest

No matter whether one considers multiple possible worlds or branching histories to be the first step, one ends up with the same framework: a modal forest of trees of branching histories.

Enter the forest

- W is a set of possible worlds,
- the worlds each have a tree-like structure of possible histories, so that for each $w \in W$, \mathcal{M} contains a partial ordering $\langle M_w, <_w \rangle$ that is like a whole branching time model (left-linear and connected), and
- T is a set of clock times, which (for simplicity) we assume to be isomorphic for all histories in all worlds (usually, e.g., isomorphic to the real line).
- A context of use then specifies a world $w_C \in W$ and a moment $m_C \in M_{w_C}$ and, accordingly, a time t_C ; but again, there is no “history of the context”, as the future is open.

Examples & Illustrations

The first setting is familiar from historical “past choice” examples above. You are in a boring meeting, which you went to instead of staying home. In fact you had to run to the bus to campus in order to catch it, and you feel remorse:

(13) If I hadn't rushed for the bus, I wouldn't be in this boring meeting.

Examples & Illustrations

Out of boredom, you play with the plastic spoon that comes with the meeting coffee. It breaks and hurts your finger. Here you can utter the two counterfactuals:

(14) If I hadn't played with that spoon out of boredom, I wouldn't have hurt myself.

(15) If that spoon had been made out of metal, I wouldn't have hurt myself.

- These counterfactual sentences are based on very different facts.
- They can also be uttered in one breath; they can be connected by "and" into a single sentence.
- So for semantic evaluation one should expect a single semantic model to do the job.

Examples & Illustrations

- The metal sentence shows that the “past as past” approach fails for obvious reasons: never was there a moment at which the antecedent could have been true—you can trace the spoon through its whole history and it’s always made from plastic, no matter what happens to it (basically this is like the kangaroo case);
- while the “past as modal” approach cannot capture the fact that the broken plastic spoon sentence expresses that *you* feel remorse for what *you* did (basically, this is the point of the Humphrey example).

Examples & Illustrations

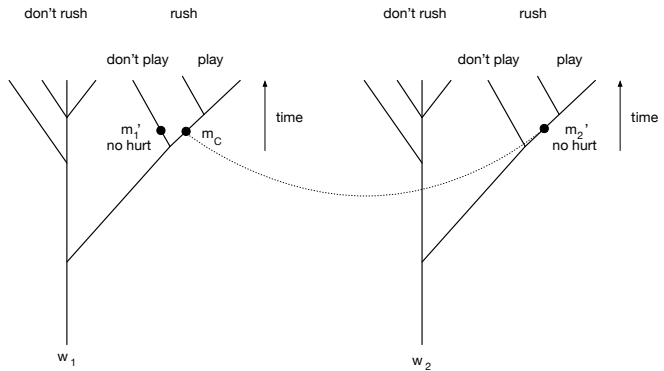


Figure: A tale of two spoons. The dotted line indicates “tree-hopping” accessibility from the actual moment of the context of utterance, m_C , in tree (world) w_1 , to a corresponding moment m_2' in world w_2 . In w_2 , the spoon is made of metal, which is not a real possibility given that it is actually made of plastic.

The past is unequal in the modal forest

The unequal index of the past (which allows hopping to a different moment or a different tree) is

- neither the $\langle w, t \rangle$ pair of the “worlds \times times” possible worlds approach,
- nor an m/h index of a single branching tree —
- rather, it is a triple $\langle w, m, h \rangle$,
- which we also write $\langle w, m/h \rangle$ to indicate the presupposition $m \in h$. (It is also presupposed that $h \subseteq w$ is a history in w ; thus, $m \in w$.)

Examples & Illustrations

(16) If I were in Mallorca now, ...

Three readings:

- I know I'm not in Mallorca, but was this ever a real possibility?
 - (a) Maybe it was a real possibility. Say I had the ticket, but decided to visit grandma at the hospital (in which case we are dealing with a different history, same world, i.e. same tree): here, $m_C \in h_1$ and $h_1 \neq h_2$.
 - (b) It was never a real possibility. I'm with grandma at the hospital (in world w_1) and Grandma and I are day dreaming (about a different world, i.e. different tree, say w_2): here $m_C \in w_1$ and $w_1 \neq w_2$.
- (c) I do not know whether that shore is Mallorca or Ibiza. Say my boat got lost in Mar Balear; it finally made it to a shore; I don't know which.

Examples & Illustrations

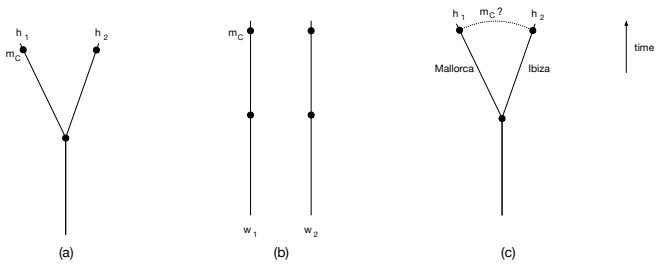


Figure: Three different models for being in Mallorca. (a) a real possibility; (b) in a different world; (c) uncertainty of self-location.

The epistemic dimension

What's noticeable in the above is that the speaker has access to the actual moment (m_C) in the first two readings, (a) and (b), but not in the third, (c), which expresses epistemic indistinguishability. Indeed, she knows she is at one specific moment. She just doesn't know which one it is. She therefore considers a set of options for m_C . These options correspond to moments on different histories, or even in different trees.

Examples & Illustrations

Note that what the speaker takes to be the set of options for m_C could also include an unreal possibility. She will be mistaken, a case of false belief, but from her epistemic standpoint, for example, she could think that she landed in Ibiza, Mallorca, or even Hawaii, which is not a real possibility!

Examples & Illustrations

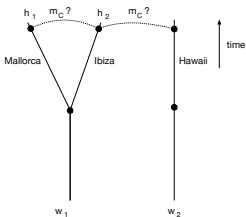


Figure: Mallorca, Ibiza or Hawaii?

The epistemic dimension

This illustrates that the speaker does not always have access to m_C , that is when she lacks information, but can still allow for certain possibilities that would be compatible with what she knows, or at least what she thinks she knows.

crucially, it also allows the speaker to express uncertainty with respect to a possibility without saying something counterfactual at all: but, simply *I don't know m_C* .

Examples & Illustrations

Similar examples are known in the literature under the label *conditionals as tests*:

- (17) I don't know if this pen is made of metal, but if it were, it would transmit heat. So, let's test.

Examples & Illustrations

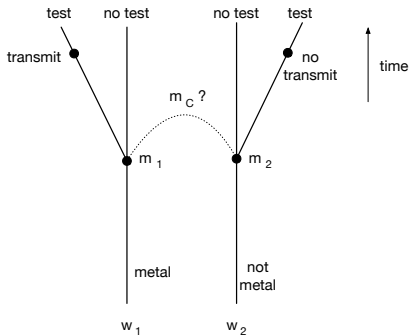


Figure: Is the pen made of metal? In w_1 it is, in w_2 it isn't, and the speaker is unsure which tree is actual one (she cannot distinguish between moments m_1 and m_2 , as indicated by the curved dotted line). Conducting the test reveals which it is: if the pen transmits heat, w_1 is actual; if not, w_2 . before testing the trees are indistinguishable

Examples & Illustrations

In terms of self location in a forest of trees: here the speaker considers the possibility of the pen being made of metal as epistemically indistinguishable from the possibility of the pen being not made of metal (equally likely, therefore also as equally unlikely).

The epistemic dimension

- That the phenomenon *conditionals as tests* fits well with the self-location representation that we can offer in our model is an advantage of the model showing its versatility.
- The speaker standing in the modal forest faces not just real possibilities in one tree, but more than one possible tree.
- The past indicates that the speaker lacks access to m_C .

The epistemic dimension

The problem of self location can extend to the past as well. There are things in the past that are objectively and metaphysically settled, but the speaker may simply not know how they turned out.

Examples & Illustrations

(18) I bought a lottery ticket last week. The numbers were drawn yesterday. I haven't checked, yet. I don't know how they turned out.

Once these numbers are drawn (whatever they are) the matter is closed – it can only be epistemically open for me: I may simply not know it. (Metaphysically settled, epistemically open)

Or, the speaker does not know as there is nothing yet to be known. (Metaphysically and epistemically open)

(19) I bought a lottery ticket last week. The drawing is tonight. I am excited how it will turn out.

Examples & Illustrations

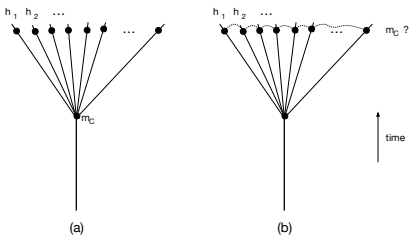


Figure: Two different lottery scenarios: **before the lottery:** different outcomes are possible; one has to **wait and see** which one is realised and **after the lottery**, the numbers are settled, but unaware of the real outcome, the different moments in the histories corresponding to the different possible outcomes are epistemically indistinguishable (indicated by curved dotted lines), but one of them is the actual one. Somebody else who has that information could **tell the speaker more** and help solve this problem of self-location.

The epistemic dimension

- Before the drawing, there is no uncertainty of self-location, only an open future – genuinely so.
- This type of uncertainty is a wait-and-see type: epistemic uncertainty w.r.t. a metaphysically unsettled possibility.

The epistemic dimension

What about the future?

- Isn't the fact that it is genuinely open enough to say that one would always speak of it with uncertainty?
- Fact is that for the purpose of living, language allows us to talk about the future (say when we make plans or predictions) with certainty.

The epistemic dimension

We now want to discuss what it means to be certain that the (metaphysically open) future is (epistemically) one way or another — genuine cases of open future: *an open future from a metaphysical perspective.*

The epistemic dimension

But first, note that metaphysically settled futures exist:

- (20) Said in Paris: (I know) there is no (real) future for me to physically make it to Berlin (through the available means of transport) in one hour.
- (21) We will all be dead in 200 years.
- (22) The moment a coin is tossed, it is metaphysically (mathematically) settled which way it will land, but most of us won't be able to tell until the outcome is visible.

Examples & Illustrations

There are states of affairs that are really open, but are, nonetheless, subjectively taken to be one way or another. We can choose to talk about them as if they are not (from an epistemic perspective). (Copley 2002 et seq., Kaufmann 2005, Karawani and Zeijlstra 2013)

- (23) (I'm certain) John will come to dinner at 8 pm.
 - (24) (I'm certain) John is going to come to dinner at 8 pm.
 - (25) (I'm certain) John comes at 8 pm.
- We speak with certainty of an open future.

Examples & Illustrations

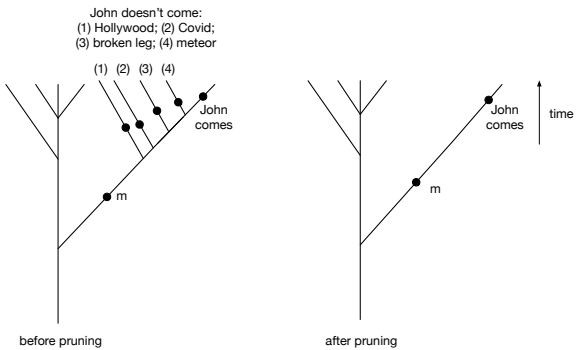


Figure: Illustrating pruning with respect to “John will come to dinner.” He still might not come of course, and we know this, but we have reason to disregard all unlikely possibilities that may intervene: e.g., Hollywood calling for an audition, catching Covid, breaking a leg, a meteor hitting, ... The tree on the right shows the effect of pruning: the only live possibility we consider is the one in which John comes.

The epistemic dimension: pruning

An operation we call *pruning*

- Pruning allows the speaker to make a claim about the *history*, by disregarding the complement possibility and pretending as if the outcome *p* is settled.
- Pruning allows the speaker to disregard certain possibilities to make a (really open) future event epistemically salient

The epistemic dimension: pruning

Formally, we can define pruning of a world (i.e., a branching tree) as the deletion of moments from the top (if you prune one moment, you have to prune all later moments as well, exactly as in pruning a real tree).

Definition (Pruning).

Let two worlds $w = \langle M, < \rangle$ and $w' = \langle M', <' \rangle$ be given. We say that w' is a *pruning* of w iff (i) $M' \subseteq M$ and (ii) for all $m \in M \setminus M'$, if $m' \in M$ and $m < m'$, then $m' \notin M'$, and (iii) $<'$ is the restriction of $<$ on M' . If additionally $M \neq M'$, we say that w' is a *proper pruning* of w .

Examples & Illustrations

Having introduced this tool, we can now also explain the use of past morphology as means to bring about the unlikelihood inference in conditionals: as in FLVs.

- (26) Candidate to journalist: I'm not going to lose, but if I were to lose, ...
(Karawani 2014)

- (27) If he took this syrup, he would get better, but I am certain that he will refuse to drink it when we ask him to do so.
(Iatridou 2000)

The example illustrates epistemic distancing via pruning a genuinely open future. The candidate has pruned the real possibility that he loses, but can still talk about what would be the case on that pruned branch. Same goes for the speaker in the syrup example, the speaker has pruned the real possibility that the sick person takes the syrup, but can still talk about what would be the case on that branch.

The epistemic dimension: unified via pruning

Futurates and FLVs receive a unified treatment. In both cases, the speaker has an opinion. In both cases, the unlikely branches are pruned. Futurates talk about the unpruned branch (just made salient) and express likelihood (or certainty). The past in FLVs refers to the pruned branch and express unlikelihood.

Examples and Illustrations

The inventory we have allows us to distinguish what has been called the contrast between a future reading of *will* and an epistemic reading *will* without abandoning the future semantics for *will* altogether. (contra, e.g., Klecha 2013, Giannakidou 2018).

- (28) It will be sunny tomorrow.
- (29) It will be the postman at the door.

On our account, however, we can distinguish them by saying that *It will be sunny* involves a pruned diagram making a history salient, *will* w.r.t. an open future makes a claim about the future; while *will* w.r.t. a settled present indicates the time when the uncertainty will be lifted.

Examples and Illustrations

- (30) That will be the postman at the door.
- (31) That would be the postman at the door.
- (32) That would have been the postman at the door.

If I hear the door bell ring and I don't know who it is, but I'm quite sure, I say: "This will be the postman – he always rings twice."

With one layer of past, I can say: "This would be the postman, but it is not 12 yet" – expressing more uncertainty.

With two layers of past, I can say something stronger: "This would have been the postman, but I know he's ill; I wonder who rang the bell."

→ The main observation is that epistemic uncertainty (w.r.t. it being the postman) is no longer possible with two layers of past.

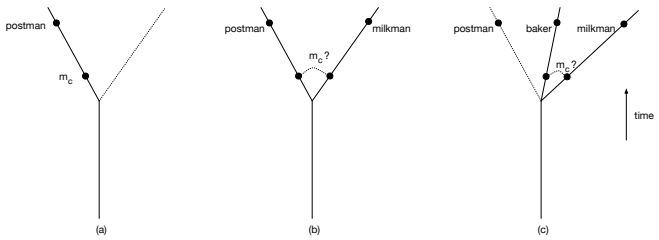


Figure: In (a), we have an interaction with the future (when will the uncertainty be resolved? I'm betting on m_C being “the postman is at the door”), the time of the discovery is in the realm of $m > m_C$. In (b), with one layer of past, m_C is still compatible with “the postman is at the door” but it is indistinguishable from other options in the realm of $m > m_C$ given my uncertainty; and in (c), with yet another layer of past (excluding “it is the postman” from the history – “it is the postman” is in the realm of $m > m_C$ but on a different history, one that is no longer accessible from m_C).

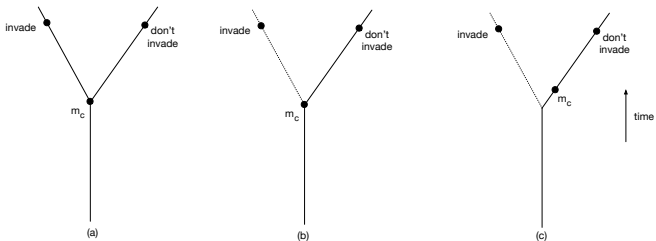


Figure: In (a), we have an indicative conditional, where both branches, “invade” and “not invade”, are compatible with m_C / open in the realm of $m > m_C$. In (b), with one layer of past, both “invade” and “not invade” are open on m_C , but from the perspective of the speaker, the “invasion” branch has been pruned. In (c), with yet another layer of past, from the perspective of the speaker, the “invasion” branch is excluded from the history – the possibility is at a time after the time of m_C , but on a different history, one that is no longer accessible from m_C .

What the fusion gets us?

- not just one tree, but a forest of trees, where each tree represents a world with real possibilities
- no historical connectedness; spatio temporal disconnect is allowed.
- no determinism
- represent “real” in-the-world possibility.
- A treatment for epistemic issues (e.g. uncertainty, epistemic indistinguishably, and the open future)
- An account of past stacking as a function of distance from m_C .

This Talk: A real fusion of both accounts

- One can emulate the possible world via branching – which is what proponents of the *past as tense* camp do – “a history is a world”
- One can emulate the branching via possible worlds – which is what the proponents of the *past as modal* camp do – “bundling”
- But, that ends up mixing virtues with vice.
- A real fusion which introduces a forest of branching trees, **getting rid of historical connectedness** and allowing for the representation of **real in-the-world possibility**.

