

Challenges for Existing Theories of Conditionals

Conditionals: Meaning and Applications

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1 Challenges

- Challenges to the intuitive idea of similarity
- Strengthening with a possibility
- Reciprocity
- Static counterexamples to Reciprocity
- Substitution

2 Causal Sufficiency

- Sufficiency in causal claims
- Reciprocity and Conjunctive Sufficiency

3 An aboutness approach to counterfactuals

- Invalidating substitution
- Invalidating conjunctive sufficiency

Kratzer derives the ordering source from a set of propositions

$$w' \leq_{g(w)} w'' \quad \equiv \quad \forall p \in g(w) : w'' \in p \rightarrow w' \in p$$

Example

Illustration: p and q are true at w .

Consider: “if p were false, q would still be true”

$$g_1(w) = \{p, q\}$$

$$g_2(w) = \{p \cap q\}$$

There is an intuitive and appealing way of thinking about the truthconditions for counterfactuals. It is an analysis that, in my heart of hearts, I have always believed to be correct...

A “would”-counterfactual is true in a world w iff every way of adding propositions that are true in w to the antecedent while preserving consistency reaches a point where the resulting set of propositions logically implies the consequent.

— Angelika Kratzer (2012, p. 127)

Definition (Admissible base set)

Let S be the set of situations (i.e. sets of parts of possible worlds). For any world w , an *admissible Base Set* is a subset F_w of $P(S)$ satisfying:

- ① Truth: Every proposition in F_w is true at w : $w \in \bigcap F_w$.
- ② Persistence: All proposition in F_w is persistent (for all $p \in F_w$ and situations s, s' , if $s \in p$ and s is part of s' , then $s' \in p$).
- ③ Cognitive Viability: All $p \in F_w$ are cognitively viable.
- ④ Non-Redundancy: F_w is not redundant (it does not contain propositions p and q such that $p \neq q$ and $p \cap W \subseteq q \cap W$).
- ⑤ Completeness: $\bigcap F_w$ contains all and only worlds that are indistinguishable from w , given the grain set by Cognitive Viability.

Define that proposition p *lumps* proposition q at world w just in case for any situation that is part of w in which p is true, q is true.

Kratzer's semantics of *would*-conditionals

Given an admissible base set and a proposition p , Kratzer defines the *crucial set* $F_{w,p}$ as follows.

Definition (The crucial set)

For any world w , admissible base set F_w , and proposition p , $F_{w,p}$ is the set of all subsets A of $F_w \cup \{p\}$ satisfying the following conditions:

- 1 A is consistent
- 2 $p \in A$
- 3 A is closed under lumping: for all $q \in A$ and $r \in F_w$: if q lumps r in w , then $r \in A$.

Definition (Truth conditions of “would”-counterfactuals)

Given a world w and an admissible Base Set F_w , a “would”-counterfactual with antecedent p and consequent q is true in w iff for every set in $F_{w,p}$ there is a superset in $F_{w,p}$ that logically implies q .

Angelika and the Zebra

Last year, a zebra escaped from the Hamburg zoo. The escape was made possible by a forgetful keeper who forgot to close the door of a compound containing zebras, giraffes, and gazelles. A zebra felt like escaping and took off. The other animals preferred to stay in captivity. Suppose now counterfactually that some other animal had escaped instead. Would it be another zebra? Not necessarily. I think it might have been a giraffe or a gazelle.

(Kratzer 1989, p. 625)



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Yet if the similarity theory of counterfactuals were correct, we would expect that, everything else being equal, similarity with the animal that actually escaped should play a role in evaluating this particular piece of counterfactual reasoning. Given that all animals in the compound under consideration had an equal chance of escaping, the most similar worlds to our world in which a different animal escaped are likely to be worlds in which another zebra escaped. That is, on the similarity approach, the counterfactual expressed by [(1)] should be false in our world.

- (1) *If a different animal had escaped instead, it might have been a gazelle.*

(Kratzer 1989, p. 625)

How lumping helps in the zebra case

We have to build the premise sets

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- We must add the antecedent "a different animal escaped instead"
- If we added "a zebra escaped" we would have to add "John escaped", by closure under lumping

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- If we added "a zebra escaped" we would have to add "John escaped", by closure under lumping
- But then the set contains both "John escaped" and "if a different animal had escaped instead". But this is **inconsistent!**

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- Let's call the zebra that escaped "John"
- In the actual world, "a zebra escaped" lumps "John escaped"
- Every situation in the actual world where "a zebra escaped" is true is one where "John escaped" is true
- We must add the antecedent "a different animal escaped instead"
- If we added "a zebra escaped" we would have to add "John escaped", by closure under lumping
- But then the set contains both "John escaped" and "if a different animal had escaped instead". But this is **inconsistent!**
- $\therefore$ we cannot add "a zebra escaped" to the premise set

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Fine's Nixon example

Lewis (1973): the similarity order represents **overall** similarity, measuring similarity across the world as a whole.

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The counterfactual 'If Nixon had pressed the button there would have been a nuclear holocaust' is true or can be imagined to be so. Now suppose that there never will be a nuclear holocaust. Then that counterfactual is, on Lewis' analysis, very likely false. For given any world in which antecedent and consequent are both true it will be easy to imagine a closer world in which the antecedent is true but the consequent false. For we need only imagine a change that prevents the holocaust but that does not require such a great divergence from reality.

(Fine 1975, p. 452)

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Lewis (1973): the similarity order represents **overall** similarity, measuring similarity across the world as a whole.

The counterfactual 'If Nixon had pressed the button there would have been a nuclear holocaust' is true or can be imagined to be so. Now suppose that there never will be a nuclear holocaust. Then that counterfactual is, on Lewis' analysis, very likely false. For given any world in which antecedent and consequent are both true it will be easy to imagine a closer world in which the antecedent is true but the consequent false. For we need only imagine a change that prevents the holocaust but that does not require such a great divergence from reality.

(Fine 1975, p. 452)

Some respond with a **time-dependent** notion of similarity (Bennett 1984, 2003, Arregui 2005, Ippolito 2013, Khoo 2017)

Lewis (1979) tries to derive the asymmetry of time from the asymmetry of counterfactual dependence: later affairs depend counterfactually on earlier ones, not vice versa

Elga (2001) argues that this proposal fails from the perspective of statistical mechanics

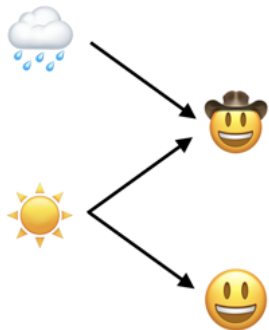
Tichý's (1976) puzzle

In bad weather, Jones always takes his hat.

In fine weather, there's a 50:50 chance Jones takes his hat.

Actual context: The weather is bad and Jones is wearing his hat.

- (2) If the weather had been fine, Jones would have been wearing his hat.



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Strengthening with a Possibility (aka rational monotonicity):

$$\frac{A > C \quad A \Diamond \rightarrow B}{(A \wedge B) > C}$$

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On Lewis's ordering semantics,
it corresponds to the order being **almost connected**.

$\leq_w$ is *almost connected* just in case for all worlds w, x, y, z ,

if $x <_w z$ then $x <_w y$ or $y <_w z$

where $<_w$ is the strict version of $\leq_w$:

$x <_w y$ just in case $x \leq_w y$ but not $y \leq_w x$

Counterexample to strengthening with a possibility

A counterexample was given by Ginsberg (1986, p. 50).

Here is one from Boylan and Schultheis (2017, 2021):

Alice, Billy, and Carol are playing a simple game of dice. Anyone who gets an odd number wins \$10; anyone who gets even loses \$10. The die rolls are, of course, independent. What Alice rolls has no effect on what Billy rolls and vice versa. Likewise for Alice and Carol as well as for Billy and Carol. Each player throws their dice. Alice gets odd; Billy gets even; Carol gets odd.

- (3)
 - a. If Alice and Billy had thrown the same type of number, at least one person would still have won \$10.
 - b. If Alice and Billy had thrown the same type of number, Alice, Billy, and Carol could have all thrown the same type of number.
 - c. If Alice, Billy, and Carol had all thrown the same type of number, at least one person would still have won \$10.

A perhaps clearer variant of the counterexample

There are three switches, A, B, and C, connected to a light. Each switch can be up or down. The light is on just in case A and B are in the same position and C is down. Currently, A is down, B is up, and C is down.

- (4) If A and B were in the same position, the light would be on.
- (5) If A and B were in the same position, A, B and C might be in the same position.
- (6) If A, B and C were in the same position, the light would be on.

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Reciprocity (a.k.a. CSO)

$$\frac{A > B \quad B > A \quad B > C}{A > C} \text{ Reciprocity}$$

Lewis's semantics validates Reciprocity

Proof.

For any world w and sentence A , let $w \models A$ denote that A is true at w . Pick any world w and suppose $A > B$, $B > A$ and $B > C$ are true at w . To show that $A > C$ is true at w , pick any $x \models A$. We have to show that there is a $y \models A$ such that $y \leq_w x$ and for all $z \leq_w y$, $z \models A \rightarrow C$, where $\rightarrow$ is the material conditional.

Since $w \models A > B$ and $x \models A$, there is a $v \models A$ such that $v \leq_w x$ and (i) for all $v' \leq_w v$, $v' \models A \rightarrow B$. Since $\leq_w$ is reflexive, $v \leq_w v$, so $v \models A \rightarrow B$. Thus $v \models B$.

Since $w \models B > A$ and $v \models B$, there is a $u \models B$ such that $u \leq_w v$ and (ii) for all $u' \leq_w u$, $u' \models B \rightarrow A$. Since $w \models B > C$ and $u \models B$, there is a $y \models B$ such that $y \leq_w u$ and (iii) for all $z \leq_w y$, $z \models B \rightarrow C$. Since $y \leq_w u$, by (ii), $y \models B \rightarrow A$. Then as $y \models B$, $y \models A$. And as $y \leq_w u \leq_w v \leq_w x$, by transitivity of $\leq_w$, $y \leq_w x$.

We show that $z \models A \rightarrow C$ for all $z \leq_w y$. Pick any $z \leq_w y$. Then $z \leq_w y \leq_w u \leq_w v$, so by transitivity of $\leq_w$, $z \leq_w v$. Then by (i), $z \models A \rightarrow B$. And since $z \leq_w y$, by (iii), $z \models B \rightarrow C$. Hence $z \models A \rightarrow C$. □

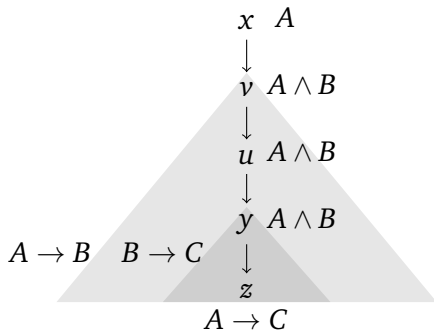


Figure: Illustrating the proof that Reciprocity is valid on Lewis's semantics.

Bacon's counterexample (Bacon 2013)



Figure: Bacon's counterexample to reciprocity.

- (7)
- a. If A fell, B would fall.
 - b. If B fell, A would fall.
 - c. If A fell, the light would turn green.
 - d. If B fell, the light would turn red.

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Figure: Bacon's counterexample to reciprocity.

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 - a. If A fell, B would fall.
 - b. If B fell, A would fall.
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- (8)
 - a. If A had fallen, B would have fallen.
 - b. If B had fallen, A would have fallen.
 - c. If A had fallen, the light would have turned green.
 - d. If B had fallen, the light would have turned red.

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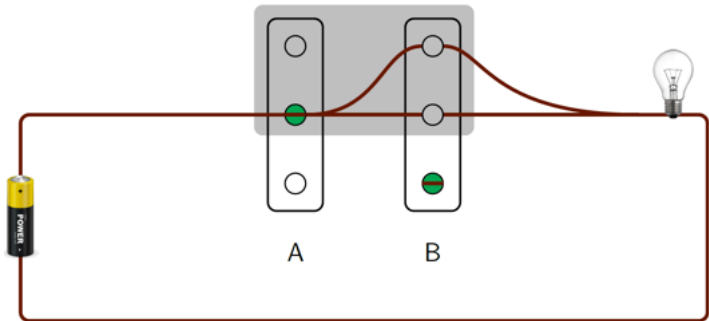
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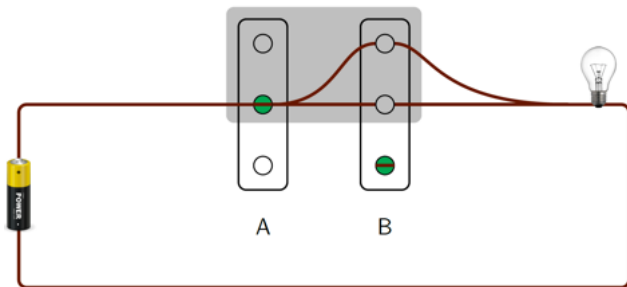
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New experimental evidence against Reciprocity



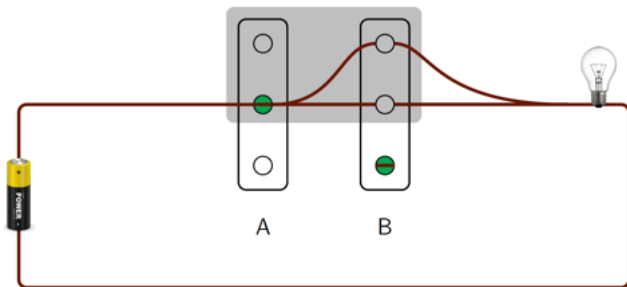
- There are two switches, A and B, are connected to a light.
- Each switch can be up, in the middle, or down.
- The light is on just in case A is in the middle and B is up or in the middle.
- A is in the middle and B is down, so the light is off.

Premise 1



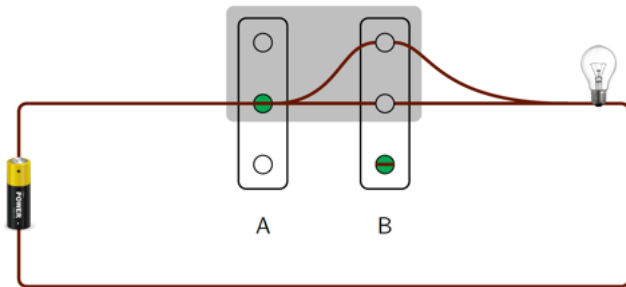
If switch B were in the shaded area,
both switches would be in the shaded area.

Premise 2



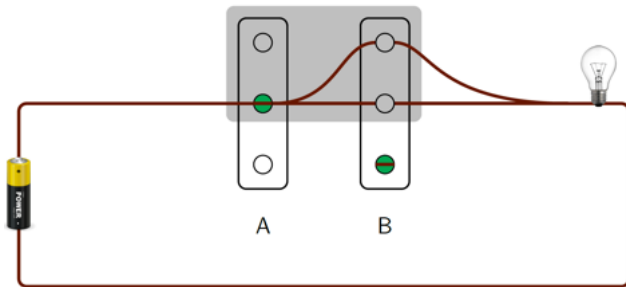
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Premise 3



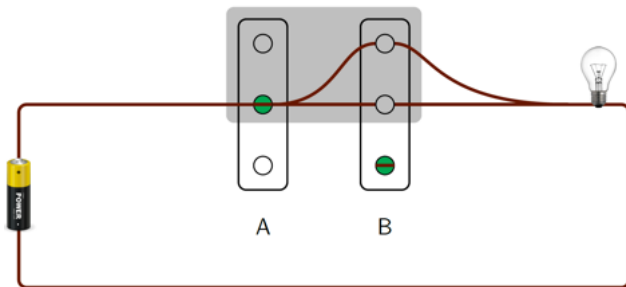
If switch B were in the shaded area,
the light would be on.

Conclusion



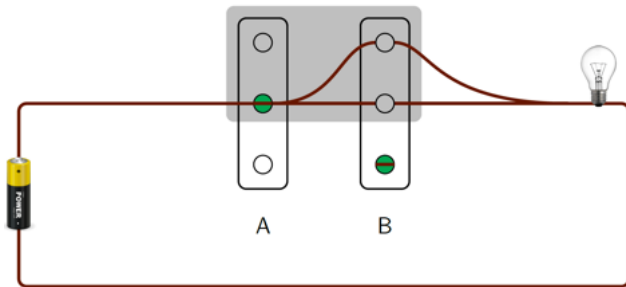
If both switches were in the shaded area, the light would be on.

True control

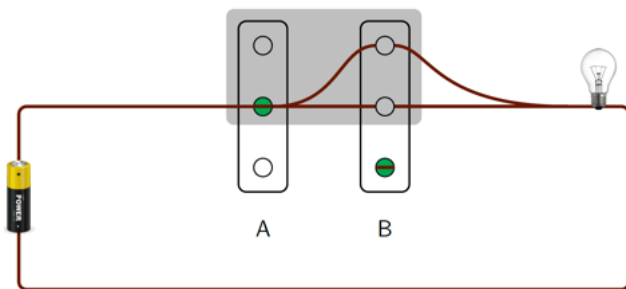


If both switches were in the shaded area, switch B would be in the shaded area.

False control



If both switches were outside the shaded area, the light would be on.



- T If both switches were in the middle, the light would be on.
- P1 If switch B were in the shaded area, both switches would be in the shaded area. $B > both$
- P2 If both switches were in the shaded area, switch B would be in the shaded area. $both > B$
- P3 If switch B were in the shaded area, the light would be on. $B > on$
- C If both switches were in the shaded area, the light would be on. $both > on$
- F If both switches were outside the shaded area, the light would be on.

Experimental design

- 80 native English speakers, recruited via Prolific
- Three sentence-picture verification tasks
- Following Romoli, Santorio, and Wittenberg (2022), for each sentence we asked whether it is true, false, or indeterminate.
 - If indeterminate: follow up whether they strongly feel that there is no correct answer or just do not know
 - We excluded the latter responses from the analysis.
- Participants understood the scenarios well
 - Mean accuracy of 89% on the filler items
 - Excluded from the statistical analysis two participants whose error rates on the fillers were above 30%.

Experiment available at

https://www.tklochowicz.com/experiment_reciprocity

Results

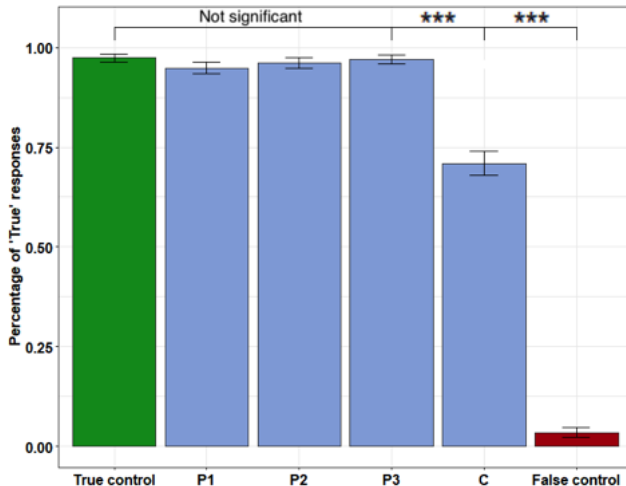


Figure: Percentage of “True” responses. Error bars denote Standard Errors.

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Substitution

$$\frac{A \models B \quad B \models A}{(A > C) \leftrightarrow (B > C)} \text{ Substitution}$$

If A and B are logically equivalent, they are substitutable salva veritate in conditional antecedents.

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$$\frac{A \models B}{A > B} \text{ Entailment}$$

Given Entailment, Reciprocity implies Substitution.

$$\frac{\frac{A \models B}{A > B} \quad \frac{B \models A}{B > A}}{(A > C) \leftrightarrow (B > C)} \text{ Reciprocity}$$

Infinitely many: a counterexample to Substitution

From Fine (2014, p. 328): There is one poison apple and infinitely many safe apples.



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- (10) If Eve ate infinitely many of the apples, she would be fine.

Infinitely many: a counterexample to Substitution

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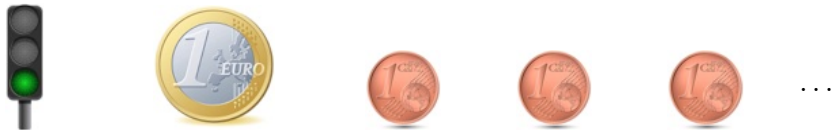
The antecedents are logically equivalent.

Eve eats infinitely many of the green apples just in case she eats infinitely many of the apples.

Infinitely many: a counterexample to substitution

From Goodsell (2022):

There is a 1 Euro coin and infinitely many pennies, all facing tails. The light is green just in case the 1 Euro coin is facing tails.



- (11) If infinitely many of the coins were facing heads, the light would still be green.
- (12) If infinitely many of the pennies were facing heads, the light would still be green.

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The need for sufficiency

- (13)
 - a. Sue was allowed into the bar because she's over 21.
 - b. Sue was allowed into the bar because she's over 16.
- (14)
 - a. The fact that Sue is over 21 caused the bouncer to let her in.
 - b. The fact that Sue is over 16 caused the bouncer to let her in.



The need for sufficiency

(15) *The radio spontaneously starts playing music.*

A: Why did the radio turn on?

B: I have no idea. I didn't touch it.

A: I see it's plugged in, and it needs to be plugged in to turn on.

B: Right, but I still have no idea why it started playing.



The need for sufficiency with reasons

Sami and Jan are fun on their own, but always fight when together. A heard that they are both attending a party and therefore decides to skip it.

- (16) a. I'm skipping the party for two reasons: because Sami is going and because Jan is going.
- b. I'm skipping the party for one reason: because Sami and Jan are going.

- (17) a. The reasons why I'm skipping the party are that Sami is going and that Jan is going.
- b. The reason why I'm skipping the party is that Sami and Jan are going.

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- (17) a. The reasons why I'm skipping the party are that Sami is going and that Jan is going.
- b. The reason why I'm skipping the party is that Sami and Jan are going.

My intuitive judgement: the (a)-sentences are odd, the (b)-sentences are fine.

The need for sufficiency with reasons

Sami and Jan are each miserable people. Even one of them going to a party is enough to make it a dull event.

- (18) a. I'm skipping the party for two reasons: because Sami is going and because Jan is going.
 b. I'm skipping the party for one reason: because Sami and Jan are going.
- (19) a. The reasons I'm skipping the party are that Sami is going and that Jan is going.
 b. The reason I'm skipping the party is that Sami and Jan are going.

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 b. The reason I'm skipping the party is that Sami and Jan are going.

My intuitive judgement: the (a)- and (b)-sentences are both fine.

The sufficiency requirement

- $E \text{ because } C \Rightarrow C \text{ is sufficient for } E.$
- $C \text{ cause } E \Rightarrow C \text{ is sufficient for } E.$

What does it mean for C to be sufficient for E ?

Sufficiency is not logical entailment

- (20) a. My laptop turned on because I pushed the power button.
 b. Pushing the power button caused the laptop to turn on.

⇒ In every **logically possible world** where I push the power button, the laptop turns on.

These are assertable even though there is a logically possible world where the laptop's battery is empty.

Is C sufficient for E just in case *if C would E is true?*

Problem

Many existing semantics of conditionals validate conjunctive sufficiency, predicting that C and E together entail *if C would E .*

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Reciprocity implies conjunctive sufficiency

$$\frac{A > B \quad B > A \quad B > C}{A > C} \text{ Reciprocity}$$

$$\frac{A \wedge B}{A > C} \text{ Conjunctive Sufficiency}$$

Walters and Williams (2013) show that, under mild assumptions, reciprocity also ensures that $A \wedge C$ implies $A > C$.

Consider any true A , C , and any B that is irrelevant to A and C , in the sense that $(B \vee \neg B) > A$ and $(B \vee \neg B) > C$ hold.

$$\frac{A > (B \vee \neg B) \quad (B \vee \neg B) > A \quad (B \vee \neg B) > C}{A > C} \text{ Reciprocity}$$

Given the existence of such a B , Reciprocity tells us that $A \wedge C$ implies $A > C$.

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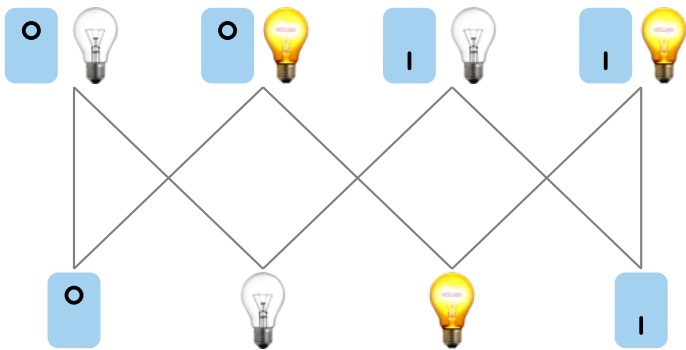


Figure: A state space of the switch and light.

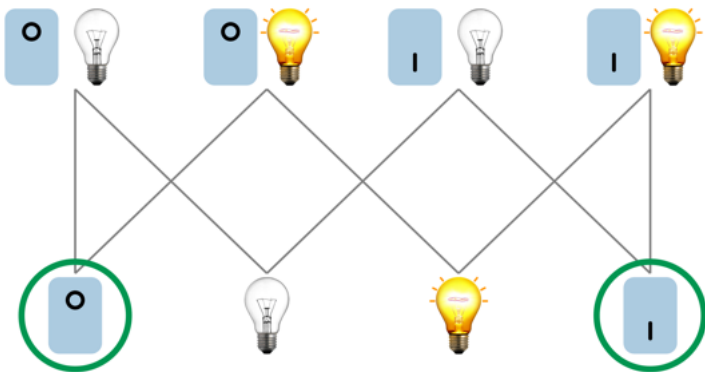


Figure: The states that “the switch is up” is about.

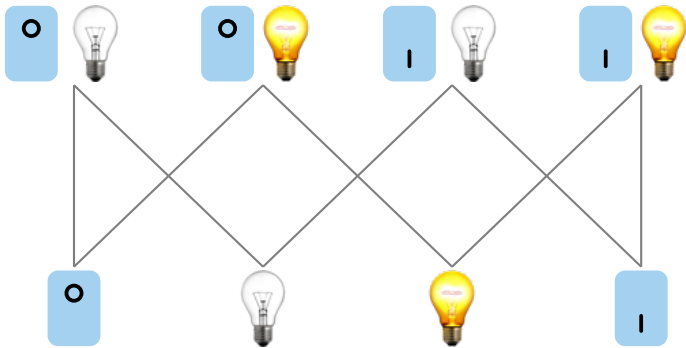
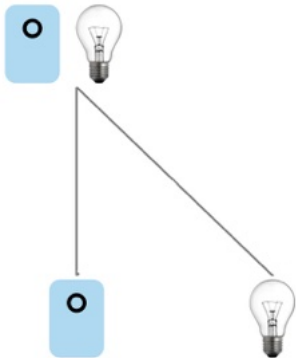
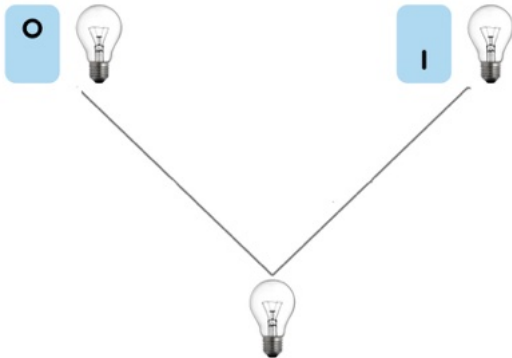


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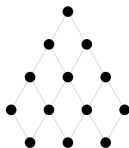
Analysis of aboutness: a sentence is about the parts of the world that exactly determine its truth value (McHugh 2023, p. 108).

- **The foreground:** the set of states A is about.
- **The background:** the set of states that do not **overlap** a state in the foreground.

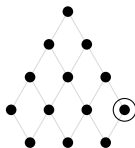
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Ceteris paribus

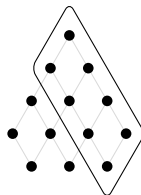
- The background is the *ceteris*, the ‘all else’ in ‘all else being equal’
- *Paribus* means having the *ceteris* as part



A world w
at a moment in time t



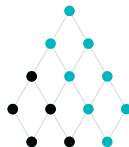
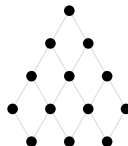
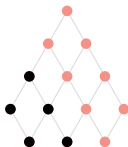
States A is about



Parts of w at t overlapping
a state A is about



Background of A



A -variants of w at t

Figure: Steps to construct the A -variants of a world at a moment in time.

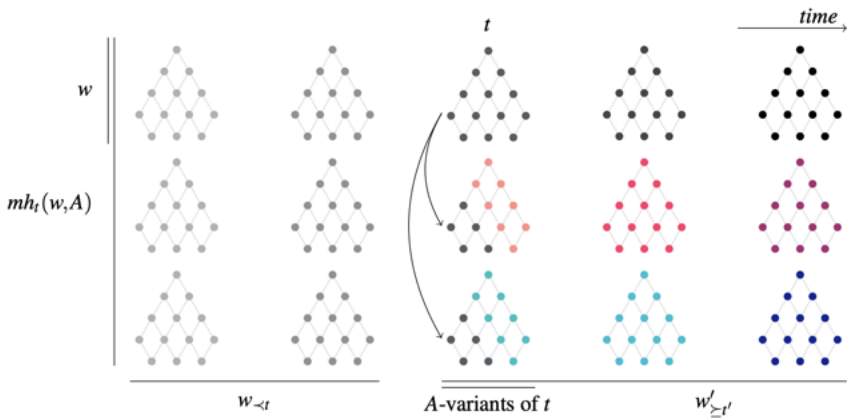


Figure: Constructing the modal horizon.

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Infinitely many: a counterexample to Substitution

From Fine (2014, p. 328): There is one poison apple and infinitely many safe apples.



- (21) If Eve ate infinitely many of the green apples, she would be fine.
- (22) If Eve ate infinitely many of the apples, she would be fine.

Infinitely many: a counterexample to Substitution

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The need for sufficiency

Suppose Sue is 30.

- (23)
 - a. Sue was allowed into the bar because she's over 21.
 - b. Sue was allowed into the bar because she's over 16.
- (24)
 - a. The fact that Sue is over 21 caused the bouncer to let her in.
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- We vary Sue's age.
- Restrict to those where she is over 21 and 16, respectively.
- This gives us the diverse ways for Sue to be over 16 (17, 18, ...) **beyond merely the actual way in which she is over 16** (being her actual age)

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