Conditionals: between language and reasoning

Class 5 - Limit assumption and conditional excluded middle

May 20, 2019

Relative similarity ordering

$v \leq_w u \iff \forall S \in \mathbb{S}(w) : u \in S$ implies $v \in S$

Closest φ-worlds

$\min_w(\varphi) = \{v \in \bigcup \mathbb{S}(w) \mid v \in |\varphi|$ and there is no $u \in |\varphi|$ such that $u <_w v\}$

Limit assumption

for any w and φ entertainable at w: $\min_w(\varphi) \neq \emptyset$

Uniqueness assumption

for any w and φ entertainable at w: $\min_w(\varphi)$ is a singleton

Part I

The Limit Assumption

- The limit assumption is the assumption that, if φ is entertainable, there are always some closest φ-worlds.

- This allows us to present Lewis's theory as a selection function theory:

$$w \Vdash \varphi \mathrel{\Box\!\!\rightarrow} \psi \iff \mathrm{min}_w(\varphi) \subseteq |\psi|$$

- Are there reasons for thinking that this assumption must hold?

- Are there reasons to think that the assumption cannot in general hold?

Lewis on the limit assumption

(1) If this line was more than a meter long, . . .

- Among the worlds where this is true, we find:
  - w_2: line is 2m long
  - $w_{1.1}$: line is 1.1m long
  - $w_{1.01}$: line is 1.01m long
  - $w_{1.001}$: line is 1.001m long
  - . . .
- Presumably, these count as more and more similar to our own world.
- There's no minimal length $>$1m, so no closest world where (1) is true.
- So, the limit assumption is violated.

Lewis's attempt

(2) If this line was more than a meter long, . . .

- Among the worlds where this is true, we find some where the line is
  - w_2: line is 2m long
  - $w_{1.1}$: line is 1.1m long
  - $w_{1.01}$: line is 1.01m long
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- Presumably, these count as more and more similar to our own world.
- But do they?

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  - $w_{1.001}$: line is 1.001m long
  - ...
- Presumably, these count as more and more similar to our own world.
- But do they?
- If the notion of "similarity" which matters for counterfactuals is the intuitive one, definitely. But we'll see that this assumption is untenable.

- In fact, assuming the intuitive ordering in the line example leads to paradoxical conclusions about counterfactuals.

(3) If this line was more than 1m long, ...

- With that ordering, the following sentences would all be true:

(4) ...it would be more than 1m long.

(5) a. ...it would be less than 2m long.
b. ...it would be less than 1.1m long.
c. ...it would be less than 1.01m long.
d. ...

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- The line would be longer than 1m, but shorter than $1+\varepsilon$ m for each $\varepsilon > 0$.

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- The line would be longer than 1m, but shorter than 1+ε m for each $\varepsilon > 0$.

- But this is impossible!

- These are not the right predictions about this case, so the intuitive similarity ordering cannot be the right one.

This problem can be turned into a general argument for the limit assumption. To see how, consider the following desideratum.

Counterfactual Consistency Condition (Herzberger 79):
the counterfactual consequences of an entertainable supposition must form a consistent set.

> *All the things that would have been true if Bizet and Verdi had been compatriots should form a coherent if somewhat sparse picture of a possible state of affairs.* *(Herzberger 79)*

Let's make this formally precise.

- Let's refer to a set of possible worlds p as a proposition.
- $w \Vdash p \iff w \in p$.
- p is an entertainable supposition at w iff p overlaps a sphere around w
- Given propositions p, q, let $p \mathrel{\Box\!\!\rightarrow} q$ be the proposition given by:

$$w \Vdash p \mathrel{\Box\!\!\rightarrow} q \iff p \text{ is not entert. at } w \text{ or } \min_w(p) \subseteq q$$

- q is a counterfactual consequence of p at $w \iff w \Vdash p \mathrel{\Box\!\!\rightarrow} q$
- Let $\mathrm{Cn}_w(p)$ be the set of counterfactual consequences of p at w:

$$\mathrm{Cn}_w(p) = \{q \mid w \Vdash p \mathrel{\Box\!\!\rightarrow} q\}$$

Counterfactual Consistency

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Proof:

- Suppose the limit assumption fails at w.
- Then around w there is an infinite descending chain of spheres $S_1 \supset S_2 \supset S_3 \supset \ldots$. Let $S = \bigcap_{i \in \mathbb{N}} S_i$.
- $w \Vdash \neg S \,\Box\!\!\rightarrow \neg S$, but for each $i \in \mathbb{N}$, $w \Vdash \neg S \,\Box\!\!\rightarrow S_i$
- $\text{Cn}_w(\neg S) \supseteq \{\neg S\} \cup \{S_i \mid i \in \mathbb{N}\}$.
- $\text{Cn}_w(\neg S)$ is inconsistent: if all the S_i are true, then S is true.
- Thus, counterfactual consistency fails.

The Limit Assumption is needed to guarantee that an entertainable assumption leads to a coherent picture of the world.

For more discussion on the limit assumption see:
Pollock 1976, 1984, Lewis 1981, Warmbrod 1982, Kaufmann 2017

Part II

The Uniqueness Assumption

Stalnaker's theory

Stalnaker's theory of counterfactuals can be presented as Lewis's theory under the uniqueness assumption: if φ entertainable at w, $\min_w(\varphi)$ is a singleton.

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World selection function

If φ is entertainable at w, let $F(w, \varphi)$ denote the unique element of $\min_w(\varphi)$. Then the truth-conditions for counterfactuals can be presented as follows:

$$w \Vdash \varphi \mathrel{\Box\!\!\rightarrow} \psi \iff \text{(i) } \varphi \text{ not entertainable at } w \text{ or (ii) } F(w, \varphi) \Vdash \psi$$

F is called the world selection function.

Note: unlike the set selection function $f(w, \varphi) = \min_w(\varphi)$, defined in all sphere models, a world selection function F is defined only in Stalnakerian models, i.e., sphere models where the uniqueness assumption is met.

Negation as opposite

If φ is entertainable at w, then $w \Vdash \neg(\varphi \Box\!\!\rightarrow \psi) \iff w \Vdash \varphi \Box\!\!\rightarrow \neg\psi$.

Proof

For φ entertainable at w the truth-conditions for counterfactuals become:

$$w \Vdash \varphi \Box\!\!\rightarrow \psi \iff F(w, \varphi) \Vdash \psi$$

Using this, we have:

$$\begin{aligned} w \Vdash \neg(\varphi \Box\!\!\rightarrow \psi) &\iff w \nVdash \varphi \Box\!\!\rightarrow \psi \\ &\iff F(w, \varphi) \nVdash \psi \\ &\iff F(w, \varphi) \Vdash \neg\psi \\ &\iff w \Vdash \varphi \Box\!\!\rightarrow \neg\psi \end{aligned}$$

Conditional excluded middle

All instances of the following schema are valid in Stalnakerian models:

$$(\varphi \mathrel{\Box\!\!\rightarrow} \psi) \vee (\varphi \mathrel{\Box\!\!\rightarrow} \neg\psi)$$

Proof

Take any model M and world w. If φ is not entertainable at w, both disjuncts are true. Otherwise, we have:

$$\begin{aligned} w \Vdash (\varphi \mathrel{\Box\!\!\rightarrow} \psi) \vee (\varphi \mathrel{\Box\!\!\rightarrow} \neg\psi) \quad & \iff \quad w \Vdash \varphi \mathrel{\Box\!\!\rightarrow} \psi \text{ or } w \Vdash \varphi \mathrel{\Box\!\!\rightarrow} \neg\psi \\ & \iff \quad F(w,\varphi) \Vdash \psi \text{ or } F(w,\varphi) \Vdash \neg\psi \\ & \iff \quad F(w,\varphi) \Vdash \psi \vee \neg\psi \end{aligned}$$

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$$\begin{aligned}
w \Vdash (\varphi \mathrel{\Box\!\!\rightarrow} \psi) \vee (\varphi \mathrel{\Box\!\!\rightarrow} \neg\psi) \quad &\iff \quad w \Vdash \varphi \mathrel{\Box\!\!\rightarrow} \psi \text{ or } w \Vdash \varphi \mathrel{\Box\!\!\rightarrow} \neg\psi \\
&\iff \quad F(w,\varphi) \Vdash \psi \text{ or } F(w,\varphi) \Vdash \neg\psi \\
&\iff \quad F(w,\varphi) \Vdash \psi \vee \neg\psi
\end{aligned}$$

Adding CEM to the axioms of VC we saw last time yields a sound and complete axiomatization of Stalnaker's logic, called C2.

- Are there reasons to think the uniqueness assumption must hold?
- Are there reasons to think the uniqueness assumption cannot always hold?

Argument 1: negations of conditionals

Suppose φ is entertainable at w.

- Stalnaker: $\neg(\varphi \mathrel{\Box\!\!\rightarrow} \psi)$ is equivalent to $\varphi \mathrel{\Box\!\!\rightarrow} \neg\psi$
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Consider:

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(7) If Bob had taken the exam, he would have failed.

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Consider:

(6) It is not true that if Bob had taken the exam he would have passed.

(7) If Bob had taken the exam, he would have failed.

These sound equivalent. This accords with Stalnaker's theory:

$$\neg(t \mathrel{\Box\!\!\rightarrow} p) \equiv (t \mathrel{\Box\!\!\rightarrow} \neg p)$$

However, conditionals can only be negated by means of paraphrases as “it is not true that”, which might also express some more meta-linguistic move.

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Idea: look at linguistic environments which lexicalize negation, such as “doubt” (=“believe not”) or the quantifier “no” (=“for all not”).

(8) I doubt that if Bob had taken the exam he would have passed.

(9) I believe that if Bob had taken the exam he would have failed.

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(8) I doubt that if Bob had taken the exam he would have passed.

(9) I believe that if Bob had taken the exam he would have failed.

Again, these sound equivalent, in accordance with negation-as-opposite:

$$(8) = B\neg(t \mathrel{\Box\!\!\rightarrow} p) \equiv B(t \mathrel{\Box\!\!\rightarrow} \neg p) = (9)$$

(10) No lazy student would have passed if they had taken the exam.

(11) All lazy students would have failed if they had taken the exam.

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Again, they sound equivalent, in accordance with negation-as-opposite:

$$(10) \;=\; \forall x(Lx \rightarrow \neg(Tx \mathrel{\Box\!\!\rightarrow} Px)) \equiv \forall x(Lx \rightarrow (Tx \mathrel{\Box\!\!\rightarrow} \neg Px)) \;=\; (11)$$

In Lewis's theory, $\neg(\varphi \Box\!\!\rightarrow \psi)$ and $\neg(\varphi \Box\!\!\rightarrow \neg\psi)$ can both be true: this will be the case when the closest φ-worlds are mixed.

So, the following should sound consistent:

(12) I doubt that if Bob had taken the exam he would have passed; and I also doubt that if he had taken the exam he would have failed.

$$B\neg(t \Box\!\!\rightarrow p) \wedge B\neg(t \Box\!\!\rightarrow \neg p)$$

(13) No student would have passed if they had taken the exam, and no student would have failed if they had taken the exam.

$$\forall x \neg(Tx \Box\!\!\rightarrow Px) \wedge \forall x \neg(Tx \Box\!\!\rightarrow \neg Px)$$

Argument 2: scope ambiguities

(14) President Carter has to appoint someone to the Supreme Court.

- Depending on the scope of "someone" and "has to", this has two readings:
  - narrow scope: $\Box\exists x Ax$
  - wide scope: $\exists x\Box Ax$

- This ambiguity is brought out in the following dialogue.

  A: President Carter has to appoint someone to the Supreme Court.

  B: Who do you think he has to appoint?

  A: There is no particular person that he has to appoint;
  he just has to appoint some person or other.

- B takes A's claim in the wide scope reading; A corrects him.

- Notice that A's correction seems perfectly coherent, since the narrow scope reading does not entail the wide scope reading.

If counterfactuals involve universal quantification over possible world, we expect to see analogous scope ambiguities with indefinites.

(15) President Carter would have appointed someone to the Supreme Court if there had been a vacancy.

- Depending on the scope of "someone" and $\Box\!\!\rightarrow$, we have two readings:
  - narrow scope: $V \Box\!\!\rightarrow \exists x Ax$
  - wide scope: $\exists x(V \Box\!\!\rightarrow Ax)$

- The following dialogue should bring out the ambiguity:

  A: President Carter would have appointed someone to the Supreme Court if there had been a vacancy last year.

  B: Who do you think he would have appointed?

  A: There is no particular person that he would have appointed; he just would have appointed some person or other.

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  B: Who do you think he would have appointed?

  A: There is no particular person that he would have appointed; he just would have appointed some person or other.

- However, here B's reply actually sounds incoherent.
- For Lewis, this is unexpected: it should be possible to deny the wide-scope reading while defending the narrow-scope reading.

This is predicted in Stalnaker's account:
(assuming that in making the assumption we don't change the set of people)

$$
\begin{aligned}
w \Vdash V \mathrel{\Box\!\!\rightarrow} \exists x A x \quad & \Longleftrightarrow \quad F(w, V) \Vdash \exists x A x \\
& \Longleftrightarrow \quad \exists d \in D : F(w, V) \Vdash A d \\
& \Longleftrightarrow \quad \exists d \in D : w \Vdash V \mathrel{\Box\!\!\rightarrow} A d \\
& \Longleftrightarrow \quad w \Vdash \exists x (V \mathrel{\Box\!\!\rightarrow} A x)
\end{aligned}
$$

Thus, the uniqueness assumption predicts that the wide and narrow scope reading are equivalent; thus it is inconsistent to assert one and deny the other.

- So, the uniqueness assumption has some attractive repercussions.
- However, on the face of it, the assumption seems grossly implausible.
  How can there always be a unique way to make an antecedent true while staying maximally close to the actual world?
- Consider:

(16) If Verdi and Bizet were compatriots, ...

- Would they be Italian or French?
- It seems that there is a perfect tie between worlds of both kinds.
  How can one kind be closer than the other?

- Put another way, the uniqueness assumption implies the validity of CEM:

$$(\varphi \mathrel{\Box\!\!\rightarrow} \psi) \vee (\varphi \mathrel{\Box\!\!\rightarrow} \neg\psi)$$

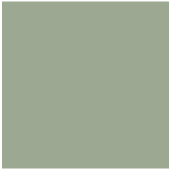
- As an instance of CEM consider (17).

(17) If V. and B. were compatriots, they would be Italian,
or if they were compatriots, they would not be Italian.

- How can this be true, given that neither disjuncts seems true?

- Stalnaker's response to this criticism: this is a case of vagueness.
- The above instance of CEM is similar to the following instance of plain EM, where the relevant patch of color is in between

(18) Either this patch is green, or it is not green.



- We need to resort to a general modeling of vagueness.

Supervaluations (van Fraassen 66)

A valuation v is the semantic determinant relative to which a sentence receives a definite truth-value.

- E.g., a valuation for the predicate green is a set of objects, the set of objects which are green under a fixed demarcation.

A supervaluation S is a set of valuations.

- E.g., a super-valuation for green is the set of all possible extensions of the predicate under different allowable demarcations.
- Our patch will count as green under some valuations in S, and as not green under others.

We can then define a partial notion of truth relative to a super-valuation S:

$$[\![\varphi]\!]^S = \begin{cases} \text{true} & \text{if } [\![\varphi]\!]^v = \text{true for all } v \in S \\ \text{false} & \text{if } [\![\varphi]\!]^v = \text{false for all } v \in S \\ \text{undefined} & \text{otherwise} \end{cases}$$

In the above context, both (19-a) and (19-b) would be undefined, since each is true under some but not all admissible valuations.

(19) a. This patch is green.
b. This patch is not green.

However, the corresponding instance of excluded middle (20) is true, because it is true under any admissible demarcation.

(20) Either this patch is green or it is not green.

More generally, the move from valuations to super-valuations does not change the validities of a theory:

- suppose φ is true relative to all valuations;
- given a super-valuation S, φ will be true relative to each $v \in S$;
- so φ will be true at S;
- it follows that φ is true relative to all super-valuations.

Back to conditionals:

- a valuation is a world selection function;
- a super-valuation is a set of such functions.

In the Bizet-Verdi case, S will contain functions that select worlds where they are both Italian, as well as functions that select worlds where they are French.

This predicts that, w.r.t. S, (21-a) and (21-b) are both undefined in truth-value, even though (22) is true.

(21) a. If V. and B. were compatriots, they would be Italian.
b. If V. and B. were compatriots, they would not be Italian.

(22) If V. and B. were compatriots, they would be Italian,
or if they were compatriots, they would not be Italian.

Counterfactual under supervaluations

- Suppose that we have several equally good candidates $w_1, \ldots, w_n$ for the closest φ-world to w.
- Then there will be vagueness as to which of these worlds is selected: S contains selection functions resolving the vagueness in various ways.
- For $\varphi \mathrel{\Box\!\!\rightarrow} \psi$ to be true at S, it must be true under each resolution.
- Thus, $\varphi \mathrel{\Box\!\!\rightarrow} \psi$ must be true whichever of $w_1, \ldots, w_n$ is selected for φ.
- This requires that ψ be true at each of $w_1, \ldots, w_n$.
- Thus for cases with ties in similarity, the supervaluationist view gives us the same truth-conditions as Lewis.

Counterfactual under supervaluations

- However, there is an important difference when it comes to falsity.
- $\varphi \mathrel{\Box\!\!\rightarrow} \psi$ is false at S iff it false under each resolution of vagueness.
- This means that ψ must be false at each of $w_1, \ldots, w_n$.
  Thus, falsity is more demanding than for Lewis.
- Thus, we get different predictions for counterfactuals like (23)

(23) a. If V. and B. were compatriots, they would be Italian.
b. If V. and B. were compatriots, they would not be Italian.

(24) a. If V. and B. were compatriots, they would be Italian.
b. If V. and B. were compatriots, they would not be Italian.

On Lewis and Pollock's analysis, these counterfactuals are false. On the analysis that I am defending, both are indeterminate — neither true nor false. It seems to me that the latter conclusion is clearly the more natural one. I think most speakers would be as hesitant to deny as to affirm either of the conditionals, and it seems as clear that one cannot deny them both as it is clear that one cannot affirm them both. *(Stalnaker 80)*

There is also a more direct way to get Stalnaker's truth and falsity conditions.

Homogeneity (von Fintel 1997): a three-valued semantics with

$$[\![\varphi \mathrel{\Box\!\!\rightarrow} \psi]\!]^w = \begin{cases} \text{true} & \text{if } \psi \text{ is true at all the worlds in } \min_w(\varphi) \\ \text{false} & \text{if } \psi \text{ is false at all the worlds in } \min_w(\varphi) \\ \text{undefined} & \text{otherwise} \end{cases}$$

- This is more parsimonious than Stalnaker's implementation: it avoids the uniqueness assumption, and the move to supervaluations.
- With the natural treatment of negation, this yields negation as opposite:

$$\begin{aligned} [\![\neg(\varphi \mathrel{\Box\!\!\rightarrow} \psi)]\!]^w = 1 \quad & \Longleftrightarrow \quad [\![\varphi \mathrel{\Box\!\!\rightarrow} \psi]\!]^w = 0 \\ & \Longleftrightarrow \quad [\![\psi]\!]^v = 0 \text{ for all } v \in \min_w(\varphi) \\ & \Longleftrightarrow \quad [\![\neg\psi]\!]^v = 1 \text{ for all } v \in \min_w(\varphi) \\ & \Longleftrightarrow \quad [\![\varphi \mathrel{\Box\!\!\rightarrow} \neg\psi]\!]^w = 1 \end{aligned}$$

- What about the lack of scope ambiguities?

If-clauses as definite descriptions (Schlenker 2004)

If-clauses are not quantifiers, but referential devices, referring to the plurality $f(w, \varphi)$. Therefore, their properties are analogous to those of plural definites.

Truth-value gaps

(25) The girls went to the party.

a. all of the girls went $\leadsto$ true
b. none of the girls went $\leadsto$ false
c. some went, some didn't $\leadsto$?

Negation as opposite

(26) The girls didn't go to the party. $\leadsto$ no girl went

Lack of scope ambiguity

(27) The girls watched a movie.

a. $\leadsto$ there is a movie that the girls watched
b. $\not\leadsto$ every girl watched some (possibly different) movie

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Notice that this also gives an argument for the limit assumption: for an entertainable antecedent, there needs to be a non-empty set for the if-clause to refer to.

Some relevant recent work:

- Barker 1993, Conditional Excluded Middle, Conditional Assertion, and'Only If'.
- von Fintel 1997, Bare Plurals, Bare Conditionals, and Only.
- Bennett 2003, A philosophical guide to conditionals.
- Schlenker 2004, Conditionals as Definite Descriptions.
- Williams 2008, Defending conditional excluded middle.
- Cross 2009, Conditional excluded middle.
- Klinedinst 2011, Quantified conditionals and conditional excluded middle.
- Santorio 2017, Conditional Excluded Middle in Informational Semantics.