Counterfactuals and Dispositions

Counterfactual Conditionals

The Material Conditional

- When we discussed formal logic, we considered the *material conditional*, $p \rightarrow q$. The *material conditional* is just a simple truth-function. Its truth value is entirely determined by the truth-values of its component sentences, as shown in the following truth-table.

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

- As we noted at the time, while this allows us to give a purely formal logic, it gives some pretty counter-intuitive results if we treat it as a *translation* of the English '*if ..., then ...*'.

- These counter-intuitive results are together known as the *paradoxes of material implication*.

  - Note that, whenever 'p' is false, '$p \rightarrow q$' is true. But that means that, if '$\rightarrow$' gives a good translation of '*if..., then ...*', then the following claims would be true:

    1. If Margaret Thatcher is still alive, then she's hiding in my basement.
    2. If Margaret Thatcher is still alive, then Margaret Thatcher is not still alive.
       - Given the definition of '$\rightarrow$', '$p \rightarrow \neg p$' is true if 'p' is false.

  - Also, whenever 'q' is true, '$p \rightarrow q$' is true. But that means that, if '$\rightarrow$' gives a good translation of '*if..., then...*', then the following claims would be true:

    3. If you don't eat your vegetables, then Margaret Thatcher will die next week. (said last week)
    4. If the moon landing was faked, then Margaret Thatcher will die next week. (said last week)

- Conclusion: the meaning of '*if p, then q*' is *not* captured by the material conditional '$p \rightarrow q$'.

Indicative and Subjunctive Conditionals

- When we have a sentence of English of the form

If p, then q.

containing two sentences p and q in the indicative mood (*eg*, *is*, *was*, *will be*), call that an *indicative* conditional.

- When we have a sentence of English of the form

  If it *were* the case that p, then it *would be* the case that q.

  call that a *subjunctive* conditional.

- Interestingly, indicative conditionals behave differently than subjunctive conditionals. For instance,

  5. If Shakespeare didn't write Hamlet, then somebody else did.
  6. If Shakespeare *hadn't* written Hamlet, then somebody else *would have*.

- The indicative conditional 5 is talking about the *actual world*; whereas the subjunctive conditional 6 is talking about a *non-actual*, *merely possible* world.

- If the antecedent of a subjunctive conditional is false, then it is called a *counterfactual conditional*.

Counterfactuals in Science

- Some examples of counterfactual conditionals taken from some random science textbooks:

  "If the measurement of E_n had not taken place, what would the probability density for finding the particle at $x = L/2$ have been?" (Risenborough, *Quantum Mechanics I*)

  "...a purely monetary change would not have real effects. All nominal quantities (such as prices and wages stated in nominal terms) would move in proportion to the change in money, and no real quantity would be affected." (Romer, *Advanced Macroeconomics*)

  "If the charge on the proton differed from that on the electron by, say, one part in a billion, then each hydrogen molecule would carry a charge of $2 \cdot 10^{-9}e$, and the departure of the whole mass of hydrogen would alter the charge of the tank by $10^{16}e$, a gigantic effect." (Purcell and Morin, *Electricity and Magnetism*)

- More mundane examples:

  If this match were struck, then it would light.
  If this salt were placed in water, then it would dissolve.

- Counterfactuals like these create a puzzle for the philosophy of science. What is it that makes claims like these *true* or *false*? What does the world have to be like for these claims to be correct?

  - Since these are *counter*factuals, their antecedents don't *actually* obtain. How, then, could there be facts about what *would* have happened, if their antecedents *had* actually obtained?

Dispositions

- Science is also litter with claims about object's or system's *dispositions*. Here's a sampling:

  > "The energy decreases with x and y, so the equilibrium is **unstable**." (Purcell and Morin)
  >
  > "The larger the [intertemporal **elasticity** of substitution in labor supply], the more **responsive** the labor supply is to technology and capital." (Romer)

- To say that an equilibrium is *unstable* is not to say that the system every *actually* moves away from equilibrium. It is rather just to say that it is *disposed* to move away from equilibrium, if it is pushed away by any outside forces.

- To say that the labor supply is *responsive* to technology and capital is *not* to say that it actually *responds* to technology and capital. It is rather to say that it is *disposed* to respond in a certain way, *if* technology and capital change.

- More mundane examples:

  > This match is *flammable*.
  >
  > This salt is *water-soluble*.

- Claims like these—claims about object's *dispositions*—create a puzzle for the philosophy of science. What is it that makes claims like these true or false?

  – Since the system needn't ever *actually* depart from its equilibrium, what makes it the case that the equilibrium was *unstable*? Since the match wasn't *actually* struck, what makes it the case that it was *flammable*?

Goodman's (Attempted) Account of Counterfactual Conditionals

- Some notation: write the counterfactual conditional '*If 'p' were true, then 'q' would be true*' as '$p \mathrel{\Box\!\!\rightarrow} q$'.

- Goodman considers the following counterfactual conditional:

  If the match were struck, then it would have lit.

  $$A \mathrel{\Box\!\!\rightarrow} C$$

  (where A = *The match is struck* and C = *The match lights*.)

- It doesn't follow as a matter of logic alone that a struck match lights. Rather, it seems to have something to do with the *laws* at our world.

  – However, it's not a consequence of the laws at our world that anytime a match is struck, it lights ('cause the wind could be too strong, the match could be damp, *etc*). So we can't say that '$A \mathrel{\Box\!\!\rightarrow} C$' is true just in case A and the laws of nature deductively entail that C.

- Goodman: Yes, but it's true that it *wasn't* too windy, and it's true that the match *wasn't* damp, *etc*. Gather together all of these *relevant ancillary conditions*—call them 'S'. Then, it should follow deductively from the laws of nature L, these relevant ancillary conditions S, and the claim that the match is struck A that the match lights C.

- This gives us the following account of counterfactual conditionals.
  - A counterfactual conditional $A \mathrel{\Box\!\!\rightarrow} C$ is true if and only if there is a set of relevant ancillary conditions S such that the conditions in S actually obtain and it is a consequence of the laws of nature that, if A and S obtain, then C obtains.
    * If we suppose that it's a law of nature that whenever a match is struck and the match is dry and it's not too windy, ..., then the match lights, then this account tells us that it's *true* that, if the match were struck, it would have lit. That's because $A =$ *the match is struck* and $S =$ *the match is dry and it's not too windy, and ...* lead by law to $C =$ *the match lights*, and the conditions in S actually obtain.

- Goodman: what can be included in the relevant ancillary conditions?
  - Suppose that we say that *anything* can be included in the relevant ancillary conditions. Then, we could reason as follows:
    * Let $A =$ *the match is struck* and let $S' =$ *it's not too windy, and ..., and the match doesn't light* (S' doesn't include the condition that *the match is dry*, but *does* include the condition that *the match doesn't light*). Then, it's true that A and S' lead by law to the claim that the match isn't dry. However, the counterfactual conditional

      If the match were struck, then it wouldn't have been dry.

      is false, not true.
  - So we can't include just *anything* in the relevant ancillary conditions. We must hold *some* things fixed, and *not* hold other things fixed, when we evaluate the counterfactual conditions.
  - The most that Goodman can come up with this: A and S must be *cotenable*.
    * A and S are *cotenable* if it is not the case that, if A were true, then S would not be true.

$$A \text{ and } S \text{ are } \textit{cotenable} \quad \leftrightarrow \quad \neg(A \mathrel{\Box\!\!\rightarrow} \neg S)$$

  - But this definition includes a counterfactual conditional. So we haven't given a non-circular *account* of the counterfactual conditional. We still don't know what it takes for counterfactual conditionals to be true in non-counterfactual terms.

C.B. Martin and Finkish Dispositions

- Hypothesis: there's a relationship between claims about dispositions and counterfactual conditionals.

<u>*Dispositions*</u>

The match is *flammable* / The match is disposed to light if struck
The salt is *water soluble* / the salt is disposed to dissolve if placed in water

<u>*Counterfactuals*</u>

The match would light if struck
The salt would dissolve if placed in water

- The hypothesized relationship is this:

x is disposed to r in conditions c $\leftrightarrow$ *if conditions c were realized, then x would r*

- Martin argues that this can't be right, since the counterfactual claim could true even while the dispositional claim is false.
- He gives the following example: consider the dispositional property of a wire's being *live*. Suppose that what it is for a wire to be *live* is for it to be disposed to transfer electricity into a conductor if the conductor touches it. (Take this as a stipulative definition of what Martin means by *live*.)
  - Suppose that we've got a device called an *electrofink*. An electrofink has the ability to detect whether the wire is about to be touched by a conductor. If it is about to be touched by a conductor, then the electrofink makes the wire live before it gets touched.
  - Imagine that we've got a dead wire hooked up to an electrofink. Then, the counterfactual '*if the wire were touched by a conductor, then electrical current would flow from the wire to the conductor*'. However, it is false that '*the wire is live*'.
  - So, the hypothesized relationship between dispositions and counterfactuals turns out to be false. The wire doesn't have the disposition, even though the counterfactual claim is true.
- So the truth of the counterfactual claim isn't *sufficient* for the truth of the dispositional claim.
- Neither is the truth of the counterfactual *necessary* for the truth of the dispositional claim.
  - For we could have a *reverse elecrtro-fink*. The reverse electro-fink makes the wire dead if it is touched by a conductor. Then, it could be true that the wire is live but false that if it were touched with a conductor, then electric current would flow from the wire to the conductor.
- So the truth of the corresponding counterfactual is neither necessary nor sufficient for the truth of the dispositional claim.