Lecture 9: Laws of Nature

Lecture 9: Laws of Nature

1. Introduction

- In a number of the previous lectures, I have spoken of 'nomological possibilities', which, I have said are possibilities that are consistent with the 'laws of nature'.
- But what *is* a 'law of nature'?
- Talk of 'laws of nature' generally crops up in science. This shouldn't be surprising: the *whole point* of science, we are often told, to find out what the laws of nature are. Here are a few of examples of laws drawn from the science GCSE (?) curriculum:
  - *Boyle's law*: the volume (V) of a fixed quantity of gas is linearly proportional to its pressure (p) (pV = k, where k is a constant).
  - *Ohm's Law*: the potential difference (V) across a conductor is linearly proportional to the intensity (I) of the current running through it (V=IR, where R is a constant corresponding to the resistance of the conductor)
  - *Newton's First Law*: A uniformly moving object will continue moving in a straight line at constant speed and a stationary object will remain at rest, unless acted upon by an unbalanced force.

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1. Introduction

- In what follows I will try to give a succinct overview of the main positions in the literature on the nature of laws.
- These main positions are all committed to at least two basic intuitions about laws.
- The first intuition is that *laws entail regularities*.
- Law statements can all be translated into the following format: 'it is a law of nature that all Fs are Gs'. In other words 'it is a law of nature that, for any x, if Fx then Gx'.
- It is generally thought that we can treat the embedded conditional in the last sentence as a material conditional (see last week's lecture) falling within the scope of a universal quantifier: 'it is a law of nature that $(\forall x)\ (Fx \rightarrow Gx)$'.
- Furthermore, it seems sensible to claim that necessarily, if it is a law of nature that $(\forall x)\ (Fx \rightarrow Gx)$, then it is the case that $(\forall x)\ (Fx \rightarrow Gx)$: in other words, laws entail regularities.

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1. Introduction

- Actually, what I have just said isn't quite exact: laws can be stated in terms of regularities or *conjunctions* of regularities:

  (i) Some law statements involve biconditionals rather than conditionals: 'it is a law of nature that all Fs are Gs and all Gs are Fs'. (i.e. 'it is a law that $(\forall x)\ (Fx \rightarrow Gx)$ and $(\forall x)\ (Gx \rightarrow Fx)$').

  (ii) Some law statements even involve conjunctions of biconditionals. This is the case with so-called 'functional' laws such as V=IR, which are just shorthand for conjunctions of many individual biconditionals: for any conductor x, [30Ω(x) & 0.2A(x)] iff 6V(x) AND for any conductor x, [31Ω(x) & 0.2A(x)] iff 6.2V(x) AND etc.

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1. Introduction

- The second widely accepted intuition is that *laws are contingent*: when it is a law of nature that all Fs are Gs, it remains the case that in some possible worlds some Fs are not Gs. There are, in other words, possible worlds with laws that are different to ours (i.e. the laws of nature could have been different).
- This, of course, is the intuition behind the suggested distinction, in lecture 6, between the set of possible worlds simpliciter and the set of nomologically possible worlds.
- One popular justification for this view is an argument from conceivability (remember lecture 4 and Black's spheres?):

  [1] It is a law of nature that all metals expand when heated.

  [2] It is conceivable that, say, metals could contract rather than expand when heated

  [3] To the extent that something is conceivable, it is possible.

  Therefore [4] there is a possible world in which metals contract rather than expand when heated and hence the laws of nature are contingent.

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2. Simple Regularity Accounts

- Ok, so we have this intuition that necessarily, if it is a law that all Fs are Gs, then all Fs are in fact Gs. Let's grant that this is true. But *why* is it true?
- Well the simplest explanation for any pattern of the form 'necessarily, if X then Y' is surely that X just *is* Y (X = Y). For instance, the fact that, necessarily, if someone is a bachelor then that someone is male and unmarried is straightforwardly explained by the simple fact that being a bachelor = being an unmarried male.
- This leads us to our first candidate for the analysis of laws, the laws-as-contingent-regularities view:

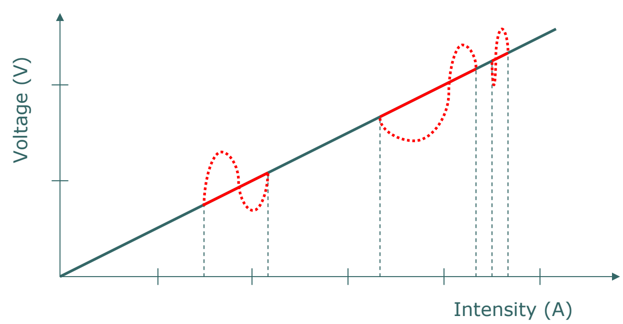
  L_1: It is a law that all Fs are Gs iff (i) in the actual world, $(\forall x)(Fx \rightarrow Gx)$ and (ii) in some possible world, it isn't the case that $(\forall x)(Fx \rightarrow Gx)$.
- It is important to note that, according to L_1, laws of nature *do not explain/cause/bring about* regularities in nature: they just *are* regularities in nature.

2. Simple Regularity Accounts

- On a similar note, on this view, laws don't explain the instances that make up the regularities either. The general fact that metallic objects A, B and C all expanded when heated doesn't explain why A expanded when heated.
- There is a clear proposed disanalogy here with, say, the relationship between the laws of the legal system and regularities in human behaviour. These laws, in the presence of appropriate means of enforcement, causally shape patterns of behaviour: a ban on smoking in pubs brings about a corresponding behavioural regularity.
- L_1 has the virtue of being ontologically simple. However, it is largely regarded to be a non-starter…
- The first objection to L_1 is that it licenses *too many* laws. Indeed, in the previous lecture, we saw that a material conditional $p \rightarrow q$ is *only* false when it is the case that p but isn't the case that q. The conditional is true, for instance, as long as it isn't the case that p (when a conditional is made true in this way, it is said to be 'vacuously' true). This has unfortunate repercussions on L_1…

2. Simple Regularity Accounts

- The following diagram illustrates, for R = 0.5Ω, (i) Ohm's Law (linear function), which we would like to say is a genuine law, as well as (ii) Schlohm's 'Law' (non-linear function), which we would like to say isn't a law at all. Sections highlighted in red on the graph indicate uninstantiated intensity/voltage pairings.



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2. Simple Regularity Accounts

▪ ***Argument against L_1 from failure of sufficiency 1 (vacuously true non-laws):*** *[1] According to L_1 if there are in fact no conductors – past, present or future – that instantiate the intensity/voltage pairs marked in red on the graph, Schlohm's 'Law' is a law of nature. [2] Schlohm's Law isn't a law of nature. Therefore [3] L_1 is false.*

▪ The obvious way to respond to this kind of counterexample is to add an existential condition, i.e. a clause requiring that there are, as a matter of actual fact, x's that are Fs:

> L_2: It is a law that all Fs ar Gs iff (i) in the actual world, $(\forall x)(Fx \rightarrow Gx)$, (ii) in some possible world, it isn't the case that $(\forall x)(Fx \rightarrow Gx)$ and (iii) in the actual world, some x is F.

▪ The problem with this suggestion, however, is that now it seems to rule out too much…

▪***Argument against L_2 from failure of necessity (vacuously true genuine laws):*** *[1] According to L_2 if there are in fact no conductors – past, present or future – that instantiate the intensity/voltage pairs marked in red on the graph, Ohm's Law isn't a law of nature. [2] Ohm's Law is a law of nature. Therefore [3] L_2 is false.*

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2. Simple Regularity Accounts

▪ So, after all that, the first objection remains…

▪ In addition to the first objection, L_1 faces another well-known objection from failure of sufficiency (a problem shared, incidentally, by L_2) …

▪ ***Argument against L_1 & L_2 from failure of sufficiency 2 (accidentally true non-laws):*** *[1] According to L_1 and L_2 it is true that (3) 'It is a law of nature that all the coins in my pocket are in British currency.' [2] (3) is false: we judge the embedded generalisation to be merely 'accidentally' true. Therefore [3] L_1 and L_2 are false.*

▪ These kinds of counterexamples generated a fairly large philosophical industry devoted to strengthening L_1 by requiring an additional condition or set of conditions over and above mere regularity.

▪ I won't review all the various attempts that have been made (there have been quite a few). Instead, I will provide you with a brief overview of the most popular proposal: the so-called 'best system' account.

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3. 'Best System' Regularity Accounts

- The best system account makes use of the notion of a 'deductive system'.
- A deductive system is a set of basic statements (axioms), rules of inference and further statements (theorems) derived from the axioms by application of the rules of inference.
- Deductive systems can be more or less strong (i.e. contain more or fewer pronouncements about the world) but also more or less simple (i.e. contain more or fewer axioms, or again simpler or more complex axioms).
- When considering how to build a deductive system that captures a given set of facts, we find an obvious tradeoff between strength and simplicity: one can always capture further facts at the cost of adding further axioms (or making existing axioms more complicated).
- Consider for instance the following toy world, containing just four objects:

$Gx_1\&Hx_1$ $Gx_2\&Hx_2$ $Gx_3\&Hx_3$ $Gx_4\&Hx_4\&Fx_4$

- Here we could settle for a simple but weak system, with axioms stating that Gx_1, Gx_2, etc. + and axiom stating that all Gs are Hs (capturing all the data but Fx_4). Alternatively we could add Fx_4 as an axiom, capture all the data but sacrifice simplicity.

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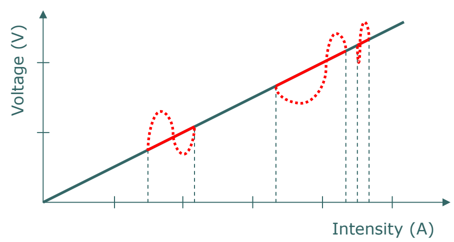
3. 'Best System' Regularity Accounts

- Drawing upon comments due to Mill (1911: 207-208) and Ramsey (1928: 131), Lewis (1973: 73-75) revived the following variant on the regularity view:

  L_3: It is a law that all Fs are Gs iff (i) in the actual world, $(\forall x)(Fx \rightarrow Gx)$, (ii) in some possible world, it isn't the case that $(\forall x)(Fx \rightarrow Gx)$ and (iii) '$(\forall x)(Fx \rightarrow Gx)$' appears as an axiom or theorem in all the true deductive systems that achieve the best combination of simplicity and strength (i.e. that capture the most facts about the world in the simplest way).
- According to its proponents, L_3 enjoys a number of advantages over its predecessors…

3. 'Best System' Regularity Accounts

▪ First of all, it avoids licensing vacuously true non-laws or ruling out vacuously true genuine laws. Repicture the graph on slide 5. Ohm's Law is the simplest function that accounts for all the existing data points. (Schlohm's 'Law' whilst fitting the data just as well, is a more complicated function). According to L_1, both Ohm's Law and Schlohm's 'Law' count as genuine laws. According to L_2, neither of them do. L_3, according to its proponents, strikes the right balance: on this account Ohm's Law is a genuine law, but Schlohm's 'Law' isn't.



3. 'Best System' Regularity Accounts

▪ Secondly, because on this view regularity isn't sufficient for lawhood, L_3 allows for a distinction between laws and accidentally true generalisations: on this view, what we call 'accidentally' true generalisations are simply true generalisations that don't figure in the best deductive system (i.e. generalisations that could be added to the system, but whose payoff in terms of capturing additional facts wouldn't outweigh the cost in terms of additional complexity).

▪ L_3 also allegedly has an additional advantage: it enables us to make sense of the preference we grant to simpler and stronger theories over their more complex and/or weaker counterparts. On this view, scientists aim for hypotheses that exhibit the best combination of strength and simplicity simply because they aim to discover laws of nature and laws of nature just are, *by definition*, deductive systems that exhibit the best combination of strength and simplicity.

▪ Problems, however, remain, according to the critics…

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3. 'Best System' Regularity Accounts

- First of all, note that L_3 requires:

  (i) an objective metric for strength (objectivity is required because lawhood is supposed to be an objective matter),

  (ii) an objective metric for simplicity,

  (iii) a weighting scheme to determine how to combine the values for strength and simplicity.

Opponents of the view argue that until this is provided, L_3 is will be too insufficiently precisely formulated to be tested against intuitions.

- Secondly, certain critics argue that, not only has no precise objective metric for simplicity been provided, no such metric is even forthcoming: simplicity, according to them, is a subjective matter that exists purely in the eye of the beholder.
- Thirdly some remain adamant that laws explain their instances. This, we have seen, is denied by proponents of L_1, but it is *also* denied by proponents of L_3.

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3. 'Best System' Regularity Accounts

- Finally, it has also been charged that L_3 doesn't do a good job of the law/accident distinction, both ruling out genuine laws as accidents and counting accidents as genuine laws.

  (i) *Laws counted as accidents*. It seems possible for a genuine law to have a minute number of positive instances. However, adding the relevant generalisation to the system isn't worth it: gaining only a few truths costs adding a whole new axiom.

  (ii) *Accidents counted as laws*. Van Fraassen (1989) asks us to consider a world in which there are two types of objects: golden spheres and iron cubes. The objects move along various trajectories but the initial conditions are such that the objects never collide. According to L_3, it is a law that all golden objects are spherical. Van Fraassen complains that this generalisation is clearly an accident: had the initial conditions been slightly different, there would have been collisions and these would have resulted in the golden spheres being dented by the cubes and loosing their shape.

4. Necessitarian Accounts

- Necessitarians break away from the contention that laws don't explain their instances. They claim that – in this respect at least - the analogy with the laws of the legal system is stronger than the proponent of the regularity theory suggests.
- The necessitarian view, associated notably with Armstrong (1983) and Dretske (1977) claims that:

  L_4: it is a law of nature that all Fs are Gs iff F-ness stands in a special kind of relation to G-ness (a relation that proponents of L_4 call 'necessitation').
- Here we have a change in focus: we move from (a) understanding laws in terms of facts involving objects instantiating properties to (b) understanding laws in terms of facts involving properties standing in in a higher order relation to one another.
- Ok fine, but for starters, what on earth is 'necessitation'?
- Well, curiously enough, proponents of L_4 don't tell us an awful lot…

4. Necessitarian Accounts

- First of all the terminology can be misleading here. The relation of 'necessitation' doesn't really have much to do with the notion of necessity in the sense that we have discussed so far.
- In particular, although it may be tempting to do so, we are *not* supposed to read N(F-ness, G-ness) as 'it is necessary that all Fs are Gs'.
- This reflects the widespread commitment, noted in the introduction, to the claim that when it is a law of nature that all Fs are Gs, it remains the case that in some possible worlds some Fs are not Gs.

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4. Necessitarian Accounts

- So, to repeat, according to proponents of L_4, necessitation is a *contingent* relation: it may be the case that in the actual world, F-ness necessitates G-ness, but in other possible worlds, this relation may fail to obtain.
- Contingency aside, proponents of L_4 also tell us that N(F-ness, G-ness) entails but isn't itself entailed by $\forall x\, (Fx \rightarrow Gx)$.
- *Furthermore*, proponents of L_4 insist that it isn't simply the case that N(F-ness, G-ness) iff $\forall x\, (Fx \rightarrow Gx)$ & X, for some suitable X. This would make the necessitarian account collapse into the kind of regularity account that it is trying to avoid.
- Now *if* we grant these features to the necessitation relation, we do obtain some convenient results…

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4. Necessitarian Accounts

- First of all, because $\forall x\, (Fx \rightarrow Gx)$ isn't sufficient for it being a law that all Fs are Gs, it cannot be a law that all Fs are Gs simply because there are no Fs (i.e. L_4 avoids treating vacuously true non-laws as genuine laws).
- Secondly, again because $\forall x\, (Fx \rightarrow Gx)$ isn't sufficient for it being a law that all Fs are Gs, accidental regularities can be ruled out as laws on the basis that the regularity isn't backed up by the requisite obtaining of a relation of necessitation between the relevant properties (i.e. L_4 avoids treating accidental regularities as genuine laws)
- Finally, because N(F-ness, G-ness) and $\forall x\, (Fx \rightarrow Gx)$ are distinct, and the former entails the latter, Armstrong tells us, laws can explain regularities.
- So.. case solved?

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4. Necessitarian Accounts

- Well not really, say the critics (and I would agree here): we simply have no good reason to believe in the existence of a 'necessitation' relation that does the job that proponents of L_4 would have it do.
- More specifically, it is difficult to see *how* N(F-ness, G-ness) is supposed to 'make' the relevant regularity obtain. The necessitarians are purchasing a result at the cost of utter and total mystery.
- Lewis (1983, 366) puts the point across nicely (though somewhat cheekily):

> Whatever *N* may be, I cannot see how it could be absolutely impossible to have *N*(*F*,*G*) and *Fa* without *Ga*. … The mystery is somewhat hidden by Armstrong's terminology. He uses 'necessitates' as a name for the lawmaking universal *N*; and who would be surprised to hear that if *F* 'necessitates' *G* and *a* has *F*, then *a* must have *G*? But I say that *N* deserves the name of 'necessitation' only if, somehow, it really can enter into the requisite necessary connections. It can't enter into them just by bearing a name, any more than one can have mighty biceps just by being called 'Armstrong'

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5. Concluding Comments

- The picture painted so far isn't a particularly satisfying one. All three views examined have their serious shortcomings.
  - The regularity view is accused of being too lenient (treating vacuously true and accidentally true non-laws as genuine laws)
  - The best systems analysis is accused of being both too lenient and too strict (treating some accidents as laws and some laws as accidents), as well as potentially rendering lawhood a subjective matter.
  - The necessitarian view is accused of peddling metaphysical mysteries.
- Perhaps then, we would be well-advised to look elsewhere…

5. Concluding Comments

- Well there is one increasingly popular alternative to all three views: ‘dispositional essentialism’.
- According to dispositional essentialism, the view that laws of nature are contingent, something that has been taken for granted in our discussion, is simply mistaken. It simply follows from the meaning of ‘metal’ that metals expand when heated. If ‘metallic’ objects contracted when heated, we wouldn’t have a different set of laws in place, we simply wouldn’t be in the presence of metallic objects in the first place.
- *Perhaps* this route may turn out to be a more promising one.
- I will try to say a little more about this in the final lecture (although I can’t guarantee that I will have time to do so).
- If you are interested in reading ahead, I recommend Bird (2005) (which I will put on WebCT this week).

References

- Armstrong, D.M. (1983) *What is a Law of Nature?* Cambridge: CUP.
- Bird, A. (2005) ‘The Dispositionalist Conception of Laws’. *Foundations of Science* **10:** 353-370.
- Dretske, F. (1977) ‘Laws of Nature’, *Philosophy of Science* **44(2)**: 248-268.
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- van Fraassen, B. (1989) *Laws and Symmetry*. Oxford: Clarendon Press.

Next week… Causation

- Set Reading: Menzies, P. (2001) 'Counterfactual Theories of Causation' in E. Zalta (ed.) *The Stanford Encyclopedia of Philosophy*. Sections 1-3 (skip 4. recent developments)