HUMAN CAPITAL
NATIONAL COHESION STRATEGY

EUROPEAN UNION
EUROPEAN
SOCIAL FUND

Philosophy and Methodology of Sciences

Tomasz Placek

Laws of nature

(lecture 5 and 6)

Project co-financed by the European Union under the European Social Fund

Laws: basic distinctions

We seem to know some laws: Newton's laws, Mendel's law, law of supply and demand, etc.

But these tentative laws are either false (literally) or have silent assumptions (making them inapplicable)

Idea: what scientists formulate as "laws" are at best candidates for laws of nature.

Do we need laws, so understood? Well, they make sense of pursuits of science.

Terminology:

- *laws of sciences* (of physics, chemistry, biology, etc.)

Examples: Newton’s laws, Mendel’s law, law of supply and demand

- *laws of nature*

- *natural laws*

Natural laws occur in moral or social contexts, perhaps in some legal debates as well.

Example: "gay marriage should not be made legal since it flies in face of a natural law that the male and female bodies are constructed for the begetting of offspring; and hence marriage is the union of one man and one woman."

The doctrine of natural laws comes from Aristotle and Thomas Aquinas.

Are there laws of nature, over and above matters of particular facts?

What properties have laws of nature?

How do we know their properties? Perhaps by knowing properties of laws of the sciences?

Particulars - material or psychological objects, processes and events

Laws as abstracta.

A particular exists (occurs) at some time, in some region, has continuous (non-intermittent) existence, is not *instantiated*.

Law is not at a time, not in a region, is likely instantiated, is about any object rather than about some particular objects.

Can laws be reduced to particulars? (if not, the world is a strange place).

Two important intuitions about laws:

- laws as universal truths
- laws as necessary truths
- well, laws as truths

For all x, if F(x) then G(x).

Some universal truths seem to be contingent.

Compare:

Every lump of gold is lighter than one ton.

Every piece of uranium 235 is lighter than 100 kg.

Even if the gold sentence is true, it seems to be accidentally true. An emperor could have amassed more gold and cast a golden statue heavier than 1 ton.

In contrast, no-one can produce a heavy piece of U235; he/she would be blown away in a process.

The intuition says: universality and necessity are distinct things. And we seem to require that laws be both, universal and necessary truths.

Test your intuitions again:

Newton’s law of gravitation (if it is a law of nature) says that every two masses attract each other by a force …. and moreover they necessarily attract …. .

What’s the power of the “necessity qualification”?

If our world evolved differently, laws wouldn't be any different. OK

If our world were different, laws wouldn't be any different. ???

Necessity qualification provides some modal stability (wrt alternative possible evolutions).

Universality qualification provides some numerical stability (wrt what occurs at a factual future course of events).

Caveat: necessity, universality, non-particularity (object-wise, space-wise, time-wise) seem to match laws of physics, but not laws of biology.

Hardy-Weinberg: if (1)-(4), then in an infinitely large population, given an initial set of allele frequencies, genotype frequencies remain constant.

Central issue about laws of nature: do they have a *necesserian* aspect?

How to have a handle at necessary connections (possibilities, and, more generally, modal properties)?

Empiricist tradition: there are no modal properties, or modal properties are supervenient upon matters of facts.

Hume’s (ca 1750) doctrine of *local supervenience*: “all there is in the world is a vast mosaic of local matters of particular fact, just one little thing and then another”

Suppose we take a God eye’s view on the Humean world, say, from the final moment of time. We see all local facts, all little things obtain their properties, or come in relations with one another. Just a vast mosaic of little things, their properties, and relations.

What cannot be seen in the mosaic? Real possibilities, dispositions, potencies.

Suppose we located in the mosaic a particular tulip bulb, one which has not grown a shoot. We may wonder: was it possible, *for that bulb*, to grow a shoot? Given how the bulb actually was, was it necessary *for it* to be dead? Had *that bulb* a potency / disposition to grow a shoot?

Note that these questions concern a particular object (that bulb rather than bulbs).

These questions are meaningless for a Humean-style empiricist.

He/she must reinterpret statements about modalities. How?

It was it possible, *for that bulb*, to grow a shoot means that there were some similar bulbs that grew, as a matter of fact, shoots.

It was necessary, *for that bulb,* to die out means that, as a matter of fact, all similar bulbs have died out.

These interpretations push us toward *simple regularity theory* (SRT)

It is a law that Fs are Gs iff all Fs are Gs.

Our intuitions rebel: not all regularities of the form above are laws. Recall the gold sentence and the uranium sentence.

Moreover, there are regularities of the form above, the truth of which relies on a single particular:

“All people with pesel 60032209472 are born in Kielce”

Perhaps some laws with only few instances (or no instances) are OK. But the Kielce example is fishy.

Laws and counterfactuals

Laws with few /no instances are OK since we think laws regulate how things would be in a counterfactual situation.

Said about a flat tire: if that tire were good and inflated to pressure p, p, volume v and temperature T would satisfy ….

If that sample of magnesium were put in a container with oxygen, …..

In what sense laws support counterfactuals?

Minimally, they say why a counterfactual is true, if it is true.

Consider: If we set up to produce a lump of U235, it would not be heavier than 100 kg.

A factual statement to the effect that every lump of U235 is lighter than 100 kg does not seem to explain why we believe the above.

Intuition: in the entire history of universe, accidentally, there are only light pieces of U235; i.e., we could have produced a heavy one.

But counterfactuals are tricky, and explaining why they are true (if they are) is tricky. Consider again:

If that tire were good and inflated to pressure p, p, volume v and temperature T would satisfy p/vT =….

If that sample of magnesium were put in a container with oxygen, …..

Typical analysis of logic of counterfactuals draws a distinction between laws and matter of (little) facts.

The magnesium sentence is true (in our world) because in a counter-to-facts world (in which the sample is put in the container…), laws of nature are exactly like in our world.

Laws (in the analysis of counterfactual) provide a modal aspect to them. So non-modal (regularity) analysis cannot account for counterfactuals.

If laws did not figure in an analysis of counterfactuals ..

An advanced regularity view of laws

Best system account (Lewis 2001, after Ramsay (1920), after Mill (1850))

Consider a system. It could be an harmonic oscillator, or our world. Think of the system’s true descriptions that cover some part of its past, present and future. That is, allow for incomplete descriptions as well.

A description must be given in a language. A part of a description may say: “On Nov 26, 2013, …, the JU Rector has 10980479027490214 hair on his head”.

Descriptions are axiomatizable. (In an extreme, all sentences of a given description are declared to be axioms).

Axiomatized systems have competing virtues: *informativeness* vs. *simplicity*

Encyclopedia Britanica, understood as an axiomatic system, has vast informativeness, but its simplicity is minimal.

In contrast, the one-axiom description “1 = 1” is extremely simple, but its informativeness is null.

Informativeness / simplicity can be rigorously defined with respect to axiomatic (formal) systems.

A description of our world is *good* iff it has the combination of informativeness and simplicity.

x is a law of nature of our world iff it is an axiom or a theorem of all good descriptions of our world.

How does it work? Not all true regularities are axioms/theorems of a good description. I.e., by adding a regularity, an increase of informativeness can be outweighed by a drop in simplicity.

Here lies a hope to clarify the gold / uranium conundrum.

A system with a sentence about the critical mass of U235 and without the gold / uranium universal statements seems better than one with the gold sentence added.

Main problem for the best system account: laws turn out to be dependent on language.

Can a regularity with only a few instances be elevated to a law?

Can laws explain? If a law is a regularity + smth else, can a law explain this regularity (i.e., part of itself)?

Induction: laws should help in answering why in some cases we correctly argue by induction.

Consider:

This raven is black, that raven is black, …., ergo, all ravens are black.

Or, this electron's spin is one-half, that …., …, ergo all electrons have spin one-half.

Often induction is good. Why? Intuitively, because we hit upon a law.

Best system account misses an intermediate step in answering why induction is good: all observed Fs are Gs because all Fs are Gs (no appeal to laws).

A problem with a basis for induction. Why emeralds/ sapphires/ blue/ green provide a good basis? Why emerires / grue yields a bad basis?

Grue:

x is grue iff x is green and observed by midnight Dec 31, 2000 or x is blue and not observed by midnight Dec 31, 2000.

Emerire:

x is emerire iff x is an emerald and observed by midnight Dec 31, 2000 or x is sapphire and not observed by midnight Dec 31, 2000.

Induction yields:

All emeralds are green.

All sapphires are blue

All emerires are grue.

Necessarian accounts

Why “electrons have spin one-half” looks like a law? Because it states a relation between two properties, being an electron and having spin one-half, and moreover, this is a necessary relation.

In logic one defines logical necessity (=truth in all logically possible circumstances). Too strict a notion. Considerable task: arrive at natural necessity.

Relation to regularities: if F necessitates G, than all Fs are Gs, but no vice versa.

Try to list sought-for properties of necessitation, hoping they will jointly single out some sufficiently restricted class of relations.

Armstrong’s list:

1. if F necessitates G, all Fs are Gs, but not vice versa
2. necessitation is a second-order relation
3. necessitation has instances (a’s being F necessitates a’s being G)

But the list is satisfied by Lewis/Ramsay RL(F) = it is a law that Fs are Gs.