CAN LAWS OF NATURE CHANGE ?

AGAINST THE “PRINCIPLE OF UNIFORMITY OF NATURE”

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JULIEN TRICARD

INTRODUCTION

- The metaphysical problem of induction is to prove a general principle of induction :
    - “All inferences from experience suppose, as their foundation, that the future will resemble the past” (Hume, *An Enquiry Concerning Human Understanding*, “Cause and Effect”, Part I, 1772)
    - “The problem we have to discuss is whether there is any reason for believing in what is called 'the uniformity of nature'. The belief in the uniformity of nature is the belief that everything that has happened or will happen is an instance of some general law to which there are no exceptions. (…) Have we any reason, assuming that they have always held in the past, to suppose that they will hold in the future?” (Russell, *The Problems of Philosophy*, chapter VI, 1912)

INTRODUCTION

- This “Principle of Uniformity” (PU) states that “for every fact of a given class, unobserved facts obey the same law as observed facts”
- The problem is that such principle :
  - can only be proven *a posteriori* because it can only be a contingent truth,
  - but it cannot be proven *a posteriori* because the inference would be circular. To prove it as a generalization from experience would presuppose that inductive reasoning is already sound, which is assuming that the principle of induction is true.
  - So the principle of induction cannot be proven : inductive scepticism.

INTRODUCTION

- Claim: a metaphysical principle of induction should only state that laws of nature exist, not that they cannot change.
    - Because it is wrong to assume that a law of nature, were it to exist, could change (e.g. over time). I deny that a law of nature can exist and "govern" facts of a certain class up to a certain time, but then disappear or be replaced by another law applying to future facts of the same class.
- Assumptions:
    - I don't assume any specific theory of laws, but merely that they are not factual regularities
    - I don't think that all the next arguments would work in a regularist framework.

OUTLINE

I. A conceptual argument based on the "perimeter" of a law
II. Three objections of "ways-out" of this argument
III. An argument based on prediction
IV. An argument based on the "legislator's regress"
V. A critique of the "formal principle of uniformity" (i.e. the statement that laws of nature yield phenomenal regularities)

I. THE PERIMETER OF A LAW
A. THE NOTION OF “NOMIC PERIMETER”

- *First “intuitive” definition*: the nomic perimeter *C* of law *L* is the class of all the facts to which *L* “is supposed” to apply.
  - e. g. if a law of gravitation exists, its perimeter is the class of all gravitational interactions between massive bodies.
- Proponents of PU assume that two (or more) laws can (successively) apply *on the same perimeter*
  - e. g. that two different laws of gravitation (successively) rule gravitational interactions between massive bodies.
- If PU is true, it is supposed to rule out this possibility by ensuring that only one law *L* apply to the whole nomic perimeter *C*.

I. THE PERIMETER OF A LAW

A. THE NOTION OF "NOMIC PERIMETER"

- It would not be a problem for induction if *different* laws were to apply to *different* perimeters.
  - e.g. it is not a problem for induction that a law of gravitation applies to gravitational interactions, while a (different) law of electrodynamics applies to electro-magnetical interactions, because their perimeters are distinct
  - also, suppose that two different laws of gravitation *L* and *L'* apply to two ***distinct*** perimeters, which correspond to "gravitational" interactions of different types (for instance, if "gravity" is not the same physical effect at microscale and at astronomical scale).
  - Then scientists may have troubles to come to know that there actually is two types of gravity, but once they do, they won't say that the law of gravitation changes, but that each law applies perfectly and uniquely to its own perimeter.

I. THE PERIMETER OF A LAW

A. THE NOTION OF "NOMIC PERIMETER"

- Thus, a nomic perimeter *C* is a class of facts that are "supposed to be" *instances of the same law*. "Supposed to be" may be ambiguous; notice that a "nomic perimeter" is not an *epistemic* but an *ontological* notion:
  - Scientists may of course hypothesize that a class of facts is a nomic perimeter. Especially if they want to apply PU on an observed regularity to infer a nomological generalization, they need to suppose that this regularity is not accidental, but a portion of nomic perimeter.
  - But I assume that when it is true that a class of facts *is a nomic perimeter*, there is indeed something about these facts which makes it true that they "are supposed to" or "should" be instances of the same law.
- Thus what makes a class of facts a nomic perimeter is also what makes for the distinction with accidental regularities.

I. THE PERIMETER OF A LAW
A. THE NOTION OF "NOMIC PERIMETER"

- Thus, a nomic perimeter *C* is a class of facts that are "supposed to be" instances *of the same law*.
- Proponents of PU admit that two different laws *L* and *L'* may actually have (distinct) instances in the same perimeter: a law *L* applies only to all facts of *C* until time *t*, but after *t*, it is *L'* which applies. They assume that a *nomic irregularity* is possible: that two facts that are "supposed to be" instances of of the same law are actually instances of two different laws.

I. THE PERIMETER OF A LAW

A. THE NOTION OF “NOMIC PERIMETER”

- I argue that this is not possible, because if two facts belong to a same nomic perimeter,
  - then by definition each is an instance of a law (and not a brut or ”accidental” fact, because the perimeter is “nomic”), and it is “supposed to be” the same law.
  - But this casts an indeterminacy that does not exist: ***either*** two nomic instances ***are indeed*** instances of the same law ***or they are not***.
  - If they are, then the same law does apply to them, so there is no “nomic irregularity”.
  - If they are not instances of the same law, then why “should” they? They merely don’t belong to the same perimeter. Scientists may suppose that they do, but their assumption is false and will probably be proven so.
- Key claim: if two facts are instances of two different laws, then there is simply nothing which makes them belong to a same nomic perimeter.

I. THE PERIMETER OF A LAW
B. AN ARGUMENT FROM HOW A PERIMETER IS DETERMINED

- The main reason is comes from the way a “nomic perimeter” is determined as a class: its actual extension depends *on which law* is the case. In other words, the existence and the extension of a nomic perimeter is not determined prior to the existence and “implementation” of a determined law.
- If it is so, then a perimeter is just the class of all the instances of the same law, ruling out any nomic irregularity.
- But why is it so?

I. THE PERIMETER OF A LAW
B. AN ARGUMENT FROM HOW A PERIMETER IS DETERMINED

- Consider the following epistemic situation, where :
  - ***Observed*** gravitational behaviors are compatible with two nomological hypothesis *H* and *H'*
  - But *H* and *H'* hypothesize two different laws of gravitation, and thus yield incompatible predictions about ***unobserved*** gravitational behaviors.
  - So *H* and *H'* correspond to two distinct ways of supplementing the observed facts with ***different*** unobserved facts, and so build up two ***different*** hypothetical perimeters of instances.
- Thus, the actual nomic perimeter is determined by *which law* is the case, and then their cannot be more than one and unique law applying to this perimeter.

I. THE PERIMETER OF A LAW

B. AN ARGUMENT FROM HOW A PERIMETER IS DETERMINED

- The general argument runs as follows:
  (1) A nomic perimeter *C* is a class, so its identity conditions are given by the identity conditions of its members
  (2) Each fact of *C* is an instance of a law (by definition, it is not a brut accidental fact), and what every instance of a law is, is determined by which law it is.
    - e.g. a body subject to a law of gravitation *L* behaves differently from a body subject to *L'*
  (3) When a law is the case, then its existence determines what *all* the nomic instances of *C* are
  (4) So when a law is the case, then it determines what the whole perimeter *C* is.
- But (3) actually begs the question: doesn't it assume that a law applies to the whole perimeter, thus creating a circularity in the argument?

I. THE PERIMETER OF A LAW

B. AN ARGUMENT FROM HOW A PERIMETER IS DETERMINED

- Yes it does. But this only mean that the argument can be formulated in a much simpler way :
  - a nomic perimeter can be nothing else than the class of instances *of the same law*,
  - because a nomic perimeter is the class of all the facts to which a law, if it exists, applies.
  - So a perimeter's existence and extension depend on the existence of a law.
- So, we actually need to argue for a concept of "law of nature" which comes with its natural perimeter of application. If we do, then two facts obeying two different laws won't indeed belong to the same perimeter. We will come to that in sections III and IV.
- For now, let's try to reverse the burden of proof by asking: how can the adversary define the extension of a nomic perimeter independently of which law is the case? on which ground two facts which actually are instances of two different laws could be said to belong to the same perimeter?

II. THREE WAYS-OUT
A. QUALIFYING PROPERTIES?

- First way-out: a nomic perimeter can exist and its extension be determined independently of which law is the case, because:
  - For a particular fact to belong to a nomic perimeter, it is merely necessary to have such and such characteristics, which act as “qualifying properties”.
  - For instance: “having a mass” and “having kinematic properties” make a body belong to the “gravitational” perimeter; i.e. the having of these properties ***qualifies it to be subject to*** a law of gravitation.
  - Thus, two distinct bodies can belong to the same nomic perimeter while being subject to two distinct laws of gravitation.

II. THREE WAYS-OUT

A. QUALIFYING PROPERTIES?

- But this won't do, because having these "qualifying properties" doesn't make a fact an instance of a law. So it cannot be the ground making for ***nomic*** perimeters.
  - e.g. a body's merely being massive and having a certain speed don't make it an instance of a law of gravitation, because instances of a law of gravitation are gravitational interactions between bodies, not bodies themselves (or: gravitational behaviors of bodies, not bodies themselves)
  - e.g. an object's merely being a piece of copper doesn't make it an instance of the law that "all pieces of copper conduct electricity", because an instance of such a law is the fact that a piece of copper conducts electricity (or "a piece of copper's having an electromagnetic behavior")
- If a "perimeter" is just a class of objects with qualifying properties and not necessarily having nomic behaviors, then it is not "nomic" anymore, and is not distinct from an accidental class
- Remark: this answer seems to commit us to an ontology of *facts* (and not only of objects)

II. THREE WAYS-OUT
B. "BEING AN INSTANCE OF A LAW-TYPE" AS A DETERMINABLE TYPE

- Second way-out: facts may belong to the same perimeter while being instances of two distinct laws, because they are all instances of ***a law*** of a certain type, but not of ***the same*** laws.
  - E. g., bodies' behaviors can all be of a determinable type: "being a gravitational interaction" while actually being instances of *different* laws of gravitation *L* and *L'*.
  - Here the determinable "being a gravitational interaction" is a determinable type **of instances**, which unifies a perimeter and means "being instance of *a law of* gravitation".

II. THREE WAYS-OUT
B. “BEING AN INSTANCE OF A LAW-TYPE” AS A DETERMINABLE TYPE

- But what is “being instance of *a law* of gravitation”, if not being an instance of such or such *determinate* law of gravitation?
- We could say that it is being instance of a law which has the characteristics of “being a law of gravitation”.
- But then the pb is just pushed to another level: “being a law of gravitation” is a determinable type **of laws**, of which *L* and *L’* both are tokens, and which must be specified. So what have *L* and *L’* in common to be both laws of gravitation?
- The most intuitive answer is that *L* and *L’* are both laws of gravitation because they both govern/apply to gravitational interactions. But this is circular, as we go back to the determinable type **of instances**.

II. THREE WAYS-OUT
C. PARTIALLY DETERMINING A TYPE OF INSTANCES/A TYPE OF LAW

- Third way-out: one may partially determine a type of instances, just enough to define a nomic perimeter, and let more determinate laws apply to parts of it.
  - E.g., "being a gravitational interaction" may cover all u-plets of bodies which are "being massive", "having kinematic properties" and "being subject to a central attractive force", forming a nomic perimeter *C*.
  - But the norm of this force and the way it depends on the distance between bodies may vary between parts of the perimeter, depending on which fully determinate law applies.

II. THREE WAYS-OUT
C. PARTIALLY DETERMINING A TYPE OF INSTANCES/A TYPE OF LAW

- But this won't do either, because *C* is merely the nomic perimeter only of a *partially determined* law : a (unique) law imposing that massive bodies are all subject to a central attractive force (with an undetermined norm).
  - So on this perimeter, my claim applies: it is determined as the class of all actual instances of a same and unique (partially determined) law
  - And massive bodies subject to a central force (with an undetermined norm) **may be or may not be** instances of a more determinate law of gravitation (which determines how the norm of the force depends on their distances).
  - So, we are actually just saying that "being subject to an undetermined central force" ***qualifies*** them to belong to a perimeter of more determined laws: we are back to the first way-out.

- So, I have argued that there is no clear way to define a nomic perimeter independently of which determinate law its members are instances of.
- The key claim is then that nomic perimeters are determined by *which law* they are instances of.
- We can reach this conclusion by another way, through two new arguments relying on the concept of “law of nature”:
  - A law of nature should offer sufficient ground for making nomological predictions on a nomic perimeter
  - An adequate concept of law should make sure that laws of nature, if they exist and possess adequate properties (like “stability”), offer a solution to the problem of induction

III. AN EPISTEMOLOGICAL ARGUMENT FROM PREDICTION

- Let's suppose that if a law *L* exists, it doesn't imply that all facts *c* of perimeter *C* are instances of *L,* because *L* can "change" over *C*.
- Let's also assume that a lawlike statement *H*, which tries to describe the law of perimeter *C,* is well confirmed by observed *c*. Then *H* is supposed to ground nomological predictions about unobserved *c* of *C*.
- But for *H* to ground predictions about unobserved *c*, the "law of perimeter *C*" that it tries to describe cannot be "*L*", because *L* may no longer apply to unobserved *c*. *H* shall rather designate as "the law of *C*" the fact that "for all *c* of *C*, *c* is an instance of *L*", i.e. not "*L*" itself but the regularity of its stable application to the whole perimeter *C*.
- Now, the regularity that all *c* of *C* are instances of *L* in turn cannot change over *C* (otherwise, see next slide).
- Hence, if a law of *C* is what designates a lawlike statement which offers a sufficient ground to predictions, then it cannot change over *C*.

IV. AN ARGUMENT FROM THE "LEGISLATOR'S REGRESS"

- That the Humean problem of induction makes the ground of induction vanish in a vicious regress, known as the "legislator's regress" (van Fraassen, 1989)
- The "Humean" problem is characterized by the fact that the *existence* of a law *L* on *C* is not enough to ground induction on *C*, but one has to further postulate that *L* doesn't change over *C*, i.e. has to add a "decree" implementing *L* on *C*, which takes the form of a regularity : "for all *c* of *C*, *c* is an instance of *L*".

IV. AN ARGUMENT FROM THE "LEGISLATOR'S REGRESS"

- But this regularity : "for all *c* of *C*, *c* is an instance of *L*", either is a "cosmic coincidence", unable to ground induction, or it is or corresponds to a law:
  - If one is a regularist, then this regularity is a new law "*D*" (for "decree")
  - If one is not, then this regularity is produced by a new law "*D*".
  - Either way, *D* is the law that all *c* of *C* are instances of *L*.
- But if *D* is a law, then it can change on its perimeter.
  - Its perimeter *C'* is a new class of facts: the facts that *c* of *C* are instances of some law
  - If *D* can change, then some *c* of *C* can be instances of *L* while some other *c* of *C* are instances of another law *L'*.
  - One thus has to further postulate that *D* is stable, i.e. that all facts of *C'* are instances of *D*…

IV. AN ARGUMENT FROM THE "LEGISLATOR'S REGRESS"

- This is the "legislator's regress": if one need, in order to attach a law *L* to its entire perimeter, to sign a new decree of application *D*, and to ensure that *L* is applied regularly, the same then applies to *D*, and so on…
- Conclusion: if we want to avoid the legislator's regress, then we need to claim that if a law *L* for *C* exists, it automatically implies that all facts *c* of perimeter *C* are instances of *L*, i.e. that *L* cannot change over *C*.

V. THE “FORMAL PRINCIPLE OF UNIFORMITY”

- Following the previous arguments, there is no need to postulate that a law doesn’t change on its perimeter:
  - either a law exists, and thus applies to its whole nomic perimeter, ruling out the possibility of a “nomic irregularity”,
  - or it doesn’t exit and there is no nomic perimeter at all, just a class of facts which correspond to no law.
- Yet, there is still a problem to face: what if, after having observed a long phenomenal regularity, a fact occurs that seems perfectly irregular? Is it not relevant, from an epistemological point of view, to infer that a law of nature which has applied until now has changed?

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"

- Suppose that until *t* bodies have behaved regularly, in a way that conforms to the law *L*, but that after *t*, they abruptly change their behavior (e.g. accelerate toward each other much faster). From this, one may consider three options:

(a) Maintain that a law *L* did apply before *t*, but infer from the phenomenal irregularity that a *nomic irregularity* occurred, as a new law *L'* took over on the same perimeter *C*

(b) Maintain that *C* is a perimeter of a unique law, but infer from the phenomenal irregularity that the hypothesis of *L* was already false before *t*, as another unkown law already prevailed.

(c) Abandon the hypothesis that *C* is a nomic perimeter, and conclude that there is no law of gravitation.

- Claim: only (b) and (c) are legitimate conclusions, not (a).

V. THE “FORMAL PRINCIPLE OF UNIFORMITY”

- That a *phenomenal* irregularity implies a *nomic* irregularity is equivalent (by contraposition) to: a nomic regularity implies a phenomenal regularity.
  - We call this thesis the “formal principle” of uniformity (FPU), which states that a law of nature, *if it exists*, manifests itself by the uniformity of phenomena.
  - Different from the standard (“material”) principle of uniformity, which states that laws *do exist and are stable*.
- Assuming this principle, then if an irregularity happens in a series of hitherto regular phenomena, one can infer that a law that has prevailed so far has ceased to apply.
- But this principle seems illegitimate, for three reasons.

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"

A. GOES DOWN WITH THE "MATERIAL" PRINCIPLE OF UNIFORMITY

The first problem is that such principle seems unprovable, like the "material" principle :

- It can only be proven *a posteriori* because it can only be contingently true,
  - We can think of laws of nature which produce phenomenal *irregularities*, while staying the same. I.e. the law that all emeralds are grue.
  - Or more plausible, the MOND (MOdified Newtonian Dynamics) theory, where the principle "F=m.a" is modified when bodies are very far from each other, so that this regularity doesn't hold for big astronomical objects (galaxies or galaxy clusters).
- but it cannot be proven *a posteriori* without presupposing the "material" PU. From the fact that until now, laws have always produced phenomenal regularities, one cannot infer that laws will always do, without assuming that nature is uniform.

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"
B. CONFLICTS WITH WHAT HAPPENS IN INDUCTIVE SITUATIONS

- Second argument: the FPU conflicts with standard inductive situations.
- Standard inductive situation:
  - (i) Scientists ***assume*** that a perimeter of facts is nomic, i.e. that they are instances of an actual law
  - (ii) And ***infer*** from *observed* facts of this perimeter ***which law*** it could be (by inductively confirming or refuting nomological hypothesis)
- But with FPU, it's the other way around:
  - (i) Having observed some regular facts of a perimeter, they ***assume which law*** should exist, if it exists
  - (ii) And they ***infer*** from the observed regularity ***that such a law exist*** (for instance by an IBE)

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"

B. CONFLICTS WITH WHAT HAPPENS IN INDUCTIVE SITUATIONS

- Consider for instance some observed emeralds, which are all green.
  - If one assumes that laws of nature manifest themselves through phenomenal regularities, then if there is a law for the color of emeralds, and once some emeralds have already been observed green, then this law it can only be that "all emeralds are green".
  - But then what is left to infer by induction? Only that *there is* indeed such a law, because otherwise it would be an implausible coincidence that all observed emeralds are green.
  - Assuming ***which*** law can only exist, one infers ***that*** such a law exists as the best explanation of the observed regularity.
- The FPU seems to work well with qualitative generalizations, but actually involves a model of induction that doesn't work in more scientifically relevant cases

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"
B. CONFLICTS WITH WHAT HAPPENS IN INDUCTIVE SITUATIONS

- Consider the gravitational case. The FPU model of induction says that:
  - Having observed regular gravitational behaviors in a few cases, a scientist would already be legitimate to postulate that ***if a law of gravitation exists, then it produces this regularity***
  - And then infer from the observed regularity that such a law most probably exist.
- The problem doesn't came from the "inference to the best explanation" form of the reasoning, but from the assumption that the model forces scientists to make *before* the reasoning.
- In the general case, scientists don't assume beforehand which determinate law would exist if a law exists. On the contrary, they only assume that a law exists, and try to infer which law it is.

V. THE “FORMAL PRINCIPLE OF UNIFORMITY”
C. GIVES RISE TO NON-NOMOLOGICAL HYPOTHESIS

- A third argument: the FPU leads to inductive hypothesis which are not “nomological”
- An hypothesis *H* is “nomological” IIF *H* can be legitimately *confirmed* by its positive instances (Goodman, 1954) **and** can also be legitimately *disconfirmed* by a negative instance.
  - E.g. for the hypothesis “All emerald are green”, a positive instance is a green emerald, and a negative instance would be an emerald which is not green, but say blue
- Argument: if one assumes FPU, then inductive hypothesis are not nomological because they cannot have any negative instance. How so?

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"
C. GIVES RISE TO NON-NOMOLOGICAL HYPOTHESIS

- Suppose that after having observed lots of green emeralds, which all seem to confirm the hypothesis *H* that "All emeralds are green", one observes a blue emerald.
  - Standard interpretation: this new observation contradicts a prediction from *H*, and so *H* is refuted. The blue emerald seems to constitute a negative instance of *H*.
  - But according to the FPU, a law about the color of emeralds can only be that they are all of the same color (which is green because emeralds have already been observed green). So a blue emerald cannot be ***instance of the same law*** as green emeralds. And thus it cannot refute an hypothesis which have been previously confirmed by green emeralds.
  - FPU thus implies that a law can only have positive instances. The standard interpretation is wrong, because from the outset any non-green emerald has been banished from the perimeter of instances of the law.

V. THE "FORMAL PRINCIPLE OF UNIFORMITY"
C. GIVES RISE TO NON-NOMOLOGICAL HYPOTHESIS

- More broadly, the formal principle breaks down the logic of refutation: as soon as the result of an observation contradicts the prediction from an hypothesis *H*, which was well confirmed so far, one can always say that the law has changed; that *H* ***was*** true but ***isn't anymore***.
- To ensure refutability from future observations, it needs to be maintained that future cases, *whatever they will turn out to be*, are instances of the same law as already observed ones
- Thus, for nomological hypothesis to be drawn on a nomic perimeter, one needs to postulated that all cases of the perimeter are instances of the same law, even if they phenomenally differ
- So from a phenomenal irregularity one cannot infer (a) that the law on the perimeter has changed, but only (b) that the law is not (and was already not) the one we believed, or (c) that there is simply no law at all on this perimeter.

CONCLUSION

- So, we shouldn't try to prove that laws of nature, if they exist, are "stable" or "uniformly apply".
  - A law cannot cease to apply and be replaced by another on its perimeter, because it is ***its*** perimeter! A nomic perimeter only exist as the perimeter of application if a determinate law
  - Of all three ways we may conceive to define a nomic perimeter independently of a determinate law, none seems to work
  - If we admit that laws don't automatically apply to their putative perimeter, then nomological predictions don't make sense, and the problem of induction cannot be solved using the concept of law
  - And from a phenomenal irregularity, it doesn't seem legitimate to infer a nomic irregularity