Philosophy 5340 - Epistemology

Topic 5 – The Justification of Induction

1. Hume's Skeptical Challenge to Induction

In the section entitled "Sceptical Doubts Concerning the Operations of the Understanding" in his *Enquiry Concerning Human Understanding*, Hume offers, in the following passage, an argument for the conclusion that inductive reasoning cannot be justified:

> All reasonings may be divided into two kinds, namely, demonstrative reasoning, or that concerning relations of ideas, and moral reasoning, or that concerning matter of fact and existence. That there are no demonstrative arguments in the case seems evident; since it implies no contradiction that the course of nature may change, and that an object, seemingly like those which we have experienced, may be attended with different or contrary effects. May I not clearly and distinctly conceive that a body, falling from the clouds, and which, in all other respects, resembles snow, has yet the taste of salt or feeling of fire? Is there any more intelligible proposition than to affirm, that all the trees will flourish in December and January, and decay in May and June? Now whatever is intelligible, and can be distinctly conceived, implies no contradiction, and can never be proved false by any demonstrative argument or abstract reasoning a priori.
>
> If we be, therefore, engaged by arguments to put trust in past experience, and make it the standard of our future judgment, these arguments must be probable only, or such as regard matter of fact and real existence according to the division above mentioned. But that there is no argument of this kind, must appear, if our explication of that species of reasoning be admitted as solid and satisfactory. We have said that all arguments concerning existence are founded on the relation of cause and effect; that our knowledge of that relation is derived entirely from experience; and that all our experimental conclusions proceed upon the supposition that the future will be conformable to the past. To endeavour, therefore, the proof of this last supposition by probable arguments, or arguments regarding existence, must be evidently going in a circle, and taking that for granted, which is the very point in question.

(*Epistemology – Contemporary Readings*, ed. Michael Huemer, pages 303-4)

Hume's argument here can be summarized as follows:

(1) It is logically possible that the future does not resemble the past.

Therefore,

(2) There can be no **deductive** justification for inductive inference.

(3) Any attempt to justify induction by appealing to an inductive inference would be circular, and would beg the question, since it would assume that inductive inference is justified.

(4) Circular justification is not acceptable.

Therefore,

(5) There can be no **inductive** justification for inductive inference.

(6) The only possible ways of justifying some proposition are either by deduction or by induction.

Therefore,

(7) There is no way of justifying inductive inference.

2. Logical Probability and Hume's Skeptical Challenge to Induction

One response to Hume's argument, advanced by David Stove in his book *The Rationality of Induction* (Oxford: Oxford University Press, 1986), is that Hume overlooks the possibility of the idea of **logical probability**.

What is logical probability? First of all, logical probability is a **type of probability**, where probability is something that obeys certain axioms. If we use "$\Pr(p) = k$" to say that the probability that proposition p is true is equal to k, then here is one standard way of formulating axioms for probability:

Axiom 1 (Normativity): For any p, $0 \leq \Pr(p) \leq 1$.

Axiom 2 (Necessary truths): If it is necessarily true that p, then $\Pr(p) = 1$.

Axiom 3 (Additivity): If p and q are logically incompatible, then $\Pr(p \vee q) = \Pr(p) + \Pr(q)$.

Two theorems that follow from these three axioms are these:

Theorem 1: $\Pr(p) + \Pr(\sim p) = 1$.

Theorem 2 (Overlap): $\Pr(p \vee q) = \Pr(p) + \Pr(q) - \Pr(p \,\&\, q)$.

Next, let us introduce the idea of **conditional probability**, using "$\Pr(q/p) = k$" to say that the probability that proposition q is true given only that proposition p is true is equal to k. Conditional probability is then defined as follows:

If $\Pr(p) > 0$, then $\Pr(q/p) =$ def. $\Pr(q \,\&\, p)/\Pr(p)$.

(The restriction $\Pr(p) > 0$ is needed since division by zero is mathematically undefined.)

Given the definition of conditional probability, one can now prove a number of other useful theorems, including the following:

Theorem 3 (Multiplication): $\Pr(q \,\&\, p) = \Pr(q/p) \times \Pr(p)$

Theorem 4 (Total Probability): If $\Pr(p) > 0$, then $\Pr(p) = \Pr(p/q) \times \Pr(q) + \Pr(p/\sim q) \times \Pr(\sim q)$

Theorem 5 (Logical Consequence): If $p \Rightarrow q$, then $\Pr(p) \leq \Pr(q)$.

In general, then, probability is anything that satisfies the axioms of probability. But what is **logical** probability? The answer is that the concept of logical probability is the concept of (1) a relation between a proposition and a number that (2) is a **necessary** relation, rather than a contingent one, and that (3) satisfies the axioms for the general concept of probability.

So viewed, one can think of logical probability as akin to the relation of **entailment** between propositions, with logical probability being a more general relation. In particular, one can think of (a) proposition p's entailing proposition q as corresponding to its being the case that the logical probability of q given p is equal to one, and (a) proposition p's entailing proposition $\sim q$ as corresponding to its being the case that the logical probability of q given p is equal to zero.

Whether there is such a relation of logical probability is a controversial matter, with a number of philosophers having argued that there is no such relation.

3. The Justification of Induction: Two Very Different Types of Cases

As Hume posed the problem of induction, it involved showing that it is reasonable to believe that regularities that have held in the past will continue to hold in the future. Since the regularities that Hume had in mind were those associated with laws of nature, I prefer to say that the problem of induction upon which Hume focused was concerned with the question of how, if at all, one can prove that there are laws underlying the regularities in question. (If one holds, as Hume did, that laws are nothing more than certain cosmic regularities, one can rephrase this by saying that the problem is how, if at all, one can demonstrate that certain regularities that have held in the past are in fact cosmic regularities, or cosmic regularities of the right sort.)

Situations are very common, however, where one moves from information about events of a certain sort having some property, *P*, to a conclusion to the effect that further events of that sort are also likely to have property *P*, where one does not think that the reason that this is the case is that there is some underlying law. An urn contains marbles, and after shaking up the urn, a marble is drawn which turns out to be red. This action is repeated, say, 99 times, and in each case, the marble drawn is red. It is then widely thought that the fact that the first 100 marbles drawn from the urn were all red makes it more likely than it initially was that the next marble will be red. But one does not think that this is so because there is some underlying law that makes it the case either that all the marbles in the urn red, or that the probability that a marble in the urn is red is equal to *k*.

4. David Stove's Approach to the Justification of Induction

I think that induction is justified in both types of cases. But I also think that the justification for the inductive inference is very different in the two cases. In the marble-and-urn sort of case, I believe that one of the proofs of the justification of induction that David Stove offers in his book *The Rationality of Induction* (1986), which is based upon the approach of D. C. Williams in his book *The Ground of Induction* (1947), and which makes use of the statistical law of large numbers, is in principle sound. Stove advanced that argument to prove, of course, not that inductive inferences were justified in marble-and-urn cases, but that they were justified when what one is attempting to arrive at are laws – or, if one prefers, relevant cosmic regularities. In this, I think that Stove was mistaken. In the marble-and-urn case, one is arriving at a conclusion about the next marble drawn from the urn based on a random selection of marbles from the urn. Any marble in the urn could have been among the marbles drawn earlier, and I think that this is crucial. But when one is attempting to show that it is reasonable to believe that there are certain laws of nature, one's observations are not being selected randomly from the totality of events, since there is no possibility of future events being part of one's sample.

A way of thinking about this is to consider a case where there are two urns containing marbles, and all of the drawings of marbles are from the same urn. The law of large numbers, properly formulated, can surely **not** be used to arrive at any conclusions concerning marbles in the **other** urn. But if this is right, then how could it be otherwise when one replaces urns with distinct spatiotemporal regions – namely, the past and the future?

In short, arriving at statistical conclusions about a population that one has sampled extensively, and arriving at laws, or nomologically based probabilities, are very different things. So, for example, if observations of drawings involving one urn led to the conclusion that some law was involved – imagine, for example, that the drawing of a red marble was always followed by a drawing of a green marble, and vice versa – then one could project that finding from the one urn to the other. But statistical information about the colors of marbles in one urn cannot be thus projected, and it seems to me that the same is true when references to urns are replaced by references to distinct spatiotemporal regions, however large the latter may be.

5. Thomas Bayes and the Justification of Induction

The idea that the concept of logical probability is relevant to the justification of induction goes back a long way – in particular, it goes back to Hume's own time. Thus, of the possible responses to Hume's skepticism concerning induction, the most interesting and the most important, in my opinion, is found in Thomas Bayes' posthumously published "An Essay Towards Solving a Problem in the Doctrine of Chances" (1763). But Bayes does not refer to David Hume, who was born in 1711 and died in 1776, and I suspect that Bayes was unaware of Hume's argument for the conclusion that induction is unjustified. But equally, one suspects, Hume was completely unaware of Bayes' argument – as are almost all present-day philosophers, Bayesians included.[1]

In brief, after proving a number of minor things, including the theorem that now bears his name, Bayes went on to consider what was once often referred to as the problem of 'inverse probability', where this is the matter of determining the probable distribution of some unobserved (or unobservable) variable given information about the distribution of some known variable that depends upon the unknown variable. So, for example, given information about how many times an uneven, weighted coin has landed heads in a given number of tosses, if one thought that the outcome of such tosses depended upon an unobservable propensity of the coin to land heads, determining the inverse probabilities would be a matter of determining the probabilities of different possible propensities.

6. The Problem of Justifying Induction

Given the idea of inference to the best explanation, briefly discussed in an earlier lecture, it is natural to think that if one wants to find a justification for induction, starting out from the idea of inference to the best explanation is the way to go. It seems to me, however, that that is not the route that one should travel, since it seems to me that a principle of inference to the best explanation is not at all a plausible candidate for a **fundamental** principle of inductive logic. (I shall not, at this point, explain why I think that that is so, but this is something that we can discuss later.)

6.1 Rudolf Carnap and Inductive Logic

If it is a mistake to think of some principle of inference to the best explanation as a fundamental principle, how should one approach questions concerning inductive

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[1] I am very indebted to Graham Oddie for drawing my attention to Bayes' essay, and its importance.

inference? Here I have been strongly influenced by Rudolf Carnap's book *Logical Foundations of Probability*, and it seems to me that what one needs to do is to think in terms of the concept of **logical probability**.

Any such system of logical probability, to be satisfactory, has to rest upon fundamental principles of equiprobability. Carnap, in his approach, thought in terms of two main alternatives. One involved treating what he called "state descriptions" as equally probable. The other involved treating what he called "structure descriptions" as equally probable. Let me describe a very simple type of world that will give those of you who are not familiar with these notions an intuitive grasp of the difference, since these two notions will be important in what follows.

Consider possible worlds where there are only three things – *a*, *b*, and *c* – and only two properties *P* and *Q*, where *P* and *Q* are incompatible with one another, and where everything must have one property or the other. Then, for each object, there are two possibilities: either it has property *P* or it has property *Q*. For the three objects, then, there are the following (2 *x* 2 *x* 2) = 8 possibilities:

State description 1: *a* has *P* and *b* has *P* and *c* has *P*

State description 2: *a* has *P* and *b* has *P* and *c* has *Q*

State description 3: *a* has *P* and *b* has *Q* and *c* has *P*

State description 4: *a* has *Q* and *b* has *P* and *c* has *P*

State description 5: *a* has *P* and *b* has *Q* and *c* has *Q*

State description 6: *a* has *Q* and *b* has *P* and *c* has *Q*

State description 7: *a* has *Q* and *b* has *Q* and *c* has *P*

State description 8: *a* has *Q* and *b* has *Q* and *c* has *Q*

Each of these eight possibilities is a state description.

Next, there is the idea of a structure description. The basic idea is that a structure description indicates only how many things have various properties and combinations of properties, but does not indicate which particular objects have the various properties. So continuing with the example of worlds that contain just the three particulars *a*, *b*, and *c* and the two incompatible properties *P* and *Q*, one has the following four possible structure descriptions:

Structure description 1: All three things have property *P*

Structure description 2: Two things have property *P*, and one has property Q

Structure description 3: One thing has property *P*, and two have property Q

Structure description 4: All three things have property *Q*.

Given these two ideas, one possible way of defining logical probability is by treating all state descriptions as equally likely, while another is to treat all structure descriptions as equally likely. These two different choices will lead to different results, as is clear from the fact that while structure description 1 corresponds to just the one state description – namely, state description 1 – structure description 3 includes state descriptions 5, 6, and 7.

Of these two approaches, the first seems very natural, while the second has no evident rationale. But Carnap set out an argument, which we shall consider shortly, for the conclusion that if one treated state descriptions as equally likely, the result would be that one could never learn from experience. As a result, he went with a definition of logical probability based on the idea that all structure descriptions are equally likely.

6.2 Thomas Bayes' Essay

Thomas Bayes is, of course, a very well known figure, with a very familiar theorem that bears his name. But that theorem is trivial, and was only a miniscule part of his essay. Bayes was interested in proving much more substantial – in particular, theorems bearing upon the following problem which he states at the very beginning of his essay:

Given the number of times in which an unknown event has happened and failed:

Required the chance that the probability of its happening in a single trial lies somewhere between any two degrees of probability that can be named.

But if one can solve this problem, if one can establish a formula relating the probability that the objective chance of a certain sort of event lies between certain bounds, given information about the relative frequency of events of the sort in question, then one has done something very substantial indeed, for one has then solved **the problem of justifying induction**. The question, then, is whether Bayes solved the problem of justifying induction, and did so in David Hume's own lifetime, and by a method that Hume never considered.

Now Hume, had he been aware of what Bayes had done, might well have objected that one could not make sense of the notion of **chance** with which Bayes was working. Hume would have been right that there was no way of analyzing that notion **at that time**. But it now seems clear that we are able to analyze that notion. If so, that sort of Humean objection can no longer be sustained, and we need to confront the question of whether Bayes did succeed in justifying induction.

My own view is that Bayes did not quite succeed, but that he was very much on the right track. Bayes' basic approach involved introducing the metaphysical idea of **chances**, or **propensities**, and then he adopted an equiprobability principle according to which, to put it a bit loosely, any two propensities of the same general type are **equally likely**.

My objection to this type of approach grows out of my interest in laws of nature. It is that I think that there are good reasons for holding that objective chances cannot be **ultimate** properties of things. Instead, **objective chances logically supervene on, and must be reduced to, causal laws of nature plus categorical properties and relations**. But if that is right, then a solution to the problem of justifying induction should be set out in terms of equiprobability principles that are formulated, not in terms of propensities, but, instead, in terms of **laws of nature**.

7. Analysis and New Alternatives in Metaphysics

The availability of a method of analyzing theoretical terms that is compatible with a non-reductionist interpretation of those terms opened the door not only to the possibility, for example, of defending indirect realism as an account of perceptual knowledge, but also to the possibility of non-reductionist analyses of a number of very important metaphysical notions, including the ideas of causation, of propensities and objective chances, of dispositional properties, and of laws of nature. Given the breakthrough in analysis, non-reductionist analyses of all of those concepts can now be given.

The possibility of setting out such analyses does not, of course, show that the concepts in question are metaphysically unproblematic. Thus it could turn out that just as in the case of the concept of a logically necessary person, where the vast majority of philosophers think that, although an analysis of that concept can be given, it turns out that the concept is such that it is logically impossible for there to be anything answering to that concept, so one might think, for example, that though one can offer non-reductionist analyses of causation, of propensities, and of laws of nature, it turns out, for some or all of those concepts, that it is logically impossible for there to be anything to which those concepts, thus analyzed, truly apply.

I shall not consider that issue here. What I want to do here, instead, is simply to explore the relevance of this issue, in the case of laws of nature, to the problem of justifying induction, and what I shall argue is that is that the justification of induction stands or falls with whether it is possible to set out a coherent non-reductionist account of laws of nature.

8. Reductionist Versus Non-Reductionist Accounts of Laws of Nature

One of the great divides in contemporary metaphysics is that between philosophers who defend reductionist approaches to such things as laws of nature and causation, and those who defend non-reductionist approaches. So let us consider this divide, in the case of laws of nature.

What is involved in a reductionist approach to laws of nature? There are various ways of explaining this, but here I think it will do simply to say that reductionist views of laws of nature involve the acceptance of something like the following thesis of Humean Supervenience:

All matters of fact logically supervene on states of affairs that consist of particulars having non-dispositional properties and standing in spatial, temporal, and spatiotemporal relations that do not involve causation.

A reductionist approach to laws of nature, then, is an approach that holds that laws of nature logically supervene upon those sorts of states of affairs involving particulars. A non-reductionist approach to laws of nature rejects this supervenience claim.

Can a non-reductionist approach be characterized in a more positive way, rather than simply in terms of a rejection of Humean Supervenience? The answer is that it can be, and the sort of account that I favor is essentially as follows:

Laws of nature are **atomic** states of affairs consisting of second-order relations between properties (universals) that, first of all, are not entailed by any set of Humean states of affairs, and that, secondly, in the case of non-probabilistic laws of nature, entail that some specific regularity involving Humean states of affairs obtains.

9. Non-Reductionism, Reductionism, and the Epistemological Challenge

9.1 The Challenge to Non-Reductionist Views of Laws of Nature

A common objection to non-reductionist approaches to laws of nature is that, in postulating the existence of states of affairs that involve something more than Humean states of affairs, there is no way of justifying the belief in the existence of the extra ontological items that are being postulated. Thus Barry Loewer, for example, in his paper "Humean Supervenience", claims, "The metaphysics and epistemology of Humean laws, and more specifically, Lewis-laws, are in much better shape than the metaphysics and epistemology of the main anti-Humean alternatives."[2] Loewer himself does not really offer much support for the epistemological part of this claim. But this type of epistemological objection is certainly defended by others, most notably, perhaps, by John Earman and John T. Roberts, who devote a two-part, 56-page paper in *Philosophy and Phenomenological Research* to an attempt to establish this objection.[3]

9.2 The Challenge Reversed

A crucial claim, then, which reductionists with regard to laws of nature advance, is that non-reductionist approaches to laws of nature face a serious epistemological challenge: How can one possibly be justified in believing in the existence of anything more that cosmic regularities? How can one be justified in believing in the existence of strong laws of nature, understood as atomic states of affairs involving second-order relations between universals that are supposed to underlie, and provide a basis for, regularities? Reductionists with regard to laws of nature generally are confident, moreover, that this challenge cannot be met.

In what follows, I shall attempt to do two things. First of all, I shall refer to some things that can be proven that together show that if **strong** laws of nature are **not** logically possible, then a belief in **reductionist** laws of nature cannot only not be justified: it can be shown to be unjustified. Secondly, I shall then cite other results that can also be proved, which show that if, on the contrary, strong laws of nature **are** logically possible, then it can be shown that certain inductive inferences are justified.

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[2] Barry Loewer, "Humean Supervenience," *Philosophical Topics*, 24 (1996), 101-27, and reprinted in John W. Carroll (ed.), *Readings on Laws of Nature* (Pittsburgh: University of Pittsburgh Press, 2004), 176-206. See page 177 of the latter.

[3] John Earman and John T. Roberts, "Contact with the Nomic: A Challenge for Deniers of Humean Supervenience about Laws of Nature Part I: Humean Supervenience," *Philosophy and Phenomenological Research*, 71/1 (2005), 1-22, and "Contact with the Nomic: A Challenge for Deniers of Humean Supervenience about Laws of Nature Part II: The Epistemological Argument for Humean Supervenience," *Philosophy and Phenomenological Research*, 71/2 (2005), 253-86.

10. Reductionist Approaches to Laws of Nature and Inductive Skepticism

The results that I have in mind depend upon whether, in formulating inductive logic, one assumes that all **state** descriptions are equally probable, or whether, as Carnap thought, all **structure** descriptions are equally probable. I shall not, at this point, offer a technical explanation of those two technical notions, since I think that the mini-world example offered earlier should suffice for present purposes.

Let me, then, simply state some results. In doing so, I shall often refer to a concrete case of the relevant theorem, rather than formulating it in a general and very abstract way. Finally, all of these results are predicated on the assumption that **strong** laws of nature are **not** logically possible.

The first two results are based on the assumption that the correct equiprobability assumption on which to base one's inductive logic is that it is **state** descriptions that are equally likely. Given that assumption, one has the following two results

Result 1

Suppose, for concreteness, that there is an urn that contains a million marbles, each of which is either red or green. Given no information at all, what is the probability that the millionth marble drawn from the urn is red? The answer is $\frac{1}{2}$. Suppose, now, that 999,999 marbles have been drawn from the urn, and that all of them are red. What is the probability, given that information, that the millionth marble drawn from the urn is red? The answer is still $\frac{1}{2}$.

Conclusion: If strong laws of nature are logically impossible, and all state descriptions are equally probable, then one cannot learn from experience.

Result 2

Suppose, first, that, through the total history of the world, there are an infinite number of things that are *F*. Suppose, further, that a billion things that are *F* have been observed, and that all of them were *G*. What is the probability that that all *F*s are *G*s? The answer is that that probability is either equal to zero, or, if one accepts infinitesimals, infinitesimally close to zero.

Suppose that, somewhat disheartened by those two theorems, a reductionist with regard to laws of nature follows Carnap's lead, and defines logical probability based on the proposition that it is **structure** descriptions, not state descriptions, which are equally likely. Then one has the following theorem:

Result 3

If property *G* does not belong to a family of positive, incompatible properties, then given only the information there are *n* *F*s, and that all of them have property *G*, the probability that the next *F* will also have property *G* is equal to $\frac{n+1}{n+2}$.

(This is Laplace's famous Rule of Succession.)

Now this is a cheering result. The more *F*s one observes, all of which have property *G*, the more likely it is that the next *F* has property *G*. So one can learn from experience.

But one also has the following theorem:

Result 4

Suppose, once again, that, through the total history of the world, there are an infinite number of things that are *F*. Suppose, further, that a billion things that are *F* have been observed, and that all of them were *G*. What is the probability that that all *F*s are *G*s? The answer, once again, is that that probability is either equal to zero, or, if one accepts infinitesimals, infinitesimally close to zero.

Results 2 and 4 look depressing if one holds that strong laws of nature are logically impossible. But Hans Reichenbach offered an interesting argument for the following theorem:

Result 5: If probabilistic laws of nature are logically possible, then no evidence can ever make it likely that a **non-probabilistic** law obtains.

If Reichenbach is right, then one can never confirm any non-probabilistic law, and so Results 2 and 4 need not trouble the reductionist with regard to laws.

Happiness for the reductionist, however, is short-lived. For, first of all, if one returns to the idea of defining logical probabilities based on the proposition that all **state** descriptions are equally likely, one can then prove the following theorem:

Result 6

Suppose, for concreteness, 1000 *F*s have been examined, and all 1000 have turned out to be *G*s. What is the probability that, if 1000 more *F*s are examined, 90% of the combined set of 2000 *F*s will be Gs? The answer is that it is 2.04944×10^{-86}.

This is a rather small number. What it illustrates is that the combination of a reductionist approach to laws of nature with a state description approach to logical probability is not going to allow one to be able confirm the existence of some law or other to the effect that the probability that an *F* is a *G* is equal to *k*, where *k* falls in some moderate interval in the vicinity of the number one.

Suppose, finally, that one shifts, once again, from a formulation of logical probability that treats state descriptions as equally likely to a formulation that treats **structure** descriptions as equally likely. Does that save the reductionist? The answer is that it does not, since one can prove the following theorems:

Result 7

Suppose that 1000 *F*s have been examined, and all of them have turned out to be *G*s. What is the probability that, if 1000 more *F*s are examined, 90% of the combined total of 2000 *F*s will be *G*s? The answer is that the probability is just over 20%.

Result 8

Suppose, finally, that one billion *F*s have been examined, and all of them have turned out to be *G*s. Suppose, further, that in the total history of the universe, there are an **infinite** number of *F*s. What is the probability that 90% of all the *F*s will be *G*s? The answer is that the probability is equal to 10%.

The moral, I suggest, seems clear: if one embraces a reductionist approach to laws of nature, then regardless of whether one adopts a state description approach to inductive logic or a structure description approach, one will not be able to avoid the following conclusion: **No interesting scientific hypothesis concerning laws of nature can be confirmed**.

11. Families of Properties and the Epistemology of Strong Laws of Nature

So how are things epistemologically if strong laws of nature **are** logically possible? The answer to that question depends upon the idea that the most basic equiprobability principle is one that is formulated, not in terms of either state descriptions or structure descriptions, but in terms of families of properties. One way of formulating such a principle is as follows:

Equiprobability and Families of Properties

Given any family of incompatible properties, if *P* and *Q* are any two members of such a family, then the *a priori* probability that *a* has property *P* is equal to the *a priori* probability that *a* has property *Q*.

Given such a principle, if strong laws of nature are logically possible, and if they can take the form of certain atomic states of affairs consisting of irreducible second-order relations among universals, then certain sets of such second-order relations will be families of relations. Accordingly, one can apply the equiprobability principle just stated to such families of nomic relations, thereby generating equiprobability conclusions **concerning laws of nature**.

Given this starting point, one can then work out the probability that a strong law of nature, falling within a certain range, does obtain, given information about events that would fall under such a law if it did exist. Doing this involves a somewhat complicated calculation, especially because one has to take into account the possibility of **probabilistic** laws connecting being *F* with being *G*. But I can set out a table that will make it evident that if one accepts the idea of strong laws of nature, the epistemology of laws of nature is in reasonably good shape.

First of all, however, I need to explain some notation:

"${}_{a}L_{1}$" means "There is some number *k* such that it is a law that the probability that something that has property *F* has property *G* is equal to *k*, where *k* lies in the range from *a* to 1."

"Q^{n}" means "*n* particular things that have property *F* all have property *G*."

"M_{2}" means "*G* does not belong to a family of positive properties, so that the only possibilities are either having property *G*, or not having it."

"$\Pr(q/p) = m$" means "The logical probability that *q* is the case given that *p* is the case is equal to *m*."

So "$\Pr\left({}_aL_1/Q^n\ \&\ M_2\right) = m$" means "The probability that there is some number *k* such that it is a law that the probability that something that has property *F* has property *G* is equal to *k*, where *k* lies in the range from *a* to 1, given that *n* particular things that have property *F* all have property *G*, and that *G* does not belong to a family of positive properties is equal to *m*."

Result 9

If *a* = 0.99, then the value of $\Pr\left({}_aL_1/Q^n\ \&\ M_2\right)$ is given by the following table:

Value of *n*	$\Pr\left({}_aL_1/Q^n\ \&\ M_2\right)$
1	0.000199
10	0.003140791
100	0.159292545
200	0.404718644
300	0.60791531
400	0.750963679
500	0.844923366
1000	0.986867122

What this table shows is that if it is **possible** for there to be strong laws of nature, then the probability that it is either a deterministic law that all *F*s are *G*s or else that there is a probabilistic law to the effect that the probability that something that is *F* is also *G* is equal to *k*, where *k* lies in the range from 0.99 to 1, can be raised to quite high values by a relatively small number of instances.

Summing Up

A very promising approach to the solution of the problem of justifying induction involves making use of the idea of logical probability. But the prospects for such an approach depend crucially upon the metaphysics of laws of nature. The reason, as we have just seen, is that, on the one hand, there are theorems that provide excellent reason for thinking that if strong, governing laws of nature are **not** logically possible, then no laws of nature can ever be confirmed, while, on the other hand, there are other theorems that provide excellent reason for thinking that that if strong laws of nature **are** logically possible, then the existence of such laws can be confirmed, and thus that induction can be justified.