Hamilton College
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Class 5 - Reflective Equilibrium in Science

I. From Foundationalism to Science

Sellars argued that the foundationalist's claim that there are some secure, infallible, immediately-justified beliefs was a myth, the myth of the given.
In place of this foundationalist myth, he argues for the security of scientific theory, based on its rationality and its holistic character.
We have thus traveled from the traditional problem of establishing foundations for knowledge to the more specific problem of grounding the rationality of science, as a corporate body.
Over the next two classes, we will look more closely at the methods of science and some associated problems.

II. The Humean Problem of Induction

Much of Goodman's article is dedicated to the problem of confirmation.
The problem involves specifying the connection between a general claims and a particular statement, between a theory and an observation.
In science, we generally want to summarize myriad diverse experiences, reducing them (in some sense) to a small set of general principles.
For example, we might see an apple fall to the ground.
Then another, and another.
We can summarize all these individual events as AG.

AG All apples fall to the ground.

AG is partly general, in that it applies to all apples, and partly limited, in that it applies only to apples.
We might then notice that pears and peaches and oranges also fall to the ground.

FG All fruit falls to the ground.

FG represents an increase in the generality of AG, but is still limited to fruit.
We might further notice that some objects other than fruit also fall to the ground.
We could propose OG.

OG All objects fall to the ground.

OG is satisfyingly general.
It looks a lot like something we would be happy to call a law of nature.
But, as it stands, OG is unfortunately false.
It entails that smoke and steam and helium balloons are not objects.
We have to refine OG, replacing a rough concept like 'falling to the ground' with concepts like density, force, and gravity.
Indeed, Newton's work on gravity unified accounts of terrestrial and celestial motions, making the laws of motion maximally general, since they apply to any two objects, whether on the Earth or in the sky.

HG	$F = Gm_1m_2/r^2$

NG applies to any two physical objects.
It does not apply to mathematical objects or propositions, though.
We might, if we were feeling holistic, take 'gravity' and 'physical object' to be inter-defined terms.
An object is physical if it is subject to NG.
An object is subject to NG if it is physical.
Still, NG is an incomplete description of the motion of objects.
To describe fully the motion of a particular object, we have to introduce other forces, ones which act at the same time as gravitational force: electro-magnetic force and nuclear forces.

We want scientific theories to be general, summary claims, applying to as many specific cases as possible.
The process by which we organize a limited number of experiences into a general claim is, of course, called induction.
What is called Hume's problem of induction is that the inference from the specific to the universal, even in AG, involves appeal to something like claims about causal connections.
That is, if we want statements like AG, FG, and NG to apply to future and unseen fruit (and other objects), then we need to introduce something like a law of the uniformity of nature, some claim that the future and unobserved will be like the present and observed.

> The typical writer begins by insisting that some way of justifying predictions must be found; proceeds to argue that for this purpose we need some resounding universal law of the Uniformity of Nature, and then inquires how this universal principle itself can be justified. At this point, if he is tired, he concludes that the principle must be accepted as an indispensable assumption; or if he is energetic and ingenious, he goes on to devise some subtle justification for it. Such an invention, however, seldom satisfies anyone else; and the easier course of accepting an unsubstantiated and even dubious assumption much more sweeping than any actual predictions we make seems an odd and expensive way of justifying them (61-2).

That is, from our experiences, we can only conclude claims like AGH, FGH, and NGH.

AGH	All observed apples have fallen to the ground.
FGH	All observed fruit has fallen to the ground.
NGH	$F = Gm_1m_2/r^2$, as far as we have observed.

Hume's solution to this problem, as Goodman notes, is to give up any claims about uniformity in nature, and to explain our claims in terms of our expectations.
We form mental habits, when seeing falling fruit.
We are built, it turns out, in such a way that our minds develop expectations that the future will be like the past, that when we see apples untethered, our past experience leads us to believe that they will fall, rather than rise or hover.
We need not claim insight into the inner workings of nature (of apples or causation) to make this conclusion.
We need merely observe that this is the way that we work.
Even our expectations are likely to be governed by laws of nature.

III. The New Riddle of Induction

Goodman's new riddle of induction proceeds from an observation that Hume's solution is missing a step.

> Regularities in experience, according to him, give rise to habits of expectation; and thus it is predictions conforming to past regularities that are normal or valid. But Hume overlooks the fact that some regularities do and some do not establish such habits; that predictions based on some regularities are valid while predictions based on other regularities are not (82).

Hume proceeds on the supposition that we know what to expect.
But, consider two simple and well-known cases, variations of which Goodman mentions in passing.
Imagine we are in a room in which all the persons are first-born children of their parents.
Contrast this situation with one in which we discover that copper conducts electricity.
In the latter case, we are led to believe that the next piece of copper we encounter will conduct electricity.
In the former case, we are not led to believe that the next person who enters the room will be first-born.
In each case, we are presented with regularities.
But only in some cases are we led (by habit) to expect that this regularity will continue to apply, that we have, in summarizing the observed facts, discovered a law of nature, one which will allow us to predict future events.

The difference between the copper case and the first-born case is that one is lawlike and the other is not.
But, to say that one is lawlike and the other is not is merely to restate the problem, not to solve it.
The question remains how to characterize the difference between lawlike and non-lawlike generalities.

> Only a statement that is *lawlike* - regardless of its truth or falsity or its scientific importance - is capable of receiving confirmation from an instance of it; accidental statements are not. Plainly, then, we must look for a way of distinguishing lawlike from accidental statements (73; Compare also 76-7).

Philosophers, mainly inspired by the philosophy of science developed by the logical empiricists and those that followed them, worked hard on developing a syntactic (or logical) criterion for lawlikeness.
Goodman reviews some of their proposals, but we will not discuss them.
I will merely mention that the problem appears not to admit of a purely formal, syntactic solution.
It is a scientific problem, not a logical one.

Goodman's new riddle of induction is designed to demonstrate the recalcitrance of the problem of distinguishing regularities in nature.
Consider the property called 'grue'.[1]
An object is grue if it is green until 1/1/2020, when it turns blue.
How can you tell if a plant, or an emerald, is green or grue?
All evidence for its being green is also evidence for its being grue.
Green things and grue things are exactly alike until 2020.
Any laws which would refer to green things could easily refer to grue things.
We could not, in principle, distinguish the green things from the grue things.

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[1] I present a simplified version of 'grue' which leads (I believe) to the same conclusion.

Similarly, we could not, in principle, be sure we were picking out pressure, rather than shmessure, volume rather than shmolume.

One objection to 'grue' and related deviant predicates is that they are not simple, or uniform, or purely qualitative.
But, grue is complex only if we start with the predicates green and blue.
Consider that something is bleen if and only if it is blue until 1/1/2020 and then turns green.
If we start with grue, then an object is green if and only if it is grue until 1/1/2020, and then turns bleen.
And, an object is blue if and only if it is bleen until 1/1/2020, and then turns grue.
That is, we can define green and blue in terms of grue and bleen just as easily as we can define grue and bleen in terms of green and blue.

The problem of determining which statements are lawlike is thus extended to the very predicates we use.
We want to say that 'green' is a lawlike predicate and 'grue' is not, but we need a reason to say so.
Just labeling the two predicates merely emphasizes the question.
It does not provide an answer.

While 'grue' is, in the words of David Lewis, a "hoked-up gerrymander," the problem can be seen in less abstruse cases, as well.

GS	All gold spheres are less than one mile in diameter.
US	All uranium spheres are less than one mile in diameter.

GS and US are identical in grammar and logical form.
Yet GS is not a law and US is a law.

IV. Justifying Inferential Practices

Goodman's riddle concerns how to characterize the relation between a particular statement and a general theory.
The riddle is evidence for the claim that such a relation is not easily characterized.
Goodman's riddle has had a lasting effect on the philosophy of science.
Our concern is how to proceed in the post-foundationalist world that Sellars describes.
Sellars argues that the justifications of our beliefs could not be based in the infallibility of some foundational experiences or claims.
Instead, our epistemic confidence arises from the rationality of science.
Goodman's discussions of induction are couched within an influential claim about epistemological methods which appear early in the lecture.

We successfully perform inductions and we successfully perform deductions.
A traditional epistemologist might claim that deductions are certain, and that there is some fundamental problem with inductions.
Goodman argues that induction and deduction are justified in the same ways.

Goodman first makes a radical departure with the traditional view that our deductive rules are justified by something like rational insight.

> How do we justify a *de*duction? Plainly by showing that it conforms to the general rules of deductive inference. An argument that so conforms is justified or valid, even if its conclusion happens to be false... Principles of deductive inference are justified by their conformity with accepted deductive practice. Their validity depends upon accordance with the particular deductive inferences we actually make and sanction. If a rule yields unacceptable inferences, we drop it as invalid. Justification of general rules thus derives from judgments rejecting or accepting particular deductive inferences (63-4).

According to Goodman, it is not that we have *a priori* insight into the correctness of abstract, general principles of deduction.
Instead, we have simple beliefs, perhaps intuitions, about which inferences are acceptable.
We formulate deductive principles which accord with these inferences.
We accept inferences which follow the deductive principles we construct.
Precisely the same method is applied in cases of induction.

> An inductive inference, too, is justified by conformity to general rules, and a general rule by conformity to accepted inductive inferences. Predictions are justified if they conform to valid canons of induction; and the canons are valid if they accurately codify accepted inductive practice (64).

The new riddle of induction and the problems of confirmation are thus subsidiary to Goodman's central claim.
They are difficulties in specifying the inductive canon.
But, the existence and function of the canon, and the process which brings together the validations of induction and deduction, is the central claim.

In the following section, Goodman provides an example of this process, though transplanted to the introduction of a general term, rather than a general (inductive) law.
Consider the introduction of a the term 'tree'.
We see that there are some similarities in our environment (elms, maples, oaks).
We introduce a general term, 'tree' to apply broadly to the elms and maples and oaks, and not to apply to the mountains or cats or grass.
Once we introduce this term, we look for some explanation of what makes something a tree, we look to determine some essence or unifying principles.
Once we have found unifying principles, we can use them to determine whether borderline cases (e.g. pomegranate shrubs, azaleas, geraniums) are, in fact, trees.
In some cases, we will discover that terms we have chosen do not apply to all the objects we thought they did.
'Fish' does not apply to whales, even if we originally introduced it to apply to all sea creatures.
Scientists discovered regularities and uniformities among the more-hidden properties of mammals and other fish which override their more obvious properties.

We might run into questions about how to proceed with usage.
We might, for example, not know how to proceed given Putnam's robot cats example.

In Putnam's case, we discover that the objects we call cats are really carefully-disguised robots from Mars.
So, they are not animals.
Do we continue to say that cats are animals, but there are no cats?
Or, do we say that cats turned out to be robots, not animals?
Our decisions how to proceed will ordinarily proceed according to scientific principles: which usage is simplest, most uniform, most parsimonious?

V. Circularity

We started this course by considering an epistemological paradox.

EP1	Beliefs must be justified either foundationally or coherently.
EP2	No beliefs can be justified foundationally.
EP3	No beliefs can be justified coherently.
EP4	Some of our beliefs are justified.

Our main evidence for EP2 attacked the plausibility of immediately-justified atomic beliefs.
Our main evidence for EP3 is a concern about consistent falsity.
A coherentist epistemology says that a belief is justified if it is consistent with our other beliefs.
Perfectly false sets of beliefs could be coherent, or consistent.
Sellars asks how such justifications could begin.

Goodman's account of justification appears to be circular, perhaps in coherentist fashion.
We justify our particular claims or beliefs in terms of general principles (whether inductive or deductive) from which they follow.
We justify our general principles in terms of the specific claims they yield.
If the general principles and the specific claims were false, though, we seem to be in the same trap as the coherentist.
How do we know that the whole consistent system is not flawed?

> This looks flagrantly circular... But this circle is a virtuous circle. The point is that rules and particular inferences alike are justified by being brought into agreement with each other. *A rule is amended if it yields an inference we are unwilling to accept; an inference is rejected if it violates a rule we are unwilling to amend*. The process of justification is the delicate one of making mutual adjustments between rules and accepted inferences; and in the agreement achieved lies the only justification needed for either (64).

Against Goodman, there is little here that defends his approach from anti-coherentist criticisms.
Calling a circle virtuous doesn't remove the problem.
In Goodman's favor, though, we have already seen the problems with foundationalism, and so we need a new epistemological approach.
The notion of a virtuous circle might be worth pursuing.
Defenders of Goodman would claim that, for example, the crystal ball's entreaties to believe the crystal ball are viciously circular, while the scientist's claims to believe the dictates of science would be virtuously circular.
Then, we would have to examine the distinction between good and bad science.

The problem of distinguishing between legitimate and illegitimate science is called the demarcation problem.
If we were to solve the demarcation problem, then we could (perhaps) accept Goodman's claim that the justification of inductive practices is virtuously circular.
(There is an interesting discussion of vicious and virtuous circles, regarding the analytic/synthetic distinction, in Quine's "Two Dogmas of Empiricism" and Jerrold Katz's response "The Refutation of Indeterminacy.")

The virtuous circle that Goodman defends has come to be known as reflective equilibrium.
The method of science, then, is one of balancing general theories with particular statements reporting observations or intuitions.
We can see that the problem of confirmation, and the new riddle of induction, are especially important.
For, according to reflective equilibrium, we must understand the connection between specific claims and general theories, exactly what the new riddle calls into question.

The term 'reflective equilibrium' was coined by John Rawls, as a decision procedure for theories of justice, as a tool for contemporary ethical theorizing.
In our next class, we will look more at the scientific (and philosophical) method that Goodman presents.
Then, we will move to the particular uses of reflective equilibrium in Rawls's *A Theory of Justice.*