There is No Scientific Method

What Science Is Really About

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Introduction

We all know what science is, right? A scientist sits down and makes an observation, then formulates a hypothesis to explain the data gathered from the observation, then predicts some outcome using the hypothesis as a model, and then performs an experiment to verify the prediction, thus arriving at some scientific truth. That is science right? The scientific method applied to a scientific problem?

In reality, the answer is no, science is not done that way by any practicing scientist. The only people who talk about the scientific method are philosophers and students preparing for science fairs, and even that is in some question.

The goal of science is not ultimate truth, it is the pursuit of a good theory. What do I mean by that? Read on and find out.

The Search for a Good Theory

We have been taught that scientific knowledge holds a special place because it is always verified by experiment. The non-scientist thinks that scientists uncover truths in their pursuits. Nothing can be further from the truth.

There is only one human pursuit that produces complete truth, and that is mathematics. The exalted position of mathematics is due to the fact that humans invented mathematics in the first place, and so all of mathematics is self-contained, as it were. In short, since we decided what constitutes mathematical truth, it is hardly surprising that we can find it.

Science, on the other hand, is not created by man. Nature is there, independent of us. Uncovering the rules is hard and necessarily incomplete. If there are rules that are beyond our understanding, then we will never be able to complete the trek for scientific knowledge. The best we can hope for is ever better theories to explain what we encounter on the way.

It is thus, that I make the statement that all of science is an effort to develop the best possible theory for the problem we are working on. You might ask, "Theory is too abstract, I want to measure

our way to truth." It will never happen without a theory. You might accidentally happen upon a measuring scheme, likely this happened when some primitive man noticed that a piece of wood was as long as his forearm and began comping things to it. The accident triggers the thought, but the thought is a theory, "I can use my arm to measure things." No measurement can take place until you have something to measure, the act of choosing to measure something requires a theory.

Thus, at its heart, science is about finding the best theory.

What Is a Good Theory?

How do we find a good theory? What are the criteria for a good theory? It seems that there are four primary criterion. This does not mean that you need all of them, though one of them is vital. There are many theories that are accepted that do not have all of them, or that have elements of all of them that are somewhat incomplete.

- The first test for a theory is that it must explain what we already know to be true about a problem. This first test means that any theory of gravity must contain within it all that we know to be true of gravity. If it does not, then it must explain in very great detail why it does not, or why what we currently know is false. When general relativity overturned Newton's theory of gravity, Einstein was able to demonstrate that his theory accounted for everything that we already knew.
- The second test for a theory is that it be able to make predictions of things we do not know now. If a theory only provides what we already know in a different way and offers nothing new, then it is not worth considering. Only when a theory extends our knowledge does it warrant consideration. Using general relativity again, the first major success was explaining the exact orbit of the planet Mercury, a thing that the Newtonian theory was incapable of doing.
- The third test for a theory is that it allows us to do things we could not do before. Not only does a successful theory make predictions, it rewires our brains to think in new ways. In general relativity it took many decades before the ramifications sunk in, rewiring the brains of J. Robert Oppenheimer and G. M. Volkoff to take seriously the idea of collapsed objects. This led to the theory of black holes, an entirely new way of looking at the world.
- The final test of a theory is that it must be testable. When a theory makes definite predictions, those predictions should be verified in nature or the laboratory. General relativity, again, predicted that light from stars would be bent on its way around the Sun. This was observed during a solar eclipse, a verification of a prediction.

As a final note for this section, a scientific theory is not mere speculation; it is the result of a great deal of work to make and verify predictions.

Who Judges a Theory?

It seems paradoxical that the only people really able to judge a scientific theory are those who use it. Scientists are the only ones who deal the with subtleties and complexities of their subjects of interest in enough depth to really understand that ramifications of a theory. One of the reasons for so much specialization in science is the requirement for expertise to be able to judge theories and thus be able to do science.

How Does a Theory Evolve?

So, now that you have a theory, that is it, right? No. Every theory that works evolves. One mark of a bad theory is one that does not change over time.

It is like building a house. You need a foundation, but that is not enough to have a house; so you are not satisfied with having only the foundation. You put in the floor, but that too is not enough; though you could l;live in the basement and use the floor as your roof. Is that a house? Not really, but it looks like what a house needs to be. You frame the walls and ceiling, it is getting closer now; and you really like the sturdiness supplied by the scaffolding — it really holds everything together. Now you take care of some details like plumbing and wiring. You put up the walls and the ceiling itself. You put in windows and doors. Then you paint it. Now, despite how much you like it, you must remove the scaffolding; it is no longer necessary. You have a house.

This is a lot like a theory. You decide on the elements you need for the theory. You gain them one by one, often using methods that later are not needed and must be discarded, no matter how much you like them.

Once you have a theory you must make predictions. If you can make them then they must be tested. If one time a test is failed then the theory is wrong. It must be either discarded or modified in a plausible way to account for the discrepancy.

In this way technology drives the evolution of a theory at the same time it is often driven by the theory. New methods come to light that allow you to make new predictions. New ways of thinking allow you to consider ideas you never would have thought of before. This is a very exciting process to be involved in, and one that changes all the time.

What is a Bad Theory?

We have thought about good theories. What is a bad theory? If you look at the list of good theory points, anything that actively goes against these ideas is a bad theory.

- A bad theory will not explain what we already know. It will be incomplete, often because the individual or individuals who developed it had some other agenda.

A bad theory will not be able to make predictions.

- A bad theory prevents us from doing things we could not do before.
- A bad theory is not testable. Any theory that prevents us from testing it is not truly scientific.