

Philosophy in Physics: Philosophical Concepts in Physics - Talk 2

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Deductive Reasoning

Deductive reasoning is a type of logical thinking that starts with a general idea and reaches a specific conclusion.

It's sometimes referred to as top-down thinking or moving from the general to the specific.

Example

All men are mortal. Anto is a man. Therefore Anto is mortal

From this we can see that this is like interpolation

Deductive reasoning seems simple but.....

Consider the following statement: If you are good, then I'll give you a gift.

From the given statement, we can tell that you will receive a gift under the condition that you are good.

But if you do receive a gift, does it mean that you were good? That is not necessarily true.

A shortcoming of this type of reasoning is that it depends upon the validity of the initial premises. Here, it is important to make sure that the initial premises are correct before drawing any logical conclusion from them.

Inductive reasoning

Inductive reasoning is an approach to logical thinking that involves making generalizations based on specific details

Inductive reasoning is a type of logical thinking that involves forming generalizations based on specific incidents you've experienced, observations you've made, or facts you know to be true or false.

Example

Every cat that you've observed purrs. Therefore, all cats must purr.

Like opposite to deductive, here it's like extrapolation

Deductive Reasoning vs. Inductive Reasoning

While Deductive Reasoning Uses a general idea to reach specific conclusion.

Inductive Reasoning Uses specific observations to reach a general conclusion.

Example

Deductive Reasoning: All street dogs are happy. Max is a street dog. Therefore, he is happy.

Inductive Reasoning: Max is a street dog. He is happy. All street dogs are happy.

We can see that this is like salt and pepper, they are different but we all know they goes together

Weird Couple !!!!

Causality

Causality (also referred to as causation, or cause and effect) is influence by which one event, process, state or object (a cause) contributes to the production of another event, process, state or object (an effect).

The cause is partly responsible for the effect, and the effect is partly dependent on the cause.

Rules of causality

- The first big rule of causality is that things have causes.
- Second, effects follow causes in a predictable, linear manner.
- Third, big effects can grow up from little causes.

Determinism

Causal determinism is, roughly speaking, the idea that every event is necessitated by antecedent events and conditions together **with the laws of nature**.

We can say this is like causality. And it is very very similar to causality. The only difference is determinism answer questions like 'How?' and 'When' in addition to 'Why?'

Instrumentalism

Instrumentalism is the view that scientific theories should be thought of primarily as tools for solving practical problems rather than as meaningful descriptions of the natural world.

Realism vs Instrumentalism

Consider Newton's theory of gravitation, a realist would remark that it teaches us of the existence, in addition to physical objects. An instrumentalist, on the other hand, will take the position that there are no such entities and He may even deny the existence of these objects

Scientific Realism

- Scientific realism is a positive epistemic attitude toward the content of our best theories and models, recommending belief in both observable and unobservable aspects of the world described by the sciences.
- This epistemic attitude has important metaphysical and semantic dimensions, and these various commitments are contested by a number of rival epistemologies of science, known collectively as forms of scientific antirealism.
- Debates about scientific realism are closely connected to almost everything else in the philosophy of science, for they concern the very nature of scientific knowledge.

No Miracle Theory

- The No Miracle Theory puts forth that our best theories are extraordinarily successful: they facilitate empirical predictions and explanations of the subject matters of scientific investigation, often marked by astounding accuracy and intricate causal manipulations of the relevant phenomena.
- One explanation for this, favored by realists, is that our best theories are true (or approximately true, or correctly describe a mind-independent world of entities, laws, etc.).
- Indeed, if these theories were far from the truth, the fact that they are so successful would be miraculous. And given the choice between a straightforward explanation of success and a miraculous explanation, clearly one should prefer the non-miraculous explanation, i.e; that our best theories are approximately true.

Hume's Criticism of Inductive Reasoning

- David Hume, an 18th Century British philosopher, historian, economist and essayist, had his own critical take on the concept of Inductive Reasoning.
- While he saw philosophy as a science of human nature at which's very heart lay experimentation and induction, he was critical of the approach towards Inductive Reasoning which he elaborated about in his works.
- Hume proposed that while we may observe that one event succeeds another, in cause and effect, it isn't necessary that these events are connected.
- There is no direct observation of a cause/connection for the supposed effect. In any given case, what we see might be events that may be associated but never connected, thereby rendering the terms cause and effect as words without a working meaning.

- In more elaborate terms, from the occurrence of constant conjunction, we infer a necessary connection. However, the difference between one such pair of events and many is that one is carried away to feel the existence of a necessary connection.
- Hume put forth the question: “What reason do we have to assume that future events would resemble past ones?”
- For example, consider Halley’s Comet, which is visible every 76 years. We have concluded Halley’s Comet will appear every 76 years based on observational data from centuries past. But can it be said with absolute certainty that it may appear again? No. There is also a good chance that it may never appear again.

It can, therefore be said that:

There is no way around the provisional character of physical laws gained by induction. Hence, while Hume did see the need for induction, he, however felt its validity to be unprovable given the way it didn't give any information about the nature of cause and effect in the futuristic sense.

Important Note

This criticism, however doesn't mean that inductive reasoning is not to be used as Hume himself said while he saw the need for inductive reasoning, he didn't see much validating it as a completely reliable method.

Criticism of No Miracle Theory

- One skeptical response is to question the very need for an explanation of the success of science in the first place.
- Bastiaan Cornelis van Fraassen suggests that since only successful theories survive, it is hardly surprising that our theories are successful, and therefore, it is just a circular argument and there is no demand here for an explanation of success.
- However, this could arise from one wondering why a particular theory is successful.

- Some authors contend that the miracle argument is, in fact, an instance of fallacious reasoning called the base rate fallacy.
- Consider this example:
 - There is a test for a disease for which the rate of false negatives (negative results in cases where the disease is present) is zero, and the rate of false positives (positive results in cases where the disease is absent) is one in ten (that is, disease-free individuals test positive 10 percent of the time).
 - If one tests positive, what are the chances that one has the disease? It would be a mistake to conclude that, based on the rate of false positives, the probability is 90 percent, for the actual probability depends on some further, crucial information: the base rate of the disease in the population (the proportion of people having it). The lower the incidence of the disease at large, the lower the probability that a positive result signals the presence of the disease.

Rationalists and Empiricists

Rationalism is defined as a methodology or a theory "in which the criterion of the truth is not sensory but intellectual and deductive".

Empiricism is a theory that states that knowledge comes only or primarily from sensory experience. It emphasizes the role of empirical evidence in the formation of ideas, rather than innate ideas or traditions.

- Each of these methodologies have their own shortcomings which we will look at below.
- We shall look at some examples below.

- As we have seen, Rationalists rely on reason and Empiricists rely on sensory perception and evidence.
- To understand both the ideas, let us take a look at a quote by Planck:

If we seek a foundation for the edifice of exact science which is capable of withstanding every criticism, we must first of all tone down our demands considerably. We must not expect to succeed at a stroke, by one single lucky idea, in hitting on an axiom of universal validity, to permit us to develop, with exact methods, a complete scientific structure. We must be satisfied initially to discover some form of truth which no skepticism can attack. In other words, we must set our sights not on what we would like to know, but first on what we do know with certainty.

Now then, among all the facts that we do know and can report to each other, which is the one that is absolutely the most certain, the one that is not open even to the most minute doubt? This question admits of but one answer: 'That which we experience with our own body.' And since exact science deals with the exploration of the outside world, we may immediately go on to say: 'They are the impressions we receive in life from the outside world directly through our sense organs, the eyes, ears, etc.' If we see, hear or touch something, it is clearly a given fact which no skeptic can endanger.⁷

- Even here, though, Planck attaches too much certitude to the reliability of what we observe with our senses. Not only can we misinterpret the stimuli that our senses send to the brain, but there remains the more serious question of interpreting the data we gather from observation and experiment.
- There have been cases in the history of science in which skilled scientists of the highest repute have 'seen' or 'verified', through observation and experiment, the prediction of some hypothesis, even though this prediction subsequently turned out not to correspond to reality and could not be reproduced by other observers.

- A good example: Dispute between Robert Millikan (1868-1953), who eventually received the 1923 Nobel Prize in physics for his observations of the electron as the fundamental and indivisible unit of negative electric charge, and Felix Ehrenhaft (1879-1952) of Vienna, who, along with his colleagues, obtained data that seemed to show the existence of electric charges much smaller than that of Millikan's electron.
- Subsequent attempts by others to reproduce Ehrenhaft's results were unsuccessful, so that Millikan's view prevailed.
- It seems as though Ehrenhaft misinterpreted his data, perhaps largely because he believed that electrical charge should be continuously divisible. There have also been suggestions that Ehrenhaft was not always as careful as he ought to have been in his experiments.

- It should be noted, however, that this doesn't question the integrity of Ehrenhaft or Millikan, but rather points out how one (Millikan, in this case) being a highly skilled observer and careful worker is quite crucial.
- In Ehrenhaft's case, the difficulty arose in the interpretation of data and with the influence that one's expectations had on this interpretation.
- Although having entered these cautions against Planck's claim of the importance and reliability of sense data, we must still appreciate that such data are what remain more or less intact as theories come and go.

Law of Contiguity and Antecedence

Antecedence postulates that the cause must be prior to, or at least simultaneous with, the effect.

Contiguity postulates that cause and effect must be in spatial contact or connected by a chain of intermediate things in contact.

- It is to be noted that not all theories posited obey the Law of Contiguity and even in some cases don't obey antecedence itself.
- We shall look at some examples below.

Galileo

- Galileo, as we know relied upon observations and past works of Copernicus to arrive at his theories.
- Galileo was experimenting with terrestrial objects according to the rules of repetition and variation of conditions.
- Galileo observed how a falling body moves, and studied the conditions on which the motion depends. His results can be condensed into the well-known formula for the vertical coordinate of a small body or particle, as a function of time:

$$z = -\frac{1}{2}gt^2 \quad (1)$$

- The law basically states that if the position and the velocity of a particle are given at any time, the equations determine its position and velocity at any other time.
- This shows that Galileo's law does not conform to the postulate of antecedence: a given initial situation cannot be regarded as the cause of a later situation, because the relation between them is completely symmetrical; each determines the other.
- However, this goes against the postulate of contiguity which was violated by Galileo's law since the action of the earth on the moving particle needs apparently no contact.

Kepler's Laws

- The three laws:
 - First Law: Planetary orbits are elliptical with the sun at a focus.
 - Second Law: The radius vector from the sun to a planet sweeps equal areas in equal times.
 - Third Law: The ratio of the square of the period of revolution and the cube of the ellipse semimajor axis is the same for all planets
- It is a good example of inductive reasoning and realism.
- Kepler tried to figure out the motions of other planets in the solar system using the observations of one planet, so Law of Contiguity wasn't followed in this case.

Newton

- Unlike Galileo, Newton's observations for his work in astronomy was purely observational and restricted.
- Newton applied Galileo's method to the explanation of celestial motions. The material on which he based his deductions was less for at that time only six planets (including the Earth) and a few satellites of these were known.
- Newton's work obviously followed Antecedence but we will now see how it also followed the Law of Contiguity
- The Moon and the other planetary satellites were then the material for the induction which led to the generalization of a mutual attraction of all bodies towards one another.

- The most amazing step, admired by Newton's contemporaries and later generations, was the inclusion of terrestrial bodies in the law derived from the cosmos.
- By applying his laws of motion to the system earth-moon, he could calculate Galileo's constant of gravity g from geodetical and astronomical data:

$$g = \frac{4\pi^2 R^3}{r^2 T^2} \quad (2)$$