Technology, Science and Philosophy

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Important distinctions

- Know the difference with epistemology and metaphysics.
- Epistemology deals with knowledge. Terms that are epistemic are for example: evidence, inference, belief, induction, credence etc.
- Metaphysics is about being. What exists in the world? Science tells us that atoms exist. That is a metaphysical claim.

Episteme and techne

- What do we mean by technology?
- What is the difference between technology and science?
- An ancient distinction between episteme and techne.
- Epistemic has to deal with knowledge
- Techne with arts/crafts (with some caveats)

Let's start with science

- One way to answer the question is to point to the different sciences and give examples of the sciences.
- Natural Science: Biology, Physics, Chemistry, Geology. Or do we look at sub disciplines? Like molecular biology and marine biology.
- Social Science: Economics, Sociology, Anthropology, Psychology.
- What about Math?

Philosophy of Science

- - Philosophy of science is epistemology and metaphysics.
- - In science there are also ethical issues.
- - Questions to think about:
  - » What is science?
  - » Why is science important?
  - » Does there exist a scientific method?

Science is…….

- "Science is an enormously successful human enterprise. The study of scientific method is the attempt to discern the activities by which that success is achieved. Among the activities often identified as characteristic of science are systematic observation and experimentation, inductive and deductive reasoning, and the formation and testing of hypotheses and theories. How these are carried out in detail can vary greatly, but characteristics like these have been looked to as a way of demarcating scientific activity from non-science, where only enterprises which employ some canonical form of scientific method or methods should be considered science (see also the entry on science and pseudo-science). On the other hand, more recent debate has questioned whether there is anything like a fixed toolkit of methods which is common across science and only science."

http://stanford.library.sydney.edu.au/entries/scientific-method/#PriMetGolSta

What is meant by success?

Confirmation/verification

- The establishment of the truth of a claim through the proper use of observation and experiment.
- Verify the claim that it is snowing outside.
- What is a confirming instance?
- Do scientists collect truth about the world? Do we get increased confirmation of our world view?

Demarcation

- A line or property that separates one thing from another. In philosophy of science, we speak of a demarcation between science and non- science or pseudoscience.
- Astrology as a pseudoscience. Astronomy as a science.
- What is the difference?

Empiricism

- The thesis that all knowledge of the world is justified by experience through the senses.
- Knowledge is *a posteriori*.
- We learn through experience.
- It is raining, he is a wearing a blue hat, the chair is gray.
- Rationalism emphasizes knowledge through rational deliberation.

Observable/unobservable

- A lot of scientific posits are unobservable to the naked eye.
- DNA, atom, electron etc.
- They are part of the scientific ontology.
- But are they problematic?
- Observation statements.

Falsification/refutation

- The demonstration that a statement is false by finding a counterexample (an observation of the physical world that is incompatible with the statement).
- Negative knowledge. To know that something is not a x.
- We explore our options and exclude the false ones.

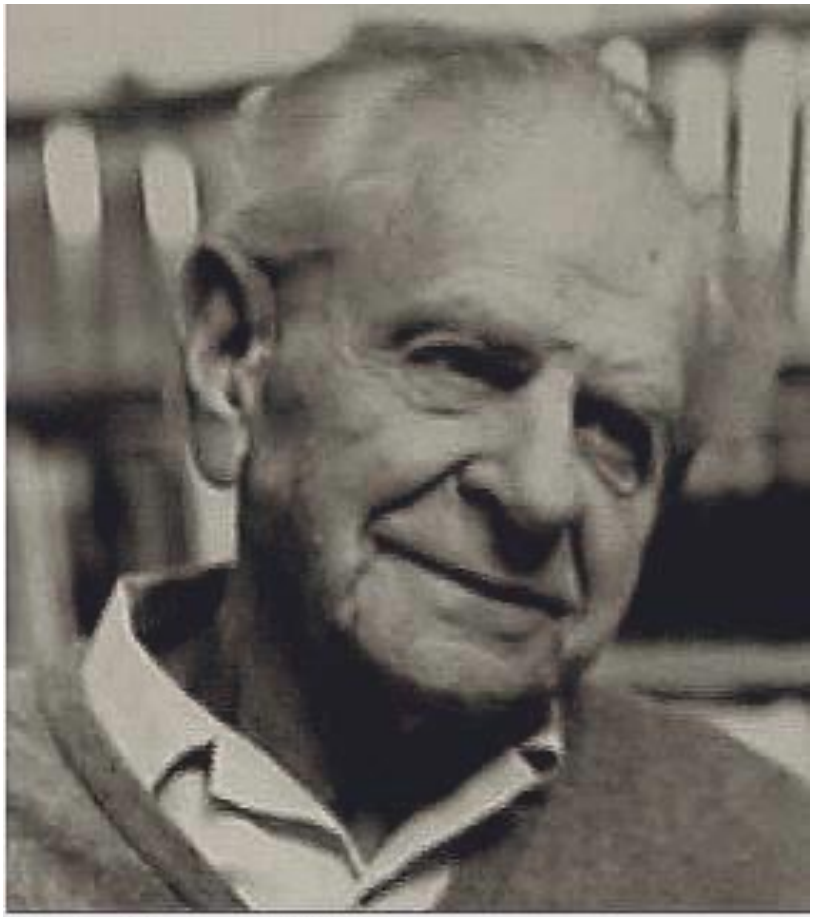
Pseudoscience

- A term that describes a system of claims that aspires to be scientific but which, for some particular reason or reasons, fails to meet the minimum conditions for being science.
- What is the difference between science and pseudoscience?

Testability

- A property of a statement (theory, law, etc.) that indicates that definite consequences for observation can be inferred from the statement and compared with actual observation to see whether the inferred consequences come true.

Karl Popper (1902-1994)



Sir Karl Popper (1902-1994)

- Advocate of the falsificationist view of science.
- Gives a clear answer on what the methodology of science.
- Solves the demarcation problem.

Induction

- A conclusion that is drawn from premises in such a way that, if the premises are all true, the conclusion has some support but is not guaranteed to be true.
- The opposite of deduction.
- All swans are white is inferred from a number of white swans.

Francis Bacon (1561–1626)

- The method of science is induction.
  - ”There are and can be only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immovable, proceeds to judgment and to the discovery of middle axioms. And this way is now in fashion. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms at last. This is the true way, but as yet untried.” (Bacon IV [1901], 50: *Novum Organum*, I, Aphorism XIX).

David Hume (1711-1776)

- “One would appear ridiculous, who would say, that it is only probable the sun will rise tomorrow, or that all men must dye; though it is plain we have no further assurance of these facts, than what experience affords us.”
- Will the sun rise tomorrow? How do we know it will?

POI

- Popper accepts Hume's argument against induction.
- But Popper argues that induction is not the method of science and hence the POI is not a problem for science.
- The method of science is falsification.

Induction (again)

- Remember that Hume's problem of induction is about the justification of induction as a method to give us knowledge.
- No matter how many instances we come across we can never justify a universal claim about those instances.
- But if we come across an instance which is a not an instance of what the general claim asserts then we have a counter-instance.

Popper's main claims (1-4)

1. It is easy to obtain confirmations, or verifications, for nearly every theory — if we look for confirmations.
2. Confirmations should count only if they are the result of *risky predictions*; that is to say, if, unenlightened by the theory in question, we should have expected an event which was incompatible with the theory — an event which would have refuted the theory.
3. Every "good" scientific theory is a prohibition: it forbids certain things to happen. The more a theory forbids, the better it is.
4. A theory which is not refutable by any conceivable event is non-scientific. Irrefutability is not a virtue of a theory (as people often think) but a vice.

Popper's main claims (5-7)

5. Every genuine *test* of a theory is an attempt to falsify it, or to refute it. Testability is falsifiability; but there are degrees of testability: some theories are more testable, more exposed to refutation, than others; they take, as it were, greater risks.

6. Confirming evidence should not count *except when it is the result of a genuine test of the theory*; and this means that it can be presented as a serious but unsuccessful attempt to falsify the theory. (I now speak in such cases of "corroborating evidence.")

7. Some genuinely testable theories, when found to be false, are still upheld by their admirers — for example by introducing *ad hoc* some auxiliary assumption, or by reinterpreting the theory *ad hoc* in such a way that it escapes refutation. Such a procedure is always possible, but it rescues the theory from refutation only at the price of destroying, or at least lowering, its scientific status. (I later described such a rescuing operation as a "*conventionalist twist*" or a "*conventionalist stratagem*.")

The method of falsification

- One can sum up all this by saying that the criterion of *the scientific status of a theory is its falsifiability*, *or refutability*, *or testability*.
- Ergo, the method of science is not induction but rather bold conjectures and refutations.
- Popper endorses *falliblism* according to which all our knowledge of the world is provisional and subject to correction in the future

Science

- Newtonian physics and the planets. Several observable consequences predicted by Newtonian physics. Amongst them the orbit of the planets.
- In Popperian terms Newtonian physics put forward a bold conjecture about the orbit of the planets.
- Potential falsifier would be a planet that would not behave in accordance with the predictions.

Mercury

- The observed orbit of Mercury was not in accordance with the predictions of Newtonian physics.
- Today we know that this is because the mass of the sun has a serious impact on the orbit of Mercury (relativity theory).
- A false consequence of the theory meant however that it was false.

Thomas Kuhn (1922–1996)

- Historian and philosopher of science.
- Kuhn was interested in what happens in theory change.
- He argued for a very influential theory about science and what happens during theory change.
- Interesting questions about rationality and science arise in relation to Kuhn's account.

Kuhn opening lines

- “History, if viewed as a repository for more than anecdote or chronology, could produce a decisive transformation in the image of science by which we are now possessed. That image has previously been drawn, even by scientists themselves, mainly from the study of finished scientific achievements as these are recorded in the classics and, more recently, in the textbooks from which each new scientific generations learns to practice its trade. Inevitably, however, the aim of such books is persuasive and pedagogic; a concept of science drawn from them is no more likely to fit the enterprise that produced them than an image of a national culture drawn from a tourist brochure or a language text.”

Paradigm

- Very important notion for Kuhn is the notion of a paradigm.
- A set of assumptions, concepts, values, and practices that constitutes a way of viewing reality for the community that shares them, especially in an intellectual discipline.
- Sometimes paradigm is understood as disciplinary matrix and other times as an exemplar.

What is a paradigm?

- Let's look at the notion of an exemplar.
- Within Newtonian mechanics F=ma would be an exemplar.
- Whoever is familiar with the Newtonian framework will have numerous ideas related to F=ma.
- The same person will also be familiar with solving certain puzzles by using the formula.

Paradigm - Newton

- background values such as preferences for efficient causal explanations, and theories that yield precise quantitative and testable predictions, rather than general and qualitative ones;
- the metaphysical picture of the world as composed of material particles, interacting by colliding with each other, and by attract- ive and repulsive forces acting in straight lines between particles, and the guiding image of the world as a giant clockwork machine;
- Newton's laws of motion and the law of gravitation, which are the core principles of the paradigm;
- the standard mathematical techniques used to apply the laws to physical systems such as pendulums, collisions of particles, and planetary motions, as well as approximations to account for friction, air resistance and so on;
- Newton's *Principia Mathematica*

Normal science

- When all is good within a scientific paradigm then the business of normal science is successful.
- Scientist's work within a given paradigm and solve puzzles. For example, they calculate the movement of falling bodies with Newton's laws.
- Or they collect various fossils that show variation amongst species (Darwin).
- Mapping the genetic makeup of organisms (DNA).

Normal science

- Normal science is conservative according to Kuhn.
- Scientists' do not easily overthrow theories like Popper held.
- Rather they work within their framework and solve puzzles by relying on the exemplars.
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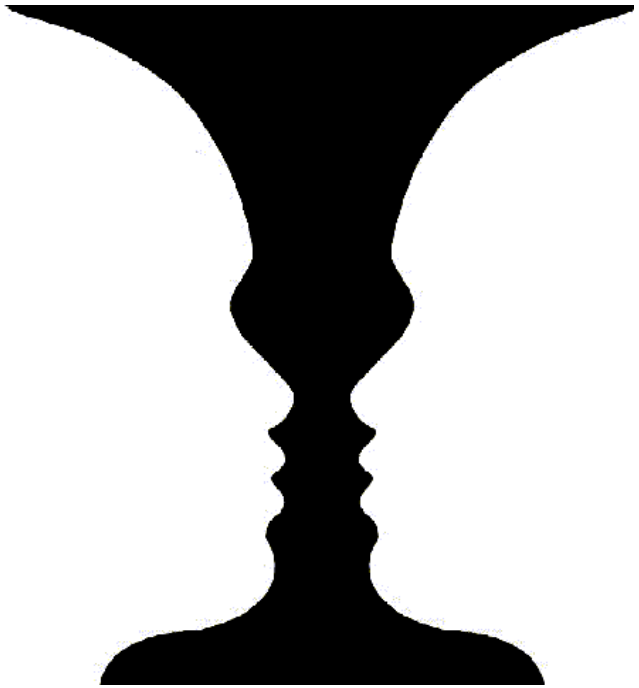
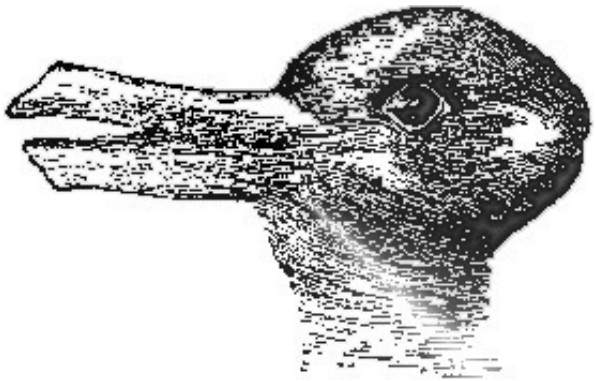
Scientific Revolution

- A scientific revolution occurs, according to Kuhn, when scientists encounter anomalies which cannot be explained by the universally accepted paradigm within which scientific progress has thereto been made.
- The paradigm, in Kuhn's view, is not simply the current theory, but the entire worldview in which it exists, and all of the implications which come with it.

Gestalt





Truth and science

- Popper emphasizes falsification as the method of science. He claims that progress in science is an increase in verisimilitude.
- Kuhn thinks that progress is made during normal science but it is difficult to talk about progress between paradigm's.