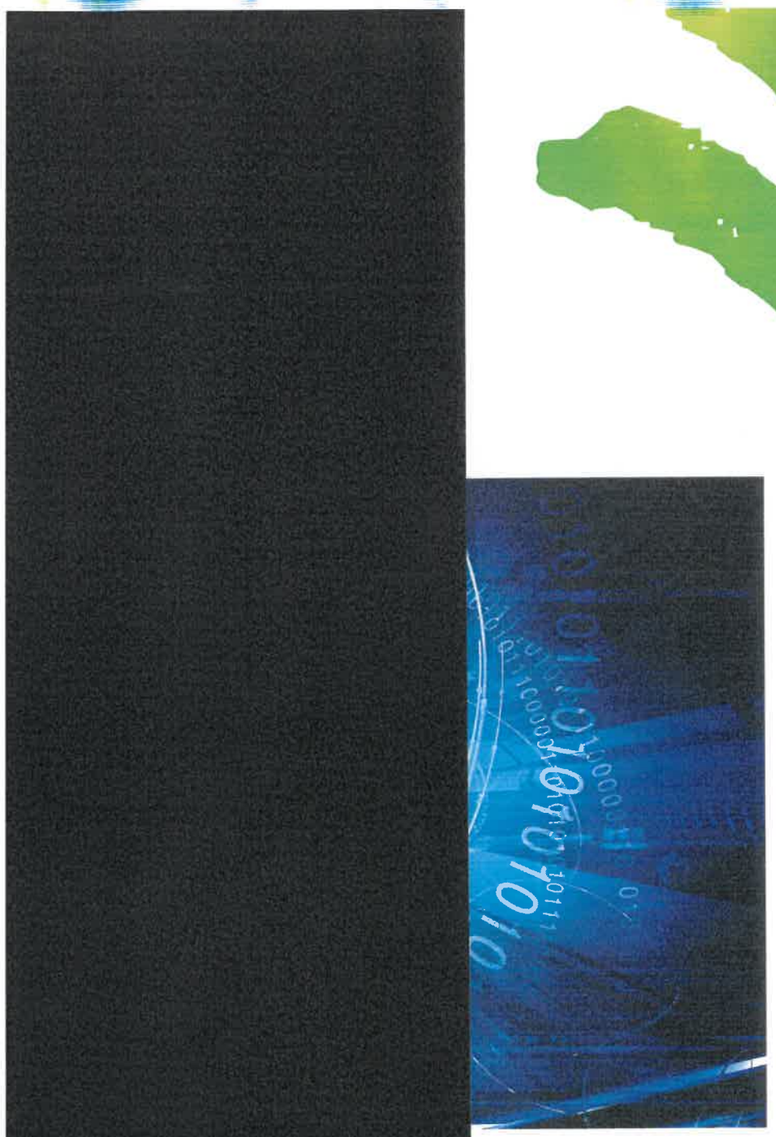

WORLD IN MOTION 2.0 er en antologi til engelskfaget i gymnasiet med et varieret udvalg af primært sagprosatekster, men også fiktionstekster om forskellige emner inden for teknologiens og videnskabens verden.

De overordnede emner spænder fra sociale medier, overvågningssamfundet, kunstig liv og kunstig intelligens til robotter og genteknologi. Bogen afsluttes med et kapitel om videnskabsfilosofi og om videnskabens fortid, nutid og fremtid.

World in Motion 2.0 viser, hvordan videnskabens verden på mange måder er ved at overhale fiktionens verden indenom, og bogen indeholder et udvalg af science fiction-tekster, hvis forfattere har stillet spørgsmålet, „What if …".

World in Motion 2.0 er en videreførelse af emnerne i den første *World in Motion*, der udkom i 2004.

Lars Ulrik Tambjerg-Ravn
World in Motion 2.0

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World in Motion 2.0

Science · Fiction · Technology

SYSTIME

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What is Philosophy of Science?

• By Samir Okasha

principal *adj.* væsentligste
en'quiry *sb.* undersøgelse
probe *vb.* granske, undersøge
un'cover *vb.* afdække
a'ssumption *sb.* antagelse
im'plicit *adj.* underforstået
ex'plicitly *adv.* udtrykkeligt
a'ssume *vb.* antage, gå ud fra
yield *vb.* yde, give
puzzle *vb.* spekulere
curious *adj.* ejendommelig
quinte'ssentially *adv.* fuldkommen
take for granted *id.* tage for givet
im'ply *vb.* antyde
confidence *sb.* tillid
limit *sb.* grænse
con'temporary *adj.* nutidig
merely *adv.* udelukkende

THE PRINCIPAL TASK of philosophy of science is to analyse the methods of enquiry used in the various sciences. You may wonder why this task should fall to philosophers, rather than to the scientists themselves. This is a good question. Part of the answer is that looking at science from a philosophical perspective allows us to probe deeper – to uncover assumptions that are implicit in scientific practice, but which scientists do not explicitly discuss. To illustrate, consider scientific experimentation. Suppose a scientist does an experiment and gets a particular result. He repeats the experiment a few times and keeps getting the same result. After that he will probably stop, confident that were he to keep repeating the experiment, under exactly the same conditions, he would continue to get the same result. This assumption may seem obvious, but as philosophers we want to question it. Why assume that future repetitions of the experiment will yield the same result? How do we know this is true? The scientist is unlikely to spend too much time puzzling over these somewhat curious questions: he probably has better things to do. They are quintessentially philosophical questions.

So part of the job of philosophy of science is to question assumptions that scientists take for granted. But it would be wrong to imply that scientists never discuss philosophical issues themselves. Indeed, historically, many scientists have played an important role in the development of philosophy of science. Descartes, Newton, and Einstein are prominent examples. Each was deeply interested in philosophical questions about how science should proceed, what methods of enquiry it should use, how much confidence we should place in those methods, whether there are limits to scientific knowledge, and so on. As we shall see, these questions still lie at the heart of contemporary philosophy of science. So the issues that interest philosophers of science are not 'merely philosophical'; on the contrary, they have engaged the attention of some of the greatest scientists of all. That having been said, it must be admitted that many scientists today take little interest in philosophy of science, and know little about it. While this is unfortunate, it is not an indication that philosophical issues are no longer relevant. Rather, it is a consequence of the increasingly specialized nature of science, and of the polarization between the sciences and the humanities that characterizes the modern education system.

You may still be wondering exactly what philosophy of science is all about. For to say that it 'studies the methods of science', as we did above, is not really to say very much. Rather than try to provide a more informative definition, we will proceed straight to consider a typical problem in the philosophy of science.

on the contrary *adv.* tværtimod
en'gage *vb.* lægge beslag på
un'fortunate *adj.* beklageligt
in'creasingly *adv.* tiltagende
polari'zation *sb.* polarisering
hu'manities *sb.* humaniora
falsi'fiable *adj.* falsificerbar, modbeviselig
definite *adj.* klar, nøje afgrænset
dis'prove *vb.* modbevise
course *sb.* retning
su'pposedly *adv.* angiveligt
satisfy *vb.* indfri
con'dition *sb.* betingelse
reconcile *vb.* afstemme, få til at harmonere
em'pirical *adj.* erfaringsbaseret
re'pressed *adj.* hæmmet
subli'mation *sb.* sublimering, erstatning af uacceptable behov vha. acceptable alternativer
render *vb.* gøre

Science and pseudo-science

Recall the question with which we began: what is science? Karl Popper, an influential 20th-century philosopher of science, thought that the fundamental feature of a scientific theory is that it should be falsifiable. To call a theory falsifiable is not to say that it is false. Rather, it means that the theory makes some definite predictions that are capable of being tested against experience. If these predictions turn out to be wrong, then the theory has been falsified, or disproved. So a falsifiable theory is one that we might discover to be false – it is not compatible with every possible course of experience. Popper thought that some supposedly scientific theories did not satisfy this condition and thus did not deserve to be called science at all; rather they were merely pseudo-science.

Freud's psychoanalytic theory was one of Popper's favourite examples of pseudo-science. According to Popper, Freud's theory could be reconciled with any empirical findings whatsoever. Whatever a patient's behaviour, Freudians could find an explanation of it in terms of their theory – they would never admit that their theory was wrong. Popper illustrated his point with the following example. Imagine a man who pushes a child into a river with the intention of murdering him, and another man who sacrifices his life in order to save the child. Freudians can explain both men's behaviour with equal ease: the first was repressed, and the second had achieved sublimation. Popper argued that through the use of such concepts as repression, sublimation, and unconscious desires, Freud's theory could be rendered compatible with any clinical data whatever; it was thus unfalsifiable.

The same was true of Marx's theory of history, Popper maintained. Marx claimed that in industrialized societies around the world, capital-

ad hoc *adj.* ad hoc, til dette formål

con'sistent *adj.* overensstemmende, forenelig

i'nevitable *adj.* uundgåelig

prole'tariat *sb.* proletariatet, arbejderklassen

zeal *sb.* ildhu, stor iver

genuinely *adv.* virkelig

con'trast *vb.* sammenligne

de'flect *vb.* afbøje, aflede

solar e'clipse *sb.* solformørkelse

cri'terion *sb.* kriterium, krav

demarcate *vb.* afgrænse

in'tuitively *adv.* intuitivt

plausible *adj.* sandsynlig

fishy *adj.* tvivlsom

overly *adv.* overdrevent

re'fute *vb.* modgå

en'counter *vb.* møde

orbit *vb.* kredse om

differ *vb* afvige

ism would give way to socialism and ultimately to communism. But when this didn't happen, instead of admitting that Marx's theory was wrong, Marxists would invent an ad hoc explanation for why what happened was actually perfectly consistent with their theory. For example, they might say that the inevitable progress to communism had been temporarily slowed by the rise of the welfare state, which 'softened' the proletariat and weakened their revolutionary zeal. In this sort of way, Marx's theory could be made compatible with any possible course of events, just like Freud's. Therefore neither theory qualifies as genuinely scientific, according to Popper's criterion.

Popper contrasted Freud's and Marx's theories with Einstein's theory of gravitation, also known as general relativity. Unlike Freud's and Marx's theories, Einstein's theory made a very definite prediction: that light rays from distant stars would be deflected by the gravitational field of the sun. Normally this effect would be impossible to observe – except during a solar eclipse. In 1919 the English astrophysicist Sir Arthur Eddington organized two expeditions to observe the solar eclipse of that year, one to Brazil and one to the island of Principe off the Atlantic coast of Africa, with the aim of testing Einstein's prediction. The expeditions found that starlight was indeed deflected by the sun, by almost exactly the amount Einstein had predicted. Popper was very impressed by this. Einstein's theory had made a definite, precise prediction, which was confirmed by observations. Had it turned out that starlight was not deflected by the sun, this would have showed that Einstein was wrong. So Einstein's theory satisfies the criterion of falsifiability.

Popper's attempt to demarcate science from pseudo-science is intuitively quite plausible. There is certainly something fishy about a theory that can be made to fit any empirical data whatsoever. But some philosophers regard Popper's criterion as overly simplistic. Popper criticized Freudians and Marxists for explaining away any data that appeared to conflict with their theories, rather than accepting that the theories had been refuted. This certainly looks like a suspicious procedure. However, there is some evidence that this very procedure is routinely used by 'respectable' scientists – whom Popper would not want to accuse of engaging in pseudo-science – and has led to important scientific discoveries.

Another astronomical example can illustrate this. Newton's gravitational theory, which we encountered earlier, made predictions about the paths the planets should follow as they orbit the sun. For the most part, these predictions were borne out by observation. However, the observed orbit of Uranus consistently differed from what Newton's theory predicted. This puzzle was solved in 1846 by two scientists, Adams in England and

e'xert *vb.* udøve

a'dditional *adj.* yderligere

a'ccuse *vb.* beskylde

i'nitial *adj.* første, umiddelbar

plausi'bility *sb* troværdighed

a'bandon *vb.* opgive

per'sistently *adv.* vedholdende

lack *vb.* mangle

po'sses *vb* besidde

questionable *adj.* diskutabel, problematisk

hetero'geneous *adj.* heterogen, forskelligartet

en'compass *vb.* omfatte

Leverrier in France, working independently. They suggested that there was another planet, as yet undiscovered, exerting an additional gravitational force on Uranus. Adams and Leverrier were able to calculate the mass and position that this planet would have to have, if its gravitational pull was indeed responsible for Uranus' strange behaviour. Shortly afterwards the planet Neptune was discovered, almost exactly where Adams and Leverrier had predicted.

Now clearly we should not criticize Adams' and Leverrier's behaviour as 'unscientific' – after all, it led to the discovery of a new planet. But they did precisely what Popper criticized the Marxists for doing. They began with a theory – Newton's theory of gravity – which made an incorrect prediction about Uranus' orbit. Rather than concluding that Newton's theory must be wrong, they stuck by the theory and attempted to explain away the conflicting observations by postulating a new planet. Similarly, when capitalism showed no signs of giving way to communism, Marxists did not conclude that Marx's theory must be wrong, but stuck by the theory and tried to explain away the conflicting observations in other ways. So surely it is unfair to accuse Marxists of engaging in pseudo-science if we allow that what Adams and Leverrier did counted as good, indeed exemplary, science?

This suggests that Popper's attempt to demarcate science from pseudo-science cannot be quite right, despite its initial plausibility. For the Adams/Leverrier example is by no means atypical. In general, scientists do not just abandon their theories whenever they conflict with the observational data. Usually they look for ways of eliminating the conflict without having to give up their theory. And it is worth remembering that virtually every theory in science conflicts with some observations – finding a theory that fits all the data perfectly is extremely difficult. Obviously if a theory persistently conflicts with more and more data, and no plausible ways of explaining away the conflict are found, it will eventually have to be rejected. But little progress would be made if scientists simply abandoned their theories at the first sign of trouble.

The failure of Popper's demarcation criterion throws up an important question. Is it actually possible to find some common feature shared by all the things we call 'science', and not shared by anything else? Popper assumed that the answer to this question was yes. He felt that Freud's and Marx's theories were clearly unscientific, so there must be some feature that they lack and that genuine scientific theories possess. But whether or not we accept Popper's negative assessment of Freud and Marx, his assumption that science has an 'essential nature' is questionable. After all, science is a heterogeneous activity, encompassing a wide range of

cluster sb. gruppe

different disciplines and theories. It may be that they share some fixed set of features that define what it is to be a science, but it may not. The philosopher Ludwig Wittgenstein argued that there is no fixed set of features that define what it is to be a 'game'. Rather, there is a loose cluster of features most of which are possessed by most games. But any particular game may lack any of the features in the cluster and still be a game. The same may be true of science. If so, a simple criterion for demarcating science from pseudo-science is unlikely to be found.

Tasks

Again, when answering theses it might be a good idea to do some 'outside-the-text' research or perhaps even draw on knowledge that you have obtained from other subjects, courses or classes!

1 Account for the notion of 'falsifiability', and for why it is a fundamental feature of any scientific theory. Also contrast/compare it to the notion of 'verification'.

> Remember to use your own words instead of just repeating what it says in the text. Using your own words will help demonstrate that you have actually understood these terms.

2 Why did Karl Popper think that Freud's famous psychoanalytic theory was not falsifiable, making it in his opinion pseudo-science?

3 Explain Marx's theory of history, and also explain why Karl Popper thought that this theory too was unfalsifiable and therefore not real science.

4 On the other hand, in the eyes of Popper, what made Einstein's theory of general relativity falsifiable and therefore genuine science?

5 Read about the American historian and philosopher, Thomas Kuhn, and his criticism of Popper's theory of falsification, and determine why Popper's theory doesn't always hold true.

6 According to Wittgenstein "there is no fixed set of features that define what it is to be a game". Consider whether this is really true? And how is this related to the philosophy of science?