Homo artefaciens

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It has been fashionable to regard science as an ‘unending quest’, which involves the formulation of a hypothesis, its submission to empirical testing and, if ‘falsified’, its replacement with a new one and repetition of the procedure [1]. This doctrine of the “logic of scientific discovery”, denying any role of induction, was established by the philosopher Karl Popper. Although it has been largely criticized by philosophers of science, it has become most popular among biologists. Three Nobel laureates in biology, Jacques Monod, Peter Medawar and Peter Mitchell, proclaimed themselves to be followers of the ‘Popperian faith’. Their authority might have reinforced the lure of Popper’s moralistic appeal to the virtues of fallibility, humility, openness and audacity. However, each experimentalist knows from daily experience that the drudgery of laboratory work is not as simple and elegant as Popper’s ‘critical rationalism’.

Popper called the inductionists in science ‘irrationalists’. There is a famous dictum of the philosopher Charlie Dunbar Broad: “Induction is the glory of science and the scandal of philosophy”. The physicist Erwin T. Jaynes dismissed Popper’s rejection of inductive reasoning and bluntly ranked Popper himself among the ‘irrationalists’ [2]. According to Jaynes, we live in a world about which we lack complete information. The only rational way to create new knowledge is to update uncertainties and probabilities we have in the light of new data. The procedure is called Bayesian inference. We start with beliefs known as prior probabilities—put forward before anything is known about a situation—collect data and end with different beliefs known as posterior probabilities, which reflect the levels of belief computed in the light of the new evidence. Indeed, as put in the title of Jaynes’s book, probability theory is the logic of science [2].

Jaynes stipulates that scientists should adhere to ‘honesty of inference’, which is

not—in contrast to what the name might suggest—a moralistic appeal, but a purely logical statement based on the principle of maximum information entropy. Of all possible probability distributions, the one that leaves a subject with the most uncertainty is best because it does not imply more than what he or she knows. The right criterion of a scientific theory is not falsifiability, but testability—the ability to modify a theory to make it more or less probable by using data from a new measurement.

Contemporary science gathers new data almost exclusively by using scientific instruments. Instruments determine the kind of problem that science can solve; they circumscribe its epistemic horizon. All research, whether we think of it as being driven by hypotheses, serendipity, data, market, grants or whatever, is ultimately driven by instruments. All our models and descriptions of the world—concepts, hypotheses, theories and mathematical formulae—which are the result of measurements, are abstract artefacts.

Any extrapolations in science, including Bayesian reasoning, have a drawback: forecasting new knowledge is not possible in principle. The famous parable of Bertrand Russell’s ‘inductivist turkey’ is a case in point. The turkey, having collected a large amount of data on being fed every day in the morning, expects the same to happen on the morning of Christmas Eve, but instead has his throat cut. We are like the turkey, we cannot leap out from our cognitive space and assume the superior position of the farmer. We should combine Jaynes’s honesty of inference with an epistemic modesty.

These days, a revolution under the banner of ‘Bayesian rationality’ is sweeping across all the sciences [3]. The Bayesian approach has produced satisfactory explanations of subconscious or preconscious mental phenomena, such as learning, visual object and pattern recognition or memory. But it is not yet clear whether higher-level human

cognitive processes also operate on Bayesian principles; in fact, psychologists from the ‘heuristic and biases’ movement maintain that humans are apparently not Bayesians. In particular, emotions can substantially distort our perception and judgements. Jaynes himself has stated: “In spite of modern science, general human comprehension of the world has progressed very little beyond the level of ancient superstitions. Indeed, the very idea that a causal influence requires a physical mechanism to bring it about is quite foreign to the thinking of the uneducated” [2].

We are mythophilic animals; our ‘uneducated’ mind is prone to superstition. Under the command of emotions, we prefer data that conform to our preconceived beliefs. We are actually blinkered, especially when it comes to information that contradicts our views. Bayesian reasoning is counterintuitive and it should be taught in schools—Bayesian literacy should become commonplace. Fortunately, our instruments, which help us to collect data, have no emotional ‘blind spots’ when they record the environment. Under the ruthless yoke of instruments, science is the only way of subjecting our beliefs to rigorous testing and to progress, by inductive reasoning, towards better matching the world and our models of it.

CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

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