

# FOREWORD

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*Women on the Verge of a Nervous Breakdown* was a funny title for Pedro Almodóvar's funny movie about how men drive women nuts. *Science on the Verge* is a funny title, too, but this book, which examines the unfolding crisis in science today, is serious. And indeed, the worrisome, in some ways even terrifying state of affairs in science revealed here, demands the sober, rigorous and intellectually compelling treatment that you are about to read.

And yet... science's problems seem also to verge naturally toward an encounter with satire. If science is the great social enterprise that separates the modern, rational human from our primitive, superstition-laden forebears, how could it have so lost its grip on reality?

The satirical potential that such a question raises has not gone entirely unnoticed, although I can think of only one seriously good satire about the scientific endeavour itself: Jonathan Swift's *Gulliver's Travels* – now nearly 300 years old. Best known for tales in which its itinerant hero is little among big people, big among little people, and a brutish human among apparently civilized horses, *Gulliver's Travels* also recounts the visit of its ingenuous and reliable narrator to the floating (in air) island of Laputa, a kingdom ruled by mathematicians, that most logical and disciplined species of intellect. In Laputa, the nation's indolent leaders are not fanned by servants with palm fronds (as would befit your standard Pharaoh or

Sultan). Rather, servants must continually flap the ears and mouths of their masters with “a blown Bladder fastened like a Flail to the End of a short Stick” in order to get their attention. Otherwise their minds “are so taken up with intense Speculations, that they neither can speak, or attend to the Discourses of others”.

Gulliver visits the Academy of Lagado, the kingdom’s scientific institute, and describes many projects being pursued by the kingdom’s visionary researchers. Here, in an 18<sup>th</sup>-century nuclear fusion lab, one scientist has spent eight years trying to extract sunbeams from cucumbers. He is confident that, with an additional eight years of work, his project will achieve its goal of storing the extracted energy in “Vials hermetically sealed”, so that they can, when needed, be “let out to warm the Air in raw inclement Summers.” Meanwhile, the Academy’s behavioural economists debate the best way to raise taxes “without grieving the subject. The first affirmed, the justest Method would be to lay a certain Tax upon Vices and Folly [...] The second was of an Opinion directly contrary; to tax those Qualities of Body and Mind for which Men chiefly value themselves”. Even ‘big data’ is very much on the agenda, as one especially ambitious professor strives to increase the productivity of scientific research with a huge machine that randomly combines “all the Words of Their Language in their several Moods, Tenses and Declensions”, and through this device “give the World a compleat Body of all Arts and Sciences”, an effort that would be greatly expedited if only “the Publick would raise a Fund for making and employing five Hundred” such machines.

And what of the world portrayed in *Science on the Verge*? In this book you will read about a scientific enterprise that is growing in productivity and influence even though the majority of publications in many scientific fields may be wrong. You’ll see how scientists re-

duce complex, unpredictable problems to much simpler, manageable models by leaving out important factors, which allows the scientists to come up with neat solutions—often to the wrong problems. You’ll learn how doing this sort of science often makes our knowledge of the world more uncertain and unpredictable, not less, and how instead of leading to ‘evidence-based policy’ we end up with ‘policy-based evidence.’ You’ll find out why precise quantitative estimates of some of the impacts of climate change are so uncertain as to be meaningless. (How, for example, can we quantify to a tenth of a percent the proportion of species that will go extinct from climate change if we don’t even know the number of species that exist now?) And you’ll find out how economic analyses based on flawed computer coding served the interests of both economists and policy makers—and as a result caused long-term damage to national economies. You’ll discover how, in a human world that is growing ever more complex, our approaches to governing science and technology are turning decisions and action over to computer algorithms and technological systems. We transfer our agency to machines in the name of efficiency and predictability, but the entirely paradoxical consequence is that the human capacity to adapt to uncertainty and unpredictability may actually be diminishing.

It’s a world that might well have been imagined by a modern-day Swift—only it’s our world, today. At its heart is a failure to recognize that the use of science in guiding human affairs is *always* a political act. It’s not that we shouldn’t do our very best to understand our world as a basis for acting wisely in it. It’s that such understanding has its limits as matters of both science and subjective sensibility. All complex systems must be simplified by scientists to render them analytically tractable. All choices about how a society should best address its many challenges must be guided by the norms and val-

ues of stakeholders, by trade-offs among those with conflicting goals, and by hedges against inevitable uncertainties. If the second condition—the necessity of subjective choice—is made subservient to the first—the limits of science—then science runs the risk of being corrupted. This happens because its practitioners, advocates and institutions do not resist the temptation of overstating science’s claims to both certainty and legitimacy. The risk for society, in turn, comes from pushing the political into the black box of the technical, thus making it invisible to democratic actors. As explained by the political theorist Yaron Ezrahi in his 1990 book *The Descent of Icarus*, “The uses of science and technology to ‘depoliticise’ action have been among the most potent *political* strategies in the modern state. The authority of this strategy has been sustained by the illusion that social and political problems like scientific problems are inherently solvable” (51).

If science is failing, then, surely a good part of the explanation is that, in turning many complex social challenges over to scientists to find ‘solutions’, politicians and citizens alike are demanding more from science than it can deliver. Swift himself feared the consequences of substituting scientific rationality for human judgment. Three years after writing *Gulliver*, he explored the problem of scientific rationality and social choice in his famous essay “A Modest Proposal”. Here, in a brutal satire of evidence-based policy, he demonstrated in dispassionate, rational, quantified scientific terms that eating poor children would be economically and socially beneficial—a logically elegant solution to poverty arising from England’s oppressive policies toward Ireland.

If we have come less far than we might wish from Swift’s view of science and politics, the authors of *Science on the Verge* lay out the regimen necessary for avoiding nervous breakdown. Above all is the importance of

recognizing that (as you'll read in Chapter 1) "the problems in science will not be fixed by better training in statistics, better alignment of incentives with objectives, better regulation of copyright" and so on. The scientific community continues to understand itself as a self-correcting, autonomous enterprise, but the knowledge it creates is no longer containable within laboratories, technical publications and patents. It has now become central to many political debates, and can be wielded by everyday citizens during activities as mundane as visiting a doctor, buying food or arguing with one's neighbour. Scientists can no longer maintain authority by insisting that they should be left alone to fix their problems. Recall what happened when the Catholic Church tried this approach after Gutenberg had loosened its hold on truth.

*Women on the Verge of a Nervous Breakdown* made the case for the essential and redemptive strength of women in a male-dominated culture. *Science on the Verge* is no less sympathetic to its subject. Many modern institutions and practices have been designed in the expectation that science was a truth-telling machine that could help overcome fundamental conditions of uncertainty and disagreement. The painful lesson of recent decades, however, is that real science will never construct a single, coherent, shared picture of the complex challenges of our world—and that the quest to do so instead promotes corruption of the scientific enterprise, and uncertainty and suspicion among decision makers and engaged citizens (exemplified in debates over GMOs or nuclear energy). At its best, however, science can provide a multiplicity of insights that may help democratic societies explore options for navigating the challenges that they face. Put somewhat differently, *Science on the Verge* explains to us why science's gifts must be understood as actually emerging from science's limits—much as grace is born from human fallibility.