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Idealization and the Laws of Nature

Springer

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This book is dedicated to the memory of Peter Lipton and Joan Ruth Perriman

Foreword

In this book, Dr. Wheeler presents an original account of laws that brings the relatively minor issue of idealization to the centre of the debate and shows how strongly it is related to the far more prominent issue of simplicity. This reimagining of the debate suggests the application of algorithmic information theory as a formal mathematical theory which deals with simplicity. Using algorithmic information theory is not entirely novel—although it is rarely done—but Dr. Wheeler goes back to the historical ideas and shows us how the theory, designed to capture simplicity, can also be used to address idealization.

This book advances the growing interest in using informational and computational methods in philosophy of science. More personally, the outcome of the new account which strikes me as most interesting is the possibility of intertwining the epistemology and metaphysics of laws in a substantive way. The difficulty of achieving this is arguably a major reason many philosophers of science have lost interest in laws, and Dr. Wheeler offers us a possible way back.

Finally, Dr. Wheeler gives us a book which examines and builds complex ideas with enviable clarity. In all, this is quite an achievement for a first book.

London, UK
March 2017

Phyllis Illari

Preface

Philosophers have known for some time that our most successful scientific laws do not describe perfectly the observed behaviour of the world. As an example, consider the law of the pendulum:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

As any high school science student can tell you, this law only accurately describes the behaviour of an 'ideal pendulum', one which is subject to no friction, has an infinitely long cord, and whose mass is concentrated at a single point. For practicing scientists, the fact real-world pendulums and other oscillating bodies do not meet these ideal standards seems to be of little concern. Engineers can work around them by making suitable approximations, and precise values, when they are needed, can be calculated by both minimizing the effect of friction and other influences, or by working out their effect mathematically and adjusting the law suitably.

That no real-world physical system can be constructed to meet the ideal standards of many laws is rarely a problem for scientists. Things are much harder to explain for philosophers of science, however, who themselves have been working under an idealization about the nature of laws and how they relate to the world. It is often assumed that whatever else a law of nature is, it provides a statement that is *universally true*. This then raises a conundrum for philosophers: how should we treat the exceptions that appear in nature? Do they show that our best current laws are not, in fact, genuine laws of nature? Do they show that laws can be true without correctly describing physical behaviour? Or do they show that laws can be both false and lawlike at the same time?

Most of the philosophical debate about exceptions has taken place around the idea of a 'ceteris paribus law'. Such laws are false and exception-ridden when given in their simple form, but true and exceptionless when hedged with a so-called 'ceteris paribus proviso'. Typically, if the law says 'Fs are Gs', then the hedged ceteris paribus laws says ‘All else being equal, Fs are Gs’. As is well known in the field, ceteris paribus laws give rise to serious problems of their own: the most famous being how to interpret ‘all else being equal’ in a way that does not make the law a tautology. Whilst I do not doubt that ceteris paribus laws can be found in numerous scientific fields, I believe the attention they have received by philosophers has been disproportionate. This is because laws which are about ‘ideal systems’, such as the law of the pendulum, are not easily cast in terms of ceteris paribus provisos. In fact, there are a number of key differences that justify separating ideal laws from ceteris paribus laws.

Take, for example, Nancy Cartwright’s classic example of a ceteris paribus law ‘aspirins relieve headaches’. This law has many instances (taking aspirin often really does relieve a headache) even if we cannot specify clearly why it fails when it does. Compare this with an ideal law, like the law of the pendulum. This law has no instances in nature (because we cannot reduce friction to zero or have an infinitely long cord) and conversely to the aspirin law, we can state clearly the conditions needed for the law to obtain. Ideal laws seem to belong to a different class of exception-ridden laws to ceteris paribus laws, and it is not initially obvious that one can be reduced to the other.

This book provides the first full-length discussion of ideal laws and how they ought to be understood metaphysically. It turns out that many of the most famous theories of lawhood, such as Armstrong’s ‘nomic necessitation view’ and Lewis’ ‘best system account’, fail to explain why there are ideal laws in scientific theories. By tracing through the problems with existing theories of lawhood, a new explanation of ideal laws is proposed. It will be argued that only by thinking of laws of nature as *algorithms* whose purpose is to compress empirical data, can we fully understand what an ideal law is and why they are so prevalent in scientific theories. This theory is inspired by David Braddon-Mitchell’s paper ‘Lossy Laws’. There he argued that the best system account can be improved if axioms are allowed to have exceptions by analogy to *lossy compression* in computer science. I agree with Braddon-Mitchell, but the theory I put forward is much broader in that it abandons Lewis’ commitment to laws as statements in favour of a theory which identifies them as algorithms. In this respect, it has a lot more in common with the ‘inference-ticket view’, originally held by logical empiricists such as Moritz Schlick and Gilbert Ryle.

In Chap. 1, I closely examine the origin of the debate surrounding exceptions to laws and critically evaluate some supposed solutions to the problem, such as that of ‘hedging’, ‘concretization’ and ‘nomic elimination’. It turns out that there is no easy solution to the problem of ideal laws, and that the only way to fully understand what they are and why they should exist in scientific theory is to examine their metaphysics.

Chapter 2 presents accounts of the metaphysics of ideal laws from the ‘governing conception’, which understands laws to be *necessary* and *determining* of the regularities observed in nature. Three governing conceptions of laws will be discussed: those of David Armstrong, Cartwright and Brian Ellis. I will show that whilst some of these theories have success in accommodating ceteris paribus laws, they fail disastrously when extended to cover ideal laws as well.

The opposite of the governing conception is the 'non-governing conception' of laws, sometimes called 'Humean', and Chap. 3 will focus on solutions to ideal laws from this tradition. Again, three accounts of ideal laws will be proposed based on three different non-governing conceptions of lawhood: Lewis' original best system account, the so-called 'better best system account' recently put forward by Markus Schrenk and Matthias Unterhuber, and the 'inference-ticket view' of Schlick and Ryle. It turns out that non-governing conceptions have much better success than existing governing conceptions in accounting for why ideal laws should be so important to science. However, none of the three discussed can currently provide a full picture.

Chapter 4 presents an *algorithmic theory of laws* which takes the best of the best system account and the inference-ticket view. It is argued that Ernst Mach's explanation of theories as efficient representations of nature provides the best explanation for why there are ideal laws in science, and the algorithmic theory provides the right metaphysical foundation for this view. When the algorithmic theory is combined with Braddon-Mitchell's distinction between lossless and lossy compression, then ideal laws are identified with the *lossy algorithmic compressors* of scientific theories. On this picture science, and in particular scientific theories, are seen as a solution to a problem: how best to encode all empirical data. By analogy with data compression in computer science, lossy compression is sometimes desirable when there is *redundancy* in data quality. I introduce the concept of *predictive redundancy* by analogy to *perceptual redundancy* in image compressors such as JPEG and explain ideal laws as the inevitable result of predictive redundancy in scientific theories.

What emerges is a new explanation of idealization and ideal laws in science that provides indirect support for the algorithmic theory as an answer to what it means to be a 'law of nature'.

Zhuhai, China Billy Wheeler

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