Uncertain Inference

Coping with uncertainty is a necessary part of ordinary life and is crucial to an understanding of how the mind works. For example, it is a vital element in developing artificial intelligence that will not be undermined by its own rigidities. There have been many approaches to the problem of uncertain inference, ranging from probability to inductive logic to nonmonotonic logic. This book seeks to provide a clear exposition of these approaches within a unified framework.

The principal market for the book will be students and professionals in philosophy, computer science, and artificial intelligence. Among the special features of the book are a chapter on evidential probability, an interpretation of probability specifically developed with an eye to inductive and uncertain inference, which has not received a basic exposition before; chapters on nonmonotonic reasoning and theory replacement that concern matters rarely addressed in standard philosophical texts; and chapters on Mill's methods and statistical inference that cover material sorely lacking in the usual treatments of artificial intelligence and computer science.

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Preface

This book is the outgrowth of an effort to provide a course covering the general topic of uncertain inference. Philosophy students have long lacked a treatment of inductive logic that was acceptable; in fact, many professional philosophers would deny that there was any such thing and would replace it with a study of probability. Yet, there seems to many to be something more traditional than the shifting sands of subjective probabilities that is worth studying. Students of computer science may encounter a wide variety of ways of treating uncertainty and uncertain inference, ranging from nonmonotonic logic to probability to belief functions to fuzzy logic. All of these approaches are discussed in their own terms, but it is rare for their relations and interconnections to be explored. Cognitive science students learn early that the processes by which people make inferences are not quite like the formal logic processes that they study in philosophy, but they often have little exposure to the variety of ideas developed in philosophy and computer science. Much of the uncertain inference of science is statistical inference, but statistics rarely enter directly into the treatment of uncertainty to which any of these three groups of students are exposed.

At what level should such a course be taught? Because a broad and interdisciplinary understanding of uncertainty seemed to be just as lacking among graduate students as among undergraduates, and because without assuming some formal background all that could be accomplished would be rather superficial, the course was developed for upper-level undergraduates and beginning graduate students in these three disciplines.

The original goal was to develop a course that would serve all of these groups. It could make significant demands on ability and perseverance, and yet it would have to demand relatively little in the way of background—in part precisely because relatively little could be assumed about the common elements of the backgrounds of these diverse students. In this event, the only formal prerequisite for the course was a course in first order logic. At the University of Rochester, this is the kind of course designed to produce a certain amount of "mathematical maturity."

The course has been taught for two years from earlier versions of this book. It is a difficult course, and students work hard at it. There are weekly exercises and a final research paper. All the material is covered, but some students find the pace very demanding. It might be that a more leisurely approach that concentrated, say, on probability and nonmonotonic acceptance, would be better for some groups of students.

The most common suggestion is that probability theory, as well as logic, should be required as a prerequisite. At Rochester, this would make it difficult for many students to fit the course into their schedules. Furthermore, although the axiomatic foundations of probability and a few elementary theorems seem crucial to understanding uncertainty, the need for an extensive background in probability is questionable. On the other hand, because the whole topic, as we view it, is a kind of logic, a strong background in logic seems crucial.

Support for the research that has allowed us to produce this volume has come from various sources. The University of Rochester, the University of New South Wales, and the Institute for Human and Machine Cognition have each contributed time and facilities. Direct financial support has come from the National Science Foundation through award ISI-941267.

We also wish to acknowledge a debt of a different kind. Mark Wheeler was a graduate student in Philosophy at the University of Rochester many years ago when this volume was first contemplated. At that time he drafted the first chapter. Although the book has been through many revisions and even major overhauls, and has even changed authors more than once, Mark's chapter has remained an eminently sensible introduction. He has allowed us to include it in this, our final version. We are very grateful, and herewith express our thanks.

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