Modal Logic for Philosophers

Designed for use by philosophy students, this book provides an accessible yet technically sound treatment of modal logic and its philosophical applications. Every effort has been made to simplify the presentation by using diagrams in place of more complex mathematical apparatus. These and other innovations provide philosophers with easy access to a rich variety of topics in modal logic, including a full coverage of quantified modal logic, nonrigid designators, definite descriptions, and the *de re–de dicto* distinction. Discussion of philosophical issues concerning the development of modal logic is woven into the text.

The book uses natural deduction systems and includes a diagram technique that extends the method of truth trees to modal logic. This feature provides a foundation for a novel method for showing completeness, one that is easy to extend to systems that include quantifiers.

James W. Garson is professor of philosophy at the University of Houston. He has held grants from the National Endowment for the Humanities, the National Science Foundation, and the Apple Education Foundation. He is also the author of numerous articles in logic, semantics, linguistics, the philosophy of cognitive science, and computerized education.

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for Nuel Belnap, who is responsible for anything he likes about this book

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Preface

The main purpose of this book is to help bridge a gap in the landscape of modal logic. A great deal is known about modal systems based on propositional logic. However, these logics do not have the expressive resources to handle the structure of most philosophical argumentation. If modal logics are to be useful to philosophy, it is crucial that they include quantifiers and identity. The problem is that quantified modal logic is not as well developed, and it is difficult for the student of philosophy who may lack mathematical training to develop mastery of what is known. Philosophical worries about whether quantification is coherent or advisable in certain modal settings partly explains this lack of attention. If one takes such objections seriously, they exert pressure on the logician to either eliminate modality altogether or eliminate the allegedly undesirable forms of quantification.

Even if one lays those philosophical worries aside, serious technical problems must still be faced. There is a rich menu of choices for formulating the semantics of quantified modal languages, and the completeness problem for some of these systems is difficult or unresolved. The philosophy of this book is that this variety is to be explored rather than shunned. We hope to demonstrate that modal logic with quantifiers can be simplified so that it is manageable, even teachable. Some of the simplifications depend on the foundations – in the way the systems for propositional modal logic are developed. Some ideas that were designed to make life easier when quantifiers are introduced are also genuinely helpful even for those who will study only the propositional systems. So this book can serve a dual purpose. It is, I hope, a simple and accessible introduction to propositional modal logic for students who have had a first course in formal logic (preferably one that covers natural deduction rules and truth trees). I hope, however, that students who had planned to use this book to learn only propositional modal logic will be inspired to move on to study quantification as well.

A principle that guided the creation of this book is the conviction that visualization is one of the most powerful tools for organizing one's thoughts. So the book depends heavily on diagrams of various kinds. One of the central innovations is to combine the method of Haus diagrams (to represent Kripke's accessibility relation) with the truth tree method. This provides an easy and revealing method for checking validity in a wide variety of modal logics. My students have found the diagrams both easy to learn and fun to use. I urge readers of this book to take advantage of them.

The tree diagrams are also the centerpiece for a novel technique for proving completeness – one that is more concrete and easier to learn than the method of maximally consistent sets, and one that is extremely easy to extend to the quantifiers. On the other hand, the standard method of maximally consistent sets has its own advantages. It applies to more systems, and many will consider it an indispensable part of anyone's education in modal logic. So this book covers both methods, and it is organized so that one may easily choose to study one, the other, or both.

Three different ways of providing semantics for the quantifiers are introduced in this book: the substitution interpretation, the intensional interpretation, and the objectual interpretation. Though some have faulted the substitution interpretation on philosophical grounds, its simplicity prompts its use as a centerpiece for technical results. Those who would like a quick and painless entry to the completeness problem may read the sections on the substitution interpretation alone. The intensional interpretation, where one quantifies over individual concepts, is included because it is the most general approach for dealing with the quantifiers. Furthermore, its strong kinships with the substitution interpretation provide a relatively easy transition to its formal results. The objectual interpretation is treated here as a special case of the intensional interpretation. This helps provide new insights into how best to formalize systems for the objectual interpretation.

The student should treat this book more as a collection of things to do than as something to read. Exercises in this book are found embedded throughout the text rather than at the end of each chapter, as is the more common practice. This signals the importance of doing exercises as soon as possible after the relevant material has been introduced. Think of the text between the exercises as a preparation for activities that are the foundation for true understanding. Answers to exercises marked with a star (*) are found at the end of the book. Many of the exercises also include hints. The best way to master this material is to struggle through the exercises on your own as far as humanly possible. Turn to the hints or answers only when you are desperate.

Many people should be acknowledged for their contributions to this book. First of all, I would like to thank my wife, Connie Garson, who has unfailingly and lovingly supported all of my odd enthusiasms. Second, I would like to thank my students, who have struggled though the many drafts of this book over the years. I have learned a great deal more from them than any of them has learned from me. Unfortunately, I have lost track of the names of many who helped me make numerous important improvements, so I apologize to them. But I do remember by name the contributions of Brandy Burfield, Carl Feierabend, Curtis Haaga, James Hulgan, Alistair Isaac, JoBeth Jordon, Raymond Kim, Kris Rhodes, Jay Schroeder, Steve Todd, Andy Tristan, Mako Voelkel, and especially Julian Zinn. Third, I am grateful to Johnathan Raymon, who helped me with the diagrams. Finally, I would like to thank Cambridge University Press for taking an interest in this project and for the excellent comments of the anonymous readers, some of whom headed off embarrassing errors.