

Dedicated to my husband, Klaus,
and to my children, Silja, Maj-Britt, and Malte.

Preface

Relationships amongst propositions are crucial pieces of knowledge. They express causal or plausible connections, bring isolated facts together, and help us obtain a coherent image of the world. Such relationships may be represented in a most general form by *if-then-conditionals*.

Conditionals are omnipresent, in everyday life as well as in scientific environments. We make use of conditional knowledge when we avoid puddles on sidewalks (being aware of “If you step into a puddle, then your feet might get wet”) and when we expect high wheat prices from observing cold and rainy weather in spring and summer (due to “If the growing weather is poor then there will be an increase in the price of wheat”). Conditionals represent generic knowledge, acquired inductively from experience or learned from books. They tie a flexible and highly interrelated network of connections along which reasoning is possible and which can be applied to different situations.

Therefore, conditionals are most important, but also quite problematic objects in knowledge representation. They are not simply “true” or “false”, like classical logical entities. In a particular situation, a conditional is applicable (you actually step into a puddle) or not (you simply walk around), it can be found confirmed (you step into a puddle and indeed, your feet get wet) or violated (you step into a puddle, but your feet remain dry because you are wearing rain boots). So the central problem in representing and modeling conditional knowledge is to handle adequately, on the one hand, inactive (or neutral, respectively) behavior, and, on the other hand, active as well as polarizing behavior.

This book presents a new approach to conditionals which captures this dynamic, non-propositional nature of conditionals peculiarly well. Conditionals are considered as agents shifting possible worlds in order to establish relationships and beliefs. This understanding of conditionals yields a rich methodological theory, which makes complex interactions between conditionals transparent and operational. Moreover, it provides a unifying and enhanced framework for knowledge representation, nonmonotonic reasoning, and belief revision, and even for knowledge discovery. In separating structural from numerical aspects, the basic techniques for conditionals introduced in this book

are applied both in a qualitative and in a numerical setting, elaborating fundamental lines of reasoning.

The novel theory of conditionals is at the heart of this work, from which its other major topics – revising epistemic states, probabilistic and nonmonotonic reasoning, and knowledge discovery – are developed. So central concerns of Artificial Intelligence research are dealt with in a uniform and homogeneous way by investigating structures of conditional knowledge. Such structures are substantial, for instance, in abductive as well as in predictive reasoning, or for simulation tasks.

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I dedicate this book to my husband, Klaus, for encouraging me all the time, and to my children Silja, Maj-Britt, and Malte, for their creativity.