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Foreword

The papers in this volume are extended versions of presentations at the fourth International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems (IPMU Conference), which was held in Palma de Mallorca, July 6-10, 1992.

The conference focused on issues related to the acquisition, representation, management, and transmission of information in knowledge-based and decision-making systems. Because of the large range of presentations, we have chosen to focus this book on the methodologies which are related to artificial intelligence. We present both theoretical and applied papers.

The first section of the book is devoted to non monotonic reasoning and the management of default knowledge. The second section deals with methods using non-classical logics to deal with imperfect knowledge and to represent its spatial and temporal components. The third section presents various methods for the acquisition of uncertain and imprecise knowledge. The fourth section is concerned with the use of qualitative, uncertain, temporal, and ambiguous pieces of information in knowledge-based systems, expert systems, and process controllers. The last section contains papers using artificial neural network methodologies.

The previous IPMU Conferences have results in three other volumes of the series Lecture Notes in Computer Science, *Uncertainty in Knowledge-Based Systems* (LNCS 286), *Uncertainty and Intelligent Systems* (LNCS 313), *Uncertainty in Knowledge Bases* (LNCS 521).

April 1993

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2. Logical Methods

Possibilistic Abduction

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1. Introduction

The following pattern which from the two premises " if **h** then **e**" and "**e** is observed to be true" infers the conclusion "**h** is plausible", where **h** stands for an hypothesis and **e** for a piece of evidence, is generally considered as the simplest pattern of abductive reasoning (Peirce [35]). This pattern can be contrasted with the deductive pattern which from "if **h** then **e**" and "**h** is true" infers that "**e** is true".

The abductive pattern although considered by many authors (e.g. Pólya [39]), has not been given any logical or numerical formalization until recently, if we except the Bayesian model (where we compute the a posteriori probability of **h** when **e** is observed), and some heuristic, numerically quantified attempts (e.g. Friedman [20], Bandler and Kohout [3], Hall [23]). Abduction is often related to the handling of causation in diagnosis problems. Pearl [32] rather distinguishes between expectation-evoking and explanation-evoking rules. With our above notations, it comes down to consider the rule "if **h** then **e**" with the interpretation "if **h** is true then **e** is expected" (deduction) and the companion rule "if **e** then **h**" understood as "the observation of **e** suggests **h** as a possible explanation" (abduction). More recently, Pearl and Verma [34] have proposed a minimal-model semantics of causation, based on directed acyclic graphs.

Clearly a key problem in abduction is to provide some status to the abductive conclusion "**h** is plausible" and maybe to assign some plausibility degree to **h**. Thus we may be able to rank possible causes of an observed state of facts according to their respective plausibilities. In the following we briefly review three approaches to abductive reasoning which come from different research areas, namely

- the relational approach where a (possibly fuzzy) relation relates causes and observations;
- the conditional approach where the rule "if **h** then **e**" is understood in terms of a conditional measure and where an a posteriori measure is computed for **h** (a probability or a possibility);
- the logical approach which looks for minimal set(s) of hypotheses which makes **e** true.

In each case we suggest how a possibility theory-based model can be used. However a comparative and unified view of these three approaches is beyond the scope of the paper.

2. Relational Approach

2.1. General Principles

In the relational model, a set of potential causes $\mathcal{H} = \{\mathbf{h}_1, \ldots, \mathbf{h}_i, \ldots, \mathbf{h}_m\}$ is related to a set of potential observations (or more precisely of observable effects) $\mathcal{E}$ =