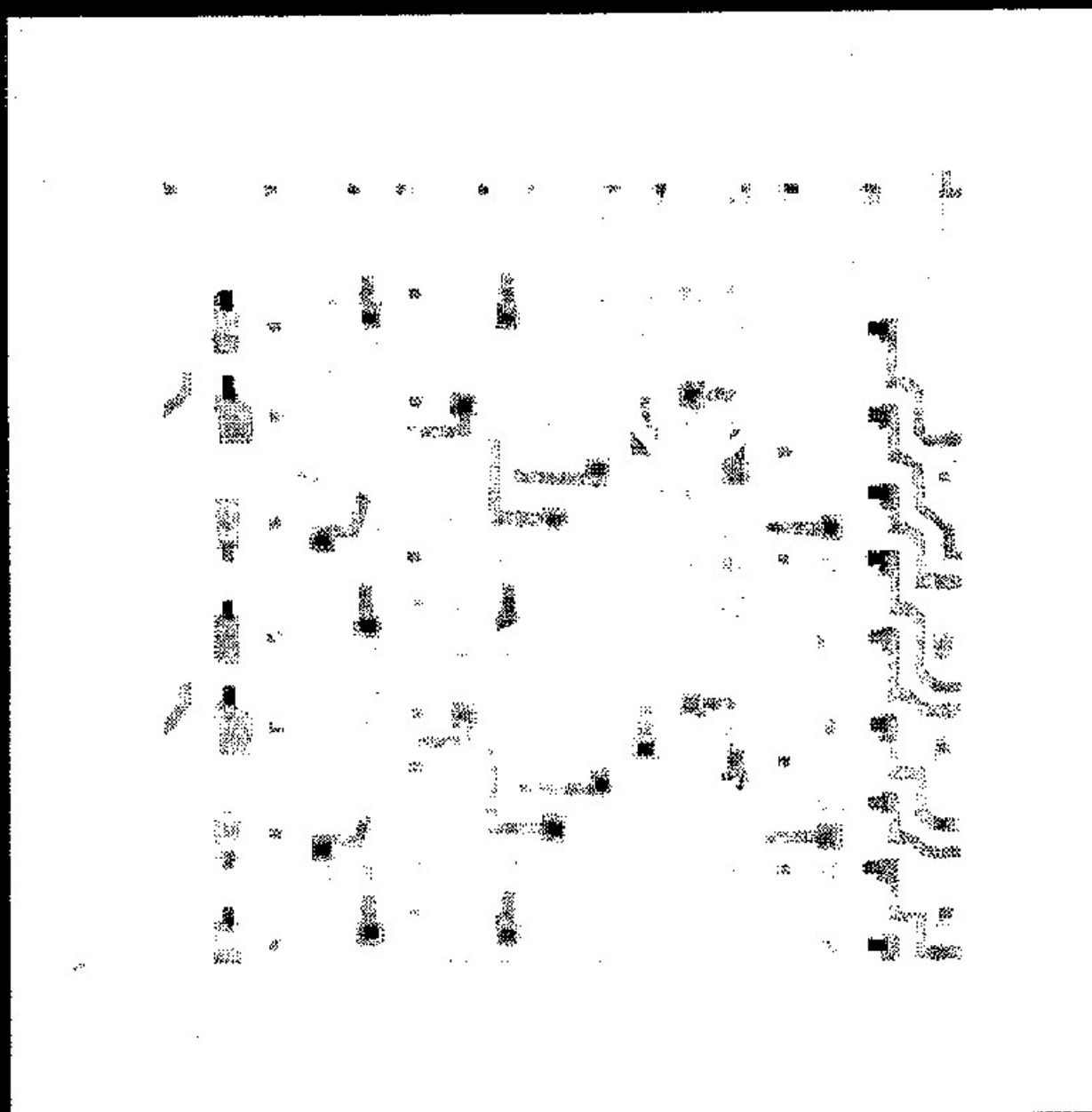




MACHINE LEARNING

A Multistrategy Approach

Volume IV



Ryszard Michalski
Gheorghe Tecuci

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PREFACE

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This is the fourth volume in a series of books on Machine Learning that aim at contributing to a global prospective on the progress of this field. Individual volumes contain selected contributions made by leading researchers during a given period of time. The first volume (Michalski, Carbonell, and Mitchell, 1983) contained specially prepared chapters and significantly revised and updated versions of the presentations from the First Workshop on Machine Learning, held in 1980 at Carnegie Mellon University in Pittsburgh, Pennsylvania. Subsequent volumes, Volume II (Michalski, Carbonell, and Mitchell, 1986) and Volume III (Kodratoff and Michalski, 1990), contain reviews and research contributions representative of major research areas in machine learning for the covered period. All volumes also contain extensive indexed bibliographies of this field.

Volume IV continues this tradition, except for one major change. In view of the extraordinary expansion and diversification of research in machine learning that has occurred in recent years, it is no longer possible to provide in a single volume a representative coverage of all major research directions and paradigms of this field. Therefore, we decided to focus the book on the area of *multistrategy learning* that constitutes a major long-term challenge for this field. Multistrategy learning represents an effort to unify the entire field of machine learning and is likely to become a central research theme for the field in the future.

In the past, most research in machine learning was concerned with methods that employ a single learning strategy, that is, with *monostrategy* methods. Such methods implement one primary type of inference, such as empirical induction, deduction, abduction, or analogy, using one computational (or representational) mechanism, such as a decision tree, decision rules, a semantic network, frames, a neural net, or a classifier system. Such methods include those for empirical inductive generalization, quantitative law discovery, conceptual clustering, genetic algorithm based learning, explanation-based learning, learning by abduction, and case-based learning.

With the growing understanding of the capabilities and limitations of monostrategy methods, there has been an increasing interest in multistrategy systems that integrate multiple inference types and/or computational mechanisms in one learning system. Such systems can learn from a wider scope of input, and be applied to a wider range of problems than monostrategy methods. Although research on monostrategy methods continues to be of great importance to the field, there is a rapidly increasing interest in multistrategy learning. The beginning of this trend was already noticeable in Volume III, which contained a separate section on this area. Volume IV is now entirely devoted to multistrategy learning, reflecting a significant expansion and growing importance of research in this area. The immediate impetus for the preparation of this volume was the *First International Workshop on Multistrategy Learning (MSL-91)*, organized by George Mason University in Harpers Ferry, West Virginia, November 7-9, 1991 (Michalski and Tecuci, 1991).

This volume contains tutorial presentations and research contributions representative of the current research by leading researchers in multistrategy learning. Individual chapters are substantially rewritten and improved versions of the papers that have been selected from among those presented at MSL-91. The book is divided into five parts. Part I addresses underlying principles and theoretical issues, as well as related topics of human learning, which is intrinsically multistrategy. Part II describes methods of theory revision through multistrategy learning. Part III presents architectures for multistrategy learners that emphasize a cooperation between different strategies or their selection according to the task. Part IV discusses issues of integrating symbolic and subsymbolic learning and compares the performances of these two paradigms on a selected class of learning problems. Part V addresses special topics and applications of multistrategy learning. Finally, the Bibliography provides a comprehensive source of references on multistrategy learning and selected background material from the entire field of machine learning. It contains over 600 entries, which are indexed by specific categories and subcategories.

Many individuals and several organizations contributed, directly or indirectly, to the preparation of this book. The editors would like to express their deep gratitude to the Office of Naval Research, especially Dr. Alan Meyrowitz, for the vision and understanding of the importance of research on multistrategy learning, for

providing an early research grant to the first editor to study this area, and subsequently for supporting the organization of the First International Workshop on Multistrategy Learning (MSL-91).

We thank Dr. Andrew Sage, Dean of the GMU School of Information Technology and Engineering, and Dr. Larry Kershberg, Chairman of the GMU Department of Information Systems and Software Engineering, for their support and interest in the Workshop. We also acknowledge the help and continuing support of the members and the staff of the GMU Center for Artificial Intelligence.

Important contributions were made by Jerzy Bala, Eric Bloedorn, Tom Dybala, Michael Hieb, Ibrahim Imam, Ken Kaufman, Jayshree Sarma, Haleh Vafaie, and Janusz Wnek, Ph.D. students at the GMU Center for Artificial Intelligence. They provided indispensable assistance in preparing and organizing MSL-91, reviewing the papers, and providing comments to the authors. Our discussions with them on multistrategy learning helped shape the final version of the book.

We are very grateful to the MSL-91 participants for their discussions and comments at the Workshop. The idea of this book originated during these discussions and exchanges.

Our deep and heartfelt gratitude goes to all the contributors to this volume. They have made a special effort to improve and update their MSL-91 papers and to present them in a highly comprehensive and easy-to-read manner. We also thank all the reviewers whose diligent and careful reviews were crucial for achieving the high quality of all the contributions.

In presenting this new volume, we hope that it will stimulate interest in this novel and exciting area of machine learning.

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