Book Reviews

Readings in Planning

Edited by James Allen, James Hendler, and Austin Tate
Morgan Kaufmann, San Mateo, CA, 1990
Pp. 754, ISBN 1-55860-130-9

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Introduction

Readings In Planning (RIP) is another volume in a fine series of anthologies published by Morgan Kaufman. This volume is a collection of previously published (save for one) papers on the subfield of artificial intelligence (AI) dealing with planning and action. This volume presents many of the historically important papers while providing a general framework for study in this field.

This book does not attempt to lead the reader to any conclusion or to make more accessible the various papers but rather to provide the bulk of the material need by anyone entering the field. As is often the case with compendiums of prior work, this work does not provide much of a view of the current state of the art. However, it does provide re-view, over-view and some current directions. Some of the background needed to make the entire volume accessible can be had from papers in prior volumes of Morgan Kaufman readings [1, 2] and general introduction to AI texts [3,4,5]. For current trends in AI and planning the interested reader is referred to the proceedings of such general AI and planning conferences such as the annual AAAI and biennial IJCAI, KR and TARK [C1,C2,C3,C4] (see also [6,7]).

The editors divide the 753 pages of RIP into 4 parts and a total of 11 chapters. Within all of the four sections each chapter has a short one page introduction. A short overview of the chapter's topic is given and papers referred to, but not contained in the volume, are listed. This is especially important for chapters in part 4, New Directions in Planning. This section contains mostly conference length papers and technical reports that provide a view of the directions current planning research is taking. The typical paper throughout these last hundred pages is only dated circa 1986. This is the only section of the four main sections to have an introduction page and the editors appropriately use it to discuss the basis for selection of papers in this section. The "not contained" references in section 4 site almost 20 additional papers from the 1988-89 time frame.

Discussion

The first section of RIP contains one chapter and is an introduction to the field of planning. Two very fine review articles are included as well as a previously unpublished, short, somewhat philosophical overview article by Allen. The review articles contain descriptions of the terminology and techniques used in planning and each provides over 120 references. The relations of many of the implemented planners and techniques are covered as well.

Part two begins with some historically relevant planners including Green's QA3 and its use of theorem prover techniques on state transformations and the important and still influential STRIPS work of Fikes and Nilsson. This section also includes important work by authors perhaps not first thought of as "planners," notably Waldinger's regression techniques for dealing with conjunctions of goals and Feldman and Sproul's work on decision theory. Other concepts introduced in this section include non-linear and abstract plans (Sacerdoti) and using notions of time in planning (Vere). The need for a richer representation of plans and actions, their execution, and for reasoning about time and action is discussed by McDermott, while the entry by the Hayes-Roths argues for the need of a more opportunistic model based on cognitive studies. Issues in decision theory and (opportunistic) control strategies, as applied to such areas as real-time problem-solving systems, are currently active areas of research.

The final chapter of this section contains papers describing integrated or engineered planners. Notable are Tate's NONLIN which was an extension of Sacerdoti's hierarchically based NOAH and O-PLAN, Tate and Currie's work following NONLIN. Vere's work on Devisor was originally designed for NASA's space program and continues as an active research project under his direction at Lockheed Areospace. This early work with time and duration is an example of one of the successes and continuing application projects in the field. This work, along with Fox and Smith's ISIS introduce the reader to the scheduling domain aspects of planning. Dean, Firby and Miller's work with time, scheduling and resources (FORBIN) is also included and similar to ISIS. These later papers are perhaps not of equal generality and importance due to their domain specific encoding and heuristic evaluations. Dean's more recent and general work with McDermott is presented later in RIP (part 3).

Part three begins with a chapter on formal models of action. McCarthy and Hayes' influential philosophical paper presents the situation calculus as a substantial improvement over state-based work such as in QA3. Reasoning using temporal world models is presented in two papers with contrasting views. McDermott presents a time logic based on points and introduces the notion of persistence in time, while Allen's formalism presents a temporal logic based on intervals. Allen's work is presented as allowing for a wider range of action descriptions than in the situation calculus. Notions of simultaneous and interacting actions and multi-agent worlds are now handled. Work on both temporal formalisms remains active today as they both are vastly more expressive than state-based theories.

The following two chapters of this section are two of the strongest and most interesting in the book and reflect the approach of the editors to this volume. New approaches to planning are not found but rather we find new papers on already posited theories and approaches. In the first of these chapters we see Lifschitz's discussion of the meaning involved in STRIPS operators and this helps in understanding the fundamentals of this important though limited state-based approach to planning. Korf discusses the efficiency of several types of knowledge sources, including abstraction and sequences of subgoals he terms macro-operators.

Chapman provides some analysis and complexity results of prior work on domain-independent conjunctive planners. His algorithm, TWEAK, is shown to be complete and correct while also giving theorems on the undecidability of planners; it continues on today in an abstract version [8] and in IPEM (Ambros-Ingerson and Steel).

The importance of planning using temporal-based world models is first evidenced by the inclusion of the Allen and Koomen paper on planning with a temporal world model. The evidence continues in the second of these strong chapters with the inclusion of papers by Shoham, Dean and Hanks. All of these papers where co-authored with McDermott and address such issues as persistence, the frame problem, assumptions, predictions and projections. The varied representations and the formal and heuristic approaches indicate that although these works are important and very current, consensus of approach has not been reached.

The fourth and final section, on current trends, is well introduced by the editors' section and chapter overviews. Minton's paper is a good introduction to explanation-based learning (EBL) with its focus on learning generalized plans for reuse. Kaebling's paper addresses the architecture needed for reactive systems while Georgeff and Lansky describe a reactive system for autonomous agents that consider beliefs, desires and intentions. Hammond's case-based reasoning and Alterman's adaptive reasoning are also presented as examples of reasoning from older and perhaps general plans into specific situations. Appropriately, the book ends with an article whose title points to perhaps the task area of most current interest: "Integrating Planning, Execution and Monitoring" (Ambros-Ingerson and Steel).

Conclusion

This book is easy to recommend. It is large and encompassing, contains good foundational material and pointers to the important and currently active research areas. The index is at least adequate in size and very well detailed. The listing of authors' current affiliation is also a nice effort towards making this a very complete resource book for anyone with continuing interest in the area of planning. Few if any important papers have been left out. Perhaps authors such as Agre ("The Dynamic Structure of Everyday Life" [9]), Brooks ("Intelligence without Representation" [10]), Ginsburg [11], Breese and Fahling [12], Russell and Wefald [C4] or Wellman [13] could have been included. One might also ask for explicit sections on issues in robotics, probability, real-time, uncertainty[13], machine-learning [14], and non-monotonic reasoning [15] as they pertain to planning but clearly not everything can be included. What is also clear is that this book could be the focus of anyone working or studying in the field of planning and acting. The less knowledgeable and also the more interested reader can augment the study with selections from the below list plus the journal literature. Perhaps the editors could have also included this in a "where other work has been and will be published" section. Overall an excellent resource to the interested researcher or student.

References

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Continuing Conferences (Proceedings available from Morgan Kaufman Publishers)

C1. American Association of Artificial Intelligence (AAAI), annual since 1980.

C2. International Joint Conference on Artificial Intelligence (IJCAI), biennial since 1969.

C3. Conference on Knowledge Representation (KR), biennial since 1989.

C4. Theoretical Aspects of Reasoning about Knowledge (TARK), biennial since 1986.