Lecture Notes in Artificial Intelligence

Edited by J. Siekmann

Subseries of Lecture Notes in Computer Science

462

G. Gottlob W. Nejdl (Eds.)

Expert Systems in Engineering

Principles and Applications

International Workshop
Vienna, Austria, September 24–26, 1990
Proceedings

Springer-Verlag
Berlin Heidelberg New York London
Paris Tokyo Hong Kong Barcelona

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CR Subject Classification (1987): I.2.1, I.2.3–5, I.2.8, I.6, J.6

ISBN 3-540-53104-1 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-53104-1 Springer-Verlag New York Berlin Heidelberg

Printing and binding: Druckhaus Beltz, Hemsbach/Bergstr.
2145/3140-543210 – Printed on acid-free paper

Preface

The application of expert systems in a technical environment has been an important topic in the last years. Techniques for this area have been described in all artificial intelligence conferences in more or less detail.

This volume contains the final versions of papers that were presented at the International Workshop on Expert Systems in Engineering held on three days in September 1990 in Vienna. Out of 49 papers submitted, 15 papers were accepted as long paper and 4 as short papers, all of which are reprinted in this volume.

Of course it is not possible to cover all facets of such a large area during one workshop, so the papers presented mainly focus on four distinct areas: model-based diagnosis (8 papers + 1 invited talk), planning/design/scheduling (5 papers), general reasoning (3 papers) and applications (3 papers).

The members of a panel discussion described and discussed applications of several of these expert system techniques in the steel industry. Abstracts of their presentations have also been included.

We thank all who have submitted a paper to this workshop and are grateful to the members of the program committee and the additional referees, who contributed a lot to the success of this workshop. The workshop was sponsored by the Austrian Industries in the context of the Christian Doppler Laboratory for Expert Systems and took place at the Technical University of Vienna.

We think the included papers will enable the reader to identify important topics and results in this field and hope that the publication of these results will further stimulate research in this rapidly changing and expanding area.

Vienna, September 1990 *Georg Gottlob, Wolfgang Nejdl*

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Characterizing Diagnoses[1]

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Abstract

Most approaches to model-based diagnosis describe a diagnosis for a system as a set of failing components that explains the symptoms. In order to characterize the typically very large number of diagnoses, usually only the minimal such sets of failing components are represented. This method of characterizing all diagnoses is inadequate in general, in part because not every superset of the faulty components of a diagnosis necessarily provides a diagnosis. In this paper we analyze the notion of diagnosis in depth exploiting the notions of implicate/implicant and prime implicate/implicant. We use these notions to propose two alternative approaches for addressing the inadequacy of the concept of minimal diagnosis. First, we propose a new concept, that of kernel diagnosis, which is free of the problems of minimal diagnosis. Second, we propose to restrict the axioms used to describe the system to ensure that the concept of minimal diagnosis is adequate.

[1]Corrected (as of June 29, 1988) version of the AAAI-90 paper.

[2]Fellow, Canadian Institute for Advanced Research.

1 Introduction

The diagnostic task is to determine why a correctly designed system is not functioning as it was intended — the explanation for the faulty behavior being that the particular system under consideration is at variance in some way with its design. One of the main subtasks of diagnosis is to determine what could be wrong with a system given the observations that have been made.

Most approaches to model-based diagnosis [4] characterize all the diagnoses for a system as the minimal sets of failing components which explain the symptoms. Although this method of characterizing diagnoses is adequate for diagnostic approaches which model only the correct behavior of components, it does not generalize. For example, it does not necessarily extend to approaches which incorporate models of faulty behavior [21] or which incorporate strategies for exonerating components [16]. In particular, not every superset of the faulty components of a diagnosis necessarily provides a diagnosis. In this paper we analyze the notion of diagnosis in depth and propose two approaches for addressing the inadequacy of minimal diagnoses. First, we propose an alternative notion, that of kernel diagnosis, which is free of the problems of minimal diagnosis. Second, we propose to restrict the axioms used to describe the system to ensure that the concept of minimal diagnosis is adequate.

The extended version of this paper [7] expands on the results, includes proofs for all the theorems, develops restrictions on the system description that allow the use of minimal diagnosis, and uses the approach to analyze current model-based diagnostic systems in more detail.

2 Problems with minimal diagnosis

Insofar as possible we follow Reiter's [17] framework.

Definition 1 *A system is a triple (SD,COMPS,OBS) where:*

1. *SD, the system description, is a set of first-order sentences.*
2. *COMPS, the system components, is a finite set of constants.*
3. *OBS, a set of observations, is a set of first-order sentences.*

Most model-based diagnosis papers [5, 6, 10, 16, 17, 21] define a diagnosis to be a set of failing components with all other components presumed to be behaving normally. We represent a diagnosis as a conjunction which explicitly indicates whether each component is normal or abnormal. This representation of diagnosis captures the same intuitions as the previous definitions but generalizes more naturally.