Verification and Validation of Knowledge-Based Systems

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Abstract—Knowledge-based systems (KBS) are being used in many applications areas where their failures can be costly because of the losses in services, property, or even life. To ensure their reliability and dependability, it is therefore important that these systems are verified and validated before they are deployed. This paper provides perspectives on issues and problems that impact the verification and validation (V&V) of KBS. Some of the reasons V&V of KBS is difficult are presented. The paper also provides an overview of different techniques and tools that have been developed for performing V&V activities. Finally, some of the research issues that are relevant for future work in this field are discussed.

Index Terms—Expert systems, knowledge-based systems, verification, validation, reliability, dependability, testing.

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1 INTRODUCTION

EXPERT systems (ES) are intelligent computer systems whose problem-solving performance would rival or exceed human performance in narrow areas of human endeavor, whereas knowledge-based systems (KBS) are computer systems that assist in problem solving. Expert systems and knowledge-based systems are among the fruitful spin-offs from artificial intelligence. Worldwide expert system expenditures in 1993 totaled $595 million. Today, these systems have found their way into many applications such as knowledge publishing, shuttle mission experiment planning, crew scheduling, medical diagnosis, computer configuration, process control, regulation compliance advising, financial advising, and nuclear engineering.

As these knowledge systems (KS)—we use KS to denote either ES or KBS—are deployed in settings where system failures may result in loss of productivity, decision-making, property, business, services, or even life, the reliability and dependability of the systems become important. It is imperative that the systems are thoroughly verified and validated before they can be deployed in the field. Verification and validation (V&V) of KS therefore is a key aspect of the development of KS. Many V&V techniques and tools have been proposed, developed, and implemented [1], [12], [16], [17], [19], [24], [28], [30], [32], [34], [35], [37], [48].

As the use of KS in various areas grows, many commercial KS are being developed. Many techniques have been applied to the development of these KS and experience has been gained about some of the specific issues and problems faced during the development of KS in the industry. These issues can be useful in understanding the progress made and some of the shortcomings of existing V&V techniques for KS in the context of industrial environments. Table 1 summarizes one survey about current industrial practice in V&V of KS [18], [33].

From Table 1, it is apparent that KS share many characteristics with conventional software. The lack of well-documented requirements, the use of prototypes as requirements and the absence of a well-defined life-cycle model are common to many conventional software development environments also. For instance, inconsistencies, incompleteness, and ambiguity in requirements specifications have been identified as major sources of bugs in software development [5]. But KS also have certain components such as the Inference Engine (IE) and domain knowledge stored in a KB, which are not present in conventional software. Thus, while many issues that impact the V&V of conventional software such as the lack of requirements documents need to be considered, additional issues such as the validation of the IE and its interactions with the KB also need to be addressed. This paper presents a perspective on the issues related to the V&V of KS and some of their goals.

2 DEVELOPMENT OF KS

The development process for a software product specifies how the development tasks are decomposed into subtasks or phases. It also determines what by-products are used and generated during the development process. V&V require checking some properties (such as internal consistency) of a by-product (such as requirements specification) or a comparison of two by-products (such as a specification

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Validation Verification And Tests Of Knowledge Based Systems

Uma G. Gupta

Validation Verification And Tests Of Knowledge Based Systems:
    Validation, Verification and Test of Knowledge-based Systems Marc Ayel,Jean-Pierre Laurent,1991-11-27 Validation Verification and Testing VVT are important and difficult to achieve for any software product Knowledge Based Systems KBS present particular problems dealing as they do in probabilities uncertainties and approximations This collection of papers looks at current research and implementation issues describes tools techniques and validation and verification criteria discusses particular projects and includes a survey of developers   Validation and Verification of Knowledge Based Systems Anca Vermesan,Frans Coenen,2013-04-17 Knowledge based KB technology is being applied to complex problem solving and critical tasks in many application domains Concerns have naturally arisen as to the dependability of knowledge based systems KBS As with any software attention to quality and safety must be paid throughout development of a KBS and rigorous verification and validation V V techniques must be employed Research in V V of KBS has emerged as a distinct field only in the last decade and is intended to address issues associated with quality and safety aspects of KBS and to credit such applications with the same degree of dependability as conventional applications In recent years V V of KBS has been the topic of annual workshops associated with the main AI conferences such as AAAI IJACI and ECAI Validation and Verification of Knowledge Based Systems contains a collection of papers dealing with all aspects of KBS V V presented at the Fifth European Symposium on Verificationand Validation of Knowledge Based Systems and Components EUROVAV 99 which was held in Oslo in the summer of 1999 and was sponsored by Det Norske Veritas and the British Computer Society s Specialist Group on Expert Systems SGES   *Knowledge-Based Systems, Four-Volume Set* Cornelius T. Leondes,2000-07-11 The design of knowledge systems is finding myriad applications from corporate databases to general decision support in areas as diverse as engineering manufacturing and other industrial processes medicine business and economics In engineering for example knowledge bases can be utilized for reliable electric power system operation In medicine they support complex diagnoses while in business they inform the process of strategic planning Programmed securities trading and the defeat of chess champion Kasparov by IBM s Big Blue are two familiar examples of dedicated knowledge bases in combination with an expert system for decision making With volumes covering Implementation Optimization Computer Techniques and Systems and Applications this comprehensive set constitutes a unique reference source for students practitioners and researchers in computer science engineering and the broad range of applications areas for knowledge based systems   **Database and Expert Systems Applications** Mohamed Ibrahim,2000-08-25 This book constitutes the refereed proceedings of the 11th International Conference on Database and Expert Systems Applications DEXA 2000 held in London in September 2000 The 92 revised full papers presented together with one invited paper were carefully reviewed and selected from a total of 183 submissions The book offers topical sections on object oriented and relational databases multimedia databases fundamentals workflow management systems database security XML advanced databases queries knowledge based systems data

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in a wide variety of settings and this handbook has been written to meet a specific need in their widening use While there have been many successful applications of knowledge based systems some applications have failed because they never received the corrective feedback that evaluation provides for keeping development focused on the users needs in their actual working environment This handbook provides a conceptual framework and compendium of methods for performing evaluations of knowledge based systems during their development Its focus is on the users and subject matter experts evaluation of the usefulness of the system and not on the developers testing of the adequacy of the programming code The handbook permits evaluators to systematically answer the following kinds of questions Does the knowledge based system meet the users task requirements Is the system easy to use Is the knowledge base logically consistent Does it meet the required level of expertise Does the system improve performance The authors have produced a handbook that will serve two audiences a tool that can be used to create knowledge based systems practitioners developers and evaluators and a framework that will stimulate more research in the area academic researchers and students To accomplish this the handbook is built around a conceptual framework that integrates the different types of evaluations into the system of development process The kinds of questions that can be answered and the methods available for answering them will change throughout the system development life cycle And throughout this process one needs to know what can be done and what can t It is this dichotomy that addresses needs in both the practitioner and academic research audiences   *Readings in Knowledge Acquisition* Karen L. McGraw,Christopher Ralph Westphal,1990 A review of AI topics divided into four main sections representing current issues The readings stress application of knowledge acquisition research and theory aiming to reflect the processes of acquiring and structuring knowledge of knowledge based and expert systems   NASA Conference Publication ,1991   **Proceedings of the ... Banff Knowledge Acquisition for Knowledge-Based Systems Workshop** ,1995   Library & Information Science Abstracts ,2000   **Telematics and Informatics, Volume 7, Number 1** ,1990

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