AI Magazine Volume 16 Number 3 (1995) (© AAAI)

Seventh Workshop on the Validation and Verification of Knowledge-Based Systems

Robert Plant

■ The annual Workshop on the Validation and Verification of Knowledge-Based Systems is the leading forum for presenting research on the validation and verification of knowledge-based systems (KBSs). The 1994 workshop was significant in that there was a definitive move in the philosophical position of the workshop from a testing- and tool-based approach to KBS evaluation to that of a formal specification-based approach. This workshop included 12 full papers and 5 short papers and was attended by 35 researchers from government, industry, and academia.

The Workshop on the Validation and Verification of Knowledge-Based Systems, held at the Twelfth National Conference on Artificial Intelligence (AAAI-94) in Seattle, Washington, marked the seventh consecutive year in which this problem area was addressed. The workshop is the leading forum for presenting research on the validation and verification of knowledge-based systems (KBSs). It has influenced the evolution of the discipline from its origins in 1988; at this time, researchers were asking the questions, How can we evaluate the correctness of KBS? How is this process different from conventional system evolution? The early years of the workshop focused on the transference of conventional techniques to the KBS testing arena, the creation of logical foundations for testing KBSs, and the development of tools to assist in the evaluation process. A collection of selected papers from the 1988–1992 workshops was compiled by Daniel O'Leary and is a useful starting point for anyone surveying the field.[1]

The 1994 workshop was significant in that there was a definitive move in the philosophical position of the workshop from a testing- and tool-based approach to KBS evaluation to that of a formal specification-based approach. The 1994 workshop included 12 full papers and 5 short papers and was attended by 35 researchers from government, industry, and academia. The full papers of the workshop were presented in three sessions: (1) formal methods and techniques for validation and verification, (2) techniques and practices, and (3) tools and practices.

The first session aimed to set the stage for the day's discussion by focusing on the issues surrounding the use of formal specification techniques in the development and evaluation of KBSs. The first paper, by Lance Miller of SAIC, was entitled "Recommended Guidelines for Validation and Verification of Various Kinds of Systems at Various Life Cycle Phases." This paper provided a basis for the comparison of validation and verification techniques to be presented in the remainder of the workshop. The paper extended his previous work for the Electric Power Research Institute in which Miller presented over 150 testing techniques and evaluated their effectiveness for a series of situations and error types. Miller presented a set of these techniques for KBS and discussed (1) the types of quality assurances addressed by the validation and verification method, (2) the needed talents of the validation and verification teams for the method, (3) the degree of application needed, (4) the metrics to be taken, (5) the actions to be taken for various metric outcomes, and (6) literature references for all validation and verification methods. Further, Miller discusses guidelines that reflect (1) the stage of development and the most effective validation and verification procedures for the stage, (2) the level of stringency of validation and verification that is judged to be needed, and (3) the type of system component being tested. The variation in all three of these contexts will lead to different types of recommended practice.

The workshop is the leading forum for presenting research on the validation and verification of knowledge-based systems (KBSs). It has influenced the evolution of the discipline from its origins in 1988.

The second and third papers, "Using Formal Specifications to Design Verifiable Hybrid KBS" by Rose Gamble, Donna Baughman, and A. Murphy (all from the University of Tulsa) and "A Formally Based Methodology for Deriving Verifiable Expert Systems from Specifications" by Anca Vermesan and Tor H. Wergeland (both from the Foundation for Research in Economics and Business Administration, Bergan, Norway) focused on the use of Z and LARCH, respectively, in their specification-oriented approaches to KBS development. Gamble and her colleagues illustrated a methodology for the creation of hybrid KBSs from formal specifications and showed initial research into the creation of a computer-aided software-engineering tool to support this approach. Vermesan also presented a formal methodology that focused on two issues: (1) the formal verification of KBSs, showing that the expert system is consistent with its specification, and (2) the refinement of formal specifications for their implementation.

The final three papers in this sec-

tion of the workshop presented formalized techniques for validating certain properties of KBSs. A paper by Alun Preece, Cliff Gossner, and T. Radhakrishnan (all from the University of Aberdeen, Scotland) considered an interesting but largely neglected area of validation and verification—the dynamic properties of a KBS. The paper presented a model for the relationship between the goal states achieved by a rule-based system, the set of interrelated rules that must fire to achieve each goal state, and the data items required for the rules in the rule sequence to fire. James Schmolze (Tufts University) and Wayne Snyder (Boston University) presented a fully automatic method that determines whether a given production rule set is confluent and a semiautomatic method that, under many circumstances, will complete a nonconfluent production rule set such that it becomes confluent. This work is important, first, in that often, determinism can be a requirement of the system under development; hence, the techniques are desirable. Second, it is easier in general to verify a confluent rule set than a nonconfluent one. Third, rule sets that are confluent and terminal are applicable to larger sets of validation and verification techniques. The final paper of session 1 was by John Yen and Xiaoqing Liu (both of Texas A&M University), who presented a framework for the specification and validation of imprecise conflicting requirements in KBSs through a fuzzy-set analysis in conjunction with a formalized trade-off analysis.

The second set of papers presented a variety of techniques that can be applied to the validation and verification of KBS. O'Leary, from the University of Southern California, presented a paper on the relationship between errors and size in KBSs. This paper is among the first to address this important issue. O'Leary investigated the empirical relationships between system size and the number of errors and between the number and the existence of different kinds of error. The paper shows that in general, system size is statistically correlated to two error types and total errors. Further, O'Leary found that the size of smaller systems is not correlated to the total number of errors, but the size of larger systems is correlated to the total number of errors. Additionally, O'Leary indicates that there is a positive and statistically significant relationship between the number of redundancy errors and the number of unused constructs.

… there was a definitive move in the philosophical position of the workshop from a testing- and tool-based approach to KBS evaluation to that of a formal specification-based approach.

Stephen Murrell (University of Miami) and I introduced an approach to the implementation of parallel KBS through the concept of graph reduction. Their approach was based on an automatic translation tool that converts decision tables into ALICE machine-implementation graphs. This has several advantages from the perspectives of performance, evaluation, and validation.

Byeong Ho Kang, Windy Gambretta, and Paul Compton (all from the University of New South Wales, Australia) considered the issue of knowledge acquisition as a hot spot of validation. They presented a paper on knowledge acquisition through ripple-down rules in which the knowledge base undergoes ongoing development-based correcting errors. Each new correction or justification is used only in the context of the same mistake being made. The method allows the possibility of constraining the experts' choices to ensure that any new knowledge added is valid and that the knowledge base structure ensures the knowledge is verified.

Mala Mehrotra (Pragati Synergetic Research) presented the latest paper in her series on clustering analysis of knowledge base rules. Her methodology is based on the proposition that no single structuring principle or abstraction hierarchy is sufficient to understand complex knowledge bases but, rather, that multiple viewpoints are necessary. She presented a tool to assist in this process. The final two papers presented at the workshop also introduced tools: Bonnie Traylor, U. Schwuttke, and A. Quan from Jet Propulsion Laboratory (JPL) introduced the prototype JPL tool that will address real-time monitoring and diagnosis domains, and Frans Coenen, Trevor Bench-Capon, and Andrew Kent (all from Liverpool University) introduced a validation tool based on incidence matrixes.

The formal theme of the workshop was continued by Chris Landauer, who closed the workshop with a presentation on the need for a new mathematics for knowledge-based systems, a theme that will be continued at the 1995 International Joint Conference on Artificial Intelligence (IJCAI '95) in Montreal, Québec, Canada.

Reference

1. O'Leary, D. E. 1994. *International Journal of Intelligent Systems* (Special Issue on Collected Papers of AAAI Workshops 1988–1992) 9(8).

Robert Plant is an associate professor in the Department of Computer Information Systems at the University of Miami and research director of the Intelligent Computer Systems Research Institute. Plant received his Ph.D. in computer science from the University of Liverpool, England. His research interests are in software methodology and AI. He was chair of the Seventh National Workshop on Validation and Verification of Knowledge-Based Systems at AAAI-94.