Artificial Intelligence and Expert Systems

Foreword

Three decades of research in Artificial Intelligence (AI) and about fifteen years of experience with its first commercial products known variously as Expert Systems and Knowledge-Based Systems have led to wild speculations about the revolutionary nature of these technologies affecting a wide range of human activities from wars to businesses, and from medical diagnosis to legal applications etc. It appears that AI has matured from the days of solving puzzles and games, proving mathematical theorems or manipulation in the block world domain of robotics to the wider world of diverse science, engineering and business applications where artificial creatures (agents, actors etc.) attempt to solve problems in benign and hostile real worlds. This special issue of *Sādhanā* brings out a collection of papers emphasizing these trends in a predominantly Indian context.

AI research has evolved with the aim of making computing machines smarter by developing programs capable of simulating and mimicking facets of human intelligence. Traditionally, such systems are built using a top-down design approach. Vast amounts of knowledge, from a few human experts, is acquired and stored to solve a narrow range of problems in a specific domain capturing competence along one dimension of a human being's intelligent behaviour. Simultaneously, psychologists and cognitive scientists are concerned with computer programs to provide models of human mental activities such as thinking, learning, perception, use of natural languages, speech and pattern recognition. It is not difficult to recognize the fact that intelligent action in a challenging environment cannot be obtained through the classical weak methods of AI involving heuristic search. Today, intelligent action is synonymous with adaptive behaviour of the agent and intelligent systems are built in a bottom-up manner.

The papers in this special issue deal with problem-solving in diverse disciplines incorporating some of the current trends in AI and expert system fields. The first paper by Dasgupta looks at the problem of designing an artifact as a very important intelligent activity in engineering and looks at the spectrum of design problems ranging from routine to creative designs. The main contribution of the paper is to provide an AI model for a design theory. The design process starts from the initial state of a set of requirements R, to the goal state of a final design D, satisfying the requirements, R, through a structured set of design options. This theory considerably enhances our understanding of engineering design and the author concludes that the same model can serve to enhance our understanding of the act of creative design or an invention.

The next two papers deal with the generic problem of diagnosis. Mahabala and his colleagues discuss different approaches for fault diagnosis of machines. They present four approaches based on fault-tree, rule, qualitative and quantitative models. They demonstrate the superiority of model-based approaches over the rule-based approach while dealing with practical situations, where it is difficult to obtain precise

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knowledge of the domain in the form of rules obtained from an expert. Model-based approaches can take care of situations not envisaged *a priori*, including minor variations in design. The authors recommend a multi-model diagnostic system which localizes the fault using a causal model and sees if the fault can be further localized by qualitative models and resorts lastly to analytical models, if warranted. In the paper on expert system applications to medicine, Banerjee, Majumder and Basu propose a system capable of long term monitoring of a chronic disease such as leprosy. Novel features of this system are the use of multiple cooperating experts, provision for correction of a mistaken diagnosis or incorrect treatment and incorporation of fuzzy production rules and fuzzy reasoning.

The next paper by Shashi, Raju and Lakshminath shows how expert system technology can be exploited for legal counselling and present a system that represents the relevant knowledge effectively. The system is capable of predicting the judgement in a case according to the available knowledge on the case. The authors introduce a frame-like knowledge structure called lattice with two-dimensional attributes for implementing the knowledge-base of the system. The authors illustrate their model of the judgement prediction system with a specific criminal case involving theft.

Sarma and Sarma demonstrate the application of expert system technology for interpreting remote sensing image data. They utilize the Dempster–Shafer theory of evidence to obtain a plausible interpretation by combining information from diverse sources such as collateral data, experiential knowledge, and pragmatics. They use the system for obtaining urban land cover and land use information.

The next three papers deal with language and speech. All these papers suggest exploitation of common features of Indian langauges. The main focus in the paper of Bharathi and his colleagues is to use AI technology for developing a machine translation system between two Indian languages. They propose and use the Paninian framework for machine translation between free word order languages. Based on Paninian theory, they introduce the idea of *Anusaraka* or language accessor, which allows a reader who knows one language to access or follow a text in another language. This enables one to overcome the language barrier for communication in Indian languages. The paper by Shreesh Choudary highlights the real issues in communication through Indian languages especially in the context of mass media such as newspapers, radio and television. He identifies several problems faced by these media while projecting a news item to different regions of the country. The author feels that developments in AI can be used effectively to reduce the communication barriers in a multilingual society like ours. The paper by Yegnanarayana and his colleagues describes the development of a text-to-speech system for Hindi using several knowledge sources such as intonation, duration and coarticulation, besides knowledge of speech production at segmental level. They show that it is essential to acquire and incorporate these rules if the system is to produce intelligible speech from an unrestricted text. The paper discusses methodology to acquire these knowledge sources for Hindi, which can be adopted for other Indian languages as well.

The final paper in the issue addresses the planning problem in AI. Planning is knowledge intensive. Planning in an uncertain domain is rarely considered in contemporary AI systems. The paper by Khemani looks at the problem of planning in a dynamic and uncertain domain exemplified by the declarer's play in the game of contract bridge. The paper proposes a two-stage mechanism for planning. In the first stage, partial plans are suggested by a theme-based planner. The planner employs knowledge structures called thematic acts. In the second stage, a scheduler continues

the actions suggested by thematic acts into a coherent plan. The author feels that such a scheme of planning is particularly attractive for planning in complex domains where partial plans for newer goals have to be incorporated into the larger plans of an agent who may be continuously interacting with the world.

It took us more than a year to bring out this special issue due to our desire to address issues and topics which are new and relevant to the Indian context. The papers illustrate the range of possible applications of AI technology. We are grateful to the authors, who have put up with our numerous suggestions for revisions and our reviewers for their critical comments which significantly improved the presentation.

Finally, we thank the editors of *Sādhanā* for giving us this opportunity and for putting up with the delay in bringing out this issue. As guest editors, we thoroughly enjoyed our interactions with the authors and the editors in this task.

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<div align="right">Guest Editors</div>