Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 1998 Proceedings

Americas Conference on Information Systems (AMCIS)

December 1998

An Overview of Contributions to the Decision Support Systems Area from Artificial Intelligence

Sean Eom
Southeast Missouri State University

Follow this and additional works at: http://aisel.aisnet.org/amcis1998

Recommended Citation
Eom, Sean, "An Overview of Contributions to the Decision Support Systems Area from Artificial Intelligence" (1998). *AMCIS 1998 Proceedings*. 53.
http://aisel.aisnet.org/amcis1998/53

This material is brought to you by the Americas Conference on Information Systems (AMCIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in AMCIS 1998 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

An Overview of Contributions to the Decision Support Systems Area from Artificial Intelligence

Sean B. Eom
Department of Management
Southeast Missouri State University

Abstract

This study investigates the contributions of artificial intelligence to the development of decision support systems research subspecialties. Author cocitation analysis was applied to an author cocitation frequency matrix derived from a comprehensive database of the DSS literature (1970-1995) to uncover twelve clusters consisting of six major areas of DSS research (foundations, group DSS, model management, user interfaces, implementation, and multicriteria DSS) and six contributing disciplines (multiple criteria decision making, cognitive science, organization science, artificial intelligence, group decision making, and systems science). This study concludes that artificial intelligence has made important contributions to the development of foundational concepts, model management, group support systems, and multiple criteria decision support systems.

Introduction

This study builds on a series of previous studies (Eom, 1996, 1997, 1998) and focuses on examining the contributions of artificial intelligence (AI) to the development of each of the DSS subspecialty areas. Cluster analysis of 1,189 citing reference data and 31,938 cited reference records uncovered six major areas of DSS research (group DSS, foundations, user interfaces, model management, multicriteria DSS, and implementation) and five contributing disciplines (multiple criteria decision making, cognitive science, artificial intelligence, organizational science, and systems science). Readers are referred to Eom (1996) for in-depth discussions in regard to implications and directions for future DSS research.

Data and Research Methodology

A database file was created consisting of a total of 31,938 cited reference records taken from the 1189 *citing* articles in the DSS area over the past 25 years (1971-1995). This study uses author cocitation analysis (ACA). ACA is the principal bibliometric tool to establish *relationships* among authors in an academic field and thus can identify subspecialties of a field and how closely each subgroup is related to each of the other subgroups. For a detailed description of the database file and research methodology, see Eom (1996, 1997, 1998).

Results

Cluster analysis (Eom, 1996, 1997) and interfactor correlations analysis (Eom, 1996, 1998) reveal that AI has influenced strongly on the following areas-- group DSS, foundations, model management, and multiple criteria/ negotiation DSS.

The Impact of AI on Foundations: The linkage between the foundations cluster and the AI factor can be found in the creation of knowledge-based DSS. The DSS architecture of Bonczek, Holsapple, and Whinston (1981) presented a substantially new approach toward decision support, that is, the integration of AI, linguistics, and database management systems. Applying the generalized state-space representation and means-ends analysis of the problem-solving process, they viewed DSS as systems that consist of knowledge systems, language systems, and problem processing systems. Many DSS researchers examined possible connections between AI and DSS and discussed some issues related to their integration to build knowledge-based systems which provide users with the intelligence in structuring a decision, selecting models, and interpreting the output. To help ameliorate human cognitive limitations, expert decision support systems have been proposed by many DSS researchers (Remus and Kottemann, 1986). A recent survey (Eom, et al., forthcoming) revealed emerging development and implementation trends of expert decision support systems (knowledge-based decision support systems, intelligent DSSs). An increasing number of intelligent systems are incorporating domain knowledge, modeling, and analysis systems to provide users the capability of intelligent assistance. Knowledge base modules are being used to formulate problems and decision models, and analyze and interpret the results. Some systems are adding knowledge-based modules to replace human judgments to ascertain (assess) future uncertainty and to select assumptions on which decision models can be based.

The Impact of AI on Model Management: In the area of AI application to model management, the concept of knowledge-based model management systems was introduced to support tasks of formulating a new decision model and/or choosing an existing model from the model base, analyzing the model, and interpreting the model's result (Dutta and Basu, 1984; Elam and Konsynski, 1987). Other researchers suggested the use of artificial techniques (predicate calculus) for determining how models

and data should be integrated to develop mechanical methods for automatic selection, synthesis, and sequencing of models to generate query responses.

The Impact of AI on MCDSS: *Multiple criteria DSS/Negotiation Support Systems* represents MCDM model-embedded decision support systems. They can be broadly categorized into a generalized data-oriented MCDSS which is based on multiattribute decision making models, a model-oriented MCDSS which is based on multiple objective decision making models, and data-oriented MCDM Group DSS, and negotiation support systems.

Some efforts have been made to integrate various AI techniques into the MCDSS to develop the knowledge-based or "intelligent" MCDSS. The knowledge-based MCDSS may guide and provide reasoning about the appropriateness of the MCDM model formulation (structuring a decision), exploration/construction of the alternative set (based on the generalized state-space representation and means-ends analysis), evaluation of the alternatives/criteria, construction of the utility functions, and interpretation of outputs.

An example of operational intelligent MCDSS is reported to overcome the gap between the knowledge of DMs and the difficulty of using MCDSS (Lévine, Pomerol, and Saneh, 1990). Moreover, an artificial neural network system is developed to solve discrete MCDM problems via formulating and assessing the utility function by eliciting information from the DMs and ranking and rating alternatives. The system does not assume any particular structure of the utility functions (Malakooti and Zhou, 1994).

The Impact of AI on GDSS: Since 1990s, GDSS is being integrated with other technologies such as expert systems and case-based reasoning, etc. A prototype system that embedded expert systems into GDSS is developed to make a GDSS a more user-friendly and powerful tool for group support by capturing the scarce expertise of human facilitators GDSS session management knowledge (Aiken, et al., 1991). The distributed artificial intelligence approach for designing and developing group problem solving systems is being investigated to coordinate organizational activities in a distributed environment through the development of prototype systems comprising a network of expert systems (Shaw and Fox, 1993).

The Impact of AI on Other Areas of DSS: A recent survey of DSS applications (Eom, et al., forthcoming) reports that real-time decision support systems are emerging due to the new development of artificial intelligence techniques such as machine learning, case-based reasoning and learning, and the improvement of computer hardware and mathematical programming packages in terms of speed of the CPU and the problem size. These tools can obtain knowledge from prior data, decisions and examples (cases), and contribute to the creation of DSS to support repetitive, complex real-time decision making in the flexible manufacturing system scheduling and control.

A host of new tools that are emerging in the DSS area are becoming an integral part of a set of recent developments in data management, DSSs, and executive information systems. These tools are and will reshape DSS developments in organizations. The new capability includes machine learning which refers to computational methods/tools of a computer system to learn from experience (past solutions), data, and observations, and consequently alter its behavior, triggered by a modification to the stored knowledge. Artificial neural networks and genetic algorithms are the most notable approaches to machine learning. Other tools include fuzzy sets, modeling by example, geographical information system (GIS), logic modeling, and visual interactive modeling (VIM) graphics, visual interactive modeling, the data warehouse/multidimensional databases (MDDB), data mining, on-line analytical processing (OLAP), intelligent agents, World Wide Web technologies, the Internet, and corporate intranets.

Data mining, also known as Knowledge Data Discovery, utilizes a plethora of tools such as artificial intelligence (expert systems, neural networks, pattern recognition, machine learning, and fuzzy logic), statistical analysis, multidimensional data analysis, visualization including geographical information systems, and database monitoring technologies to discover new information, patterns, and trends from a company's databases. Intelligent agents (known also as intelligent interfaces, adaptive interfaces) research is an emerging interdisciplinary research area involving researchers from such fields as expert systems, decision support systems, cognitive science, psychology, databases, etc.

Conclusion

This study investigates the contributions of artificial intelligence to the development of decision support systems research subspecialties. This study concludes that artificial intelligence has made important contributions to the development of foundational concepts, model management, group support systems, and multiple criteria decision support systems.

Goul, Henderson, and Tonge (1992, p. 1268) asserted that "future DSS research must reflect the reality from AI that machine-based intelligence has become an important aspect of computer-based support for humans" and addressed a need for revising the definition and focus of DSS to include the idea that selected tasks, in limited domains, involving human decision makers' judgment and intuition can be performed by computer-based intelligent agents as well as humans.

References

Aiken M.W., Sheng, O.P.L. and Vogel, D.R., "Integrating Expert Systems with Group Decision Support Systems." *ACM, Transactions on Information Systems* 9, (1991) 75-95.

Bonczek, R.H., Holsapple, C.W., and Whinston, A.B., *Foundations of Decision Support Systems*, New York: Academic Press, 1981.

Dutta, A., and Basu, A., "An Artificial Intelligence Approach to Model Management in Decision Support Systems," *IEEE Computer* 17/9 (1984) 89-97.

Elam, J.J., and Konsynski, B.R., "Using Artificial Intelligence Techniques to Enhance the Capabilities of Model Management Systems," *Decision Sciences* 18/3 (1987) 487-502.

Eom, S.B., "Mapping the Intellectual Structure of Research in Decision Support Systems Through Author Cocitation Analysis (1971-1993)," *Decision Support Systems* 16/4 (April 1996) 315-338.

Eom, S.B., "Assessing the Current State of Intellectual Relationships between the Decision Support System Area and Academic Disciplines," *Proceedings of the Eighteenth International Conference on Information Systems*, Kuldeep Kumar and Janice I. DeGross, (eds), Atlanta, GA, December 1997, pp. 167-182.

Eom, S.B., "Relationships between the Decision Support Systems Subspecialties and Reference Disciplines: An Empirical Investigation," *European Journal of Operational Research* 104/1, January 1, 1998, 31-45.

Eom, S.B., Lee, S.M., Kim, E., and Somarajan, C., "A Survey of Decision Support System Applications (May 1988-1994)," *Journal of the Operational Research Society* 49/3, 1998, 109-120.

Lévine, P., Pomerol, M.J., and Saneh, R., "Rules Integrate Data in a Multicriteria Decision Support System," *IEEE Transactions on Systems, Man, and Cybernetics* 20/3 (1990) 678-686.

Malakooti, B., and Zhou, Y.Q., "Feedforward Artificial Neural Networks for Solving Discrete Multiple Criteria Decision Making Problems," *Management Science* 40/11 (1994) 1542-1561.

Remus, W.E., and Kottemann, J.E., "Toward Intelligent Decision Support Systems: an Artificially Intelligent Statistician," *MIS Quarterly* 10/4 (1986) 403-414.

Shaw, M.J. and Fox, M.S., "Distributed, Artificial Intelligence for Group Decision Support: Integration of Problem Solving Coordination, and Learning," *Decision Support Systems* 9 (1993) 349-367.