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Information Forensic Application using Soft Computing Techniques

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Abstract-In all these forensic applications, soft computing techniques such as neural networks, fuzzy logic, evolutionary computing, and rough set, play an important role in learning complex data structures and patterns, and classifying them to make intelligent decisions. Image forensic techniques use natural properties of image to determine forgery or locate tampering. This special issue aims to highlight state-of-the-art research and novel solutions in information forensic applications using emerging soft computing techniques .The aim of this paper is that with the rise of digital crime (signature forgery, image forgery, illegal transaction, etc.) and the pressing need for methods to combat these forms of criminal activities, there is an increasing awareness of the importance of information forensics for security applications. The emergence and evolution of new digital technologies are dramatically changing how information is captured, processed, analyzed, interpreted, transmitted, and stored. While digital technology has greatly improved the collection and analysis of evidences, the underlying research challenges primarily focus on the integrity and the reliability of validating the resulting forensic decisions accurately. Furthermore, digital evidences can be easily tampered, altered, or forged to commit fraud, identity theft, or impersonate someone else, to remain elusive from law enforcement. Using image processing techniques, it is easy to tamper the original image by replacing an individual's face, and making the change difficult to detect. The main objective, and major contribution, of the research is two-fold: conducting research in soft computing methodologies to improve their computational powers, and use these methodologies as means to provide a new approach for solving the problems of quality of service communications as an example of the class of complex, dynamical, multi-variable, multi-body, uncertain systems, for which, the author believes, soft computing is not only preferred but actually inevitable.

INTRODUCTION

Soft Computing is a multi-disciplinary field. Soft Computing is a new multidisciplinary field that goal was to construct new generation Artificial Intelligence, known as Computational Intelligence. Soft Computing in its latest incarnation as the fusion of the fields of Fuzzy Logic, Neuro-computing, Evolutionary and Genetic Computing, and Probabilistic Computing into one multidisciplinary system. The main goal of Soft Computing is to develop intelligent machines and to solve nonlinear and mathematically system problems, the applications of Soft Computing have proved two main advantages. First, it made solving nonlinear problems, in which mathematical models are not available, possible. Second, it introduced the human knowledge such as cognition, recognition, understanding, learning, and others into the fields of computing. This resulted in the possibility of constructing intelligent systems such as autonomous self-tuning systems, and automated designed systems. Different techniques have been employed to solve problems occurring in various dynamic segments of supply chain. As more soft computing applications are introduced and used, a growing body of papers has been established that can guide the future design and deployment of supply chain solutions. This research aims at reviewing the common soft computing techniques applied to supply chain management, the main issues to address include: what are the main problems within supply chain that have been investigated using soft computing techniques? What techniques have been employed? What are the main findings and achievements up to date?

SOFT COMPUTING

Soft Computing is a group of unique methodologies, contributed mainly by Expert System (ES), Fuzzy Logic (FL), Neural Networks (NN), and Evolutionary Algorithms (EA), which provide flexible information processing capabilities to solve real-life problems. The advantages of employing soft computing is its capability to tolerate imprecision, uncertainty, and partial truth to achieve tractability and robustness on simulating human decision-making behavior with low cost . In other words, soft computing provides the opportunity to represent ambiguity in human thinking with the uncertainty in real life. The major soft computing techniques are following.

(a) Fuzzy logic

As the basic theory of soft computing, fuzzy logic supplies mathematical power for the emulation of the thought and perception processes. Fuzzy systems are very useful not only in situations involving highly complex systems but also in situations where an approximate solution is warranted. To deal with qualitative, inexact, uncertain and complicated processes, Fuzzy control is one prominent example. In fuzzy control, data is characterized by linguistic variables and expert knowledge (IF-Then-rules) using these variables are mapped into rule bases. In fuzzy control these bases can be used for logical inferences for controlling purposes. One of the reasons for the success of fuzzy logic is that the linguistic variables, values and rules enable the engineer to translate

human knowledge into computer evaluable representations seamlessly. Fuzzy logic is one of the techniques of soft computing which can deal with impreciseness of input data and domain knowledge and giving quick, simple and often sufficiently good approximations of the desired solutions. Fuzzy logic is different from probability theory because fuzzy logic is deterministic rather than probabilistic. Imprecision is modeled via fuzzy sets, linguistic variables, membership functions, inferences and defuzzification. These concepts are all handled in an entirely deterministic manner. Fuzzy logic operators (such as fuzzy 'and', 'or', 'not' operators) and defuzzification (i.e. the transformation of a fuzzy set into a crisp value), can be modeled in various ways and are still widely discussed. A prominent example how fast growing and complex the field of fuzzy logic has become can be seen from the t-norm, which is a non-classics logic operator used for fuzzy conjunctions interpretation. In addition, a fuzzy multi-criteria decision-making algorithm has been developed for the network reconfiguration problem. It has been implemented in a proof-of- concept tool and applied to multi-criteria problems successfully.

(b) Neural network

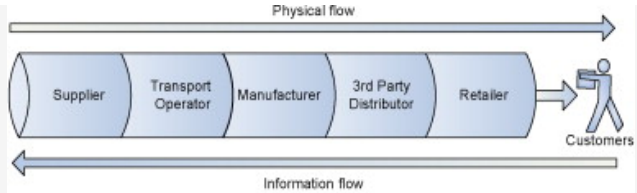
A neural network is a parallel distributed information processing structure consisting of a number of nonlinear processing units called neurons. The neuron operates as a mathematical processor performing specific mathematical operations on its inputs to generate an output. It can be trained to recognize patterns and to identify incomplete patterns by duplicating the human-brain processes of recognizing information, burying noise literally and retrieving information correctly. In terms of modeling, remarkable progress has been made in the last few decades to improve artificial neural networks (ANN). Artificial neural networks are strongly interconnected systems of so called neurons which have simple behavior, but when connected they can solve complex problems. Changes may be made further to enhance its performance. Neural networks and fuzzy systems, usually regarded as elements of artificial intelligence, have their shortcomings. Some of these shortcomings may be overcome if fuzzy logic operations are incorporated into neural networks and neural networks are classified into fuzzy systems. In fact, several authors have already combined fuzzy logic with neural network as neural-fuzzy systems. It may be a new class of computing systems provided by the integration of all these evolving disciplines for the emulation of higher-order cognitive power. They have been applied in various products in a number of fields.

(c) Genetic algorithms

Evolutionary algorithms (EA) were invented to mimic some of the processes observed in natural evolution. Evolution occurs on chromosomes – organic devices for encoding the structure of living beings. Processes of natural selection then drive those chromosomes that encode successful structures to reproduce more frequent than those that encode failed structures. In other word, the chromosomes with the best evaluations tend to reproduce more often than those with bad evaluations. By using simple encodings and reproduction mechanisms, the algorithms can then display complicated behavior and turn out to solve some extremely difficult problems. Genetic algorithms (GA) are a special subclass of a wider set of EA techniques. In resolving difficult problems. GA had been most frequently applied to the domain of optimization. Based on the principles of natural evolution, genetic algorithms are robust and adaptive methods to solve search and optimization problems. Because of the robustness of genetic algorithms. The ability to apply genetic algorithms to real-world problems has improved significantly over the past decade. The applications will be introduced further in later sections.

Supply chain management

As the sub-process of supply chain management, logistics deals with planning, handling, and control of the storage of goods between manufacturer and consumer as demonstrated in Fig.1, the concept of supply chain refers to the idea of developing a logistics pipeline approach for finished goods to transfer through the supply chain. The supply chain highlights the close partnership from upstream supplier, transport operator, manufacturer, to the downstream 3rd party distributor and retailer. Its objective is to produce and distribute the commodity in the right quantity, to the right place, and at the right time to minimize overall cost while maintaining customer satisfaction.



Source: Rushton et al. (2000)

The challenges encountered in the logistics processes and supply chain network will be discussed in later sections.

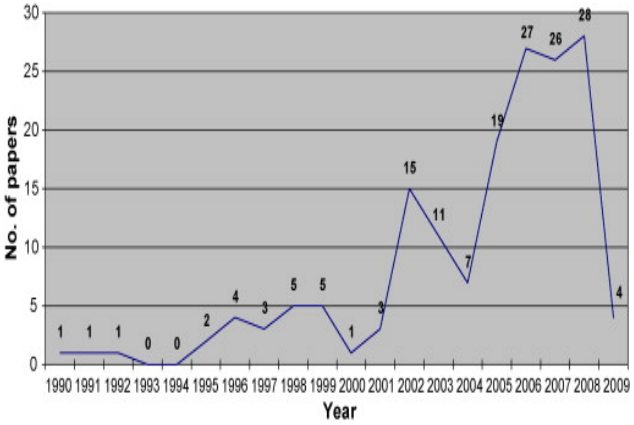
METHODOLOGY

The research methodology involves reviewing papers for soft computing techniques applied to the related processes in supply chain management.

(a) Sources and search methods

The databases that had been searched in this study include Science Direct, Emerald, ProQuest, Inspec, and Comrendex. The reviewed papers were sorted out from more than 40 journals such as European Journal of Operational Research, International Journal of Production Economics, Computers & Industrial Engineering, Expert Systems with Applications, Computers & Operations Research, Fuzzy Sets and Systems, Decision Support Systems, Applied Soft Computing and Applied Mathematics and Computation. Initially, two groups of keywords were used to cross-search related papers in specific databases. The first group of key words includes soft computing, artificial intelligence, neural network, fuzzy logic, evolutionary computation, and genetic algorithm while the second group includes supply chain, transportation, logistics, forecasting, and inventory. Given the specific interest in how soft computing techniques have been applied to supply chain

management, the empirical and diverse studies published from 1990 to 2008 were selected for further analysis. Additionally, the reference sections of these papers were reviewed to locate additional studies of interest. As a result, the final references consist of 163 papers published in referred journals. The growing trend of research in supply chain management as demonstrated in Fig, there were only a few studies in the supply chain management area using soft computing approaches in early 90s. Then the produced papers fluctuated slightly from 1995 to 2000. Over the next two years there was a dramatic increase of research. In spite of the decrease in the number of papers from 15 in 2002 to 7 in 2004, the number rose significantly and reached a peak of 28 in 2008. Looking at the general trend, the number of papers can be expected increase in the future.



The employment of individual soft computing technique

As clearly demonstrated, genetic algorithm has become the most frequent soft computing technique that has been applied to both manufacturing flow management and order fulfillment. Neural network has been often applied to demand management. In general, compared with other soft computing techniques, genetic algorithm is relatively popular for researchers. Particularly, there are a few works employing more than one soft computing technique for either achieving superior result or comparing respective performance. The techniques used in every individual paper are recorded for analysis. Thus the total number of techniques employed exceeds the number of papers reviewed.

(a) Scope

The concept of supply chain management has been analysed by many researchers from various perspectives. However, it is beyond the scope of this paper to address all problems in details. In an attempt to provide a more intensive review of existing papers in this area, this paper mainly focuses on management-related issues. The studies with non-management-related subjects will not be discussed in this paper, such as robotics and automation, traffic flow prediction, public transportation policy, traffic congestion/control, traffic flow and its pattern analysis. The soft computing techniques and their applications have been developed vastly in recent years. The techniques introduced in Section are the major focus in this research.

(b) Framework

The framework applied in this research is defined and developed by the Global Supply Chain Forum (GSCF) and sponsored by the Council of Logistics Management (since 2005 it is called the Council of Supply Chain Management Professionals). The following eight processes of supply chain management have been categorized by the GSCF:

- Manufacturing flow management
- Order fulfillment
- Demand management
- Supplier relationship management
- Product development and commercialization
- Returns management
- Customer service management
- Customer relationship management

The sub-processes of the GSCF framework are illustrated in Appendix. All reviewed papers are classified into the categories introduced above. Review articles on similar subjects have been published previously. However, both papers mainly concentrated on transportation issues instead of the whole supply chain domain.

CONCLUSIONS AND FUTURE RESEARCH

Some of the research papers involve more than one domain. Therefore it is difficult to classify individual research to a single category. It is attempted to place each work in the closest representative category. However, this classification scheme aims to draw a general picture for the distribution of related papers. It does not impact the associated findings derived and the uncovered opportunity for future research. Both genetic algorithms and fuzzy logic approach are the most popular techniques adopted to solve supply chain management problems, particularly in the manufacturing management and order fulfillment issues. Neural networks are broadly used to improve sales forecasting performance. The numerous and complex data sources are always needed to solve most of the problems in supply chain management. Soft computing tools seem promising and useful to analyze this data and to support manager's decision making in a complex environment. By examining the number of papers in manufacturing flow management, order fulfillment and demand management, the evidence seems to be strong that the issues in supply chain management have attracted a growing attention. It could be identified that there has been a significant upward trend of applying soft computing techniques to solve diverse supply chain management problems since 2002. The reasons may not only be that more researches have been involved in traditional supply chain domain, but also far more studies have been developed in new areas such as supplier relationship management and product development and commercialization since 2002. In addition, the emergence of user-friendly tools (e.g. Matlab) enables easier application of soft computing techniques, even by non-specialist users. An interesting observation is that two or more soft computing techniques were combined or varied to enrich the flexibility of problem solving. The number of soft computing techniques used is more than the number of

papers. It indicates that an integrated solution which combines multiple techniques is developed to pursue superior results. Therefore, there may be a great potential for further research either to improve the efficiency and effectiveness of existing practice or to create a new paradigm by integrating more practical algorithms. Another suggestion for further research is how to fulfill more practical e-commerce business models by developing a dynamic demand-responsive technology which integrates real time electronic orders and en-route fleet management algorithms. To make or buy is always a trade-off consideration. 3PLs service providers might be an ideal alternative solution to fulfill e-commerce business requirements. With sophisticated information systems and dedicated equipments, 3PLs can provide reliable services to fulfill customer orders, especially for both dynamic forward flows and reverse flows. Thus it could be an interesting research to make the most of 3PLs' value-added service to develop an integrated and flexible supply chain strategy. This paper reviews the existing research papers in supply chain management, analyses their distribution in respective subject processes, and provides suggestions for future research. While some of the main problems in supply chain management have been addressed by soft computing techniques, there are still some areas of possible application which have not yet been well explored. This is particularly true in the field of customer service management. The qualitative issues dominate customer service management research. The qualitative nature of this domain also implies that it is difficult to frame problems in this area in a way that soft computing techniques can be readily applied. This may have resulted in the limited number of studies in this area. It is therefore expected that this paper can stimulate more research in the field of supply chain management.

REFERENCES

[1] S. Pal and A. Ghosh, Soft computing data mining, *Information Sciences* **163** (1–3) (2004), pp. 1–3.

[2] R. Roy, T. Furuhashi and P.K. Chawdhry In: R. Roy, T. Furuhashi and P.K. Chawdhry, Editors, *Advances in Soft Computing: Engineering Design and Manufacturing*, Springer, London (1999).

[3] A. Tettamanzi and M. Tomassini, Soft computing: Integrating Evolutionary, Neural, and Fuzzy Systems, Springer, Heidelberg (2001).

[4] N.K. Sinha and M.M. Gupta, Introduction to soft computing and intelligent control systems. In: N.K. Sinha and M.M. Gupta, Editors, *Soft Computing and Intelligent Systems: Theory and Applications*, Academic Press, San Diego (2000).

[5] T.C. Du and P.M. Wolfe, Implementation of fuzzy logic systems and neural networks in industry, *Computers in Industry* **32** (3) (1997), pp. 261–272.

[6] F.E. Petry and L. Zhao, Data mining by attribute generalization with fuzzy hierarchies in fuzzy databases, *Fuzzy Sets and Systems* **160** (15) (2009), pp. 2206–2223.

[7] F. Esteva, L. Godo and F. Montagna, The ŁΠ and ŁΠ½ logics: Two complete fuzzy systems joining Łukasiewicz and product logics, *Archive for Mathematical Logic* **40** (1) (2001), pp. 39–67.

[8] P. Bosc, D. Kraft and F. Petry, Fuzzy sets in database and information systems: status and opportunities, *Fuzzy Sets and Systems* **156** (3) (2005), pp. 418–426.

[9] P. Musilek and M.M. Gupta, Neural networks and fuzzy systems. In: N.K. Sinha and M.M. Gupta, Editors, *Soft Computing and Intelligent Systems: Theory and Applications*, Academic Press, San Diego (2000).