Paper from Proceeding of the National Conference on Innovative Developments in Science, Technology & Management (NCIDSTM-2015) Organized by Ganga Technical Campus, Soldha, Bahadurgarh, Haryana (India) March 1st 2015 Published by International Journal of Engineering Sciences Paradigms and Researches (IJESPR) with ISSN (Online): 2319-6564, Impact Factor: 2.20 and Website: www.ijesonline.com

Role of Soft Computing Techniques in Real World Applications

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Abstract

Soft Computing (SC) reflects the fact that the human mind possesses a remarkable ability to store and process information which is pervasively imprecise, uncertain and lacking in categoricity. It has been used to obtained quick and accurate solutions. Soft computing techniques have been explored and many applications found within various research areas and application domains. Many soft computing techniques have been specifically developed for certain application domains. In this paper, an overviews of different application areas are discussed, where the Soft Computing Techniques has applied, and then critically analyzed the work done by the various researchers in the field of soft reliability.

Keywords: *Fuzzy Logic (FL), Neural Networks (NN), Genetic Algorithm (GA), Bee Colony Optimization (BCO).*

1. Introduction

Optimization technique is a way to find the most cost effective, highest performance system under the given constraints, by maximizing desired factors and minimizing undesired ones.

Soft computing (SC) is an evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost. it represent the ambiguity in human thinking with real life uncertainty. Fuzzy logic (FL), neural networks (NN), and evolutionary computation (EC) are the different soft computing methodologies. However, FL, NN, and EC should not be viewed as competing with each other, but synergistic and complementary instead. SC has been theoretically developed for the past decade, since L. A. Zadeh proposed the concept in the early 1990s.

This paper is organized as follows: section II includes, soft computing techniques. In section III different application areas of soft computing have discussed. Description of applicability of soft computing techniques in various fields is given in section IV. Section V concludes this paper.

2. Soft Computing Techniques

Soft Computing (SC) represents a significant paradigm shift in the aims of computing, which reflects the fact that the human

mind, unlike present day computers, possesses a remarkable ability to store and process information which is pervasively imprecise, uncertain and lacking in categoricity.

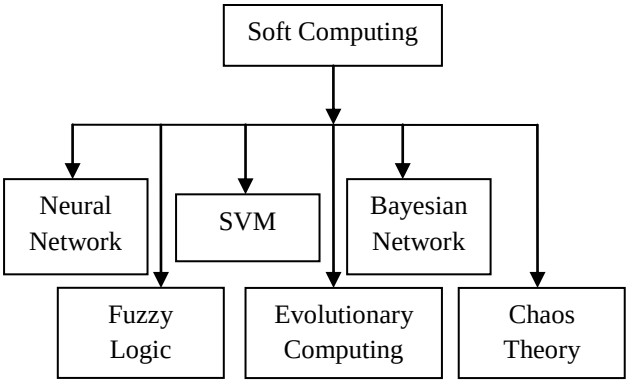

Fig. 1: Soft Computing Techniques

a. Neural Networks (NN)

In 1943, 1st artificial neuron was produced by the neuro physiologist, Warm Meullash and the locan wath rits. ANN works as an expert due to various uses/application in different fields. In a human being biological nervous system does all the tasks called is biological NN, Artificial Neural Network works similarly with some extra features which enhances the feature of ANN. It stores data and used for further operations like it solves the problem on the based on past problems.

b. Fuzzy Logic (FL)

Fuzzy Logic, which was first introduced by Zadeh (1965), it deals with uncertainty, ambiguity and vagueness. It translates qualitative and imprecise. Information into quantitative (linguistic) terms. FL is a non-parametric classification procedure, which can infer with nonlinear relations between input and output categories, maintaining flexibility in making decisions even on complex biological systems.

c. Support Vector Machine (SVM)

The support vector machine (SVM) [11], [31] is a training algorithm for learning classification and regression rules from data, for example the SVM can be used to learn polynomial, radial basis function (RBF) and multi-layer perceptron (MLP) classifiers. In 1960 Vapnik first suggested the Support vector machine for classification and have recently become an area of intense research owing to developments in the techniques and theory coupled with extensions to regression and density estimation.

d. Evolutionary Computing

All nature inspired problems can be solved by using evolutionary Algorithm. It is a computational intelligence which solves optimization problems. It is applied for black box problems with feature of stochastic optimization.

e. Bayesian Network

Bayesian Network is DAG, which represents a set of random variable & their conditional dependencies for problem solving. BN is the graphical representation that is used to represent knowledge about an uncertain domain. There is a family of probabilistic graphical models, BN is one of them. BN has the different gestures from statics, graph theory, computer science & probabilistic theory.

f. Chaos theory

Chaos theory is the study of complex, nonlinear, dynamic systems. The field was pioneered by Lorenz, who was studying the dynamics of turbulent flow in fluids. Although we all recognize the swirls and vortices that characterize turbulent flow, the complexities of turbulent flow have confounded mathematicians for years

3. Application Areas of Soft Computing Techniques

Soft Computing algorithms are playing very important roles in many disciplines today. In this section, we have discussed about different Application areas of soft computing techniques.

1. Neural Networks (NN)

Although work on artificial neural networks began some forty years ago, but widespread interest in this field of research has only taken place in the past six or seven years. Consequently, artificial neural networks are a new field of science for large majority of researchers.

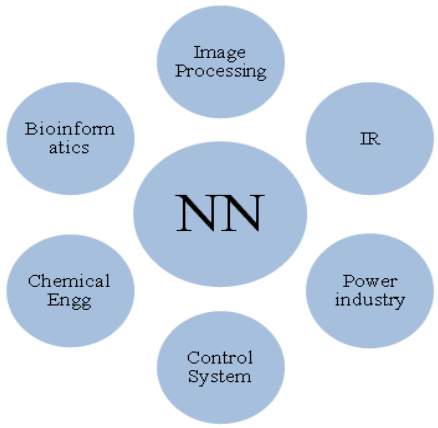

Fig. 2: Neural Network Application Areas

1.1 Bioinformatics

It is used in gene structure prediction, protein structure prediction, and gene expression data analysis, almost anywhere when you need to do classification. Neural network is used to create a data set with input sequences (x) and output labels (secondary structures), encode the input and output to neural network and then train neural network on the dataset. [1][2][3].

1.2 Chemical Engineering

In this paper [4] the development artificial neural network (ANN) models for three steady state chemical engineering systems, which are 1) a crude oil distillation column for use in real time optimization, 2) physical properties of palm oil components, and 3) pore size determination for membrane characterization.

1.3 Control System

The ability of neural networks to represent nonlinear mappings has been found to be particularly important for the area of control systems. During some past years of this research, this property has been extensively applied for nonlinear systems identification and for the control of nonlinear plants.

In this paper [5] described, the important property of neural networks that has been applied to a commonly encountered problem, PID auto tuning. A new method, involving multilayer perceptrons, was proposed. Since the tuning procedure has similarities to the actual process employed when performing manual tuning, no special hardware is required. [10] There has been a tremendous amount of activity in applying Neural Networks for adaptive control. Neural Networks are especially suitable for the adaptive flight control applications where system dynamics are dominated by the unknown nonlinearities.

1.4 Electric Power Industry

In this paper [6] presented one point of view about the use of ANN to deal with the modeling of nuclear power systems. [7] Addressed the problem of estimation of process variables using an ANN. A feed-forward ANN with a back-propagation learning algorithm has been utilized. The faithfulness of predictions demonstrated that ANNs can be used in place of physical or empirical models. [8] Presented a procedure using ANN to identify the nonlinear empirical model of a steam generator. A hybrid feed-forward/feedback ANN is used. The feed-forward portion provides interpolation, while the feedback portion enables representation of temporal variations in the nonlinearities of the system. [9] addressed the problem of modeling the thermodynamic behavior of a nuclear power plant using a hybrid ANN. Measurements of heat rate acquired over 1-yr period were utilized.

1.5 Information retrieval (IR) systems

In this paper [12] neural network models have many attracting properties and some of them could be applied into an IR system. It is expected the research on the application of neural network models into IR will grow rapidly in the future along with the development of its technological basis both in terms of hardware and software.

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1.6 Image processing

In their 1993 review article on image segmentation, Pal and Pal predicted that neural networks would become widely applied in image processing [13]. [14] Reviewed more than 200 applications of neural networks in image processing and discuss the present and possible future role of neural networks, especially Hop1eld neural networks, Kohonen feature maps and feed-forward neural networks.

2. Fuzzy logic

Fuzzy Logic has a wide application in many industrial areas, such as subway trains, automobiles and washing machines, aerospace, control system, home monitoring and manufacturing etc.

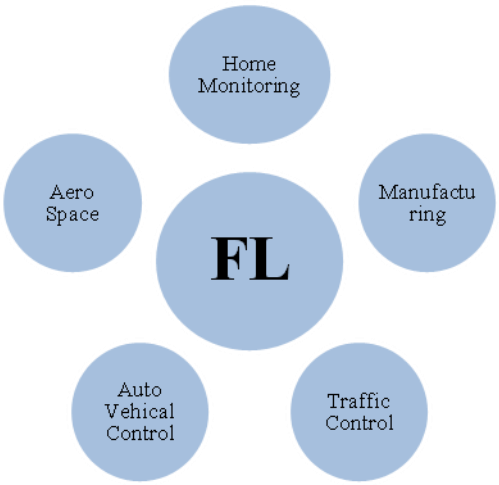

Fig. 3: Fuzzy Logic Application Areas

2.1 Aero space

In this paper [15], [16] fuzzy logic can approximate any function the stability of FLC is usually studied under the perspective on nonlinear control theory.

2.2 Automated Vehicle Control

In this paper [17] developed a test bed infrastructure for vehicle driving that includes control-system experimentation, strategies, and sensors. These four facilities and instruments are available for collaboration with other research groups in this field. Now we've automated and instrumented two Citroën Berlingo mass-produced vans to carry out our objectives.

2.3 Home Monitoring

This paper [18] described a fuzzy logic system for recognizing activities in home environment using a set of sensors: physiological sensors, microphones, infrared sensors, debit sensors and state-change sensors. All these are motivated by the fact that Fuzzy controllers have been successfully embedded within billions of dollars in commercial products, plus the characteristic of data providing from each sensor, the fusion of the different sensors has been performed by using fuzzy logic. It allowed us to recognize several Activities of Daily Living (ADLs) for Ubiquitous Healthcare.

2.4 Manufacturing

This paper [19] represents the scheduling process in furniture manufacturing unit, which provides a fuzzy logic application in flexible manufacturing system. In furniture manufacturing unit, flexible manufacturing systems are production system. FMS consist of same multipurpose numerically controlled machines. Here in this project the scheduling has been done in FMS by using fuzzy logic tool in MATLAB software.

2.5 Traffic Signal Control

In this paper [20] a new approach for fuzzy logic signal control is considered and a model which contains a fuzzy logic phase sequencer is developed. Performance of the fuzzy model is investigated by simulation studies and is compared with traffic actuated control method.

3. Support Vector Machine

Support vector machines (SVM) are a group of supervised learning methods that can be applied to classification or regression. Support vector machines represent an extension to nonlinear models of the generalized portrait algorithm developed by Vladimir Vapnik. The SVM algorithm is based on the statistical learning theory and the Vapnik-Chervonenkis (VC) dimension

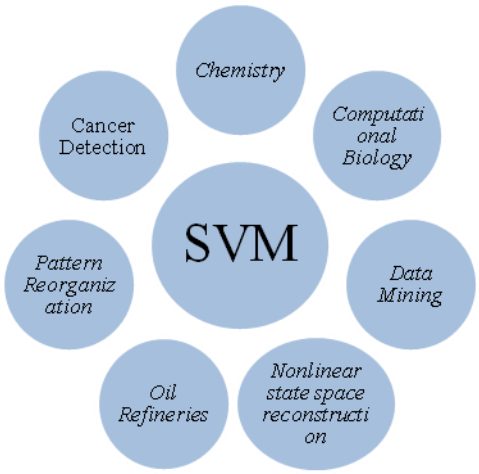

Fig. 4: SVM Application Areas

3.1 Cancer Detection

In this paper [21] proposed a classifier which can differentiate patients having benign and malignant cancer cells. Also determine the optimal size of the training set and perform feature selection to improve the accuracy of classification
In this paper [22] address the problem of selection of a small subset of genes from broad patterns of gene expression data, recorded on DNA micro-arrays and build a classifier suitable for genetic diagnosis, as well as drug discovery.

3.2 Chemistry

In this paper [23] we found an application in chemistry such as recognition problem based on structural risk minimization. Functionally

3.3 Computational Biology

In this paper [24] the support vector machine learning algorithm has been extensively applied within the field of computational biology. It has been used to detect patterns within and among biological sequences, to classify genes and patients based upon gene expression profiles, and have recently been applied to several new biological problems

3.4 Data Mining

In this paper [25] the support vector machine has been developed as robust tool for classification and regression in noisy, complex domains.

3.5 Nonlinear state space reconstruction

This paper [26] presented the application of a powerful state space reconstruction methodology using the method of support vector machines (SVM) to the data set

3.6 Oil Refineries

This paper [27] is an attempt to provide an overview on applications of support vector machines within the oil refineries to the professionals inside oil refineries, researchers and academicians.

3.7 Pattern Recognition

This paper [28] presented an overview of the concepts of VC dimension and structural risk minimization, and then describes linear Support Vector Machines (SVMs) for non-separable and separable data.

4. Evolutionary Computing

Evolutionary computation is a probabilistic searching algorithm which simulates Darwin's evolutionism and the biological evolution process of natural selection. It is also a new computing method combines computer science, mathematics and natural genetics.

4.1 VLSI

In this paper [29] reviewed evolutionary algorithms for physical design and the observe and analyze the common traits of the superior contribution. Also discussed the important requirements for evolutionary based approaches for even greater acceptance within the VLSI community.

4.2 Web information filtering

This paper [30] discusses the present status and future developments in the applications of evolutionary computation in filtering information on web pages, including texts, images, audios and videos, etc

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5. Bayesian Network

Bayesian networks (BNs) are graphical models for reasoning under uncertainty, where the nodes represent variables and arcs represent direct connections between them. These direct connections are often causal connections.

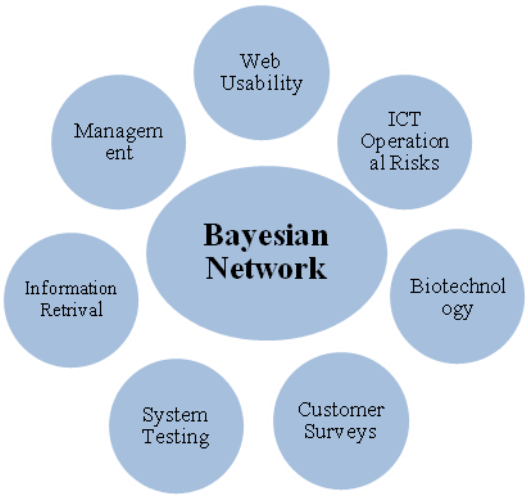


Fig. 5: Bayesian Network Application Areas

5.1 Management: The Statistical Efficiency Conjecture
It describes a systematic approach to the evaluation of benefits from process improvement and quality by design that can be implemented within and across organizations. [35]

5.2 Web Usability: Handling Big Data
Construct a Bayesian Network derived from analysis of web log analyzers and also use the network for predicting posterior probabilities after conditioning on variables affecting others or, in a diagnostic capacity, by conditioning on end result variables.

5.3 ICT Operational Risks: Sensitivity Analysis of a Bayesian Network
In information and communication technology (ICT) operational risk analysis, different data sets are typically merged. Examples of such data sources include CRM call centre data, financial data from companies and log data utilized to monitor the provisioning of IT services. [32]

5.4 Biotechnology: An Example of Tracking Performance over Time
This paper [33] demonstrates the application of Bayesian Networks to analyze data collected over time. Its main aim is to generate insights on the behavior of the bioreactors for improved operation and monitoring.

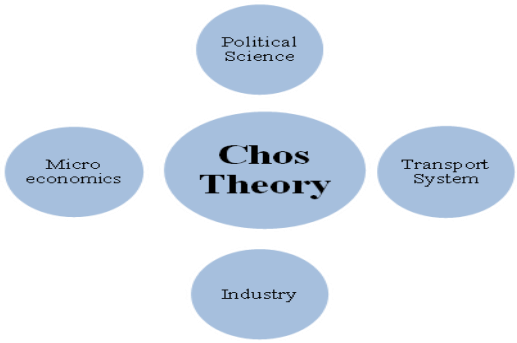
5.5 Customer Surveys: Analysis of Ordinal Data
A Bayesian Network has been applied to data collected from 266 companies participating in an Annual Customer Satisfaction Survey.

5.6 System Testing: Risk Based Group Testing
Risks are measured and predicted using Bayesian Network analysis techniques that are based on the semantic models. With this approach, test cases are associated to the semantic features and scheduled based on the risks of their target features

5.7 Information Retrieval
A new probabilistic information retrieval (IR) model, based on Bayesian networks, is proposed. Then consider a basic model, which represents only direct relationships between the documents in the collection and the terms or keywords used to index them. [34]

6. Chaos Theory

Chaos theory, which is the study of nonlinear dynamic systems, promises to be a useful conceptual framework that reconciles the essential Un-predictability of industries with the emergence of distinctive, pattern. [36]



6.1 Micro economics
This paper is the first to apply the theory of deter-ministic chaos to a micro economic problem. It shows that a modified test statistic from chaos theory is an extremely valuable tool in

micro economic model specification because it shows when excluded information is correlated with given information. [37].

6.2 Political Science

This paper [38] intends to review the still embryonic literature regarding the application of the chaos theory in political science, particularly into the fields of public policies and international relations

6.3 Industries

William Ditto and Louis Pecora have been pioneering methods of controlling chaotic mechanical, electrical and biological systems.

6.4 Transport System

Fig. 6: Chos Theory Application Areas

In this paper [11] a series of analyses find and exploit chaos are outlined, including time delays and embedding dimensions, Fourier power series, the correlation dimension, the largest Lyapunov exponent, and predictions.

4. Summarization

In this section we summarized different application areas of soft computing techniques. Also summarized each application and the references used to implement these applications. Soft computing is used in different forms for different areas.

TABLE-1: Summary of Soft Computing Application Areas.

Sr. No.	Technology	Applications	References
1.	Neural Networks	Bioinformatics, Chemical Engineering, Control system, Electric Power Industry, Information retrieval (IR) systems, Image processing.	[1-10], [12-14]
2.	Fuzzy Logic	Aero-space, Automated vehicle control, Home monitoring, manufacturing, Traffic Signal Control.	[15-20]
3.	Support Vector Machine	Cancer detection, chemistry, computational biology, data mining, non-linear state space reconstruction, oil refineries, pattern reorganization.	[21-28]
4.	Evolutionary Computing	VLSI, web information filtering.	[29-30]
5.	Bayesian networks	Management, Web usability, ICT operational Risk, Bio-technology, Customers survey, system testing, Information retrieval.	[32-35]
6.	Chaos theory	Micro economics, Political Science, Industries, transport system.	[11], [37],[38]

5. Conclusion

There are number of application areas for soft computing, we highlights as many references as possible, however it may also be possible that we missed out some areas. Based on this paper, we found that soft computing is well suited for general assignment problem, cluster analysis, constrained problem optimization, structural optimization, and advisory system. It has also been applied to software engineering for software testing and parameter estimation in software reliability growth models. It also plays an important role in medical, as used in Boi-technology, face pose estimation, bioinformatics etc. The successful applications of soft computing and its rapid growth suggest that its impact will be felt increasingly in coming years. It persuades the use of this and its tools into different

advanced applications. It is hoped that this paper will benefit computer scientist who are keen to contribute their works to the field of artificial bee colony.

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