

A Review of Soft Computing Techniques and Applications

Satinder Bal Gupta^{#1}, Shivani^{#2}

[#]Department of Computer Science and Engineering
Indira Gandhi University, Meerpur, Rewari, Haryana, India

Abstract-- Soft Computing can be defined as a science of thinking, reasoning that helps to deal with complex systems. Its main aim is to develop intelligent machines in order to solve real-world problems. It differs from the conventional hard computing as it can handle uncertainty, imprecision easily. It includes use of different techniques such as machine learning, artificial neural networks etc. that can be used together for solving complex problems that are difficult to tackle using conventional models of mathematics. These techniques play a vital role in identifying hidden patterns from the data and doing the classification for making intelligent decisions. This paper reviews some of the soft computing techniques and its applications.

Keywords-- AI (Artificial Intelligence), Neural Network, Genetic Algorithm, Fuzzy logic, machine learning.

I. INTRODUCTION

Soft computing can be considered as a combination of both computer science and mathematics [1]. It helps to deal with real-life situations. The different components of soft computing are required in the development of expert systems that work automatically. These systems can easily perform difficult tasks without the need of human beings. These systems are trained using different soft computing techniques. The different components of soft computing includes: (i) Fuzzy Logic: It is a kind of multi-valued logic which deals with approximate reasoning rather than assigning fixed values of either 0 or 1 to the variables. It assigns a membership value in the range [0, 1] to the variables. (ii) Evolutionary Computing: It is a field of Artificial Intelligence that is used in problem-solving systems which uses computational models as key elements. It involves a lot of optimization problems. (iii) Machine Learning: It makes use of learning algorithms to solve a particular problem with higher accuracy and to enhance the performance level of any particular task. (iv) Probabilistic Reasoning: It deals with uncertainty present in the knowledge by using the concept of probability [2]. Soft computing can be used for solving real world problems that involves uncertainty, approximation and imprecision. It provides more advantages over conventional computing methods ([3]-[5]). These new techniques can be used in different branches such as medicine, education, and engineering. This paper focuses on different techniques of soft computing and its application areas.

II. LITERATURE REVIEW

A lot of work has been done by researchers in this field. In this paper, the authors have reviewed some of the work done.

Jainab Zareena [1] reviewed some of the papers explaining different soft computing techniques and concluded that these techniques provide advantage over traditional techniques.

Ankit R. Deshmukh [2] discussed some of the soft computing techniques such as SVM, Genetic algorithms etc. which are used for achieving web intelligence. The concept of data mining was also discussed which helps in finding patterns from the data.

Aruna Bajpai [3] discussed some of the soft computing techniques such as fuzzy logic, genetic algorithm, ANN, SVM (Support Vector Machine) and some of the application areas in which soft computing techniques are used including agriculture engineering, biomedical etc. It was concluded that soft computing play a significant role in science and engineering.

III. SOFT COMPUTING TECHNIQUES

Soft computing is a group consisting of AI based computational techniques that provide fast and cost effective solution for the complex real-life problems ([2],[3],[6]-[13]). It includes following techniques:

- A. *Fuzzy Logic*: This technique is based on the “degree of truth” instead of just assigning either True or False to the variables ([2],[3],[6]). The fuzzy logic process includes following steps as shown in Fig. 1 below:

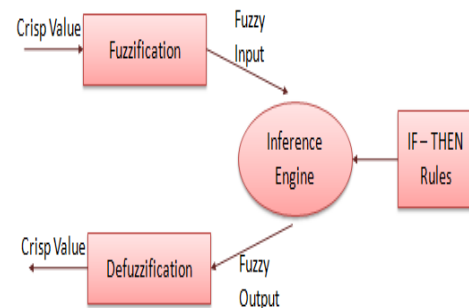


Fig.1 Process of fuzzy logic [3]

The above fig.1 shows the steps involved in fuzzy logic process and are explained below:

Fuzzification: It means fuzzifying all the input crisp values by assigning membership values to the inputs.

Applying Rules: It involves applying IF-THEN rules on the fuzzy input in order to obtain fuzzy output functions. These rules make use of linguistic variables.

Defuzzification: It involves converting the fuzzy output functions into crisp values.

B. *Artificial Neural Network*: It is called neuro computing which includes study of a group of interconnected nodes called neurons. ANN is used for computing and is inspired by biological nervous system. It comprises three layers- Input; Hidden and Output layers ([2],[3],[6]). These layers are made of neurons and are connected to each other using weights as shown in fig. 2.

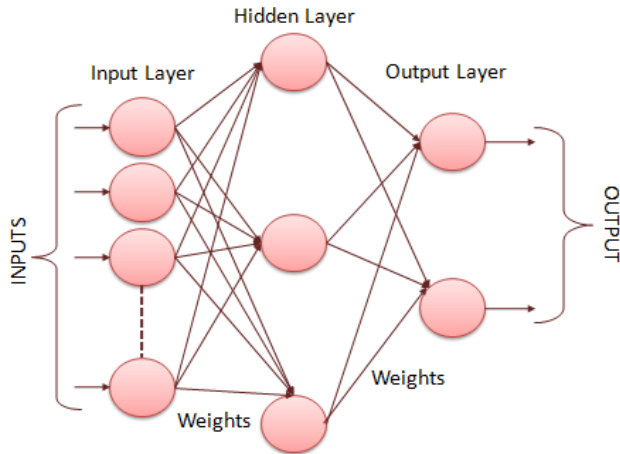


Fig. 2 Artificial Neural Network [2]

Types of ANN:

- *Feed forward ANN*: In this neural network, the information flow is unidirectional i.e. in forward direction. No loop can be formed in this neural network.
- *Feed backward ANN*: In this neural network, the information flow is bi-directional. It is also known as recurrent neural network. Loops can be formed in this type of neural network.

C. *Evolutionary computing and Genetic Algorithms (GA)*: Evolution means competition among the individuals for resources. It includes genetic algorithms which are based on the process of natural selection. GA is an optimization technique which includes a population of individuals and each individual is known as a chromosome ([2],[3],[6],[11],[12]). Its working is shown in fig. 3 below:

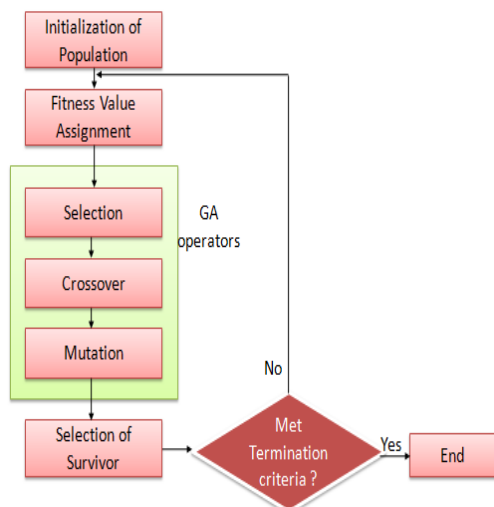


Fig. 3 Working of Genetic Algorithm [3]

The fig.3 shows the steps involved in genetic algorithm. It includes three operations:

- *Selection*: It means selecting an individual on the basis of fitness value.
- *Crossover*: It involves exchange of genes between two individuals so as to create a new individual.
- *Mutation*: It involves change of particular genes of an individual.

IV. APPLICATIONS OF SOFT COMPUTING

Soft computing is used for solving real-life problems and can be applied in different fields some of which are as follows ([10],[14]-[20]):

- A. *Robotics*: Robots are used nowadays to automate tasks and for this purpose different soft computing techniques are used such as fuzzy logic and expert system techniques [15]. Robots are used by e-commerce companies for managing goods. It is also used in industries for production and inventory management.
- B. *Data Mining*: It refers to the process of extracting useful information from the database which is then used in making informed business decisions. This process makes use of AI and different machine learning algorithms and thus, helps in increasing the profit of any business organization.
- C. *Transportation*: The transportation industry makes use of soft computing techniques at different stages which include use of AI, expert system, machine learning, and evolutionary computing for predicting traffic, navigation purposes, and troubleshooting.
- D. *Healthcare*: It is a very critical field in which right decisions need to be taken by the doctors for saving the lives of patients. Soft computing techniques are used for diagnosing the patients correctly at an early stage and for treating and monitoring them [16].
- E. *Education*: Soft computing techniques are used in the field of education for improving the performance of students in academics [10]. NN and fuzzy logic helps in doing the evaluation of students' grades in different courses. Bayesian network helps in detecting the learning style of students. This enables the teachers to forecast the GPA of students and take effective measures in improving the score [17].
- F. *Crime forecasting*: Machine learning algorithms can be used to reduce the crime rates. ML helps to analyse the crime data and make predictions on the type of crime that might occur in future at some location. Thus, ML and data mining helps in minimizing the crime rate levels in the society ([18]-[20]).

V. CONCLUSION

The use of Soft Computing techniques in different fields help in making well informed decisions easily and quickly. They are used to make the systems intelligent by making use of complex algorithms. These techniques can be used in almost all the fields as discussed in the paper. Their use is growing at a very fast rate and in the coming years its impact could be seen clearly.

REFERENCES

- [1] Jainab Zareena, Performance on Soft Computing Techniques, International Journal of Innovative Technology and Exploring Engineering, Vol. 8, Issue 7, May 2019.
- [2] Ankit R. Deshmukh and Sunil R. Gupta, Data Mining based Soft Computing Methods for Web Intelligence, International Journal of Application or Innovation in Engineering and Management, Vol. 3, Issue 3, March 2014.
- [3] Aruna Bajpai, A soft computing technique and their applications, International Journal of Advanced Research in Computer Science, Vol. 9, Issue 2, March-April 2018.
- [4] Gilliar Meng and Heba Saddeh, Applications of Machine Learning and Soft Computing techniques in real world, International Journal of Computer Applications and Information Technology, Vol.12, Issue 1, pp.298-302, March 2020.
- [5] Morteza Husainy Yar, Vahid Rahmati and Hamid Reza Dalili Oskouei, A survey on evolutionary computation: Methods and their applications in Engineering, Modern Applied Science, Vol.10, Issue 11, pp.131-139, Aug 2019.
- [6] Rajdeep Kaur and Er. C. K. Raina, Soft computing and its domains – An overview, International Journal of Scientific Research in Computer Science, Engineering and Information Technology, Vol. 2, Issue 2, 2017.
- [7] Asim Iftikhar, Shahrulniza Musa, Muhammad Alam and M.S. Mazliham, A survey of soft computing applications in global software development, IEEE Conference on Innovative Research and Development, Bangkok, pp.1-4, May 2018.
- [8] Zahra Pezeshki and Sayed Majid Mazinani, Comparison of artificial neural networks, fuzzy logic and neuro fuzzy for predicting optimization of building thermal consumption: a survey, Artificial Intelligence Review, Vol. 52, Issue 1, pp.495-525, June 2019.
- [9] Oludare Issac Abiodun, Aman Jantan, Abiodun Esther Omolara, Kemi Victoria Dada, Nachaat AbdElatif Mohamed and Humaira Arshad, State-of-the-art in artificial neural network applications: A survey, Heliyon, Vol. 4, Issue 11, Nov 2018.
- [10] Dr.Ramjeet Singh Yadav, Review of Academic Performance using soft computing techniques, International Journal of Computer Engineering and Applications, Vol. XI, Issue I, Jan 2017.
- [11] Tanweer Alam, Shamimul Qamar, Amit Dixit and Mohamed Benaida, Genetic algorithm reviews, implementations and applications, International Journal of Engineering Pedagogy, June 2020.
- [12] Adam Slowik and Halina Kwasnicka, Evolutionary algorithms and their applications to engineering problems, Neural Computing and applications, Vol. 32, pp.12363- 12379, 2020.
- [13] Dogan Ibrahim, An overview of soft computing, Procedia computer science, 12th International Conference on Application of Fuzzy Systems and Soft Computing, Vienna, Austria, Vol. 102, pp.34-38, Aug. 2016.
- [14] Santosh Kumar Das, Abhishek Kumar, Bappaditya Das and A. P. Burnwal, On Soft Computing Techniques in various areas, Computer Science and Information Technology, Vol. 3, pp.59-68, 2013.
- [15] Asefeh Asemi, Andrea ko and Mohsen Nowkarizi, Intelligent libraries:a review on expert systems, artificial intelligence, and robot, Library Hi Tech, June 2020.
- [16] Ashish Mishra, G. Suseendran and Trung-Nghia Phung, Soft computing applications and techniques in healthcare, CRC press, Taylor and Francis Group, Oct 2020.
- [17] Syed Mubashir Ali, Muhammad Alam and Asim Iftikhar, Soft Computing applications in education management- A review, IEEE International Conference on Innovative Research and Development, Bangkok, Thailand, 1-4, May 2018.
- [18] Nurul Hazwani Mohd Shamsuddin, Nor Azizah Ali and Razana Alwee, An overview on crime prediction methods, 6th ICT International Student Project Conference, pp.1-5, May 2017.
- [19] Shraddha Ramdas Bandekar and C. Vijayalakshmi, Design and analysis of machine learning algorithms for the reduction of crime rates in India, Procedia computer science, The 9th World Engineering Education Forum Vol. 172, pp.122-127, 2020.
- [20] Sudan Jha, Eunmok Yang, Alaa Omran Almagrabi, Ali Kashif Bashir and Gyanendra Prasad Joshi, Comparative analysis of time series model and machine testing systems for crime forecasting, Neural Computing and applications, May 2020.