A Survey of Soft Computing Techniques on Bio Medical Image Processing

S.Poorani
Research Scholar, Department of Computer Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641043, Tamil Nadu, India.

Dr.Vasantha Kalyani David
Professor, Department of Computer Science, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore-641043, Tamil Nadu, India.

Abstract – Soft Computing is the fusion of methodologies that are designed to model and enable solutions to real world problems, which cannot be modeled or too difficult to model mathematically. Soft computing is a consortium of methodologies that work synergistically and provide in one form or another, flexible information processing capabilities for handling real-life situations that are ambiguous. Soft Computing is a field that consists of complementary elements of fuzzy logic, neural computing and evolutionary computation. Soft computing techniques have found applications in many areas. One of the most important application is image processing. This paper presents applications of different Soft Computation methods in industrial, biological processes, engineering design, investment and financial Trading. It analyses the literature according to the style of soft computing method used, the investment discipline used, the successes demonstrated, and the applicability of the research to real world problems.

Index Terms – Soft computing techniques, Particle Swarm Optimization, Fuzzy logic Genetic Algorithms, Artificial Neural Network.

1. INTRODUCTION

Soft computing deals with imprecision, uncertainty, partial truth, and approximation .Soft Computing are inspired by the human brain. The principle of soft computing is: to exploit the tolerance for imprecision, uncertainty, partial truth, and approximationachieve tractability, robustness and low solution cost and solve the fundamental problem associated with the current technological development, the lack of the required intelligence of the recent information technology that enables human brain functionality [1]. The basic ideas underlying soft computing in its current incarnation have links to many earlier influences.

Soft computing techniques have been recognized as attractive alternatives to the standard, well established hard computing paradigms [2]. Soft computing is still in its initial stage of crystallization. Soft computing techniques in comparison with hard computing employ different methods which are capable of representing imprecise, uncertain and vague concepts. Soft computing techniques are able to handle non-linearity and more over offers computational simplicity [2].

The inclusion of neural and genetic computing in soft computing came at a later point. At this juncture, the principal constituents of Soft Computing (SC) are: Fuzzy Systems (FS) [3], including Fuzzy Logic (FL); Evolutionary Computation (EC), Optimization techniques with [8] Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Neural Networks (NN)[14], with Neural Computing (NC); Machine Learning (ML); and Probabilistic Reasoning (PR).

2. RELATED WORK

Particle swarm optimization (PSO) algorithms are nature-inspired population-based meta heuristic algorithms. These algorithms mimic the social behavior of blocking birds and schooling fishes. Starting from a randomly distributed set of particles (potential solutions), the algorithms try to improve the solutions according to a quality measure (fitness function).

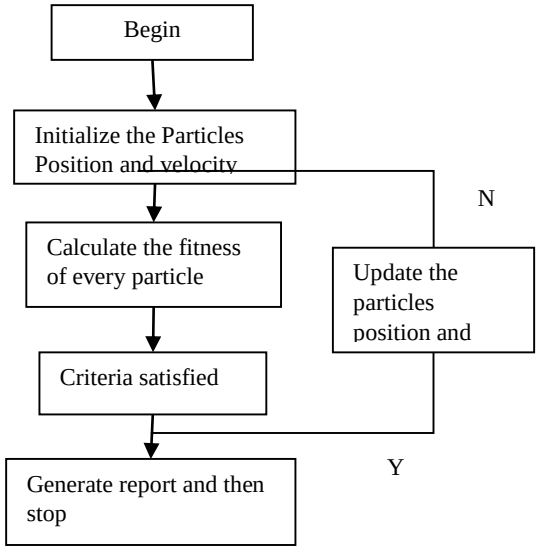

Figure.1 Flow Chart for PSO

The improvisation is performed through moving the particles around the search space by means of a set of simple mathematical expressions which model some interparticle communications. These mathematical expressions, in their simplest and most basic form, suggest the movement of each particle toward its own best experienced position and the swarm's best position.

Figure.1 illustrates the steps of particle swarm optimization. Though being generally known and utilized as an optimization technique, PSO has its roots in image rendering and computer animation technology where Reeves defined and implemented a particle system as a set of autonomous individuals working together to form the appearance of a fuzzy object like a cloud or an explosion. The idea was to initially generate a set of points and to assign an initial velocity vector to each of them. Using these velocity vectors, each particle changes its position iteratively while the velocity vectors are being adjusted by some random factors.

The general structure of a PSO algorithm is as follows:

Procedure:

Particle Swarm Optimization begin

Initialize xi, vi and xbesti for each particle i; while (not termination condition) d

begin

foreach particle i

Evaluate objective function;
Update xbesti

end

foreach i

Set g equal to index of neighbor with best xbesti;

Use g to calculate vi; Update
xi ¼ xi + vi; Evaluate
objective function; Update
xbesti

end

end

end

3. PROPOSED SESTEM

3.1. Fuzzy Genetic Algorithms:

Genetic Algorithm:

The basic genetic algorithm philosophy developed by Goldberg was inspired by Darwin's theory of evolution. This theory suggests that the survival of an organism is affected by the rule that the strongest species survives [8].

Darwin's theory also suggests that the survival of an organism can be maintained through the process of reproduction, crossover, and mutation. Darwin's concept of evolution is also used in the computational algorithm to find a solution to a problem using an objective function in a natural fashion. A solution generated by the genetic algorithm is called a chromosome while as a population is the collection of the referred chromosomes. A chromosome is composed of genes and its value can be either numerical, binary, symbols or characters depending on the given problem. These chromosomes is should safety a fitness function to measure the suitability of a solution generated by the genetic algorithm.

Some chromosomes in the population are to mate through a process called crossover. Offspring is the production of new chromosomes which are the composition of genes of their parent. A few chromosomes are to go through mutation in their gene.

The number of chromosomes which are to undergo crossover and mutation are controlled by crossover rate and mutation rate value. Chromosomes in the population that are to be maintained for the next generation are to be selected according to the Darwinian evolution rule. In addition, the chromosome which has higher fitness value has a greater probability of being selected again in the next generation. After several generations, the chromosome value converges to a certain value which is the best solution for the problem.

Mechanism of GA

The fundamental mechanism of GA consists of the following stages

1. Generate randomly the initial population.
2. Select the chromosome with the best fitness value.
3. Recombine selected chromosomes using crossover and mutation operators.
4. Insert offspring into the population.

5. Return the chromosome(s) with the best fitness value. Otherwise, go to Step 2.

In GA, the population is defined to be the collection of individuals. A population is a generation that undergoes changes to produce a new generation. GAs has also collection of several members to make population healthy as in nature. A chromosome that is a collection of genes corresponds to an individual of population. Each individual chromosome represents a possible solution to the optimization problem. The dimension of the GA refers to the dimension of the search space which equals the number of genes in each chromosome.

Genetic Algorithm Applications

Genetic algorithms are inspired and based on theprocess of evolution by natural selection in order to provide solutions to real-world problems. The genetic algorithm is applied in order to solve several optimization problems, like problems where the objective function is discontinuous, non-differentiable, stochastic, or of higher order and nonlinear.

The genetic algorithm can address problems of mixed integer programming, where several components are restricted to be integer-valued. Furthermore, genetic algorithms (GA) are used to solve complex search problems such as engineering to create incredibly high-quality products due to their ability for a thorough search with a huge combination of parameters to find the best match. For instance, GA searches through different combinations of materials and designs to get an overall enhanced result. Additionally, they are used to design computer algorithms to schedule tasks, and to solve several optimization problems.

Fuzzy Logic

Fuzzy logic provides inference morphology in order to enable approximate human reasoning capabilities to be applied to knowledge-based systems [3]. The conventional approaches to knowledge representation lack the means for representation of fuzzy concepts. Fuzzy logic is an approach to computing based on "degrees of truth" rather than the "true or false" (1 or 0) Boolean logic on which the modern computer functioning is based. Fuzzy logic includes 0 and 1 as extreme cases of struth; nevertheless, the various states of truth in between are also included. Fuzzy logic has been extended to handle the concept of partial truth, where the value is ranged between completely true and completely false. Fuzzy logic has values from [0,1] Compared to traditional binary sets (where variables only take true or false value), fuzzy logic variables have a truth value that ranges in degree. Fuzzy systems suggest a mathematical model to translate the real processes of human knowledge and false values from [0,1].

The use of Fuzzy Logic-based techniques for either improving GA behavior or modeling GA components, have been called fuzzy genetic algorithms (FGAs). Genetic algorithms are applied in various optimization and search problems involving fuzzy systems. A Fuzzy Genetic Algorithm is defined as an ordering sequence of instructions in which some of the instruction or algorithm components are designed with the use of fuzzy logic based tools. A fuzzy fitness finding mechanism guides the GA through the search space, combining the contributions of various criteria identified as the governing factors for the formation of the clusters.

3.2. Fuzzy Genetic Algorithms Optimization

A single objective optimization model is not able to serve the purpose of a fitness measuring index due to the fact that multiple criteria could be responsible for stringing together data items into clusters [9-10].

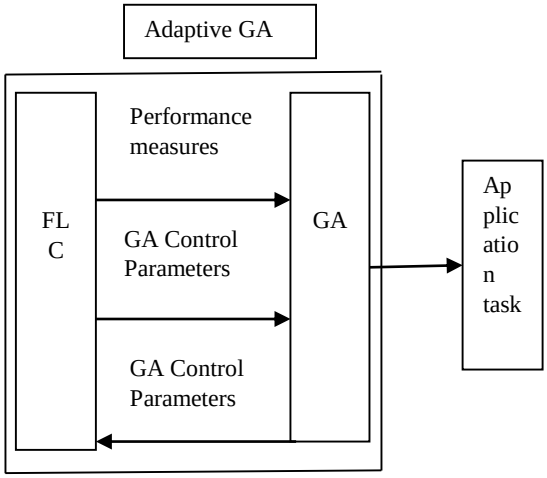

Figure.2 Fuzzy Genetic Block Diagram

In Figure.2 shows the combination of Fuzzy with Genetic Algorithm. This is valid for the clustering problem and for each and every problem using GA with multiple criteria. In multi-criteria optimization, the notion of optimality is vaguely defined. The algorithm has two computational elements that work together i.e. the Genetic Algorithm (GA) and the Fuzzy Fitness Finder (FFF). In the simple cases, there is only one criterion for optimization, for instance, maximization or minimization of profit or cost respectively.

In many real-world decision-making problems, the multiple objectives for simultaneous optimization are essential i.e., survival of the fittest. Hence evolution programming techniques, based on genetic algorithms are applicable to many hard optimization problems, Optimization of functions with linear and nonlinear constraints, the traveling salesman problem, and problems of scheduling, partitioning, and control are considered. Evolution programs are parallel in nature, and parallelism is one of the most promising directions in computer science. An evaluation function to rate solutions in terms of their "fitness" needed. Therefore, genetic operators change the composition of the children in order to make a successful run of a GA. The values for the parameters of the GA have to be defined as the population size and the parameters for the genetic operators and the terminating condition are evaluated by survival of the fittest. Evolution programming techniques, based on genetic algorithms, are applicable to many hard optimization problems, such as optimization of functions with linear and nonlinear constraints, the traveling salesman problem, and problems of scheduling, partitioning, and control. The Fuzzy Genetic Algorithms are the most efficient algorithm when compared to standard Genetic Algorithms in solving the optimization problems.

4. RESULT ANALYSIS

4.1. Artificial Neural network:

There are millions of very simple processing elements or neurons in the brain, linked together in a massively parallel manner [14-16]. This is believed to be responsible for the human intelligence and discriminating power. Neural Networks are developed to achieve the biological system type performance using a dense interconnection of simple processing elements analogous to biological neurons. Neural Networks are information driven rather than data driven. Typically, there are at least two layers, an input layer and an output layer. One of the most common networks is the Back Propagation Network (BPN) which consists of an input layer, and an output layer with one or more intermediate hidden layers. Neural Networks are trained to perform a particular function by adjusting the values of the connections weights) between elements using a set of examples before they can be employed to the actual problem. Neural Networks are adjusted, or trained, so that a particular input leads to a specific target output. The method used to generate the examples to train the network and the training algorithm employed has a significant impact on the performance of the neural network-based model. One of the training algorithms used is the Back Propagation (BP) algorithm. This algorithm aims to reduce the deviation between the desired objective function value and the actual objective function value.

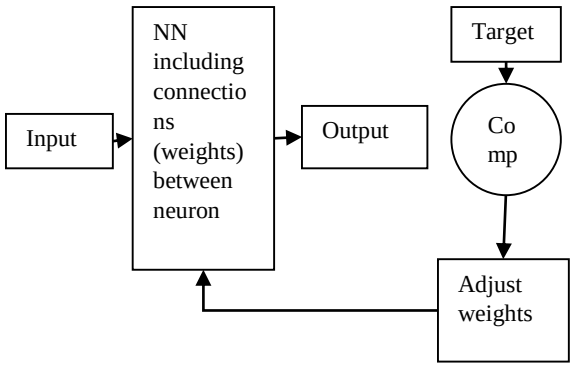

Figure.4.1 Artificial Neural Network Flow Diagram

Figure.4.1 shows the flow of artificial neural network with weights and 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 based on 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 ANN. They are strongly interconnected systems of so called neurons which have simple behavior, but when connected they can solve complex problems.

5. CONCLUSION

The soft computing approaches, fuzzy based approaches, Genetic algorithms based approaches and Neural networks based approaches are applied on a real life image of nature scene and the results show the efficiency of image Processing. Soft Computing is an emerging field that consists of complementary elements of fuzzy logic, neural computing and evolutionary computation. Soft computing techniques have found wide applications in this paper we have given the information of soft computing application domain. Through this paper an expert can choose their work for particular domain. This paper will be helpful to the people who want to contribute to this field.

REFERENCES

[1] Ovidiu MOLDOVAN, CSOKMAI, “A Survey on soft computing techniques used in Intelligent\ BuildingControl”, Recent Innovations inMechatronics’, Vol.1.(2014)

[2] Ridhima. A. Dhopte, Zeba Ali,” Recent Trends and Applications of Soft Computing: A Survey” International Journal Of Computer Science And Applications Vol. 6, No.2, Apr 2013 ISSN: 0974-1011

[3] F. T. Martins-Bede, L. Godo, S. Sandri, C. C. Freitas, L. V. Dutra, R. J. P. S. prevalence using fuzzy case-based reasoning. In Proc of IWANN'09.

[4] Tan , C.N.W. , Artificial Neural Network:Application in Financial Distress Prediction And Foriegn Exchange Trading . 2001, gold coast ,QLD:

[5] Mantas Paulinas and AndriusUsinskas, ”A Survey of Genetic Algorithms Applicatonsfor Image Enhancement and Segmentation”, Information Technology and Control, Vol.36, No.3, 2007, pp.278-284.

[6] M. Jamshidi. Special issue on neural networks and fuzzy logic: theory and applications in robotics and manufacturing. Computer. Electro. Eng., 19(4), 1993.

[7] De Jong, K. A., Spears, W. M., Gordon, D.F., Using genetic algorithms for concept learning, Machine Learning, Vol. 13, Is. 2-3, pp. 161–188, 1993.

[8] Pawar, P. M., Ganguli, R., Genetic fuzzy system for online structural health monitoring of composite helicopter rotor blades, Mechanical Systems and Signal processing, 21: 2212- 2236, 2007.

[9] Smoczek, J., Szpytko, J., A genetic fuzzy approach to estimate operating time of transport device, Journal of KONES Powertrain and Transport, Vol. 18, No. 4, pp. 601-608, 2011.

[10] Weiss, G., Time weaver: A genetic algorithm for identifying predictive patterns in sequences of events, In Proceedings of the Genetic and Evolutionary Computation Conference, Morgan Kaufmann, pp. 718–725, San Francisco, CA 1999.

[11] Chan, K.C.C. and K.T. Foo. Enhancing TechnicalAnalysis in the Forex market using Neural Networks. In IEEE International Conference on Neural Networks 1995.

[12] Metin Kaya, ”Image Clustering and Compression Using An Annealed Fuzzy Hopfield Neural Network”, International Journal of Signal Processing, 2005, pp.80-88.

[13] J. Scharcanski and C. T. J. Dodson, “Neural network model for paper-forming process,” IEEE Trans. Ind. Applicant., vol. 33, pp.826–839, May/June 1997.

[14] Y.-Z. Lu, M. He, and C.-W. Xu, “Fuzzy modeling and expert optimization control for industrial processes,” IEEE Trans. Contr. Syst. Technol., vol. 5, p.212, Jan. 1997.

[15] Y. Maki and K. A. Loparo, “A neural-network approach to fault detection and diagnosis in industrial processes,” IEEE Trans. Contr. Syst. Technol., vol. 5, pp.529–541, Nov. 1997. logic controller. Int. J. Man-Machine Studies, 7:1{13, 1975.