Available online at: http://www.ijmtst.com/vol5issue12.html

International Journal for Modern Trends in Science and Technology

ISSN: 2455-3778 :: Volume: 05, Issue No: 12, December 2019

A Review on Various Soft Computing and Swarm Intelligence Techniques

Rupinder Kaur | Vikas Kumar Garg | Shikha

Department of Computer Science Engineering, Bhai Gurdas Institute of Engineering and Technology, Punjab, India.

To Cite this Article

Rupinder Kaur, Vikas Kumar Garg and Shikha, "A Review on Various Soft Computing and Swarm Intelligence Techniques", *International Journal for Modern Trends in Science and Technology*, Vol. 05, Issue 12, December 2019, pp.-81-85.

DOI: https://doi.org/10.46501/IJMTST051237

Article Info

Received on 21-November-2019, Revised on 12-December-2019, Accepted on 21-December-2019, Published on 26-December-2019.

ABSTRACT

This paper gives you the overview of the Soft computing techniques i.e. Genetic algorithm (GA), Artificial neural networks (ANN) and some of Swarm Intelligence techniques i.e. Artificial Bee Colony (ABC), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Grey Wolf Optimization (GWO) etc. Soft Computing is basically an optimization technique which helps to find the results of problems which are very difficult to reply. It is the integration of methodologies which are planned to represent and find the solutions to real world problems that are not represented or which are very hard to represent mathematically. Swarm Intelligence (SI) can be defined as a subfield of Artificial Intelligence which is used to represent the collaborative behavior of communal swarms in nature, such as ant colonies, honey bees, bird flocks, grey wolves, fireflies and cuckoo search. The term swarm is used for the collection of animals such as fish schools, bird flocks and insect colonies which use their sorroundings and services significantly to communicate by mutual intelligence. In this paper, all these algorithms are discussed in brief.

Keywords–*ABC, ACO, ANN, GA, GWO, PSO, Soft Computing, Swarm, Swarm Intelligence, wdGWO*

NOMENCLATURE

1. ABC - Artificial Bee Colony
2. ACO - Ant Colony Optimization
3. ANN - Artificial Neural Networks
4. CSA - Cuckoo Search Algorithm
5. FFA - Firefly Algorithm
6. GA - Genetic Algorithm
7. GWO - Grey Wolf Optimizer
8. PSO - Particle Swarm Optimization
9. SC - Soft Computing
10. SI - Swarm Intelligence
11. wdGWO -Weighted Distance Grey Wolf Optimizer

I. INTRODUCTION

'Soft Computing' was introduced by Lofti A. Zadeh who is also the creator of fuzzy logic. Soft Computing (SC) is defined as the tolerant of imprecision, uncertainty, partial truth and approximation. The role model of Soft Computing is human mind [1]. Soft computing differs from conventional (hard) computing. Various SC techniques which are widely used are:

A. Artificial Neural Networks
B. Genetic Algorithm
C. Swarm Intelligence

Artificial Neural network is a learning model where a limited number of neural networks is firstly collected and then trained for the same task [2]. It is developed by Hansen and Salamon's work [3], which tells that the neural network systems has generalization ability which can be enhanced through uniting a number of neural networks effectively i.e. First many neural networks are trained and then they are combined by their projections. Genetic algorithms (GAs) are those algorithms which work with a group of points, which is also called chromosomes, it is very easy to use GAs in multi objective optimization problems where we can find a number of results concurrently. Swarm Intelligence is the subfield of artificial intelligence which is inspired from the working behavior of the swarms.

2. VARIOUS SOFT COMPUTING TECHNIQUES

In this section, we discuss all the techniques in detail:

2.1 Artificial Neural Networks

Hansen and Salamon proposed Artificial Neural Networks (ANNs). These are global and extremely adaptable function approximators which are widely used in the fields of cognitive science and engineering [4]. Neural Networks are global function approximators which are used to tell any nonlinear function. The adaptable function approximators are very powerful methods for pattern identification, classification and for the predictions also. Hartati and El-Hawary introduced an enhanced application which is used to solve the OPF problem which has the motive of having the enlarge fuel cost [5]. ANN has the ability that they are not so much responding to error term suppositions and they can also tolerate sound, disorganized components and massive tails better than the other used methods.

2.2 Genetic Algorithm

Genetic Algorithms (GAs) is one of the most used soft computing technique. In GAs, the natural genetics are used to find the solutions to various problems which are used as general-purpose search algorithms. Genetic algorithms are influenced by Darwin's theory regarding evolution [6]. GAs are successfully executed by a huge number of scientific and engineering problems in which optimization, machine learning, automatic programming, transportation problems, adaptive control kind of problems are described. GA works with the large group of randomly created chromosomes. This large group of randomly created chromosomes grows when it goes through a continuous iteration process of competition and controlled variation. Each state of large group of randomly created chromosomes is called generation. Chromosomes are connected with a fitness value at every generation, which tells us about the quality of the solution that is produced by the chromosome values. According to these fitness values, the chromosomes are selected, which further helps to make the new generation. In the same way in nature, genetic operators are used to generate the new chromosomes such as crossover and mutation.

2.3 Swarm Intelligence

The term "swarm" denotes the group or collection of insects or animals or birds which works together to complete the difficult tasks in a systematic way which are very difficult to be completed by an individual entity. This working behavior of swarms has inspired the researchers to solve various problems in many technical fields like in robotics, telecommunications, fuzzy systems etc. Thus Swarm Intelligence is defined as a collaborative behavior of self organized systems whether it is natural or artificial which are inspired from swarms. So, Swarm Intelligence is widely used as a new branch of artificial intelligence. Swarm intelligence basically works on two primary theories: **self organization, stigmergy.**

a) Self Organization:

Self Organisation is known as a group of dynamical mechanisms where higher level elements interact with its lower level components.

b) Stigmergy:

Stigmergy is derived from two words stigma and ergon which means that "stimulation by work". Stigmergy is based on the theory which indicates that an environment is used as a work state memory where the work does not depend on particular factors.

Various swarm intelligence techniques are:

2.3.1 Particle swarm optimization

In 1995, Dr. Eberhart and Dr. Kennedy introduced a new technique which is inspired by social behavior of bird flocks or fish schools which is known as Particle Swarm Optimization (PSO) [7]. In PSO, we termed population as 'swarm' and

individuals as 'particles'. Each particle either directly or indirectly communicates with the one another for the directions and search space for the best locations. Each particle moves through the multi-dimensional space and produces an objective function at the various positions. According to this function, the best solution is taken out and is represented. Each particle that is move through the search space has an initial velocity. The velocity and position of the particle is continuously updated until it may get the best position of itself or the best position that is generated by its neighbor in the swarm. The best position we get is the optimized result. The performance of the particles can be easily calculated with the help of fitness function. This technique may not show the great results in adjusting the parameters but it is easy to implement.

2.3.2 Ant Colony Optimization

Ant Colony Optimization (ACO) was developed by M. Dorigo et. al. [8] and in the late 1980s, it has been basically used to solve discrete optimization problems. ACO is inspired from the social behavior of ant colonies. It is observed that a group of 'almost blind' ants can easily find out the shortest path between the food source and the nest without any visual information although they are not so smart or intelligent as individuals. This shortest path is achieved by the real ants by using a chemical substance called pheromones which ants leaves on their way by returning to their nest. It is also called the pheromone laying/pheromone following behavior of real ants so that they can find the shortest path between the food source and the nest. In order to move through the shortest path, the quantity of pheromone laying is very high as all the ants starts to attract and move through the same shortest path. Thus the longer path will automatically disappear as the pheromone laying on that path will be evaporated due to the volatile nature of pheromones. Therefore, ACO has been widely used to solve many optimization problems in which Traveling Salesman Problem (TSP), sequential ordering, scheduling, assembly line balancing DNA sequencing, 2D-HP protein folding and protein–ligand docking are included.

2.3.3 Artificial Bee Colony

In 2005, Karaboga introduced an optimization algorithm which is known as Artificial Bee Colony algorithm (ABC) which is based on the honey collecting behavior of honey bee swarms. In the ABC model, the bee colony contains three groups: employed bees, onlookers and scouts. Employed bees move to various directions randomly to find the food source. They move from one flower patch to another to find the best probable food source that have the rich quality than the pre-defined quality threshold deposit their nectar. After finding the best food source, employed bees move to the dance floor to perform a special kind of dance to describe the quality of food detected to other bees. This special kind of dance that employed bees perform on the dance floor so that they can converse to other bees is known as waggle dance. This waggle dance primarily helps the other bees to know that where is the direction of patch, what is the distance of patch and the quality of food source. After getting this information, onlooker bees are sent to that patch and they employ themselves by choosing the best probable food source. The employed bees whose food source has been deserted becomes a scout and it starts to find a new food source. Thus with the joined efforts of employed bees, onlookers and scout bees used to find the rich food source and hence may be implemented for solving optimization problems [9].

2.3.4 Grey Wolf Optimizer

The Grey Wolf Optimizer (GWO) is an optimization algorithm
proposed by Seyedali et. al. in 2014 which is inspired from the prey hunting behavior of grey wolves in nature [10]. The Grey wolves generally lives in a social group called pack [11]. These grey wolves hunt the prey efficiently, since they follow very strict social hierarchy. In the hierarchy, they divided themselves into four parts: 1) alphas, 2) beta, 3) omega and 4) delta. The alphas has the highest position in hierarchy and omega has the lowest. The alphas are the strongest in the pack and gives the orders to the group. These grey wolves have the power to spot the location of prey and hence the whole pack will move and attack on the prey. The prime steps of hunting are as in [10]; 1) 'Finding, chasing, and reaching prey', 2) 'Surrounding and harassing prey till it becomes standstill', and 3) 'Attacks the prey'. This hunting technique and the social hierarchy of grey wolves are designed mathematically in order to model GWO and perform optimization to solve the complex problems.

2.3.5 Weighted distance Grey Wolf Optimizer

To enhance the performance of the classical GWO algorithm, authors propose the Weighted distance

Grey Wolf Optimizer (wdGWO) [11]. In wdGWO algorithm, a number of iterations are used so that the position update equation is weighted. The best location of the leaders in the pack is weighted and according to that, the location of the grey wolves in the pack is calculated. In every iteration, the weights are evaluated which are depended on the coefficient vectors. According to the evaluated weights, the location update equation is modified. In wdGWO algorithm, the location update equation is modified and instead of using a simple average, weighted sum of best locations are used. This strategy is very helpful in complex environment where landscape of the problem has narrow and multiple peaks. The performance of wdGWO algorithm is not affected with the increased higher dimension. It has shown consistent quality of solution with increased higher dimension.

2.3.6 Cuckoo Search Algorithm

Cuckoo Search Algorithm (CSA) was proposed with the inspiration taken from egg laying characteristics of cuckoo species. The CSA was developed and implemented by Xin-she Yang et. al. in 2009 [12]. This algorithm was influenced by the characteristics of cuckoo species who lay their eggs in the nests of other host birds (of other species) forcefully. Every cuckoo bird lays one egg at a time and that egg in the nest is referred as the solution. The quality of egg is evaluated on the optimization problems and the egg which has the highest quality will be taken to the next generation. This process of analyzing the quality of the egg is done by the host bird which decides whether it may either throws the cuckoo egg away or it itself desert its nest to make a new nest somewhere else.

2.3.7 Firefly Algorithm

The Firefly Algorithm (FFA) introduced by Xin-She Yang in 2009 which has taken the inspiration from the flashing light characteristics of fireflies [13]. Each firefly has the power that it produces flash lights which attracts the other fireflies to come near it. The intensity of flash light depends upon the characteristics of a firefly and the distance of observing the firefly. The attractiveness depends upon the brightness between two fireflies and also the distance between them means the lesser bright firefly will be more attracted towards the brighter one. If there is no firefly brighter, then it will move randomly. The main and heart of Firefly algorithm is the location update equation which depends upon the intensity and attractiveness of fireflies.

3. APPLICATIONS

Swarm intelligence has been widely used across a large range of applications. In this specific section, we cannot talk about all the swarm intelligence applications in detail but we can discuss the applications in brief.

Basically swarm intelligence applications are widely used to solve most optimization problems and the problems which can be easily converted into optimization problems. The technical fields in which swarm intelligence is the most widely used are Robotics Applications, Data Mining, Communication Networks, Fuzzy Systems, Military Applications, Traffic Patterns, System Design, Pattern Identification, Signal Processing, Decision Making, Simulation etc. Examples of these techniques are fuzzy controller design, job scheduling, image segmentation, EEG signal simulation, speaker verification, gesture identification and automatic target detection etc.

4. CONCLUSION

In this paper, we have discussed various soft computing and swarm intelligence techniques. These techniques have been applied in a number of fields and no doubt they showed a remarkable result in various fields. For the further improvement in the results in various applications, the hybrids of these algorithms are also proposed which can be also used in various fields and can also show remarkable results.

REFERENCES

[1] L. A. Zadeh, "Fuzzy logic, neural networks, and soft computing," Communications of the ACM, vol. 37, pp. 77-84, 1994

[2] P. Sollich, A. Krogh, “Learning with ensembles: How over-fitting can be useful, in: D.S. Touretzky, M.C. Mozer, M.E. Hasselmo (Eds.), Advances in Neural Information Processing Systems 8,” Denver, CO, MIT Press, Cambridge, MA, 1996, pp. 190–196.

[3] L.K. Hansen, P. Salamon, “Neural network ensembles,” IEEE Trans. Pattern Anal. Machine Intelligence 12 (10) (1990) 993–1001.

[4] Kaastra, Iebeling, and Milton Boyd. "Designing a neural network for forecasting financial and economic time series." Neurocomputing 10.3 (1996): 215-236.

[5] R.S. Hartati, M.E. El-Hawary, “Optimal active power flow solutions using a modified Hopfield neural network,” in: Canadian Conference on Electrical and Computer Engineering, 2001, pp. 189–194

[6] Houck, C. R., Jeff Joines, and M. G. Kay. "A genetic algorithm for function optimization: A Matlab Implementation." NCSU-IE TR95.09 (1995).

[7] R. Muangsong, D. Koolpiruck, A. Khantachawana, and P. Niranatlumpong, "A particle swarm optimization approach

for optimal design of PID controller for position control using shape memory alloys," in Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology, 2008. ECTI-CON 2008. 5th International Conference on, 2008, pp. 677-680.

[8] M. Dorigo, V. Maniezzo, and A. Colorni, "Positive feedback as a search strategy," Tech. Report 91-016, Dipartimento di Elettronica, Politecnico di Milano, Italy, 1991.

[9] D. Karaboga, "An idea based on honey bee swarm for numerical optimization," Computer Engineering Department, Engineering Faculty, Erciyes University, Turkey, Tech. Rep. TR06, 2005.

[10] S. Mirjalili, S. M. Mirjalili, and A. Lewis, "Grey wolf optimizer,"Advances in Engineering Software, vol. 69, no. 0, pp. 46 – 61, 2014.

[11] Mahmad Raphiyoddin S. Malik, E. Rasul Mohideen, Layak Ali, "Weighted distance Grey wolf optimizer for global optimization problems," 2015 IEEE International Conference on Computational Intelligence and Computing Research.

[12] X.-S. Yang and D. Suash, "Cuckoo search via lvy flights," in Proceedings of the World Congress on Nature and Biologically Inspired Computing (NaBIC 2009).

[13] X.-S. Yang, "Firefly algorithms for multimodal optimization," in Proceedings of the 5th international conference on Stochastic algorithms: foundations and applications, ser. SAGA'09. Berlin, Heidelberg: Springer-Verlag, 2009, pp. 169–178