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Review Article

ANALYSIS OF NATURE INSPIRED ALGORITHMS

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Abstract
Nature Inspired Optimization algorithms has grabbed a significant notice for their methodologies in problem solving. Some of the popular nature inspired algorithms which were used for optimization are Genetic Algorithms (GS), Particle Swam Optimization (PSO), Fuzzy Systems (FS), Artificial Neural Network (ANN), Cuckoo Search (CS). Several real world problems are achieved using nature inspired algorithms and also optimization with these algorithms place a crucial role in solving the problems. In our project we were implementing various nature inspired algorithms and compare among them in terms of performance, speed, and their ability to reach best solution.

Keywords: Nature-Inspired Algorithms, Genetic Algorithm, Particle Swarm Optimization, Neural Network, Evolutionary Algorithm.

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INTRODUCTION

Optimization, as a rule, is worried about getting the most desirable answers for a negotiated issue. Its relevance in various orders executes it difficult to provide a careful explanation. Analysts, for instance, are keen on getting the peaks and least of a genuine capacity inside a passable arrangement of factors. [14] In registering and designing, the objective is to expand the exhibition of a framework or application with insignificant runtime and assets. In the business, individuals expect to upgrade the effectiveness of a creation procedure or the quality and attractive quality of their present items. [15] Every one of these models shows that streamlining is in reality part of our regular day to day existence. We frequently attempt to augment our benefit by limiting the cost we have to hold up under. Be that as it may, would we say we are extremely ready to accomplish an "ideal" condition? Honestly, whatever issues we are managing, It is difficult to predict that the optimization procedure will provide an accurate solution. It might be ideal for an individual person or a specific purpose, however, unquestionably does not work for the rest of the problems. [16]

Different methods have developed to handle various types of optimal issues. To be more precise, these strategies can be ordered into exact and stochastic calculations. The best-fit techniques such as branch and bound, dynamic programming are profoundly compelling for tiny datasets. [17] Some difficulties are enormous and complicated, which makes the user choose either NP-Complete or NP-Hard, In which the polynomial-time arrangements are not known and the utilization of stochastic calculations gets compulsory. [18] These stochastic calculations don't ensure an ideal arrangement, however, they can discover semi ideal arrangements inside a sensible measure of time. Lately, metaheuristics, a group of stochastic procedures, has become a functioning examination region.

They can be characterized as more elevated level structures focused on proficiently and adequately exploring a search space. The introduction of these nature-inspired algorithms began input 60 years ago. Subsequently, a lot of various strategies have been introduced in today's life which contains some popular methods, for instance, Particle Swarm Optimization, Evolutionary Algorithms, Ant Colony Optimization, and so forth. There are various methods for characterizing and depicting meta-heuristic calculations. [19] The broadly acknowledged order would be the perspective on nature-inspired versus anti-nature-propelled, which is regardless of whether the calculation by one way or another imitates a procedure found in nature. Developmental Algorithms, the most generally utilized metaheuristics, have a place with the nature-motivated class. Different procedures with expanding fame right now are Particle Swarm Optimization what is one of the examples of non-nature propelled metaheuristics.

There will be a convergence at any time for global optimization algorithms. The main problem in Global Optimization is, it is regularly impractical to decide if the most suitable answer as of now is present in local or global optimization and hence if there is acceptance of convergence. To be more precise, it is not easy to decide when to halt or where to be focused on improving the best solution during the optimization process, or whether it ought to inspect different pieces of the search space.

Two different types of optimization algorithms were popular. They are Deterministic algorithms and Stochastic algorithms. In deterministic, they use a set of rules in defining the solution. On the other hand, stochastic algorithms use probabilistic predictions to determine the solution.

Here is the list of nature-inspired algorithms, we use for the optimization purpose.

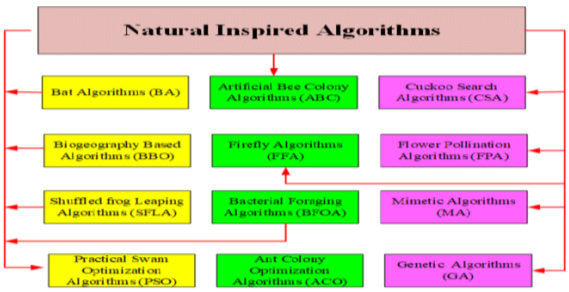

Figure 1: Taxonomy of nature inspired algorithms

RELATED WORK

Algorithms such as genetic algorithms(GAs) and immune algorithms(IAs) which come under evolutionary algorithms are more adaptable than sensitive based methods as they only need objective function values[1],[2]. Ant Colony Optimization algorithm (ACO) was introduced by Dorigo M. [3] in 1991. The foraging behavior of an ant colony [4], [5], [6] is the main motivation behind the algorithm. Problems such as job scheduling [7] problem(JSP), traveling salesman problem (TSP), network routing(NR) and vehicle routing problem(VRP) and many more where ASO has been used popularly. Eberhart and Kennedy[8]in 1995 developed Particle Swarm Optimization(PSO) which is a crucial part of swarm intelligence. Cuckoo search algorithm (CS) was jointly developed by Xinshe Yang at Cambridge University and Suash Deb at C. V. Roman Engineering Institute in 2009 and it is inspired by the cuckoo behavior in a parasitic way and includes Lévy flight habits of birds and drosophila. It is a heuristic algorithm.

RESULTS AND DISCUSSIONS

Genetic Algorithm

The Genetic Algorithm is a part of Evolutionary algorithms, where offsprings are generated based on the fittest hypothesis of the current population. While undergoing the process there are two operations mutation and crossover which takes place on the best fittest hypothesis and generates offspings. These offsprings were updated with the current population.

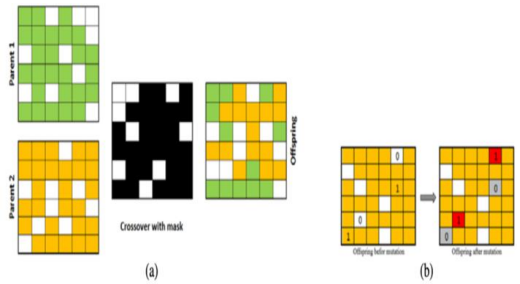

Figure 2: Crossover in Genetic Algorithm

We conclude that with GA we can reduce the cost keeping important gain compared with the conventional model.

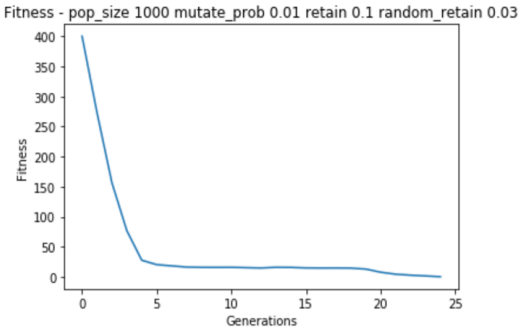

Figure 3: Line graph between fitness and No of generations

It is observed that as the generations increase the fitness values reaches the optimal value. In this data set the least fitness value is considered which is not always same for the rest of the problems. In some scenarios max fitness value is considered.

Particle Swarm Optimization*:*

Particle Swarm Optimization is a function with optimization of continuous non-linear function. The algorithm is based on the swarm intelligence which consists of five parts. First part is the proximity principle, in which population is able to carry out time computations and search space. The second one is the quality principle, where population is able to respond to the factors of quality in the environment. The third is the diverse response principle here the population should not move to the excessively narrow channels. And the fourth and fifth were the stability and the adaptability where the population should not chance its mode every time and to make chances only is there is a worthy computational price.

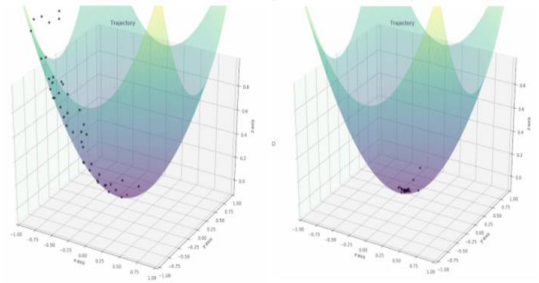

Figure 4: Visualization of PSO data in initial stage and the final stage

By using python as interpreter. Target error criteria, number of particles into the swarm and the number of iterations were the input for the implementation of Particle Swarm Optimization.

Differential Evolution for Tuning Fuzzy Interface System

Differential Evolution algorithm is an extension from Evolutionary Computing. DE reduces the iterative nature and comes up with improving of candidate solutions. The tuning process uses optimization technique created by fuzzy system. As the iterations increases with the increase of optimized sets of solutions. The implementation of this model has many objective functions which includes correlation, Mean square error, prediction of direction, Nash-Sutcliffe index, Entropy, Cross Entropy, Kullback-Leibler Divergence.

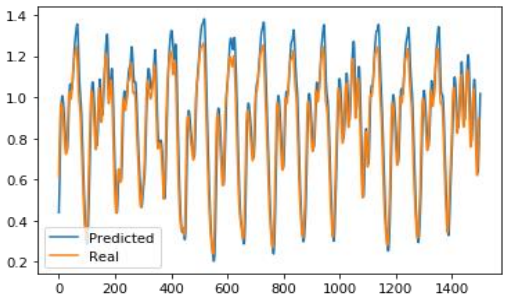

Figure 5: EA's predicted values vs. Real Values

The Evolution time for training the data is about 0.998. And, the best fitness value is found after the 11 generations i.e. 0.025998.

Optimization using Artificial Neural Network:

Artificial Neural Network is the technique that is inspired by human behavior, Which is accurate with faster in training the data when compared with the existing conventional techniques.
Mini-batch gradient descent is inherent from gradient descent algorithm where the data in the training set is divided into small batches and calculates the error and update by end of the individual batch. By the end of the training data, the model is updated with accurate weights.

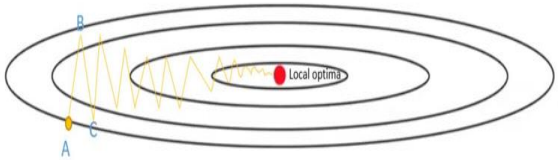

Figure 6: Mini Batch Gradient Descent

The above output describes the flow of accuracy till the local optima.

Gradient Descent with Momentum considers the beyond gradients to clean out the replace. It computes an exponentially weighted average of your gradients, and then use that gradient to replace your weights as a substitute. It works quicker than the usual gradient descent set of rules.

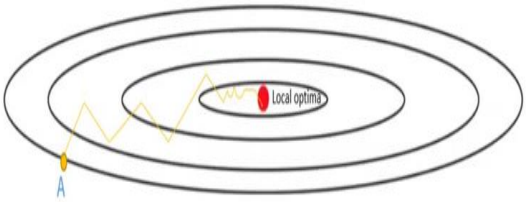

Figure 7: Gradient Descent with Momentum

It is observed that Gradient Descent with Momentum requires less steps to reach Local Optimal when compared with the Mini Batch Gradient Descent.

Comparisons b/w the algorithms

Based on the comparisons of these algorithms is quite complex. The best can be varied with data sets. Just a complementary competition for efficient solutions on the frontiers of deep learning. It's just survival of the fittest in action.

	Genetic Algorithm	Particle Swarm Optimization	Differential Evolution	Neural Networks
Require Ranking of Solutions	Yes	No	No	Yes
Speed	Slow	Medium	Very Slow	Fast
Influence of Population Size	Exponential	Linear	Linear	Both
Influence of Best Solution on Population	Medium	Most	Less	Most
Tendency of Convergence	Medium	High	N.A	Low
Ability to reach good solution without local search	Less	More	More	Poor

Figure 8: Table of comparisons on various criteria

It is observed that for the considered data neural networks were the top in lead when compared with the rest of the models.

CONCLUSION

The comparisons which were observed is based on medium population size, and these will not give the these algorithms enough solution space to produce accurate results. Future scope is to implement various nature inspired algorithms with large population size and also the studies which were introduced in recent times and to come up with the best one among all.

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