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Swarm Intelligence Techniques focusing Particle Swarm Optimization (PSO)

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ABSTRACT: Swarm Intelligence can be defined as a branch of artificial intelligence used for analyzing the behavior of swarm in nature. Here, a swarm is a large number of homogenous, simple agents interacting locally among themselves, and their environment. The social interactions among them can either be direct interactions or indirect interactions. Some examples of direct interactions are visual or audio contact, like the dance of honey bees. And examples of indirect interaction occurs when one individual changes the environment and the other individual respond to the new environment, like that of pheromone trails of ants which they deposit on their way while they are in search of some food. Some of the examples in natural system swarm intelligence includes ant colonies, bird flocking, bacterial growth, and also the microbiological intelligence. This paper comprises a brief about particle swarm optimization algorithm with its applications.

KEYWORDS: Swarm Intelligence (SI), Artificial Intelligence (AI), Particle Swarm Optimization (PSO)

I. INTRODUCTION

Since the computational model of swarms was proposed, there has been a steady increase in the number of research papers reporting the successful application of Swarm Intelligence algorithms in several optimization tasks and various other research problems. The Swarm Intelligence principles have been successfully applied in a variety of problem domains including function optimization problems, finding optimal routes, scheduling, image and data analysis. Following are some of the techniques which researchers uses to solve the given problem,

1. Particle Swarm Optimization
2. Ant Colony Optimization
3. Bees Algorithm
4. Artificial Bee Colony Algorithm
5. Differential Evolution
6. Artificial Immune System
7. Bat Algorithm
8. Glow warm Swarm Optimization
9. Gravitational Search Algorithm[1][2]

II. PARTICLE SWARM OPTIMIZATION

The Particle Swarm Optimization (PSO) technique was developed by Kennedy and Eberhart in 1995. This technique is based on the social behavior of flocking birds and schooling fish when they are in search of food. The PSO technique simulates the behavior of individuals in a group to maximize the species survival. Each particle "flies" in the direction based on their particular experience and also that of the whole group. Individual particles move randomly (stochastic) towards the position that is affected by the previous best performance of a particle, best performance of group and its present velocity. The most important advantage of PSO is its robustness in controlling parameters and its high computational efficiency (Kennedy and Eberhart, 2001). This method is basically suitable for optimization of

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continuous non-linear functions. The Particle Swarm Optimization algorithm is similar to many population based algorithms such as Genetic Algorithm but they don't have any direct re-combination of individuals of the population. It has become popular due to its simplicity and effectiveness in wide range of applications along with its low computational costs. Like all other evolutionary algorithms, Particle Swarm Optimization (PSO) is appropriate for the problems with immense search spaces that present many local minima. [3]

III. PARTICLE SWARM OPTIMIZATION ALGORITHM

Step 1: Each and every particle evaluates the function to maximize and achieve peak value at each point it visits it spaces.

Step 2: Each particle remembers the best value of the function that is achieved so far by it (p-best) and its co-ordinates. (p-best is local best value)

Step 3: Each particle know the global best position that one member of the flock has achieved, and its value (g-best). (g-best is the global best value) [2]

A. ALGORITHM – PHASE 1 (one- dimension)

Using the co-ordinates of p-best and g-best of each particles calculate its new velocity with following equation,

vi = vi+ c1 x rand() x (pbestxi–presentxi) + c2 x rand() x (gbestx –presentxi)

where,

0 < rand() <1 presentxi= presentxi+ (vixΔt)

B. ALGORITHM – PHASE 2 (n- dimensions)

cognitive component

$$\vec{v}_i = \vec{v}_i + \text{rand()} \times \vec{c}_1 \otimes (\overrightarrow{pbest}_i - \overrightarrow{present}_i) + \text{rand()} \times \vec{c}_2 \otimes (\overrightarrow{gbest} - \overrightarrow{present}_i)$$

social component

Note that the symbol ⊗ denotes a point-wise vector multiplication.

The below figure shows the algorithm and the overall working of Particle Swarm Optimization. Firstly generate a random initial population of various types of particles. Check the fitness value in local members of the group. If the value is more than the other value, it gets stored into the a variable. And at the end this value is compared with the global best value of the whole group. Once the global best value of the group is obtained, the velocity is marked along with its position. If no change is seen in the velocity and position of the members then it goes again inside in the loop and checks again. Once the changed or the updated value is obtained, it goes out from the loop once the termination criteria of the function match with the required optimal value.

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```
Randomly generate an initial population
repeat
    for i = 1 to population_size do
        if f(present_i) < f(pbest)
            then pbest = present_i;
        gbest = best(pbest);
        for d =1 to dimensions do
            velocity_update();
            position_update();
        end
    end
until termination criterion is met.
```

[2]

IV. PSEUDO CODE

Step 1: Initialize a population of particles.
Step 2: do
Step 3: for each particle p
Step 4: $value_p \leftarrow$ Evaluate (x_p)
Step 5: if (value (x_p) < value ($pbest_p$)) then
Step 6: $pbest_p \leftarrow x_p$
Step 7: if (value (x_p) < value ($gbest_p$)) then
Step 8: $gbest \leftarrow x_p$
Step 9: end_for
Step 10: for each particle p
Step 11: $velocity_p \leftarrow$define_velocity(pr_1, pr_2, pr_3)
Step 12: $x_p \leftarrow$ update (x_p, $velocity_p$)
Step 13: end_for
Step 14: $pr_1 = pr_1*0.95$; $pr_2 = pr_2*1.01$; $pr_3 = 1-(pr_1 + pr_2)$
Step 15: while (a stop criterion is not satisfied) [3]

V. FLOW CHART OF BASIC PARTICLE SWARM OPTIMIZATION

The below figure shows the basic flow chart of Particle Swarm Optimization. It initializes population randomly in a flock of birds or fish school. Then it calculates the fitness value of each and every member of the flocks or schools. Selects the global best value from all the members of a particular group along with its velocity at that moment. If it changes then updates particle's velocity as well as position. If no change is seen in the velocity and position of the particles then it again calculates the fitness value. The cycle repeats unless a change is seen in velocity and position. If change occurred then it stores the value.

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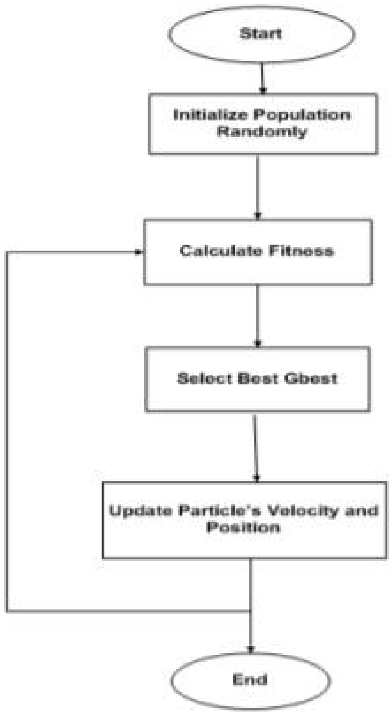

Fig. 1. Flow chart of Basic PSO.

4]

VI. PSO APPLICATIONS & CURRENT TRENDS

The first practical application of PSO was in the field of neural network training and was reported together with the algorithm itself by Kennedy and Eberhart in 1995. Many more applications have been explored ever since, including telecommunications, power systems, signal processing, data mining and many more. Till date, there are lots of publications reporting various types of applications of particle swarm algorithm and many more fields. Although PSO has been used mainly to solve single objective problems that are unconstrained, multi-objective optimization problems, problems with dynamically changing landscapes, and to find multiple solutions. [6]

A number of research are currently pursued, including some of the following one's,

1. Theoretical Aspects
2. Matching Algorithms to problems
3. Parameter Selection
4. Application to more and / or different class of problems.
5. Image recognition
6. Antenna Design
7. Predictive and Forecasting
8. Areas where Genetic Algorithm can be applied
9. And also in the field of Robotics.
10. Artificial Neural Networking [6]

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VII. SIMULATIONS AND RESULTS

Many scientists have created simulations of computer with various types of interpretations of movements of organisms in fish school and even bird flock. Reynolds and Heppner, Grenander are some of the notable persons who presented simulations of bird flocking. Reynolds was fascinated by the aesthetic flocking of birds choreography. While Heppner was a zoologist interested in discovering the rules that enabled birds to flock in synchronous way. Both of them had a thought that models like cellular automata, might underlie unpredictable group dynamics of birds behavior. It does not seem too large logic to suppose rules that underlie animal social behavior, including herds, schools or flocks. Famous Sociobiologist E.O. Wilson had written that "In theory individual members of the school can profit from discoveries and previous experiences of all the members of school during the search of food. This advantage can become decisive outweighing disadvantage competition for food items." This statement provides information that social sharing of information among the neighbors offers evolutionary advantage to the whole group. [8]

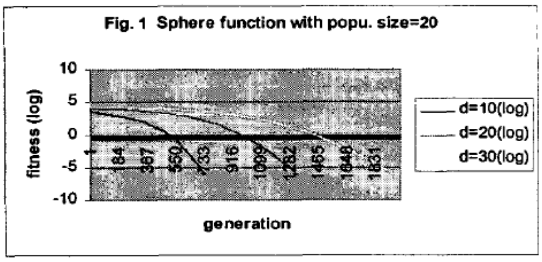

Fig. 1 Sphere function with popu. size=20

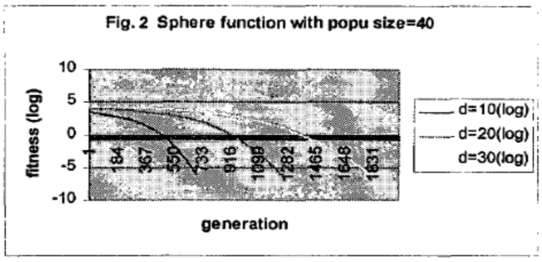

Fig. 2 Sphere function with popu size=40

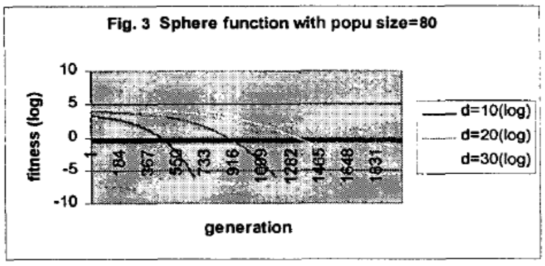

Fig. 3 Sphere function with popu size=80

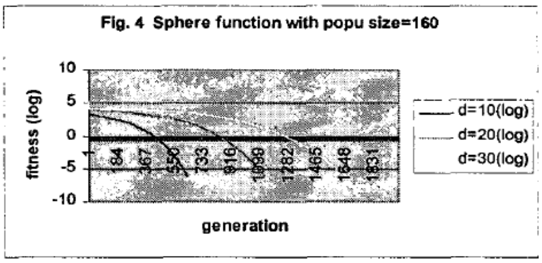

Fig. 4 Sphere function with popu size=160

Fig. 1 to 4 shows the results of sphere function with four different population sizes. Now, below Table-3 lists the mean fitness values of the best particles found for the 50 runs for four functions. Its easy to see sphere function that We can find the optimal solution very fast from the given data and even the PSO algorithm scales very well. In Table-3 since only four digits after decimal are recorded , you can see in from the table that values here are all zero. [9]

Table 3: The mean fitness values for the sphere function.

Popu. Size	Dimension	Generation	Mean Best Fitness
20	10	1000	0.0000
	20	1500	0.0000
	30	2000	0.0000
40	10	1000	0.0000
	20	1500	0.0000
	30	2000	0.0000
80	10	1000	0.0000
	20	1500	0.0000
	30	2000	0.0000
160	10	1000	0.0000
	20	1500	0.0000
	30	2000	0.0000

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VIII. ADVANTAGES & DISADVANTAGES

A. Advantages of PSO
1. Effective global search algorithm
2. Calculation is simple, compared to others and has bigger optimization capability
3. Can be applied to both scientific as well as engineering use.
4. PSO have no overlapping calculations. Search could be carried out on the speed of particle. [7]

B. Disadvantages of PSO
1. Cannot work on problems of scattering
2. Cannot workout problems of non-coordinate system like solution of energy field and moving particles in that field
3. Method easily suffers from partial optimization, which cause less exact at the regulation of its speed and direction. [7]

IX. CONCLUSION AND FUTURE WORK

The simulation results showed that the proposed algorithm performs better with effective global searching algorithm. The proposed algorithm provides approximate results of the problem given to it with the help of the best fitness particle among all the given members.PSO is metaheuristic. This algorithm has got some advantages and disadvantages, like it works perfectly for problems based on group of members. While good part is there's no need to manage the algorithm, members follow each part based on the fitness value of other neighboring particles.

REFERENCES

1. Hazem Ahmed, Janice Glasgow, Swarm Intelligence- Concepts, Models and Applications, School of Computing Queen's University Kingston, Ontario, Canada, February, 2012, 585.
2. Swarm Intelligence Techniques focusing on PSO and ACO (IRJET-V3I6460) Zalak Vyas & Amit Mankodi.
3. Elizabeth F. G. Goldbarg, Marco C. Goldbarg and Givanaldo R. de Souza (2008). Particle Swarm Optimization Algorithm for the Traveling Salesman Problem, Traveling Salesman Problem, Federico Greco (Ed.), ISBN: 978-953-7619-10-7.
4. Muhammad Imran, RathiahHashim and Noor Elaiza Abd Khalid, An overview of Particle Swarm Optimization Variants, ELSEVIER, Vol No. 53, pp-491-496, 2013.
5. Particle Swarm Optimization

Algorithm for the Traveling Salesman Problem, Federico Greco (Ed.), ISBN: 978-953-7619-10-7.

6. http://www.scholarpedia.org/article/Particle_swarm_optimization
7. Qinghai Bai 'Analysis of Particle Swarm Optimization Algorithm', 'College of computer science and technology' Inner Mongolia University for NationalitiesTongliao vol.3 no.1 Feb,2012.
8. James kennedy and Russel Eberhart, Particle Swarm Optimization, IEEE, Vol.3, pp.7803-2768, 1995.
9. Yuhuishi and Russell Eberhart, Empirical Study of Particle Swarm Optimization, IEEE, pp.7803-5536, 1999.
10. Y. del Valle et al., "Particle Swarm Optimization: Basic Concepts, Variants and Applications in Power Systems," IEEE Transactions on Evolutionary Computation, Institute of Electrical and Electronics Engineers (IEEE), Mar 2008.
11. Zwe-Lee-Gaing, A Particle Swarm Optimization Approach for Optimum Design of PID Controller in AVR System, IEEE Transactions on Energy Conversion, Vol. 19, No.2, JUNE, 2004.
12. M.A. Abido, Optimal Power Flow using Particle Swarm Optimization, ELSEVIER, Vol. 24, pp- 563-571, 2002.