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A Brief Survey of Self Organized Particle Swarm Optimization

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Abstract- **This paper transplants a new variant of PSO i.e. SOPSO(self organizing PSO) for improving the performance of PSO. SOPSO emphasizes the information interactions between the particle-lever and the swarm-lever, and introduce feedback to simulate the function. Through the feedback information, the particles can perceive the swarm-lever state and adopt favorable behavior model to modify their behavior, which not only can modify the exploitation and the exploration of the algorithm adaptively, but also can vary the diversity of the swarm and contribute to a global optimum output in the swarm. This paper presents a brief introduction to the new variant of PSO i.e. Self Organizing PSO (SOPSO) which alleviates the premature convergence. The paper aims at providing the difference between SOPSO and original PSO, giving the merits of SOPSO as compared to PSO. An algorithm and mechanism for the working of SOPSO has been presented here. The particles in SOPSO can adjust its moving mode according to the swarm states. The dynamics of the particles search moving in iterations is also analyzed.**

Keywords- **feedback , information, , Particle swarm optimization, self organized.**

I. INTRODUCTION

A. *Optimization*

Optimization is the search for a set of variables that either maximize or minimize a scalar cost function. The n-dimensional decision vector, x, consists of the n decision variables over which the decision maker has control. The cost function is multivariate since it depends on more than one decision variable, as is common of real world relationships. The decision maker wants a more efficient method than trial to obtain a quality decision. [8]

B. *Particle swarm optimization*

Particle swarm optimization (PSO) is a swarm-intelligence-based algorithm and inspired originally by the social behavior lying in the bird flocking. The algorithm initialized with a population of random solutions, called particles. During a search process, each particle has a tendency to fly towards better search areas with a velocity dynamically adjusted according to its own and other particles'
its behavior. As a stochastic algorithm, PSO owns some attractive features such as :
-simple concept
-few parameters
-easy implementation

C. *Self Organized*

Self-organization is a process where some kind of overall order or coordination arises out of the local interactions between the components of an initially disordered system. This process is spontaneous, that is; it is not necessarily directed or controlled by any agent or subsystem inside or outside of the system. It is often triggered by some random fluctuations that are amplified by some positive feedback. The resulting organization is wholly decentralized or distributed over all the components of the system. It becomes robust and is able to survive and self-repair substantial damage.

II. SELF-ORGANIZED PSO (SOPSO)

A. *PSO (Particle Swarm Optimization)*

Particle swarm optimization (PSO) is a population based stochastic optimization technique [9] proposed by Kennedy and Eberhart in [6]. Particle swarm optimization (PSO) is an artificial intelligence (AI) technique that can be used to find approximate solutions to extremely difficult or impossible numeric maximization and minimization problems [10]. In computer science, particle swarm optimization (PSO) is a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of the quality. The PSO optimizes a problem by having a population of candidate solutions (particles), and moving these particles around in the search-space according to simple mathematical formulae over the article's position and velocity[6]. Kennedy and Eberhart developed a PSO algorithm based on the

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behavior of individuals of a swarm. It is based on the movement of individuals (e.g., fishes, birds, or insects) within a group. The members within a group share information among them. It leads to increased efficiency of the group. The PSO algorithm searches in parallel using a group of individuals similar to other AI-based heuristic optimization techniques.[11] It was originally created to model the flocking of birds to find food. Since it's relation, it has been applied in many different areas, but many of the test functions used to benchmark it are single-funnel functions with optima located at the origin. Particle swarm optimization (PSO) is a population based algorithm in which particles "fly" about the search space with trajectories influenced by their own search history as well as that of the rest of the swarm. [12] The PSO finds its best position by comparing different particles in a population, with each other. Comparison in PSO can be done in three ways: pbest, lbest and gbest .The pbest is the best solution achieved by the particle so far . The lbest is the another best value that is tracked by the particle swarm optimizer . It is the best value, obtained so far by any particle in the neighbors of the particle . The gbest is the globally found best value in the swarm.[7] The PSO algorithm updates its velocity and position when the particle finds its best solution and improves the swarm towards better position.

B. *SOPSO (Self Organized Particle Swarm Optimization)*

In this algorithm, in addition to particle information and swarm information, feedback agent is employed to improve the particle performance. It sets and improves its behavior in the next iteration. This agent will lead to some improvements in the discovery. It avoids premature convergence of the total algorithm.). In the algorithm, particles can adjust dynamically its moving mode based on the swarm states. Thus, the algorithm has a high efficiency to solve the test functions. [1] For the knowledge to be extracted from datasets generated using these technologies, have to be presented to a scientist in a meaningful way.[5] It aims at alleviating the premature convergence with SOPSO. The SOPSO emphasizes the information interactions between the particle-lever and the swarm-lever, and introduce feedback to simulate the function.[2] Evolutionary methods like particle swarm optimization perform better for problems such as economic dispatch , but these methods converge to sub-optimum solutions prematurely. [4]

III. RELATED WORK DONE

*[1] Jie Qi,,"Dynamics Analysis on a Self-organized Particle Swarm Optimization "*This paper proposes a new self-organized particle swarm optimization (SOPSO). In the algorithm, particles can adjust dynamically its moving mode based on the swarm states, so that algorithm has a high efficiency to solve the test functions.

[2] Jing Jie1,2, Jianchao Zeng2, and Chongzhao Han1, "Self-Organization Particle Swarm Optimization Based on Information Feedback" It aims at alleviating the premature convergence with SOPSO. The SOPSO introduces feedback to simulate the function. Through the feedback information, the particles can modify their behaviour. It not only can modify the exploitation and the exploration of the algorithm adaptively, but also it can vary the diversity of the swarm and contribute to global optimum output in the swarm.

[3] M. Lotfi Shahrezaa, D. Moazzamia,b,c, B. Moshiri d, M.R. Delavar , "Anomaly detection using a self-organizing map and particle swarm optimization" Anomaly detection refers to detecting patterns in a given data set that do not conform to an established and normal behavior. The patterns hence detected are called anomalies, and often translate to critical and actionable information in several application domains.

[4] K. T. Chaturvedi, Manjaree Pandit, " Self-Organizing Hierarchical Particle Swarm Optimization for Nonconvex Economic Dispatch" The economic dispatch has an objective of generating allocation to the power generators in such a manner that the total fuel cost is minimized while all operating constraints are satisfied. The conventional optimization methods assume generator cost curves to be continuous and ever-increasing, but modern generators have nonlinearities in their cost curves making this assumption inaccurate. The evolutionary methods like particle swarm optimization performs better for such problems as no convexity assumptions are imposed.

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[5] Xiang Xiao, Ernst R. Dow, Zina Ben Miled, Robert J. Oppelt ," Gene Clustering Using Self-Organizing Maps and Particle Swarm Optimization" Gene clustering is the process of grouping the related genes in a same cluster. Microarray technologies have made it possible tomeasure gene expression levels for thousands of genes simultaneously. Gene clustering methods serve the purpose of generating the datasets using these technologies and presenting these datasets in a meaningful way to the scientists for extracting the knowledge.

IV. SOSPSO Algorithm

The performance of an algorithm is related to its dynamical process to a certain extent. What kind of dynamic characteristics a good algorithm should have is a significant research topic, which helps obtain the means of improving the algorithm efficiency, preventing prematurity and balancing the global search and local search. However, due to the heuristic rules and strong randomness of intelligent optimization algorithms, it is difficult to model the dynamic procedure of the algorithms. Therefore, research in this field is sometimes subject to a certain limitation. This paper uses statistical methods to study the dynamic properties of the algorithm and analyzes the relation between algorithm's performance and its dynamic characteristics. The proposed SOPSO has good performance to solve the complex multimodal functions (the particles can adjust their move modes according the current distribution of the swarm), so the dynamic characteristics of the SOPSO algorithm is analyzed, and compare them with those of the other two standard PSOs. In order to catch the dynamic characteristics of the algorithm, a dynamic parameter is defined tomeasure the search area in the solution space in iterations.

A. The Original PSO

PSO is a population based optimization technique, where a swarm of particles $I = \{1,...,i,...,n\}$ is randomly initialized and the algorithm searches for optima by updating generations.

B. Self-organized mechanism

The algorithm realizes self-organized by adjustment the operation mode according to the current states information. The swarm states is described by the parameter *C* which inflects the covered area by the swarm. Which mode is under operating is dependent on the value of *C* and a pre-set threshold *T*. The algorithm begins with PSO evolution mode in the initial stage, which makes the algorithm converge during the run so that the scan radius *C* is reduced. When $C \leq T$, the dynamic adjustment mode is under operating and the value of *C* is increasing. When $C > T$, the algorithm returns to the PSO mode, which make *C* decrease again. Therefore, to set a right value of *T* is the key to obtain an effective balance between local exploit and global explore.

C. The self-organized Particle Swarm Optimization

Based on the original PSO, the self-organized PSO has four main extensions:

1. Use a variable *C* to measure the radius of the coverage area for the swarm.
2. Set a threshold T of the value of *C*. The threshold is adapted according to the current iterations states.
3. Design a dynamic adjustment strategy to renew the algorithm.
4. Execute a switch between a PSO evolution mode and the dynamic adjustment mode based on the algorithm's current states. The definition of the coverage radius of the swarm The radius *C* of swarm's coverage area is defined as the average distance of each particle to the center of the swarm.

$$C=1/N \sum^{N}_{i=1} \sqrt{\sum^{D}_{d=1}(x_{id}-x_{md})^2}$$

where $x_{md}= 1/D \sum^{N}_{i=1} x_{id}$ is the *d*th coordinate of the swarm's centre. Large *C* indicates the large distance between particles, so that the swarm covers a large region and a large range search is possible. As the *C* decreasing, the covered area is reduced followed by a small scale search or a local exploit. The formula also states the degree of the particles diversity. Large diversity means large distance of particles which results in high velocity to scan large region. When *C* decreases to a certain degree, the searching range is confined and the algorithm is possible to be trapped in local optimum. As thus a renew mechanism is required to relocate the particles so as to expands the search range of the swarm.[1]

D. Analysis of PSO Based on Self-Organization Theory

Considering the difficulties in developing PSO into a global optimization, we should go back to analyze its simulation mechanisms. Swarm Intelligence can prompt PSO to be a successful and robust optimization. This system is characterized by four basic components:

- positive feedback
-negative feedback
-random fluctuations
- multiple interactions

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which just can explain why the complex collective production can emerge in a system through the interactions among the low-lever individuals.

Based on the concept of Self-organization, the PSO system should be considered as a dynamic closed system, and its dynamic behavior should be understood from two aspects: its low-lever - the individual lever and its high-lever- the swarm lever, an emergence of a high-lever quality in such a system is mainly due to the internal interactions between the two levers. An information feedback is introduced into BPSO and a self-organization particle swarm optimization (SOPSO) is developed.[2]

V. CONCLUSION

In this paper, a new self-organized particle swarm optimization is proposed, where the particles can adjust its moving mode according to the swarm states and the dynamics of the particles search moving in iterations is also analyzed.

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