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PERFORMANCE EVALUATION OF OPTIMIZATION ALGORITHM USING SCHEDULING CONCEPT IN GRID ENVIRONMENT

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ABSTRACT

Grid computing has been an important technology by a noteworthy span in the fields of scientific and engineering. This boundless enactment of Grid computing paradigm has taken place very promptly even faster than the case for the web. Optimization is the process of choosing the desirable event in the "finest" way. The perception of 'different factors' means that there are different feasible solutions, and a perception of 'achieving enticing outcomes' means that there is an objective of searching progress on how to find the best result. In this paper, comparisons of three optimization approaches are proposed for grid Scheduling problem. As in other generic techniques of optimization such as genetic algorithm, ant colony optimization, etc.,Swallow Swarm Optimization (SSO) is the new algorithm in optimization with high convergence rate is compared with the two existing standard other optimization techniques namely Particle Swarm Optimization (PSO) which is very difficult to optimize in a highly discontinuous data surface features and Fish Swarm Optimization (FSO) algorithm may give local minimum results in occurrence of stagnation condition and eventually converges at global minimum points. Simulation results show that the SSO algorithm performs better than existing methods, and performance improvement is especially significant in large-scale applications. We analyze here the use of a Grid computing systems to cope up with the limits of performance metrics. It is obtained from results that FSO gives the next higher execution time in large values. SSO on contrary executes all jobs in minimum time interval, thus obtained to be the optimal algorithm from three methods. They produce good results with the large scale applications.

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KEY WORDS

Grid computing, Resource management, Scheduling, Performance metrics.

INTRODUCTION

Grid computing is mostly widely used in computational science: bridging the gap between Grid computing and workflow management is the further progress.

Over the last decade we have gathered an experience in process modeling, analysis and enactment in a great accord. One of the most eloquent and sophisticated open-source workflow systems available today is YAWL (Yet Another Workflow Language). Furthermore, the analysis process is specialized in the management of workflow. With the help of Petri nets as a foundation of theoretical, variety of real-life process models have been analyzed and ranging from BPEL (Business Process Execution Language) and workflow stipulation to the entire SAP model.

In recent years, on focusing the analysis of processes based on system logs. The ProM framework has been developed at TU/e provides an adaptable toolset for mining process that is notably useful in a Grid environment.
The server on the web has direct contact to the individuals to talk independently in large numbers: the collection of servers and clients often working together to solve a problem with the help of Grids. Grids are viewed by the user as a virtual environment with uniform access to resources but actually they are intrinsically distributed and heterogeneous. Major issues in Grid software addresses the security, scheduling of resources along with quality of services and many, which allows Grid to be anticipated as a single virtual platform by the users. The Grid is viewed as the backbone of the Internet, for all users. Since now the Grid computing is primarily focused on framework. Users can submit their problems to the Grid using Grid software. Most application helps the user in finding the solutions to the problem efficiently.

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Optimization is the process of finding an alternative with the most cost efficient or best feasible performance for some constraints, by maximizing desired aspects and minimizing the excluded ones, which must be correct in regardless of a solution. In other words, the optimization finds the solution for a function within an addicted domain. On comparing, maximization is trying to attain the best solution or highest result or better outcome no matter what the cost is. Due to the lack of full information and time to evaluate all the available information is restricted.

The design of optimization is simple, to reduce the cost of production and improve the efficiency of production. The procedure of optimization algorithm is that the process is executed iteratively and compared the results until the optimal solution is achieved. Optimization has taken its role in computer aided design activities. The optimization algorithm has been divided into two distinct types, they are, Deterministic and Stochastic algorithms. The main contribution of this paper is Scheduling. A Grid computing provides both hardware and software framework that provides true, persistent, ubiquitous, and low-cost access to high-end computational capabilities [1]. Grid is a shared environment created through the distribution of a constant, based on standard service framework that is used for creation and resource sharing within communities. Resources can be any computer, storage media, instruments, software applications or data, all connected through the web. The middleware software provides services mainly for security and resource management. Resources under various organizations are being shared by locally defined policies that indicate what is actually shared to whom is the access allowed and under what conditions it is transferred [2]. Resource sharing and problem solving in dynamics are the two major problems that underlie the Grid concept [3].From the scheduling point of view, a higher level abstraction for the Grid can be applied by eliminating some framework parameters such as authentication, authorization, and resource discovery and access control. To facilitate the discussion, the following frequently used terms are defined:

- The job properties are parameters like memory requirement, targets, priorities, etc.
- A job is a set of tasks that is executed on a various resources. In this paper, each jobs minimal completion time is carried for scheduling.
- A resource is something that is used to perform some operation.
- A job scheduling is the mapping of jobs to selected resources which is distributed in multiple domains.

RELATED WORK

In Swarm Intelligence, Self-organization plays a major role with fewer restrictions and interactions with agents. Swarm intelligence came up with many famous examples from the world of wildlife, such as birds flock, fish school and insects swarm.The social interactions with social by individual help it to adapt to the situations more effectively because more information are collected from the entire swarm.

James Kennedy and Russell Eberhart [4] has reviewed on the relationship between PSO and both artificial life and metamorphic computation. Proposed the neural network and training and robot task learning and tested using Benchmark functions. They use a three layered network design to solve the XOR problem, as a demonstration of the particles swarm optimization concept. The network consists of two inputs, three hidden processing elements and one output processing element. The goal of this concept is to obtain the simplicity and robustness with the frequency which models cycle interminably around a non-global optimum.

Zainal et al., [5] presented an overview of Artificial Fish Swarm (AFSA) algorithm by describing the evolution of the algorithm along with all the improvements and its combinations with various algorithms and methods as well as its applications in solving industrial problems.

Zhehuang Huang and Yidong Chen [6] proposed an improved artificial fish swarm algorithm based on hybrid behavior selection to select behavior of fishes. First, they proposed an improved algorithm based swallowed behavior to speed up the convergence. Second it deals with the problems of easy fall into local optimum value. The experiment shows that the proposed algorithm has more powerful global exploration ability and faster convergence speed.

Revathi and Krishnamoorthy [7] made a comparison of PSO, FSO and SSO algorithms with different parameters. The swallow swarm optimization algorithm has been proven to have faster convergence speed of getting the optimal result at lower number of iterations. The design and performance evaluation of SSO were presented.

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Farzi and Saeed [8] presented an Efficient Job Scheduling in Grid Computing with Modified Artificial Fish Swarm Algorithm. Job scheduling was the NP complete problem and an important issue in grid computing. To overcome the difficulties a new algorithm called modified artificial fish swarm algorithm (MAFSA) was proposed. In AFSA algorithm, leaping behavior was added, and adaptive step was used.

Biao Zhang, [9] developed Homogeneous Ant Colony Optimization (HACO) Algorithm to overcome the convergence of the Basic Ant Colony Optimization (BACO) algorithm for continuous domain problems. The proposed algorithm was demonstrated to be effective and robust, that has the potential to be implemented in various inverse heat transfer problems that are treated as the solving model for the coupled radiation and conduction of heat transfer. This is simulated by the Finite Volume Method (FVM) were served as an input for the inverse analysis. Fine-tuning of the algorithm and practical application of ACO algorithms in heat transfer.

SYSTEM DESIGN

The workflow of the proposed system includes the following steps

- Initialize: The particles that are to be evaluated are formed a population.
- Leader Selection: From the population initialized the particle with lower convergence to the optimal solution is predicted as a leader. Always the leader particles guide the other particles in process.
- Update: After each iteration the position and velocity of every particle is updated to the predicted new value.
- Global best particle: By using distinct optimization method the unique global best value that is nearer or exact to the optimal value is obtained.
- Benchmark functions: Earlier they are tested with the standard 19 benchmark functions, result shows that SSO gives best result than the other two methods.
- Scheduling: Scheduling the jobs to the optimized resources in order to save time.
- Performance metrics: The various parameters are included for comparing the three algorithms say Time, Speed, etc., **[Figure- 1]**. Shows the Workflow of the proposed system.

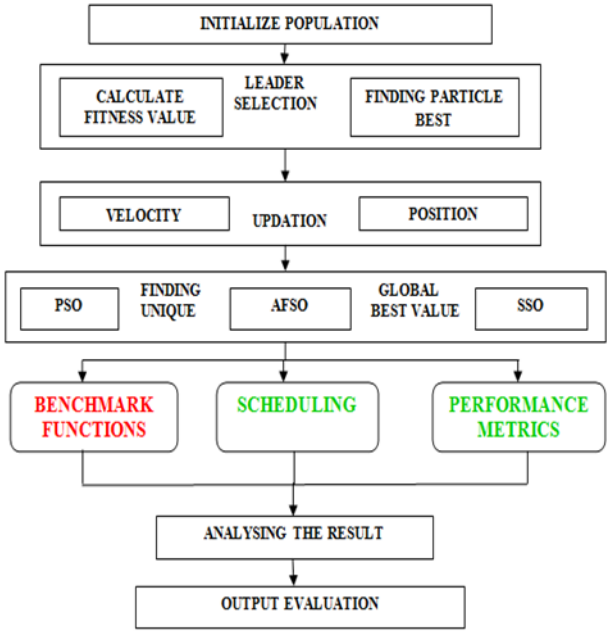

Fig: 1. Workflow of the proposed system

FEATURES OF SWARM OPTIMIZATION

Some of the Swarm optimization is Ant Colony Optimization (ACO) where Pheromone segregation by ant easily gets evaporated which is the advantage of lowering the convergence rate at local optimal solution. Bee Colony Optimization (BCO) where the scope of exploration at local points is constantly focused on the best results. Particle Swarm Optimization (PSO) is a method based on searching the pattern that is not used to the elevation of

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the problem to be optimized. Artificial Fish Swarm Optimization (AFSO) which achieve fast convergence rate and some parameters to be adjusted to not get stuck at local points. Swallow Swarm Optimization (SSO) has proved to have high efficiency and high convergence speed and not get trapped in local minima values.

PARTICLE SWARM OPTIMIZATION

Particle Swarm Optimization (PSO) is a probing technique appropriate for finding of the optimal solution. The Particle Swarm Optimization algorithm is a biologically-encouraged algorithm excite by a social living. PSO has the ability to face the database classification occurrence is inspected. PSO algorithms using population contour or sections, which are small, factional subsets of the best value. The formula (1) gives the updating of velocity for every particle in PSO algorithm.

$$V_i^d = € [v_i^d + c_1\, rand_1^d(pBest_i^d - x_i^d) + c_2\, rand_2^d\, (gBest^d - x_i^d)] \quad (1)$$

where, V_i^d indicates the velocity updation, € is Constriction factor, gBest is Particle's best position (global), x_i is the Current position of the particle, pBest is the particle's best position (local), w_{max}andw_{min}represents the maximum and Minimum weight (0.9 and 0.4), c_1 and $c_2$is the Constant value. Sum of both constants is 4.1

ARTIFICIAL FISH SWARM OPTIMIZATION

The next behavior of artificial fish mainly depends on its present state and ecological conditions. Aimless action indicates the initialization phase of the algorithm. The next step is a 'visual scope' of the Artificial Fish Swarm optimization algorithm. An elemental organic attitude of any creatures is to search of food, either by their eyes or through sensibility [10].

- Whenever the visual scope of fish is find empty, and there are no other fish to lead, current fish takes the random tour in searching of better position.
- Whenever the visual scope is hammed the fish failed to follow any single leader and takes random movement and searches for a better region.
- Whenever the visual scope is not hammed the fist chooses among two choices: to swarm energetic towards the best position.

$$X_i^v = X_i + \text{Visual. rand ()} \quad (2)$$

$$X_{next} = X + \frac{Xv - X}{||Xv - X||}. \text{ Step. rand ()} \quad (3)$$

The formula 2 and 3 gives the fish current position velocity and next step position and velocity updating respectively. Where, rand() indicates the random number between 0 and 1, X_i is fish Current position of fish, X_{next}represents the next before position of fish, Step indicates the Step length of the fish.

SWALLOW SWARM OPTIMIZATION

Extensive design of this new optimization technique is motivated by the swallow swarm intelligence. There are three types of particles in this algorithm, they are

- Explorer particle (e_i)
- Aimless particle (o_i)
- Leader particle (l_i)

Those particles moves in parallel to each other and keep interaction with one another. Every particle in the colony (each colony can be consisted of some sub colonies) actively participate in obtaining the better situation all the time. Each particles behavior is briefly explained below.

- **Explorer particle**

These particles beset the major population of the colony and their main responsibility is to analyze the space problems. When the swallow reaches an extreme point that is best solution, using a contrasting sound it pays the attention of the group toward there. Suppose that place is the leading solution for the entire problem they act as a Head Leader (HL). On the contrary, if the particle is in a favorable position in parallel with its neighboring particles, it is enforced as a local leader (LL) or else, each explorer particle e_i respecting their velocities of both

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leaders V_{HL} (velocity vector of particle toward HL), V_{LL} (velocity vector of particle toward LL), and competence of reaction of these two manner makes an extensive move.

- **Aimless particle**
The aimless particles do not follow their leaders. They do not have good position with the other particles. They take random movement in search of food. In case of food founded, they make different calls and pay the attention of other particles towards them.

- **Leader particle**
The Leader particles always guide the explorer particles. There exists two leaders in swallow swarm algorithm, one guides the local particles within the colony is the Local Leader. Another one guides the entire particle in progress is the Head Leader. The Head leader is the best leader. The forward movement of the velocity of leaders are given below

$$V_{HLi+1}=V_{HLi}+\alpha_{HL}\text{rand}()(e_{best}-e_i)+\beta_{HL}\text{rand}()(HL_i-e_i) \quad (4)$$

$$V_{LLi+1}=V_{LLi}+\alpha_{LL}\text{rand}()(e_{best}-e_i)+\beta_{LL}\text{rand}()(LL_i-e_i) \quad (5)$$

where,V_{HL} represents the Velocity of Head leader whereas V_{LL} represents the velocity of Local Leader and e_{best} represents the best position of the explorer particle and

e_i indicates current position of the explorer particle.

Update the velocity using the formula,

$$V_{i+1} = V_{HLi+1} + V_{LLi+1} \quad (6)$$

The particle value is updated as,

$$e_{i+1} = e_i + V_{i+1} \quad (7)$$

SCHEDULING AND PERFORMANCE METRICS

Resource management and job scheduling are very important and complex problems in grid computing environment. It is necessary to do resource state prediction to get proper job scheduling. Swallow Swarm algorithm is a new heuristic algorithm. The inherent parallelism and scalability makes the algorithm very suitable to be used in grid computing resource optimization whose structure is dynamic changed almost all the time. Here scheduling process is done as, the jobs execution time is given as an input to all three optimization algorithms. Every job is scheduled to the optimized resources to get minimum execution time in a
resource.

In order to produce a good schedule, estimating the performance of tasks on resources is crucial, especially for constructing a preliminary workflow schedule. By using performance estimation techniques, it is possible for workflow schedulers to predict how jobs in a work flow will be have on distributed heterogeneous resources and thus make decisions on how and where to run them. As indicated above, there are several performance estimation approaches: Time consumption, Delay rate, Transmission speed, Energy consumed and Accuracy predicted by each optimization technique.

RESULTS

In our experiments, Particle Swarm Optimization (PSO) and Fish Swarm Optimization (FSO) algorithms along were used to compare with a new method Swallow Swarm Optimization (SSO). Specific parameter settings of all the considered algorithms are described in **Table-1**. Each experiment (for every algorithm) was repeated 100 times with different jobs completion time as input value. The input file is converted into the comma separated value file and feed into each optimization methods for evaluating their performance.

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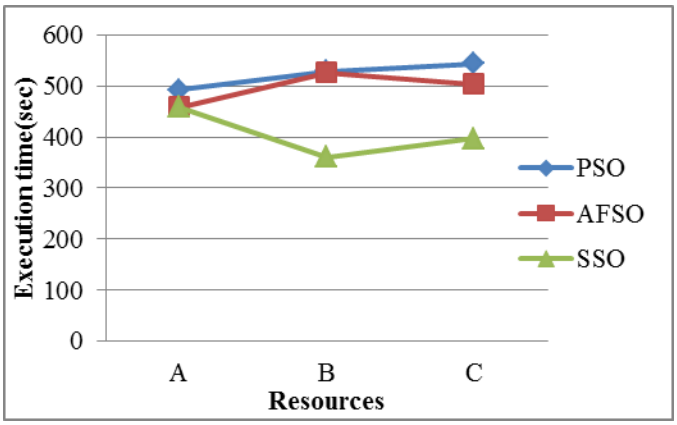

Fig: 2. Minimum execution time for job scheduling

In a grid environment, the main emphasis was to generate the schedule as fast as possible. So the completion time for 100 trials was used as one of the criteria to improve their performance. First from the given 7 resources say 3 resources is selected using optimization algorithm to execute jobs in minimum time. The total time for executing the job in three resources A, B and C is given in the **[Figure-. 2]** the PSO has higher execution time since they have lower convergence rate in large scale applications. FSO gives the next higher execution time in large values. SSO on contrary executes all jobs in minimum time interval, thus obtained to be the optimal algorithm from three methods. They produce good results with the large scale applications.

Table: 1. Minimum execution time for job scheduling

#	A (sec)	B (sec)	C (sec)
PSO	493	529	544
FSO	459	526	504
SSO	459	361	397

Performance Estimation

- **Time consumption**
  The jobs are distributed according to the time frame assigned to the jobs. Increasing time or decreasing time algorithm may be one of the examples of time based scheduling. Algorithm with higher convergence rate consumes more time. On the other hand algorithm with lower convergence rate algorithm consumes less time to find the optimal solution. **[Figure-3]** shows that PSO method consumes more time than FSO and SSO consumes very less time which is considered to be the best result.

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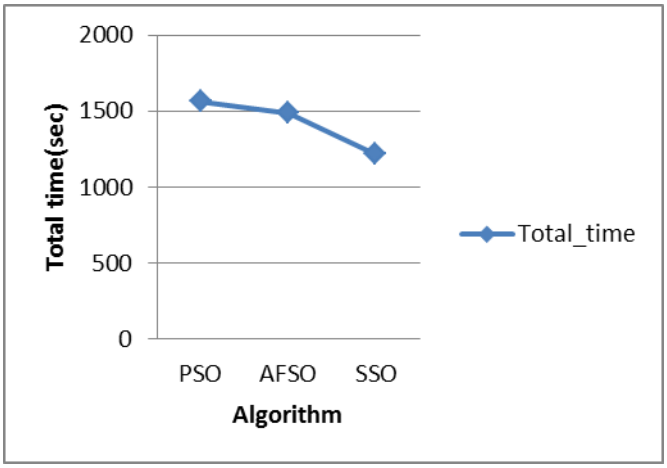

Fig:3. Time consumed by three optimization algorithms

- **Delay**

  A delay is a period of time by which getting the optimal solution is postponed. **[Figure -4]** shows that PSO algorithm with less delay indicates that the particles gets stuck at the local minima points very easily. The high delay value in SSO algorithm indicates that SSO do not get stuck at the local minima points easily because they have two leaders head leader and the local leaders to guide the explorer particles.

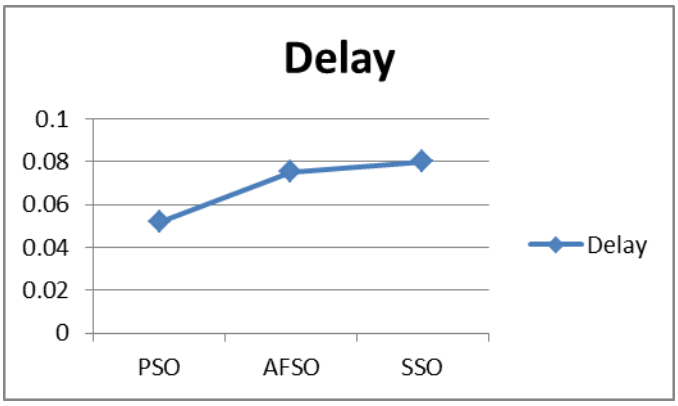

Fig:4. Delay time of optimization algorithms

- **Transmission Speed**

  The rate at which the algorithm finds the optimal solution that is, one best particle from the given number of particles. **[Figure -5]** shows the transmission speed of each algorithm to get the best result. Lower the transmission speed higher the standard of the algorithm. Here PSO and FSO methods require more speed to converge the optimal solution than to the SSO method which executes in less transmission speed.

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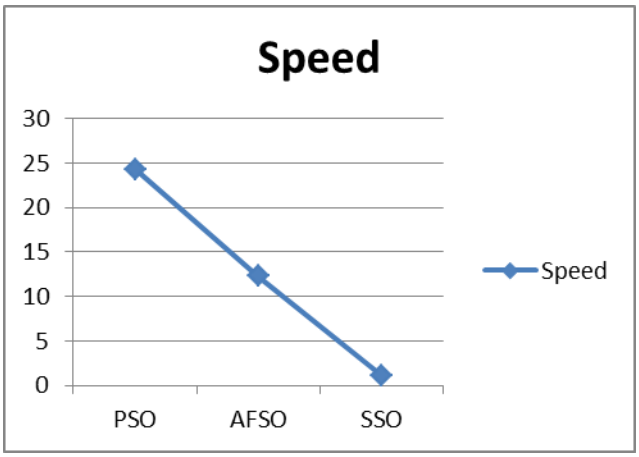

Fig: 5. Transmission speeds of optimization algorithms

- **Energy**

Virtue of the particles position to obtain the optimal solution. **[Figure -6]** shows that the new optimization method SSO requires less energy than to the other optimization methods.

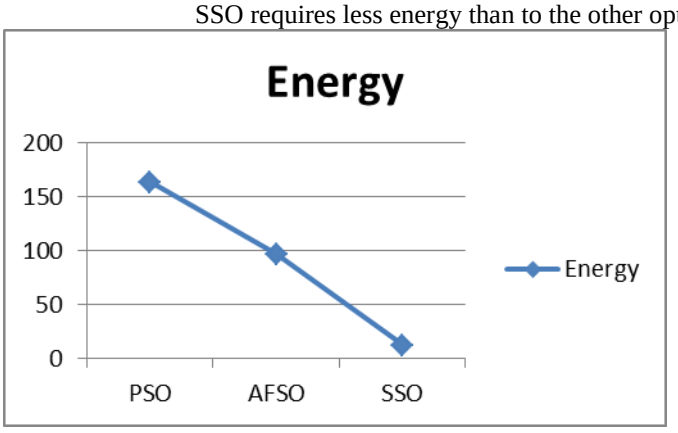

Fig: 6. Energy consumed by three optimization algorithms

CONCLUSION AND FUTURE WORK

The proposed work is designed for comparing the behavior of optimization techniques in two forms. Firstly, Scheduling in which the jobs are executed in the optimized resources in order to save the time. Finally, the results are compared to estimate the best optimization technique that have high convergence rate and do not easily get stuck at the local minimum points. Secondly, Performance measure of all techniques is compared which includes various characteristics in terms of Time consumption, Delay rate, Transmission Speed, Energy consumed and Accuracy. On comparing results of three optimization methods, Swallow Swarm optimization algorithm proves to be even faster than the other two algorithms in having higher convergence rate and particles do not get stuck at the local minimum points easily, because there is more number of particles that follow their leaders. Unlike other optimization methods that have a one head leader here we have two leaders, one for local and other for global guidance to achieve the optimal solution even faster. The future work of this paper can be hybridization of SSO with other techniques gives better results and implementing SSO algorithm in other grid computing areas.

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CONFLICT OF INTEREST

The authors declare no conflict of interests.

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The authors report no financial interests or potential conflicts of interest.

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