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Hybridization of GA and Back-Propagation for Load Balancing in Grid System

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Abstract : Load Balancing is an important factor in a grid system to improve the global throughput of Grid Resources. Load balancing using genetic algorithm in grid systems improves the response time and the resource utilization and very effective in term of scalability. The proposed algorithm uses the GA to determine the weights of a multilayer feed-forward network with back-propagation learning. Conventional back-propagation networks make use of gradient descent learning to obtain their weights. However, there remains the problem of the network getting stuck in local minima. This problem is solved by combining the back-propagation with genetic algorithm. In this we find global minima without getting stuck at local minima. Hence, this paper integrates the Genetic algorithm and Back-propagation for effective load balancing in grid system.

Keywords: Back-Propagation, Genetic Algorithm, Grid, Load Balancing.

INTRODUCTION

A Grid computing is self-managing virtual computer out of a large collection of heterogeneous systems that share various resources among each other. Due to the sharing of resources among different computers in grid, the complexity of managing the resources in grid is increased. To handle this problem there is some load balancing scheme that balances the load across all the processors.

Many algorithms have been used to solve the problems, such as, Genetic algorithm (GA), simulated annealing, heuristic algorithm, ant colony algorithm, tabu search procedure, particle swarm optimization, etc.

A Genetic Algorithm (GA) is a search heuristic algorithm based on the principles of natural selection and natural genetics. GAs combines the exploitation of past results with the exploration of new areas of the search space. Simulated annealing is a meta-heuristic algorithm for the global optimization problem of locating a good approximation to the global optimum of a given function in a large search space. It is often used to find the good solution in a fixed amount of time, rather than the best possible solution. Tabu search is a meta-heuristic local search algorithm that can be used for solving combinatorial optimization problems. It takes a potential solution to a problem and checks its immediate neighbors to find an improved solution. The ant colony-optimization algorithm (ACO) is probabilistic techn ique for solving computational problems which can be reduced to finding good paths through graphs. Particle swarm optimization is a member of ant colony optimization.

Hybridization of GA with these entire algorithm has been also done [1],[2],[3],[4],[5]. The work here is aim to combine GA with neural network (back-propagation). Genetic Algorithms are powerful search and optimization methods based on the concepts of natural selection and natural evaluation. GAs are applied for those problems which may contain noisy or irregular data or it take so much time to solve or it is simply impossible to solve by the traditional computational methods. Back-propagation is a gradient method and there is no guarantee at all the global minimum of error surface can be reached.

GA can be used to train a multilayer perceptrons in which the weights are taken as a parameter space. The main advantage of using genetic algorithms for the training of feed-forward neural networks is that they can find global minima without getting stuck at local minima. So, this paper proposes a load balancing algorithm based on hybridization of GA with Back-propagation technique of neural network.

RELATED WORK

Load balancing has been an active field of research for over a decade. Substantial amount of work has been done on various platforms viz. shared memory systems, distributed memory multiprocessors, clusters, multi-clusters and grid.

Pratibha and Manoj [6] proposed an approach to finding the global optimum in a space with many local optima is a classic problem for all systems that can adapt and learn. GA provides a comprehensive search methodology for optimization. GA is applicable to both continuous and discrete optimization problems. In global optimization scenarios, GAs often manifests their strengths: efficient, parallelizable search; the ability to evolve solutions with multiple objective criteria and controllable process of innovation.

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To enhance the capability of GA more has been done on hybridization of genetic algorithm with other algorithm.

Jula, Khatoo and Naseri [5] proposed a approach to Solve Grid Task Scheduling Problem. In this proposed approach gravitational attraction search as a local search algorithm has been associated to genetic algorithm to enhance its capability to search more intelligent in problem search space and achieve accurate response in less time. Comparing HYGAGA and genetic algorithm results asserts significant enhancement in the performance of search algorithm.

Edson, Iamashita, Frederico, Arica [9] proposed the genetic technique, for solving complex integrated offshore gas planning problems. This is a large quadratic mixed-integer problem, where non-convexity and non-differentiability is found. The results of this paper shows that the performance of this approach is very good and its results very close to exact solutions. This algorithm could be used for sizing and optimizing designs of gas pipeline networks and also for the gas transmission planning of an existing network for profit maximization.

Belhadj, Duwaish, Shwehdi and Farag [10] proposed the paper in which a Neural Network-Based method is used for on-line voltage stability estimation, prediction and monitoring at each power system load bus. Tie-training of the Radial Basis Function Neural Network (RBF") was accomplished by using load flow voltage magnitude and phase as input information, and fast indicators of voltage stability infonnation covering the whole power system and evaluated at each individual bus as output layer information. The generalization capability of the designed Networks under large number of random operation conditions and for several power systems has been tested. Fast performance, accurate evaluation and good prediction for the voltage stability margin have been- obtained. Results of tests conducted on standard IEEE 14-bus test system are presented and discussed.

This paper is focused balancing the load in grid using genetic algorithm and back-propagation technique.

PROPOSED POLICY

A.Grid Model

In the model, grid sites are clustered into regional grids which contain a set of meta-schedulers connected to each other through internet and meta-schedulers are organized in a fully decentralized fashion as shown in Fig. 1. All requests from users are directed to the meta-scheduler which further selects the feasible resources from its region for these tasks. Load on each resource is managed by proposed policy in which genetic algorithm combine with back-propagation.

B.Load Balancing

the In the proposed policy, the genetic algorithm is used as a search technique based on the concept of the survival of the fittest. In this hybrid approach the weights of the neural network are calculated using genetic algorithm approach. From all the search spaces of all the possible weights, the genetic algorithm will generate new points of the possible solution.

When a task is submitted by user to the meta-scheduler, it select the site according to the task submitted by the user. This is done using the Genetic algorithm, where the weight of all tasks is calculated.

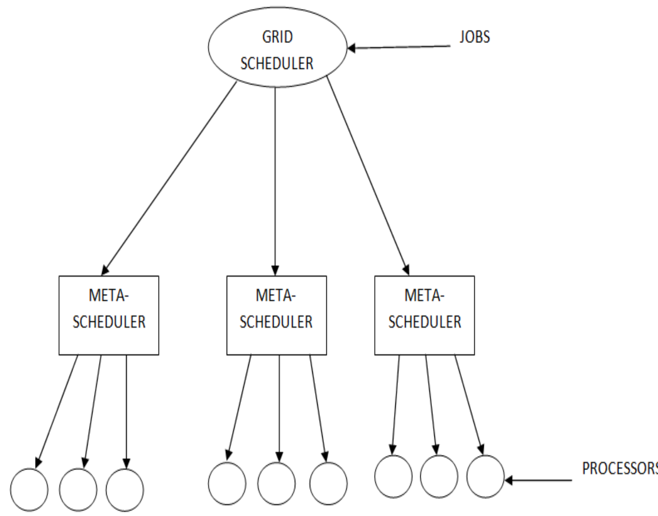

Fig. 1: Grid System

After that the calculated weights are trained using the neural network technique Back-propagation, where the two steps (1) Feed Forward Propagation (2) Backward Propagation are performed.

In the first step, Output from the Hidden layer is calculated as:

$$H_o = \phi\,(\textstyle\sum_{i=0}^{n} x_i . w_{ij} - \Theta_j),$$

Where n is the no. of inputs, ϕ is thresholding function, w_{ij} is the weights from input to hidden layer and Θ_j is threshold value of hidden layer.

Output from the Output layer is calculated as:

$$O_o = \phi\,(\textstyle\sum_{i=0}^{n} x_{jk} . w_{jk} - \Theta_k),$$

Where m is no. of inputs k from output layer, w_{jk} is weights from hidden to output layer, Θ_k is threshold value of output layer.

In the second step, Error is calculated as:

$$E = (\text{Threshold value} - R_o)$$

And adjustment of weights and biases is done by changing the weights on output layer and hidden layer. This is called a back-propagation.

After the training process, fitness function using [11] is calculated:

Calculate the busy time for all resources of each schedule as:

$$B\_Time\ (i, j) = \max_t\{R\ (i, j, k, t)\},\quad \text{for } 1\le i\le n,\quad 1\le j\le G,\quad 1\le k\le m$$

Calculate the makespan for all resources of each schedule as:

M_Span (j) = max {B_Time (i, j)}

Calculate the utilization for all resources of each schedule as:

Ut (i, j) = B_Time (i, j)/ M_Span (j)

Calculate the average utilization for all resources of each schedule as:

A_Ut (j) = $\sum_{i=0}^{n} Ut$(i, j)/n

After calculating the fitness function, make a mating pool in decreasing order according to fitness value of processors. After that apply the genetic operator Crossover and Mutation to balance the load of sites. The proposed Load balancing process can be explained using the algorithm whose pseudo code is given below.

```
Algorithm Load_Bal_GABP
  Set numbers of generations G for genetic optimization of weights (generation size=G)
        Set generation count as g=0
    Generate initial population pg, where 0 ≤ g ≤G
 for g= 0 to  G do
    Extract weights for each of the population pg
    Initialize training process
        Get extracted weights and initialize threshold value.
        Feed Forward propagation(input & hidden layer)
            Calculate the output from the Hidden layer
            Calculate the output from the Output layer
            Calculate the error
        The Backward propagation of the error and adjustment of the weights and biases
    Calculate the Fitness Function
        Calculate the busy time for all resources of each schedule
        Calculate the makespan for all resources of each schedule
        Calculate the utilization for all resources of each schedule
        Calculate the average utilization for all resources of each schedule
  Get the mating pool ready: add the population in decreasing order
  Apply Genetic operators
            Reproduction
            Crossover & Mutation
 End for
Training is complete. Extract optimized weights from converged population pg.

End for
```

CONCLUSION

In back-propagation networks, there is the problem of the network getting stuck in local minima. This problem is solved by combining the back-propagation with genetic algorithm. In this we find global minima without getting stuck at local minima.

This paper proposes a hybrid GA-BP technique for balancing load in grid system. In this paper, the main goal of the scheduler is to balance the loads placed on the various processors and another goal is to scheduling itself. In hybrid GA-BP technique, genetic algorithm is used to extract the weights for each scheduler and then back-propagation technique is used for training process.

In future a test bed will be used to evaluate the performance of the proposed scheduling technique.

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