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Adaptive job Scheduling for Computational Grid based on Ant Colony Optimization with Genetic Parameter Selection

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Abstract

Demand of new generation of internet technology applied a distributed process of computing for service providing and resource allocation. The service and resource allocation needed a computational grid for task processing. Computational grid manages a process of resource and task allocation process. The allocation of resource and task effect the performance of grid mechanism. For the scheduling of task and resource for computational grid used a queuing process model such as first come first served process. But the performance of this model is very impartial, now various authors and researchers used a process of efficient searching technique for job allocation such as heuristic and meta-heuristic improved the performance of computational grid. But the uncontrolled nature of meta-heuristic such as ant colony optimization degraded the performance of grid allocation. In this paper we proposed a controlled mechanism of ant colony optimization with genetic algorithm for task scheduling in computational grid. For the performance evaluation of computational grid we used 6 *6, 10*10 and 20 *5 grid parameter and the measurement of performance in terms of job completion and failure of job. Our empirical evaluation shows that better performance instead of ANT and PSO scheduling technique.

Keywords

Grid computational, meta-heuristic, ANT-GA

1. Introduction

Grid computing overcomes the limitation that subsists in conventional shared computing mood, and becomes a principal trend in distributed computing system.

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Grid core service is the Centrum of entire grid computing which takes charge of entire grid system in order to ensure grid system work effectively, it is an important part of grid computing, and task scheduling technology is a part of grid core service technology. When grid resources are required by lots of tasks, the system can optimize the resources only by scheduling the tasks reasonably.

By harmonizing and distributing the grid resources efficiently, an advanced task scheduling strategy can reduce total run time and total expense greatly and bring an optimal performance, which makes the task scheduling strategy a key technology to grid computing [1] .Grid computing is a type of distributed computing that involves coordinating and sharing computational control, data luggage compartment and network assets across dynamic and purely widely dispersed cluster. It allows the management of diverse, physically distributed and with dynamism available computational resources which may belong to different individuals and institutions to solve large-scale scientific applications. The acquiring information of grid resources are two types grid resource monitoring and grid resource forecast. Grid resource state monitoring cares about the running state, distribution, load, and fail of resources in a grid system by means of monitoring strategy[3]. Grid resource state prediction focuses on the variation trend and running track of resources in a grid system by means of modeling and analyzing historical monitoring data. chronological information generated by monitoring and future variation generated by prediction are combined together to feed a grid system for analyzing performance, eliminating bottleneck, diagnosing error, and maintain active load assessment, thus, to help grid users obtain desired computing results by efficiently utilizing system resources in terms of reduced cost, improved performance, or trade-offs between outlay and routine[9]. To reduce overhead, the goal of designing a grid resource monitoring and prediction system is to achieve seamless fusion between grid technologies and efficient resource monitoring and prediction strategies [4]. The Grid applications use resources such as processors in multiple clusters simultaneously. So they need processor co-allocation. With this processor co-allocation, the execution time of grid applications may increase because of communication overhead and heterogeneity among clusters. Despites this drawback, Co-allocation provides lower average job response times. In current scenario, a number of task scheduling algorithm such as genetic algorithm and ant colony algorithm improve capability of grid computing to some extent [6]. In particular, in most case, some of computation intelligence techniques are combined together, so that they can perform more powerfully in solving problem. analyses the advantages and disadvantages of ant colony algorithm and genetic algorithm at different stage particularly and present a new scheduling strategy, this strategy form the initializing key quickly at former stage by utilizing genetic algorithm until meets the terminating condition and transforms the key into pheromone needed by ant colony algorithm, subsequently makes use of the character of ant colony algorithm to find the optimal result rapidly. The rest of paper is organized as follows. In Section 2 discuss related work of grid resource allocation. The Section 3 proposed METHOD for ANT-GA selection. The section 4 discusses experimental result and finally followed section 5 conclusions and future scope.

2. Related Work

In this section we discuss some related work for resource allocation and task scheduling of grid computing in terms of process optimization for reduces the time span for execution of time and reduce communication overhead of grid computing. An algorithm for scheduling of jobs in grid environments was investigated by Lorpunmanee et al. [6] as an optimization problem. The proposed algorithm developed a framework for scheduling using the current status of resources and a cost model for minimizing the total tardiness time of a job. Ant Colony Optimization algorithm was used in the algorithm to make an efficient resource assignment for each job being processed. A scheduling decision was found for every resource to allocate to a task thereby minimizing delay of execution beyond the expected time when the job was scheduled in the system.

Chtepen et al. [7] proposed a fault-tolerant algorithm based on the methods of checkpointing and replication. Dynamic Scheduling in Distributed Environments (DSiDE), a grid simulation environment was newly developed based on several adaptive heuristics. It allowed modeling of a dynamic system with dynamic job behavior more easily. To improve system performance, various system characteristics such as failure frequency, submission pattern of jobs, system load etc. was considered. With varying loads, the DSiDE was evaluated and it was shown that the average job execution time was minimized.

In [8], the authors presented a tree-based model to represent any Grid architecture into a tree structure. The model takes into account the heterogeneity of resources and it is completely independent from any physical Grid architecture. However, they did not provide any job allocation procedure. Their resource management policy is based on a periodic collection of resource information by a central entity, which might be communication consuming and also a bottleneck for the system.

In [9], the authors proposed a ring topology for the Grid managers which are responsible for managing a dynamic pool of processing elements (computers or processors). The load balancing algorithm was based on the real computers workload.

In [10], the authors proposed a hierarchical structure for grid managers rather than ring topology to improve scalability of the grid computing system. They also proposed a job allocation policy which automatically regulates the job flow rate directed to a given grid manager.

In [11], the authors consider a hierarchical tree structure for grid computing services similar to ours. However, they have not proposed any task allocation procedure. Their resource management strategy is based on a periodic collection of resource information by a central entity, which is communication intensive. In our algorithm, resource information collection is done only when it is needed. Jiang Chen et al. [12] have introduced a grid resource scheduling algorithm which is based on utility function. This algorithm was proposed to solve the issue of heterogeneity of user requirements in grid resource allocation, by examining the relationship between the execution time, cost and the user utility function. The algorithm accomplishes superior performance in terms of cost than the time based optimization algorithm and also in terms of time than the cost based optimization algorithm, when they consumed equal amount of time and cost.

Juan Chen and Bin Lu [13] have presented a new grid resource scheduling algorithm that augments the consumption of resources and system throughput, and in addition, accomplishes the load balancing and utility optimization between resource providers and users inside the grid systems. They have described the diverse functional parts of the proposed algorithm and conducted two types of simulative experiments about completion time and cost of tasks. It is experimentally shown that the proposed algorithm is efficient. Li Chunlin [14] has utilized the interlayer coupling of a cross-layer design concept in grid computing. They have proposed a joint application and fabric layer resource scheduling algorithm that merges the benefits of both the application-centric and the system-centric scheduling. They have devised an integrated design of resource scheduling and user QoS satisfaction control into a constrained optimization issue. The application layer alters the user's resource demand which is based on the current resource settings, and the fabric layer assigns CPU, storage and bandwidth as needed by the upper layer in an adaptive way.

3. Proposed Method for Adaptive Task Scheduling

The idea of ant colony genetic algorithm is to use the genetic algorithm to choose, the selection of pheromone update (increment and decrement of constant deposit of interval value of phenomenon) parameters of ant colony optimization to control the sensitive value. For a given scheduling task the problem of resource selection can be stated as follows: given the original set, F ,of n resources, find subset S ,which consists of m resources($m < n, S c F$),such that the scheduling accuracy is maximized. The resource selection representation exploited by artificial ants includes the following:

1. n Resources that constitute the original set, $F = \{r_1 .... rn\}$.
2. A number of artificial ants to search through the resource space (na ants).
3. τ_i , the intensity of pheromone trail associated with resource f_i ,which reflects the previous knowledge about the importance off_i.
4. For each ant j , a list that contains the selected resource subset, $R_j = \{R_1 .... R_m\}$.

We proposed to use a hybrid evaluation measure that is able to estimate the overall performance of subset as well as the local importance of resources. A scheduling algorithm is used to estimate the performance of subset .On the other hand, the local importance of a given resources measured using the correlation based evaluation function, which is a filter evaluation function. In the first iteration, each ant will randomly choose a resource subset of m resources. Only the best k subsets, $k < na$, be used to update the pheromone trail and influence the resource subset of the next iteration. In the second and following iterations, each ant will start with $m - p$ resources that are randomly chosen from the previously selected $k -$ best subsets, where p is an integer that ranges between 1 and $m - 1$. In this way, the resources that constitute the best k subsets will have more chance to be present in the subsets of the next iteration. However, it will still be possible for each ant to consider other resources as well. For a given ant j, those resources are the once that achieve the best compromise between pheromone trails and local importance with respect to S_j , where S_j is the subset that consists of the resources that have already been selected by ant j. The Updated selection Measure (USM) is used for this purpose the defined as:

$$USM_i^{S_j} = \begin{cases} \dfrac{(\tau_i)^\alpha \left(LI_i^{S_j}\right)^\beta}{\sum_{g \notin S_j} (\tau_g)^\alpha \left(LI_g^{S_j}\right)^\beta} & if \quad i \notin S_j \\ 0 & otherwise \end{cases} \qquad (1)$$

Where $LI_i^{S_j}$ is the local importance of resource f_i given the subset S_j.The parameters α and β control the effect of pheromone trail intensity and local resource importance respectively. $LI_i^{S_j}$ is measured using the correlation measure and defined as:

$$LI_i^{S_j} = \frac{|C_{iR}|}{\sum_{f_s \notin S_j} [C_{is}]} \qquad (2)$$

Where $|C_{iR}|$ is the absolute value of the correlation between resource $i(f_i)$ and the response (class) variable , and $|C_{is}|$ is the absolute value of the inter-correlation between resource $i(f_i)$ and resource $S(f_s)$ that belongs to S_j

Below are the steps of the algorithm:

1. Initialization:

- Set $\tau_i = cc$ and $\Delta\tau_i = 0, (i = 1, ..., n)$,where cc is a constant and $\Delta\tau_i$ is the amount of change of pheromone trail quantity for resource f_i.
- Define the maximum number of iterations.
- Define , where the $k - best$ subsets will influence the subsets of the next iteration.
- Define , where $m - p$ is the number of resources that each ant will start with in the second and following iterations.

1. If the first iteration,

- For$j = 1\ to\ na$,

- Randomly assign a subset of m resources to S_j.
- Goto step 4.

2. **Select the remaining p resources for each ant:**

- For $mm = m - p + 1 \; to \; m$,
- For $j = 1 \; to \; na$,
- Given subset S_j, choose resource f_i that maximizes $USM_i^{S_j}$
- $S_j = S_j \cup \{f_i\}$.

- Replace the duplicated subsets, if any, with randomly chosen subsets.

3. **Evaluate the selected subset of each ant using a chosen scheduling algorithm:**

- For $j = 1 \; to \; na$,
  - Estimate the Error (E_j) of the scheduling results obtained by classifying the resources of S_j.
- Sort the subsets according to their E. Update the minimum E (if achieved by any ant in this iteration), and store the corresponding subset of resources.

4. **Using the resource subsets of the best *k* ants, update the pheromone trail intensity:**

- For $j = 1 \; to \; k$, /* update the pheromone trail */

$$\Delta\tau_i = \begin{cases} \dfrac{\max\limits_{g=1:k}(E_g) - E_j}{\max\limits_{h=1:k}\left(\max\limits_{g=1:k}(E_g) - E_h\right)} & if \;\; f_i \in S_j \\ 0 & otherwise \end{cases} \quad (3)$$

$$\tau_i = \rho.\tau_i + \Delta\tau_i \quad (4)$$

Where ρ is a constant such that $(1 - \rho)$ represents the evaporation of pheromone trails.

5. **If the number of iterations is less than the maximum number of iterations, or the desired E has not been achived, initialize the subsets for next iteration and goto step3:**

- For $j = 1 \; to \; na$,
  - From the resources of the best k ants, randomly produce $m - p$ resource subset for ant j, to be used in the next iteration, and store it in S_j.
- Goto step 3.

Table 1: resource characteristics

Parameter	Value
Length	0-5000MI
Matrix size	100
Output Size	200
Total number of jobs	40,140,150

4. Experimental Result

The MATLAB software allows modeling and simulation of entities in parallel and distributed computing systems users, applications, resources, and resource brokers (schedulers) for design and evaluation of scheduling algorithms. It provides a comprehensive facility for creating different classes of heterogeneous resources that can be aggregated using resource brokers for solving compute and data intensive applications. We used this simulation software to evaluate our algorithm performance. We create 6 *6, 10*10 and 20*5 grid model for simulation task. For the validation of our proposed model compare with RJA(FCFS), PSO in terms of job completion and failure of job. For experimental task some standard parameter are used such as resource characteristics and job characteristic. The job and resource table give below in table 1 and 2.

Table 2: job characteristics

Parameter	Value
Number of machines per resource	1
Number of PEs per machine	1-5
Load	100%
Total number of resources	36,100,125

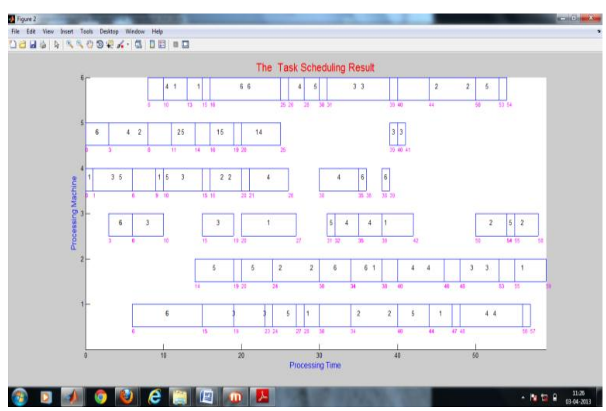

Figure 1: shows that result of task scheduling of given grid in make span time 60

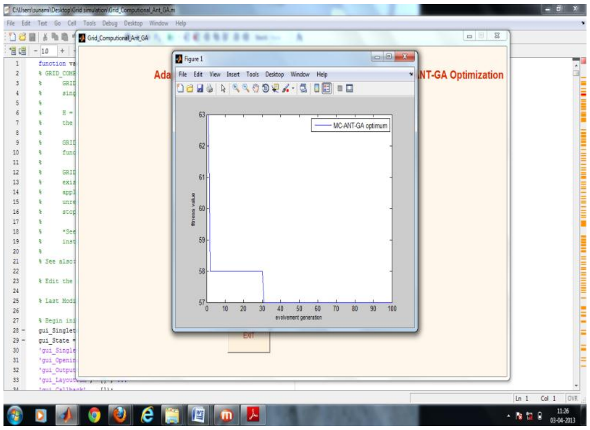

Figure 2: shows that result of task scheduling of given grid in make span time 60 over ANT-GA allocation plan for execution of job

Table 3: shows that performance evaluation of grid task scheduling in given method

Grid	method	Job failure	Job completion
6 *6	RJA(FCFS)	5.50	11.83
	MC-ACO	4	49.50
	MC-POS	43.50	54
	MC-ANT-GA	3.5	87.50
10 *10	RJA(FCFS)	12.50	26.36
	MC-ACO	8.90	78.6
	MC-POS	12.34	86.34
	MC-ANT-GA	4.56	91.02
20*5	RJA(FCFS)	20.12	50.34
	MC-ACO	15.65	80.32
	MC-POS	19.23	79.0
	MC-ANT-GA	6.06	93.32

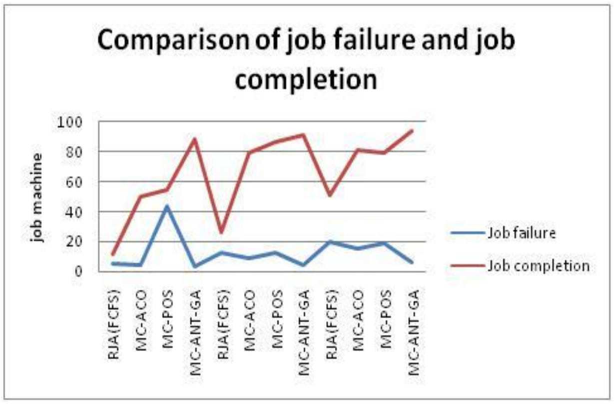

Figure 3: shows that result of task scheduling of given grid in make span time 60 over all allocation plan for execution of job technique

5. Conclusion and Future Work

In this paper we proposed a novel method for job scheduling in grid computing using ANT-GA. We analyzes the results in research and puts forward a new grid task scheduling strategy. The grid task scheduling algorithm based on the use of genetic algorithm and ant colony algorithm achieves better results than the grid task scheduling algorithm only built on ant colony algorithm. We expect this algorithm is applied to the actual task of scheduling grid, to obtain a more reliable and effective results rather than built on the model on the basis of a priori.

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