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The application of Ants' society algorithm for Management of resources in continuous bilateral auction

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ABSTRACT

Background: The main purpose of this paper is to improve the efficiency of grid computing by means of Ants' society algorithm. Application of this algorithm in various problem led to an improvement in efficiency and reduction in processing time. This enables us to use this algorithm in grid computing. Economic solutions in the field of management of heterogeneous resources for grid computing showed significant performance. The main idea was economic solutions for product exchange in market. This paper aims to introduce a new method for bilateral auction scenario by means of genetic algorithm (GA). In this method, by making resources intelligent, we move the packages of call for proposal so that it can reduce response time as well as being able to supply resources with lower prices. For simplicity in controlling packages, we used the network structure in implementation. Applied structure includes routers and communication of users and auctioners and auctioners and resources owners. The method was implemented using GridSim simulator. This is an open source software written in Java programming language. Results reveal that the method of bilateral auction using GA reduces sale stages and consequently leads to faster responding to requests and also resources are supplied with a lower cost.

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INTRODUCTION

Grid computing allows execution of processing in a large scale of data. That is, it divides data into smaller portions and broadcasts each portion to a specific computer in the network. In simpler words, grid computing is an architecture for parallel and simultaneous processing in which CPUs of computers which are the sources of computation are extended under a network. In this way, all machines of the network perform as a supercomputer. In other words, grid computing is a set of resources which perform from various points for accomplishing an objective (Taheri, J., 2013). Each of these grid environments can be considered as a distributed system which interacts with other networks and covers a great deal of data. Of the benefits of this method over clustering method (Gkoutioudi, K., H.D. Karatza, 2010) is that it can be located in various geographic points in an asymmetric manner. According to distribution of datasets, selection of computational resources and data resources must be appropriate so that it can minimize the overload resulted from transferring these sets to the grid (Goa, Y., 2005). In this paper, the issue of timing programs requiring data is taken into account. Since optimal timing demands selection of appropriate resources, in grid computing, environments are dynamic; that is, resources may be turned on in a while and turned off in other times. Moreover, these computations can be different with respect to hardware and software. Ants' algorithm is a heuristic one with optimal local search which is utilized in combined problems (Chang, R.S., 2009). This method is inspired by natural behavior of ants. In nature, ants excrete a chemical called pheromone by which they show the way to other ants. In many researches, hard NP problems are solved by means of ants' colony method. This method is used for solving problems such as itinerant seller (Yang, J., 2008; Mavrivounitis, M. and S. Yang, 2013; Chen, S.M. and C.Y. Chien, 2011), graph painting (Chen, S.M. and C.Y. Chien, 2011; Bui, T.N., 2008; Dowsland, K.A. and J.M. Thompson, 2008), and path finding (Cong, Z., 2013; Reed, M., 2014; Xiao, Z. and W.J. Qing, 2012). Ants' society is a set of intelligent ants

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which act collectively. This group searches in environment to find the optimal solution. In issue of grid environments timing, each of these activities are considered as an ant. Each of these ants move toward their intended resources. Prioritization and timing are two of the main challenges in grid computing. The issue of timing in grid computing is composed of three parts: finding resources which can be utilized, collecting information about them and selection of the best of these resources. Activities are performed in this step. The issue of finding the best set of the resources is a NP-complete problem. N timing duties, there are two objectives: maximum efficiency and maximum output.

For the first objective, a method must be presented to reduce the processing cost and for the second objective, a method was be provided to divide the timing into a set of independent jobs. This leads to increase in capacity of the system for performance. To solve these problems, various methods are introduced. One of the methods is mapping the problem in itinerant seller problem. In this method, the path of resources to each other is important. In grid computing, since resources are in different and asymmetric distances, this method can be useful in many cases. The main purpose of this work is to improve the efficiency of grid computing by means of ants' algorithm. Using these algorithms in many cases led to an increase in efficiency and reduction of processing time. This makes the application of the algorithm in grid computing possible.

Literature review:

In this section, we review important researches performed on grid computing. In (Cao, Junwei, 2002), a system based on factor for management of resources is introduced. One of the issues discussed in grid computing is management of resources. Scalability and adaptability of systems are important issues in design of systems. In the method presented in aforesaid paper, a hierarchy of factors for making them adaptive and scalable is used. In this method, factors are able to transfer information and interact with each other. Similar works are presented in (Meera, A., 2013; Rajni, 2013; Wu, J., 2011).

GA is used as well for grid computing (Dudy, L., 2007; Priya, 2007; Aggarwal, 2005). In this method, jobs are considered as chromosomes. Each of the chromosomes can be a solution for intended problem. Each chromosome is a list of n-elements in which position i represents the i^{th} job. Moreover, the value of each of the elements is between 1 and m which illustrates the processor assigned to the job. The algorithm stages are as follows:

- Population is first established with a certain number of chromosomes.
- An evaluation function valuates the chromosomes in this stage.

In this stage, we reproduce the population while now, chromosomes having higher value are selected. Moreover, two operations of crossover and combination are used for making divergence.

- The second stage of the algorithm is repeated until the intended solution is found.

Other works (Singh, S., 2013; Nesmachnow, S., 2012; Mrtino, V.D., 2004; Tantar, A.A., 2007; Kolodziej, J., 2011) are performed on grid computing using GA. In (Galstyan, A., 2004; Jianxin, Y., 2006), reinforcement learning is used for improvement of grid computing problems. One of the important issues in grid computing is the manner in which resources such as processor, bandwidth and so on are captured in a useful way taking into account the fact that existence of a central controller cannot be useful and resources may be present in grid. In this method, a system is considered as a set of heterogeneous learning factors. Furthermore, these factors share their resources if necessary (Jain, A., 2013). Resources are recognized based on their processing speed. Moreover, this system is capable of performing various jobs simultaneously. Each factor has a Q value which represents its past performance. Initially, factors select their jobs randomly and uncertain. Then, for new job, factors select the resource having the highest Q according to greedy algorithm. Function evaluating the Q is as follows:

It must be noted that the strategy of selecting resources is effective. If in a system, resources having high memory are in priority, then, it is possible that the performance of the system is lower compared to the case in which processing speed is more important.

Presented algorithm:

As stated earlier, one of the challenges in grid computing is the method of sharing and management of resources. By utilizing the method of product exchange, economic models provide a new way for solving this problem which is briefly described below:

- In use resources are priced in process. These prices are based on their efficiency and productivity. Another factor which must be taken into account is the supply and demand.
- The method of exchanging product between sellers and customers illustrates the inclusion of resources in model.
- Sellers can use decentralized method for timing of jobs.

In auction, auctioneers act to sell their resources. Customers express their intentions by providing proposals. Auctioneers seek the best prices according to method of auction. Characteristics of this method are as follows:

- a decentralized structure
- ease of implementation of regulations
- implementation of resources in an intelligent manner

auction model can itself be classified into various types:

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- English auction
- Dutch auction
- Unilateral auction
- Bilateral auction

There are three main elements in this model: seller, auctioneer and customer. Initially, user reports the job to auctioneers. Auctioneers are responsible for selling and control of jobs. Auctioneer agent has parameters such as: number of auction steps, method of auction and size of jobs.

In fig. 1, a general schematic of the method is provided. Users' demands are broadcasted through packages called call for proposal. These packages include intended price for getting the resources. In bilateral auction model, users broadcast their demands to resources owners and owners propose their resources to users. If one of the proposals of the users is consistent with owner proposal, exchange will be done. In literature of this topic, there are two types of bilateral auction: first type is interval auction. In this model, auction has a predetermined time in which it is only possible to submit demands and proposals. Second type is continuous with respect to time and demands and proposals can be submitted at any time. In this research, we applied this model for implementation. Request for receiving resources are announced through packages called call for proposal including proposed price for that resource. In proposed method, these packages are considered as ants. The main objective of this work is to present packages of call for proposal in such a way that it can be possible to get the intended resources in less stages of auction.

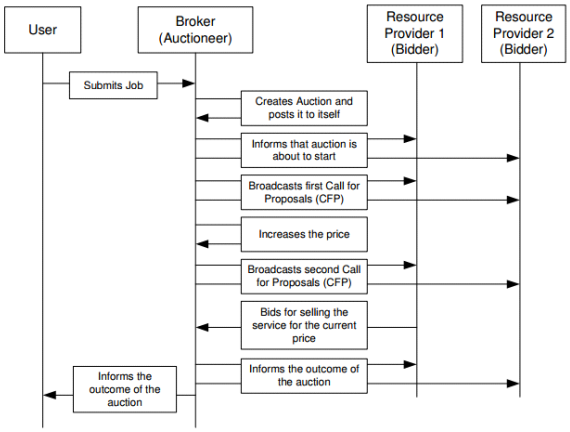

Fig. 1: general schematic of resources auction model.

In auction model in grid computing, following parameters are known before auction initiates: number of resources, number of users, and maximum number of stages of auction.

These factors remain unchanged during implementation and are static. For implementation, we consider the auction model based on a grid structure containing routers. All users are aware of the resources. Method of broadcasting demands is as follows: demands are broadcasted by users to auctioneers and auctioneers are responsible for:

- Broadcasting demands to resources owners
- Ending up the demands after exchange is accomplished

In performed implementation, there is only an auctioneer but we have several resources and users. Algorithm of prioritization of routers is based on the rule of "servicing first who comes first". Since all jobs are initiated simultaneously, classic timing algorithms (Xhafa, and A. Abraham, 2010; Chang, 2012; Xu, 2003) do not apply here. In this method, using ants algorithm and according to governing conditions, it is possible to perform auction in less stages and lower costs. In proposed algorithm, following parameters are used:

- A list of heuristic variables for selection of resources having higher value and lower price
- Factor of pheromone evaporation rate in basic formulation of the algorithm having a value between 0 and 1
- Sequence parameter for showing the usefulness of the path
- Each resource of the grid environment can have one or more machines whose number is one of the factors contributing to graph structure.
- A matrix including all values of the sequence, whose dimension is equal to the number of jobs and machines.

The values of heuristics corresponding to each resource is calculated using the following formula:

Value of heuristic for performing job i on machine j is the inverse of the required price. Value of the sequence is computed from the following formula:

Above relationship is applicable if the resource is not allocated to another user or job. Code corresponding to the algorithm is described below:

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- Initial valuation of pheromones
- Before finding the solution: New ants are produced until desired solution is found.
- For all ants: According to sequence value, ants perform the operation.
- For ant which finds the solution: Pheromone will be updated.

For implementing the intended algorithm, GridSim simulator is used. This software is written using Java. Software has the following utilities:

- Making resources nodes for processing
- Making machines for enabling processing in nodes
- Possibility of making several users and auctioneers
- Making auction models

General structure of the software is shown in figure below. Class of auction is used for initiating an auction. Class of auctioneer is used for making an auctioneer. For making packages Message class is used. These packages contain the proposed prices of the users. For receiving packages and reading their contents, Auction Observer class is used.

Results:

For implementation of proposed method, GridSim is used. In performed implementation, there are five classes:

- Class corresponding to user (AuctionObserver.java)
- Class corresponding to resources available in auction (AuctionResource.java)
- Class corresponding to auctioneers (broker.java)
- Class corresponding to responder (ResponderImpl.java)

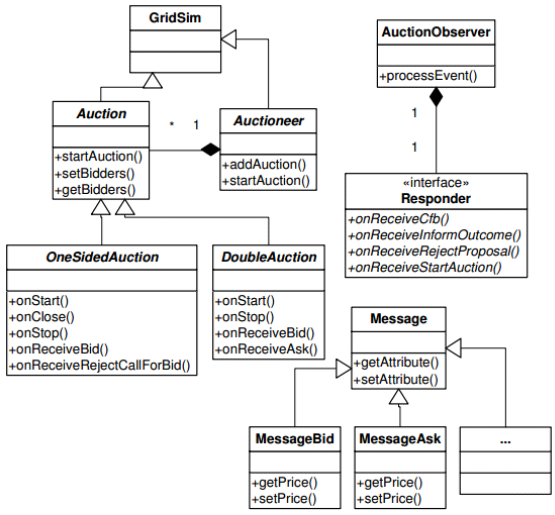

Fig. 2: general structure of GridSim software.

Relationship between users, auctioneers and owners is made through grid and grid links. Capacity of these links is considered as much as 1000bps. Broadcasting delay time is 10ms. Maximum value of broadcasted packages is 1500 bytes. Two routers are available in grid. Timing algorithm used in routers is first in, first out (FIFO). Each of users and auctioneers have an identity by which they are recognized. An auctioneer is allocated to each user who is responsible for broadcasting packages containing prices. Further, each user has a list of jobs and stores them in a Gridlet type variable. In one case of implementations, we considered three users and two resources. There are three machines in each resource. In table 1, a sample auction performed according to above conditions is investigated. Costs paid by GA method and traditional one are compared.

As can be seen in Table, ants selected paths having lower costs and costs of performing jobs experienced a significant reduction. Table 2 represents the number of stages of each auction for performing above jobs. Lower number of stages reduces the computation time as well.

Conclusion:

Economic model for resource management in grid computing demonstrated effective and acceptable performance. The main idea of these models was based on the method of exchanging products in market. Owing to simplicity and dynamism, these models are employed today in algorithms used for control of resources and timing of jobs. Many of the models are deficient in responding during management of resources. In auction model, auctioneers announce their intended prices and the customer who announced the appropriate price receives the resource. This issue leads to increase of the response time as a result of customers' demands. In this work, we introduced a

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new method for bilateral auction scenario using GA. In this method, we moved call for proposal packages in such a way that it can reduce response time and lower the price of resource as well. For simplicity of packages control, we used grid structure in performed implementation. This structure includes routers and linkages of users and auctioneers and auctioneers and owners. The method was implemented using GridSim simulator. This simulator is an open source software which is written in Java. Results demonstrated that bilateral auction using GA reduces the number of auction stages and accordingly, shortens the response time and lowers the price of resources.

Table 1: comparison of costs paid in presented method and traditional one.

.No	Cost of proposed method	Cost of traditional method
1	1.293	22.5
2	1.232	22.5
3	1.163	22.5
4	1.222	7.62
5	1.66	7.017
6	1.958	2.20
7	1.293	22.5

Table 2: number of steps of auction for performing above jobs.

.No	Number of steps in proposed methods	Number of steps in traditional methods
1	1	2
2	1	1
3	1	1
4	1	1
5	1	1
6	1	1
7	1	4

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