HONEY BEE BASED TRUST MANAGEMENT SYSTEM FOR CLOUD COMPUTING

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ABSTRACT. Cloud computing has been considered as the new computing paradigm that would offer computer resources over the Internet as service. With the widespread use of cloud, computing would become another utility similar to electricity, water, gas and telephony where the customer would be paying only for the services consumed contrary to the current practice of paying a monthly or annual fixed charge irrespective of use. For cloud computing to become accepted by everybody, several issues need to be resolved. One of the most important issues to be addressed is cloud security. Trust management is one of the important components of cloud security that requires special attention. In this paper, the authors propose the concept that honey bee algorithm which has been developed to solve complex optimization problems can be successfully used to address this issue. The authors have taken a closer look at the optimization problems that had been solved using the honey bee algorithm and the similarity between these problems and the cloud computing environment. Thus concluding that the honey bee algorithm could be successfully used to solve the trust management issue in cloud computing.

Keywords: cloud computing, trust management, bees algorithm

INTRODUCTION

Trust management systems have been heavily used by distributed systems like peer to peer systems, cluster computing, grid computing and sensor networks. Trust and reputation management systems help nodes to select the trustworthy peer to communicate with based on the quality of service and quality of resources provided by the peer (Blaze, Feigenbaum, Ioannidis, & Keromytis, 1999). Cloud computing has been the new computing paradigm that makes computing resources be accessible anywhere, anytime and pay only for the services accessed (Buyya, Pandey, & Vecchiola, 2009). With the emergence of cloud computing, organizations and individuals can cut down the expenditure on computer resources drastically. For cloud computing to be acceptable for everyone several issues including security, legal and economic factors need to be resolved first. Organizations are reluctant to move their resources and computing to the cloud as the cloud security system has not been properly addressed yet. Trust and reputation management is one of the most important components of security. This paper proposes that the honey bee algorithm that has been used to solve complex optimization problems can be adapted to address the trust management problem in cloud computing.

CLOUD COMPUTING

Cloud computing has been called the 5th utility in the line of electricity, water, telephony and gas (Buyya, Yeo, Venugopal, Broberg, & Brandic, 2009). The reason why cloud has been nomenclatured with such a name is that the cloud computing has been changing the way computer resources have been used up to now. Until the emergence of cloud computing, computing resources were purchased outright or leased in the form of dedicated hardware and software resources. Cloud computing has brought a paradigm change in how computing resources have been purchased. When the cloud computing becomes more pervasive like the Internet, the computing resources including raw computing power, fully fledged development platforms and customizable applications would be available as services over the Internet. Consumers will be able access these resources like any other utility and pay for only what is accessed.

Cloud providers host their resources on the Internet on virtualized systems and make them available to multiple clients. Multiple virtual computers can run on a single physical hardware sharing the resources such as storage, memory, the CPU and interfaces giving the feeling that each client has his own dedicated hardware to work on. Virtualization thus gives the ability to the providers to sell the same hardware resources to multiple clients. This sharing of the hardware resources by multiple clients help reduce the cost of hardware for clients while increasing the profitability of the providers. Accessing or selling hardware in the form of virtual computers is known as Infrastructure as a Service (IaaS) in the cloud computing terminology (Prodan & Ostermann, 2009). Once a client has procured infrastructure from a service provider, he is free to install and run any Operating System platform and application on it. Other kinds of services that are made available via the cloud computing model are Platform as a Service (PaaS) and Software as a Service (SaaS).

TRUST AND TRUST MANAGEMENT

The trust and reputation have their origin in the social sciences that study the nature and behavior of human societies (Yu, Shen, Miao, Leung, & Niyato, 2010). Trust has been studied by researchers in diverse fields such as psychology, sociology and economics (Gan, He, & Ding, 2009). Trust management systems play an important role in distributed systems such as peer to peer systems, grid computing, cluster computing and sensor networks (Cai, Li, Cheng, Fu, & Cheng, 2009; Vijayakumar & Banu, 2008; Mishra, Kushwaha, & Misra, 2010; Wu, et al., 2011; Tae & Hee, 2008). Trust management systems help client to select the right peer or server to communicate with and access resources. Without trust management systems, nodes in a distributed system would be affected by rogue nodes making the entire network infrastructure inaccessible.

HONEY BEE ALGORITHM

The bees algorithm is a population based search algorithm that mimics the food foraging behavior of honey bees. This algorithm starts by searching the neighborhood along with random search that is suitable for both combinatorial and functional optimization (Pham, Ghanbarzadeh, Koç, Otri, Rahim, & Zaidi, 2006). Honey bees travel over long distances in flocks looking for nectar in flowers in all directions. They coordinate their travel in such a manner that flower patches with large amount nectar will be foraged by large number of bees while the patches with less nectar are foraged by small number of bees (Beekman, Sumpter, Seraphides, & Ratnieks, 2004; Beekman, Gloag, Even, Wattanachaiyingchareon, & Oldroyd, 2008). Honey bees are social insects living in large colonies and carry out their jobs with precise coordination with each other by communicating through movements, odor, cues and food exchanges (Wilson, 2000).

At the beginning of the foraging process, scout bees are sent out on search of flower patches. These scout bees search for flower patches randomly moving from one patch to

another. When the scout bees return to the hive, the ones those found a flower patch above a certain quality deposit the nectar or pollen and perform the waggle dance. This waggle dance conveys all the information necessary for other bees to explore the flower patches with the highest quality (Pham, Otri, Afify, Mahmuddin, & Al-Jabbouli, 2007).

Algorithms based on the behavior of bees have been developed to solve complex optimization problems. Bees algorithm has been used in variety of fields like manufacturing, water management, wood defect classification, solving the travelling salesman problem, vehicle routing and data clustering in data management systems (Pham, Afify, & Koc, 2007; Pham, Koc, Lee, & Phrueksanant, 2007; Pham, Soroka, Ghanbarzadeh, Koc, Otri, & Packianather, 2006; Haddad, Afshar, & Marino, 2006; Marinakis & Marinaki, 2009; Marinakis, Marinaki, & Dounias, 2008; Pham, Otri, Afify, Mahmuddin, & Al-Jabbouli, 2007).

Applications of Honey Bee Algorithm

This section takes an in depth look at the problem domains honey bee algorithm has been applied. The main purpose of this analysis is to identify the similarities and differences between these application areas and cloud computing environment with special reference to trust management.

Pham, Afify, & Koc (2007) have applied the Bees algorithm to solve the problem of cell formation in cellular manufacturing systems. Cellular manufacturing systems have been used as an alternative to both job shops and flow line incorporating the strengths of both techniques. Cellular manufacturing is flexible like job shops at the same time it possesses the capability of high production rate similar to flow lines. In cellular manufacturing setup, machines with similar functions are placed together making them more robust to machine breakdowns. The main objective of cellular manufacturing is to exploit the similarity between components through standardization and assign them to a group of machines that are placed together. This concept reduces the distance travelled by components, inventory, cumulative lead times and waste resulting in improved efficiency and productivity. The main issue in cellular manufacturing is cell formation where the manufacturing systems are decomposed into groups called cells and component families requiring similar operations assigned to them. This assignment problem is known as NP-hard problem where an increase in problem size increases the computation time exponentially. The authors of this paper have solved this problem by grouping the machines and corresponding part families together in such a manner that intercellular movements are minimized.

Pham, Soroka, Ghanbarzadeh, Koc, Otri, & Packianather (2006) have used Bees algorithm for the optimization of neural network to detect wood defects. In this work, images of wood with and without defects were used to extract 17 features to train the neural network along with 12 wood defects and clear wood as outputs. The neural network used in this experiment had 51 hidden neurons in addition to the 17 input and 13 output neurons. For the purpose of optimization of the weights between the neurons, Bees algorithm had been employed, instead of traditional back propagation.

Haddad, Afshar, & Marino (2006) have employed the Bees algorithm to solve the water resources optimization problem. The issue addressed in this work was managing water resources from a single reservoir feeding an area that has time varying demand throughout the year. Also the input to the reservoir depends on the environmental and seasonal conditions. The honey bee mating algorithm based on the mating behavioral pattern of the honey bee has been used to arrive at an optimum solution to meet the demand. In a bee colony, a single queen bee mates with several hundred drones in a season for the purpose of reproduction. The similarity between this behavior and the reservoir environment has been exploited as a non linear constrained optimization problem.

Marinakis and Marinaki (2009) have studied the issue of the probabilistic travelling salesman which is a variation of the classic travelling salesman problem. The main objective of the travelling salesman problem is to come up with a strategy that results in the best route to visit a set of customers located in some metric space. The authors have adapted the honey bee mating optimization algorithm to solve this probabilistic routing problem.

Table 1. Comparison of Problems Addressed against Cloud Environment

Problem	Characteristics	Cloud Environment
Cellular manufacturing	Cell formation. Similar machinery and components are clustered together.	Service providers with similar QoS parameters clustered together.
Detecting wood defects	Multiple parameter optimization. Wood defects are categorized based on presence of multiple criteria such as appearance, roughness, color, defects etc.,	Trust in cloud computing is a combination of multiple parameters such as speed, integrity, cost etc. These parameters need to be combined to arrive at the uniform score.
Reservoir optimization	Managing the resources of a single reservoir to meet requirements of multiple customers with varying demands.	In cloud computing, different services are hosted on virtual servers in a single physical computer. This is similar to feeding different consumers with different needs from the same reservoir.
Probabilistic travelling salesman	Computes the best path to serve the customers based on a probabilistic demand by a single salesperson.	In cloud computing services are accessed by multiple customers from a single physical machine using virtual computing elements.
Vehicle routing	Computes the best path and fleet to accommodate varying demand of the customers.	In cloud environment, service providers and customers will be distributed over the Internet. Hence, it is necessary match the customer requirements with the service provider capabilities based on the SLA. This is similar to the vehicle routing problem discussed by the authors of this paper.
Data clustering	Identifying and grouping the objects with similar attributes together.	In cloud computing, it is necessary to identify the service providers with similar characteristics and group them together, so that customers can be allocated to these clusters based on their service requirements.

(Marinakis, Marinaki, & Dounias (2008) have addressed the vehicle routing problem, through the honey bees mating optimization algorithm. Vehicle routing problem addresses the issue of seeking to service a number of customers with a fleet of vehicles. The main objective of this problem is to minimize the distances travelled by vehicles in terms of distance, cost and time without compromising on the services delivered to the customers. Different vehicles have different capacities and each customer has certain demand which leads to a complex optimization problem. The authors have applied a combination of honey bees mating algorithm and the multiple phase neighborhood search – greedy randomized adaptive search procedure to solve the problem.

Pham, Otri, Afify, Mahmuddin, & Al-Jabbouli (2007) have applied the Bees algorithm to solve the clustering of data. Clustering partitions objects into homogeneous groups where the objects within a group (cluster) have similar properties while the objects in different groups have dissimilar properties. Clustering has been used in many applications such as image processing, data mining, information retrieval, market segmentation etc. Generally the clustering methods have the tendency to converge towards the local optima irrespective of the availability of a global optimum. In this work, the authors have proposed a clustering method integrating the k-means algorithm with the Bees algorithm that avoids the convergence towards the local optima. Table 1 shows the comparison of the problems addressed in the literature along with the similarity of these problems to that of the cloud computing environment.

On a critical look at the information provided in Table 1, the following can be inferred. The clustering of cloud service providers offering similar services or similar quality of service in similar to the clustering similar machine components in a manufacturing plant or data clustering in a distributed database system that is accessed by geographically distributed clients. Multiple parameters such as speed, integrity, cost etc., contribute to the computation of the overall trust of a service provider, this is in line with the problem addressed in the detection of wood defects. The probabilistic salesman problem addresses issue of how the best route can be computed to serve multiple customers, also in cloud computing multiple clients access the same physical hardware using virtual computing elements. Hence in both scenarios, a single resource needs to be optimized among multiple users. The vehicle routing problem is a typical network management problem where different resources and clients are located at different locations and they need to be routed to the right resources that would provide the best quality of service. From the above discussion, it can be that the issues resolved using the Bees algorithm and the cloud computing environment have similar features. Hence the Bees algorithm would be a suitable mechanism to address the trust related issues in cloud computing.

CONCLUSIONS

This paper took an in depth look at the trust issue in cloud computing along with the solutions devised for addressing various real world problems using the Bees algorithm. From the critical evaluation carried out on both cloud computing and Bees algorithm, the authors arrived at the conclusion that the Bees algorithm could be applied successfully to solve the trust related issues in cloud computing. Finally, the results of the critical review of the application of Bees algorithm to various problems and the corresponding component of the cloud environment have been presented in a table for easy reference.

REFERENCES

Beekman, M., Gloag, R., Even, N., Wattanachaiyingchareon, W., & Oldroyd, B. (2008). Dance precision of Apis florea —clues to the evolution of the honeybee dance language? *Behavioral Ecology and Sociobiology, 62* (8), 1259-1265.

Beekman, M., Sumpter, D. J., Seraphides, N., & Ratnieks, F. L. (2004). Comparing foraging behaviour of small and large honey-bee colonies by decoding waggle dances made by foragers. *Functional Ecology, 18* (6), 829 - 835.

Blaze, M., Feigenbaum, J., Ioannidis, J., & Keromytis, A. D. (1999). The role of trust management in distributed systems security. In J. Vitek, & C. D. Jensen, *Secure Internet Programming: Security Issues for Mobile and Distributed Objects* (pp. 185-210). London: Springer-Verlag.

Buyya, R., Pandey, S., & Vecchiola, C. (2009). Cloudbus Toolkit for Market-Oriented Cloud Computing. *1st International Conference on Cloud Computing,* (pp. 1-4). Beijing, China.

Buyya, R., Yeo, C. S., Venugopal, S., Broberg, J., & Brandic, I. (2009). Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. *Journal of Future Generation Computer Systems, 25* (6), 599-616.

Cai, B., Li, Z., Cheng, Y., Fu, D., & Cheng, L. (2009). Trust Decision Making in Structured P2P Network. *2009 International Conference on Communication Software and Networks,* (pp. 679-683). Macau, China.

Gan, Z., He, J., & Ding, Q. (2009). Trust relationship modelling in e-commerce-based social network. *International conference on computational intelligence and security,* (pp. 206-210). Beijing, China.

Haddad, O. B., Afshar, A., & Marino, M. A. (2006). Honey-Bees Mating Optimization (HBMO) Algorithm: A New Heuristic Approach for Water Resources Optimization. *Water Resources Management, 20*, 661–680.

Marinakis, Y., & Marinaki, M. (2009). A hybrid honey bees mating optimization algorithm for the probabilistic traveling salesman problem. *11th IEEE Congress on Evolutionary Computation (CEC'09)*. Trondheim, Norway.

Marinakis, Y., Marinaki, M., & Dounias, G. (2008). Honey Bees Mating Optimization Algorithm for the Vehicle Routing Problem. In K. Natalio, N. Giuseppe, M. Pavone, & D. Pelta (Eds.), *Nature Inspired Cooperative Strategies for Optimization (NICSO 2007)* (Vol. 129, pp. 139-148). Berlin / Heidelberg, Germany: Springer.

Mishra, S., Kushwaha, D. S., & Misra, A. K. (2010). A Cooperative Trust Management Framework for Load Balancing in Cluster Based Distributed Systems. *International Conference on Recent Trends in Information, Telecommunication and Computing,* (pp. 121-125). Kochi, Kerala, India.

Pham, D. T., Afify, A., & Koc, E. (2007). Manufacturing cell formation using the Bees Algorithm. *IPROMS 2007 Innovative Production Machines and Systems Virtual Conference*. Cardiff, UK.

Pham, D. T., Ghanbarzadeh, A., Koç, E., Otri, S., Rahim, S., & Zaidi, M. (2006). The Bees Algorithm – A Novel Tool for Complex OptimisationProblems. In D. T. Pham, E. E. Eldukhri, & A. J. Soroka (Ed.), *Proccedings of 2nd I*PROMS Virtual International Conference* (pp. 454-459). Cardiff, UK: Elsevier.

Pham, D. T., Koc, E., Lee, J. Y., & Phrueksanant, J. (2007). Using the Bees Algorithm to schedule jobs for a machine. *Proc Eighth International Conference on Laser Metrology, CMM and Machine Tool Performance, LAMDAMAP,* (pp. 430-439). Euspen, UK.

Pham, D. T., Otri, S., Afify, A. A., Mahmuddin, M., & Al-Jabbouli, H. (2007). Data clustering using the Bees Algorithm. *40th CIRP International Manufacturing Systems Seminar*. Liverpool.

Pham, D. T., Soroka, A. J., Ghanbarzadeh, A., Koc, E., Otri, S., & Packianather, M. (2006). Optimising neural networks for identification of wood defects using the Bees Algorithm. *2006 IEEE International Conference on Industrial Informatics*. Singapore.

Prodan, R., & Ostermann, S. (2009). A Survey and Taxonomy of Infrastructure as a Service and Web Hosting Cloud Providers. *10th IEEE/ACM International Conference on Grid Computing,* (pp. 17-25). Banff, AB, Canada.

Tae, K. K., & Hee, S. S. (2008). A Trust Model using Fuzzy Logic in Wireless Sensor Network. *Journal of World Academy of Science, Engineering and Technology,* 42 (13), 63-66.

Vijayakumar, V., & Banu, R. W. (2008). Security for Resource Selection in Grid Computing Based On Trust and Reputation Responsiveness. *International Journal of Computer Science and Network Security, 8* (11), 107-115.

Wilson, E. O. (2000). Sociobiology: The New Synthesis (25th Anniversary ed.). Boston, MA, USA: Harvard University Press.

Wu, Y., Gang, C., Liu, J., Fang, R., Huang, X., Yang, G., & Zheng, W. (2011). Automatically constructing trusted cluster computing environment. *The Journal of Supercomputing, 55* (1), 51-68.

Yu, H., Shen, Z., Miao, C., Leung, C., & Niyato, D. (2010). A Survey of Trust and Reputation Management Systems in Wireless Communications. *Proceedings of the IEEE, 98* (10), 1755-1772.