An Efficient Task Scheduling Method In A Cloud Computing Environment Using Firefly Crow Search Algorithm (FF-CSA)

Senthil Kumar Avinashi Malleswaran, Bhaskararao Kasireddi

Abstract: Cloud is a collection of interconnected computers which varies from personal computer to servers. It offers huge amount of storage and increased computing power to the user applications via internet. In cloud computing, task scheduling is an important issue which needs to be managed in a better way. Task scheduling assigns user tasks to the suitable Virtual Machines in order to attain Quality of Service (QoS) parameters. Optimization algorithms can be used to solve Non-deterministic Polynomial (NP) hard problem like Task scheduling. In this paper, Crow Search algorithm is combined with Firefly algorithm to improve the global search capability. The proposed algorithm minimizes the makespan and maximizes the throughput of the cloud system. Crow search algorithm is used to enhance the global optimization of the Firefly algorithm. The proposed algorithm results perform higher than the Crow search algorithm and Firefly algorithm results.

Index terms: Cloud computing, Task scheduling, Makespan, Throughput, Firefly Algorithm (FA), Crow Search Algorithm (CSA)

1 INTRODUCTION

Cloud computing evolves from parallel and distributed computing and it offer dynamic services to the end users via internet based on Service level agreement established between service providers and consumers. Cloud computing consists of a huge network of interconnected resources. The resources may be software, hardware, servers, personal computers, platform, infrastructure, applications, data centers etc. In cloud computing, resources are executed in parallel to generate the huge computing power. Users and brokers from any part of the world can submit requests to the cloud data centers.SLA resource allocator mange the activities such as request and Virtual Machine (VM) monitoring, billing, and dispatching between users and service providers. Based on demand, VMs can be activated and de activated on a physical machine to serve the user requests. Data centre contains multiple servers which include various physical machines. Cloud supports variety of applications which requires different configuration of hardware and software. Tremendous computing power is required in data centers to handle these various application requests. This may affect the Quality of Service (QoS) of the datacenters.[1, 2] In a cloud computing environment, task scheduling plays the major role. The ultimate aim of the task scheduling is to assign the suitable virtual machines to the requests in order to obtain the better performance in terms of completion time and makespan. Inefficient task scheduling may affect the QoS parameters like completion time and makespan. Hence, the proper task scheduling methods are required to serve the user requests on the virtual machines with minimum. Task scheduling is a kind of as Non-deterministic Polynomial (NP)-hard problem [3]. Task scheduling issue can be solved by various hybrid optimization algorithm[12-17].

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Many NP-hard problems are solved using the Bio-inspired algorithms and their applications are spread over in many fields such as image processing, robotics and computing[18-19] In order to solve this task scheduling NP-hard problem in a better way, we have proposed a new hybrid Firefly Crow Search Algorithm (FCSA) algorithm to minimize the makespan of the user requests on the resources. The proposed hybrid Firefly Crow Search Algorithm (FF-CSA) minimizes the makespan of the user requests on the resources. The proposed algorithm core idea is based on Firefly Algorithm and Crow Search Algorithm [4, 5]. In this hybrid algorithm, CSA algorithm improves the global optimization performance of the FA algorithm. The major contributions of the proposed research work are given as follows:

1) The proposed hybrid task scheduling approach improves the global optimization performance of standard FA
2) The performance of the hybrid approach is validated and compared with conventional Genetic Algorithm (GA), FA, CSA algorithms.

The paper content is organized as; Section 2 demonstrates the background details of hybrid optimization algorithms. The problem formulation is given in section 3. Section 4 details the proposed hybrid algorithm. Experimental results are presented in section 5. Section 5 includes the conclusion and future work.

2 RELATED WORK

Firefly Algorithm is introduced by Xin –She Yang [6] in 2008 to solve optimization problems. It is developed based on the firefly behavior, light emission and absorption and mutual attraction. Fireflies produce rhythmic flash which is highly powerful sight. The flashing light used to perform two functions such as attracting partners and prey. The fireflies flashing light can be associated with the objective function which is to be optimized in the given problem. Attractiveness and brightness are related parameters which are indirectly proportional to the mutual distance. Crow Search Algorithm is proposed by Askarzadeh [7] in 2016 to mimic the crows food hiding method. Crow is one of the intelligent bird among the bird category. Crows alarm other

species about some critical situations which are going to occur. The other highlighting factor about crow is it has very good memory. Due to memory, crows can hide the foods in one place and memorize the location. Due to these advantages,CSA has been solve various optimization application problems. Qi et al., [8] proposed a hybrid firefly algorithm to improve the optimization performance. Mating behavior of genetic algorithm is introduced in conventional firefly algorithm. Cross over operation is applied in the FA to exchange the information between the fireflies and elite fireflies are identified. Aydilek [9] presented a hybrid firefly and particle swarm optimization algorithm for high computational numeric problems. Local search is introduced by optimizing global best values. The results are outperforms the conventional FA and PSO algorithm results. Arunachalam et al., [10] have presented a hybrid particle swarm optimization and firefly algorithm (HPSOFF) to solve Combined Economic and Emission Dispatch (CEED) problem. In this paper, particle swarm optimization and firefly algorithm are combined. Here, PSO optimal results are given as initial population for firefly algorithm. Kora et al., [9] presented a hybrid algorithm for detection of Bundle Branch Block (BBB). In this paper, FA and PSO algorithms are integrated and it helps in Levenberg Marquardt Neural Network (LMNN) classifier. Here, modified PSO is used to improve the local search of FAFanin et al., [11] have proposed a hybrid task scheduling algorithm in a cloud computing environment using FA and Simulated Annealing (SA) algorithms. In this paper, SA algorithm is used to improve the local search capability of conventional FA algorithm. The results of proposed hybrid algorithm perform better than FA, SA, Max-Min and Min-Min algorithms. The proposed hybrid task scheduling algorithm in this research work improves the optimization performance in comparison to the FA, CSA, Max-Min, Min-Min and HPSOFF algorithms. Our research work focuses on task scheduling on a cloud environment using hybrid optimization algorithms.

3. PROBLEM FORMULATION

The proposed task scheduling algorithm objective is to optimize the makespan of the system. Make span is calculated by adding waiting time and completion time of all the tasks. Makespan is the total completion time of all tasks which are submitted by the user. Completion time is the difference value of finishing time and starting time of the tasks. Response time is the summation value of submission and waiting time of the tasks.

$$CT = \sum_{t=1}^{T} (ft_t - st_t) \quad (1)$$

$$RT = \sum_{t=1}^{T} \sum_{r=1}^{R} (subt_{tr} + wt_{tr}) \quad (2)$$

MakeSpan=min {CTr,,RTr| R=1,2,..N} (3)

Subject to

t , r <=1

t $\in T$

r $\in R$

Where CT is a completion time and RT is a response time.

4. FIREFLY ALGORITHM – CROW SEARCH ALGORITHM (FF-CSA) BASED TASK SCHEDULING

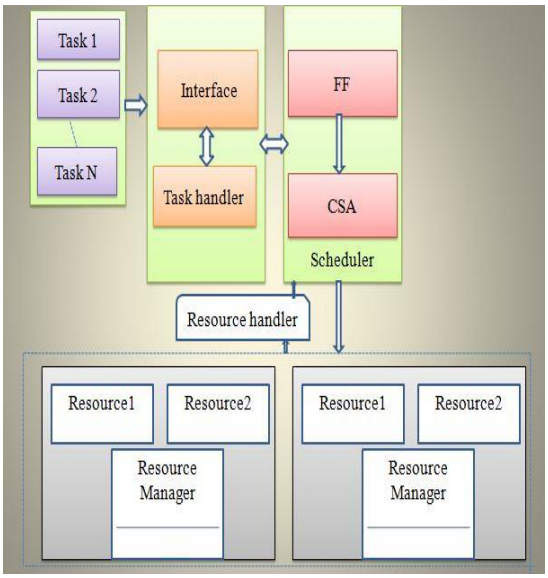

Fig1. *Proposed Task scheduling model*

The proposed hybrid task scheduling architecture is shown figure 1. Users can submit the task to the task handler through the user interface. User interface forwards the tasks to the task handler where the tasks are stored. Task scheduler fetches the tasks from queue and it schedules the tasks to the suitable resources with the help of FF-CSA algorithm. In FF-CSA, randomly initialize the fire flies positions and velocities. Fitness function is applied against all the fireflies and pbest and gbest values are calculated. At each iteration, inertia, position and velocity are updated. New particles are evaluated against the fitness function in the CSA. Particles positions are updated based on the awareness probability of the crows. The fitness of particle's new position is calculated. New position values are updated in crow's memory when new values are better than memorized position. Finally, the best position of crow memory is identified to obtain the optimal solution.

5. PROPOSED HYBRID SCHEDULING ALGORITHM

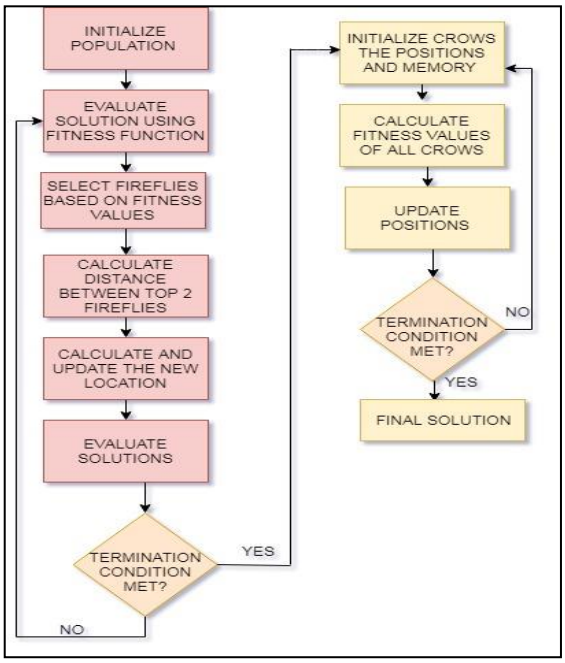

Fig.2 *FF-CSA algorithm*

The proposed algorithm shown in figure 2. Initially, firefly algorithm is executed and output is enhanced by crow search algorithm.
Firefly algorithm:

5.1 Initial Population generation

Initial population of the firefly algorithm is generated randomly. Firefly size is initialized based on the number of tasks and each firefly is assigned with random task and virtual machine combination.

5.2 Fitness calculation

Fitness function evaluates the fitness of the all fireflies in the population. The firefly's fitness value is evaluated. The firefly brightness is adjusted based on the objective function.

5.3 Updation of fireflies' location

The each pair of firefly's lightness value is evaluated and compared with each other. The high density light level fireflies attract the less density light level fireflies. At each iteration, the best firefly is identified and updated based on objective function and light density.
Crow Search Algorithm:

5.4 Updating of solutions using CSA

The best solution of FA is transformed to CSA. In CSA, the crow positions are initialized randomly. The memories of crows are initialized.

5.5 Fitness calculation

All crows are evaluated against the fitness function. The fitness function (3.4) is designed based on make span. The most fitted crows are identified and memories of all crows are obtained.

5.6 Updation of crow positions

The crow positions are updated at each iteration using the CSA update procedure.. Fitness evaluation and updating steps are repeated until algorithm obtains better solutions. The final solution is the optimal task scheduling method of given user tasks.

6. Experimental results

The simulation is executed on cloudsim and the cloudlets are assumed as tasks. The physical host machine which is considered as data centre and 30 Virtual Machines are instantiated. The main goal of the proposed research work is to observe and compare the completion time and response time. The values are recorded by changing the cloudlet from 100 to 500 and setting the VM parameters RAM as 1024 mb and bandwidth 2500 B/S.

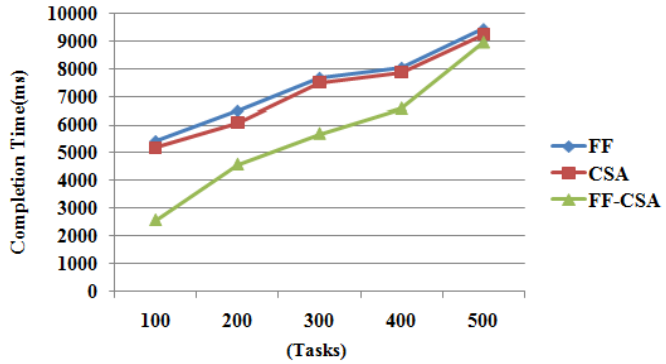

Fig.3 *Completion time*

Figure 3 shows the completion time of FF-CSA,FF,CSA techniques. It is noted that the completion time of the FF-CSA is lesser than FF and CSA algorithms. Completion time is the time difference between starting time and finishing time. Completion time increases when the combination of Task and VM's are increasing. When the combination of tasks and VM's are 500, it is observed that FF-CSA algorithm completion time is lesser by ms and ms compared to FF and CSA techniques.

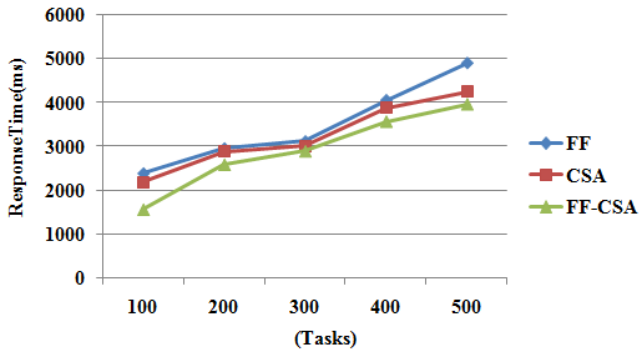

Fig.4 *Response time*

Figure 4 shows the comparison between proposed FF-CSA,FF and CSA algorithms response time. Response time is the summation of waiting time and submission time. Response time is recorded and compared when resource range from 0 to 30 and task range from 100 to 500. It is noted that the FF-CSA response time is lesser than the conventional algorithms such as FF and CSA algorithms.

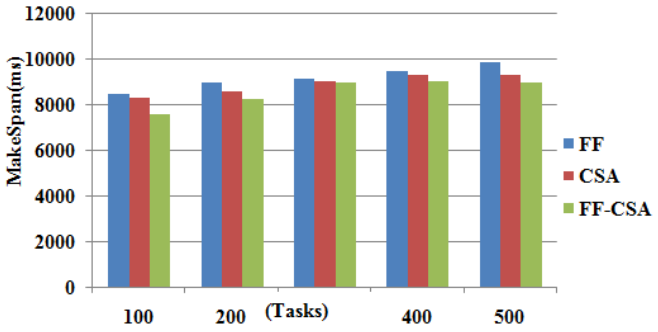

***Fig.5**. Makespan*

In figure 5, makespan comparison between FF-CSA and FF and CSA algorithms. Makespan is the overall time taken by the tasks to complete the execution. Makespan is evaluated and analysed by varying the tasks and resource values. It is shown that the FF-CSA algorithm makespan values are minimum when compared to FF and CSA.

6. CONCLUSION

Task scheduling issue in a cloud computing environment is discussed in this paper. The solution is applied using the hybrid Firefly Crow Search Algorithm. In FF-CSA algorithm, CSA algorithm is used to enhance the results by improving the global optimization performance of the FF algorithm. This hybrid algorithm effectively assigns the user tasks to the matched VM's by optimizing the completion time, response time and makespan of the system. The Proposed algorithm FF-CSA optimizes the results in terms of completion time, response time and makespan. In future, resource management and new combination of bio-inspired optimization algorithms can be addressed to improve the optimization results in a cloud computing environment.

REFERENCES

[1] .Buyya, R., Yeo, C.S., Venugopal, S., Broberg, J., Brandic, I.: Cloud computing and Emerging IT Platforms: Vision, Hype, and Reality for Delivering Computing as the 5th Utility. In: Future Generation Computer Systems, vol. 25(6), pp. 599–616.

[2] .Amsterdam (2009) B. Richard. "Report to congress on server and data center energy efficiency: Public law 109-431". Lawrence Berkeliey National Laboratory, pp. 0–10, 2008.

[3] X. S. Yang, "Firefly algorithms for multimodal optimization". Stochastic Algorithms: Foundations and Applications, Vol. 5792, pp. 169–178, 2009.

[4] Askarzadeh, A. A novel metaheuristic method for solving constrained engineering optimization problems: Crow search algorithm. Comput. Struct. 2016, 169,pp. 1–12

[5] Xiangbo Qi1, Sihan Zhu2 , Hao Zhang1, A Hybrid Firefly Algorithm,IEEE pp.287-291

[6] Yang, X. S. (2008). Nature-Inspired Metaheuristic Algorithms. Luniver Press. ISBN 978-1-905986-10-1.

[7] Alireza Askarzadeh,A novel metaheuristic method for solving constrained engineering optimization problems: Crow search algorithm,Computers & Structures,Volume 169,2016,Pages 1-12,

[8] Ibrahim Berkan Aydilek, A Hybrid Firefly and Particle Swarm Optimization Algorithm for Computationally Expensive Numerical Problems, Applied Soft Computing

[9] S.Arunachalam,T. AgnesBhomila, M. Ramesh Babu, Hybrid particle swarm optimization algorithm and firefly algorithm based combined economic and emission dispatch including valve point effect, in: Lect. Notes Comput. Sci. (Including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics), Springer International Publishing, 2015: pp. 647–660. doi:10.1007/978-3-319-20294-5_56.

[10] . P. Kora, K.S. Rama Krishna, Hybrid firefly and Particle Swarm Optimization algorithm for the detection of Bundle Branch Block, Int. J. Cardiovasc. Acad. 2 (2016) 44–48. doi:10.1016/j.ijcac.2015.12.001.

[11] Fanian, F., Bardsiri, V.K., & Shokouhifar, M. (2018). A New Task Scheduling Algorithm using Firefly and Simulated Annealing Algorithms in Cloud Computing. Journal of Advanced Computer Science and Applications(ijacsa), Volume 9 Issue 2, 2018.

[12] Senthil Kumar A M ,Venkatesan M ,Task scheduling in a cloud computing environment using HGPSO algorithm, Cluster Computing, 2018(In press)

[13] .Senthil Kumar A M ,Venkatesan M , Multi-Objective Task Scheduling Using Hybrid Genetic-Ant Colony Optimization Algorithm in Cloud Environment, Wireless Personal Communications, 2019(In press)

[14] A.M.SenthilKumar, M. Venkatesan, A. Rajivkannan , ERAM2-Energy Based Resource Allocation With Minimum Reckon And Maximum Reckon, - Journal of advances in chemistry, vol.12(23).pp- 5485-5493 2016

[15] A.M. SenthilKumar, M. Venkatesan ,A Novel Based Resource Allocation Method on Cloud Computing Environment Using Hybrid Differential Evolution Algorithm - Journal of Computational and Theoretical Nanoscience, vol.14(11),pp- 5322-5326 2017

[16] A.M.SenthilKumar, M. Venkatesan, A. Rajivkannan, A Novel Approach for Multiple Object Resource Allocation Using Hybrid Algorithm, Middle-East Journal of Scientific Research,vol.23(10),pp-2586-2591 2015

[17] A.M.Senthil Kumar, M Venkatesan, An Efficient Multiple Object Resource Allocation Using Hybrid GA-ACO Algorithm, Australian Journal of Basic and Applied Sciences, vol.9(31),pp-53-59, 2015

[18] V Enireddy, RK Kumar "Improved cuckoo search with particle swarm optimization for classification of compressed images" Sadhana 40 (8),pp. 2271-2285

[19] KK Reddi, V Enireddy "Cuckoo Search Framework For Feature Selection And Classifier Optimization In Compressed Medical Image Retrieval" i-manager's Journal on Image Processing 3 (1).