Preeti Chahal et al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 3, Issue 3, September 2016, pp. 20-24

# Energy Efficient Resource Allocation by Firefly Optimization in Cloud Computing

**Preeti Chahal[1], Vinod Saroha[2]**

[1]M.Tech Scholar, Bhagat Pool Singh Mahila Vishwavidyalaya Khanpur Kalan, Sonipat
[2]A.P, Bhagat Pool Singh Mahila Vishwavidyalaya Khanpur Kalan, Sonipat

***Abstract:*** **In our work we have focused our work to minimise the energy consumption in cloud data centres. We have considered the Euclidean distance between physical nodes and virtual machines rather than calculating energy directly. Since less is the distance less is the energy consumption. We have considered here two resources which are to be utilised by VMs which are disk in TB and CPU in MIPS. The firefly optimisation algorithm is used to assign the VM to physical nodes for maximum utilisation of these two resources within available capacity of system. The number of VMs is varied to test the performance and utilisation of CPU and disk and compared with the previously used particle swarm optimisation algorithm.**

***Keywords:*** **Cloud, Cloud computing environment, load balancing, Firefly optimization**

## I. INTRODUCTION

Green Computing, or Green IT, is the practice of implementing policies and procedures that improve the efficiency of computing resources in such a way as to reduce the energy consumption and environmental impact of their utilization. Cloud computing is a current advancement where applications and IT infrastructure are provided as 'services' on a usage based payment model. There are many issues in Cloud computing such as Automated Service Provisioning, Virtual Machine Migration, Energy Management, Server Consolidation, Data Security, etc. as discussed in previous section that have not been fully addressed. Central to these issues is the Energy Management. There is a rapid expansion in data centres, due to the exponential growth of the Cloud computing. This expansion has triggered the dramatic increase in energy used and its effect on the environment in terms of carbon footprints. In order to reduce power consumption, it is necessary to consolidate the hosting workloads. Various existing techniques manage the heterogeneous workloads but are not energy efficient for the Cloud computing platform. Aim of the thesis is to consolidate the heterogeneous workloads in an efficient way so that the resource utilization can be maximized and the energy consumption of the data centre could be minimized that can further result in reducing carbon footprints and hence assist in achieving Green Computing.

Many researchers have proposed algorithms for energy efficient resource allocations. However, the algorithms above only consider the energy efficiency of the CPU, rather than other resources such as disk, memory, and bandwidth. Once multiple resources in cloud data center are considered, the multidimensional bin packing problem tends to be more complicated. Srikantaiah et al. study the relationship between energy consumption and resource utilization which focuses on two kinds of resource: CPU and disk, while a modified best fit heuristic algorithm is utilized for allocation. But these heuristic algorithms easily fall into local minima in case of multi objective functions. To minimize the total energy consumption, the number of active nodes should be reduced and the idle nodes should be turned off. For our work we used firefly algorithm for optimisation purpose.

## II. PROPOSED METHODOLOGY

In this work we have allocated multiple virtual machines to different number of hosts. Efficient allocation of resources to given number of VM (virtual machine) is a quite complex task in cloud computing. This is a NP hard problem which can't be solved mathematically. As discussed in literature survey many researchers have worked for this kind of problem but they used artificial intelligence for it. In our work we solve this problem with firefly optimisation algorithm and compared the results with Particle swarm optimisation which is used in reference paper. The optimal resource allocation is NP hard problem so the algorithm should run to minimize the Euclidean distance as given in equation 1.

$$\delta = \sum_{i=1}^{n} \sqrt{\sum_{j=1}^{d} (u_i^j - ubest_i)^2} \quad ..1$$

Where is the dimension which denotes kinds of resources, such as CPU, disk, memory, and bandwidth and denotes the number of hosts in cloud data centre. $u_i^j$ is the utilizationfor host j and the resource i, $ubest_i$ is the best utilization for $u_i^j$. The total Euclidean distance denotes the optimal balance between multiresourcesutilization and energy consumption. Minimizing the total Euclidean distance will get optimal energy efficiency in the whole system. In this situation, the multiresources energy efficiency model is described as follows:

$$objective : min\ \delta \quad ..2$$

$$constraints: x_h^j = 0$$

$$\sum_h x_h = 1 \quad ..3$$

 

Where $x_h^j$ denotes virtual machine VM allocated to node $h$; $x_h^j = 0$ denotes VM is not allocated to resources and expression 3 states that each VM can be allocated to one node only. In order to satisfy the limitations, each resource must satisfy the following inequality constraints as follows:

$$\sum_j r_j^{CPU} * x_h^j \le c_h^{CPU}, \quad \sum_j r_j^{RAM} * x_h^j \le c_h^{RAM}, \quad \sum_j r_j^{BW} * x_h^j \le c_h^{BW},$$

$$\sum_j r_j^{DISK} * x_h^j \le c_h^{DISK}, \qquad ..4$$

Here in this expression $r_j^{CPU}, r_j^{RAM}, r_j^{BW}, r_j^{DISK}$ denotes the demand of resources and $c_h$ denotes the capacity of these resources. The above expression must be satisfied while assigning optimal nodes to VMs. The capacity is the maximum resource available to allot to VMs. In our work we have assumed only two kind of resources which are CPU and disk. The maximum and minimum allotted capacities of these are given in table 1.

Table 1: maximum and minimum limit of resources allocated to each VM

| | | Low | High |
|---|---|---|---|
| 1 | CPU (MIPS) | 60 | 150 |
| 2 | Disk (GB) | 100 | 200 |

Each VM must be allocated the available resources within this range. So this problem has many constraints to fulfil and object to minimise the Euclidean distance, it becomes the NP hard problem and firefly is used in our proposed work to solve this equation.

**Algorithm Steps**

Optimization problem of resource allocation to VMs by hosts is a NP hard problem as discussed above and firefly algorithm helps us to allocate resources for maximum utilization. Though we have one system as cloud computing and other is firefly algorithm which doesn't have any relevance but still both are used in synchronization. As discussed the objective function used is the Euclidean distance so this is the output from cloud computing system which is provided to firefly system and firefly algorithm gives the different values of CPU and disk to cloud computing system. Figure 1 shows the communication between these two isolated systems.

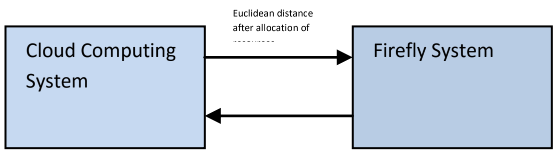


Figure 1: Communication between two used isolated system in our work

The algorithm steps for proposed work are as:

Step1. Provide the input data like number of VM, number of physical nodes, number of resources and their limits available to every VM.

Step2. Pass these inputs to firefly algorithm.

Step3. Initialize the variables of firefly algorithm like alpha, beta and gamma and total number of fireflies along with iteration number.

Step4. Initialize the positions of all fireflies randomly for first iteration. These positions are values of $x_h^j$ in equation 4.4 above. It tells which VM is allocated to which physical machine.

Step5. Pass these position values of firefly to objective function which calculates the Euclidean distance using equations 4.1-4.4.

Step6. Now firefly's positions are updated following the equation

$$x_i = x_i + \beta_0 e^{-\gamma r^2}(x_j - x_i) + \alpha€i$$

Step7. For the next iteration these new updated positions will move into the objective function for calculation of Euclidean distance.

Step8. Distance calculated in each iteration is saved by firefly algorithm and compared with the value in previous iteration. The minimum value is kept and rest is discarded.

Step9. After completion of all iterations, the position of fireflies for which minimum distance is obtained, is the final output of firefly algorithm.

Step10. Use these final values to allocate the resources.

Step11. With same initial values of resources PSO is aloes tuned and provide the SPO tuned values of resource allocations.

Step12. Compare and plot the results of firefly algorithm and PSO.

## III. RESULTS & DISCUSSION

We have compared our work with PSO optimisation results using same availability of resources and number of virtual machines. The developed MATLAB script is dynamic so that any number of virtual machines and resources can be optimised to reduce energy consumption in cloud data centre. This depends upon the Euclidean distance in between VM and host.Table 2Shows the input parameters used for energy minimisation in cloud computing data centre, these values are picked from [6].

Table 2: Input Parameters considered for cloud computing data centre

| | |
|---|---|
| Number of VMs | 10 |
| Number of physical nodes | 100 |
| Number of resources | 2 (hard disk, CPU) |
| Bets resource utilisation ratio(hard disk, CPU) | [0.5, 0.7] |
| Capacity of physical nodes | [2260 MIPS,21000 TB] |

We have tested results for 10-60 virtual machines over 100 physical nodes with same capacity of resources available. Using any kind of optimisation is bounded by restriction of randomness. Every optimisation algorithm is initialised randomly, so is ours and due to this random initialisation, results will be different in each trial. So we pasted best results here in 5-6 trials. Since equation 1 is to be minimised so the objective function value must be decreased with number of iterations. If it is not so then fine tuning of algorithm is required. Figure 2 shows the objective function value with every iterations. This is plotted for 20 numbers of virtual machines. A comparison between objective function of PSO and firefly is also shown in figure. Red color lines are of PSO optimisation and blue lines are for firefly algorithm. Since we need to minimise the Euclidean distance (objective function), so proposed algorithm should give more minimum value than PSO work. Our graph proves firefly algorithm usage is better than PSO algorithm.

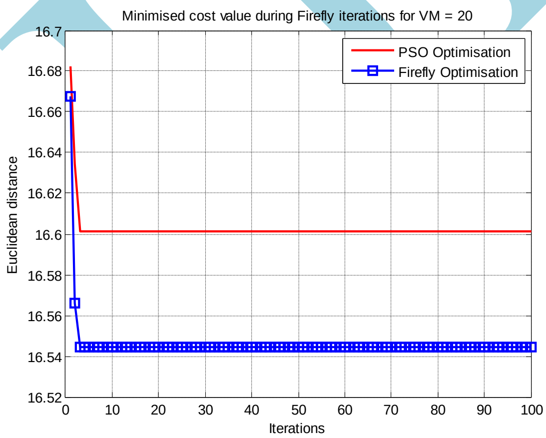


Figure 2: Objective function graph with number of iterations

For these final Euclidean distance is shown in table 3 with bar plot comparison in figure 3. for large number of VMs like 50-60, firefly algorithm is not performing well in terms of Euclidean distance. Further since we are allocating the VM to physical nodes for two resources: CPU and hard disk, so there must also be a comparison between them for different number of virtual machines. Their utilisation must be high as much it can be upto maximum available for each VM. The bar chart for disk utilisation and CPU utilisation is shown in figure 4 and 5 respectively.

Table 3 : Comparison of Euclidean distance by both algorithms

| Number of virtual machines | Firefly Algorithm (in MIPS) | PSO Algorithm (in MIPS) |
|---|---|---|
| 10 | 8.30891967740399 | 8.30891967740399 |
| 20 | 16.5445720453973 | 16.6015111247640 |
| 30 | 25.1185986839278 | 25.1295530931789 |
| 40 | 33.7234104254618 | 33.7315752408699 |
| 50 | 42.3068477033484 | 42.1044378603041 |
| 60 | 50.9081192587204 | 50.4684663417916 |

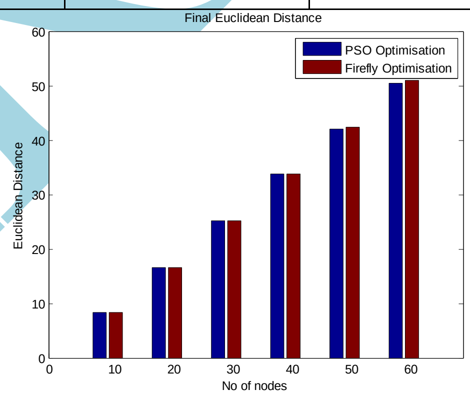


Figure 3: Euclidean distance comparative bar plot

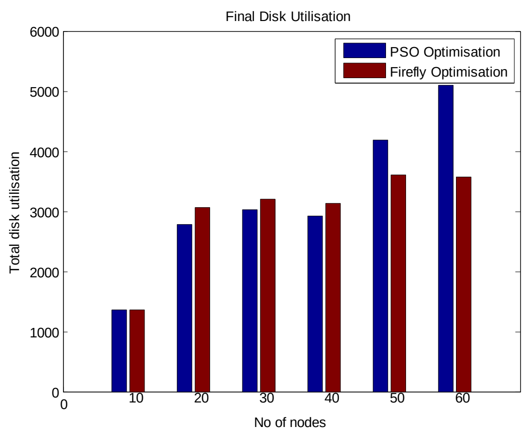


Figure 4: final disk utilisation comparative bar plot

 

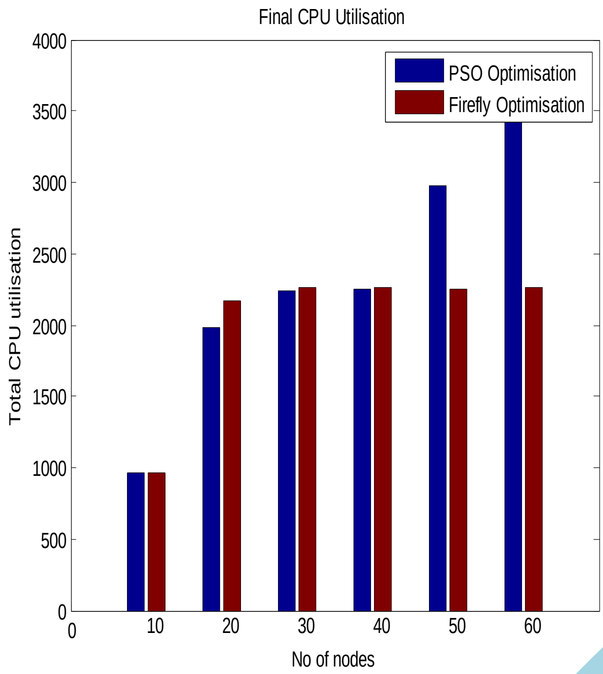


Figure 5: final CPU utilisation comparative bar plot

## IV CONCLUSION

Our work is based on utilising the maximum resources for a particular number of VM within the available capacity of each resource. For this purpose Euclidean distance between hosts and VMs is considered as deciding factor since minimum is the distance, less is the energy consumption. So we used firefly optimisation algorithm for this purpose since this is not the linear problem which can be solved mathematically, this is a problem bounded with many constraints and parameters. The outcome of algorithm is checked for various number of VM like 10,20,30,40,50 and 60. Their performance with firefly algorithm is compared with PSO and it has been noted that whatever is the algorithm, resource utilisation is increasing with number of VM.

## REFERENCES

[1]. SaurabhBilgaiyan, SantwanaSagnika, Madhabananda Das, " An Analysis of Task Scheduling in Cloud Computing using Evolutionary and Swarm-based Algorithms", International Journal of Computer Applications (0975 – 8887) Volume 89 – No.2, March 2014.

[2]. Korir Sammy, RenShengbing, Cheruiyot Wilson, "Energy Efficient Security Preserving VM Live Migration In Data Centers For Cloud Computing" ,IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 2, No 3, March 2012. ISSN (Online): 1694-0814.

[3]. Manasa H.B, AnirbanBasu , "Energy Aware Resource Allocation in Cloud Datacenter", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-5, June 2013 277 .

[4]. WannengShu, Wei Wang and Yunji Wang, "A novel energy-efficient resource allocation algorithm based on immune clonal optimization for green cloud computing" ,EURASIP Journal on Wireless Communications and Networking 2014, 2014.

[5]. N.R.RamMohan, E.Baburaj, "Resource Allocation Using Interference Aware Technique in Cloud Computing Environment", International Journal of Digital Content Technology and its Applications(JDCTA) Volume8, Number1, February 2014.

[6]. An-ping Xiong and Chun-xiangXu, "Energy Efficient Multiresource Allocation of Virtual Machine Based on PSO in Cloud Data Center" , Hindawi Publishing Corporation Mathematical Problems in Engineering Volume 2014, Article ID 816518.

[7]. ArindamBanerjee, PrateekAgrawal and N. Ch. S. N. Iyengar, "Energy Efficiency Model for Cloud Computing" , International Journal of Energy, Information and Communications Vol.4, Issue 6 (2013), pp.29-42. ISSN: 2093-9655 IJEIC Copyright ⓒ 2013 SERSC.

[8]. AkshatDhingra and Sanchita Paul, "Green Cloud: Heuristic based BFO Technique to Optimize Resource Allocation", Indian Journal of Science and Technology, Vol 7(5), 685–691, May 2014.

[9]. Giuseppe Portaluri, Stefano Giordano, DzmitryKliazovich and Bernab´eDorronsoro, "A Power Efficient Genetic Algorithm for Resource Allocation in Cloud Computing Data Centers" , 2014 IEEE 3rd International Conference on cloud Networking (Cloud Net).

[10]. S.R.Suraj, R.Natchadalingam, "Adaptive Genetic Algorithm for Efficient Resource Management in Cloud Computing" , International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 2, February 2014).

[11]. G. Portaluri, S. Giordano, D. Kliazovich and B. Dorronsoro, "A power efficient genetic algorithm for resource allocation in cloud computing data centers," *Cloud Networking (CloudNet), 2014 IEEE 3rd International Conference on*, Luxembourg, 2014, pp. 58-63.

[12]. W. Wang, B. Liang and B. Li, "Multi-Resource Fair Allocation in Heterogeneous Cloud Computing Systems," in *IEEE Transactions on Parallel and Distributed Systems*, vol. 26, no. 10, pp. 2822-2835, Oct. 1 2015.

[13]. PY Yin, SS Yu, PP Wang, YT Wang," A hybrid particle swarm optimization algorithm for optimal task assignment in distributed systems", Computer Standards & Interfaces 28 (4), 2006,441-450

[14]. ShekharSrikantaiah, AmanKansal, Feng Zhao," Energy Aware Consolidation for Cloud Computing", HotPower'08 Proceedings of the 2008 conference on Power aware computing and systems

[15]. A. Beloglazov and R. Buyya, "Energy Efficient Allocation of Virtual Machines in Cloud Data Centers," *Cluster, Cloud and Grid Computing (CCGrid), 2010 10th IEEE/ACM International Conference on*, Melbourne, Australia, 2010, pp. 577-578.