Energy Aware Metaheuristic Approaches to Virtual Machine Migration in Cloud Computing

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Abstract. In mandate to drop the power utilization, virtual machine migration is utilized for cloud computing. At present many algorithms are there, that diminishing the energy consumption with the assistance of virtual machine migration and power proficient planning of VMs. The target to migrate the virtual machine from one under-burden server to other over-burden server is to have ideal outcomes. Over-burden or Under-burden host detection strategy utilized as a part of proposed work is Inter Quartile Range. After detection of an Over-burden or Under-burden host, the following stage is to pick the specific virtual machines to relocate from one under-burden host to the over-burden host. VM choice arrangements Minimum Migration Time (MMT) along with various Metaheuristic optimizations are executed. For assessing proposed algorithm, CloudSim is used to assess and look at the execution of proposed algorithm. To analyze the effectiveness of planned system seven parameters the power utilization, standard deviation of host, standard deviation of virtual machine placement, standard deviation of virtual machine migration, SLA performance degradation due to migration, and total SLA violation are considered.

Keywords: Information Technology, Virtual Machines, Minimum Migration Time, Inter Quartile Range, Service Level Agreement, Particle Swarm Optimization, Ant Colony Optimization, Cuckoo Search, Modified Ant Lion Optimization, Modified Grey Wolf Optimization.

1. Introduction

It is a way of computing in which a client uses a group of services hosted by service provider over the web. It provides access to hired computers and storage capability to your laptop. Sizable amount of firms like Amazon, Microsoft and Google provides cloud services to the users. The most use of cloud computing is that user don't seem to be needed to shop for laptop and storage areas for his or her short-run needs [6] [7] [11]. Virtualization procedure helps in serving the cloud facility providers to overcome these issues. One and only of the key aims that must be painstaking in schemes that install virtual machines is the proper distribution of the VMs to servers. For every distribution technique, if the resultant distribution is not talented to see a few of the resource necessities, the virtual machines need to be transferred from the prearranged server to certain other appropriate server [8]. Hosting many virtual machines on a particular host is very stimulating because of resource controversy between submissions and outcome degradation credited to server overutilization. Above problems can be resolved by carefully choosing and transferring Virtual machines from under-utilized servers to over-utilized servers [2] [4] [14].

2. Related Work

As indicated by [1], after analyzing usage examination and expectation, planned works efficiently assign resources. "Linear Predicting Method" (LPM) and "Flat Period Reservation-Reduced Method" (FPPRM) is hired to acquire valued statistics from the asset usage log. As per [2] Cloud processing...
frameworks provides resources on demand, pay according to usage, and can serve various customers on the identical physical server. Anyway, the cost/benefit of cloud computing depends on many factors, such as (Quality of Service) QOS limitations, power utilization. This is skilled via combining assignments on virtual groups by observance the CPU usage. As per [3] the expanding interest for capacity, networking and computation has focused the heightening of extensive multifarious server farms, the gigantic host promotes that, run a significant number of the current Internet, monetary and commercial applications. A server plantation can comprise a huge amount of hosts and can run through as greatly as a tiny city. The enormous actions mechanism, compulsory to operate server frameworks gets numerous problems like power usage, outflow of greenhouse gases, reinforcements and restoration issues. High cost of oil and an unnatural weather change is a share of the ultimate problems of the present-day world. This paper examines in what way virtualization can be used to enhance the performance and energy proficiency of server farms.

As indicated by [4] in cloud computing many activities are mandatory to be performed by the available assets to achieve finest execution, reduce response time. Investigate the outcome of Load Balanced Min-Min plan for Fixed Meta-Task Arrangement in system processing. Upgraded Burden adjusted Min-Min calculation rest on Min-Min procedure and undertakings rearrangement to use the under-utilization assets adequately. It chooses the task with most extreme consummation time and appoints it to proper resource to provide well make traverse. As indicated by [5] Cloud task management is viewed as a NP hard advancement issue and many meta-heuristic algorithms are appropriate to tackle it. Analyze three procedures proposed for vibrant undertaking planning for cloud computing. The three methodologies with the field of swarm insight are utilized to determine solutions for worrying or unthinkable. The fundamental objective is to provide a valuation and comparable investigation of these methodologies which are utilized to control the makespan of an assumed undertaking set. Execution of the algorithm is simulated utilizing toolbox bundle of CloudSim. Procedure has been matched with the renowned existing algorithms for dynamic job planning problem. As per [9] suggests an innovative method to assign virtual machines by the Family Gene approach. Investigational examination verifies that the projected method decreases energy intake and the frequency of migrations. As indicated in [10] serious phases and associated topographies of present VM migration arrangements are examined through comprehensive qualitative investigation. Important constraints from surviving literature are mined to deliberate the unities and changes among VM relocation schemes. Finally, to improve ideal VM relocation arrangements in Cloud Data Centers, problems and challenges with VM relocation are concisely addressed. As per [11] suggest a novel job-planning algorithm grounded on Lion Optimization Algorithm (LOA), for cloud computing. Projected job planning procedure is matched with job planning procedures grounded on Genetic Algorithm and Particle Swarm Optimization. The outcomes reveal the great performance of the suggested algorithm matched with the further algorithms. As per [12] suggest a cloud prototypical using the goals of reducing energy intake while bearing in mind the CPU deployment simulated with procedures Genetic Algorithm, Particle Swarm Optimization, and hybrid GA-PSO. As per [13] offers a improved thoughtful of live migration of virtual machines. Its emphases on studying state-of-the-art optimization methods devoted to evolving live VM relocation according to memory migration. It examines and compares these methods to understand optimization and challenges.

3. Metaheuristic Algorithms

The swarm cleverness is the one subcategory of Metaheuristic that focuses to study the crowd behaviours that effect from the confined relationship of the entities with each other and their environment. Some of the popular Metaheuristic Optimization Techniques are particle swarm optimization (PSO), Ant Colony Optimization (ACO). Moreover, others optimization techniques are Cuckoo Search, Optimization of Grey Wolf and Ant lion optimization. Particle Swarm Optimization (PSO) It is a part of AI which spotlights on the aggregate properties and conduct of self-composed and decentralized frameworks with a social structure e.g. flock of birds and
colonies of ant. These frameworks comprise of basic coordinating operators ordered in little social orders, called swarms, which show traits of knowledge, for example, basic leadership limits and the capacity to respond to ecological dangers. It was developed by Kennedy and Eberhart in 1995 and offers searching process based on population in which people called particles modify their situation after a specific time. In this, particles fly in the district of multidimensional inquiry space. All through their development, every molecule uses its own particular experience and the experience of its neighboring molecule to modify its situation by judging the best situation established by it and its neighbor. It utilizes both locally inquiry strategies and globally search techniques.

**Optimization of Ant Colony (ACO)** An algorithm of ant colony is utilized for discovering ideal lane from a beginning spot toward eatable material which based upon the conduct of ants looking for their nourishment. At the initial stage the type of movement an ant performs must be random. At the moment source of nourishment is discovered, group of ants start walking towards the colony while leaving the indicator on their way. These indicators work as benchmark for the others ants to locate the food source. Moreover, when they do, they at that point populate the way with their own particular indicators as they carry the nourishment rear. The path becomes more popular and more grounded enough since such a huge number of ants take after a similar path. Shorter paths will probably be more grounded in light of the fact that the ants fall pheromones each time they bring sustenance. In addition, meanwhile, a few ants are as yet looking for nearer nourishment sources randomly. A comparative approach can be utilized to discover best possible solution to represent the sales issue for voyaging. When the source of sustenance is spent, that route is not required further and gradually begins reducing. Cases of such frameworks incorporate computer networks, computerized reasoning and artificial intelligence simulations of specialists.

**Optimization of Cuckoo Search (CS)**

CS is grounded on the exciting activities of specific cuckoo kinds a nature-inspired, which laid their eggs in the shells of other birds; it creates the over-all hunt further effective. The modest usage of CS is as keep an eye on: An egg is a key and a shell is an singular of the population; a bad key may possibly be exchanged by a fresh one or new probable keys; the amount of shells is fixed and one and the same to the extent of population; and an wild shell demonstrating an single is swapped by a fresh one. The typical CS stands for by three directions

- All cuckoo birdie leaves single egg at a stage and places it into an arbitrary shell
- Shells using extraordinary superiority of eggs are passed to the subsequent generations
- A crowd birdie (shell holder) may realize an unknown egg with a chance $P_{\alpha} \in (0, 1)$, and rug it away or abandon the shell and form a fresh one.

**Modified Grey Wolf (MGWO)**

The grey wolf tuner is some of the modern bio-inspired optimization. The central idea of this method is to act out the grey wolf activities to alive in a pack. They require a thoughtful group leading grading.

- The topmost stage is the frontrunners, named alpha. The alpha is accountable for creating judgments within the pack. The determination of the wolf pack is grounded on alpha’s judgment.
- The succeeding stage is the minor wolves, named beta. The job of beta is to provide help to the alpha in judgment building or additional accomplishments.
- The next stage is the minor wolves, named delta. The supporters in this set involve detectives, guards, chiefs, trackers and wardens. Detectives are accountable for opinion the borders of area and cautioning the pack in situation of some risk. Guards guard and promise the safety of the pack. Chiefs are the talent wolves which can be cast-off to be either alpha or beta. Trackers help the alphas and betas at what stage hunting prey and providing foodstuffs intended for the pack and the wardens are accountable for loving for the feeble, hostile, and hurt wolves in the pack.
- The bottommost stage is omega. The omega wolves are responsible to conform to entirely the additional leading wolves. In certain belongings, the omega is too the babysitters in the pack.
Grey wolves ensure ability towards memorizing the positions of prey and to surround them. The alpha implements the frontrunner in the search. Modified GWO (MGWO) emphases on appropriate sense of balance among investigation and mistreatment that tips to an ideal presentation of the procedure.

**Start**

- Initialize quantity of wolves and prey location space

- Compute average of wholly strategy variables (VMP, VMM, EC, and SLA)

- Find the finest contender resolutions alpha, beta, and delta

- Trail and enclose the prey with guidance

  - If alpha == prey?
    - No
    - Yes: Attack and acquire ideal VM

**End**

*Figure 1. MGWO Metaheuristic Algorithm*

**Modified Ant Lion (MALO)**

Literature concerning the use of ALO for the harmonization problem lacks? Ant lion optimizations have its place to the naturally motivated computational exploration. This procedure simulates the accepted activities of the Ant lion creature. The lifespan of Ant lion creatures involves binary stage: young insect and fully developed. The full development can take around 3 years that typically happens in young insect. The fully developed usually lives for about 25-45 days. The Ant lion adulthood stage is in use for reproduction and young insect for pursuing. An Ant lion young insect pits a tightened setup in the soils by moving above a rotational path and propelling out grits by his large shovel-shaped skull. Afterward digging the trap, the young insect concealed himself below the soil at the middle of the narrowed setup and waits for their ant or further prey to be locked in the pit. The setup is a flawlessly narrowed form with sheer edges and its edge is sharp sufficient for ants to drop out to the pit. As soon as the ant drops out in the pit, it attempts to raise the walls of the pit to discharge from it. The Ant lion attempts to clip it by means of removing the soils near the end of the pit and trying to mouthful it. Later dragging and consuming the ant, Ant lions rug the scraps and soils outer the pit and make the setup for the succeeding hunt.
4. Proposed Work

Varieties of metaheuristic procedures are implemented with Cloud Simulator to get quasi-optimal solutions. This optimization policy is employed to get as tuned as promising conformation parameters of the VM selections (Standard Deviation of Host, VM Placement, VM Migration, Power Utilization, SLA violation, SLA Performance Degradation). Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Cuckoo Search (CS), Ant Lion Optimization (ALO), Modified Gray Wolf Optimization (MGWO) techniques are used to improve live VM migration process. These techniques try to enhance the migration by reducing the standard deviation of VM placement and migration, energy consumption, SLA performance degradation due to migration, and total SLA violation. The excellence of the Information as a Service layer (IaaS) in cloud computing can be assessed by keeping in attention together quality of service (QoS) and power utilization. We followed and did likewise to identify both under loaded and overloaded hosts by using Adaptive Inter quartile Range (IQR): Over-burden threshold is planned with dynamism by Inter Quartile Range method and furthermore for VM selections Minimum Migration Time (MMT) is used. The experimental analysis was done using the CloudSim toolkit. It is an open foundation package used by many researchers to simulate the Cloud background.
5. Results and Discussion

For virtual machine selection, Minimum Migration Time procedure is evaluated. To compare the effectiveness of planned optimization algorithms seven parameters the power utilization, standard deviation of Host, standard deviation of VM placement, standard deviation of virtual machine migration, SLA performance degradation due to relocation, total SLA violation and Makespan are taken into account. The result for all the above mentioned seven parameters are formed by proposed optimization algorithms is given in table 1 to table 4.

| Table 1. Standard deviation of Host, VM placement and VM migration |
|---------------------------------------------------------------|
| Optimization Algorithm | Host SD | Host Mean | VM Placement SD | VM Placement Mean | VM Migration SD | VM Migration Mean |
|------------------------|---------|-----------|------------------|-------------------|-----------------|-----------------|
| Any Colony Optimization | 0.00357 | 0.00151   | 0.00650          | 0.00596           | 7.89            | 17.62           |
| Particle Swarm Optimization | 0.00406 | 0.00179   | 0.00908          | 0.00613           | 7.93            | 20.33           |
| Cuckoo Search Optimization | 0.00389 | 0.00185   | 0.00746          | 0.00590           | 7.44            | 20.39           |
| Modified Ant Lion Optimization | 0.00472 | 0.00188   | 0.00429          | 0.00181           | 7.95            | 20.35           |
| Modified Grey Wolf Optimization | 0.00358 | 0.00122   | 0.00473          | 0.00213           | 8.03            | 20.06           |
Table 2. Energy Consumption

| Optimization Algorithm                  | Energy Consumption |
|-----------------------------------------|--------------------|
| Any Colony Optimization                 | 47.85              |
| Particle Swarm Optimization             | 46.86              |
| Cuckoo Search                           | 46.73              |
| Modified Ant Lion Optimization          | 34.35              |
| Modified Grey Wolf Optimization         | 34.13              |

Table 3. SLA Performance Degradation and Overall SLA Violation

| Optimization Algorithm                  | SLA Performance Degradation due to Migration (%) | Overall SLA Violation (%) |
|-----------------------------------------|-----------------------------------------------|---------------------------|
| Any Colony Optimization                 | 0.23                                          | 1.05                      |
| Particle Swarm Optimization             | 0.26                                          | 1.13                      |
| Cuckoo Search                           | 0.25                                          | 1.16                      |
| Modified Ant Lion Optimization          | 0.14                                          | 3.17                      |
| Modified Grey Wolf Optimization         | 0.14                                          | 3.69                      |

Table 4. Makespan

| Optimization Algorithm                  | Makespan ($) |
|-----------------------------------------|---------------|
| Any Colony Optimization                 | 0.00131       |
| Particle Swarm Optimization             | 0.00011       |
| Cuckoo Search                           | 0.00016       |
| Modified Ant Lion Optimization          | 0.00005       |
| Modified Grey Wolf Optimization         | 0.00082       |

Figure 4. Energy Consumption
The result of energy consumption is given in Figure 4. It can be observed that Modified Grey Wolf Optimization scored minimum energy consumption followed by Ant Lion Optimization.

![Figure 5. Standard deviation of VM migration](image)

The result of standard deviation of VM migration is given in Figure 5. It can be observed that Cuckoo Search Optimization scored minimum standard deviation followed by Ant Colony Optimization.

![Figure 6. Standard deviation of VM placement](image)

The result of standard deviation of VM placement is given in Figure 6. It can be concluded that Ant Lion Optimization scored minimum standard deviation followed by Modified Grey Wolf Optimization.
The result of standard deviation of Host placement is given in Figure 7. It can be observed that Ant Colony Optimization scored minimum standard deviation followed by Modified Grey Wolf Optimization.

The result of SLA performance degradation due to migration is given in Figure 8. It can be concluded that Ant Lion and Modified Grey Wolf Optimization scored minimum SLA performance degradation due to migration followed by Any Colony Optimization.
Figure 9. Overall SLA Violation

The result of overall SLA violation is given in Figure 9. It can be concluded that Ant Colony Optimization scored minimum overall SLA Violation followed by Particle Swarm Optimization.

Figure 10. Makespan

The results of Makespan is shown in figure 10. It can be concluded the Modified Ant Lion Optimization scored minimum Makespan followed by Particle Swarm Optimization.

6. Conclusion

Extra assets are required throughout the VM relocation procedure. Submissions running on migrant VMs are harshly exaggerated till VM movement finishes. VM movement procedure must be effectively accomplished within minimal relocation time so that arrangement assets can be made free as soon as possible. Ideal host and network assets utilization is necessary to improve claim presentation and relocation clearness. At the end of running all simulation, we find out which policy delivered agreeable outcomes, it can be seen that for power usage Ant Lion and modified Grey Wolf optimizations give
great result, compared with rest of the optimizations; for standard deviation of VM placement and SLA performance degradation due to migration Ant Lion and Grey Wolf produced good outcome. From our outcome we additionally discover that for standard deviation of VM migration Cuckoo search significantly outperforms other optimization algorithms. Ant Colony optimization and Particle Swarm optimization give minimum overall SLA violation. To optimize the VM Migration, initial step is to find out burdened host and next step to find out the precise VMs to transfer from any host to the other.

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