International Journal of Mathematics and Computer Research

ISSN: 2320-7167

Volume 11 Issue 09 September 2023, Page no. 3740-3745

Index Copernicus ICV: 57.55, Impact Factor: 7.362

DOI: 10.47191/ijmcr/v11i9.07

Role of Mathematical Model in Cloud Computing

Sandeep Shrinath Gupta[1], Jayprakash Yadav[2]
[1] Research Scholar, JJT University, Jhunjhunu, Rajasthan
[2] Prahladrai Dalmia Lions College, Mumbai

ARTICLE INFO	ABSTRACT
Published online: 09 September 2023 Corresponding Author: **Jayprakash Yadav**	Various Mathematical Model plays an important role in the modeling of Cloud Computing. Cloud Computing environment is the task scheduling which plays major role of efficiency for various cloud computing facilities. Task scheduling means the workspace to allocate best suitable resources for the task to be executed with the consideration of different kinds of parameters like timeliness, cost function, scalability, reliability, availability, utilization of resource, etc.. The proposed model algorithm considers reliability, utilization of resource and availability. Most task scheduling algorithms do not consider the some of the aspects like scalability, reliability and availability of workspace (Cloud Computing Environment) because of various parameters. There is one of the best model using Mutation of Load Balancing by Particle of Swarm Optimization (MLBPSO) which is based on task scheduling. MLBPSO is based on schedule and allocation for cloud computing that takes the task into account reliability, execution time, transmission time, round trip time, transmission cost and load balancing between tasks and virtual machine. A virtual machine (VM) is an Operating System (OS) or application environment that is installed on software, which imitates several dedicated hardware. The end user has the same experience on a virtual machine as they would have on dedicated hardware. Created MLBPSO can play a important role in reliability of cloud computing environment and also there are chances of rescheduling of various task.

KEYWORDS: Cloud Computing, Virtual Machine, Swarm Optimization, MLBPSO, Load Balancing, MathematicalModel, etc…

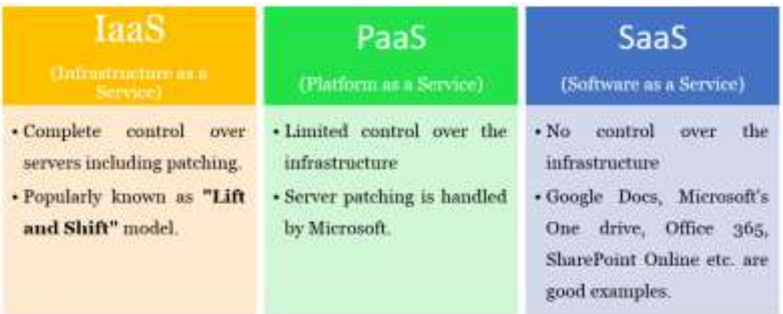
INTRODUCTION

Cloud Computing is theuse of various services, such as software development platforms, servers, storage and software, over the internet, which is termed as "cloud."

In general, there are three cloud computing characteristics that are common among all cloud-computing vendors. (a) The back-end of the application (especially hardware) is completely managed by a cloud vendor. (b) A user only pays for services used (memory, processing time and bandwidth, etc.). (c) Services are scalable.

The cloud is a very broad concept, and it covers just about every possible sort of online service, but when businesses refer to cloud procurement, there are usually three models of cloud service under consideration, Software as a Service (**SaaS**), Platform as a Service (**PaaS**), and Infrastructure as a Service (**IaaS**).

Difference between IaaS, SaaS &PaaS :



Proposed Mathematical Model Structure

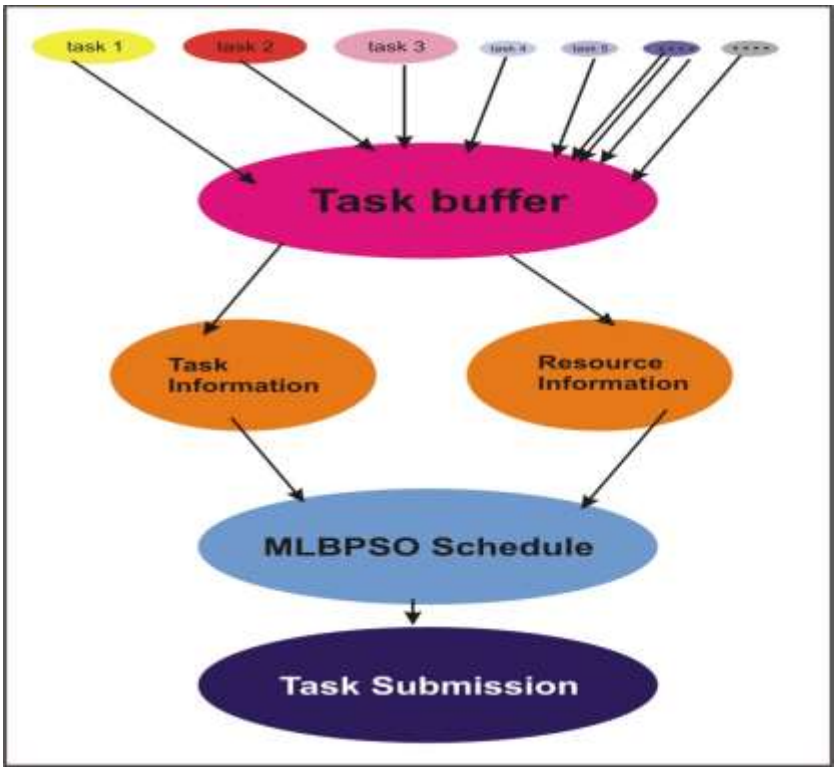


Figure 1

The main work of our model is to allocate tasks to various virtual machines(VMs) with analyzing reliability. The structure of our proposed model is shown in Figure 1. Proposed mathematical model consists of five phases. They are :

Task Buffer

There are millions of users require to execute tasks in the cloud computing. Task buffer is responsible for collecting tasks from user.

Task Information

This phase provides the necessary information of Tasks arrived into cloud computing environment for execution. Those information such as Expected Execution Time (EE_T), Expected Transmission Time(ET_T), Resources-Required Time (RR_T) and Round Trip Time(RT_T) .

Resource Information

This phase is responsible for collecting the information about resources in cloud computing environment. The resources in cloud computing are Datacenter Hub, Hosting and Virtual Machines (VMs). Datacenter Hub information is host list, VMs list, storage list and cost of memory and other information. Each hosting can contain more than one VM. The information of hosts and VMs such as ram, bandwidth and other information. These information machines are passing to next phase of mathematical model.

MLBPSO

Mutation of Load Balancing by Particle of Swarm Optimization (MLBPSO)is used to reschedule tasks, that makesfailure to schedule. Particle of Swarm Optimization (PSO) have two problems. First problem, tasks may make failure to allocate to virtual machine. Second problem, task may allocate to more than one VM. In this phase solve the problems by reschedule wrong tasks and take in account load balancing of virtual machine. Solving these problems help to achieve reliability, users assert task executed without failure, minimize execution, minimize round trip time and improve other parameters.

Task Scheduling Problem Formulation of proposed systems

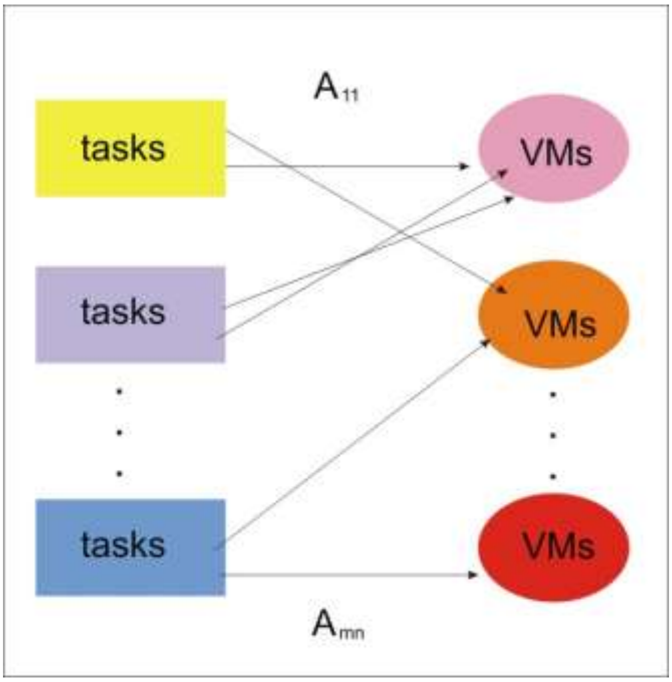


Figure 2: task mapping to virtual machines

Nomenclature	
N	Observed number of tasks
M	Observed number of Virtual Machines (VMs)
Xij	Decision variable of allocating i task to j VMs or not
EE_T	Expected Execution time
ETR_T	Expected Transmission Rate Time
ERT_T	Expected Round Trip Time
mem_j	Memory allocate to VMs j
cpu_j	Cpu allocate to VMs j
Tmem	Total memory of datacenter
Tcpu	Total cpu of datacenter

There are several tasks and several virtual machines (VMs). There are n tasks and m number of VMs. Each task may allocate to any VMs. Figure 2 shows mapping of Tasks to Virtual Machines. Each task must schedule to only one virtual machine. PSO attempts to select optimal distribution of tasks to virtual machines for achieving objective. Three mathematical models proposed for task scheduling. Each model consists of objective function and several constraints. Objective function of first model is to minimize execution time based on expected execution time (EE_{Tij}) of task i in VMs j. Equation (1) used in calculate processing time as: EE_T(processing time) = length $_i$. lengthi is number of instruction of task i require to execute. Second objective function is to minimize transmission time (ETR_{Tij}). Expected transmission time (ETR_{Tij}) of task i to VMs j responsible for achieving second objective function. ETR_{Tij} equals file size / bandwidth. To minimize round trip time (RT_T) (3) is achieved by third mathematical model. The RTT is the (latency) time for the whole procedure involving the sending and the receiving. ERT_{Tij} is expected round trip time calculate by ETR_{Tij} + delay + EE_{Tij} + delay. x_{ij} is allocating task i to VMs j or not . The value of x_{ij} may one or zero. Each model has the same constraints. Each Task allocate to only one virtual machine achieve by first constraint in (2). Equation (3) and (4) represent resource of all virtual machine less than or equal resource of datacenter. x_{ij} assign positive number.

First Mathematical Model Based on Expected Execution Time

Minimize

$$z = \sum_{i=0}^{n}\sum_{j=0}^{m} EE_{Tij} * x_{ij}$$

Subject to

$$\sum_{j=0}^{m} x_{ij} = 1 \qquad \forall i$$

$$\sum_{j=0}^{m} cpu_j \leq Tcpu$$

$$\sum_{j=0}^{m} mem_j \leq Tmem$$

$$x_{ij} \geq 0 \qquad \forall\, i, j$$

Objective function of Second Mathematical Model based on Expected Transmission Time(ETR_T)

Minimize

$$z = \sum_{i=0}^{n}\sum_{j=0}^{m} ETR_{Tij} * x_{ij}$$

Objective function of Third Mathematical Model based on Expected Round Trip Time(ERT_T)

$$z = \sum_{i=0}^{n}\sum_{j=0}^{m} ERT_{Tij} * x_{ij}$$

Mutation of load balancing by Particle Swarm Optimization (MLBPSO)

The particle swarm optimization (PSO) algorithm is a population-based search algorithm based on the simulation of the social behavior of birds within the flock and fish school proposed by Kennedy and Eberhart. Let us define the notation adopted in this paper during the D-dimensional search space, each particle in this space defined as apotential solution to a problem, i.e. the i^{th} particle of the swarm represented as $X_i = (x_{i1}, x_{i2,} \dots \dots .., x_{iD})$, and its velocity defined as $V_i = (v_{i1}, v_{i2,} \dots \dots .., v_{iD})$. The update the particles at each generation are accomplished accordingto (7), (8). In the iteration t, the velocity $v_i(t)$ has been update to pull the particle i_{th} towards its own best position x_{pi} and the best position for all the particles x_g that has the best fitness value until the preceding generation. Also it is observe, the current velocity of each iteration t based on v_i (t-1) is the velocity of the pervious iteration, r_1, r_2 mean a uniform random variables between 0 and 1 this two random values are generated independently, c1, c2 are a positive constant, and w is the inertia weight. Equation (3) updates each particle's position in the solution hyperspace using the computed v_i (t) and the coefficients c and d that could be set to unity without loss of generality. Pso was used to allocate tasks to vms but, there are some problems. First problem, some task doesn't allocate to vm. Second problem some tasks allocate to more than one vm. Third problem is premature convergence. Load balancing mutation added to Particle Swarm Optimization to solve previous problem as show in Fig. 3. Load balancing mutation improved in other parameters such as minimize make span, minimize execution time, minimize round trip time and minimize cost. Also, achieve reliability and load balancing. The idea of Load balancing mutation Particle Swarm Optimization (LBMPSO) reschedule the failure tasks to the available (VM) with take into account load of each vm. LBM guarantee all vm executed number of tasks appropriate with their load of vm. In LBM, First Determine failure tasks.Second calculate load of virtual machines as load of vmi=(resource of vm_i /total resource)*N. Third sort tasks based on resource needed and sort vms based on load. Last Reschedule failure tasks to vm based on load of each vm as in algorithm 1.

$$v^{k+1} = wv^k + (c * r) * (pbest - x^k) + (c * r) * (gbest - x^k)$$

$$x^{k+1} = x^k + v^{k+1}$$

Nomenclature	
v^k	Velocity of particle at iteration k
v^{k+1}	Velocity of particle at iteration k+1
w	Inertia weight
c	Acceleration coefficient
r	Random number between 0 and 1
x^k	Current position of particle at iteration k
x^{k+1}	Current position of particle at iteration k+1
pbest	Best position of particle

gbest	Position of best particle in population

Get best solution of pso
for all task $\{t_i\}$ЄT **do**
Determine unallocated tasks
Determine tasks allocated to more than one *vm*(wrong tasks)
end for
for all virtual machine {vmi}ϵVM do
Determine current tasks allocated to vmi (current load vm)

Determine real load of vmi (real load vm)
end for
Sort vm based on real load

Sort wrong tasks based on resource needed

for all sorted virtual machine {svmi}ЄVM do

for all sorted task {sti}ЄT do
if real load vm>current load vm
Schedule task from wrong tasks

Remove task from sorted tasks list

Current load vm++

Else

break; // Exit to get next vm because this vm take load based on resource
end if
end for

end for

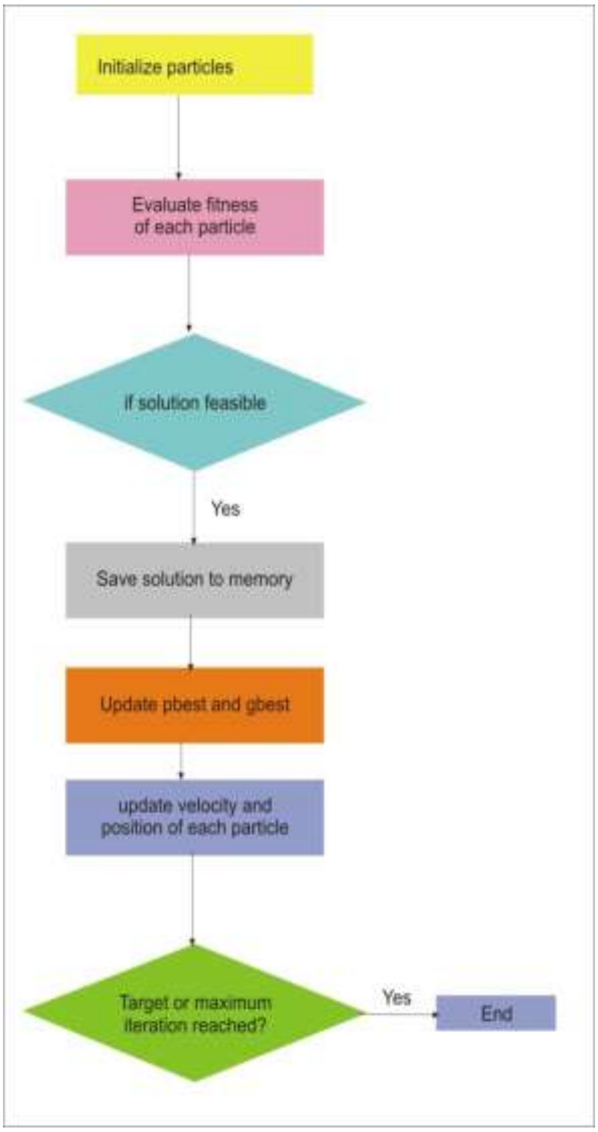


Figure 3 : MLBPSO Algorithm

CONCLUSION AND FUTURE WORK

In this paper, taska scheduled based on Mutation of load balancing by Particle Swarm Optimization (MLBPSO). MLBPSO used to minimize cost, minimize roundtransmission time, achieve load balancing between tasks and virtual machine, consider available resource and minimize the complexity in cloud computing environment. MLBPSO improves the Reliability of cloud computing and good distribution of tasks onto resources compared to other algorithms. We found that round trip time load balancing mutation PSO can achieve the best compared to other algorithms. In addition, proposed algorithm take in account the load balancing when distributing tasks to available resources, tasks assign as earlier as possible, finished as earlier as possible and reschedule failure tasks. It can be used for any number of tasks and resources.

REFERENCES

1. https://searchservervirtualization.techtarget.com/definition/virtual-machine
2. https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/

3. https://www.techopedia.com/definition/2/cloud-computing
4. https://apprenda.com/library/paas/iaas-paas-saas-explained-compared/
5. https://www.google.com/search?source=hp&ei=lUaXW4PzG4SKvQTv9rOQCg&q=iaas+saas+paas&oq=iaas%2Csaas&gs_l=psy-b.1.0.0l10.21726.25258.0.28632.11.10.0.0.0.0.707.2288.2-2j0j1j1j1.5.0....0...1.1.64.psy-ab..6.5.2284.0..0i131k1j0i10k1.0.wkw5-XHE-P0
6. https://i2.wp.com/susheeldakoju.com/wp-content/uploads/2015/12/IaaSPaaSSaaS.png
7. EberhartR , Kennedy J, “*A New Optimizer Using Particle Swarm Theory*", 6th International Symposium. Micro Machine and Human Science, Nagoya;1995,p. 39-43.
8. BalaA,Chana I. "A *Survey of Various Workflow Scheduling Algorithms in Cloud Environment*". 2nd National Conference on Information and Communication Technology;2011,p. 26-30