Enhance Cost Aware Ant Colony optimization

Based on Cloud Scheduling

Project report submitted in partial fulfillment of the requirement for the degree of Bachelor of Technology

in

Information Technology

By

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To

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CERTIFICATE

I hereby declare that the work presented in this report entitled "Enhance Cost Aware Ant Colony optimization Based on Cloud Scheduling" in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Information Technology submitted in the department of Computer Science & Engineering/Information Technology, Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from August 2017 to Dec 2017 under the supervision of (Dr.Punit Gupta) (Assistant Professor Grade II, Department of Information Technology).The matter embodied in the report has not been submitted for the award of any other degree or diploma.

(Students' Signature) (Students' Signature)

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

(Supervisor Signature)

Dr.Punit Gupta

Assistant Professor(Grade II)

Department of Information Technology

Dated:

ACKNOWLEDGEMENT

I owe my profound gratitude to my project supervisor Dr. Punit Gupta, who took keen interest and guided me all along in my project work titled **"Enhance Cost Aware Ant Colony optimization Based on Cloud Scheduling**" till the completion of my project by providing all the necessary information for developing the project. The project development helped me in research and I got to know a lot of new things in my domain. I really thank him for the constant unstinted support and invaluable guidance throughout the completion of my project.

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LIST OF ABBREVIATIONS

ABBREVIATION	FULL FORM
SAAS	Software As A Service
PAAS	Platform As A Service
IAAS	Infrastructure As A Service
Qos	Quality of Service
MIPS	Millions of instructions per second
PSO	Particle Swarm Optimization
ACO	Ant Colony Optimization
VMM	Virtual Machine Monitor
VM	Virtual Machine
SLA	Service Level Agreement

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ABSTRACT

ANT Colony Optimization is a task scheduling algorithm in which we schedule tasks by allocating them to resources. In this project, resources are designated as virtual machines and tasks are designated as cloudlets. Earlier many task scheduling algorithms are proposed to improve the performance but have not cost efficient at the same time. PSO and Round Robin are efficient solutions but not cost effective. So to overcome the issues We have proposed learning based cost efficient algorithm for cloud infrastructure. In early proven task scheduling algorithms network cost is not included but in my proposed ACO network overhead or cost is taken into consideration which thus improves the efficiency of the algorithm as compared to the previous algorithm. We have made the comparison of my proposed ACO with FCFS algorithm as well as with PSO. Also, We have used cloud simulation which is a framework for modeling and simulation of cloud computing infrastructures and services and real-time as well as the local cloud environment. The proposed ACO works well and is much improved in terms of efficiency and execution cost.

CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

Before cloud computing comes to life, business was very expensive and complicated. Most of the costs were getting wasted in hardware and software requirement. Traditional business needs the whole team for the update, run, test etc. Now this headache of maintaining hardware and software requirement for managing the big amount of data has become the responsibility of the third party vendor like Salesforce. With the help of cloud computing, the decrease of the cost is drastic, we only pay what we need. Most of the big companies have shifted their business towards cloud computing because managing that much of large data is almost impossible and costly as well. Cloud computing includes many features like adaptability, multitenant, reliability, scalability and security. The most familiar topic that is in use for every network is cloud computing. This serves as a medium for the user so that they can access the information of all type using a web browser or a network. People do not need any costly or time-consuming techniques for computing huge data. Features for this cloud computing technique are a reduction in cost, scalability, a small amount of effort required in the field of management does not depend on any device or location. Cloud computing provides three services IaaS (infrastructure as a service) in this service client does not need to buy any software or server for operating the data on the cloud it delivers everything from our operating system to the servers, PaaS (Platform as a service) this service is the most complex service among three. Has some similarity that of SaaS, the major difference is that it does not deliver any application online it provides the client with a platform for creating an application that can be delivered online, Saas (Software as a service) provide the licensure of application to the clients. Cloud computing delivers the services over the internet through various tools, opposing to direct communication to a server. Storing files on hard drive etc is a difficult and costly task and accessing them from a remote area is somewhat impossible. So cloud computing is the best solution for this problem.

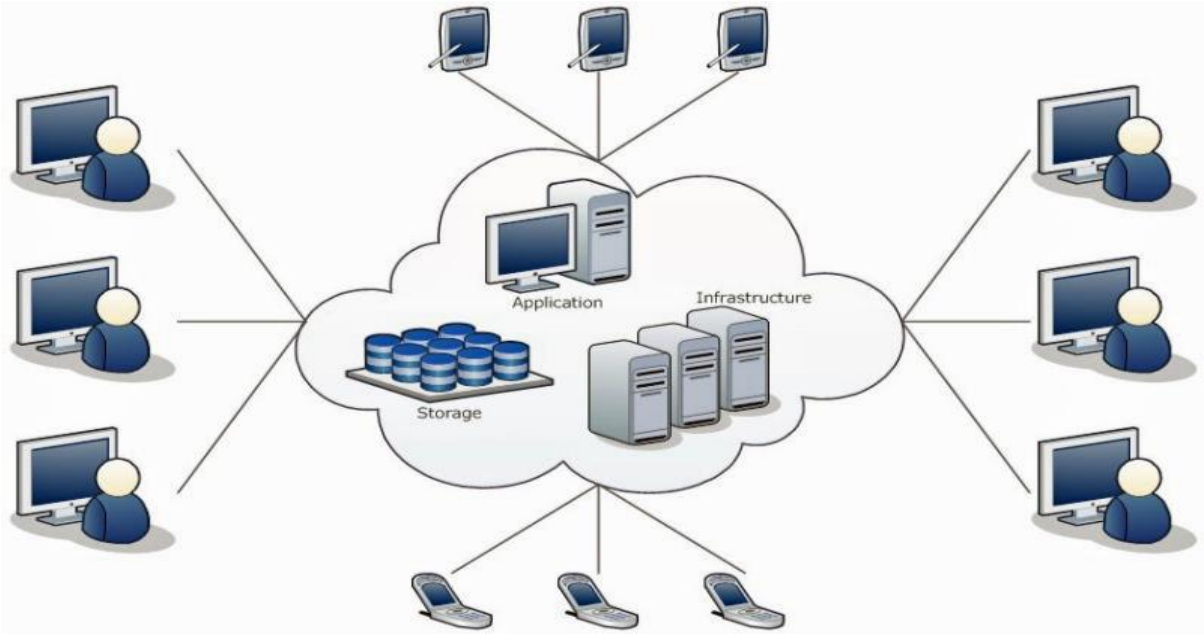

Figure 1. Cloud Computing

DEPLOYMENT MODELS

Deployment model define the type of success that you can have for the cloud. Mainly there are 4 types of deployment models present in the market.

- Public,
- Private,
- Hybrid
- Community

Public cloud

Publically shared virtualized resources. supports multiple customers. Supports connectivity over the internet. Suited for less confidential data. Multi-tenant implementation. Owned and operated by service provider. Bound by multi-tenant data management policies. Similar self-service and automation capabilities as private cloud. Multiple clients. Hosted at providers location. Shared infrastructure. Access over the internet. Low cost.

Figure 2: Public cloud

Private cloud

Privately shared virtualized resources. Clusters of the dedicated customer. Connectivity over the internet, fiber and private network. Suited for secured confidential information & core system. Single tenant implementation. Owned and operated by IT organization. Define your own data management policies. Self-service and automation capabilities provide new agility

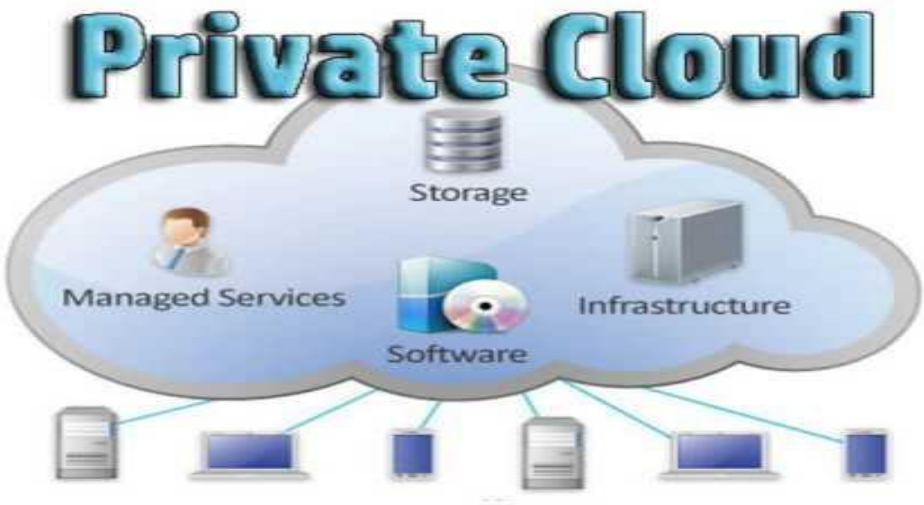

Figure 3 : Private cloud

Hybrid cloud

A cloud computing service that is composed of some combination of private , public and community cloud services from different services providers for capacity or capability.

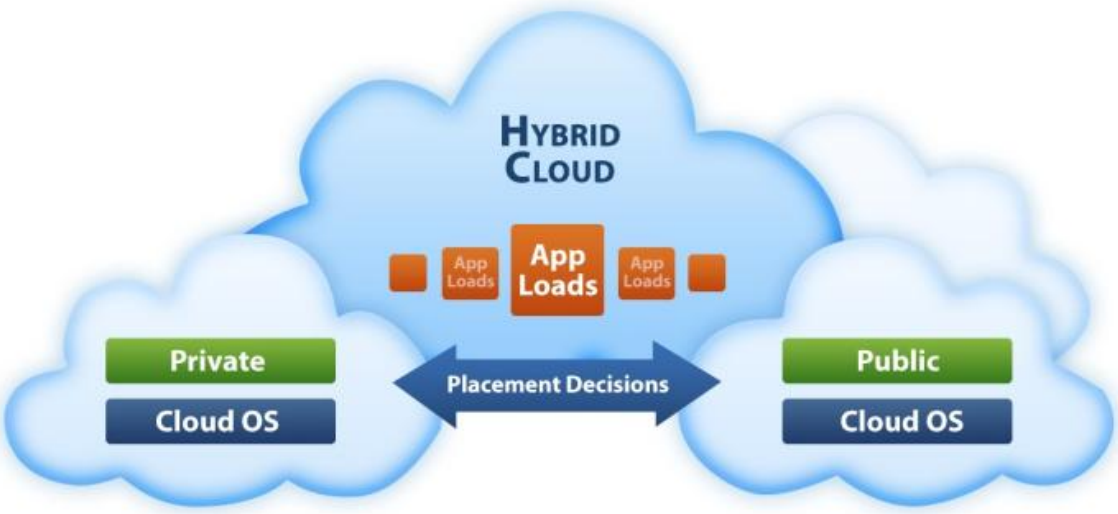

Figure 4: Hybrid cloud

SERVICE MODELS

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Software as a Service (SaaS)

Cloud computing are based on references models these models are known as service models that provide services to the cloud computing.

Infrastructure as a Service (IaaS)

Compute, storage. networking. AWS, Google cloud platform, Azure, OpenStack stack. Virtualization as a service. A virtual platform on which required operating environment and application are deployed. includes storage as a service offering. outsource elements of infrastructure like virtualization, storage and networking. Used by system managers. Services provided by IaaS are virtual machines, operating system, messaging queues, network, storage, CPU, memory, backup services. its create platforms for service and application test, development, integration and deployment.

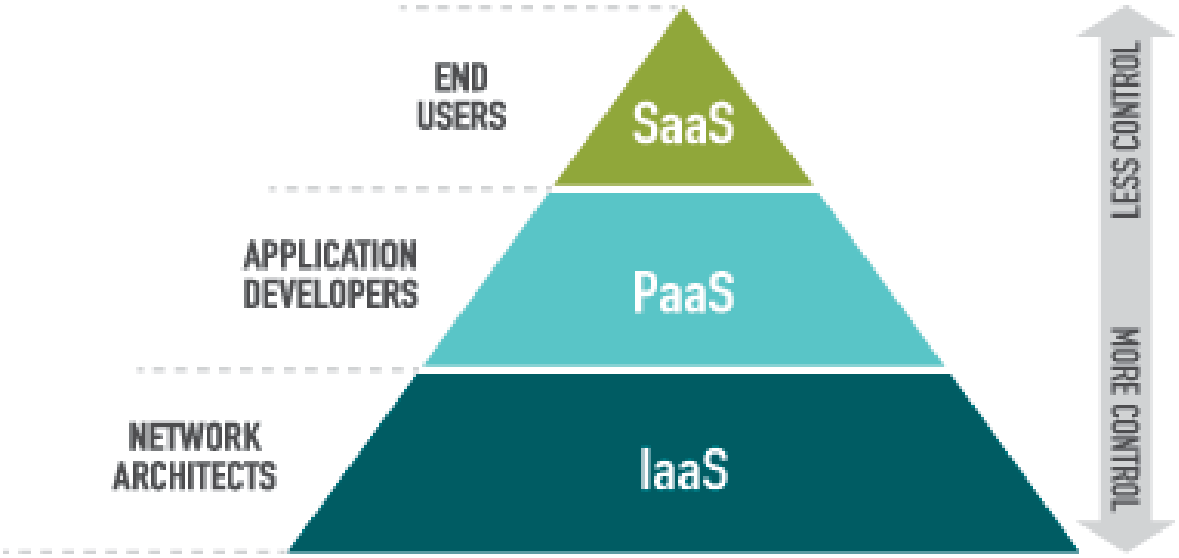

Figure 5: Service models

Saas (Software As A Service)

Saas is a short form of software as a service, wherein software can be accessed through the web. A user can access applications using any internet enabled devices. Such software can be accessed anywhere, anytime. they are low-cost subscription based. Scaling up or down is easy with saas. It is a distribution model in which application is hosted by the vendor or service provider and made available to customers over a network typically the internet.

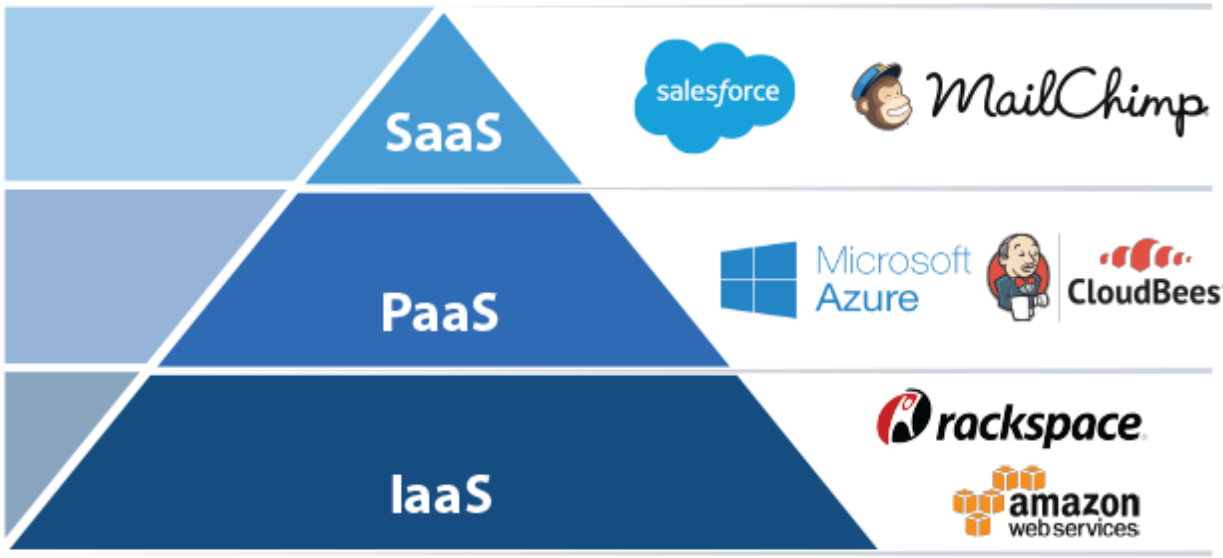

Figure 6 : examples of service models

Paas (Platform As A Service)

Application development framework as a service. Rapid development framework resource provisioning without admin involvement. Best efficiency through high resource utilization. Reduced expenditure on own maintenance specialists. Services to develop, test, deploy, host, and maintain applications. CPU, memory usage, infrastructure, operating system, programming language and execution environment, database, web server, and security maintained by the service provider. Access for multiple concurrent users to the same development application. Support for development team collaboration. Ability to the use software components controlled by a third party

.

Figure 7: Cloud computing

1.2 PROBLEM STATEMENT

Now a day's tasks are big and require high computations. For this, we need cloud computing technique that provides us with a reliable and problem-solving platform. All big industry in all department whether you take name any in banking, e-commerce, trading all industries are following the new trend of cloud computing for storage and retrieval of data over the internet. In case any failure occurs, it will divert the request to the other server. Techniques that are used in scientific research such as forecasting of weather reports, imaging of satellites, and all the application in which computational tasks are very high can be done by cloud computing in which they do not have to create their own private server. Migration of computation tasks scheduling and managing resources in the cloud is the problem.

We need scheduling algorithms like PSO, FCFS, MSO, MAX-MIN, and MIN-MAX to properly schedule them. In our project, we have used the existing ACO and modified it to give better result in terms of time and execution cost. Our ACO provides the most efficient result compared to round robin and existing ACO.

Security in the cloud

The information housed on the cloud is often seen as a value to individuals with malicious intent. There is a lot of personal information and potentially secure data that people store on their computers, and this information is now being transferred to the cloud.

The first thing you must look into is the security measures that your cloud provider already has in place

- What encryption methods do the providers have in place?
- What methods of protection do they have in place for the actual hardware that your data will be stored on?
- Will they have backups of my data? Do they have firewalls set up?
- If you have a community cloud, what barriers are in place to keep your information separate from other companies?

.

Cloud computing challenges

Some of the notable challenges associated with cloud computing.

• **Security and privacy:** perhaps two of the more "hot button" issues surrounding cloud computing relate to storing and securing data, and monitoring the use of the cloud by the service providers.

These issues are generally attributed to slowing the deployment of cloud services.

Results in hybrid cloud deployment with one cloud storing the data internal to the organization.

•**Lack of standards:** clouds have documented interfaces; however, no standards are associated with these, and thus it is unlikely that most clouds will be interoperable.

•**Continuously evolving:** the requirement of interfaces, networking, and storage.
This means that a cloud especially a public one, does not remain static and is also continuously evolving.

•**Regulatory and compliance restriction:** the Sarbanes-Oxley act(sox) in the US and data protection directives in the EU are just two among many compliance issues affecting cloud computing, based on the type of data and application for which the cloud is being used.

Results in hybrid cloud deployment with one cloud storing the data internal to the organization.

1.3 OBJECTIVE

A task scheduling algorithm in which VMs are designed as resources, cloudlets are designed as task and we are scheduling all the task by allocating each of them resources. Many task scheduling algorithm have been out there which are giving result on the basis of the performance but all of them are not effective if we take in account the cost as well. Particle swarm optimization, round robin etc all these algorithm gives you improved result in terms of performance but of we talk about cost as well they fail.

In our project we will improve the existing ACO that will give improved result in terms of performance and cost for cloud architecture. Our study includes the comparison between various other algorithms with our proposed ACO model. PSO, FCFS, ACO etcetera.

Our proposed ACO is much more effective and give better cost and execution time.

1.3 METHODOLOGY

The field of ‘ant colony algorithms’ studies models derived from the behavior of real ants and it's wide used for combinatorial improvement issues. Ant colony algorithms are developed as heuristic strategies to spot economical methods through a graph and are applied to spot best solutions for service composition issues. The options of Ant colony algorithms embody feedback and native heuristics. Associate in nursing Ant colony improvement (ACO) algorithmic program iteratively performs a loop containing 2 basic procedures. The primary is however the ants construct solutions to the matter, and also the second is the way to update the secretion trails. Victimization ACO algorithms to unravel combinatorial improvementissues, needs a illustration of the matter and also the definition of the that means of secretion trails, furthermore because the heuristic info. As a result of the results of the many ACO applications to NP-hard combinatorial improvement issues show that the most effective performance is achieved once coupling ACO with native optimizers, it's necessary to implement Associate in nursing economical native search algorithmic program.

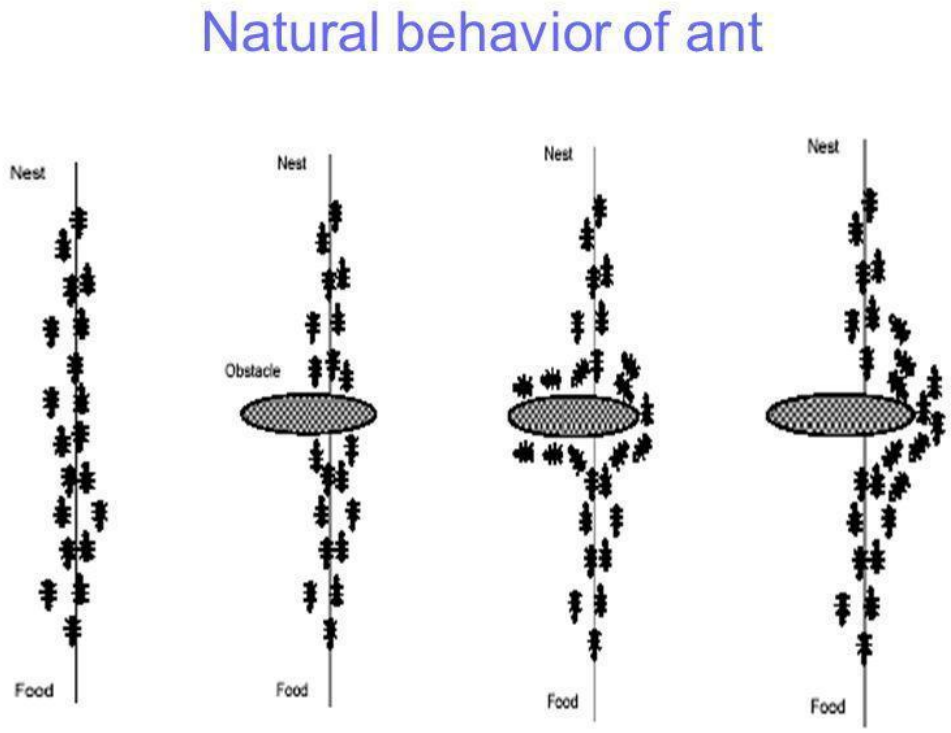

Figure 8: Ant behavior

In this section we have propose an task scheduling algorithm in cloud using ACO as cost as an fitness parameter. The algorithm works on the basic fundamentals of ant colony optimization with a little modification. This algorithm is divided in 4 phases. Each phase has its importance in making cloud scheduling more cost efficient and highly utilized. The phases are as follows.

1. **Initialize Pheromone Values**

It is the first step performed when an ant moves between the nodes value is update as per ant's movement. In this default, values are updates according to the datacenter values when a request is received

2. **Construct Solution**

After initializing pheromone values "datacenter resources" a map of resources is kept from where the resource will be allocated to the new cloudlets demanding new resources.

3. Local Search

When a request for resource is made, the ACO search algorithm comes into function finding the best available resource considering utilization of resource, particular resource is allocated to the cloudlet.

4. Pheromone Update & Evaluation

When the cloudlet is allocated its required resource, the local pheromone values "the resource values available at datacenters" are updated. This update is done on both allocation and freeing up of resource.

1.4 ORGANISATION

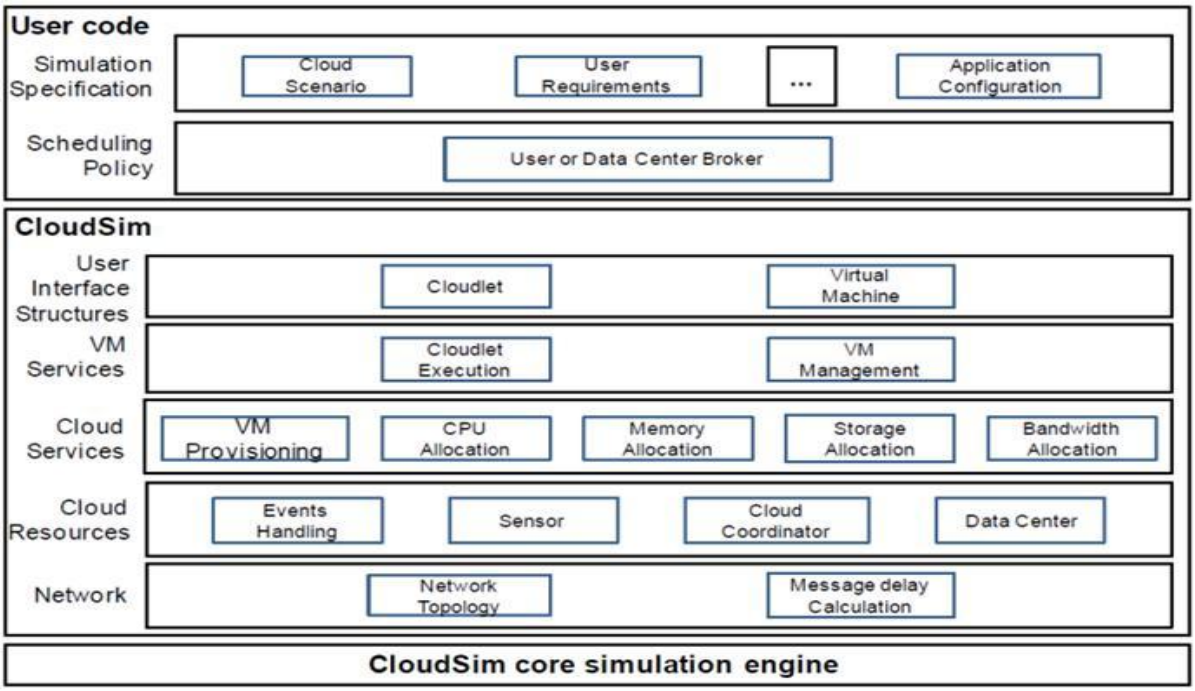

Figure 9: Architecture

The above figure represents the software framework for the cloudsim and its implementation in layered architecture. The layers at the top of the architecture known as user code consists of all the functionalities of hosts that is number of vms, hoe many users are and the types of their application , hosts' functionalities , how many tasks and what are their requirement , scheduling policies of the broker.

This layer is use for performing robust test based on the configuration of the cloud and can obtain the various scenarios for the mix of configuration of application, availability of cloud, and distribution of request.

Data centre characteristics:

It contains all the configuration and all the iformation need for data center resource .

Data centers

It is infrastructure for various cloud computing services provided by the provider. It also consist of all the servers no matter whether it is oh homogenous or heterogonous and also don't depend on any other hardware configuration they have their own requirement.

Hosts:

This is model for resources that are physical in nature and include both computation and storage.

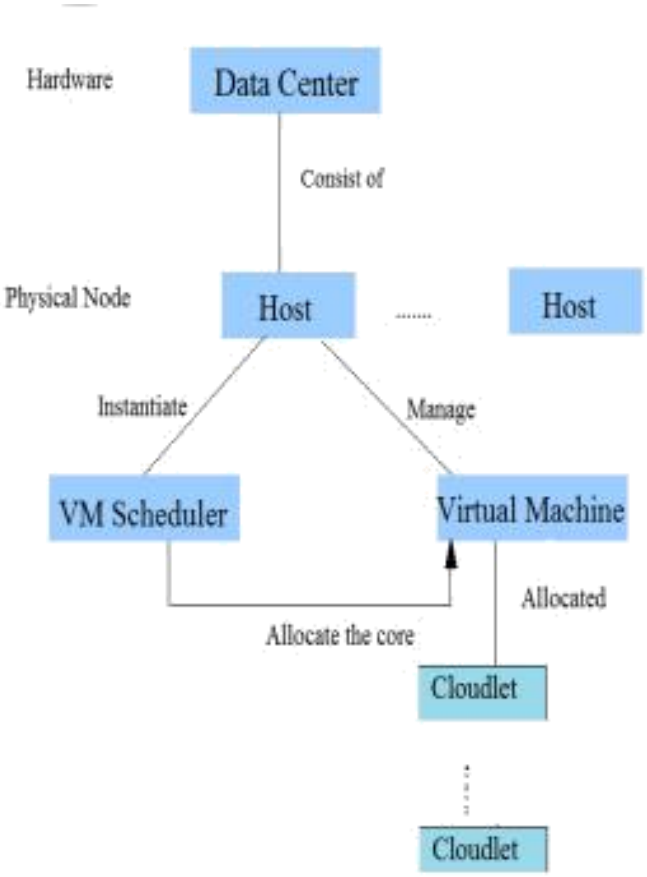

Figure 9: Flow chart of architecture

CHAPTER 2 LITERATURE SURVEY

2.1

A swarm is an approach to problem-solving technique that takes in account of the social behavior of insects, birds animals etc. The natural behavior of ants helps us in many successful optimization techniques, known as ANT colony optimization.

2.2 BIOLOGICAL INSPIRATION

Ant Colony Optimization Artificial Ants as a Computational Intelligence Technique

Marco Dorigo, Mauro Birattari, and Thomas St¨utzle Universit´e Libre de Bruxelles, BELGIUM September 2006

Swarm is an approach for problem solving technique that takes in account of social behavior of insects, birds animals etc. The natural behavior of ants helps us in many successful optimization techniques. one is known as ANT colony optimization .

What ants do is they produce pheromone on the path they travel from which other family members trace that pheromone to find favorable path.

This article introduces us to ACO and its application. Section I gives us knowledge about natural behavior Section II introduces us to ACO. Section III surveys theoretical results of ACO, and Section IV gives us its application. Section V is about some current hot research topics, and Section VI gives us the overview of other algoritm that is somehow related to the behavior of ants. Section VII concludes the article.

Deneubourg investigated an experiment “double bridge experiment” in which there are two bridges one longer than the other one that connects ants’ nest to their food source. Ant reaches the nest first are those who had choose the shorter bridge that is why the shorter bridge receives pheromone earlier than the other bridge and this fact somehow increases the probability for the further ants of their family member to choose that particular shorter bridge.

A model was proposed for this behavior to find the probability for ants to choose shorter path

$$p_1 = \frac{(m_1 + k)^h}{(m_1 + k)^h + (m_2 + k)^h} \ ,$$

Where m1 ants chooses the first bridge and m2 chooses the second bridge , monte carlo simulations shows good result for k=20 and h=2.

Problem type	*Problem name*	*Authors*	*Year*	*References*
Routing	Traveling salesman	Dorigo et al.	1991, 1996	[6], [8]
		Dorigo & Gambardella	1997	[11]
		Stützle & Hoos	1997, 2000	[15], [47]
	Vehicle routing	Gambardella et al.	1999	[48]
		Reimann et al.	2004	[49]
	Sequential ordering	Gambardella & Dorigo	2000	[50]
Assignment	Quadratic assignment	Stützle & Hoos	2000	[15]
		Maniezzo	1999	[18]
	Course timetabling	Socha et al.	2002, 2003	[35], [51]
	Graph coloring	Costa & Hertz	1997	[52]
Scheduling	Project scheduling	Merkle et al.	2002	[53]
	Total weighted tardiness	den Besten et al.	2000	[54]
	Total weighted tardiness	Merkle & Middendorf	2000	[55]
	Open shop	Blum	2005	[56]
Subset	Set covering	Lessing et al.	2004	[57]
	l-cardinality trees	Blum & Blesa	2005	[58]
	Multiple knapsack	Leguizamón & Michalewicz	1999	[59]
	Maximum clique	Fenet & Solnon	2003	[60]
Other	Constraint satisfaction	Solnon	2000, 2002	[61], [62]
	Classification rules	Parpinelli et al.	2002	[63]
		Martens et al.	2006	[64]
	Bayesian networks	Campos, Fernández-Luna,	2002	[65], [66]
	Protein folding	Shmygelska & Hoos	2005	[67]
	Docking	Korb et al.	2006	[68]

Figure 10: Application of ACO

Lots of researchers are applying ACO for N-P hard problems and only few are concern with dynamic and stochastic aspects as well as multiple objectives. In near future how to apply ACO to these problems may emerge as a major research.

Around 15 years from now when this idea was first coined it may seems to be crazy idea. But now many applications that are given above changes are thinking. This approach of using ants' behavior approximate solution of difficult optimization problems.

2.3 Ant Colony Optimization

Saad Ghaleb Yaseen Nada M. A.AL-Slamy June 2008

ACO is bio-simulation because of their relative individual simplicity & composite group behavior. This paper takes account of ACO into TSP. It takes a case study from Amman Seaport to derive the shortest route for good transportation inside Amman.

TSP ANT system

$$a_{ij} = \frac{[t_{ij}]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{l \in A_i}[t_{il}]^{\alpha}[\eta_{il}]^{\beta}} \forall_j \in N_i$$

This above formula is used to obtain ant routing table for node i and j where Ni is set of all neighbor node .

t_{ij} is pheromone trail and η_{ij} is local heuristic value . Where α is for pheromone trail and β is for heuristic value.

$$\mathrm{P}_{\mathrm{ij}}^{\mathrm{k}}(\mathrm{t}) = \frac{\alpha_{ij}(t)}{\sum_{l \in A_i}[\alpha_{il}}$$

The probability Pij (t) with which at the t-th algorithm iteration an ant k located in city I chooses the city j Є N to move to is given by the following above probabilistic decision rule.

The functioning of an ACO algorithm can be summarized as follows:

Ants move by using stochastic local decision policy based on following parameters, attractiveness & trails. Each ant's trail contributes to the solution. During construction phase ant modifies the trail value Updated information of pheromones helps future ants' trails. In ACO, an artificial ant builds a solution by travelling the completely connected construction graph G (C, L), where C is a set of vertices and L is a set of edges. An artificial ant moves through random edge and vertices and deposit pheromone on their trail to contribute towards promising result.

2.4 Ant Colony System: A Cooperative Learning Approach to the Traveling Salesman Problem

Marco Dorigo , Luca Maria Gambardella

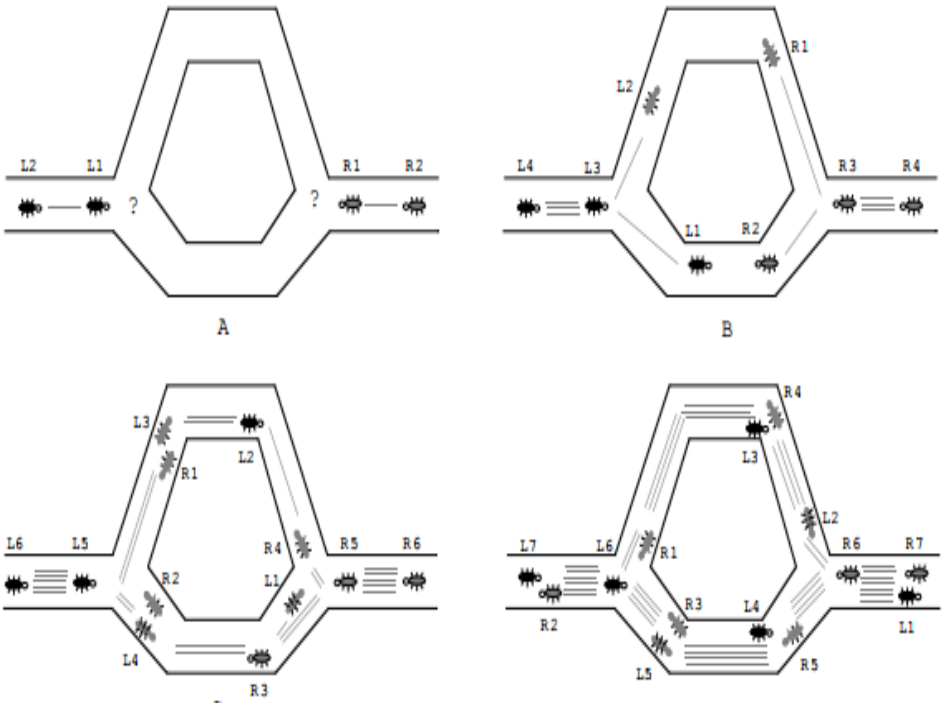

Figure 11: Travelling of ANT

This is how ant chooses their paths. At first some ants choose longer path some shorter the choice is purely random. Approximately ants' speed is nearly same those whose chooses the shorter path reaches the destination early than those who chooses the longer path. On the shorter path pheromone accumulation is more .

TSP

Let $V = \{a, \ldots, z\}$ be a set of cities, $A = \{(r,s) : r,s \in V\}$ be the edge set, and $\delta(r,s) = \delta(s,r)$ be a cost measure associated with edge $(r,s) \in A$.

The TSP is the problem of finding a minimal cost closed tour that visits each city once.

In the case cities $r \in V$ are given by their coordinates (x_r, y_r) and $\delta(r,s)$ is the Euclidean distance between r and s, then we have an Euclidean TSP.

ATSP

If $\delta(r,s) \neq \delta(s,r)$ for at least one edge (r,s) then the TSP becomes an asymmetric TSP (ATSP).

Figure 12: Algorithm of TSP

After all the ants completed their trail, at the ant of iteration that is in T time best and deposits its pheromone, defining the best path for next t+1 time during t+ ants will choose the edge that have most pheromone or high probability .but as the ant passes the path amount of pheromone get diminishes making it less desirable for future ants that allows the ant to search for new better path.

2.5 What is ANT COLONY OPTIMISATION?

Deneubourg investigated an experiment “double bridge experiment” in which there are two bridges one longer than the other one that connects ants’ nest to their food source. Ant reaches the nest first are those who had to choose the shorter bridge that is why the shorter bridge receives pheromone earlier than the other bridge and this fact somehow increases the probability for the further ants of their family member to choose that particular shorter bridge. A model was proposed for this behavior to find the probability for ants to choose shorter path.

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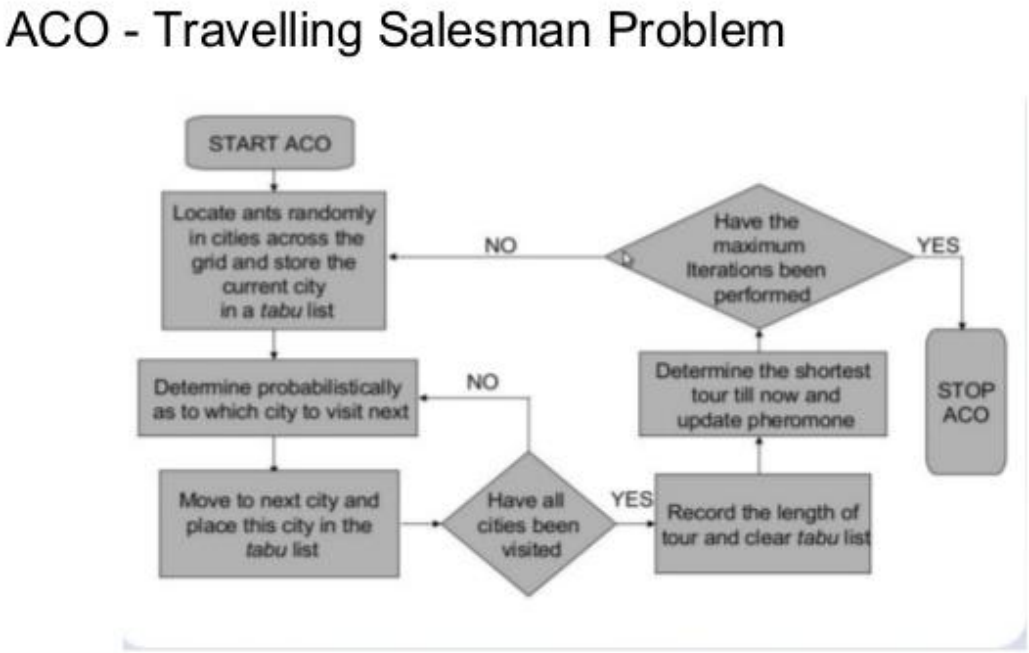

Figure 13: Flowchart of TSP

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Dorigo proposed that At first, some ants choose longer path some shorter the choice is purely random. Approximately ants' speed is nearly same those whose chooses the shorter path reaches the destination early than those who choose the longer path. On the shorter path pheromone accumulation is more.

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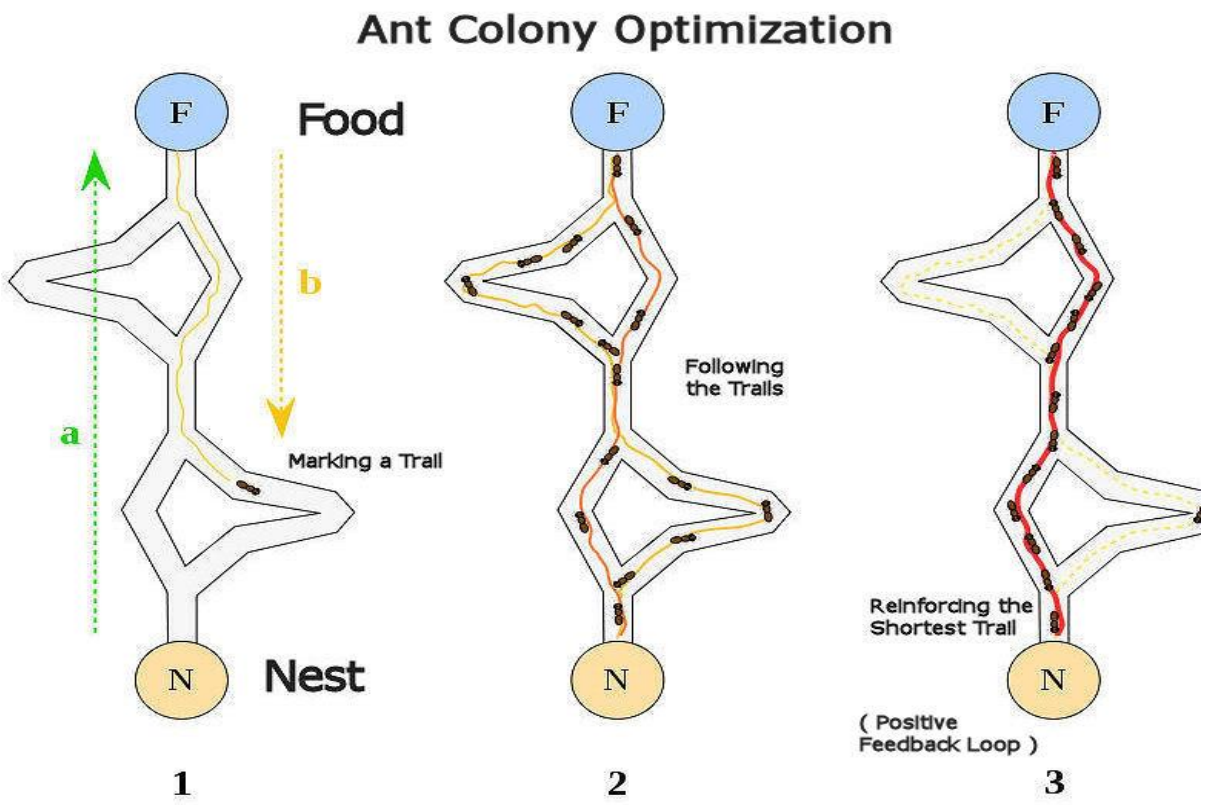

Figure 14: Ant colony optimization

LEE in his paper proposed the job scheduling & resource allocation in the cloud on data analytics system with heterogeneity for workloads and platforms. suggested the system for allocating the resources to the data analytics heterogeneous cluster for achieving high performance. Suggesting a new architecture to allocate resources to data analytics cluster in clouds with various modules listed below.

- **Resource allocation**

The resources are allocated according to the data analytics requirement as in HADOOP the storage cluster stored at different places may cause the delay in processing.

- **Scheduling**

Share and Fairness in a heterogeneous cluster, performance can vary if the data is stored in different places it may decrease the performance of the data analytic cluster. To improve such

problem Progress share is introduced.Progress share. This checks the amount of progress each job is making with assigned resources.cr is computing rate of slot ‘s’ for job ‘j’.

$$PS(j) = \frac{\sum_{s' \in S_j} CR(s', j)}{\sum_{s'' \in S} CR(s'', j)}$$

- **Scheduler**

It calculates the progress share of each job, as analytic engine scheduler is aware of computing rate per slot it goes through two stages calibration and normal. The result of this phase gives a well-utilized cluster with fair amount of resources allocated.

CHAPTER 3 SYSTEM DEVELOPMENT

3.1 ALGORITHMS

Ant colony optimization algorithm is known as Ant System and was proposed in the early nineties. Since then, several other ACO algorithms have been proposed.

The Ant Colony Optimization Metaheuristic

Set parameters, initialize pheromone trails

While termination condition not met **do**

ConstructAntSolutions

ApplyLocalSearch (optional)

UpdatePheromones

End while

Ant System Algorithm

Pheromone values are updated by all the ants that have completed the tour.

$$\tau_{ij} \leftarrow (1 - \rho) \cdot \tau_{ij} + \sum_{k=1}^{m} \Delta\tau_{ij}^{k}$$

Where

ρ is the evaporation rate

m is the number of ants

ΔT_{ij}^{k} is pheromone quantity laid on edge (i, j) by the kth ant

—

In the construction of a solution, ants select the following city to be visited through a stochastic mechanism. When ant k is in city i and has so far constructed the partial solution sp, the probability of going to city j is given by:

$$P_{ij}^{k} = \begin{cases} \dfrac{\tau_{ij}^{\alpha} \cdot \eta_{ij}^{\beta}}{\sum_{c_{il} \in N(s^p)} \tau_{ij}^{\alpha} \cdot \eta_{ij}^{\beta}}, & if\, c_{ij} \in N\,(s^p) \\ 0, & otherwise \end{cases}$$

Where N(sp) is the set of feasible components; that is, edges (i, l) where l is a city not yet visited by the ant k. The parameters α and β control the relative importance of the pheromone versus the

heuristic information η_{ij} , which is given by:

$$\eta_{ij} = \frac{1}{d_{ij}}$$

Where nij is the distance between cities j and I.

3.2 Flow Chart

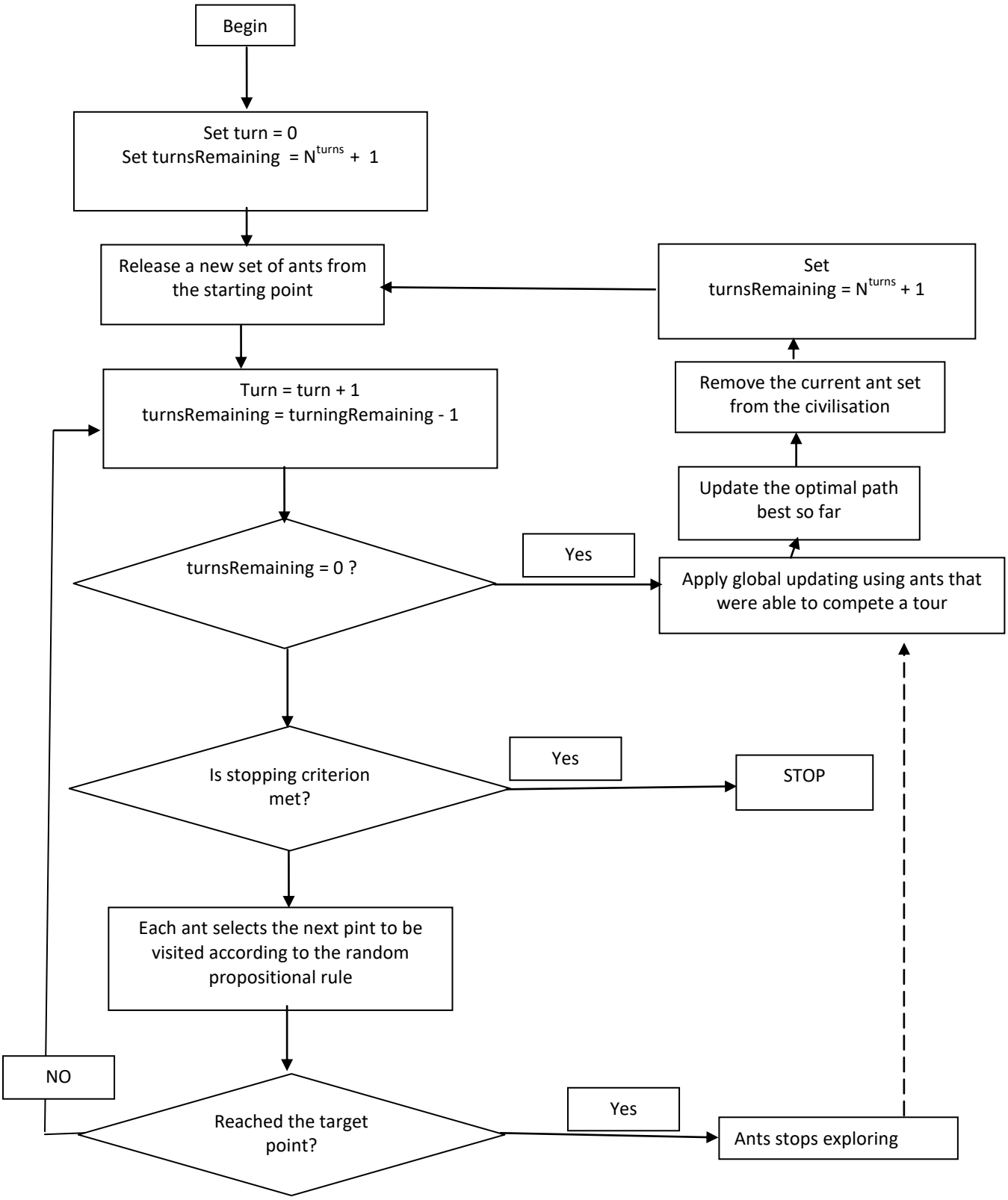

Figure 15. Flowchart ACO

3.3 PSEUDO CODE

Input: ProblemSize, $Population_{size}$, m, ρ, β, σ, q0

Output: P_{best}

$P_{best} \leftarrow$ CreateHeuristicSolution (ProblemSize)

$P_{best} \leftarrow$ Cost (S_h)

$$Pheromone_{init} \leftarrow \frac{1.0}{ProblemSize * Pbest_{cost}}$$

Pheromone InitializePheromone ($Pheromone_{init}$)

While (¬StopCondition ())

For ($= 1$ To $\boldsymbol{m}$)

$S_i \leftarrow$ ConstructSolution(Pheromone, ProblemSize, β,q0)

$Si_{cost} \leftarrow$ Cost(S_i)

If ($Si_{cost} \leq Pbest_{cost}$)

$Pbest_{cost} \leftarrow Si_{cost}$

$P_{best} \leftarrow S_i$

End

LocalUpdateAndDecayPheromone(Pheromone, S_i , Si_{cost},σ)

End

GlobalUpdateAndDecayPheromone(Pheromone, P_{best} , $Pbest_{cost}$,ρ)

End

Return (P_{best})

3.3.1 Pseudo Code Explanation

1. **Initialize Pheromone Values**

It is the first step performed when an ant moves between the nodes value is update as per ant's movement. In this default, values are updates according to the datacenter values when a request is received.

Initialing the problem

Input: ProblemSize, *Populationsize*, *m*, *ρ*, *β*, *σ*, q0
Output: *Pbest*

Pbest ← CreateHeuristicSolution (ProblemSize)
Pbest ← Cost (*Sh*)
Pheromoneinit ← *1.0ProblemSize* * *Pbestcost*

Initialize Pheromone Values

Pheromone InitializePheromone (*Pheromoneinit*)

2. **Construct Solution**

After initializing pheromone values "datacenter resources" a map of resources is kept from where the resource will be allocated to the new cloudlets demanding new resources.

Construct Solution

While (¬StopCondition ())
For (*=1* **To** ***m***)
Si ← ConstructSolution(Pheromone, ProblemSize, *β*,q0)
Sicost ← Cost(*Si*)
If (*Sicost* ≤*Pbestcost*)
Pbestcost ←*Sicost*
Pbest ←*Si*
End

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3. **Local Search**

When a request for resource is made, the ACO search algorithm comes into function finding the best available resource considering utilization of resource, particular resource is allocated to the cloudlet.

Local Search

LocalUpdateAndDecayPheromone(Pheromone, Si , $Sicost$, σ)
End

4. **Pheromone Update & Evaluation**

When the cloudlet is allocated its required resource, the local pheromone values "the resource values available at datacenters" are updated. This update is done on both allocation and freeing up of resource.

Pheromone Update and Evaluation

GlobalUpdateAndDecayPheromone(Pheromone, $Pbest$, $Pbestcost$, ρ)
CostEff = (Cost*0.5) + (Utilization*0.5)
End
Return ($Pbest$)

3.4 SOFTWARE REQUIREMENTS

The software requirements of the project include:

- JAVA
- Cloudsim

Java

Cloud computing explains the latest delivery model, supplement as well as consumption for computing services depending upon the Internet network. Java has now been the latest programming language for quite a long time which provisions the structure for applications Related to Web, and recently development of Java has even reached the applications of cloud.

The rapid growth in development of web services has been a popular trend that has completely been changing the field of playing, as adoption movement and cloud conversion from Java EE 7 to Java EE 8 are growing. Some self-describing "late adopters," and firms, have informed stability and security issues as critical risks in transporting the platform of their development. To tackle the fear of this kind, there has been an era of pouring out of positive comments from the Java community after the release of EE 8, which highly increases features of code simplification by using Lambda Expressions. The recent release of the open source tool NetBeans 8.0.2 as well as official Java IDE are revamping faster the discussions of migration. With even more easier machine learning, about 30% less programming code required with Java 8 (no need to describe more effective code), and lessened code complexity for Java and Spark programmers who might not have specific professionalism in Big Data earlier, may ultimately create machine learning in approximately half of the code lines with almost identical programs of Hadoop.

CloudSim

CloudSim is the tool for simulation which facilitates the cloud program developers to check the operation of all their policies for provisioning in a controllable and repeatable surrounding, for free of any expenditure. It also helps keep a check on the bottlenecks before deployment in real time for the real world. It's a simulator; therefore, it does not compile and then run any original software. In nutshell, it may be described as 'compiling and running a module of a surrounding in a module of hardware', where technical details are encapsulated.

CloudSim is basically a library for various cloud scenario simulations. Moreover, it provides critical classes for defining the computational resources, data centres, applications, users, virtual machines, and schemes for the handling of different constituents of the system including provisioning and scheduling. Running these constituents, it is easier to analyze latest introduced strategies monitoring the working of clouds, as also considering policies of load balancing, schemes, scheduling algorithms, ,etc. It can further be used for assessing the Complexity of different strategies from typical perspectives including execution time of application, cost, etc. It even helps in the evaluation process of the Green IT schemes. It may also be used to work as a fundamental base for cloud environment that has to be simulated and may even add latest schemes for new scenarios, scheduling, and load balancing. It is scalable to work as a library which facilitates the user for adding a scenario desired by programming in JAVA. Using CloudSim, firms, industry-based programmers and R&D departments may also check the operation of a latest programmed application in an easy set-up as well as controlled environment.

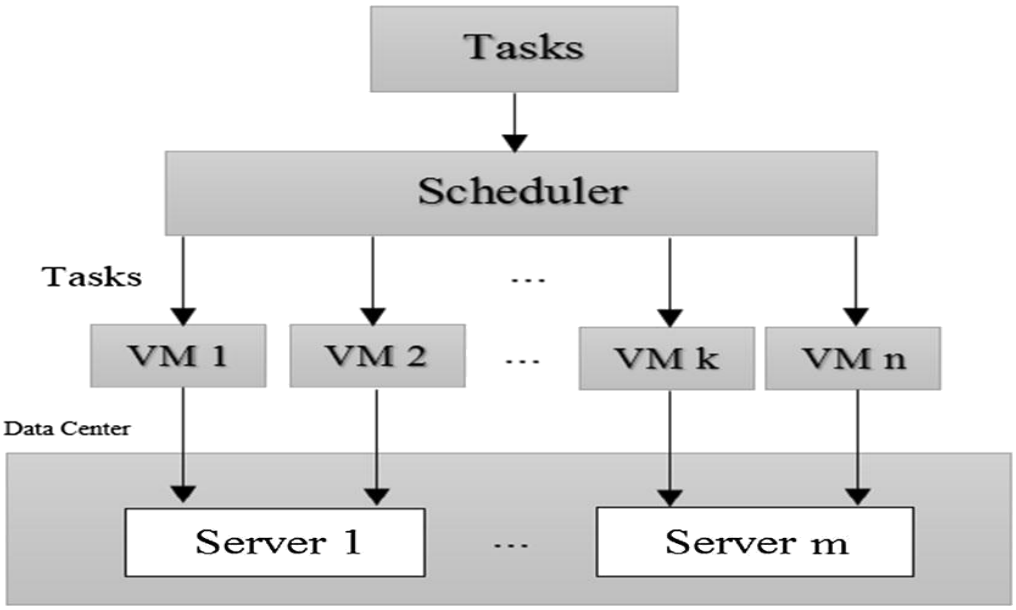


Fig.16: Task scheduling in cloud environment

CHAPTER 4 PERFORMANCE ANALYSIS

Initial task is task scheduling in local environment which has been done using algorithms, namely Round Robin, Existing ACO and Proposed ACO These algorithms are run on the CloudSim simulator having 4 datacenter.

4.1 Test Plan

Certain test cases are made to test our proposed algorithm with the old algorithms proposed for the resource allocation. By changing the values and amount of cloudlets, datacenters we can check the efficiency and performance of our proposed algorithm with other algorithms.

4.1.1 Test - 1

With the use of cloudsim 3.0.3 we are here doing comparative study of some algorithms used in scheduling such as:

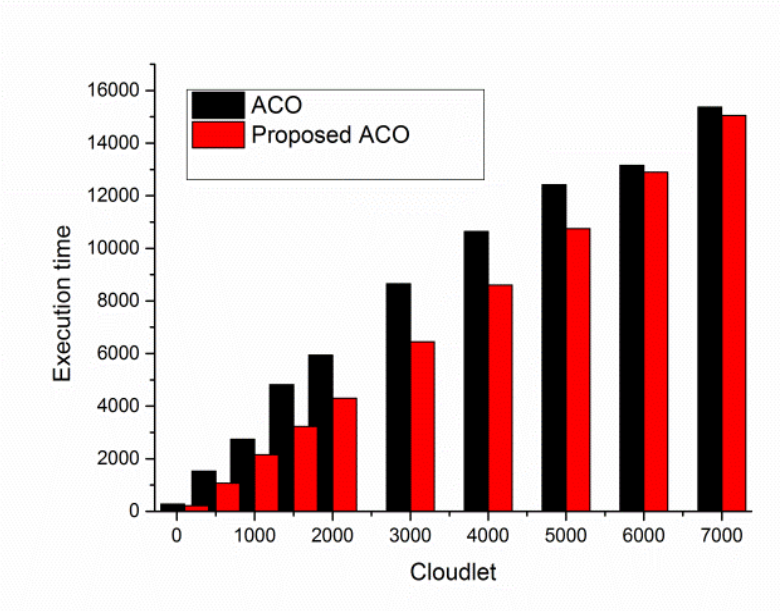
1. Existing ACO
2. Round Robin
3. Proposed ACO

2. **Number of virtual machines** available in the Virtual machine repository The number of virtual machines was set to 2 for datacenter 2 and 10 to datacenter 4.

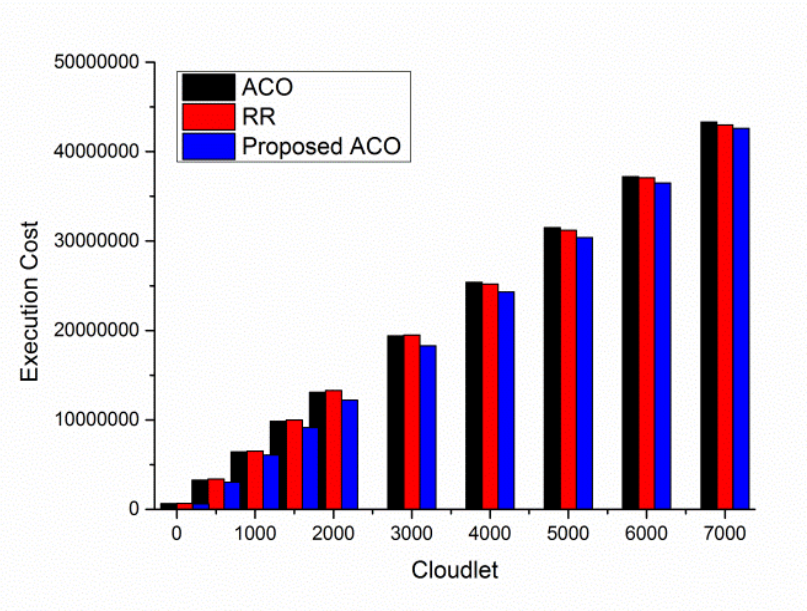
3**.Cloudlets**: range between 200 to 7000.

	ACO			**Proposed ACO**			**ROUNDROBIN**	
Cloudlets	**VM =2**			**VM =2**			**VM =2**	
	Cost ACO	Time ACO		Cost P.ACO	Time P.ACO		Cost RR	Time RR
100	527300.32	939.1		527300.32	939.1		530956	1075.1
500	2641286.24	4873.1		2641205.6	4870.1		2654780	5375.1
1000	5279427.519	9629.1		5275825.6	9495.1		5309559.9	10750.1
1500	7910821.9	14134.1		7.89E+06	13513.1		7964340	16125.1
2000	1.05E+07	17939.1		1.05E+07	17650.1		1.06E+07	21500.1
3000	1.58E+07	26269.1		1.58E+07	26028.1		1.59E+07	32250.1
4000	2.10E+07	34827.1		2.10E+07	33713.1		2.12E+07	43000.1
5000	2.62E+07	41585.1		2.62E+07	41016.1		2.65E+07	53750.1
6000	3.15E+07	50936.1		3.15E+07	51338.1		3.19E+07	64500.1
7000	3.67E+07	59486.1		3.67E+07	58644.1		3.72E+07	75250.1

Table 1. Comparison of algo with 2 vms



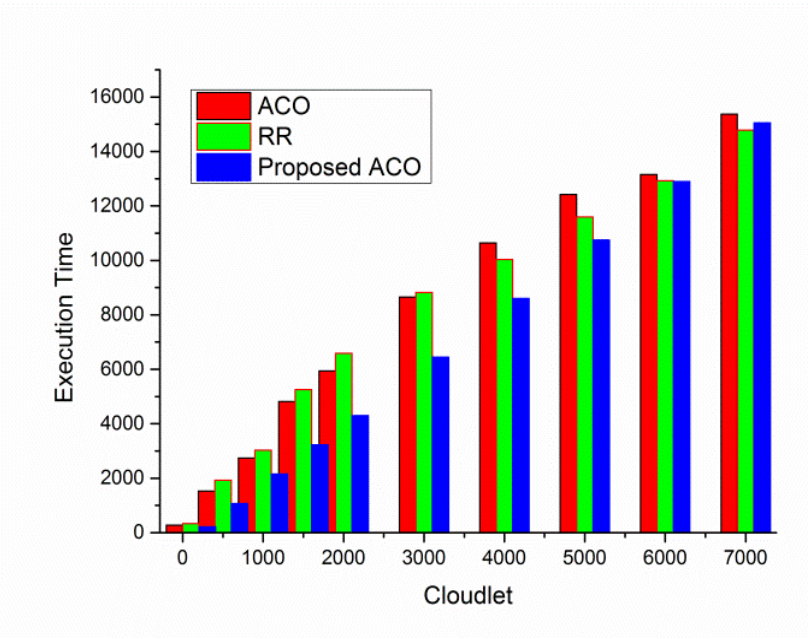
Graph 1. Cost using 2 vms



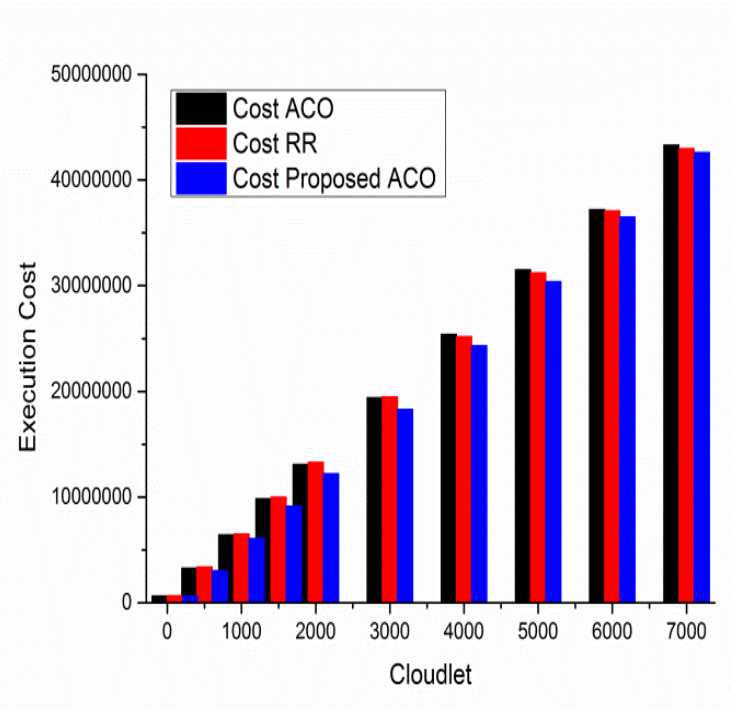
Graph 2. Time using 2 vms

	ACO			**RoundRobin**			**P.ACO**	
Cloudlets	**VM =10**			**VM =10**			**VM =10**	
	Cost ACO	Time ACO		Cost P.ACO	Time P.ACO		TotalCost RR	Time RR
100	649916.32	277.2		674161.86	336.2		608541.86	215.2
500	3268058.026	1527.2		3386259.94	1923.2		3042709.33	1075.2
1000	6434084.9	2742.2		6522212.31	3024.2		6085418.66	2150.22
1500	9838212.79	4821.2		1.00E+07	5251.2		9128127.99	3225.22
2000	1.31E+07	5938.2		1.33E+07	6585.2		1.22E+07	4300.25
3000	1.94E+07	8654.2		1.95E+07	8819.2		1.83E+07	6450.2
4000	2.54E+07	10639.2		2.52E+07	10037.2		2.43E+07	8600.2
5000	3.15E+07	12420.2		3.12E+07	11599.2		3.04E+07	10750.2
6000	3.72E+07	13158.2		3.71E+07	12929.2		3.65E+07	12900.2
7000	4.33E+07	15374.2		4.30E+07	14784.2		4.26E+07	15050.2

Table 2. Comparison of algo with 10 vms



Graph 3. Cost using 10 vms



Graph 4. Cost using 10 vms

4.1.2 Test – 2

With the use of cloudsim 3.0.3 we are here doing comparative study of some algorithms used in scheduling such as.

1. Existing ACO
2. Round Robin
3. Proposed ACO

In this test plan, we will use same number of cloudlets for request purpose and the number of VM's will be changing from 14 to 16. We will make 2 cases in such format have different values of datacenter's used. Cloudlets values taken are 5000 and 10000 to check a single case.

Datacenter ID	Memory (Gb)	RAM (Gb)	PE	CORE
D1	100000	64	6	4
D2	100000	64	6	4
D3	100000	64	6	4
D4	100000	64	6	4
D5	100000	64	6	4

Table 3: Datacenter resources

VM Type	Image Size	RAM	MIPS	PE	Bandwidth
VM1	10000	512	250	1	1000
VM2	10000	512	500	1	1000
VM3	10000	512	700	1	1000

Table 4: VM's allocated resources

Task Type	Task Length	File size	Output file Size	PE	
Task1	4000	300	300	1	
Task2	2000	300	300	1	
Task3	400	300	300	1	

Table 5: Task length table

CASE 1:

Datacenter ID	Cost Per Memory	Cost Per Storage	Cost per Bandwidth
D1	0.07	0.03	
D2	0.5	0.05	
D3	0.9	0.15	
D4	0.09	0.5	
D5	0.099	0.99	

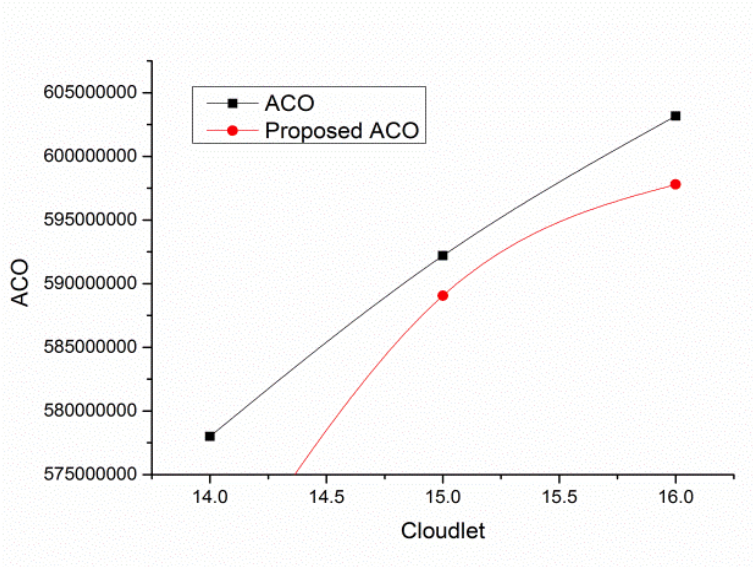
Table 6: Resource cost of each datacenter

Cloudlets = 5000	ACO	Proposed ACO	Round Robin
VM's	Cost	Cost	Cost
14	578006053.3	585065814.8	552062058
15	592197681.3	589050090.5	563948831.4
16	603171125.1	597791677.7	577872261.8

Table 7: Cost Table of applied simulation cloudlets = 5000

Cloudlets = 10000	ACO	Proposed ACO	Round Robin
VM's	Cost	Cost	Cost
14	1131861076	1128341135	1104031511
15	1157978374	1153008561	1127908809
16	1183078662	1180351848	1156287200

Table 8: Cost Table of applied simulation cloudlets = 10000



Graph 5: Cost graph for different VM's

CASE 2:

Datacenter values	Cost	Cost Per Memory	Cost Per Storage
1	3	0.07	0.03
2	4	0.5	0.05
3	90	0.5	0.05
4	190	0.099	0.99

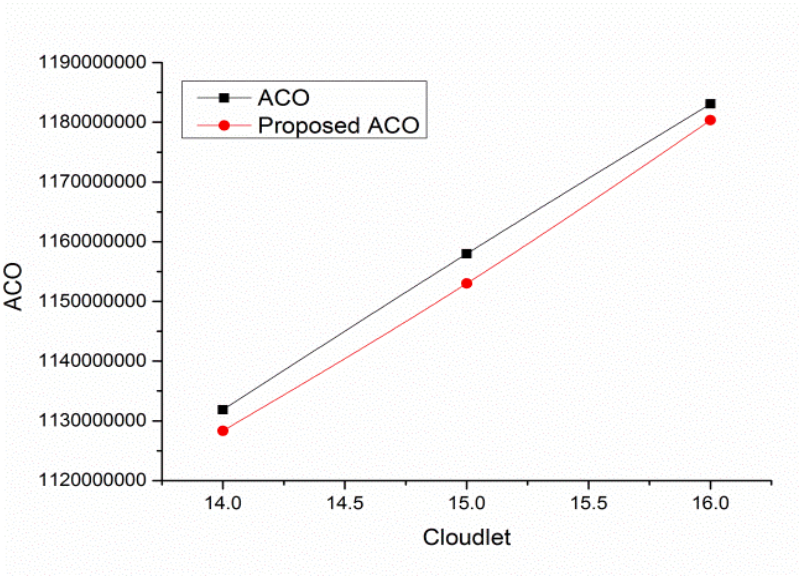
Table 9: Resource cost of each datacenter

cloudlets=5000	ACO	Proposed ACO	Round Robin
VM's	Cost	Cost	Cost
14	35063771.04	35088998.61	34400758.03
15	35515925.33	35203426.24	34295031.36
16	35760644.53	35729512.48	37813261.76

Table 10: Cost Table of applied simulation cloudlets = 5000

Cloudlets=10000	ACO	Proposed ACO	Round Robin
VM's	Cost	Cost	Cost
14	69459468.21	69362039.95	68783011.04
15	70079743.95	69632716.85	68577808.96
16	70725208.53	69905572.21	75662200

Table 11: Cost Table of applied simulation cloudlets = 10000



Graph 6: Cost graph for different VM's

CHAPTER 5 CONCLUSION

The design of an ACO programming algorithmic program to deals with the Task-Resource assignment in such the simplest way that the entire price & time is decreased Simulation results demonstrate that ACO algorithmic program is outperforming Existing ACO & RoundRobin.

Cloud computing could be a massive shift from the standard method businesses rely on IT resources. Cloud computing eliminates the capital expense of shopping for hardware and code and fitting and running on-site datacenters—the racks of servers, the continuous electricity for power and cooling, the IT consultants for managing the infrastructure. It adds up quick. Most cloud computing services square measure provided self-service and on demand, thus even large amounts of computing resources are often provisioned in minutes, generally with simply some mouse clicks, giving businesses tons of flexibility and taking the pressure off capability coming up with measure scan completely and different log files offered on the net of varied sizes square measure downloaded and incorporated into the project.

5.2 FUTURE SCOPE

Study supported the results,it is additionally finished that there's not one planning rule that has superior performance with relevancy numerous sorts of quality services. this can be as a result of job planning algorithms ought to be selected supported its capability to confirm sensible facet of services with cheap value and maintain fairness by fairly distribute the accessible resources among all the roles and reply to the constraints of the users. Existing planning rule provides high turnout and efficienthowever they are doing not take into account dependability and convenience. It involves the event of proposing a way supported ANT Colony optimization to resolve the matter of load equalization within the cloud setting. In future work can propose a brand new rule for resource planning and comparative with existing algorithms. The potency of the user request initial is also optimized for the processor and executes the request.

In the future the project is increased by implementing a interface or a graphical computer program within which the user might input the amount of directions he /she needs to execute from the log file at a specific time instead of execution the

entire heap of directions. Moreover, once the project is completed victimization the CloudSim toolkit it's tested on Google dataset i.e. the time period dataset. Instead of finding dummy results on dummy datasets we tend to work on the time period information set.

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