A JOB SCHEDULING ALGORITHM IN CLOUD ENVIORMENT USING PARTICLE SWARM OPTIMIZATION

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A

Dissertation

submitted in partial fulfillment of the

requirements for the award of the degree of

MASTER OF TECHNOLOGY

in

ARTIFICIAL INTELLIGENCE AND ARTIFICIAL NEURAL NETWORK

by

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I hereby certify that the dissertation entitled "**A Job Scheduling Algorithm in Cloud Enviourment using Particle Swarm Optimization**" in partial fulfilment of the requirements for the award of the Degree of MASTER OF TECHNOLOGY in ARTIFICIAL INTELLIGENCE AND ARTIFICIAL NEURAL NETWORK and submitted to the Department of Computer Science & Engineering at Center for Information Technology, University of Petroleum & Energy Studies, Dehradun, is an authentic record of my work carried out during a period from **January, 2015** to **May,2015** under the supervision of **Dr. G Hanumat Sastry, Assistant Professor (SG) CIT.**

The matter presented in this project has not been submitted by me for the award of any other degree of this or any other University.

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ABSTRACT

Scheduling is understanding the activities and planning/sequencing the activities in a manner to complete the task/job in an effective and optimal way. In Cloud system user creates request for resources to execute tasks. There are different kinds of resources with different cost and different speeds, so scheduling algorithm is needed to schedule these jobs to the resources. Different algorithms are used to optimize time and cost in cloud enviourment. Swarm intelligence mimics the nature of a swarm when they search for food. They transfer information regarding where is the best possibility to find food and move to that location. Particle swarm optimization (PSO) is a swarm intelligence technique to solve optimization problem. Velocity of each particle is governed by a function which tries to minimize the distance between the current position of particle to the best position of the particle and the global best (best of all particle in problem space). The position of the particle is updated by its velocity and present position.

This work discusses the development of a PSO with two objective functions with weighted factor specified by user based on his requirement and applying sorting in the resource stack to execute task and compare them with single objective algorithm. This algorithm optimizes both cost and makespan to execute task. The change in cost and makespan is also analyzed with change in weight factor. The task in resource are sorted based on the descendent task and the execution time.

KEYWORD: PSO, ACO, SaaP, PaaS, IaaS

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Chapter 1 INTRODUCTION

Cloud computing is latest distributed system paradigm that deliver Infrastructure as a service (IaaS), Platform as a service (PaaS), Software (Application) as a Service (SaaS). Deploying teams of remote servers and software network to transfer completely different varieties of knowledge sources in real time while not storing processed knowledge on cloud is completed by cloud computing, applications square measure expedited by virtualized resources which will be regular dynamically. Cloud computing environment adopt use of pay-per-use model, cloud computing specialize in increasing effectiveness of shared resources. Task of work flow of these virtualized computing resources is completed by provisioning.

An organization moving away from method of buying every hardware needed by process (CAPEX model: capital expenditure) to the method of paying only for the use of shared infrastructure (OPEX model: operational expenditure) refers to the term moving to cloud. By using cloud, company vendor can focus on business improvement rather than worrying about infrastructure. High-capacity-networks, storage devices, low cost computer also as widespread adoption of hardware virtualization, service familiarized design, utility computing and involuntary leads to the growth of cloud computing.

Virtualization is the main enabling technology of cloud. Physical computing device separates into many "virtual" devices that can be used and manage to perform task separately by Virtualization software. The legerity required to decrease price and increase the speed of IT operation is provided by virtualization. Concept of Service-oriented-Architecture (SOA) helps user to divide problem into different small problem (Services) that are executed and in the last to provide at the solution they are combined (merged) into single service by cloud computing. Global and simple use of cloud services in an exceedingly normal manner is provided by SOA

The concepts from utility computing are used by cloud computing to generate metrics to evaluate the provided services. These metrics are used as the heart of public cloud. Additionally in automatic computing the feedback loop has an essential part that are measured services. This perform recovery of automatic failure and allows scale on demand. The quest to address reliability problem and Quality of service (QoS) problems has played an important role in evolution of cloud

computing from grid computing. As compared to traditional parallel computing technique, all the tools and technologies with affordable prices are provided by cloud computing to build the data/compute intensive parallel applications.[1]

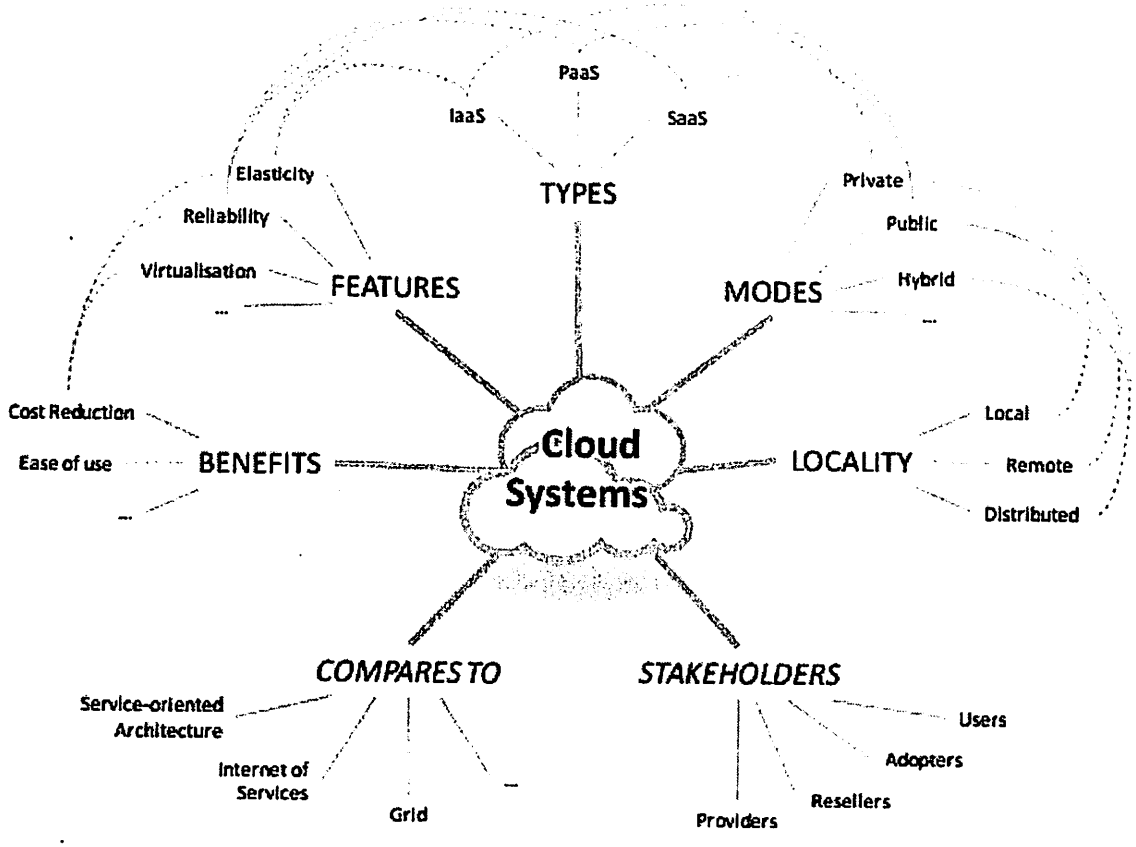


Figure 1.1: Cloud System [1]

Cloud computing is similar to Server-Client-model, Utility Computing, Mainframe Computers, Peer-2-Peer computing, and Grid Computing. Any distributed application that has capability to discriminate between servers and clients refers as Client–server computing.

1.1 Characteristics of cloud computing:

1.1.1 Economical aspect:

Elasticity is an obligatory feature of cloud ,the power of the primary infrastructure to adapt the change for example size of data and number of concurrent users supported by an application etc,. Cloud scalability should satisfy both the amount of instances to (horizontal scalability) and size of the instances (vertical scalability).

Reliability is one of the essential features to that utilize capabilities of cloud system. Reliability provides continuous operation of system without interference [1], example without dynamic code reset and loss of data. Redundant resource utilization is used to achieve reliability. Reliability aspects move from a hardware to a software-based solution. Prevention of loss is focused by reliability.

Quality of Service is very essential capability in many cases where resource has to support many specific requirement such as response time, cost etc.

Agility and adaptability are essential features that strongly related to elastic capabilities of cloud system. It improves user capability to re-provision infrastructure resources [1].

Availability of data and services are very core aspect to rise cloud system. It support redundancy f service and data so that failure can be reduced. Fault tolerance is achieved by introducing new redundancy as previously failed or fresh nodes in an online manner without affecting performance.

Some of the economic aspect of cloud system are cost reduction (Cloud system which can adept customer behavior and change in cost of services), pay-per-use (capability to change in cost on the basis of use of resource and based on QoS, improved time to market, return of investment (ROI) and going green[1].

1.1.2 Technological aspects:

Virtualization is a technique which is used as an abstract layer for cloud system to hide the complexity of system from customer [16]. It creates virtual enviourment which hides the actual complex structure from user and increase flexibility of system. Virtualization support many features as:

Ease of use: By hiding the design level to user it makes it easier for user to develop new application and reduce the overhead/time for controlling the system.

Infrastructure Independency: virtualization increase interoperability by making code platform independent.

Flexibility and Adaptability: Flexibility of underlying infrastructure to change under different requirement and condition is increased by virtualization.

Independent of location: Service can be accessed by user independent of location of user and resource location.

Multi-tenancy: Cloud system is highly essential for multi-tenancy. At the same time same resource can be assigned to more than one user, the location of data is not known. Application, data and service that are hosted on shared resources and need to be accessed by all user that requested for them. Information is accessed by more than one instance and may be altered by them concurrently [1]. It leads to many issues on data protection, security of data is necessary if it is accessed by many user at the same time by using virtual tables. Security, compliance and privacy of data is essential issue in all system dealing with sensitive data.

Data management: Data is very important aspect mainly for storage cloud system. In storage cloud data is distributed across many resources [1]. Maintaining data consistency is necessary over distributed data on multiple resources and data location should be known while replicating data across data centers. Horizontal and vertical scalability of data should be maintained as data size is not fixed over time. Providing consistency for data is essential in data management.

Metering of the resources and services based on consumption is important in order to offer pricing and elasticity. Metering is essential to compete in market with multiple service providers, user should be satisfied with your service and price both.

Five essential service measures are on-demand self-service (server time and storage service are provided without human interaction), Broad network access (access of capability by using different client platform as mobile, phone, tablet, laptop and workstation), Resource pooling (different physical and virtual resource are assigned based on consumer demand), Rapid elasticity, and measured services.

1.2 Service Model:

Cloud computing services are provided based on various service model:-

1.2.1 IaaS (Infrastructure as a service)

According to model of Infrastructure as a service (IaaS) and IETF (Internet engineering task force) provider of IaaS offer physical computer or virtual machine (mostly) and other resources such as hypervisor (Xen, KVM, VirtualBox, VMware runs as a guest on

machine). To support large number of storage and ability to scale service up and down according to requirement of user/customer in cloud system is achieved by pool of hypervisors [1]. Additionally resources as disk image, low block storage, library and firewall, file storage, IP address, load balancers, software bundles and VLAN (virtual LAN) services are provided on demand of customers from data centers.

1.2.2 PaaS (Platform as a Service)

PaaS model deliver services as ambience of execution, servers for web operation, platform of execution of computer services, storage software and operating system etc. For development and execution of software services there is no need to buy and manage complex and costly requires software and hardware [1]. Some of the cloud providers provides automatic allocation of software and computer services depends on the demand of the problem or running service, so it saves time and complexity in assignment of allocating them manually. Some of the other services like encoding of media/storage/data into different form is also provided by some of the cloud providers, it increases the facility of service and decrease customer load.

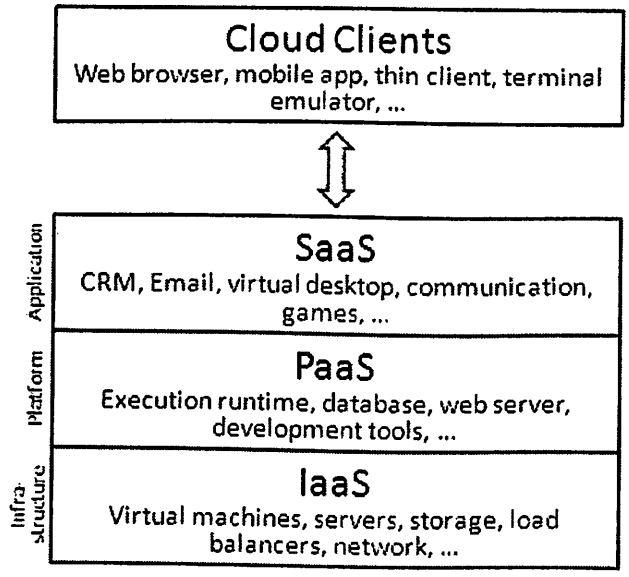


Figure 1.2: Service Model of Cloud System [1]

1.2.3 SaaS (Software as a Service)

In the code, as a business model damage computer service (SaaS), I was offered access to the user square measurement application computer code and database. Cloud supplier management infrastructure, platform, I run the application. SaaS, it is described as a normal "on-demand software", the price to pay for each use is sometimes adopted the basic or subscription fee. SaaS model refers to installation of computer program to cloud by cloud supplier, user access the program from cloud. The load of managing the infrastructure and program is decreased by use of cloud.

Evaluation model is often flat rate per user per month, or year, and therefore value for the SaaS application can be climb, if it is deleted in adjustable user square measure incidental or any purpose. By maintenance and support of the SaaS that claim supporters back to business markdown it operational outsourcing hardware and computer code potential to cloud supplier. As a result, business to allocate a distant operation price from labor costs towards the different target of hardware / software disbursal and conferences. In addition, you may update centrally in the host application free user is not required to place in the code of the new computer. One disadvantage of SaaS is, keeping the user's knowledge square.

1.3 Deployment models:

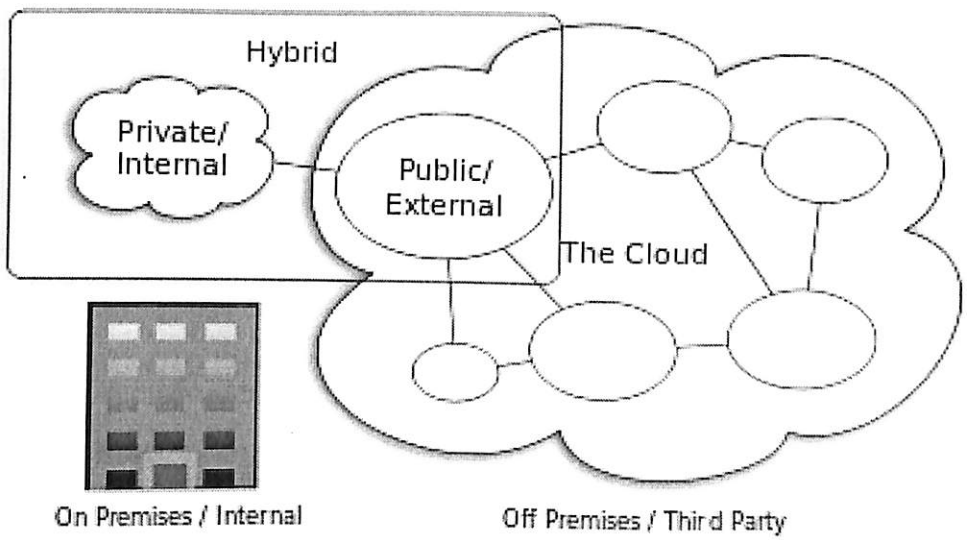


Figure 1.3: Deployment Model of Cloud System [1]

1.3.1 Private cloud

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party, and hosted either internally or externally. Undertaking a private cloud project requires a significant level and degree of engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. When done right, it can improve business, but every step in the project raises security issues that must be addressed to prevent serious vulnerabilities. Self-run data center are generally capital intensive. They have a significant physical footprint, requiring allocations of space, hardware, and environmental controls. These assets have to be refreshed periodically, resulting in additional capital expenditures. They have attracted criticism because users "still have to buy, build, and manage them" and thus do not benefit from less hands-on management, essentially "[lacking] the economic model that makes cloud computing such an intriguing concept

1.3.2 Public cloud

A cloud is called a "public cloud" when the services are rendered over a network that is open for public use. Public cloud services may be free. Technically there may be little or no difference between public and private cloud architecture, however, security consideration may be substantially different for services (applications, storage, and other resources) that are made available by a service provider for a public audience and when communication is effected over a non-trusted network. Saasu [1] is a large public cloud. Generally, public cloud service providers like Amazon AWS, Microsoft and Google own and operate the infrastructure at their data center and access is generally via the Internet. AWS and Microsoft also offer direct connect services called "AWS Direct Connect" [1] and "Azure Express Route" respectively, such connections require customers to purchase or lease a private connection to a peering point offered by the cloud provider.

1.3.3 Hybrid cloud

Hybrid cloud can be a composition of two or many clouds (private, public or community) who are still separate entities but safe zone along the unit, providing the advantages of

several models to prepare. Hybrid cloud even can mean to join cooperation location, managed services and / or reserved resources from the cloud.

Gartner, Inc. [1] defines a hybrid cloud services as a cloud consisting of a combination of public and private cloud in the cloud community. It is a hybrid cloud services crossing the border insulation and suppliers, who cannot be simply put in personal classes, public or community cloud services. It allows to increase the capacity or ability service in the cloud, for aggregation, integration or customization with other cloud computing services. There are cases of benefit to the composition of the hybrid cloud. For example, a company can store sensitive knowledge of consumers in a house in personal cloud request, however, to connect CV intelligence application in public cloud services program. CV intelligence in hybrid cloud extends a company's ability to offer services. Company selected to supplement the market cloud of public services. The adoption of hybrid cloud depends on various things such as knowledge and respect for the safety requirements, level of knowledge management, as well as the company's application for benefits.

Another example of a hybrid cloud is one where this organization using public cloud computing resources to respond to the wishes of temporary capacity that cannot be met for personal cloud. Capability enables hybrid cloud use of explosive cloud of scale through the clouds. The outbreak of the cloud associated with the preparation of model application in which the request leads partners in the cloud or knowledge very personal center and the "explosion" in the public cloud one will increase the demand for calculating capacity. One of the main advantages of the explosion cloud and hybrid cloud model is that companies pay to additional resources when necessary surface units are calculated. The explosion of knowledge centers to clouds that form a connected internal infrastructure that supports average workload and use of resources from the cloud clouds public or private, through the Summits treatment demand.

1.3.4 Community cloud

Community cloud shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party, and either hosted internally or externally. The costs

are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized

1.3.5 Distributed cloud

Cloud computing while still connected to a single network or hub can also provide a distributed set of machines running elsewhere. Examples of this, such as BOINC and Folding @ home[1] can include distributed computing platform. Such indications interesting attempts have voluntarily shared resources on cloud computing deployment model aimed provisioning cloud @ home [1].

1.3.7 Intercloud

It is based on the architecture of Internet as network of networks, so it is a cloud of many clouds. Direct interoperability b/w public cloud service providers is the main focus of Intercloud rather than consumer/user and providers as in multi-cloud and hybrid cloud.

1.3.8 Multicloud

Multiple cloud computing services is used in a single heterogeneous architecture that decrease dependency on single cloud provider, increase flexibility by choice, ease under failure/disaster [1]. It refer to multiple cloud server rather than multiple deployment model as in hybrid cloud (private, public, etc.).

1.4 Need of Scheduling:

Scheduling is understanding of activity and plan/sequencing the activity in a manner to complete the task/job in an effective and optimal way. Scheduling is a form of decision making in every filed from government (planning of any new scheme), personal (designing a new plan for today), cultural (organizing any event) or economic decision making. In every field scheduling has an important role. Several strength of scheduling are scalability, optimization, modeling feasibility. Proper designed secluding algorithm leads to an optimal solution of a problem. In cloud secluding is used to assign task to resources. Which task is assigned to which resource and when is depend on scheduling algorithm and the result of

proper scheduling algorithm defines optimal result. Cloud secluding or provisioning is used to assign the task/jobs to resources in a way to get optimal timespan and cost. Many secluding algorithm are used to schedule task on resources in cloud enviourment. To seclude a task the aim is to assign task to best resource. Aim of secluding is to utilize all resources and complete all jobs in min time.

In this paper, present a Particle Swam Optimization (PSO) based scheduling algorithm to schedule task on virtualized resources. Experiment is conducted by various number of particle, number of task and weight values of makespan and cost to fitness function. Cloud computing enviourment application scheduler have different objectives to minimize total cost, total execution time and load balancing.

Chapter 2 BACKGROUND

Evolutionary computing is a combination of problem solving technique that are based on the principle of biological inheritance such as natural selection and genetic inheritance. These technique are widely used in industry to solve many optimization problem which are unable to give result in polynomial time by using evolutionary computing these problem are solved to get approximate optimal solution. Some of evolutionary computing technique are genetic algorithm, ant colony optimization, Particle swam optimization.

Evolutionary computing is refers to computer based problem solving method/system which use computational model of evolutionary process such as natural selection, survival of fittest and reproduction as fundamental of computational system. Evolutionary algorithm is a stochastic search process which leads to optimal solution. Evolution by natural selection process from a population can be expressed as a selection of solution from a search space possible chromosome values.

Step 1. Initialization
    Generate initial population ***P*** at random or with prior knowledge
Step 2. Fitness evaluation
    Evaluate the fitness for all individuals in ***P***
Step 3. Selection
    Select a set of promising candidates ***S*** from ***P***
Step 4. Reproduction
    Step 4.1. Crossover (optional)
        Apply crossover to the mating pool ***S*** for generating a set of offspring ***O***
    Step 4.2. Mutation (probabilistic)
        Apply mutation to the offspring set ***O*** for obtaining its perturbed set ***O'***
Step 5. Replacement
    Replace the current population ***P***
Step 6. Termination
    If the termination criteria are not met, go to Step 2

Figure 2.1: Pseudo-code of Simple Evolutionary Algorithm

Evolutionary commuting has four main function:

Representation: Representation of individual is a very important role in performance of EC algorithm. A search method gives good performance with one particular representation so the representation of population individual is very performance of the algorithm. The efficiency and complexity of algorithm depends on how solution is represented. An algorithm produces different result for different representation.

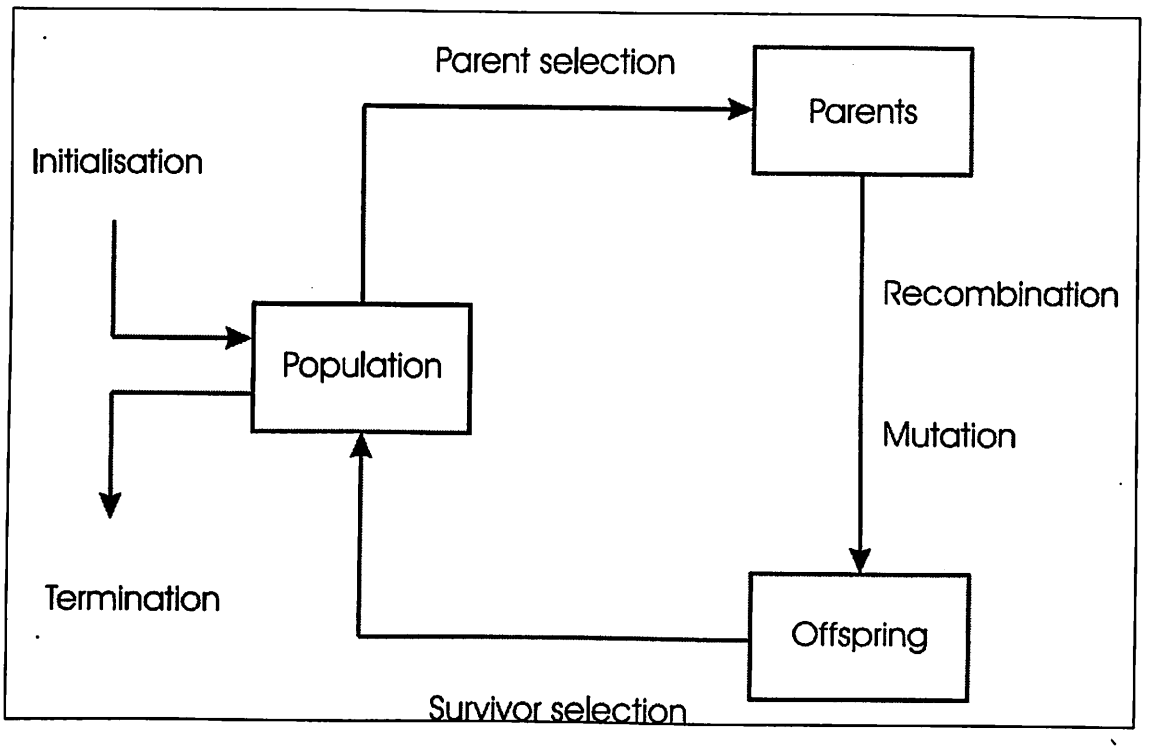


Figure 2.2: General Flow chart of Evolutionary algorithm

Initial Population: Evolutionary commuting is a population based stochastic search algorithm. Every algorithm has its population of candidate solution. First step of any evolutionary algorithm is to create an initial population. The standard way to generate initial population is to generate random population from search space. It should cover every region of search space if any region left than chances are there that the left region will not be covered in solution and possibility is there than optimal solution exits in that region, so selection of initial population is also affect solution of problem.

Fitness Furcation: Fitness fiction is used to test that the solution generated is optimal or not, solution with max fitness value will be considered as the most optimal solution in the search space in that epoch.

Selection: Selection is one of main operator. Selection is used to select the next generation of population so by using selection operator next generation is decided. Emphasize better solution in population is main function of selection operator.so selection of next population is best on fitness value, solution having higher fitness value has higher chances of to survive in next generation.

Reproduction (crossover and mutation): It is used to create new population from two parent that are selected by selection operation are used to generate new solution by crossover. Crossover uses two parent to generate a child. Mutation is used to generate new individual from a single parent.

Stopping criteria: Stopping criteria is used to stop the algorithm .Evolutionary is iteratively applied until the stop criteria is reached. Simpler way to decide stopping criteria is limit number of generation, it should not be too small so that full search space is not searched and not too large that algorithm takes too much time.

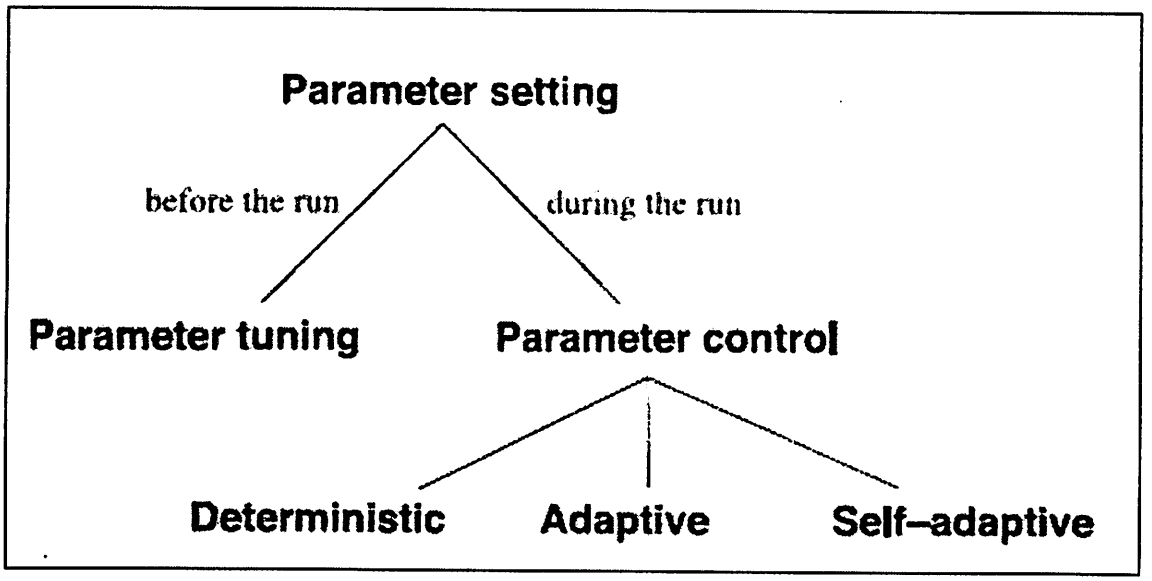


Figure 2.3: Parameter setting in EA

2.1 Genetic Algorithm:

Genetic algorithm is an evolutionary computing technique inspired from evolution. The theory of evolution was first proposed by Charles Darwin in his famous work origin of species. The basic idea behind evolution is that nature favors the stronger individual than the weak one. Genetic algorithms tinseled this basic idea into a platform suitable for optimization.

Initial Population

Initial population is that the group of all the solution that area unit utilized in the genetic algorithmic rule to look out the optimum resolution. Each resolution within the population are referred as private and for all solutions is depicted as a body for creating it appropriate for the genetic operations. The Solution area unit is hand-picked from the initial set of solution and a few operations area unit applied on those to create consecutive generation. The sexual activity chromosomes area unit hand-picked supported some specific constraints.

Fitness Function

The quality of solution within the set of solution is measured by using fitness function with respect to the give optimization objective. The creation of fitness

function depends on the need of problem if we need to optimize time or cost, fitness function is derived w.r.t that.

Selection

To select the next generation from the generated new solution after the cross-over or mutation selection different operator is used as tournament selection, roulette wheel selection etc. In tournament selection first n element is selected and after that the fittest among them is selected from next generation. Roulette wheel selection is based on probability.

Crossover

Crossover operator is used to create new solution from the previous solution, it takes two parents and creates a new solution after crossover. Different types of crossover is used to create new solution from the parents as single point crossover, multipoint crossover etc.

Mutation

If the solution of problem stuck in a search space they are not spreading by using crossover so mutation is applied. For applying mutation only single solution is needed the solution is replaced by opposite factor values as if binary representation is use so the zero is replaced by one and vice-versa. It is used to spread a solution if it stuck in one area only.

2.2 Swarm Intelligence:

Concept of swarm intelligence is derived from behavior of organisms like bees, ants, goose, fish and other species which form groups called swarms. Swarm intelligence (SI) is the collective behavior of decentralized, self-organized systems, natural or artificial. The concept is employed in work on artificial intelligence. The expression was introduced by Gerardo Beni and Jing Wang in 1989, in the context of cellular robotic systems. Swarm intelligence systems consist typically of a population of simple agents or agents interacting locally with one another and with their environment. The inspiration often comes from nature, especially biological systems. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local, and to a certain degree random, interactions between such agents lead to the

emergence of "intelligent" global behavior, unknown to the individual agents. Examples in natural systems of SI include ant colonies, bird flocking, animal herding, bacterial growth, fish schooling and microbial intelligence.

2.2.1 Particle Swam Optimization

Particle Swam Optimization (PSO) is swam intelligence based optimization technique. It is inspired by behavior of fish and bird flocks. It is developed in 1995 by Kennedy and Eberhard. PSO is a collection of particle (swam inspired particles) which represent solution of problem in continuous search space. Out of them one particle is selected global best fitness until stopping criteria. Every member is having two parameter velocity and position. Position of the particle indicates the position where particle is having current best in search space, velocity indicates the movement of particle in search space. A Particle store local best (best of the particle until now) and global (best of all the particle exits in search space till now).The velocity of particle in updated in the direction of global best and particle best, particle is attracted in both direction his own best and global best. The value of new velocity is decided by using old velocity, particle best and global best of particle. Position of particle is updated based on old velocity and updated velocity. Each particle in pso is searching for optimal solution. Particle is moving and has velocity for his own. Particle remember the position of his best (local best) until so far and the global best also. Particle is swam share information about what they have discovered so far, particle has neighbor associated with it and use the position of best in neighbor this position is used to adjust velocity of particle.

The velocity of particle is updated with current velocity plus a weighted random movement in the current best direction and a weighted random movement in the direction of neighborhood best. The position is simply old position plus the new velocity.

Velocity [ ]= d0* Velocity [ ] + random () * (ParBest [ ]- Present [ ]) + d2* Velocity [ ] *random () * (GlobalBest [ ]- Present [ ])

Present [] = Present [] + Velocity [ ]

Particle velocity in each particle is bounded by a limit Vmax (limit on velocity) to control movement of particle, so that the search space should traversed fully if the velocity of

particle exceeds Vmax than the particle velocity will be Vmax only. d1 and d2 are the importance of personal best and global best respectively.

```
1:  Initialize particles' position and velocity randomly.
2:  While stopping criterion is not satisfied do
3:      For each particle do
4:          Calculate its fitness value using fitness functior
5:          Update its local best position.
6:      End For
7:      Update global best position.
8:      For each particle do
9:          Update its velocity and position.
10:     End For
11: End While
12: Return global best position.
```

Figure 2.4 :Basic PSO Algorithm [3]

2.2.2 Ant Colony Optimization (ACO)

ACO (Ant colony optimization) was proposed by Marco dorigo in 1991. ACO is used to solve the problem which can be represented in the form of graph. Ant colony optimization is based on the behavior of ants. When group of ants goes in search of food they follow the optimal path to search food so here we want to put that property in computer for any search problem.

ACO is based on "Stigmetry", Stigmetry is a form of communication between agents by modifying the environment. Stigmetry is a local form of communication it communicates with neighbor when it comes to the local area of the enviourment. In ACO ant is wandering randomly and laying down a phenomenon trail and change the enviourment (enviourment is using the concentration of phenomenon) , when other ant comes and finds pheromone with higher concentration so it will follow that path if there are more than one path so ant

will go to the path with maximum concentration of pheromone. Pheromone also evaporates with time so that unless more ants reinforced it, the pheromone will disappear.

When the searching starts the first ant will try to find food source through random search and while returning to nest it will put pheromone in the path. Other ants will also repeat the same process and they will go to the path which is having more strength of pheromone in the path and after some time all ants will be following the path which is having most pheromone and that path will be called as optimal path (shortest path).The pheromone trail on large path will disappear after some time because no ant will follow that path.

For implementing ACO first of all we will represent the problem in the form of graph. Start and End node will be represented as nest and food in problem. Ants will be replaced by artificial ants or agents, Visibility (reciprocal of distance n), phenomenon (Artificial phenomenon), foraging behavior (random walk through graph guided by phenomenon.

2.3 CloudSim

CloudSim is a simulation package library developed on the top of SimJava that can run on both Windows and Linux platforms. CloudSim inherits from GridSim programming model so that it can support research and development of cloud computing, and provide the following new features:

(1) Supporting the modeling and simulation of large scale cloud computing infrastructure.

(2) Supporting a self-contained data centers, service agents, scheduling and platform allocation strategy.

CloudSim also includes some unique features. Firstly, it provides virtualization engine that is designed to help users to create and manage multiple data centers and collaborative virtualization services; Secondly, at the time of allocating virtualized services and processing cores, it has the flexibility to switch between time-share and space-share. CloudSim platform helps accelerate the development of cloud computing algorithms and methods.

CloudSim emulator architecture, uses a hierarchical organization, which consists of four levels. From bottom to top, are the SimJava GridSim, CloudSim and user code. The lower is a discrete event simulation SimJava, which is responsible for the implementation of the basic functions of the framework of simulation of high level, such as: consultation and events of transformation, to build the components of the system (services, customers, data centers, agents and virtual machines), the communication between the different components and the management of the analog clock.

GridSim is at the top of SimJava, that supports the components and models of a plurality of network infrastructure, including networks and documents of network traffic, such as component based grid resources, data sets, load testing and software high-level information services. CloudSim runs on the next layer, which extends the basic functionality provided by GridSim. CloudSim layer provides management interfaces of data center virtual including machine, RAM, band width and virtual disk storage. Manage essential entity (such as VM, customers, data centers, applications) in the simulation process.

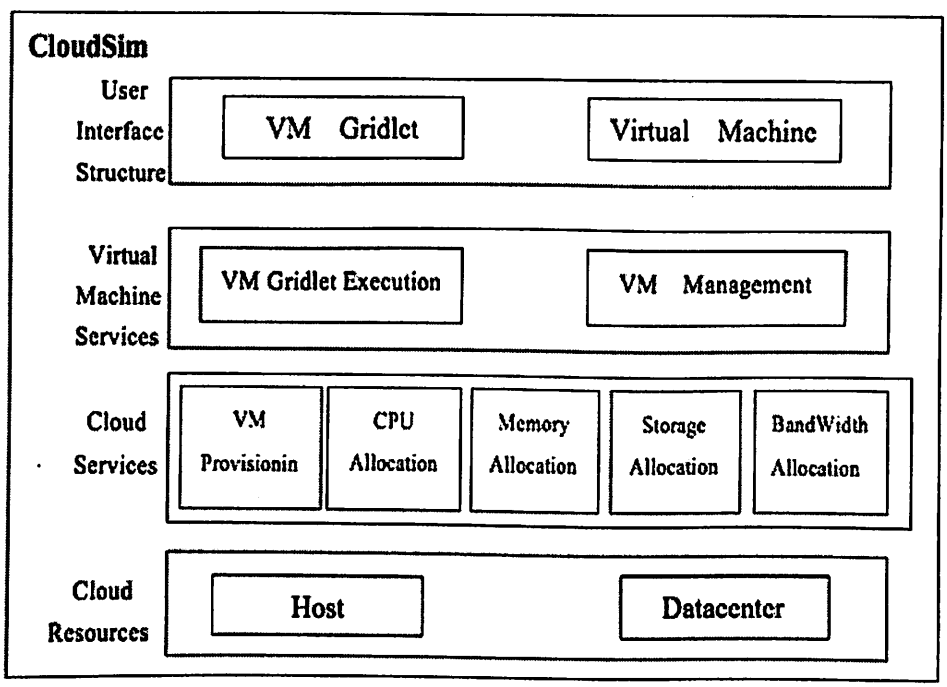


Figure 2.5: CloudSim Layer Architecture [2]

Chapter 3 RELATED WORK

Cloud computing could be a new technology and is becoming standard day attributable to their choices While. During this technology virtually all hardware, package and platform are provided as a service. Pay-per-use charging policy is used to load user services. A cloud provider offering cloud computing services requests. A vital issue in cloud allocate resources such applications in order that the work required is completed in a minimum consistent with the user indicates time. A decent programming technique together help the economical use of resources. Several scheduling algorithms are investigated as Max-Min, X-suffrage, Min-Min, program genetic algorithm, particle Swarm optimization etc. The performance of the algorithm genetic quality and also the planned breeding program algorithm are compared with existing knowledge. Max-Min and Min-Min is optimized with a new approach that uses two of them. An array with machine / resource "n" of the task and "m" is shown in Fig containing the time (in seconds) required task on each machine.

	M0	M1	M2	M3
T0	160	400	80	200
T1	40	100	20	50
T2	100	250	50	125
T3	20	50	10	25
T4	140	350	70	175
T5	80	200	40	100

Figure 3.1: Task Matrix [3]

3.1 Min-Min Algorithm:

Min-Min Algorithm [3] starts to start assigning a set of non-assigned task to resources, firstly it calculates the minimum execution time to complete task with all unassigned task. From all these minimum time of all task the minimum (of all) is selected/found and it is the least value among all task on any resource. W.R.T the minimum

time that task it assigned to the corresponding machine with that value. After that the execution time of that task is added to all other task and that task is removed from matrix/list of unassigned task/to be assigned task. This procedure is repeated until all task are assigned to the resources. Assigned of task in figure 11 is done by min-min and shown execution time in figure 12.

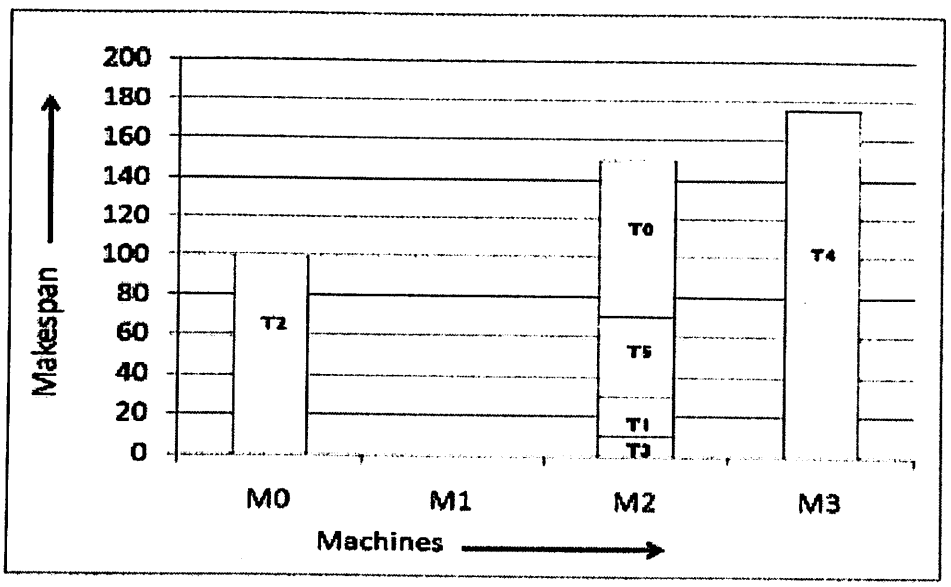


Figure 3.2: Resource allocation for Min-Min algorithm [3]

3.2 Max-Min Algorithm:

Working of Max-Min algorithm [3] is upgraded from Min-Min, it also finds out the minimum task among all task from to be assigned task and after that it select the maximum task which is having maximum time between tasks from any machine. Than w.r.t to that maximum value task is assigned to that corresponding machine. After assignment of that the execution time of other task is updated by summing up the execution time of other machine with the execution time of current executed task and the task is poped of from the list of un-assigned task on the machine. This procedure is iterated for all the task in the list, assignment of task in figure 11 w.r.t max-min method is shown in figure 13 it task 150 unit time to complete all the task that are perform better than min-min.

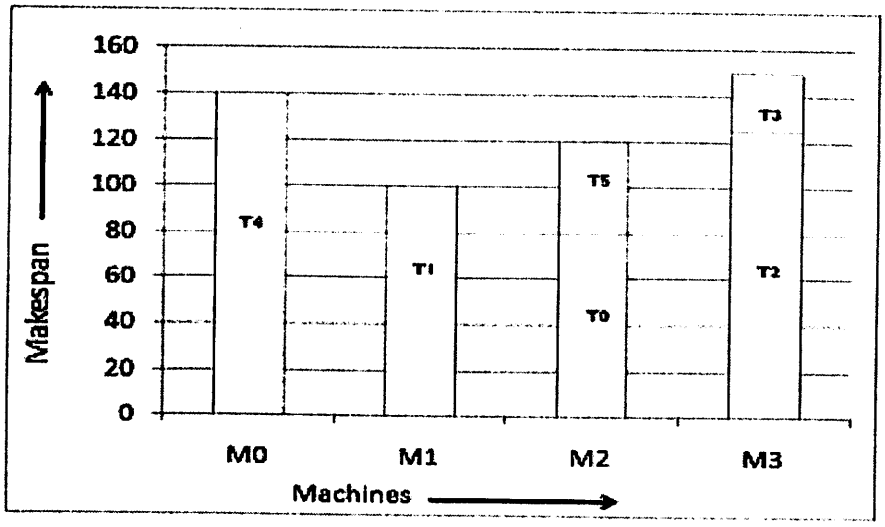


Figure 3.3: Resource allocation for Min-Min algorithm [3]

3.3 Genetic Algorithm:

Genetic algorithm is an evolutionary computing technique inspired from evolution. The theory of evolution was first proposed by Charles Darwin in his famous work origin of species. The basic idea behind evolution is that nature favors the stronger individual than the weak one. Genetic algorithms tinseled this basic idea into a platform suitable for optimization.

3.3.1 Initial Population

Initial population is that the group of all the solution that area unit utilized in the genetic algorithmic rule to look out the optimum resolution. Each resolution within the population are referred as private and for all solutions is depicted as a body for creating it appropriate for the genetic operations. The Solution area unit is hand-picked from the initial set of solution and a few operations area unit applied on those to create consecutive generation. The sexual activity chromosomes area unit hand-picked supported some specific constraints.

3.3.2 Fitness Function

The quality of solution within the set of solution is measured by using fitness function with respect to the give optimization objective. The creation of fitness function depends on the need of problem if we need to optimize time or cost, fitness function is derived w.r.t that.

3.3.3 Selection

To select the next generation from the generated new solution after the cross-over or mutation selection different operator is used as tournament selection, roulette wheel selection etc. In tournament selection first n element is selected and after that the fittest among them is selected from next generation. Roulette wheel selection is based on probability.

3.3.4 Crossover

Crossover operator is used to create new solution from the previous solution, it takes two parents and creates a new solution after crossover. Different types of crossover is used to create new solution from the parents as single point crossover, multipoint crossover etc.

3.3.5 Mutation

If the solution of problem stuck in a search space they are not spreading by using crossover so mutation is applied. For applying mutation only single solution is needed the solution is replaced by opposite factor values as if binary representation is use so the zero is replaced by one and vice-versa. It is used to spread a solution if it stuck in one area only.

Genetic Algorithm works in the following manner:

1. Begin
2. Initialize population by random solutions
3. Evaluate each candidate
4. Repeat until (termination condition occur)
5. Do
    a. Select parents
    b. Recombine pairs of parents
    c. Mutate the resulting offsprings
    d. Evaluate new candidate
    e. Select individuals for next generation
6. End

Figure 3.4: Genetic Algorithm

3.4 Improved Genetic Algorithm:

Genetic algorithm takes two random parents from population are apply genetic operation on them to create new generation/individual, in improved genetic algorithm idea is there that the initial population/parents is selected by the result of min-min and max-min algorithm than genetic algorithm is applied on the in the same way, so b increasing better initial solution the further generation is also improved and result will come fast. [3]

The new Improved Genetic Algorithm will be like:

1. Begin
2. Find out the solution by Min-Min and Max-Min
3. Initialize population by result of Step 2
4. Evaluate each candidate
5. Repeat until (termination condition occur)
6. Do
   a. Select parents
   b. Recombine pairs of parents
   c. Mutate the resulting offsprings
   d. Evaluate new candidate
   e. Select individuals for next generation
7. End

Figure 3.5: Improved Genetic Algorithm

The improvement in genetic algorithm is analyzed by assigning the task in fig 11 to the resources and it gives best result than min-min, max-min and simple genetic algorithm, it complete all task in 140 time interval.

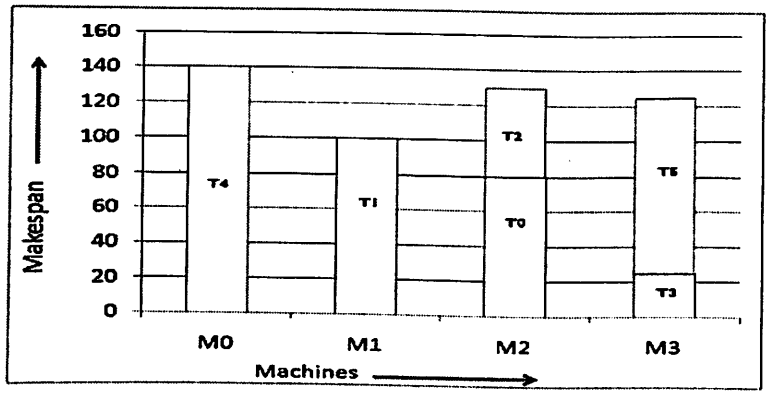


Figure 3.6: Resource Allocation for Improved Genetic Algorithm [3]

3.5 Ant Colony Algorithm:

Ant algorithm is a kind of new heuristic algorithm which based on the behavior of ants. Its idea is: On their way of walking around in searching food, it release pheromones on the way they passed, so pheromones will increase very quickly in the shorter path. And the number of pheromones on each path, at the same time, indirectly reflects the probability that other ants' choices. Finally, all ants will choose the shortest path. According to experiences, the scheduler can get the forecast results more quickly and easily.

Comparative analysis of two heuristic algorithms: Genetic algorithm possesses fast search capabilities, while it is not conducive to use feedback information in an entire system.

When the solution is in redundant case, the exact solution is obtained inefficiently. Ant algorithm possesses global search capabilities which are parallel and distributed. The efficiency is very low when it is lack of information in early time. By analysis, when designing task scheduling algorithm, the fusion of the two algorithms can be used. As a result, you can get the accumulation of information and can search quickly at the same time, then get a better scheduling effect by complementing advantages and disadvantages.

Chapter 4 PROBLEM DEFINITION

Scheduling is a task of assigning resources to jobs for achieving pre-established goals. The abstract idea of assigning resource to task is called resource planning. Over recent decades, researchers have done a lot of analysis on the downside of planning that has received widespread attention in math, research, engineering and different fields. Different methodologies like linear computation, dynamic programming are widely used to address issues with effective scheduling. Scheduling is understanding the activities and planning/sequencing the activities in a manner to complete the task/job in an effective and optimal way. Scheduling is a form of decision making in every filed from government (planning of any new scheme), personal (designing a new plan for today), cultural (organizing any event) or economic decision making. In every field scheduling has an important role. Several strength of scheduling are scalability, optimization, modeling feasibility. Proper designed secluding algorithm leads to an optimal solution of a problem. In cloud secluding is used to assign task to resources. Which task is assigned to which resource and when is depend on scheduling algorithm and the result of proper scheduling algorithm defines optimal result. Cloud scheduling or provisioning is used to assign the task/jobs to resources in a way to get optimal timespan and cost. Many scheduling algorithm are used to schedule task on resources in cloud enviourment. To seclude a task the aim is to assign task to best resource. Aim of scheduling is to utilize all resources and complete all jobs in min time.

Programming problem is how to allocate tasks with limited resources to achieve some of the preset objectives. The task, machine, resources in programming problem are abstract concepts. However, in reality they represent extremely wide range of practical objects. In recent decades, people has done a great job of research on the problem of programming that has received great attention from the applied mathematics, operations research, engineering and other fields. Linear calculation, dynamic programming and algorithm analysis of decision in operations research have been widely used to study programming problem.

The aim cloud programming algorithm to assign any task / job given by the user in optimal time to machine resources with minimal cost and burden on the machine. The overall through the commissioning of the system must be increased to optimize time, QoS, load balancing and cost. target cloud computer programming is to achieve optimal planning sent by the user, you should try to improve the overall performance of cloud computing systems with specific objectives include the minimum time, load balancing service, economic principles and so on.

Optimal makespan: makespan could be a vital and common goal programming task. Users sometimes expect their task is completed as soon as potential. Optimal makespan is the common goal of each cloud suppliers and buyers.

QoS: Quality of Service is very essential ability in many cases where it has resources to support many specific requirements such as response time, costs, etc. In appearance, should improve the potency of the application characteristics compliant resource to confirm operation and accuracy of buyers. On the opposite side, and air resources should choose permanent changes dynamically supported users to comply with the economy and user satisfaction. Therefore, the aim is not only to protect users but also useful for developing long property cloud computing.

Equalizing charge as the number of computers within the cloud computing platform is incredibly massive. In others, the complicated composition and totally different heterogeneous load balancing cloud computing platform construction in May current difficult.

Economic principles: budget could be a key factoring in scheduling attributable to massive cloud computing business model radical and pay-per-use. Market vendors cloud users will associate degree mutual advantages of a system of economic planning.

Since cloud services need a lot of administration and resource management, planning an honest advancement is vital to manage tasks. Advance planning plays a key role in the advancement management system. Figure one illustrates the cloud advance planning. Introducing the progress of a consumer, broker or hardware is used to execute the planning rule so that the system will start calling form. In cloud infrastructure, physical machines

are virtualized resources into unified known as virtual machines (VMs). The hardware decides that resources (VMs) will be used in addition to the tasks they will be killed by each of these resources.

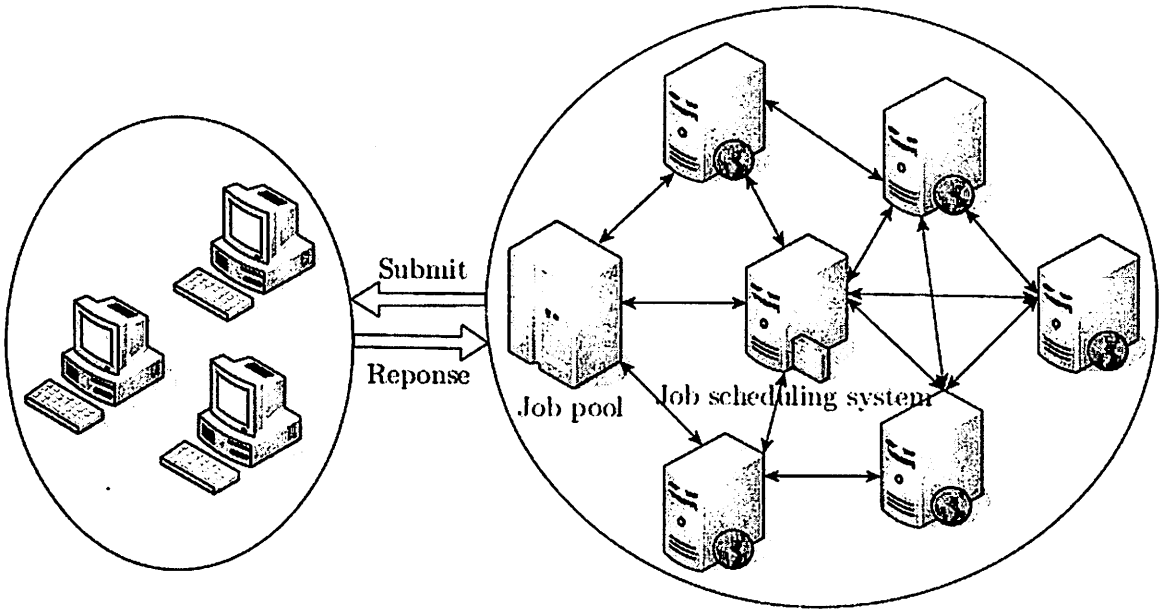


Figure 4.1: Cloud Job Scheduling [6]

Chapter 5 DESIGN

In the following, I adopt the general model and notation used by existing works on PSO-based scheduling. A workflow is usually represented by a Directed Acyclic Graph (DAG), and denoted by = (V, E). The set of nodes V= $\{T_1 \ldots T_n\}$ represents the tasks in the workflow applications, and n is the total number of tasks in the workflow. The arcs E= {dij}, di j denotes the data dependencies among the tasks. An arc, dij = (T_i, T_j) implies that T_i transfers data to Tj. In this relationship, T_i is the parent task of T_j and T_j is child of T_i .The child task cannot be executed without receiving data transferred from all of its parents. Fig. 1 shows a workflow example of 8 interdependent tasks. Note that any single task can have one or more children (except for the bottom nodes), and any

Single task can have one or more parents (except for the top node). Suppose there are a total of resources in the cloud environment. The resources can be denoted as R= {R1....Rm}. All the resources are interconnected with each other so that they can transfer data among each other. The scheduling problem is to find an optimal mapping between tasks and resources according to some optimization objective. As mentioned before, cost is a common objective that is more concerned by user; makespan is another objective that is critical for scheduling.

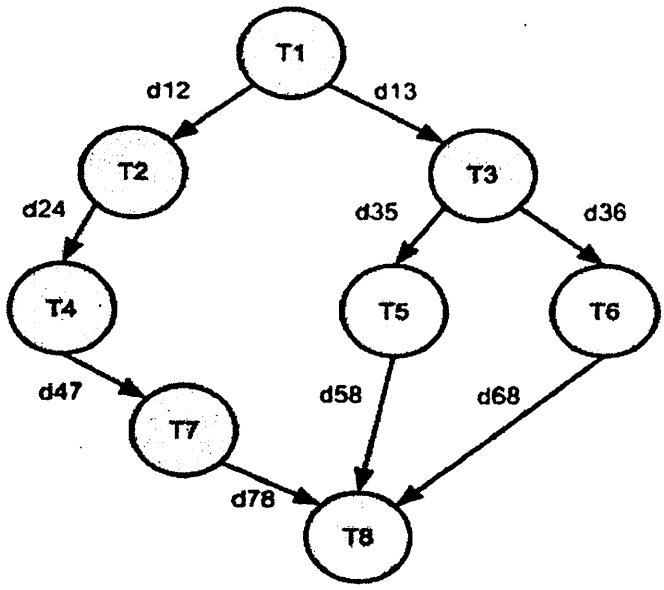


Figure 5.1: DAG for Task

In the following, I formulate several optimization objectives. Let Makespan total (M) denote the makespan of workflow with respect to mapping.

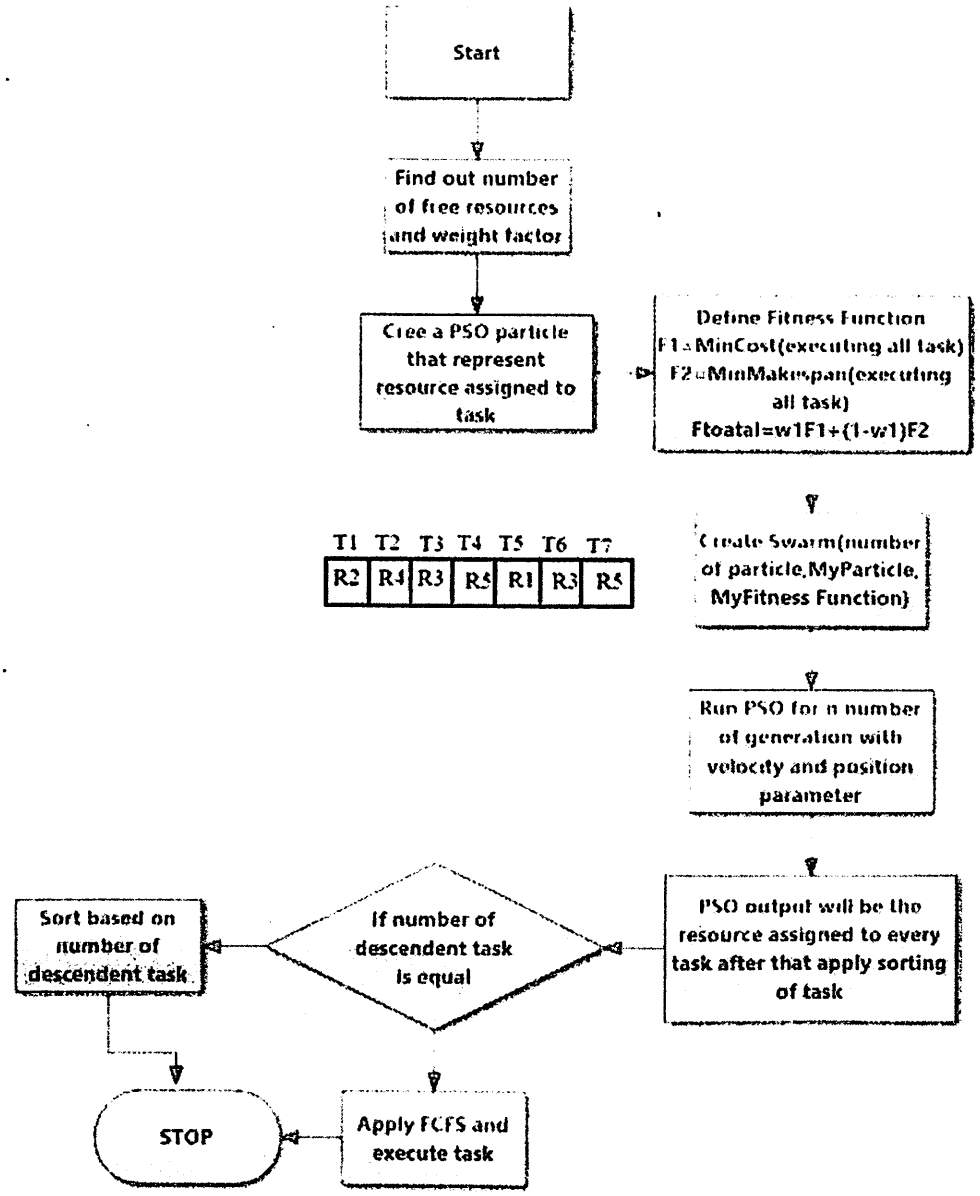


Figure 5.2: Flow Chart

Makespan _Total (M) = finish time of last task-start time of first task

The makespan of a workflow is the time duration from the process of first task till finishing all tasks. Since a workflow consists of interdependent tasks, both execution time and transfer time

need to be considered. Next, let $Cost_{exec}$ (R_i) and $Cost_{trans}$ (Ri) be the execution and transfer costs of resource Ri:

$Cost_{total}$ (Ri) = $Cost_{exec}$ (Ri) + $Cost_{trans}$ (Ri), 1 <=i<=m..... (2)

Let $Cost_{total}$ (M) denote the total cost of processing workflow w.r.t the mapping:

$Cost_{total}$ (M) =$\sum$ $Cost_{total}$ (Ri)..... (3)

For the objective of minimizing the cost while balancing the load, the fitness function is given as:

Fitness Fuction1 = Max ($Cost_{total}$ (R_i)), 1<=i<=m..... (4)

The objective is to minimize. The reason for not using the total cost of all the resources is to prevent from mapping all the tasks to a single, least-cost resource. For the objective of optimizing makespan, the fitness function can be defined as:

FitnessFuction2 = $Makespan_{total}$ (M)..... (5)

The objective is to minimize FitnessFuction2

An objective of minimizing the weighted sum of total cost and makespan; the fitness function can then be defined as:

Fitness Fuction3 = wCosttotal (M) + (1 − w) $Makespan_{total}$ (M), 0<=w <1..... (6)

Where α is the weight given to the total cost and (1-w) is the weight given to makespan. This fitness function can be easily tuned by changing the value to satisfy the various QoS requirements including budget constraints. Again the objective is to minimize.

Where α is the weight given to the total cost and (1\α) is the weight given to makespan. This fitness function can be easily tuned by changing the value to satisfy the various QoS requirements including budget constraints.

Chapter 6 METHODOLOGY

Existing PSO is optimize only time of the execution of task over cloud system so it is not worrying about cost of execution that the task is assigned to higher cost resource than lower in real life cost and time both are main concern so algorithm ought to be able to optimize price of completion of all task and time over cloud enviourment. To optimize both of them the fitness function is designed for both and them they are adscititious by victimization weight parameter that decides the user need (time or cost). First fitness function optimize time to complete all task over cloud and second one optimize price of execution the final is the sum of each with constant or weight factors.

$$TotalCost(M) = \sum_{i=i}^{n} cost(Ri) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

$$Minimize(w1TotalCost(M) + Minimize((1 - w1)TotalMakespan(M).. (8)$$

PSO algorithm for task

1. Set particle dimension with set of ready task {ti}
2. Initialize particle position randmly P=1...j and vi.
3. For each particle calculate fitness value by eq 6.
4. If the fitness value is better than previous best pbest than set fitness value to current best.
5. After applying step 3 and 4 for all particle, select the best particle as gbest.
6. for each particle update velocity and update new position.
7. If the stopping criteria or maximam iteration doesn't satisfy repeat from step

Figure 6.1: PSO algorithm

The objective is to optimize sum of both of them with weighted factors. After assignment of jobs to resource sorting is used in resource to decide which job will execute first and which is last (sequence of execution) depend on the number of decedent of the task by using first come first serve and sort the task in the vm resource two factors are considered first one is the number of decedents are most next or first and second one is the execute time of task. First the task with most first descendants are sorted and then they are sorted according to time of execution.

1.For each resource do

2. For all ready tasks in resource

3. Sort all ready task in decresing order of decedent

4. For each task which is having same number of decedent

5. Sort all task in incresing order of execution time

Figure 6.2: Sorting of tasks in VM

Chapter 7 ANALYSIS

Every VM is specified with MIPS (million instruction per second) and cost to use vm. Cost of data transfer between every vm is specified. Every task is specified with MI (million instruction) size of task and data transfer between tasks. Time taken to execute task is division of size of task and MIPS of vm, total cost is summation of task execution time and data transfer time or transaction time.

Algorithm 1 with FCost as fitness function, algorithm 2 as FMakespan as fitness function, algorithm 3 as the weighted sum of them as fitness function and algorithm 4 is algorithm 3 with sorting applied on every resource. Comparison of algorithm is done with 10 resources and 50 number of particles.

Comparison of cost between algorithm 1 and algorithm 4 in shown in figure 7.1, as the number of particle increases the performance of algorithm 4 increases. Comparison of algorithm 2 and 4 is shown in figure 7.2.

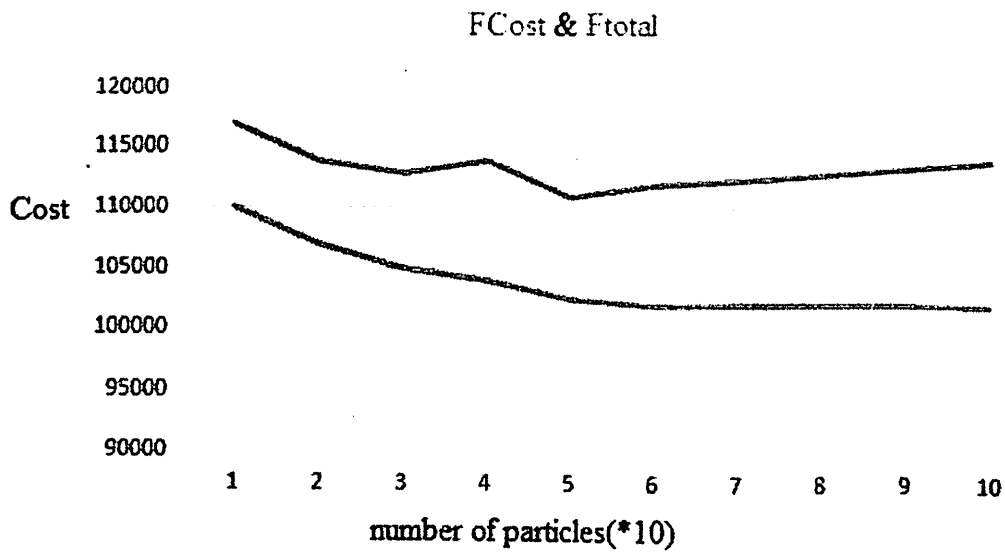


Figure 7.1: Cost of algorithm 1 and 4 with different number of particle

As it is seen algorithm 4 perform better for large number of particles and after some time increment is constant so no need to increase number of particle, change in number of particle is not affect the performance it will be constant. In figure 7.2 the time of algorithm decreases with increase in number of particles and after some time it remain constant. As the weight value of cost increases the cost, the cost decreases while makespan increase.

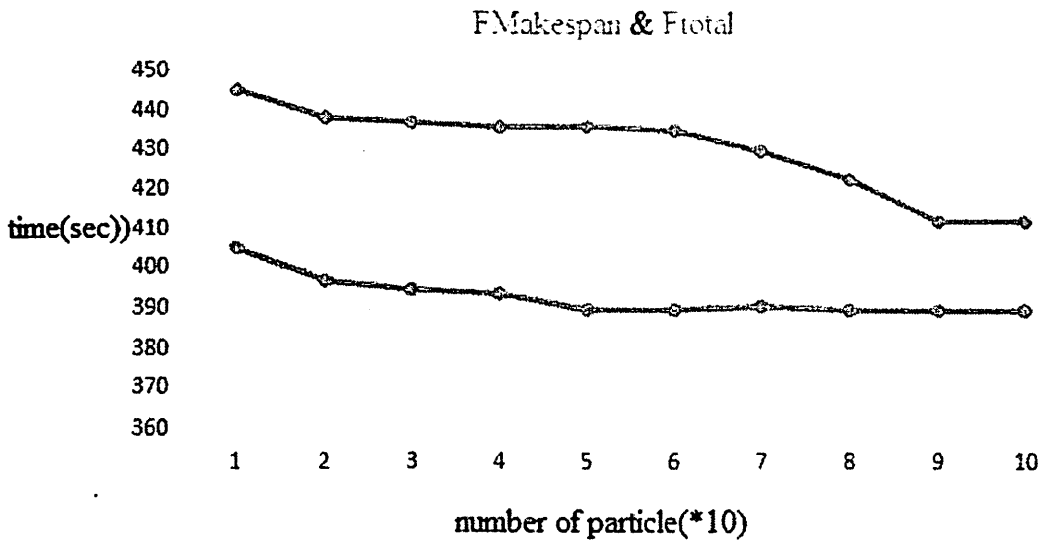


Figure 7.2: Time of algorithm 1 and 4 with different number of particle

Chapter 8 CONCLUSION

Cloud Computing technology has brought a huge in business model, enterprise solution and traditional software's. It became more and more useful with time to improve performance of cloud system. Scheduling the task on the resources in very essential problem in the cloud enviourment. For utilize the resources an efficient scheduling is needed and user time. In this algorithm two objective is considered cost (cost to use the resource in cloud system) and Performance (time to completer all task/job in cloud system with QoS), with applying sorting it perform better than all other algorithm. It optimize the time and cost both for the customer and cloud provider. Weighted factor is used to give priority to cost and time depend on user. PSO with sorting of resource task will optimize both parameters cost and time in scheduling. In future my making suitable decision making algorithm with multi-objective algorithm performance of the system can be improved duplication technique can also be applied if it causes more difference in the performance of the system.

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