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Optimizing Processing Cost of Cloud Using Genetic Algorithm

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Abstract -**The cloud computing involve the computational architecture, storage units, networks and the computational units. These units are used for serving the huge amount of request, therefore the resource utilization and their management is essential aspect of cloud computing. In this presented work the resource optimization is the primary goal of the study. In addition of simulation and modeling of the cloud resource preservation is the next goal of the work. In this context recently contributed articles and the research papers are studied. Most of them are utilizing the optimization techniques for improving the performance of the resources. In other words the scheduling of resources can optimize the performance of the cloud resources with respect to the appeared jobs for scheduling. Therefore the genetic algorithm for cloudlet scheduling is presented in this work. Additionally for simulation and modeling of the proposed technique is performed using the cloudSim simulation tool. That is a JAVA based simulation library for supporting the events of cloud and managing cloud resources. After implementation of the genetic algorithm based scheduling technique the proposed model is compared with the exiting space shared cloud scheduling technique. The performance of both the techniques are evaluated in terms of time and space complexity and for providing the difference about the resource utilization the processing cost of the both techniques are also computed. The results demonstrate the proposed technique is efficient and preserve the cost of process execution effectively.**

Keywords: cloud computing, resource scheduling, Clouds, processing cost, genetic algorithm

I. INTRODUCTION

In recent years the need of computation is increased much significantly. A number of new devices, users and technological gadgets are appeared that frequently accessing the web and internet based services for computing and storage. In order to handle the increasing traffic load on network and computational servers cloud computing is used. The cloud technology offers the different kinds of storage and computational services. These services and their capabilities are not limited they scale their performance and capabilities according to their need. Thus a number of organizations are utilizing the cloud services. On the other hand cloud resources are much expensive and their running cost is large enough. Thus it is also required to preserve these resources by optimization of the scheduling strategy of cloud schedulers.

In this presented work the main aim is to study about the cloud scheduling strategies and investigation of their benefits. In next the aim is focused on design and simulation of cloud computing infrastructure for demonstrating the scheduling effect of the cloud. Thus the proposed work involves the implementation of the genetically inspired algorithm for scheduling the cloud resources for optimizing the performance of computational cloud. The genetic algorithm is a soft computing technique that helps to search or optimize constrains. In addition of that the comparative performance studies among the traditionally available scheduling technique for preserving resources.

II. PROPOSED WORK

The understanding of the proposed approach for optimizing the cloud resource performance is provided in this chapter. Thus the chapter includes the basic understanding and the methodology for accomplishing the required objectives.

A. System Overview

In computational cloud the main service is to process the user's job and generate the outcomes of the input list of processes. When the user produces their jobs to the cloud server these jobs are listed on a job queue. In further the scheduler pick a job and allocate the resource for process this job. In terms of cloud computing the jobs are identified as the cloudlets. In this context the resource allocation is a task of scheduler thus as the designer configure the scheduler it performs the processes. There are a number of different kinds of scheduling algorithms in literature such as round robin, and others.

The term resource includes the number of machines available in the system, with the number of processing elements in machine. All these units are commonly termed as the computational resource of cloud. Basically the resource scheduling is performed for achieving two goals either for optimizing the cost or time or for both. In this presented work the main aim of the resource scheduling is to optimize the processing cost with respect to the traditional space shared algorithm. Therefore the genetic algorithm is used as the problem optimization technique. The genetic algorithm is a heuristic based search approach that finds the best fit solution for the existing problem space. But it accepts a single string for processing it, on the other hand the key issue of the work is to combine the resource list with the cloudlets for finding best match. In this context an additional encoding scheme is implemented with the algorithm that first encodes the processes and resources into a single binary string for utilizing with the genetic algorithm. This section provides the basic overview of cloud terminology used for job scheduling and the basic concept of the proposed approach in next section the detailed methodology of work is discussed.

B. Methodology

The key concept of the proposed methodology is demonstrated using figure 2.1. Additionally the components are also described in this section.

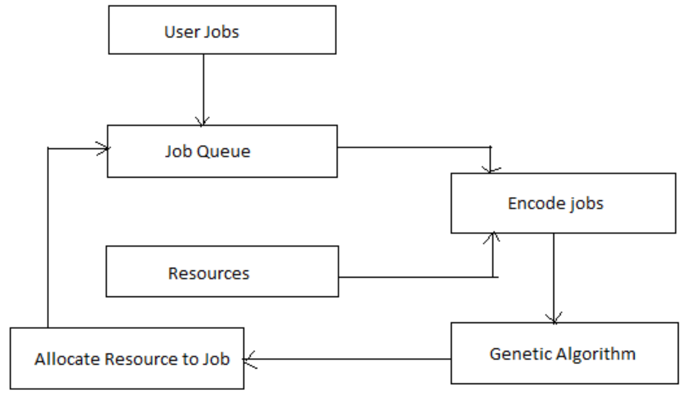

Figure 2.1 proposed system architecture

User jobs: user provides a list of jobs to be process using the cloud, these jobs list can be in form of a dataset which is produced to the system as input. This list of jobs is containing a number of fields among the jobID and process length is the key factors which are used for converting the jobs list into the cloudlet. During the configuration of cloudlets the cloudlet id and the length of cloudlet is the main parameters.

Job queue: basically the cloudlets are stored in a queue which are fetched according to their IDs and directly allocated to the resources if the resource is available. If the resources are not available or not free then the cloudlet need to be waiting till any resource not becomes free.

Resources: a cloud server can maintain more than one resource. Basically that is clustered organization of the computational resources. An individual resource has one or more machines and a machine have one or more number of processing elements. Additionally each processing element of the resources has their ratings in terms of MIPS (million instructions per second). Thus the number of resources in cloud infrastructure can impact on the performance of process execution.

Encode jobs: this phase accepts two strings of the similar length dynamically first the list of resources and the queue jobs. The number of jobs extracted from the queue is depends on the number of resources in the cloud infrastructure. Now using both the inputs the jobs are encoded using the following process. First need to find the load on resource, load is the length of jobs remain to process which is allocated before. If the load of current resource is less than the mean load of resource the process can be allocated for the particular resource otherwise need to search other resource for that purpose.

That can be written in the following manner:

- If resource loads less then mean load then

- Include 1 into the sequence
- Else
  - Include 0
- End if

This process is performed for all the available resources and the extracted jobs from queue. The output of this process is a binary string.

Genetic algorithm: the genetic algorithm is implemented in this phase for finding the sequence that contains maximum number of 1's in their sequence using both the list resource list and jobs list. The returned sequence is passed into next phase for allocating the resources to jobs.

Allocate jobs: the obtained best matched sequence of resources is allocated to the given cloudlet IDs for processing the cloudlets. Meanwhile the performance of the process execution is also computed through the cloudlet traces.

C. Proposed Algorithm

This section provides the summary of the proposed system which is demonstrated in previous section using the algorithm steps. The required step of the process is given in table 2.1.

Input: user jobs J, list of resources R

Output: sequence of resources

Process:

1. $U_j = ReadUserJobs(J)$
2. $Q_n = putJobstoQueue(U_j)$
3. $R_l = getListResources()$
4. $for(i = 1; i < R_l.size; i++)$
    a. $Job_i = Q_i$
5. $end\ for$
6. $for(j = 0; j < l; j++)$
    a. $if(R_l.meanLoad < Job_j)$
        i. $S.Add(1)$
    b. Else
        i. $S.Add(0)$
    c. End if
7. End for
8. $SEQ = geneticAlgo.GetBest(S)$
9. $return\ SEQ$

Table 2.1 proposed algorithm.

III. SIMULATION

This section provides the details about implemented simulation and their parameters.

A. Simulation Setup

In order to simulate the proposed Gang Scheduling Based Resource Optimization technique in computational cloud environment the following configuration is prepared for simulation. The configuration on which the simulation is performed is given in table 3.1.

Table 3.1 Simulation Setup

S. No.	Parameters	Values
1	Virtual machine RAM	512
2	Host RAM	2048
3	Number of Cloudlet	40
4	Host Band width	10000Gbit/s
5	Host Storage	1000000 GB
6	VM Image Size	10000
7	Number of CPU	1

B. Simulation Scenarios

In order to simulate the effectiveness and the power consumption criticalness there are two different simulation scenarios are desired to implement.

1. **The simulation using the Traditional Space Shared Scheduling:** In this simulation implementation the traditional Space-shared VM scheduling approach is implemented using the CloudSim discrete event simulator and performance of scheduling is calculated.
2. **The Simulation using the Proposed Genetic Approach:** In this simulation analysis the proposed technique is implemented with the CloudSim simulation platform and the performance of different parameter is calculated on CPU utilization time and memory consumption.

IV. RESULTS ANALYSIS

The implementation of the proposed resource allocation approach is described in previous section. This section includes the detailed understanding about experimental evaluation and performance of the proposed system. The essential parameters are used for evaluation are listed with observed values.

A. CPU Utilization Time

In order to execute an individual process for that an amount of time is consumed. This time of execution is termed as CPU Utilization. The CPU Utilization time can be calculated by using following formula:

$$CPU_{ut} = 100\% - (\%\ \text{of time spent in idle task})$$

$$\%\ \text{time in idle task} = \frac{(\text{Average Period of background task with no load}) * 100}{\text{Average Period of background task with some load}}$$

Where, CPU_{ut} = CPU Utilization Time

The figure 4.1 and table 4.1 shows the CPU utilization time both implemented algorithm i.e. proposed and traditional approaches of resource scheduling. In given figure X axis contains the processes arrived for scheduling and the Y axis contains the amount of CPU Time consumed. In each of the scheduling approach the results analysis for the CPU utilization time is given in terms of milliseconds. According to the comparative performance analysis the proposed technique needs less CPU cycles to execute the task as compared to the traditional technique.

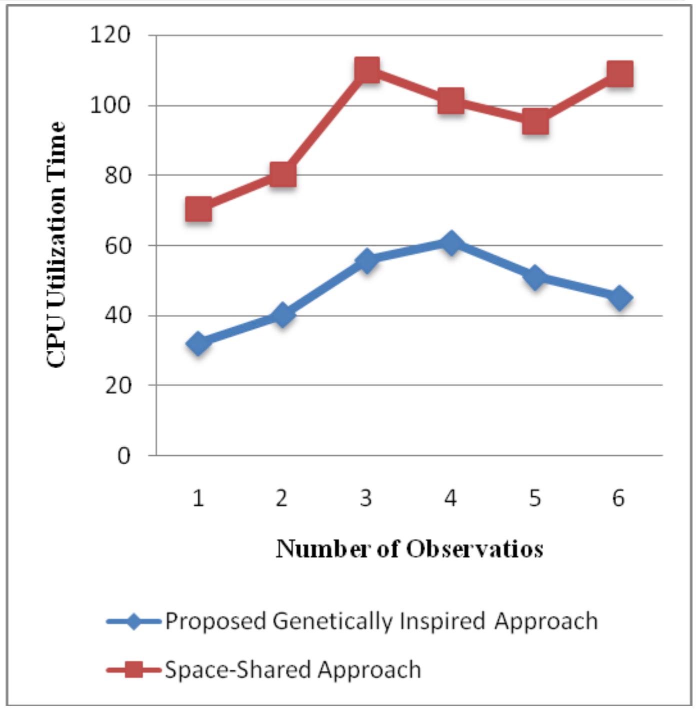

Figure 4.1: Comparative CPU utilization

Table 4.1: Tabular values of CPU Utilization

Number of Observation	Proposed Genetically Inspired Approach	Space-Shared Approach
1	32.114	70.497
2	40.265	80.336
3	55.746	110.157
4	60.893	101.321
5	51.002	95.501
6	45.236	108.983

Therefore CPU utilization is comparable by their result demonstration. Additionally we show the mean time of both approaches in figure 4.2. According to mean performance space-shared is consumed more CPU time to complete the task as compared to proposed genetically inspired approach.

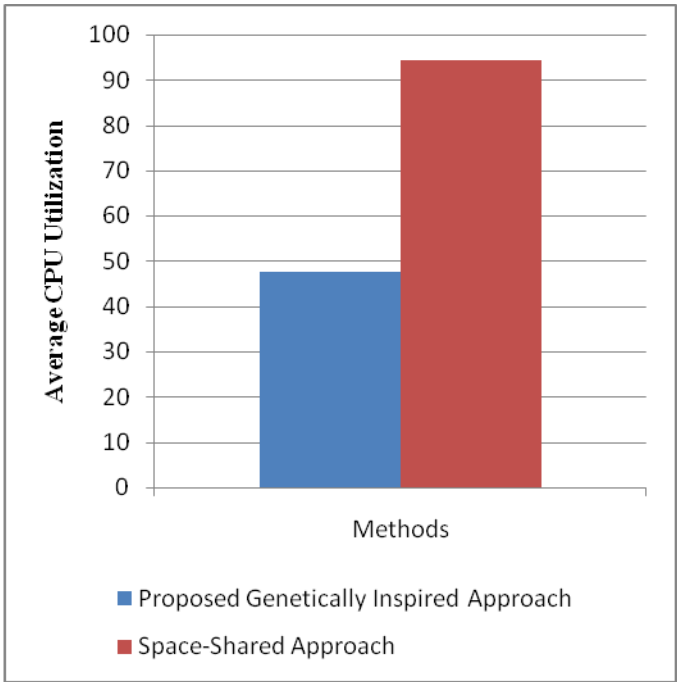

Figure 4.2: Mean CPU Utilization

B. Memory Consumption

The amount of main memory required to execute the algorithm with the input amount of data is known as the memory consumption or space complexity. The total memory consumption of the algorithm is computed using the following formula:

$$\text{Consumed Memory} = \text{Total Memory} - \text{Free Memory}$$

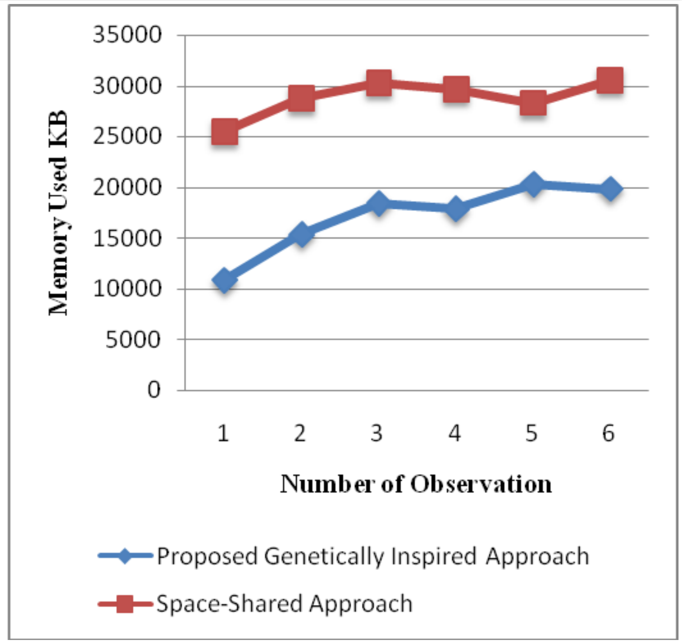

Figure 4.3: Memories Used

The figure 4.3 and the table 4.2 show the memory or space complexity of proposed and traditional approach of resource scheduling. In this diagram the amount of main memory consumed in terms of kilobytes (KB) is given in Y axis and the different observations are reported at X axis. According to the obtained results the proposed algorithm consumes lesser resources as compared to space shared technique. In this figure, blue line depicts the proposed genetic algorithm and orange line show the space shared policy.

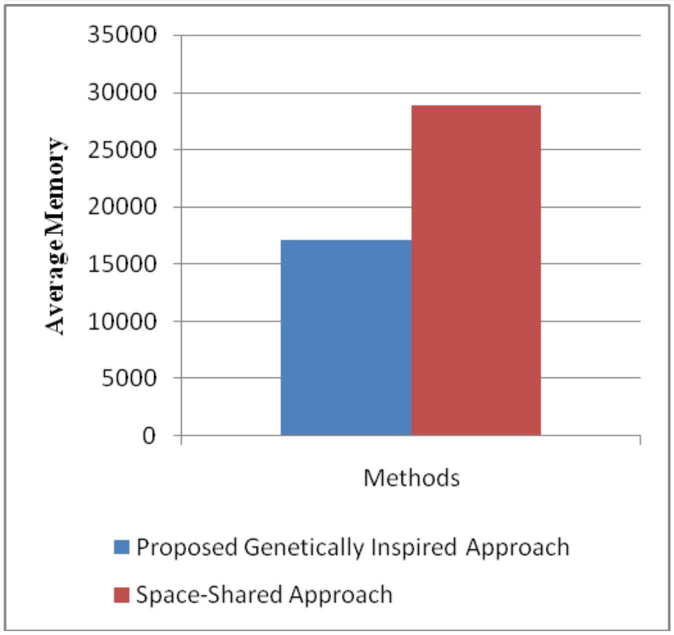

Figure 5.4: Mean Memory Consumption

For clearer difference in performance the mean memory consumption is computed and given using the figure 4.4. In this diagram the implemented approaches are reported in X axis and the Y axis contains the amount of average memory consumed in terms of kilobytes. According to the mean performance the proposed approach requires less amount of space as compared to the space shared.

Table 4.2 Tabular Values of Memory Consumption

Number of Observation	Proposed Genetically Inspired Approach	Space-Shared Approach
1	10831	25478
2	15369	28695
3	18423	30251
4	17862	29652
5	20315	28303
6	19863	30514

C. Processing cost

The process or cloudlets requires an amount or cost to be executed on the cloud. This cost is depends on the cloud resource per second cost and the length of cloudlet jobs. Over the different configuration of the cloud resources the following outcomes in terms of processing cost is obtained as defined in the figure 4.5 and table 4.3. Additionally the mean performance of both the techniques namely space shared and the proposed technique is also described using figure 4.6. The figure 4.5 visualizes the performance of both the implemented technique which is defined in table 4.3. In this figure the X axis of the diagram demonstrate the number of different experiments performed with different datasets and the Y axis represents the processing cost of the technique corresponding to the input dataset. Similarly the figure 4.6 contains the performance of both the techniques using the bar graph. In this diagram the X axis contains the methods implemented for scheduling the cloud resources and the Y axis contains the mean cost of cloudlet processing. According to the obtained results the proposed techniques requires less cost for executing the similar amount of load as compared to traditional space shared technique.

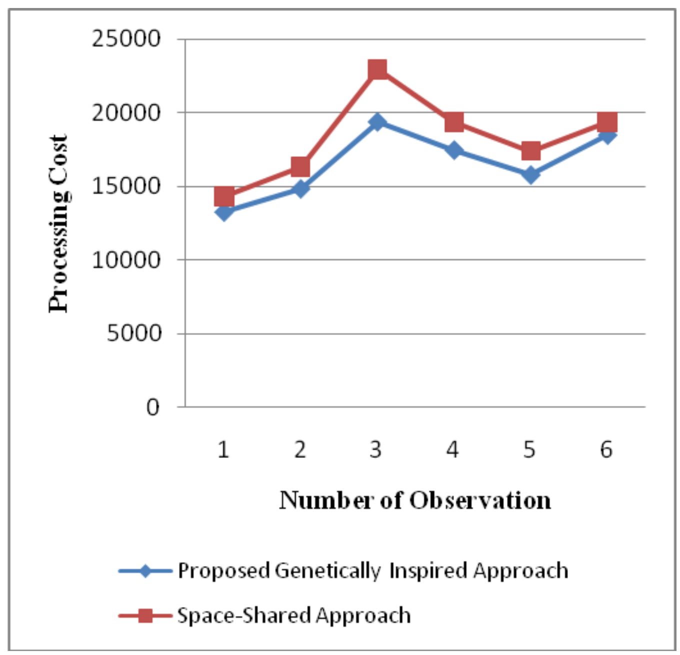

Figure 4.5 processing cost

Table 4.3 Tabular Values of processing cost

Number of	Proposed Genetically	Space-Shared

Observation	Inspired Approach	Approach
1	13264.42	14285.42
2	14837.36	16284.28
3	19377.63	22947.95
4	17463.44	19336.01
5	15773.94	17382.61
6	18483.19	19374.33

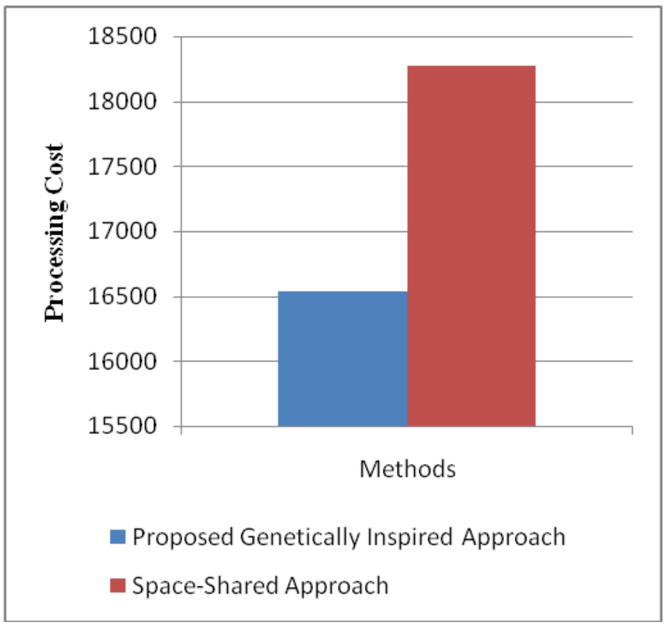

Figure 4.6 Mean Performance of processing cost

V. CONCLUSION

This chapter draws the conclusion of the presented study for optimizing the cloud performance by optimizing the resource scheduling with reference to the input user jobs. In addition of that the future scope of the proposed study is also discussed.

A. Conclusion

The cloud is young generation technology and for improving their capabilities new efforts are placed day by day. A significant amount of research work is undergoing for security, energy optimization and reduction of resource consumption. In addition of that various other research domains are also associated with this domain. Among various research domains of the cloud computing the resource management and resource preservation is also a major area of study and development. In this study the key focus is made on the resource preservation and performance optimization using the scheduling approach. For scheduling two popular techniques namely genetic algorithm and the space shared algorithms are utilized.

The proposed technique is based on the concept of heuristic based search algorithm. That search algorithm is responsible for finding the most appropriate resource for execution of the jobs. The optimization or best matched sequence of resources is computed using the traditional genetic algorithm. Therefore first cloudlet length and the list of resources are accepted from the queue and then optimize the resource according to the available resources. Before the optimization process of genetic algorithm using the sequences of the resources and job length the binary encoded strings are prepared as population for genetic algorithm. Additionally in these populations the genetic algorithm is applied for finding the optimal outcomes.

The proposed technique is implemented using the JAVA technology and with the help of CloudSim simulation tool kit. Additionally for visualizing the performance of the implemented techniques the jFree chart API is used. After the implementation and simulation of the approaches the performance is computed and summarized in table 5.1.

S. No.	Parameters	Proposed genetic approach	Space shared
1	Time consumption	Low	High
2	Space requirements	Low	High
3	Processing cost	Low	High

Table 5.1 performance summary

According to the described performance summary in table 5.1 the proposed technique is an effective solution as compared to the traditional space shared technique. Thus the technique is less resource expensive and efficient in terms of processing of large jobs.

B. Future Work

The main aim of the proposed work is to optimize the performance of cloud platform is achieved successfully. In future the following enhancement is proposed for work:

1. Evaluation of different kinds of genetically inspired algorithms for obtaining the best performance
2. Hybridize more than one algorithms for combining the good properties of algorithms
3. Computing more performance parameters for demonstration of clear line among the different approaches.

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