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Multi-objective Differential Evolution (MODE) for Task Scheduling in Cloud Computing

Anu Rani, Dr.Kanwal Garg

Research Scholar, Dept. of Computer Science and Applications, Kurukshetra University, Kurukshetra, Haryana, India

Assistant Professor, Dept. of Computer Science and Applications, Kurukshetra University, Kurukshetra, Haryana, India

ABSTRACT: Cloud computing is a rising technology in distributed computing which facilitatespay per model as per user demand and requirement. It process huge amount of data so scheduling mechanism works as a vital role in the cloud computing.In this paper, the researcher presents the multi-objective differential evolution algorithm to optimize scheduling based on energy and makespan. The result gain by MODE validate by an open source cloud platform(CloudSim).At the end, the results were compared to existingscheduling algorithm MOPSO and found that the proposed algorithm(MODE) provide an optimal balance output for multiple objectives.

KEYWORDS: Cloud Computing,CloudSim, Differential Evolution (DE), Multi-objective optimization,PSO (Particle Swarm Optimization),Task Scheduling, Minimize makespan and energy

I. INTRODUCTION

Cloud computing is the new computing standard which contributes enormous pool of dynamical scalable and virtual resources as a service on demand. The main key role behind the cloud computing model is to offer computing, storage, and software as a service or as a utility. We use these services throughinternet and it is reliable computing paradigm. In cloud computing architecture there is a front end and a back end connected by Internet or Intranet.At front end used user devices such as thin client, fat client or mobile devices etc. The users use some interface and applications for retrieving the cloud computing system. At the back end, various servers and data storage systems are working. Administration of the cloud system done by a central server and it handles the overall load and fulfilling the client demands in real time.

The main aim of cloud computing environment is to optimally use the available computing resources. Recently, it is construct that many researchers are fascinate approaching for using cloud for performing scientific applications and even the big organizations are interested forswitching over to hybrid cloud. There are various complicated applications used parallel processing toexecute the jobs actively. Due to the transmission and synchronization among alongside processes the utilization of CPU resources are decreased. The data center is used to achieve the utilization of nodes while maintaining the scheduling of parallel jobs. The cloud computing grow number of applications to execute on remote datacenters. Many complex applications require parallel processing capabilities. There are some parallelapplications which decline in utilization of CPU resources whenever parallelism become greater, if the jobs are not schedule properly then it drops the computer performance.There are many algorithms & protocols are proposed for scheduling mechanism of the cloud computing but some algorithms are proposed to reveal the scheduling mechanism in cloudcomputing.

Task scheduling is important in cloud computing because it directly affects a systems load and performance. An effective task scheduling technique requires not only fulfill the user's needs but also improving the efficiency of the whole system. The main purpose of scheduling is to program the functions in a decent sequence in which tasks can be executed under problem specific constraints.Task scheduling problems are a typical NP-hard problem. The algorithm is

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a probabilistic and uncertain global 0optimization algorithm; therefore, it is easy to obtain a global optimal solution. So the author take consideration to improve the utilization of servers allocated to the jobs and by assigning the small interval resources to the job to minimizing the makespan and energy. So, the aim ofproposed protocol is

- Improve the exertion of servers allocated to the jobs.
- Upgrade the utilization of resources.
- Minimizes the completion time (Makespan) of MapReduce jobs
- Minimizing the energy

This paper presents an optimization algorithm for job scheduling to accomplishoptimization of energy expenditure and overall computation time. The rest of the paper is organized as, section 2 consist of literature review of taskscheduling in cloud computing, section 3 describes about the model development. Section 4 discusses about multi-objective DE Algorithm. Section 5 discusses details about experimental setup and results of the proposed model and the paper concludes with conclusion in Section 6.

II. RELATED WORK

As cloud computing control different types and very large amount of data so it is called as heterogeneous system. Now days Cloud Computing is an advanced arrangement of great-scale distributed computing. So to improve the promotion of capability in cloud, reducing the processing cost, grow up the achievement of the server, minimizing the processing time and completion time it is very importantfor organizing the jobs in the cloud. So our main objective is to schedule mechanism of the tasks in cloud. This schedule model was studied by variousresearcher who have suggested various algorithms in order to resolve the various problems. The paper [1],[2],[3] discuss a complete survey of cloud computing. The authors of these papers basically discuss basic fundamentals of Cloud computing.

Dr.AmitAgarwal and Saloni Jain [4] presented the comparison of traditional algorithms for efficient execution of task that are Generalized Priority algorithm ,FCFS (First Come First Serve) and Round Robin scheduling. Algorithm tested in CloudSim toolkit and consequence shows that it gives finer execution as compared to other traditional scheduling algorithms. SapnaKatiyar et.al [5] [6] compared the algorithms PSO(Particle Swarm Optimization) and (Genetic Algorithm) for computational effectiveness, improve performance and result concluded that PSO performed better than GA. Mohammed Alhanjouri et.al [7] solved the TSP(Travelling Salesman Problem) by using two algorithms ACO (Ant Colony Optimization) and GA. The researcher of this paper concluded that GA perform better than ACO for this problem.JingXue et. al[8] used the improved differential evolution algorithm is efficient to optimize cloud computing task scheduling problems in load balancing energy and time. The author of the paper [9] evaluated the comparison of optimization algorithms that are GA,PSO,DE(Differential Evolution) and Simulated Annealing(SA) .In this paper,among these algorithms DE performed better than other algorithms.R.K. Jena [10] focused on task scheduling using a multi-objective nested Particle Swarm Optimization (TSPSO) to optimize energy and processing time. The experimental results illustrated that the proposed method multi objective particle swarm optimization (MOPSO) outperformed the BRS and RSA.

From the above discussion, it is found that most of the researchers worked on optimizing a single objective, but very few of them optimize more than two objectives at a time. Therefore, it is a skilful idea to estimate the effect of multiple objectives on cloud scheduling problem. To tackle with these gaps, a multi-objective DE algorithm(MODE) is proposed to optimize the energy and time.

III. MODEL DEVELOPEMENT

To solve the problem of task optimization using DE algorithm within the cloud framework, model of cloud computing is proposed as shown in fig. 1. The cloud system consists of many data center that are scatteredtopographical all over earth and are accessible using internet. Each data center has many computing, saving elements and other resources. Processing Elements (PEs) in each data center are connected by a high frequencyconverse on network. Therefore, insignificanttransmission delay is considered in this model. In the advance model, user can access the cloud devices

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using user interface. The desired task scheduling module in theframework is responsible for efficient allocation of user jobs into different available PE with an objective to optimize energy consumption and time. In fig. 1, 'DC' indicates the Data Center and 'PE' indicates the sets of Processing Elements.

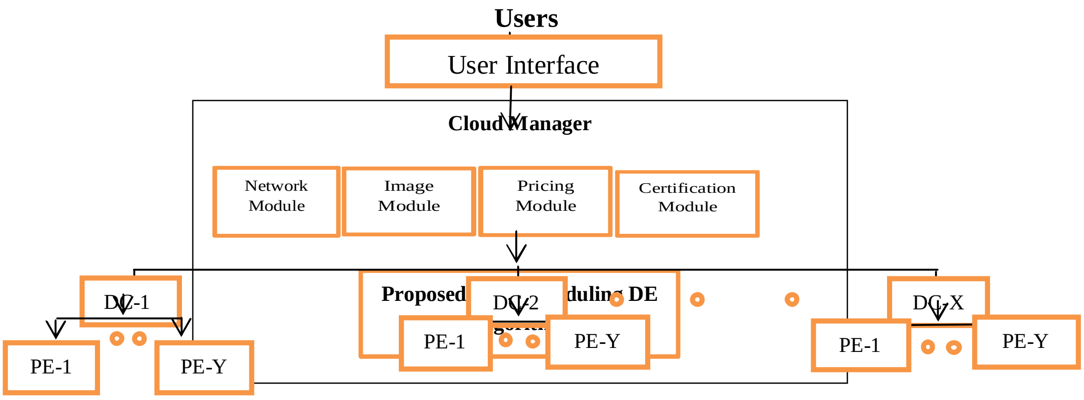

Fig:1Cloud Scheduling Environment

A. Objective Function

Suppose user job U_i is assigned to Data center D_i and T_j(a set of tasks of user job $(U_{i)})$) is assigned to a Processing Element (P_j). If the time require executing T_i using P_i is denoted byT_i .The finishing time of T_i can be expressed as:

Finish (T_i) =Start(T_i)+T_i (1)

So, the total time spend to complete the user job by D_i (Makespan$_i$) can be defined as:

Makespan$_i$= max{Finish(Tj)} (2)

Where T_i = 1….n the tasks are assign to D_i

The Energy consumption to compute the user job z(Ui) by Datacenter D_i is calculated as follows:

$E_i = \sum_{J=1}^{N} (T_j \times P_j)$ (3)

The goals of this proposed model can be served as:

Minimize Makespan$_i$I = 1…K(4)

MinimizeEnergy$_i$I = 1….K (5)

Subject to:

1. The user job must finish before deadline D_i
2. Each user job can be allocated to only one Data center.

IV.MULTI-OBJECTIVE OPTIMIZATION

In multi objective optimization (MO),more than one objectives to be optimized that's why there are various answers which are not comparable, referred to as Pareto-optimal solutions.A multi-objective minimization issue with 'n' variables and 'm' objectives can be formulated as:

Min q = f('x') = min of (f_1('x'),f_2('x'),….., fm('x')) (6)

Where 'x'= (x_1,x_2…….., $x_{n)}$ and q = (q_1,q_2……..,q_m)

The concept of pareto-optimality is use,in which most of the cases the objective functions are in conflicts, so there is chance more than one optimal solutions are superior than other but one solution cannot be said to greater than another .For deal with this problem, a multi objective DE based framework was proposed.

A. Differential Evolution Technique

Differential Evolution (DE) is a type of evolutionaryalgorithm originally recommend by Price and Storn [10] for optimization issues over an ongoing region. It creates new candidate solutions (called agents) by combining the parent individual and several other individuals of the same population.These agents are moved around in the search-space by using mathematical formulae to combine the positions of existing agents from the population. If the new position of an

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agent is improved than it is accepted and forms part of the population, otherwise the new position is easily throw away. The series of action is repetition until achieve the results and by doing so it is hoped, but not guaranteed, that a satisfactory solution will eventually be discovered. This is a greedy selection scheme that often outperforms traditional EAs.

B. Differential Evolution for Multiobjective Optimization

When applying DE to MOPs, we tackle with many difficulties. Besides preserving a uniformly spread in ahead of nondominated answers, which is a demanding duty for any MOEA (Multi-objective Evolutionary Algorithm), the author has to deal with another query, that is, when to replace the parent with the candidate solution. In single-objective optimization, the determination is very easy the candidate replaces the parent only when the candidate

Differential Evolution for MultiobjectiveOptimization(MODE)

Step 1: Evaluate the initial population Pop of random individuals.

Step2: Whileiteration is less than maximum iteration, do:
2.1. For each individual Pi (i = 1, . . . , popSize) from Pop repeat:
(a) Create candidate C from parent Pi.
(b) Evaluate the candidate.
(c)If the candidate is pareto optimalthan the candidate replaces the parent.
If the parent is pareto optimal than the candidate is discarded.
Otherwise, the candidate is added in the population.
2.2. If the population (Pop) has more than popSize individuals, truncate it.
2.3. Randomly enumerate the individuals in Pop.

Fig: 2Outline of DEMO/parent

issuperior to the parent. In MOPs, on the other hand, the decision is not so straightforward. We could use the concept of dominance (the candidate replaces the parent only if it dominates it), but this would make the greedy selection scheme of DE even greedier. Therefore, DEMO applies the following principle (see Fig. 2).The candidate replaces the parent if it dominates it. If the parent dominates the candidate, the candidate is discarded. Otherwise (when the candidate and parent are nondominated with regard to each other), the candidate is added to the population. This step is repeated until popSize number of candidates are created. If the population has enlarged than truncate it, to prepare it for the next step of the algorithm.

Candidate creation
Input: Parent Pi
Step 1: Randomly select three individuals Pi_a, Pi_b, Pi_c from Pop,where i, i_a, $i_b$and i_c are pairwise different.

Step 2: Calculate candidate C as $C = Pi_a + F \cdot (Pi_b - Pi_c)$, where F is a scaling factor.

Step 3: If C is pareto optimal than modify the candidate by binary crossover with the parentusing crossover probability crossProb.

Output: Candidate C

Fig:3 Outline of the candidate creation in scheme DE

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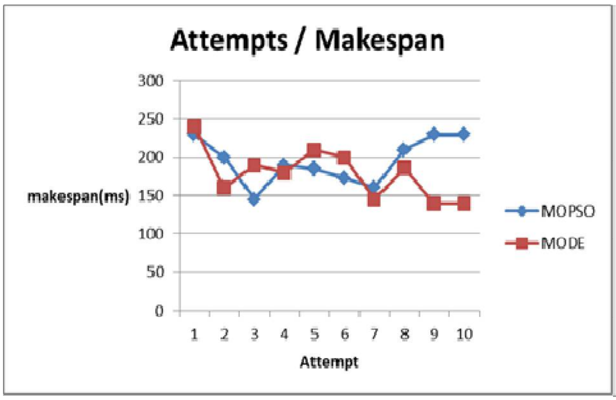
V. Implementation And Results

The Multi-objective Differential Evolution (MODE) implemented with J.D.K (1.8) and those workloadparameters used in the experiment are one datacenter,1-10 number of tasks and the length of tasks is 1000 to 3000. The processing element (PE) on each data center is five which is equal number of VM's(Virtual Machines) and speed of PE is 1000-9000 MIPS. CloudSim-3.0.3 is used to evaluate the scheduling of MODE. The fig. 4, 5 showed the effect of pareto optimal results with respect to raised number of attempts. The increased number of iteration improves the quality of solution up to a specific limit.



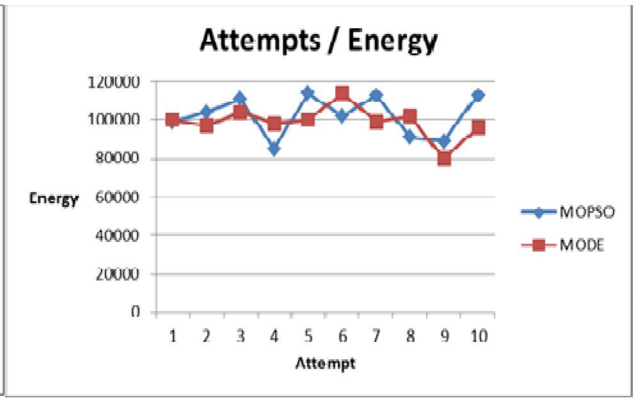
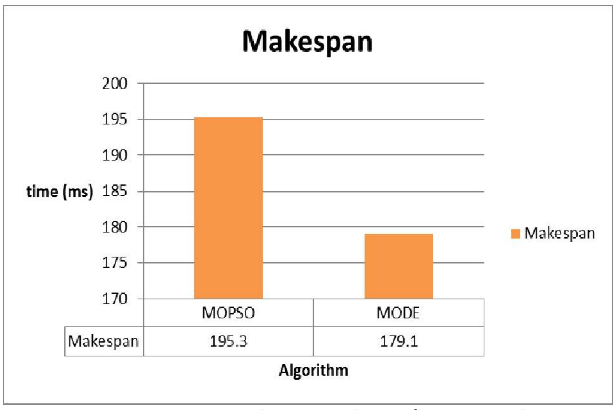


Fig:4 Optimal values of makespan with respect to attempts   Fig:5 Optimal values of energy with respect to attempts

Many experiments are performedwith different parameters to evaluate the efficiency of MODE algorithm. This paper shown the comparison of PSO and DE algorithms with two objectives energy and makespan as shown in fig:6 and fig:7. The proposed algorithm (MODE) reduced 30% of energy consumption and 25% of time in compare to other scheduling algorithm.



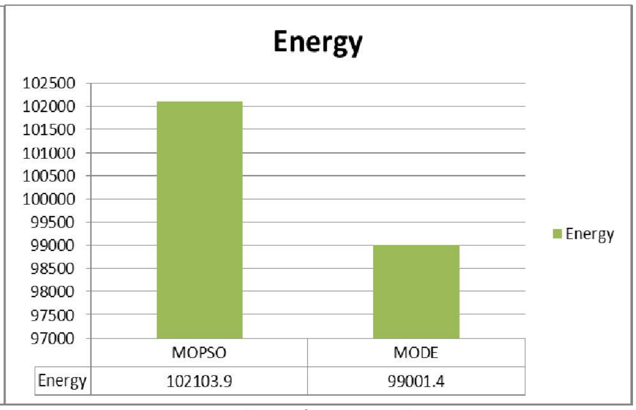


Fig:6Makespan analysis of MODE and MOPSO   Fig:7 Energy analysis of MODE and MOPSO

VI. Conclusion And Future Scope

The author of the paper presented multi-objective DE evolutionary optimization based technique which can resolve issues of job scheduling under the computing environment, where the number of data center and user job changes dynamically.But, in changing environment, cloud computing resources needs to be operated in optimally manner. Therefore, multi-objective DE algorithm suitable for cloud computing environment because the algorithm is able to effectively utilize the system resources to reduce energy and makespan. The experimental results explained that the proposed method MODE minimize the energy consumption and total time as compared to MOPSO. In the future work,

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the optimization model should add more objectives (transmission capacity, load balancing, expenditureetc.) and should focus more robust algorithm.

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BIOGRAPHY

Anu Raniis a Research Scholar of (M.Tech.) in the Computer Science and Applications ,Department of Computer Science and Applications, Kurukshetra University. Her research interests are in Cloud Computing (Task Scheduling), DoSattacks,load balancing etc.