Intelligent Algorithms for Optimal Selection of Virtual Machine in Cloud Environment, Towards Enhance Healthcare Services

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Abstract. Cloud computing plays a very important role in healthcare services (HCS). Cloud computing for HCS can restore patients' records, diseases diagnosis and other medical domains in less time and less of cost. In cloud computing, optimally chosen of virtual machines (VMs) is very significant to interest in healthcare services (IHS) (patients, doctors, etc.) in HCS to implementation time and speed of response to medical requests. This paper proposes a new intelligent architecture for HCS. also, this paper proposes three intelligent algorithms are a genetic algorithm (GA), particle swarm optimization (PSO) and parallel particle swarm optimization (PPSO) to find optimal chosen of VMs in a cloud environment. For that, this paper uses MATLAB tool to find optimal intelligent algorithm and CloudSim to find optimal chosen of VMs in a cloud environment. The results proved that PPSO algorithm is better than GA and PSO algorithms.

Keywords: Cloud computing · Healthcare services · Genetic algorithm · Parallel particle swarm optimization

1 Introduction

HCSs are considered of the most medical domains of interest to the world at present. The optimal utilize of HCS protects much public from death. IHS of the HCS such as the patients and the doctors use old methods to restore patients records to detect the patients' health condition in a long time, but using new methods such as cloud computing can restore patients records in less time and less cost.

Cloud computing has become critical to IHS in many fields for transmitting medical services over the Internet. Cloud computing is sending application, infrastructure services to huge numbers of IHS with assorted and dynamically changing requirements.

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Cloud is consists of datacenters, servers, VMs, resources, etc. Datacenters are containing a big number of resources and list of different applications. Hosts are consists of a large number of VMs to store and regain several medical resources to stakeholders.

The IHS in healthcare services suffers from time retard of medical requests on cloud computing environment [14]. Many causes are lead to time retard of medical requests such as execution time (make span) and the waste of resources utilization. This paper proposes intelligent algorithms to find optimal chosen of VMs helps the IHS to minimize their total execution time of medical requests on cloud computing environment and maximize utilization of resources.

To estimate the quality of those three algorithms, this paper introduces a comparative study to their work in a cloud environment. The comparison targets to see which algorithm can be used to enhance the quality of HCS. This paper also chooses the optimal algorithm through execution time and speed.

The contribution of this paper can be summarized as follows:

- Optimal selection of VMs is very significant to IHS to minimize total execution time of medical requests on cloud environment and maximize utilization of resources.
- Present Comparison between intelligent algorithms (GA, PSO, and PPSO) [11–13, 15] to execution of these algorithms on MATLAB package. It also selected the optimal algorithm through execution time and speed. Implement the optimal intelligent algorithm on CloudSim tool to find the optimal chosen of VMs on a cloud environment.

This paper is organized as follows: Sect. 2 introduces presents related work. Section 3 introduces a proposed intelligent model of cloud computing for HCS, Sect. 4 introduces a proposed GA, PSO and PPSO based algorithms for cloud computing, Sect. 5 introduces the exponential results. Section 6 presents conclusion and future work.

2 Related Work

Through related work, many types of research were done on applying and using intelligent algorithms such as PSO and GA as follow:

AJITH SINGH. N and et al. [1], presented a new approach to finding optimal VM placement in a datacenter in cloud environment based on honeybee algorithm with hierarchical clustering. This study seeks to detect optimal VM placement to maximize resources utilization and reduce energy consumption in servers. This study implemented experiments on Planet Lab where new approach help to detect optimal VM placement and reduce energy consumption. Researcher opinion, clarity of proposed a new approach to finding optimal VM placement and reduce energy consumption in servers in cloud computing environment.

Lei Chen and et al. [2], this study is presented multitarget heuristic algorithm to solve VM placement problem to improve retrieve resources efficiently and reduce the number of servers in cloud computing. This study focuses on VM placement efficiently, maximize resources utilization, wastage rate and reduce energy consumption in

servers in the datacenter. Researcher opinion, multitarget heuristic algorithm can detect optimal VM placement in a cloud environment.

R. S. Camati and et al. [3], presented a new approach to solving VM placement problem based on multiple multidimensional knapsack problem. This study tries to find treatment to VM placement problem to facilitate task scheduling and minimize energy consumption in servers in the datacenter. Simulation experiments are implemented on CloudSim package. Researcher opinion, clarity of proposed a new approach to solve VM placement problem, facilitate task scheduling and minimize energy consumption in hosts in cloud computing environment.

B. Benita Jacinth Suseela and et al. [4], presented a novel model to find optimal VM placement based on hybrid particle swarm optimization (PSO) and Ant colony optimization (ACO). This study tries to detect optimal VM placement to improve VM allocation time, minimize energy consumption and maximize resources utilization. Implementation results show that a novel model maximizes resources utilization, reduces power consumption and provides load balancing in hosts in the datacenter. Researcher opinion, PSO-ACO algorithm may outperform on ACO algorithm to find optimal VM placement in a cloud environment.

J. Zhao and et al. [5], presented a new approach to finding the selection the best VM placement in datacenter based on improved PSO. This study seeks to enhance the total incremental energy consumption in servers, protects the quality of VM running and maximizes resources utilization. Simulation experiments are implemented on planet lab. Researcher opinion, improved PSO algorithm may find the best VM placement in cloud computing environment.

Y.S. Dong and et al. [6], presented a new strategy to detect the optimal VM placement in cloud environment based on distributed parallel GA (DPGA). This study tries to improve performance VM running, reduce energy consumption in servers and maximize utilization of resources. Researcher opinion, DPGA outperforms on default GA to find optimal VM placement in a cloud environment.

C. G. Garino [7] presented a new model to find the optimal scheduling of VMs on cloud environment based on PSO. This study makes a comparison between PSO, round robin (RR) and GA to detect the best VM placement. Simulation experiments are implemented on CloudSim tool. Researcher opinion, PSO outperforms on RR and GA to detect the best scheduling of VM placement in cloud computing environment.

K. Parikh and et al. [8], presented a new policy to find the best VM allocation in cloud computing based on Hungarian algorithm. This study tries to find the best load balancing of services on the cloud through scheduling of VM in the datacenter. This study verified the results on CloudSim package tool. Researcher opinion, a new policy may find the best VM allocation to solve load balancing problem on a cloud environment.

G. Kaur and et al. [9], presented various domains based on Cloud computing such as virtualization, distributed computing, grid computing, etc. This paper introduced a new way to obtain high benefit from resources; optimized resources utilization is important. Researcher opinion, lack of clarity of PSO algorithm to achieve optimized of resources utilization.

3 The Proposed Intelligent Architecture of Cloud for HCS

This section introduces the architecture of the proposed intelligent cloud computing for HCS. It composed of four levels are IHS devices, IHS tasks, cloud broker and network administrator as shown below in Fig. 1. The communication devices services are responsible for executing variety network communication management between IHS and the cloud.

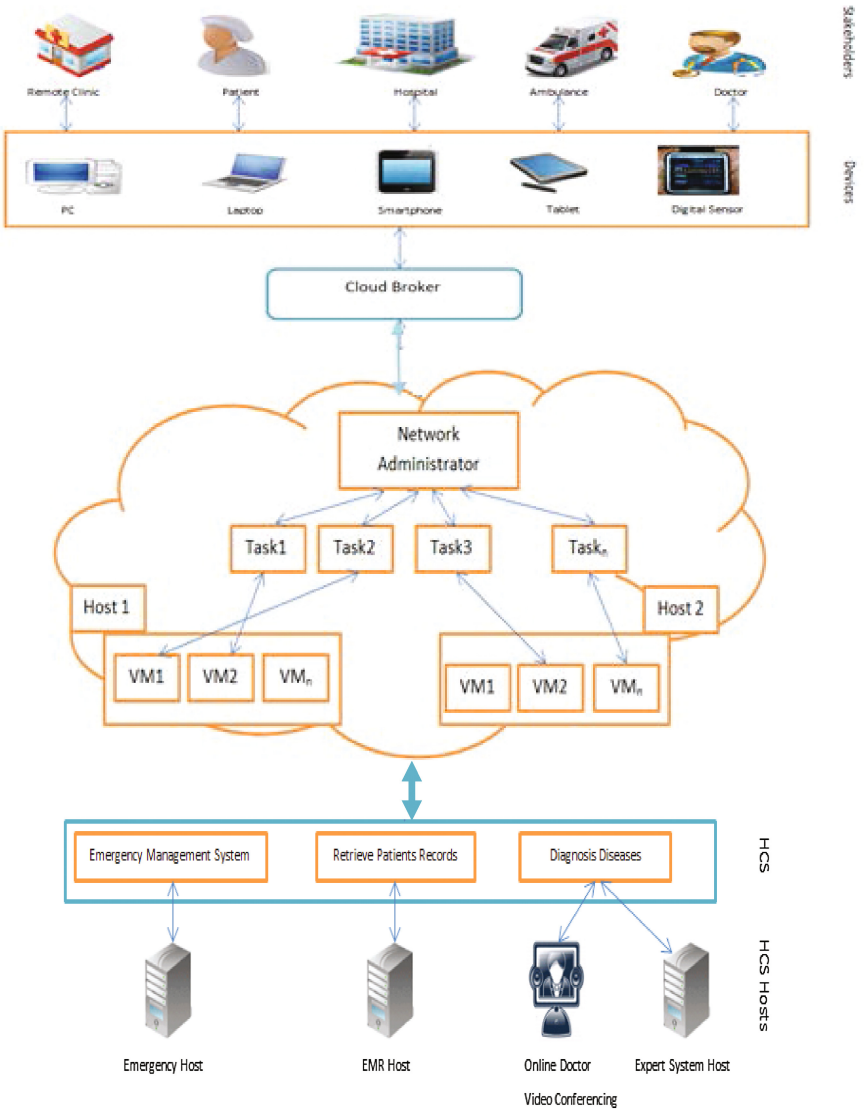

Fig. 1. Intelligent architecture of cloud computing for HCS

IHS uses a different of devices (PC, Laptop, Smartphone, etc.) to send a different of medical tasks easily through cloud computing to get variety medical services such as restoring patient's records, diseases diagnosis, electronic medical records (EMR), etc. Cloud broker is responsible for transmitting and receiving tasks from the cloud service. Each network may have many application servers = {server1, server2… and $server_n$} providing the SaaS and can be allocated to execute the cloud IHS tasks. Each application server has a set of resources = {R1, R2 … and Rn} that can be allocated for the coming IHS tasks. Each network has a network administrator that is responsible for the coordination of the communication between the servers inside the network and between this network and other networks in the clouds. A network administrator is responsible for applying the intelligent technique (PPSO algorithm) that it uses to obtain the optimal chosen of VMs in the cloud to improve the task scheduling process which leads to minimize total time of IHS requests and maximize resources utilization.

4 Proposed GA, PSO and PPSO Based Algorithms for Cloud

The proposed architecture is based on GA, PSO and PPSO algorithms to calculate implementation time of IHS requests and fitness function to determine the optimal VM in datacenter through three attributes are CPU utilization, turnaround time and waiting time. This attributes consists of three parameters are arrival time (AT), burst time (BT) and completion time (CT), shown below in Table 1.

Table 1. Parameters of optimal selection of VMs

SN	Data	Description	Formula
1	CPU Utilization (U)	The percentage of CPU capacity used during a specific period of time.	U = 100% − (% time spent in the idle task)
2	Turnaround time (TT)	Time difference between completion time and arrival time.	TT = CT − AT
3	Waiting time (WT)	Time difference between turnaround time and burst time.	WT = TT − BT

This paper proposed GA, PSO and PPSO based algorithms of cloud computing for HCS as shown below in Figs. 2 and 3. The proposed algorithms seek to get optimal chosen of VMs to minimize implementation time off requests from IHS and maximization of resources utilization.

4.1 The Proposed GA for Cloud Computing

Assume that there are M chromosomes (VMs) in all the clouds. Each VM in the cloud (s) is considered a chromosome which represents a potential solution (VM) that can be allocated for executing the stakeholder's subtasks. GA for Cloud Computing is proposed as follows (A declarative flow chart [16] is shown in Fig. 2):

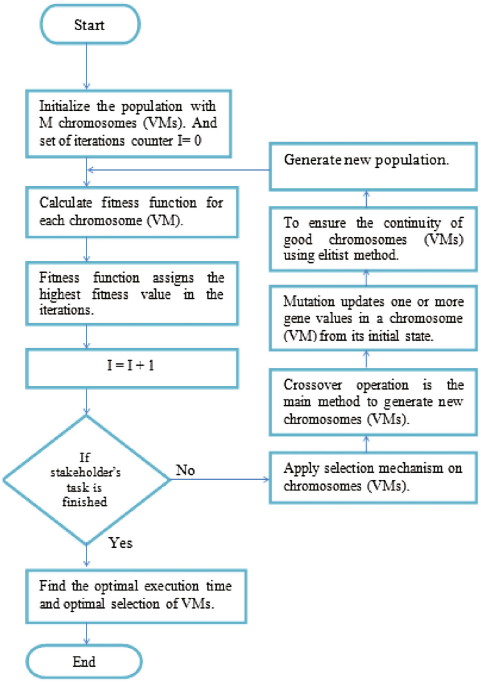

Fig. 2. The proposed flow chart of GA for cloud computing

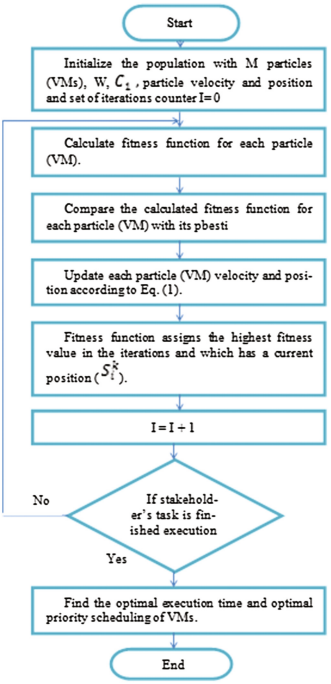

Fig. 3. The proposed flow chart of PSO for cloud computing

4.2 The Proposed PSO for Cloud Computing

Assume that there are M particles (VMs) in all the clouds. Each VM in the cloud(s) is considered a particle which represents a potential solution (VM) that can be allocated for executing the stakeholder's subtasks. PSO for Cloud Computing is proposed as follows (A declarative flow chart is shown in Fig. 3):

– Update each Particle Velocity and position according to Eq. (1) [10].

$$V_1^{k+1} = {}_w\, V_1^k + C_1\, \text{rand}_2 \times (\text{pbest}_i - S_i^k) + (\text{gbest}_i - S_i^k) \quad (1)$$

Where:

V_1^{k+1} = Velocity of agent i at iteration k,
W = Weighting function,
Rand = Random number between 0 and 1,
S_i^k = Current position of agent iteration k,
pbest_i = Pbest of agent i,
gbest_i = gbest of the group.

The weighting function used in Eq. 2:

$$w = W_{max} - \frac{W_{max} - W_{min}}{iter_{max}} \times iter \quad (2)$$

Where:

W_{max} = Initial weight,
W_{min} = Final weight,
$iter_{max}$ = Maximum iteration number,
iter = Current iteration number.

In PPSO, parallel processing aims to produce the same results that achievable using multiple processors with the goal of reducing the run time. The same steps described in PSO will be applied.

5 Experimental Results

This section is composed of implementation of GA, PSO, and PPSO on MATLAB tool and implementation of PPSO on CloudSim tool as follows:

5.1 Implementation of GA, PSO, and PPSO on MATLAB

This paper provides the execution of the GA, PSO, and PPSO on MATLAB tool and comparison between these algorithms through execution time (ET). GA algorithm showed a positive relationship between the populations and implementation time, whenever the increased the number of populations which reflects the increased in the implementation time. PSO algorithm showed a positive relationship between the particles and implementation time, whenever the increased the number of particles which reflects the increased in the implementation time. PPSO algorithm showed a positive relationship between the particles and implementation time, whenever the increased the

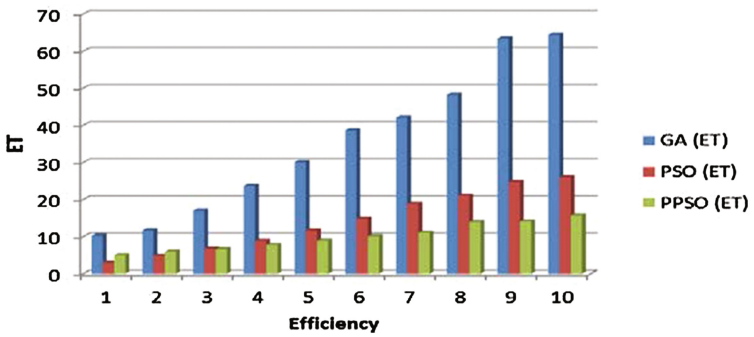

Fig. 4. Relationship between GA, PSO, and PPSO

number of particles which reflects the increased in the implementation time. Figure 4 showed the relationship between GA, PSO, and PPSO where implementation time in PPSO decreased compared with GA and PSO.

5.2 Implementation of PPSO Algorithm on CloudSim

This section proposes PPSO algorithm on CloudSim to get optimal chosen of VMs for IHS to minimize implementation time off requests and maximize resources utilization. The first execution is default CloudSim where the first task takes the first VM, the second task take the second VM, etc. Total time to build successful cloudlets is 3 s as shown in Fig. 5.

```
========== OUTPUT ==========
Cloudlet ID    STATUS    Data center ID    VM ID    Time    Start Time    Finish Time
     0         SUCCESS         2             0        800        0.1         800.1
     1         SUCCESS         2             1        1200       0.1         1200.1
     3         SUCCESS         2             3        8000       0.1         8000.1
     2         SUCCESS         2             2        16000       0.1         16000.1

BUILD SUCCESSFUL (total time: 3 seconds)
```

Fig. 5. Results of default CloudSim

The second execution is PPSO algorithm on CloudSim to get optimal chosen of VMs where the first task may take the second VM; the second task may take the fourth VM, depending on the number of processors, task status, and VM status. Total time to build successful cloudlets is 1 s. PPSO algorithm better than CloudSim default to total time in build successful cloudlets as shown in Fig. 6.

```
========== OUTPUT ==========
Cloudlet ID    STATUS    Data center ID    VM ID    Time    Start Time    Finish Time
     0         SUCCESS         2             1        1600       0.1         1600.1
     1         SUCCESS         2             1        2000       0.1         2000.1
     3         SUCCESS         2             3        8000       0.1         8000.1
     2         SUCCESS         2             2        16000       0.1         16000.1

BUILD SUCCESSFUL (total time: 1 second)
```

Fig. 6. Sample of results of PPSO algorithm on CloudSim

Figure 7 showed an inverse relationship between the number of processors and Makespan (time) of requests from IHS, whenever the increased the number of processors which reflects the decreased in the makespan.

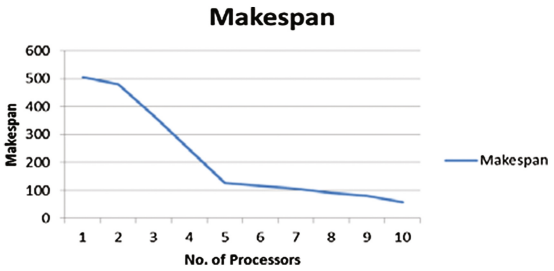

Fig. 7. Proposed PPSO leads to minimized makespan with increasing in no. of processors

6 Conclusion and Future Work

This paper introduced intelligent architecture based on GA, PSO, and PPSO to get optimal chosen of VMs in a cloud environment. This paper showed PPSO algorithm better than GA and PSO to implementation time. Therefore, this paper proposes the application of PPSO algorithm to obtain the best chosen of VMs to support IHS in minimizing implementation time of medical requests (tasks), improve task scheduling, maximize resources utilization and applied this algorithm on CloudSim package. The future work is to apply new swarm optimization algorithms such as gray wolfs, cat optimization and ant colony optimization to obtain an optimal selection of VMs on a cloud environment.

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