

Novel Approach of Workflow Scheduling with Deadline Constraint using Pareto Distribution with Hybrid Swarm Intelligence in Cloud Computing

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Abstract: Cloud computing is a latest approach that is growing faster day by day due to its effective feature and security. Cloud computing provide a way to access the data from any place at any time. This feature makes it popular because it reduces the burden of the users. Cloud computing provides the services like infrastructure, platform and software as a service on it. Due to these feature the Size of data on cloud in increased and its effects on the efficiency of cloud. To overcome the problem like this scheduling of task on data is the best option. Workflow scheduling is a challenging task in cloud computing because user requirements and satisfaction is also considered in it, so to reduce the cost, cloud environment, has been deployed in cloud environment, resources will increase but its utilization is another challenge. To maintain & utilize resources in the cloud computing scheduling mechanism is needed. Many algorithms and protocols are used to manage the parallel jobs and resources which are used to enhance the performance of the CPU in the cloud environment. This work Particles swarm Optimization (PSO) and Grey Wolf Optimization (GWO) are used for effective scheduling. . This work is based on the optimization of Total execution time and total execution cost. The results of the proposed approach are found to be effective in compare to existing methods. Intelligence optimization Particle Swarm optimization is used which is initialized by Pareto distribution. . GWO is used to converge the decision of Virtual Machine (VM) migration by its convergence to minimize cost and time as illustrated by Total execution time (TET) and Total execution cost (TEC) .It is concluded that GWO performs better in compare to existing BAT algorithm.

Index Terms— Cloud computing, Cloud Deployment Model, Resource pooling, Fast elasticity

I. INTRODUCTION

A. Cloud Computing

Cloud computing is a distributed design that brings together server resources on an acceptable stage in order to provide on request figuring resources and administrative data. A cloud specialist organization (CSP's) provides the different stages to their customers to use the services and make the web administrative control. This service is similar to a broadband band connection offered by the service provider for the internet connection. Cloud computing

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provides the services through the internet, these service belongs to hardware and software both. Cloud computing concept has high impact in research due to its service pay per usage concept [1, 4]. When cloud provides the service in the form of platform, it is called as Platform as a service model (PaaS) When cloud provides the hardware to the consumer, it is called as Infrastructure as a service (IaaS) model. When cloud provided the software services, it is also called as Software as s service.

B. Cloud Service Models

Cloud computing is categorized in IAAS, PAAS, SAAS. Cloud service model illustrated in figure 1. Depending upon their particular needs an organization may acquire any gathering of these service models [3].

(a) **Software as a Service (SaaS):** Over the web, the Software as a Service (SaaS) delineates any cloud organization where purchasers can get to programming applications. For both individuals and affiliations the applications are encouraged in "the cloud" and can be used for an expansive assortment of assignments. By techniques for any web engaged contraption the Twitter, Facebook and Flickr are all examples of SaaS, with customers prepared to get to the organizations. Rather than securing it the programming as Service clients, subscribes, and regardless to the things, if all else fails on a month to start. Rather than on singular PCs the applications are acquired and used online with records saved as a bit of the cloud.

(b) **Platform as a Service (PaaS):** Using instruments given by the provider the Platform as Service licenses clients to make programming applications. Customers can subscribe to the PaaS organizations can contain preconfigured fragments; while discarding those that don't they can combine the parts that meet their necessities.

(c) **Infrastructure as a Service (IaaS):** In the IaaS clouds, the cloud customers clearly use IT bases (dealing with, structures, stockpiling, and other essential planning assets) is given.

Virtualization is comprehensively utilized as a touch of IaaS cloud reviewing a legitimate focus to sort out/break down physical resources in an extraordinarily assigned way to deal with meet making or contracting resource request from cloud customers [2].



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The essential course of action of virtualization is to setup free VM that are disconnected from both the secured mechanical assembly and specific VMs. This framework is not totally the same as the multi-residency show up, which intends to change the design of application programming so that different cases can keep running on a particular application [3]. A case of IaaS is Amazon's EC2.



Fig.1 Cloud service Model[14]

C. Cloud Deployment Model

As depicted in Figure subject on necessities the going with four sending models have been perceived, each with particular qualities that reinforce the prerequisites of the organizations and customers of the clouds specifically ways [3]. The models are defined as follows:

(a) **Private cloud (PC):** The cloud foundation is worked in a particular union, and facilitated by the association or an untouchable notwithstanding whether it is found prelude or off reason. The motivation to build a private cloud inside an affiliation has two or three perspectives. Regardless, to strengthen and streamline the utilization of existing in-house assets. The second, security concerns includes information protection and trust in like way make PC a likelihood for a couple of affiliations. Third, information exchange passed on from near to IT foundation to a PC is still rather stunning. The fourth, affiliations reliably require full control over mission-basic exercises that stay back of the firewalls. Community cloud a few affiliations usually make and have a relative cloud base and in like way diagrams, necessities, qualities, and concerns. The cloud bunch shapes into a level of gainful and free change.

(b) **Public cloud:** this is the key sort of current Cloud managing sending model. People considering all things cloud is utilized by the general masses cloud customers and the cloud association supplier has the full duty as to open cloud with its own particular system, respect, and great position, costing, and charging model [5, 12s]. Particular comprehended cloud affiliations are open mists including Amazon EC2, S3, and Force.com.

(c) **Hybrid cloud:** The cloud base is a mix of no under two hazes (private, storing up, or open) that stay striking parts however are bound together by systematized or select development that pulls in information and application transportability (e.g., cloud influencing for weight changing between hazes). Affiliations utilize the cream cloud appear with a specific phenomenal concentration to push their advantages for build up their inside points of confinement by margining out edges business limits onto the cloud while controlling spotlight rehearses on-premises through private cloud [4, 6].

D. Cloud Applications

(a) **Development and Testing:** Cloud plays an effective role as it is used for test and development. It saves the cost of setting up environment by setting up physically which

includes the manpower and time [10]. The installation and configuration of the software also take more time and this problem is also solved by using cloud resources.

(b) **Big Data Analytics:** Cloud is using the concept of big data and provides the effective data extraction of the business value. It provides the effective data to the retailers and suppliers by extracting the buying patterns of the consumers. The buying patterns of the consumers show their liking and disliking of the consumers to the product.

(c) **File storage:** Cloud offers the facility of data storage, retrieval and access from any web-enabled interface. The user can access data anytime, anywhere with high speed and availability. The large organization stores their data on cloud and only pay for the storage of data and they do not worry about the daily maintenance of the storage system.

(d) **Disaster Recovery:** Cloud provides the effective data recovery in case of disaster at very effective cost. Data recovery by traditional method is very expensive and slow.

(e) **Backup:** Backing up data is always a complex and time consuming process. The backup includes the tapes and drives to collect the data manually and then dispatching them for backup. Cloud provides the data backup automatically and no need to worry if the data is deleted. By using cloud it is easy to recover the data [9].

E. Benefits of Cloud Computing

Cloud computing have some essential or unique characteristics to provide qualitative services. These characteristics are as follows [2]

- **On-demand self-service:** This self-advantage notification to the organization given by appropriated registering merchants that enables the course of action of cloud assets on ask for at whatever point they are required. In on-ask for self-advantage, the customer finds the opportunity to cloud benefits through an online control board [11].
- **Broad network access:** Cloud computing isolates computing abilities from their consumers, with the goal that they don't need to keep up the capacities themselves. A consequence of this is the computing abilities are found somewhere else, and must be accessed over a network.
- **Resource pooling:** Resource pooling is an Information Technology term used as a piece of distributed computing conditions to depict a situation in which suppliers serve diverse clients, clients or "inhabitants" with impermanent and flexible organizations [13].
- These organizations can be usual to suit every client's needs with no developments being clear to the client or end client.



- **Fast elasticity:** It is described as the ability to modify resources both all over as required [14]. To the buyer, the cloud has every one of the reserves of being immense, and the purchaser can purchase to such an extent or as pitiful enlisting power as they need.
- **Measured service:** Cloud systems therefore control also, redesign asset use by utilizing a metering limit at some level of direction sensible to the sort of affiliation (e.g., dealing with, stockpiling, information transmission, and dynamic customer accounts).

II. RELATED WORK

Boloniand Turgut [1] proposed work is done on the Infrastructure as a service platform of the computer for scheduling and resource provisioning. The scheduling process is done by using the Shuffled Frog Leaping Algorithm (ASFLA). The performance evaluation is done by comparing the result or proposed algorithm with PSO (Particle Swarm optimization). The experiment is performed on different workflows by using Java Simulator and it gives outcome at low cost and completes the task on deadline. Ghose et al. [2] proposed the concept of computation scheduling which is used for prediction of computation cost and financial cost. It also predicts the benefit of the output and it is called as value of information. This work is based on the analysis process of real-estate investment opportunities. The scheduling algorithm used in this work is called as volume based scheduling algorithm. Yibinet al. [3] formulated the energy efficient scheduling approach in cloud environment. In this work six different scheduling strategies are proposed for a collection of scientific workflows. The performance evaluation of the scheduling approaches is compared with existing policies and presented the average energy reduction of 70%. Quang et al. [4] introduced the concept of dynamic voltage scaling to maintain power and reduce the voltage supply and frequency of the processor. In this work, the algorithm for programming dynamic tasks with energy consciousness is used to reduce energy consumption. This algorithm reduces energy consumption compared to parallelism and the critical path programming algorithm. Ghanamet al. [5] proposed an approach for energy saving virtual machine scheduling in cloud computing with fixed interval constraints. This approach reduces the busy time and total energy consumption by the resources. The experiment is performed on the parallel workload models. The simulation result shows that the total energy consumption is less than the existing model. Melland Grance[6] proposed a deadline constrained workflow scheduling algorithm for IaaS. In this paper, the author proposed partial critical path algorithm with IaaS environment and this is called as PCP with deadline distribution. Both the algorithm supports the polynomial time complexity which is good for the scheduling in large workflows. This algorithm also reduces the execution cost and response on the deadline. The simulation result of the proposed methodology is also compared with other methods and gives better results. Malawski et al. [7] focused on optimizing the value of buying infrastructure-as-a-service cloud competencies to attain clinical work goes with the flow execution in the unique closing dates. Authors considered the

quantity of purchased times, example types, buying options, and venture scheduling as constraints in an optimization technique. Particle swarm optimization augmented with a variable community seeks approach turned into used to discover the superior solution. Results display promising performance from the views of the total fee and fitness convergence when in comparison with other trendy algorithms. Mao and Humphrey [8] recommended that the users put up their workflows alongside a few QoS constraints like closing date, budget, and consider, reliability and so on. For computation, Authors considered the two constraints: closing date and finances and recommend cut-off date and finances Due date and Budget Distribution based cost-Time Optimization (DBD-CTO) work process scheduling set of rules that points of confinement execution regard while get together time diagram for giving over outcomes and separate the direct of the estimation. Rodriguez and Buyya[9] recommended a various Quality of services compelled scheduling strategy of multi-work processes (MQMW). The procedure can plan different work processes which are begun whenever and the QoS prerequisites are considered and ready to build the planning achievement rate essentially. Rahman et al. [10] proposed an Adaptive Hybrid Heuristic for purchaser limited insights examination work process planning for hybrid Cloud surroundings through organizing the dynamic method for heuristic based techniques and furthermore work process degree change helpfulness of meta-heuristic based frameworks. The sufficiency of the proposed framework was sketched out by strategy for an extensive case take a gander at in assessment to introduce strategies. Dillon et al. [11] offered a procedure whereby the major figuring elements are virtual machines (VMs) of various sizes/costs, employments are exact as work processes, clients indicate execution prerequisites by method for allotting (delicate) time points of confinement to occupations, and the reason for existing is to ensure all employments are finished inside their due dates at negligible money related charge. Creators finish their objective by utilizing progressively dispensing/deal locating VMs and scheduling duties at the most extreme esteem green cases. They assessed approach in four delegate cloud workload styles and show charge money related reserve funds from 9.8% to 40.four% contrasted with various methodologies.

Sridhar and Rama [12] displayed hybrid routing algorithm, Ant Colony Optimization algorithm and Particle Swarm Optimization (PSO) is utilized to enhance the different measurements in MANET routing. The ACO algorithm utilizes portable specialists as ants to distinguish the most possible and best way in a system. Likewise ACO algorithm finds ways between two hubs in a system and gives contribution to the PSO strategy. The PSO finds the best answer for a particle's position and speed and limits cost, power, and end to end delay. This hybrid routing shrewd algorithm has an enhanced execution when contrasted and basic ACO algorithm as far as delay, power, consumption, and communication cost. Bala and Chana[13] researched and investigated different cost mindful difficulties of WFS in cloud computing, for example, Quality of administration, execution, framework usefulness and framework engineering.



In this they additionally talked about different WFS cost mindful methodologies from the accessible pools of options. Different WFS challenges influencing particular WFS execution cost has additionally been thought about.

III. THE PROPOSED METHOD

A. Proposed Methodology

Various scheduling algorithms have been studied and implemented using CloudSim during the research. The approach followed has been listed below:

- Different optimization algorithms have been studied and analyzed on the basis of their execution time.
- An improved scheduling algorithm using QoS parameters for virtual machine has been developed. In this, tasks are scheduled using the priorities which are calculated using weights assigned to each task and virtual machines are sorted using MIPS.
- After that, the tasks are mapped to virtual machines using some grouping factor in order to optimize the processing and average waiting time.

B. Proposed methodology: Flowchart

Step1: Initialize the workflow-CloudSim package by creating the datacenter, broker, virtual machines and cloudlets

- (a) Initialize the virtual machines list.
- (b) Initialize the workflows and it is following type

SIPHT: It is used to automate the search for untranslated RNA for bacterial replicons in the NCBI database.

CYBERSHAKE: This workflow is used by the California to characterize the earthquake hazards in a region

Ligo: It is used to generate and analyze gravitational waveforms from data collected during coalescing of compact binary system.

Montage: It is created by NASA/IPAC together input image to create custom mosaics of the sky.

Step2: Parse the workflows according to levels and maintain distribution.

Step3: Apply VM mapping by FCFS algorithm then apply following optimization

Step4: Evaluate performance parameters of optimization Scheduling Strategies considering the following parameters:

TET:

Processing time = Cloudlet ength/vmMips*vmNumberOfPes

TEC:

Cost = DataCenter_CostPerMemory * VM_Ram

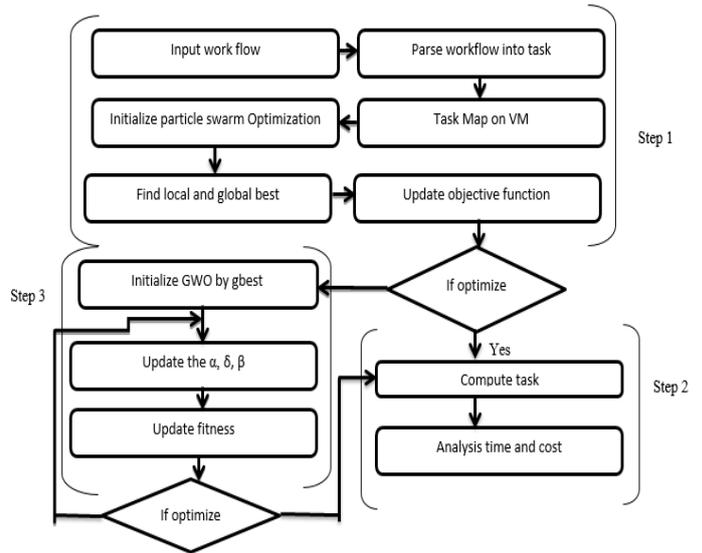


Fig.2: Proposed Flowchart

C. Proposed methodology: Algorithm

PSO: It stands for particle swarm optimization. PSO is a stochastic optimization algorithm that is based on the behavior of birds. It works in a similar way to the genetic algorithm. In PSO it is initialized with a group of random particles. In each iteration, each particle is updated with the two "best" values. The first best solution shows the aptitude of the particles and is called as pbest. The best value is tracked by the optimizer is the best value. This value is called better global (gbest). When a particle takes part of the population as its topological neighbors; the best value is the best local and is called lbest.

GWO: Grey Wolf optimization algorithm is a bio-inspired algorithm which is based on the leadership and hunting behavior of the wolves in the pack. The grey wolves prefer to live in the pack which is a group of approximate 5-12 wolves. In the pack each member has social dominant and consisting according to four different levels. The figure below shows the social hierarchy of the wolves which plays an important role in hunting.

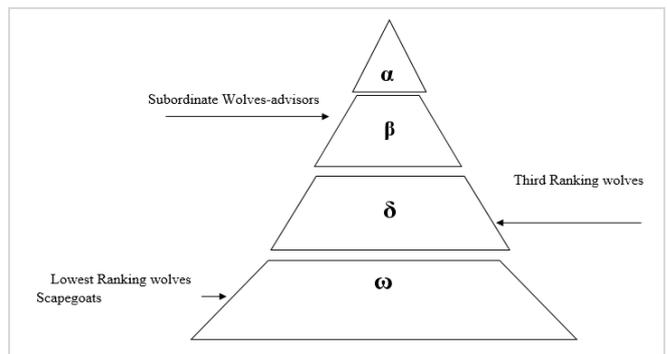


Fig.3: GWO Hierarchy [14]

ALGORITHM USED PSO_GWO

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Step 1: Input the mammographic images.
Step 2: Apply Gray Scale on the images.
Step 3: Edge detection by using the Prewitt Filter.
Step 4: For optimization input in the PSO model.
Step 5: Apply the loop in PSO model. for each particle n in S do
Step6 : for each dimension d in D do
Step7: //initialize each particle's position and velocity
Step8:  $y_{p,q} = Rnd(y_{max} y_{min})$ 
Step9:  $z_{p,q} = Rnd(-z_{max}/3, z_{max}/3)$ 
Step10: end for
Step11: //initialize particle's best position and velocity
 $z_p(l+1) = z_p(l) + \gamma 1_n(p_n - y_n(l)) + \gamma 2_n(G - y_n(l))$ 
New velocity
 $y_n(l+1) = y_n(l) + y_n(l+1)$ 
Where
p denotes the particle index
l denotes discrete time index
 $z_p$  denotes velocity of nth particle
 $y_p$  denotes position of nth particle
 $p_n$  denotes best position found by nth particle(personal best)
J denotes best position found by swarm(global best, best of personal bests)
 $J_{(1,2)i}$ - random number on the interval[0,1]applied to the nth particle
Step12:  $pb_n = y_p$ 
// update global best position
Step13: if  $f(pb_n) < f(gb)$ 
Step 14:  $gb = pb_n$ 
Step15: end if
end for
Input the optimized output into GWO.
Step16:Initialize GWO  $A_i(i=1, 2, \dots, n)$ 
Initialize x, X, and Y
Step 1 :Calculate fitness function for every search agent
 $A_\alpha \leftarrow$  best search agent
 $A_\beta \leftarrow$  second best search agent
 $A_\gamma \leftarrow$  Third best search agent
While (T<Max iterations)
For ( $X_i$  in every pack)
Update current position of wolf by eq. (1)
Update x, X and Y
Calculate the fitness function for all search agents
Update  $A_\alpha$ ,  $A_\beta$ , and  $A_\omega$ 
End for
For best pack insert migration ( $m_i$ )
Evaluate fitness function for new individuals selection of best pack
New random individuals for migration
End if
End while
    
```

IV. RESULT ANALYSIS

A. Simulator used:

The proposed work is done on the CloudSim simulator for using virtually cloud environment workflows. CloudSim provides a platform for modeling, simulation and experimentation of cloud computing. This simulator provides the user cloud system and investigated without concerning the low level details. CloudSim is basically a library for the simulation of cloud scenarios. It provides the feature in which useful classes are available for describing the data centers, virtual machines, applications and users. CloudSim also provides the facilities of scheduling and provisioning to manage the cloud resources. It is also used as a perspective of cost, execution time and application. In the proposed work

CloudSim is used because this work is also based on the phenomena of reducing the cost and time in cloud environment. The main components of the CloudSim framework are following:-

1. Regions: define the geographical regions in cloud
2. Data Centers: Combination of hosts and servers
3. Hosts: physical resources like storage
4. Cloudlet: specify the set of users request
5. Service Broker: decide the data center that are allocated to the service
6. VM scheduler: Models time or space shared
7. VM allocation Policies: define the policies how to allocate VM to hosts

B. Scientific Workflows Used:

1. **SIPHT**: It is used to automate the search for untranslated RNA for bacterial replicons in the NCBI database.
2. **CYBERSHAKE**: This workflow is used by the California to characterize the earthquake hazards in a region
3. **Ligo**: It is used to generate and analyze gravitational waveforms from data collected during coalescing of compact binary system.
4. **Genome**: It is created by USC Epigenome center and used to automate various operations in genome sequence processing.

C.Result Analysis:

The proposed methodology is implemented with the help of CloudSim and Eclipse. CloudSim is the library that provides the cloud computing simulation environment and also provides core classes that describe virtual machines, data centers, users and applications.

C.1 Comparison of BAT and PSO_GWO using SIPHT:

In given Table.1 below show the behavior of SIPHT workflows in different number of workflows and Virtual machines which represent by ensemble size. In results, show the BAT and hybridization of particle swarm optimization and GWO on total execution time, total execution cost and response time

Table.1 Comparison table of BAT and PSO_GWO using SIPHT

RESULTS OF BAT AND PSO_GWO USING -SIPHT				
Ensemble Size	BAT		PSO_GWO	
	TET	TEC	TET	TEC
2	23.06	5620.855	5.59	4550.063
4	41.16	10009.35	12.26	8603.69
6	38.05	13456.19	14.13	12125.43
8	52.98	13523.39	34.83	14265.19
10	87.61	17540.09	29.77	16958.17
12	62.5	20456.6	32.34	19965.58
14	52.64	21665.64	33.06	22432.37
16	62.21	25785.99	55.59	30112.12
18	93.3	33482.56	75.36	33230.33
20	72.04	34112.99	62.55	33012.34



C.1.1 Comparison graph of TET of BAT and PSO_GWO using SIPHT: In fig. X-axis represent the number of virtual machines and Y-axis total time of execution in graph at 2 VM execution time BAT approach is 1 ms and PSO_GWO 0.5 msec , at 10 VMs In BAT execution time 31ms and PSO_GWO execution time 82 ms and in 20 VMs BAT execution time 72 ms and PSO_GWO execution time 62 ms

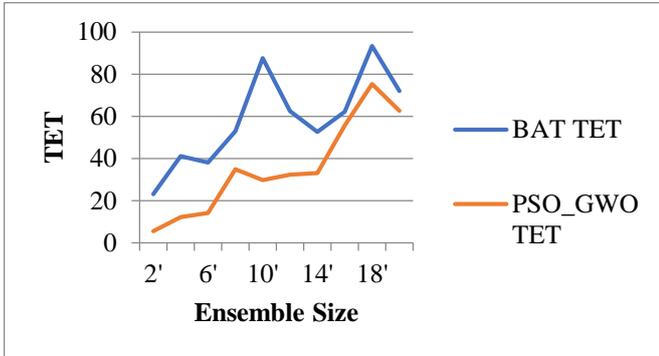


Fig.4: Comparison graph of TET of BAT and PSO_GWO using SIPHT

The line graph analysis these parameter PSO_GWO total execution time perform well in cost and time parameter because of PSO_GWO searching time decide by two-time decision one by PSO if optimize or otherwise GWO optimize the decision and VM task migration depend on Transient problem but in BAT is depend on candidate solution and which is static but PSO_GWO initialization is depend on pare to distribution which is depend on normal distribution.

C.1.2 Comparison graph of TEC of BAT and PSO_GWO using SIPHT: In fig.5 X-axis represent the number of virtual machines and Y-axis total. Total cost execution in graph at 2 VM execution time BAT approach is 22\$ and PSO_GWO 5 \$, at 10 VMs In BAT execution time 85 \$ and PSO_GWO execution time 32 \$ and in 20 VMs BAT execution time \$ 72 and PSO_GWO runtime 52 \$ approximation is below the linear graphical analysis this parameter PSO_GWO total execution cost well in the cost parameter due to the search time PSO_GWO decide for two times decision one for PSO if optimize or otherwise optimize GWO decision and migration of the VM task depends on the transient problem, but in BAT depends on the candidate solution and is static, but the initialization of PSO_GWO depends on the parallel distribution, which depends on the normal distribution .

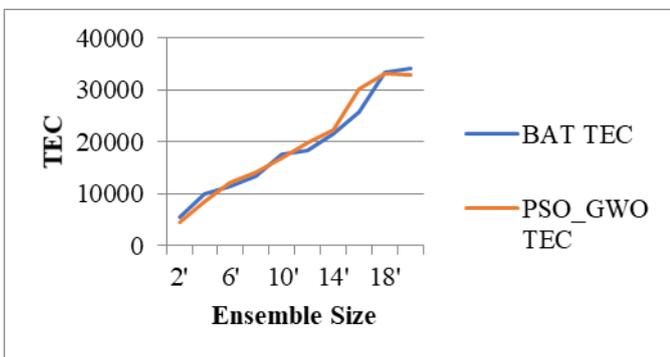


Fig.5: Comparison graph of TEC of BAT and PSO_GWO using SIPHT

C.2 Comparison of BAT and PSO_GWO using CYBERSHAKE: Table.3 below shows the behavior of CYBERSHAKE workflows in different workflows and virtual machines that represent by set size. In the results, show the optimization of the ant colony and the optimization of the genetic algorithm in the total execution time, the total cost of execution and the response time.

Table.2 Comparison table of BAT and PSO_GWO using CYBERSHAKE

RESULTS OF BAT AND PSO_GWO USING -CYBERSHAKE				
Ensemble Size	BAT		PSO_GWO	
	TET	TEC	TET	TEC
2	0	0	0	0
4	18.57	822.6585	2.4	687.9981
6	24.25	1136.987	3.36	950.981
8	26.05	1545.962	6.92	1518.366
10	29.85	1883.18	4.50	1689.733
12	30.78	1729.39	8.08	1724.117
14	36.80	2530.267	10.96	2463.681
16	34.34	2106.646	9.25	2731.877
18	37.77	2311.253	11.58	1989.96
20	39.50	2541.908	11.42	1982.903

C2.1 Comparison graph of TET of BAT and PSO_GWO using CYBERSHAKE: In figure 4.5X-axis represent the number of virtual machines and Y-axis total time of execution in graph at 2 VM execution time BAT approach is 22ms and PSO_GWO 5 m sec , at 10 VMs In BAT execution time 30 ms and PSO_GWO execution time 4 ms and in 20 VMs BAT execution time 35 ms and PSO_GWO execution time 12 ms below analysis these parameter. PSO_GWO performs a time parameter well because the optimization time of particle swarm decides by adaptive pheromones and the migration of VM tasks depends on the transient problem but in genetic algorithm it depends both on the candidate solution and static, but the initialization of PSO_GWO depends on the parallel distribution that depends on normal distribution.

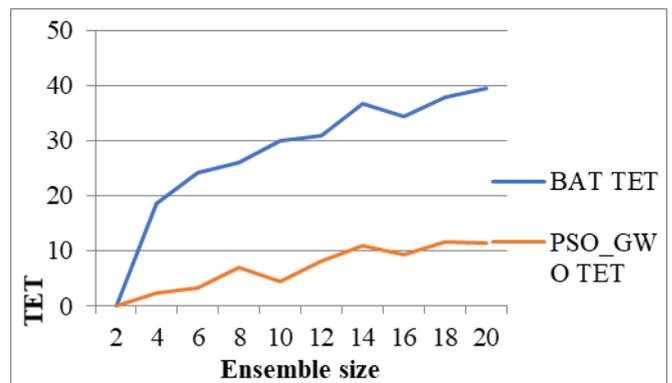


Fig.6: Comparison graph of TET of BAT and PSO_GWO using CYBERSHAKE

C.2.2 Comparison graph of TEC of BAT and PSO_GWO using CYBERSHAKE: In figure 4.6 X-axis represent the number of virtual machines and Y-axis total cost execution in graph at 2 VM execution time BAT approach is 2\$ and PSO_GWO 1\$, at 10 VMs In BAT execution time 1800\$ and PSO_GWO execution time 1500\$ and in 20 VMs BAT execution time 2500\$ and PSO_GWO execution time 2000\$. execution cost of BAT is better than ACO because of pare to distribution take more time for mapping of VM by task. It will affect on Total cost execution because pare to VM mapping but TET always significance improve.

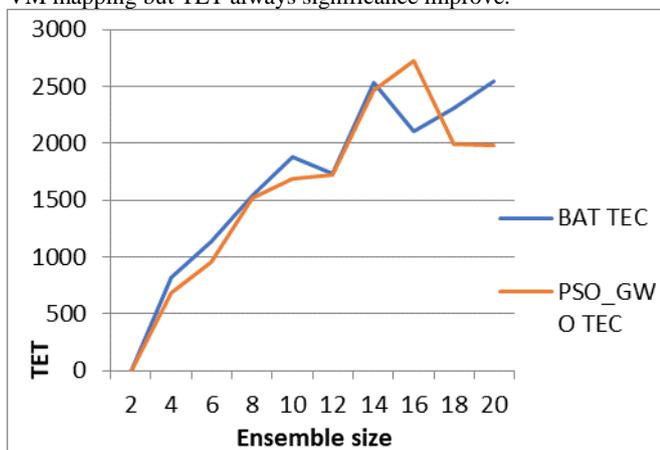


Fig.7: Comparison graph of TEC of BAT and PSO_GWO using CYBERSHAKE

C.3 Comparison of BAT and PSO_GWO using LIGO: In table 4. below LIGO analysis on TET and TEC parameter in different virtual machine or ensemble size. In this paper, 2 to 20 ensembles size and optimize by genetic algorithm and ant colony optimization. In experiment results, PSO_GWO reduces the average TET and TEC in different workflow. Therefore, we concluded that PSO_GWO optimize and converge workflow scheduling in cloud scenario.

Table.3 Comparison table of BAT and PSO_GWO using LIGO

RESULTS OF BAT and PSO_GWO USING -LIGO				
Ensemble Size	BAT		PSO_GWO	
	TET	TEC	TET	TEC
2	0.0	0.0	0.0	0.0
4	44.91	2762.633	6.61	1467.243
6	65.89	4191.678	24.09	4022.422
8	35.66	4883.178	45.34	5699.963
10	68.82	5304.774	15.98	4708.369
12	102.39	7331.103	26.65	6271.538
14	58.96	7729.967	33.7	7550.524
16	151.28	10608.93	49.58	9948.208
18	87.77	11384.08	71.95	11188.03
20	153.22	13094.86	90.9	12582.79

C.3.1 Comparison graph of TET of BAT and PSO_GWO using LIGO: In fig.9 X-axis represent the number of virtual machines and Y-axis total time of execution in graph at 2 VM execution time BAT approach is 22ms and PSO_GWO 5 msec, at 10 VMs In BAT execution time 82 ms and PSO_GWO execution time 18 ms and in 20 VMs BAT execution time 145 ms and PSO_GWO execution time 82 ms below result analysis, find that response time of PSO_GWO is

more as compare to BAT in local simulation. Hence, in-order to reduce response time of PSO_GWO, it can be executed in real-time cloud environment using SLA. In addition, this work can be extended for multi-objective algorithm to get solution for load balancing and task failures.

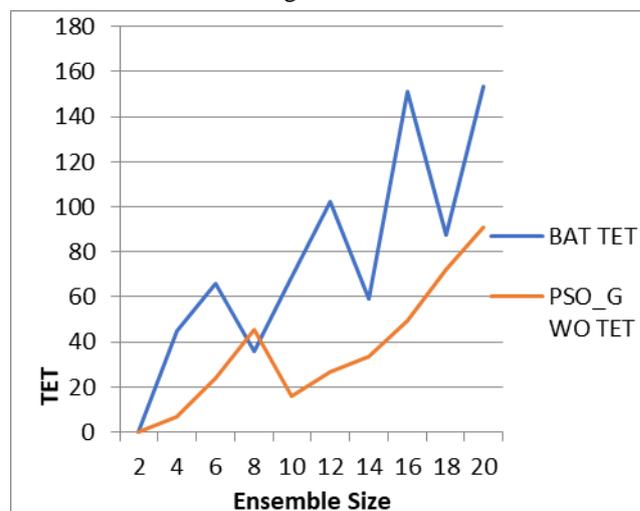


Fig.8: Comparison graph of TET of BAT and PSO_GWO using LIGO

C.3.2 Comparison graph of TEC of BAT and PSO_GWO using LIGO: In figure 4.8 X-axis represent the number of virtual machines and Y-axis Total cost execution in graph at 2 VM execution time BAT approach is 2\$ and PSO_GWO 1\$, at 10 VMs In BAT execution time 5800\$ and PSO_GWO execution time 5000\$ and in 20 VMs BAT execution time 12000\$ and PSO_GWO execution time 11000\$. below result analysis, find that response time of PSO_GWO is more as compare to BAT in local simulation. Hence, in-order to reduce response time of PSO_GWO, it can be executed in real-time cloud environment using SLA. In addition, this work can be extended for multi-objective algorithm to get solution for load balancing and task failures.

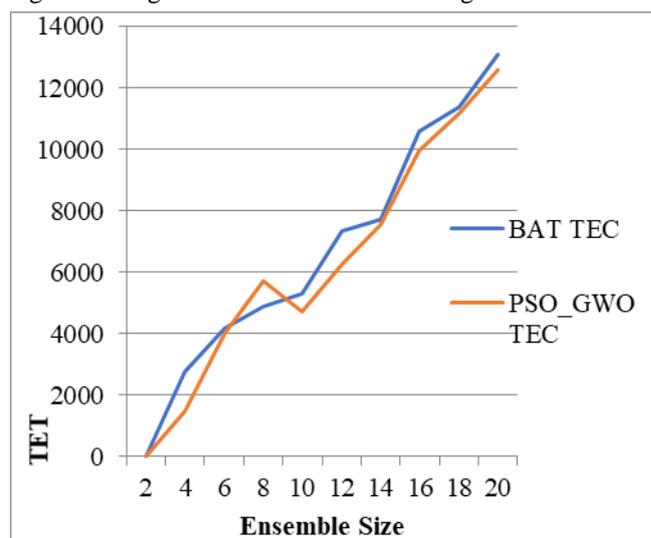


Fig.9 Comparison graph of TEC of BAT and PSO_GWO using LIGO

Novel Approach of Workflow Scheduling with Deadline Constraint using Pareto Distribution with Hybrid Swarm Intelligence in Cloud Computing

C.4 Comparison of BAT and PSO_GWO using GENOME: In given Table 4.5 below show the behavior of GENOME workflows in different number of workflows and Virtual machines which represent by ensemble size. In results, show the Ant colony optimization and genetic algorithm optimization on total execution time, total execution cost and response time.

Table.4 Comparison table of BAT and PSO_GWO using GENOME

RESULTS OF BAT and PSO_GWO USING -GENOME				
Ensemble Size	BAT		PSO_GWO	
	TET	TEC	TET	TEC
2	12.23	8825.232	23.2	9915.513
4	137.78	7549.552	73.24	27030.74
6	201.57	42511.93	133.83	42569.68
8	370.15	28155.45	315.65	41656.28
10	284.46	58872.21	745.24	86234.89
12	365.5	77034.56	546.78	88012.68
14	423.76	66004.98	317.76	93654.41
16	486.7	82720.56	401.95	106579.9
18	530.13	113448.6	791.04	123916.8
20	419.1	119935.5	491.21	139920

C.4.1 Comparison graph of TET of BAT and PSO_GWO using GENOME:

In fig.11 X-axis represent the number of virtual machines and Y-axis total time of execution in graph at 2 VM execution time BAT approach is 22ms and PSO_GWO 5 ms , at 10 VMs In BAT execution time 700 ms and PSO_GWO execution time 300 ms and in 20 VMs BAT execution time 600 ms and PSO_GWO execution time 400 ms analysis these parameter PSO_GWO perform well in time parameter because of ant colony searching time decide by adaptive pheromones and VM task migration depend on Transient problem but in genetic algorithm both is depend on candidate solution and which is static but PSO_GWO initialization is depend on pare to distribution which is depend on normal distribution. However, TET of BAT is not better than PSO_GWO because of pare to distribution take more time for mapping of VM by task. It will affect on Total cost execution because pare to VM mapping but TET always have significance improve.

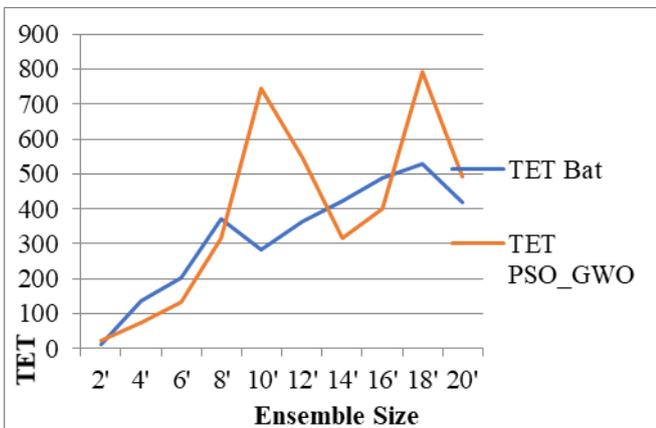


Fig.10 Comparison graph of TET of BAT and PSO_GWO using GENOME

C.4.2 Comparison graph of TEC of BAT and PSO_GWO using GENOME:

time in graph at 2 VM execution time BAT approach is 4\$ and PSO_GWO 2\$ at 10 VMs. At execution time BAT 1001 \$ and PSO_GWO runtime \$ 401 and on 20 virtual machines Runtime BAT 140000 \$ and PSO_GWO runtime 100000 \$ analysis this parameter PSO_GWO works fine on the cost parameter due to the search time of hives. Decide for adaptive pheromones and task migration VM. It depends on the transient problem, but in the genetic algorithm both depend on the candidate solution and are static, but the initialization of PSO_GWO depends on the parental distribution, which depends on the normal distribution. .

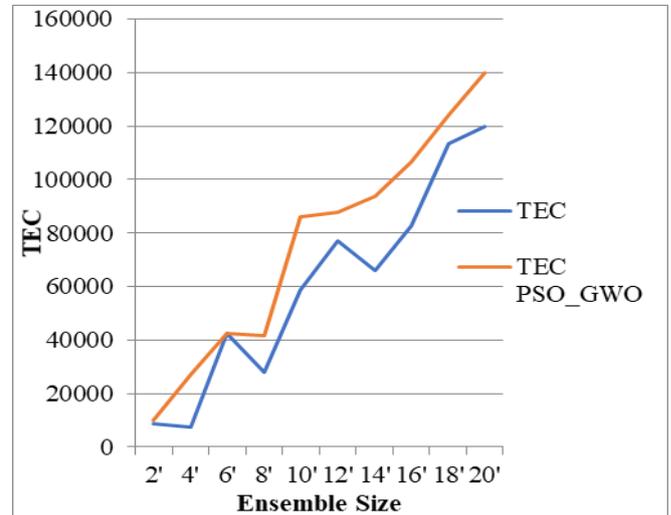


Fig.11:Comparison graph of TEC of BAT and PSO_GWO using GENOME

However, TEC of BAT is not better than PSO_GWO because of pare to distribution take more time for mapping of VM by task. It will effect on Total cost execution because pare to VM mapping but TEC always have significance improve.

V. CONCLUSION

In this work, we proposed the scheduling mechanism for execution of the sensible forms on the IaaS clouds. The main issue in the cloud computing while decreasing makespan is execution cost. This issue is solved by using Hybrid PSO with GWO. The tests were directed by mimicking four surely understood work processes (Cybershake, Ligo, Genome, Montage) on Cloudsim, which demonstrates that our answer has a general more beneficial execution than other existing algorithms.

- In above given graphs and tables, represented a comparative analysis of TET and TEC parameters on the basis of Bio inspired optimization (BAT) and Particle Swarm optimization (PSO) with Grey Wolf Optimization. In experiment, we used workflow scheduling in cloud environment with the utilization of different type of scientific workflow.
- In our analysis, total cost and execution time are improved by optimization but optimization also dependent on initializing factors. In the proposed approach, we use Pareto distribution instead of random initialization.



- If random distributions are used, more time will be taken to converge and sometime enforces the convergence by iteration but enforcing of convergence will increase the computation and execution time therefore does not meet the deadline condition.
- So, task initialization is an important task as defined in this paper. Another thing represented in these graphs and tables is that PSO_GWO performs better in comparison to BAT for reduction of cost and time because of the random crossover.

The worthy results are achieved because PSO (particle swarm optimization) play important role in global optimization and GWO optimize locally and we have merged the two algorithms by taking the best out of them. With the proposed approach in most of the work processes we can deliver bring down cost efficient schedule then additionally decreasing the time delay.

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