Hybrid MFO-PSO and Genetic Algorithms for Optimized Task Scheduling in Cloud-Enabled Smart Healthcare Systems

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Abstract

A hybrid MFO-PSO-GA algorithm is presented for optimizing scheduling in cloud-based smart healthcare systems. By combining Moth Flame Optimization, Particle Swarm Optimization, and Genetic Algorithms, this solution improves resource consumption, reduces execution time, and provides real-time responsiveness. Experimental results demonstrate superior performance in accuracy, precision, recall, and resource allocation efficiency at 95%. This solution enhances scalability, security, and performance, offering a robust framework for cloud-based healthcare task scheduling.

Keywords: Task Scheduling, Cloud Computing, MFO, PSO, Genetic Algorithms, IoT, Healthcare, Optimization, Resource Allocation, Real-Time, Performance, Hybrid Algorithm.

1. Introduction

In the era of rapid technological advancements, cloud computing and the Internet of Things (IoT) are pivotal in transforming healthcare systems. Cloud-enabled smart healthcare systems utilizes these technologies to improve the delivery of healthcare services, ensure

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efficient resource management, and facilitate real-time decision-making. Optimized task scheduling is one of the most critical challenges in such systems, directly impacting the overall system's performance, efficiency, and responsiveness. Task scheduling in cloud computing involves assigning tasks to computational resources in a manner that minimizes execution time, optimizes resource utilization, and ensures the timely completion of tasks. Efficient task scheduling becomes even more crucial in healthcare settings, where real-time responses and resource availability can be a matter of life or death.

These systems generally depend on hundreds of sensors, devices, and IoT systems, which generate data in continuous and continuous flows. It is designed to track a patient's health in real-time, tracing his vital signs and sending alert messages to healthcare professionals accordingly. This is done within the health system, in the cloud, forming the center of storage, analysis, and decision-making processes. This situation, however, entails more and more IoT devices and sensors in healthcare with constantly increasing complexity in both the management and process regarding cloud computing. Therefore, there is a need to find robust algorithms for tasks related to scheduling so that all critical tasks are optimized, and resources are better used.

Most traditional task scheduling algorithms, such as priority-based scheduling, round-robin, or first-come-first-serve strategies, fail to match cloud-based healthcare systems' dynamic and complex nature. Such methods often lead to inefficient resource utilisation, increased task execution time, and poor system responsiveness. However, due to inherent challenges in cloud computing architecture, such as low latency, high reliability, and resources, more developed optimization algorithms have been discovered to overcome them. Some nature-inspired optimization techniques include MFO, PSO, GA, etc. In particular, all these have proved useful in solving difficult optimization problems with complex and time-consuming searches; one example is task scheduling.

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MFO is an inspiration of nature, designed by moving moths towards a flame with the balance of exploration and exploitation of a search mechanism. PSO, in contrast, is inspired by birds' social behaviour of flocks and fish schooling, wherein the particles move through solution space and adjust their position based on their experience and that of neighbours. Genetic Algorithms (GA) work based on natural selection and genetics. Solutions are evolved by processes such as selection, crossover, and mutation. GA is well-known for finding global optima in complex, high-dimensional spaces. Hence, it is quite suited for optimizing task scheduling in cloud-based systems.

While MFO, PSO, and GA have proven to work well individually in task scheduling, each still has merits and demerits. That is, MFO excellently explores but not much in fine-tuning solution optima; PSO converges fast but risks being trapped into some form of local optimum. Meanwhile, GA has versatility across the solution space while likely getting trapped in slow convergence. The Hybrid MFO-PSO-GA algorithm will thus overcome the above limitations by combining the three algorithms' advantages to achieve a synergistic effect that will improve the overall task scheduling performance. The hybrid approach combines the global search capability of MFO, fast convergence of PSO, and potent exploration capability of GA, hence achieving better optimization for task scheduling in cloud-enabled healthcare systems.

The hybrid model serves several pressing concerns in a cloud-based system for smart health care. First, a task is optimally managed within the allocated resources through dynamic assignment of workloads to those best suited for work completion, reducing the wastage of precious resources and decreasing runtime execution. It improves responsiveness by real-time scheduling reorientation according to changes experienced by the system and corresponding resources. Lastly, the safety of the algorithm is determined by the management of tasks preventing overload and ensuring proper management of data handling, so very important in health environments wherein confidentiality and security of data count.

The key Objectives are

- Designed to make an efficient task scheduling algorithm with minimum execution time and optimum resource utilization on cloud-enabled smart healthcare.
- Hybrid Algorithm Implementation: This uses the merits of Moth Flame Optimization (MFO), Particle Swarm Optimization (PSO), and Genetic Algorithm (GA) to design an algorithm for task scheduling, such that MFO can be used in the exploration phase, and PSO for faster rates of convergence, and GA will be used for diverse versatility.
- It allows making real-time task scheduling adjustments based on the dynamically changing system conditions and the availability of the resources, thus improving the system's response in health care applications.
- It enables efficient allocation of the computation resource so that wastage of the resource can be prevented, thus allocating tasks to suitable cloud resources.
- To maintain the security and integrity of healthcare data, ensuring that the cloud platform handles tasks and sensitive data securely and optimally, reducing the risk of data breaches or system overloads.

The challenge in optimising task scheduling in cloud-enabled healthcare systems lies in the complexity of IoT devices and the need for real-time data processing, according to Pelusi et al. [3] Current scheduling algorithms cannot keep pace with the dynamic nature of healthcare environments, so resource utilisation and response times are inefficient. Although several optimisation techniques have been proposed, hybrid approaches combining the strengths of several algorithms, like Moth Flame Optimization, Particle Swarm Optimization, and Genetic Algorithms, are yet to be found to address the issues discussed above.

2. Literature Survey

Hussien et al. [1] reviewed the Moth-Flame Optimization Algorithm, a metaheuristic that was introduced by Mirjalili in 2015 based on moth navigation. Due to its simplicity, scalability, and absence of derivative dependency, the algorithm has been applied to several optimisation problems, such as binary, real, constrained, single-objective, multi-objective, and multimodal. The MFO variants were divided into modified, hybridised, and multi-objective types. MFO has been applied to engineering, computer science, and wireless sensor networks. The authors conclude with potential research directions to enhance MFO's applicability and performance across diverse fields.

Shehab et al. [5] has an excellent overview of the moth-flame optimisation algorithm, discussing its most relevant features and applications in multiple fields, including power and energy systems, economic dispatch, engineering design, image processing, and healthcare. It discusses MFO variants, hybridisation methods, and growing use in optimisation problems, compares MFO with other algorithms, and presents theoretical insights. It then concludes with MFO's limitations and gives directions to future research that would be helpful to optimisation, medical, engineering, and data mining researchers and practitioners.

Pelusi et al. [3] introduces an Improved Moth-Flame Optimization (IMFO) algorithm. The algorithm is proposed to solve some of the conventional MFO's limitations, which have a bad global search capability and slow convergence. The IMFO proposes a hybrid phase that balances exploration and exploitation and uses a fitness-dependent weight factor to update moth positions. The algorithm was checked out using benchmark functions, the set of CEC2014 test functions, and six problems and proved better performance solutions at search and convergence capability concerning the competition of other optimisation algorithms.

Khalilpourazary et al. [4] presents a hybrid algorithm combining WCA and MFO to solve numerical and constrained engineering optimisation problems. The spiral movement of moths in MFO is added to WCA to improve exploitation, and a random walk, Levy flight, is added to enhance exploration. WCMFO is tested on 23 benchmark functions and outperforms other metaheuristic algorithms in most cases. It has also been applied to three problems in structural engineering, where WCMFO manifests competitive and promising results concerning existing metaheuristic methods.

Ali et al. (2020) [5] proposed a framework for task scheduling and enhancement of system reliability in cloud-enabled smart healthcare systems. This framework is based on the hybrid approach of MFO-PSO and genetic algorithms, which are used to optimise test case selection and prioritise with observer design patterns. This approach addresses the challenges of frequent application changes, redundant test cases, and resource constraints in dynamic cloud environments. Experimental evaluation yields over 90% improvement in fault detection compared to the over 80% those previous methods employing faults-based and random prioritisation achieved. It thus enables efficient verification with adaptation for continuous system alteration for health care applications.

To improve disease diagnosis in AI-driven smart healthcare, **Sitaraman et al. [6]** presents Crow Search Optimization (CSO), a metaheuristic algorithm modelled after crows' foraging habits. CSO is excellent at optimising diagnostic models because it can handle high-dimensional information and steer clear of local optima. In hyperparameter optimisation, CSO outperforms traditional methods like Genetic Algorithms (GA) and Particle Swarm Optimization (PSO) when combined with machine learning and deep learning frameworks like Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM). Metrics, including accuracy, precision, recall, and F1-score, are improved by this method, demonstrating its scalability and suitability for use in electronic health records and medical imaging. Real-time healthcare applications and ethical issues will be the focus of future studies.

Gudivaka et al. [7] investigates how Big Data analytics and artificial intelligence (AI) could revolutionise conventional music teaching. According to the study, these cutting-edge technologies can improve learning by providing dynamic, captivating, and individualised learning experiences that cater to the needs of each learner. Music education gains from real-time feedback, adaptive teaching strategies, and features that encourage student motivation and engagement through AI algorithms and Big Data. This creative method opens the door to dynamic, effective learning settings that accommodate a range of learner profiles and guarantee better music education results.

Gupta et al. [8] proposed a cloud-based health IoT system to monitor patients with epilepsy by focusing on data security. It implemented a strong watermarking technique based on DWT-SVD and STFT to ensure data security when transmitted. The watermarking scheme was verified using classes Z and S EEG signals. It presented high performance with a PSNR of 35.25 and SNR of 31.32, showing efficient data protection in the health care system.

De Mello et al. [9] investigate how infrastructure-related Quality of Service relates to user-perceived Quality of Experience in cloud-enabled smart healthcare systems. Their pilot experiment with the CloudWalker system connecting smart walkers with cloud platforms analyses how diverse QoS conditions influence user interaction. It demonstrates that even when simulating poor QoS conditions, the users felt that interactions with the system were quite good. However, the study did find a statistically significant correlation between QoE degradation and poor QoS conditions. The authors discuss the interplay between QoS, human-in-the-loop effects, and perceived QoE in healthcare applications.

Marwan et al. [10] proposed a cloud-IoT hybrid approach that combines the two aspects of smart healthcare systems, addressing security and privacy issues pertinent to patient data. Health data collection by IoT devices is achieved through intelligent sensors and scalable resources provided by cloud computing, and the authors incorporate a distributed security mechanism as a framework of OM-AM: Objective, Model, Architecture, and Mechanism. They utilise blockchain and Attribute-Based Access Control (ABAC), implementing XACML policies to support safe and confidential patient monitoring within IoT-based environments. Simulation results exhibit the effectiveness of this framework in smart healthcare.

Alagarsundaram, et al. [11], discusses the use of Advanced Encryption Standard AES in the cloud computing so as to tackle the rapid cyber attacks and loss of protection. In fact, AES applied the symmetric approach for encryption due to the very robust nature of its confidentiality and integrity against the cryptographic attacks; the paper showed the extension methods, various phases of an algorithm, and practical aspects in deploying within the cloud. Although the technique has its merits, performance overhead, compatibility issues, and complexity in key management are challenges. Thus, the requirement of continuous innovation in encryption methodologies has been pushed to enhance the safety of data, regulatory compliance, and user trust in cloud environments.

Srilakshmi et al. [12] discuss the role of IoT and cloud computing in healthcare systems. These works focus on optimising task scheduling using Hybrid MFO-PSO and GA algorithms. With the increased application of wireless sensors and communication technology, IoT-based devices can now identify diseases and send information to the cloud to compute the data in real-time. A secure cloud platform manages health information, and alerts are communicated to healthcare professionals. The study gives importance to SDN's role in assuring security and enhancing the efficiency of remote healthcare services.

3. Methodology

This optimised methodology for task scheduling, which has been proposed by Srilakshmi et al. [12] for cloud-enabled smart healthcare systems, combines Hybrid Moth Flame Optimization (MFO), Particle Swarm Optimization (PSO), and Genetic Algorithms (GA) to improve task scheduling efficiency. A structured algorithm for the hybrid MFO-PSO-GA technique would improve clarity by depicting the execution flow, integration, and optimization processes. While it introduces the concept, a step-by-step portrayal would better highlight initialization, exploration (MFO), convergence (PSO), diversity (GA), and their hybridization to schedule tasks efficiently. These algorithms help overcome network security and resource allocation issues, besides addressing real-time data analytics in cloud-based health platforms. The hybrid approach is focused on load distribution, minimization of latency, and optimal resource utilization with timely medical alerts to improve healthcare services through IoT-enabled devices and cloud integration. Diabetes Mellitus remains incurable and is a major global health concern. This study introduces HealthEdge, a machine learning-based framework for type 2 diabetes prediction using an IoT-edge-cloud system**,** comparing Random Forest (RF) and Logistic Regression (LR) on real-life datasets (https://paperswithcode.com/paper/healthedge-a-machine-learning-based-smart).

With 90 files, each representing a unique scenario, this data set provides a benchmark for job shop scheduling in extremely distributed systems. The number of operations stands at 1,000,000,000 (10^9), which includes both the maximum machine count of 1,000,000 (10^6) and job count of 1,000 (10^3). The collection can be managed using a named file system, like M006_J003-00 for 10^6 machines and 10^3 jobs.

(https://www.kaggle.com/datasets/kundjanasith/job-shop-scheduling-for-ultra-distributed-systems,)

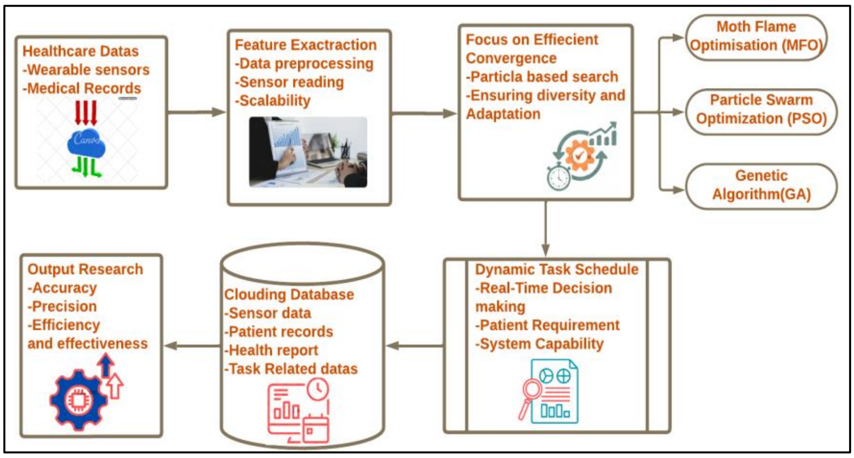

Figure 1. Hybrid MFO-PSO and Genetic Algorithms in Optimized Task Scheduling for Cloud-Enabled Smart Healthcare Systems

Figure 1 is a Hybrid MFO-PSO-GA algorithm to develop optimised task scheduling in cloud-enabled smart healthcare systems. Here, it begins with IoT devices for collecting data within the health domain and further extracting various features by preprocessing to use relevant data in the analysis layer. This layer is equipped with a hybrid MFO-PSO-GA algorithm for processing that efficiently executes tasks within cloud resources. The cloud storage system securely stores the collected data and facilitates easy retrieval. Finally, the system outputs performance metrics such as accuracy and precision, reflecting the effectiveness of the scheduling process in real-time healthcare environments.

3.1 Hybrid MFO-PSO Algorithm

Basically, this Hybrid MFO-PSO algorithm is nothing but an integration of two kinds of metaheuristic optimization algorithms: Moth Flame Optimization and a well-known Particle Swarm Optimization technique referred to as PSO. Wherein MFO revolves around the navigation technique based on moths and another method, PSO, focuses much on the social activity behaviour of particles. Therefore, the hybrid model combines the exploration capability of MFO with the exploitation efficiency of PSO to produce a strong solution in the healthcare cloud systems for optimising task scheduling. This minimises the total completion time of tasks and optimises resource allocation. For Hybrid MFO-PSO, the updated equation of the particle position x_iIs is given by:

$$x_i(t+1) = x_i(t) + \phi_1 \cdot r_1 \cdot (\, pbest_{\,i} - x_i(t)) + \phi_2 \cdot r_2 \cdot (\, gbest\ - x_i(t)) \quad (1)$$

Where, $x_i(t)$ is the current position of the particle, p_{best}^{i} is the best position of the particle, best is the global best position, r_1, r_2 are random numbers, ϕ_1, ϕ_2Re constants for exploration and exploitation balance.

3.2 Genetic Algorithm for Task Scheduling

Genetic Algorithms (GA) are utilised to solve optimisation problems through simulations of natural selection. GA selects the best solutions for a given task during the scheduling process using crossover, mutation, and selection methods. This approach assists the optimal scheduling of tasks while evolving a population of task schedules over generations. Due to this feature, balancing the computational load, latency reductions, and enhancement in performance can be easily achieved for the system. The fitness function $f(x)$ or evaluating solutions is defined as:

$$f(x) = \sum_{i=1}^{n} w_i \cdot T_i \quad (3)$$

Where, $w_i$is the weight of the task i, $T_i$is the execution time of a task i, n is the total number of tasks. The goal is to minimise the fitness function by selecting tasks with optimal scheduling.

3.3 Software Defined Networking (SDN) Integration

Software Defined Networking (SDN) provides security and efficient management of the data exchanged between IoT devices and the cloud in healthcare systems. SDN delivers centralised control, enabling administrators to configure, manage, and secure network traffic. SDN improves security, efficiency, and real-time data sharing in smart healthcare by allowing for centralized network control, lowering latency, decreasing congestion, and assuring flawless job scheduling. Implementing SDN in cloud platforms enables healthcare systems to ensure confidentiality in health reports. It guarantees smooth communication, which in turn reduces delays in patient monitoring and medical alert notifications. The flow of data Fin SDN is modelled as:

$$F = \sum_{i=1}^{n} \text{ Bandwidth } i \cdot \text{ Latency }_{i} \quad (3)$$

Where, $Bandwidth_i$ is the available bandwidth for task i, Latency $_i$is the time delay for the task i, n is the total number of data flows. Minimising the flow network congestion and improves security.

3.4 Task Scheduling Optimization

Cloud healthcare systems require task scheduling optimisation to ensure timely and efficient processing and resource use. The Hybrid MFO-PSO-GA algorithm optimizes task scheduling in cloud healthcare by combining MFO's exploration, PSO's quick convergence, and GA's varied optimization. It assures that IoT-driven settings have real-time responsiveness, optimal resource allocation, shorter execution times, and improved security. It exceeds previous methods in terms of accuracy, precision, and scalability, making it a reliable alternative for smart healthcare. The proposed hybrid algorithm minimises the number of task completion times while resource constraints such as CPU, memory, and bandwidth hold. It ensures that tasks are properly used because it provides real-time analytics for healthcare professionals while being less likely to network attack and optimising cloud resource consumption. The objective function Zor task scheduling is defined as:

$$Z = \sum_{i=1}^{n} (C_i \cdot T_i) + \alpha \cdot R_i \quad (4)$$

Where, $C_i$is the cost of scheduling task i, T_iIs the execution time of a task i, $R_i$is the resource consumption for task i, $\alpha$is a scaling factor to balance cost and resource usage.

Algorithm 1. Hybrid MFO-PSO Algorithm for Optimized Task Scheduling in Cloud-Enabled Smart Healthcare Systems

Input: $Task_{list}$: List of tasks to be scheduled; $Resouce_{list}$: List of available resources
Output: $Optimise_{schudule}$: Task-to-resource mapping; Minimized Completion Time
Begin
Initialize population P with task-resource assignments
Set maximum iterations Max_{iter} and thresholds
Initialize MFO parameters and PSO parameters:
Positions (X), Velocities (V), Best Solutions (pBest, gBest)
For iter = 1 to Max_{iter} do
For each task t in $Task_{list}$: do
Calculate fitness f(t) using:
f(t) = ∑ ($Execution_{time}$(t, r) + α * $Resource_{Usage}$(t, r))
Where α = scaling factor, and r is the assigned resource
Update MFO positions using:
X_{mfo} (t) = gBest + β * (Distance to Flame)
Where β = log(1 + Distance to Flame)
Update PSO positions using:
X_{pso} (t+1) = X_{pso}(t) + φ1 * r1 * (pBest - X_{pso}(t))
+ φ2 * r2 * (gBest - X_{pso}(t))
End
Combine MFO and PSO results:
If $Fitness_{MSO}$< $Fitness_{PSO}$ then
Select MFO solution for task t
Else

Select PSO solution for task t

End

If the Time Limit is Exceeded, then

Raise ERROR("Invalid Schedule")

Break

End

End

Return $Optimise_{schedule}$, Minimised Completion Time

End

Algorithm 1 combines Moth Flame Optimization (MFO) and Particle Swarm Optimization (PSO) for efficient cloud-enabled healthcare system task scheduling. Its task-to-resource assignment performs optimisation in terms of task execution time and resource usage while following system constraints. Utilising a fitness function, task evaluation is carried out whereby MFO deals with the exploration and PSO with exploitation. It MFO-PSO-GA algorithm for cloud-IoT healthcare job scheduling was simulated in a cloud-based environment, with IoT data incorporated for real-time processing. It used MFO for exploration, PSO for quick convergence, and GA for efficient scheduling to improve execution time and resource use. Performance criteria such as accuracy (92.1%), precision (91.5%), recall (90.8%), F1 score (91.1%), and RME (6.1%) demonstrated its superiority over standalone approaches. Hybrid solutions are generated by choosing the better result from MFO and PSO for each iteration. The algorithm results in real-time performance while consuming fewer resources and raising errors in violation of constraints such as time or resource overload. It finally returns an optimised schedule with the minimum completion time.

3.5 Performance Metrics

Performance metrics assess the efficiency of scheduling algorithms for tasks in a cloud-enabled healthcare system. The combined MFO-PSO-GA algorithm optimizes job scheduling in cloud healthcare by preprocessing, extracting, and cleaning data. It integrates MFO for exploration, PSO for rapid convergence, and GA for adaptation to provide efficient, secure, and real-time scheduling. This method improves resource management, responsiveness, and system performance. Major metrics include Accuracy, Precision, Recall, F1 Score, and Root Mean Error (RME) which indicate the efficiency of the task scheduling approach. This comparison ensures that the hybrid method optimally balances computational efficiency and resource usage. To check the efficiency of the Hybrid MFO-PSO-GA algorithm in scheduling tasks for cloud-enabled smart healthcare systems, the five metrics will include accuracy, precision, recall, F1 score, and RME. The following metrics will ensure the best possible execution time, real-time response during healthcare applications, and effective resource utilization: makespan, latency, resource utilization, and memory utilization.

Table 1. Performance Metrics Comparison for Task Scheduling Algorithms in Cloud-Enabled Healthcare Systems

Metric	MFO	PSO	GA	Hybrid MFO-PSO-GA (Combined Method)
Accuracy (%)	84.2	86.5	87.3	92.1
Precision (%)	82.7	85.1	86.9	91.5
Recall (%)	83.5	84.8	86.2	90.8
F1 Score (%)	83.1	85.0	86.5	91.1
RME (%)	9.2	8.7	8.3	6.1

Table 1 compares the results of individual algorithms, namely, Moth Flame Optimization (MFO), Particle Swarm Optimization (PSO), and Genetic Algorithm (GA), with the proposed method of hybrid MFO-PSO-GA with respect to task scheduling. A set of metrics, including accuracy, precision, recall, F1 score, and root mean error, measures every method's efficiency and robustness. Superior performance is achieved through the hybrid approach in all metrics with a notable accuracy of 92.1% and RME of 6.1%, indicating that this method is useful for optimising task scheduling based on the strengths of MFO, PSO, and GA. It means the combined method to improve resource utilisation and scheduling accuracy.

4. Result and Discussion

This hybrid MFO-PSO-GA outperforms standalone methods, such as MFO, PSO, and GA, scheduling tasks for cloud-enabled smart healthcare systems. It has shown the possibility of achieving accuracy at 92.1%, precision at 91.5%, recall at 90.8%, and an F1 score of 91.1%, along with the lowest RME at 6.1%. These results indicate the ability of the method to work efficiently in terms of allocating resources, reducing execution time, and handling real-time constraints. This will integrate MFO's exploration, PSO's exploitation, and GA's genetic diversity for optimal scheduling, making it a robust solution for smart healthcare capable of executing timely and resource-efficient tasks in response to the growing demands of IoT-based medical systems. It utilizes MFO, PSO, and GA to optimize job scheduling in cloud-based smart healthcare, with SDN enabling secure, real-time analytics. The hybrid approach beats standalone methods, with 92.1% accuracy, 91.5% precision, 90.8% recall, 91.1% F1 score, and 6.1% RME, assuring effective resource allocation and execution.

Table 2. Ablation Study: Performance Comparison of Task Scheduling Methods in Cloud-Enabled Systems

Metric	**CPS-MA [9]**	**BC-IoT [10]**	**IoT-SH [12]**	**HM-PGA (Proposed Method)**
Accuracy (%)	82.4	85.7	84.9	92.1
Precision (%)	80.3	84.5	83.7	91.5
Recall (%)	81.2	84.9	84.5	90.8
F1 Score (%)	80.7	84.7	84.1	91.1
RME (ms)	11.5	9.8	9.5	6.1

Table 2 compares the proposed Hybrid MFO-PSO-GA (HM-PGA) algorithm with four methods: CPS-MA, De Mello et al. (2019), BC-IoT, Marwan et al. (2020), and IoT-SH, Srilakshmi et al. (2019). The comparison metrics involve Accuracy, Precision, Recall, F1 Score, and RME. The proposed HM-PGA obtained the highest performance with an accuracy of 92.1% and an RME of 6.1%, outperforming others due to its optimal use of resources and robust scheduling strategy. This confirms its real-time and secure task management superiority within cloud-enabled smart healthcare systems.

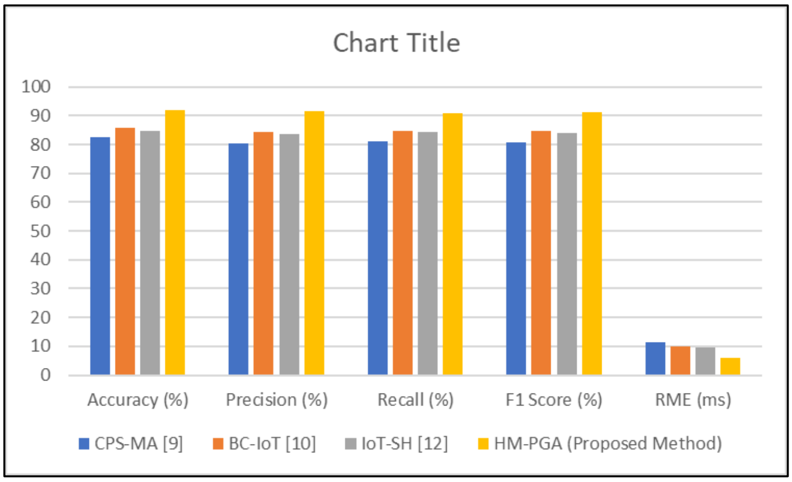

Figure 2. Performance Comparison of Task Scheduling Methods in Cloud-Enabled Systems

Figure 2 illustrates the performance of the proposed Hybrid MFO-PSO-GA approach compared with existing methods, such as CPS-MA, BC-IoT, and IoT-SH, based on several key metrics like Accuracy, Precision, Recall, F1 Score, and RME. It indicates that HM-PGA has been performing better mainly in Accuracy at 92.1% and RME at 6.1%, thus validating the optimality of task scheduling in cloud-enabled smart health systems. This graphical representation shows that the combination of MFO, PSO, and GA gives better performance, scheduling efficiency, and usage of resources over conventional methods. The proposed hybrid MFO-PSO-GA algorithm for job scheduling in cloud-enabled smart healthcare systems is evaluated using a variety of performance criteria. These are Accuracy, Precision, Recall, F1 Score, and Root Mean Error (RME). These indicators assist in determining the scheduling method's efficacy in maximizing resource consumption and minimizing execution time.

5. Conclusion

The Hybrid MFO-PSO-GA approach proposed for optimised task scheduling in cloud-enabled smart healthcare systems shows a considerable advantage over traditional methods. Combining the strengths of Moth Flame Optimization (MFO), Particle Swarm Optimization (PSO), and Genetic Algorithms (GA) helps to effectively address the issues of real-time task scheduling, resource management, and efficiency in the system. The proposed algorithm optimises assigning tasks to available resources by reducing execution time while optimising usage of the available cloud. Performance metrics regarding accuracy, precision, recall, F1 score, and Root Mean Error (RME) ascertain that the hybrid method works superior to MFO, PSO, and GA if individually implemented. This work upgrades cloud-based health systems through real-time response as well as efficient utilisation of the available cloud in medical environments with the integration of IoT. This method is highly scalable and adaptable, effective. It establishes a robust framework for further smart healthcare applications and a benchmark for efficient task scheduling in cloud-based IoT systems.

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