EVALUATION OF WEB SERVICES COMPOSITION PROBLEM IN MULTI-CLOUD ENVIRONMENT

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***Abstract*: The development of Web services as a distribution, service consumption, and discovery architecture was successful. The components of SOA are widely used in e-business, process control, multimedia services, and several other disciplines. A QoS is still helpful for connecting non-functional concepts to Web services, and it is next used as a key point of differentiation for the different Service provider. In a multi-cloud environment (MCE), each atomic web service published by any cloud provider with the same functionality has a different price and quality of service (QoS). Service discovery and composition are the key challenges for web services development. The challenges in the composition of services distributed in multi-cloud environments include increased cost and a reduction in its speed due to the increasing number of services, providers, and clouds. Consequently, to overcome these challenges, the QoS-aware multi-cloud web service composition is presented in this work a Hybrid Firefly and Bee Colony Optimization Algorithm is introduced for the Multi-cloud service composition problem of NP-Hard in a multi-cloud environment.**

***Keywords*:** *Services Composition, Firefly, Bee Colony Algorithm, QoS Metrics.*

I.INTRODUCTION

In the field of cloud computing, the storage and computing resources are framed as a service that can be utilized or delivered as needed utilities for the needed one. The personal applications and business systems started to adopt the cloud computing whereas web services are widely utilized by the individual users [2]. With the assistance of web service, the software systems are established by the integration and reusing of existing resources. The quality of the web service system relies on the quality of the services that is Quality of Services (QoS). The prediction of future values that is QoS attributes is considered as a significant concern in the context of web service. The values of QoS have to be determined to meet the needs of the users.

A. Web Service Composition in Multi-Cloud Environment

Service composition problems can be resolved by selecting a set of web services in such a way that their combination meets the functional and non-functional requirements of the user. With the advent and rapid development of cloud computing, more clouds can carry out the existing tasks in the cloud with different functions, and this cloud environment is a natural choice for providing various types of resources as a service. The service composition in cloud environments allows for the integration of various cloud resources into a set of integrated services for providing cloud-based solutions that meet certain qualitative criteria. Most of the service composition methods that have been proposed for cloud computing consider all the composite services in one cloud, rather than searching for services from the various available clouds. Organizations often distribute their services using cloud providers to ensure the availability and quality of the provided services, and also to reduce the risk of data loss. In addition, service composition in multi-cloud environments poses many issues such as the cost of communications within the cloud, increased fiscal costs, and security issues. Subsequently, challenging tasks include reducing the number of participating clouds and the number of providers due to the limitations of the services [4].

To ensure the efficiency and security of work, a multi-cloud service composition environment is presented. However, to overcome the Web Service Composition problem of NP-Hard in a multi-cloud environment, a hybrid Firefly and Bee Colony Optimization Algorithm is presented in this work. The rest of the paper is demonstrated as follows, section 2 depicted the literature survey of the study, and section 3 depicted the problem definition and motivation of the work. Section 4 illustrates the proposed work.

II. LITERATURE REVIEW

In a multi-cloud environment, a framework for service composition is proposed by Abdelbasset Barkat et al [4], these services are composed based on two factors to create a composing service that meets the user's request: the first one for each service, a set of QoS (quality of service) criteria, and the second is the number of cloud bases involved in the composition process. In multi-cloud environments, a hybrid formal verification approach is proposed by Alireza Souri et al [5] for assessing service composition, then a final service composition with a high level of QoS is achieved by reducing the number of cloud providers. In a multicloud context, this approach uses behavioral modeling to investigate the process of composition, user requests, and service selection.

The business procedure employed as a composition of web service, which accomplishes the set of facilities to attain the business goal. It helps to manage the Business Process Management (BPM) [6] approach that contains techniques, methods, and tools for supporting the enactment, design, analysis, and management of the business progressions. BPM's life-cycle comprises of 4 phases: designing, setup, representation, and analysis. The architecture is the first and foremost stage in business process development between these stages as it offers assistance in developing the business process model, organizing tools, finding new opportunities and forecasting threats. Process analysts sketch business procedures using graphical modeling tools.

In a multi-Cloud context, Samar Haytamy et al [7] developed an upgraded QoS-based Service Composition Approach to precisely compose the best Cloud providers to contract with them for composing the desired services to reduce the Cloud consumer cost function. The best services based on the uncertainty of QoS attributes were composed using a modified Particle Swarm Optimization (PSO) in this article. Using a real QoS dataset, the proposed approach has been implemented. In comparison to existing models, the proposed approach has attained a high degree of optimality with low time complexity, according to the comparative results.

A security-aware multi-cloud service composition approach based on fuzzy Formal Concept Analysis (FCA) and rough set theory (RS) is proposed by Fatma Lahmar et al [8], which are the two mathematically strong techniques. The paper introduced the fuzzy relations of fuzzy FCA and the approximation of RS to ensure a high level of security for the hosting clouds and selected services. Fuzzy FCA will ensure that the composing services are chosen from a small number of clouds because of its bottom-up parsing technique, which lowers inter-cloud communication costs. The approach's effectiveness and performance were demonstrated by the experimental results.

M. Heidari et al [9] suggested the Skyline service algorithm composing services in multi-cloud environments, which examined all the clouds during the service composition process. The proposed method can provide an applicable composition service to the user with the lowest communication cost by considering the number of clouds and by using fewer providers. Additionally, there are two steps involved in the Skyline algorithm

III. PROPOSED METHODOLOGY

Today's world, cloud providers display their services in a variety of contexts using a variety of functional and non-functional features. A major problem in multi-cloud service composition is finding and selecting an appropriate atomic service from a pool of activated services. In the service composition problem, reducing the number of cloud providers is crucial, since it influences total cost, energy consumption, and response time. Consequently, this research work proposed a Hybrid Firefly and Bee Colony Optimization Algorithm to assess the service composition in multi-cloud environments decreasing the number of cloud providers to compose the best services based on uncertain QoS attributes.

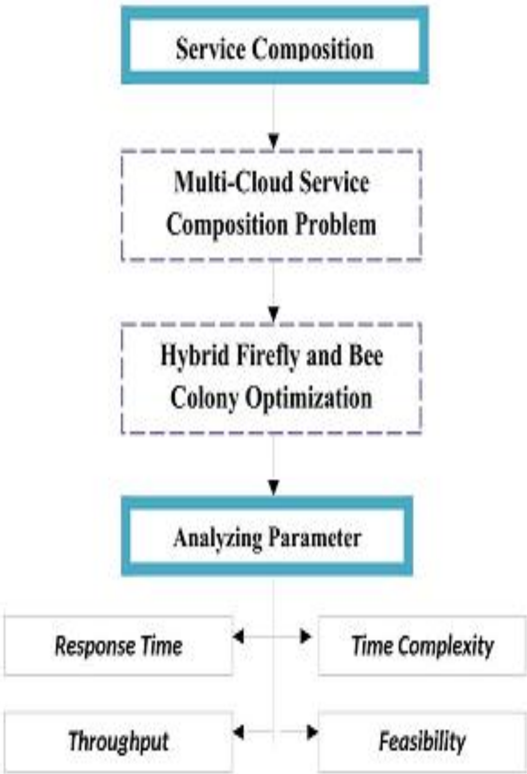

***Fig1**:-Flow diagram for Proposed System*

The firefly (FF) is a population-based metaheuristic inspired by flashing fireflies' communication behavior. Based on the idealized properties of flashing fireflies, its mathematical model has been proposed as follows: (1) All fireflies are unisex, (2) the attractiveness of a firefly is proportional to its brightness or light intensity, and (3) the landscape of the fitness function determined the brightness of a firefly.

Accordingly, based on the foraging behavior of natural honey bee swarms, the BCO algorithm is inspired and it is a metaheuristic technique. Employed bees, observer bees, and scouts are the three types of bees are considered in a colony of artificial bees in the BCO. One-half of he population of artificial bees is employed bees, while the other half consists of onlookers and scouts.

The quantity of bees engaged is proportional to the number of food sources available (possible solutions). Employed bees are bees that are currently pursuing a food source and, in the meantime, with onlookers, these bees share their knowledge of food sources. From those discovered by employed bees, onlooker bees select high-quality food sources and then seek the foods in the immediate vicinity. Scout bees are employed bees that forsake their unpromising food sources in quest of fresh ones.

In addition, the diversity measure is used to help in the switch criteria. Consequently, the proposed HFF-BCOA has three main components, the global search optimizer, the local search algorithm and the switch criteria. The details of each component and implementation steps of the HFF-BCOA are presented as follows.

Global Search Optimizer: The global searcher in the proposed hybrid algorithm is a variation of FF that employs a random attraction model. In this FF variation, each solution is compared to a randomly chosen solution from the population's pool of promising solutions. Assume that the objective function values of all WP individuals in the population are sorted. Consequently, the first firefly x_1 is the best and the last WP firefly is the worst. Each solution x_i selects one solution from the set $\{x_1, x_2, \ldots, x_{i-1}\}$ in the suggested random attraction model. Consequently, for each parameter value $x_{I,k}$, , the update is determined by

$$x_{i,k}^{t+1} = x_{i,k}^{t} + \beta.(x_{j,k}^{t} - x_{i,k}^{t}) + \alpha S_k.\left(rand_i - \frac{1}{2}\right) \quad \text{----- (1)}$$

Local Search Algorithm: BC performance mainly depends on its search equation given by equation (2). According to equation (2), the new candidate solution is created by moving the old solution to a randomly selected individual, and the search direction is completely random. Subsequently, the equation (2) is random enough for exploration and consequently can provide solutions with plenty of diversity and far from the actual solutions. In the employed phase, every solution xi is updated by

$$v_{i,m} = x_{i,m} + \varphi.(x_{i,m} - x_{l,m}), \quad i = 1,2,\ldots,WP/2 \quad \text{--- (2)}$$

Combining search strategies that have different abilities so that they can complement each other during the search process can achieve better optimization results than a single search strategy as in the basic BCO. Subsequently, an ensemble of multiple solution search strategies for BCO is developed to perform a local search. Two search equations coexist throughout the search process in the proposed MBCO and compete to develop better new solutions. The first is a basic BCO search technique is given in equation (2). The second search strategy employed in the MBCO to generate a new candidate solution Vi by using the solution x_i is described by

$$v_{i,k} = x_{i,m} + \varphi_i.(x_{i,m} - x_{1,m}) \text{------- (3)}$$

In order to determine how to assign these search strategies to solutions from the population, an encoding method is used. Let denote the search strategy given by equation (2) as S_1 and the search strategy given by equation (3) as S_2. Each solution xi is randomly assigned a search strategy, S_i, from the set {S_1, S2} at the beginning of the search. In the course of the search process, the value i S is changed according to the quality of the new candidate solution V_i. If the candidate V_i has a lower objective function value than its parent x_i, it indicates that the current search equation is appropriate for the search. In that case, the current strategy is kept for further search and the parent solution is replaced with the candidate solution. Otherwise, it means that the current strategy cannot enhance the quality of the solution and it is replaced. Otherwise, it means that the current strategy cannot enhance the quality of the solution and it is replaced.

if $f(v_i) < f(x_i)$ then
$x_i = v_i$;
{solution x_i is updated and its assigned search strategy S_i is kept for further search}
else
if $S_i = S_1$ then
$S_i = S_2$;
else
$S_i = S_1$;
end if
{solution x_i is kept and its assigned search strategy is replaced for further search}
end if

Table 1:-Algorithm for Search Strategy

Also, in that case, the parent solution is kept for the next generation. Consequently, the search strategy algorithm is presented in table 1. The input of the algorithm includes the parent solution x_i and its assigned search strategy S_i, the candidate solution V_i and the objective function *f*. The output of the Algorithm is the solution xi and its assigned search strategy Si which will be used in the next generation.

Switch Criteria: Differences among individuals of a population are a prerequisite for exploration, but too much diversity in each phase of the search may lead to inefficient search. Population diversity is usually high at the beginning of a search process, and it decreases as the population moves towards the global optimum.

In the implementation of the HFF-BCOA, it is important to know when to switch from the FF to MBC. For this purpose, the FFMBC incorporates the diversity metric as equation (4) to measure the population diversity.

$$Diversity = \frac{1}{WP}\sum_{i=1}^{SP}\sqrt{\frac{1}{D}\sum_{k=1}^{D}(x_{i,k} \quad x'_k)^2} \quad \text{-----(4)}$$

IV.RESULT AND DISCUSSION

The proposed model uses a service composition dataset and service process call records from the Programmable Web website to conduct experiments. The QoS evaluation uses a real benchmark dataset called WSDream dataset using response time, availability, and throughput. The throughput (in bits per second) and response time (in seconds) of each web service are varied in this dataset based on the calls made by different users. Accordingly, this simulates the behavior of the real web services and the changes in the QoS values during the service execution engine running.

The proposed method is implemented using Python software. The proposed method can be simulated and evaluated using the Python Jupiter Version 3.8.0. The operating system of the proposed work is Ubuntu, their memory capacity is 4GB DDR3, their processor is Intel Core i5 @ 3.5GHz and simulation time is 100 seconds, respectively.

Parameters Values	Values(SECONDS)
Execution Time	66.48
Efficiency	84.51
Throughput	92.91
Feasibility	84.45

Table 5: Performance Values of Proposed Method

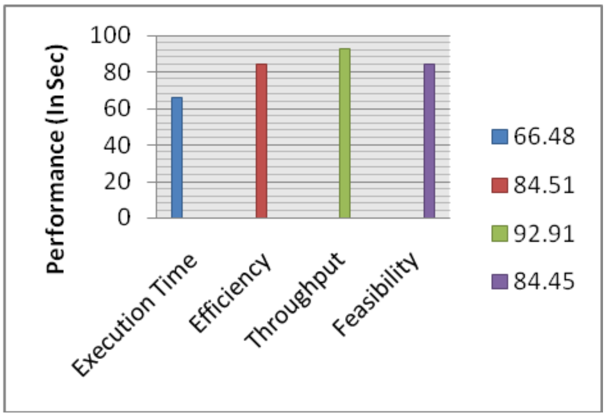

Fig 2:- Performance Chart

V.CONCLUSION

Cloud computing is an elastic service provisioning model that enables on-demand network access to a shared pool of computing resources. The popularity of cloud computing has increased in recent years. Each cyber security attack on security tenets can make a business financial loss or even fail. Today, users and enterprises are increasingly using the cloud to access software resources in the form of web services. A hybrid firefly and bee colony optimization algorithm is presented in this article for multi-cloud composition problems; it provides the best service by reducing the cloud providers. In future the work can be enhanced using Fuzzy theory and deep neural network.

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