Optimized QoS Ranking Prediction Using Generalized Jaccard Coefficient Similarity based Grey Wolf Optimization (GJCS-GWO)

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***Abstract*—QoS (Quality of Services) is a very important research topic in cloud computing. When we select an optimal cloud service from functionally equivalent service we use QoS value for a good decision making. QoS ranking provides priceless information in selecting the best cloud service in cloud computing. In order to avoid time consumption and to select the best service for the cloud customer a good QoS ranking prediction framework is required. It should be a much user as friendly and less time consuming. In this paper Generalized Jaccard Coefficient Similarity based Grey Wolf Optimization (GJCS-GWO) based optimization method is proposed for ranking prediction. It will give higher accuracy and be less time consuming. When the proposed framework is compared with the previous works on the basics of response in time, throughput, and latency the proposed work is proved to be much better than the previous works.**

Keywords—Generalized Jaccard Coefficient, Grey Wolf Optimization, Ranking Prediction, Optimization, QoS.

Cloud computing is a developing technology that are exponentially increasing the interest among users to use the cloud applications. Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to shared pool of configurable computing resources that are rapidly provisioned and released with minimal management effort. Cloud services are broad category that encompasses many IT resources provided over internet. In addition, it also describes the professional services that support selection, deployment and ongoing management of many cloud-based resources. Fig1 shows the common architecture of cloud services. Cloud services are introduced to present easy, scalable access to applications, resources and services that are fully managed by cloud service providers. Quality-of-Service (QoS) is an essential idea for service selection and user satisfaction in cloud computing. QoS rankings present valuable information for optimal cloud service selection from set of functionally equivalent service candidates. QoS ranking prediction is the process of predicting the top ranked cloud services. But, the existing ranking prediction techniques failed to increase the prediction accuracy and to reduce the prediction time.

QoS is measured in the client side or server side. The client side QoS properties provide us a very realistic measurement by user experience [3]. The QoS properties commonly used include throughput, response time, Latency etc. In this paper we focus mainly on client side QoS properties. In our proposed work client side QoS properties are used for experimental analysis.

The remaining section of this paper is structured as: Section II analyses the related work. Section III explains the proposed system methodologies. Section IV displays the results. Section V completes the paper with the scope for future enlargements.

I. Literature Review

This section of the paper shows the present researches and works that have been done relating to QoS value prediction using different techniques.

A fully dynamic, self-adaptive and online QoS modeling approach was introduced in [1] for generating the QoS model to predict QoS value as output. In-depth analysis was carried out on correlations of chosen inputs to the QoS model accuracy in cloud. For choosing the inputs at runtime and tune accuracy, self-adaptive hybrid dual-learners divide the input space into two sub-spaces. The two sub-spaces used symmetric uncertainty based selection techniques. But, the designed approach failed to control the agenda for intelligent engineering applications.

A ranking-oriented prediction method was introduced in [2] for determining cloud service candidates with highest customer satisfaction. The designed approach includes two functions, namely ranking similarity estimation and cloud service ranking prediction for customer preference and expectation. However, semantics-enhanced cloud service ranking and selection framework failed to consider the customer personalized QoS requirements.

A resource usage distribution prediction technique was introduced in [3] to calculate complete spectrum of resource utilization as probability density functions. The designed technique employed linear road benchmark and TPC Benchmark™H (TPC-H) in private and public clouds. The efficiency of technique was improved for two applications. The first one is predictable auto-scaling policy setting that emphasized distribution prediction with cloud elasticity rules. The second one is distribution based admission controller to accept or reject queries depending on probabilistic service level agreements compliance objectives. Mixture density network (MDN) failed to construct prediction models at runtime.

A metaheuristic algorithm called L-ACO and heuristic ProLiS were introduced in [4]. For minimizing the execution cost of workflow in clouds under deadline limitations, ProLiS allocated deadline to every task with the probabilistic upward rank and followed two-step list scheduling. L-ACO utilized ant colony optimization to perform deadline-constrained cost optimization. The ant build ordered task list consistent with pheromone trail and probabilistic upward rank. But, it failed to consider the spot instance-based cloud services for workflow scheduling. In addition, it not considered the pricing dynamics and interruption caused with bidding failures.

II. Proposed Methodology

A. Jaccard Similarity Coefficient

JaccardSimilarity Coefficient is a term invented by Paul Jaccard, calculate the similarities between sets [5][6]. It is defined as the size of the intersection divided by the size of the union of two sets.Jaccard Coefficient, a statistic method used for comparing the similarity and diversity of sample sets. Jaccard similarity is computed using the following formula.

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

In our proposed work Jaccard Similarity is used for grouping the similar cloud services. Fig1 shows the example of Jaccard Coefficient Similarity.

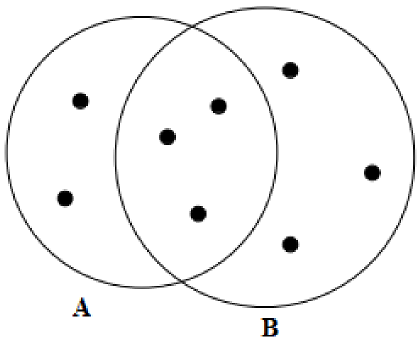

Fig 1: Two sets with Jaccard Similarity

B. GWO Optimization Algorithm

Grey wolf optimizer (GWO) is a latest updated intelligent optimization algorithm inspired by hunting behavior of grey wolves by Mirjalili et al. in 2014 [7]. Four types of grey wolves such as alpha, beta, delta, and omega are working for simulating the leadership hierarchy. In addition, three main steps of hunting, searching for prey, encircling prey, and attacking prey, are implemented to perform optimization. Fig 2 show the pseudo code for GWO algorithm.

- Initialize the grey wolf population Xi (i = 1, 2, ..., n)
- Initialize a, A, and C
- Calculate the fitness of each search agent
- X_α =the best search agent
- X_β =the second best search agent
- X_δ =the third best search agent
  - while (t < Max number of iterations)
    - for each search agent
      - Update the position of the current search agent by above equations
    - end for
    - Update a, A, and C C
    - Calculate the fitness of all search agents
    - Update X_α, X_β, and X_δ
    - t=t+1
  - end while
- return X_α

Fig 2:GWO Optimization Algorithm

C. GJCS-GWO optimization

The proposed algorithm starts with the traditional grey wolf optimization with Jaccard Coefficient Similarity. Initially in GJCS-GWO technique, Generalized Jaccard Coefficient Similarity Measure is used to find the similarity between the active user and other users in training data. The similarity measure presents the output either '0' or '1'. The similar cloud user service is taken as initial population for grey wolf optimization. The fitness value for all grey wolves are calculated based on the QoS properties (Delay, Throughput, Failure probability, energy consumption, etc). Based on the fitness value, the first three grey wolves rank are considered as the alpha, beta and delta. Then with help of these three values, the rank value of other grey wolves gets updated. This process gets repeated until it meets stopping criterion. By this way, the top ranked users cloud service gets predicted with minimal time consumption and higher accuracy. Experimental evaluation is carried out on factors such as prediction accuracy, prediction time and error rate with respect to number of historical cloud user service..

III. Experimental Analysis

The Cloud platform used in this paper is under windows operating system. Java cloud-simulator is used for implementing this ranking prediction model (GJCS-GWO). It provides data centers, virtual machines (VMs) and resource provisioning policies. The client side QoS properties are used for experimental analysis: throughput, response time and Latency.

Response time: The time taken by the cloud service provider to give response to the cloud user. It is measured in millisecond.

Throughput: Throughput is a measure of how many units of data can process in a particular time. It is measured in mbps.

Latency: The time interval between submitting a packet and arrival at its destination. It is measured in millisecond.

Table1 performance comparison by response time

Number of tasks	GJCS-GWO	[1]	[2]	[3]
1	334	672	642	578
2	349	685	648	589
3	358	687	656	599
4	372	691	672	602
5	379	693	678	607
6	392	699	702	609

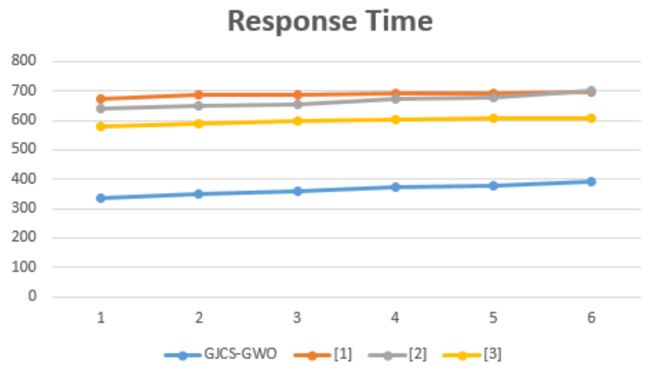

Fig 4 Response time chart

Table1 shows the average response time of various methods. Fig1 shows the response time chart. It shows that proposed Optimization method for QoS ranking prediction methods response quicker than the existing methods.

Table2 performance comparison by Throughput

Number of tasks	GJCS-GWO	[1]	[2]	[3]
1	292	302	309	352
2	296	356	333	357
3	296	390	338	359
4	299	450	340	370
5	300	472	342	393
6	302	500	345	400

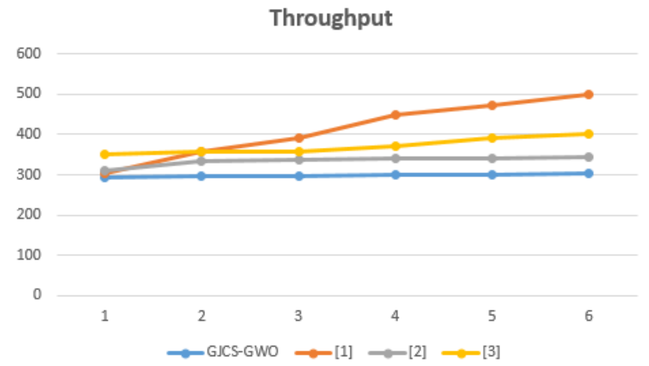

Fig 5 Throughput chart

Table 2 and fig 5 shows the result of QoS Throughput for GJCS-GWO Optimization Method for QoS Prediction. It shows that proposed Generalized Jaccard Coefficient Similarity based Grey Wolf Optimization for QoS Prediction method achieves higher throughput result than existing QoS Ranking Prediction methods.

Table3 performance comparison by latency

Number of tasks	GJCS-GWO	[1]	[2]	[3]
1	67	92	122	71
2	69	99	125	71
3	69	105	129	75
4	70	105	131	79
5	73	109	133	82
6	75	111	133	83

Table 3 and fig 6 shows the result of average latency for the proposed QoS Prediction and Optimization. It shows that Grey Wolf Optimization reduces the average latency rate.

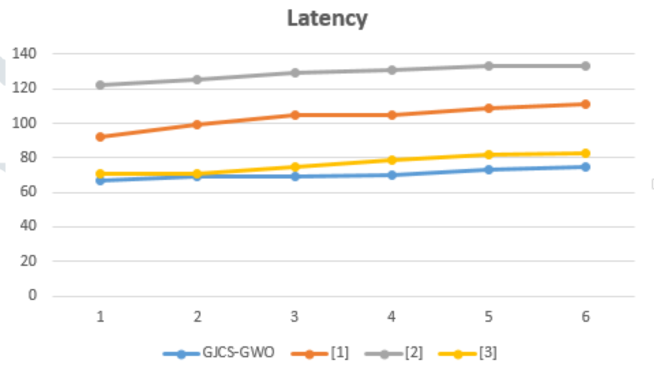

Fig 6 Latency chart

IV. CONCLUSION

Nowadays cloud service is gaining popularity. Cloud is providing shared pools of configurable computer resources over the Internet. The QOS is a very important topic in cloud service. It is already seen through the literature survey there are still several drawbacks in the cloud service ranking prediction. Two main methods are used in the proposed work. First, Jaccard Similarity Coefficientmethod is used to select the similar cloud services. Secondly, the B. GWO Optimization Algorithm is used to select the optimal rank, improve the accuracy, prediction speed and decrease the error rate. Our experimental results are based on response time throughput and latency. The system we proposed provides less error rate and more optimal ranking prediction.

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