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A QoS-Oriented Novel Optimization Schemes for Web Service Composition for Improved Healthcare

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Abstract*: Due to massive increase in Web service in order to provide users an improved service it is necessary to develop a dynamic approach based on multi constraint Quality-of-Service (QoS) driven web service composition model to recommend suitable services to intended users is a big challenge. QoS plays a prominent role in selecting a Web Service. QoS is mainly determined by several non-functional parameters like availability, reliability, robustness, integrity, accessibility, interoperability, accuracy and security. It is evidenced based on experimentation that the proposed Improved Rider Optimization scheme achieves near optimal solution where group of riders racing towards a target location and attains adaptability and scalability by making a more confident web service selection with QoS prediction.

Keywords: Web service recommendation, QoS prediction, Rider Optimization Algorithm (ROA)

I. INTRODUCTION

W3C defines a web service as a self-describing software system designed to support interoperable machine interaction over a network (W3C, 2004) by remote invocations. Such distributed system with service orientations finds its usage in Health care systems, E-Commerce, Multimedia Services, Financial Services, automotive systems E-Learning etc[1]. In Service oriented architectures QoS based Web service discovery plays an important role almost all applications require most accurate services. During the past years it has been observed that to involve and deliberate on their own business activity many enterprises outsourced potential services or same web service may provide link to lots of atomic services for a given task which makes it composite. Therefore enormous increases in web services are offered and user requires only certain services of their choice with certain conditions.

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QoS [2] is a vital factor for selecting an optimal service among list of services for a user. Situation may arise where multiple services may provide similar functionality. So a requester can have a request with some specific quality aspects like performance, reliability, reputation, response time, scalability, execution time, throughput, availability, etc. The prime aim of optimization is to maximize the outcome under certain required conditions. Due to its problem complexity the traditional optimization algorithms needs higher computational cost. According to No Free Lunch theorem [3] there exists no universal algorithms which can solve all real-world optimization problems.

LITERATURE SURVEY

Bio inspired algorithms are one among the prime mechanisms which are used to solve the modern-day problems of high complexity. Prime bio inspired algorithms are ant Colony Optimization [4] that uses the behavior of ant which searches for its food. Likewise, artificial bee Colony Optimization [5] also utilizes Bee's forging behavior. Simulated annealing[6] is a physics-based Optimization algorithm, differential evolution[7] and genetic algorithms [8] are the famous algorithms that are based on evolutionary behavior. Other algorithms like particle Swarm Optimization algorithm[9] based on swarming behavior have also been proposed. Such algorithms use the Swarm behavior of the particles and find the optimal solution. Under swarm search optimization algorithms are the bat algorithm which mimics the hunting behavior of the bat[10], Cuckoo search algorithm [11] and krill heard algorithm[12].

The ROA is a unique optimization algorithm, [13] which contemplates a few rider groups and can achieve global optimal solutions by speeding up the convergence rate.

The steps in ROA are as follows:
(i) Group and rider parameter initialization (ii) Identification of success rate (iii) Identification of leading rider (iv) Position update of Rider (v) Identification of success rate (vi) Rider parameter updating (vii) Riding off time.

RIDER OPTIMIZATION ALGORITHM

Rider Optimization algorithm is an imagination-based algorithm which has a group of Riders who ride in a coordinated manner with each other towards target. The best Raider is declared to be the winner. The groups of Riders are split into four groups

1. **Bypass Riders:** these Riders try to achieve the target without following the leading Rider or leading path.
2. **Follower:** These followers are the ones who follow the leading Riders.
3. **Overtaker:** this group of Riders use the location of the leading Rider, but they follow their own position to acquire the target
4. **Attacker:** they are the aggressive group, who utilize maximum speed to acquire the target.

The total population of the riders R are divided into the above mentioned four groups. Q is defined as the number of dimensions. X^t denotes each individual Rider at time t.

$$X^t = \{X^t(i,j)\};\ 1 \le i \le R;\ 1 \le j \le Q \quad (1)$$

B, F, O, A are used to denote the four group of Riders such as Bypass Riders, Followers, Overtaker and Attacker respectively.

$$R = B + F + O + A \quad (2)$$

The total number of riders are divided into four groups where the first quarter are the bypass Riders, second quarter comprises of followers the third quarter are over takers and the final quarter are the attackers.

The four main parameters that control these group of Riders are break (K), gear (E) , acceleration (e) and steering angle (T).

Each of these parameters are initialized as follows:

$$Tt = \{T^t_{i,j}\};\ 1 \le i \le R;\ 1 \le j \le Q \quad (3)$$

$$E = \{E_i\};\ 1 \le i \le R \quad (4)$$

$$e = \{e_i\};\ 1 \le i \le R \quad (5)$$

$$K = \{K_i\};\ 1 \le i \le R \quad (6)$$

After initialization the success rate of each Rider is calculated using the reciprocal of the distance in between the current Rider and position of the target.

$$ri = \frac{1}{\|Xi - LT\|} \quad (7)$$

The leading Rider is fixed dynamically based on the given success rate. The position update of each group of the riders is done separately with different methods according to their capacity.

Bypass rider update:

The Eqn.8 introduces high randomness with parameters such as δ and β a random number between [0,1] where β has Q dimensions, η and ξ which selects a random number between 1 and R.

$$X^B_{t+1}(i,j) = \delta[X_t(\eta,j) * \beta(j) + X_t(\xi,j) * [1 - \beta(j)]] \quad (8)$$

Follower update:

The Eqn.9 updates the follower's position based on the position of the leading rider. Where, k is the coordinate selector. L is the index of the leading rider and X^L is the leading rider's position. The variable $T^t_{i,k}$ is the steering angle and d^t_i denotes the remaining distance that has to be travelled by the i^{th} rider.

$$X^F_{t+1}(i,k) = X^L(L,k) + [\cos(T^t_{i,k}) * X^L(L,k) * d^t_i] \quad (9)$$

The variable d can be measured using the Eqn.10, where v^t_i denotes the velocity and T_{OFF} is the maximum number of iterations

$$d^t_i = v^t_i * (1/T_{OFF}) \quad (10)$$

The velocity is calculated as the below equation where V^i_{max} is the top speed.

$$v^t_i = \frac{1}{3}[E^t_i * V^E_i + V^i_{max} * e^t_i + (1 - K^t_i) * V^i_{max}] \quad (11)$$

The coordinate selector K is selected based on the P^t_{ON} on-time probability.

$$P^t_{ON} = (t/T_{OFF}) * Q \quad (12)$$

The coordinate selector is given by the Eqn.13

$$k << \{(j * P^t_{ON});\ if\ (j * P^t_{on}) < Q\ \forall j \quad (13)$$

Overtaker update:

The overtaker position is updated based on the following factors k, the coordinate selector and $D^I_t(i)$, the direction indicator, which is again based on relative success rate $S^R_t(i)$

$$X^O_{t+1}(i,k) = X_t(i,k) + [D^I_t(i) * X^L(L,k)] \quad (14)$$

The value of the relative success rate is between the range [0,1] which is based on the success rate $r_t(i)$

$$S^R_t(i) = r_t(i)/max^R_{i=1} = r_t(i) \quad (15)$$

The coordinate selector k for the overtaker is given by following equation where, $l(i,j)$ is the normalized distance vector.

$$k << \{j;\ if\ l(i,j) < \mu_i\ \forall j \quad (16)$$

The normalized distance vector is calculated using the Eqn.17 which is given below.

$$l(i,j) = |X_t(i,j) - X^L(L,j)| \quad (17)$$

Attacker update:

The update equation is mostly similar to that of the follower equation but also updates all the values in the coordinate.

$$X^A_{t+1}(i,j) = X^L(L,j) + \left[cos\&\left(T^t_{i,j}\right) * X^L(L,j)\right] + d^t_i \quad (18)$$

Once the positions of the riders are updated, the success rate and the other parameters are re-initialized based on the current position of the riders.

GREY WOLF OPTIMIZATION ALGORITHM

Grey wolf Optimization algorithm [14] is one among the nature inspired algorithm based on the hunting behavior of the grey wolves.

Algorithm 1: pseudocode for ROA

```
Input: Random Rider Positions initialization X_t
Output: leading rider X^L
Initialize rider population
Rider parameter initialization Steering angle T, brake k,
 accelerator e, Gear E
Calculate success rate r_t
while t < T_OFF
 for each particle in R
     Bypass rider position update (Eq.8)
     Follower position update (Eq.9)
     Overtaker position update (Eq.14)
     Attacker position update (Eq.18)
     Rank based on success rate r_t
     Assign max rider r_t as leading rider
     Update rider parameters
     Return X^L
     t= t+1
 end for
end while
```

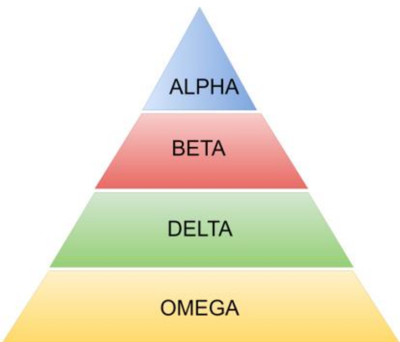

Fig. 1 hierarchy in GWO

The grey wolves are one among the pack which follow strict hierarchy among them. The Alpha wolves sit on top of Hierarchy while beta and delta are next to Alpha in the respective order. These wolves encircle the Prey and hunt them down. The main advantage of this algorithm is the usage of Alpha, Beta and delta positioned wolves, for improving the guidance of the other solutions and encircling mechanism to hunt the target. On using the average of these three solutions there is a high chance to avoid getting stuck in the local minima.

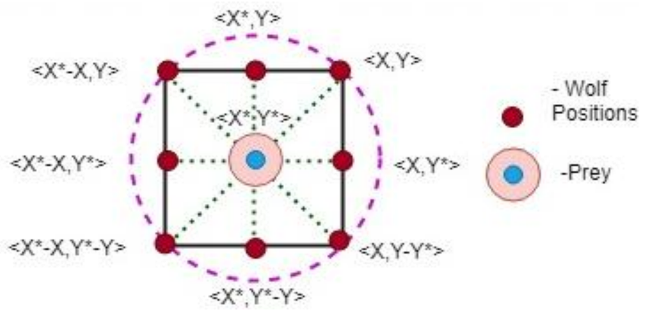

Fig. 2 Encircling in GWO

The update equation of the grey wolf algorithms is given as follows:

$$\vec{X_1} = \vec{X_\alpha} - \vec{B_1} * (\vec{D_\alpha}), \vec{X_2} = \vec{X_\beta} - \vec{B_2} * (\vec{D_\beta}), \vec{X_3} = \vec{X_\delta} - \vec{B_3} * (\vec{D_\delta}) \quad (20)$$

$$\vec{X}(t+1) = \frac{\vec{X_1} + \vec{X_2} + \vec{X_3}}{3} \quad (21)$$

$$\vec{D_\alpha} = \|\vec{G_1} * \vec{X_\alpha} - \vec{X}\|, \vec{D_\beta} = \|\vec{G_2} * \vec{X_\beta} - \vec{X}\|, \vec{D_\delta} = \|\vec{G_3} * \vec{X_\delta} - \vec{X}\| \quad (22)$$

The variable X denotes the position of the solutions or wolves and D denotes the distance, thus the distance for Alpha, Beta and the gamma wolves are calculated using the Eqn.22. Using the distance the new positions and their average is calculated using the Eqn.20 and Eqn.21.

APPROACH DESCRIPTION:

From the above grey wolf algorithm, the proposed work adopts the Alpha Beta and Delta guidance mechanism of the grey Wolf is adopted and deployed in the Rider Optimization Algorithm. Instead of using a single Rider as the target position, the proposed algorithm uses the average of the three best Riders as the target XL in Eqn. 22 and the others steer with respect to the averaged target location. This modification leads the rider Optimization algorithm in local minima avoidance and finding out various potential areas to find out the solution.

$$X^L(t+1) = \frac{X^L_\alpha + X^L_\beta + X^L_\delta}{3} \quad (22)$$

II. PROBLEM DESCRIPTION

Internet and Web based solutions provide Patient Centric [15] form of new Era. Thus, technologies improve medication reminders to take medicines, fixing appointment, understanding the stages of diabetes etc. hence it leads to several convenient online services which links service providers and patients. The amount of sugar in the blood is controlled by insulin which is a hormone produced by a gland which is behind stomach called pancreas. When food digested unites to blood stream insulin moves glucose out of the blood into cells, where it is broken down in order to produce energy. Identifying a QoS optimal web service selection is an optimization problem. QoS is an indispensable criterion for finding an optimal web service among the list of services.

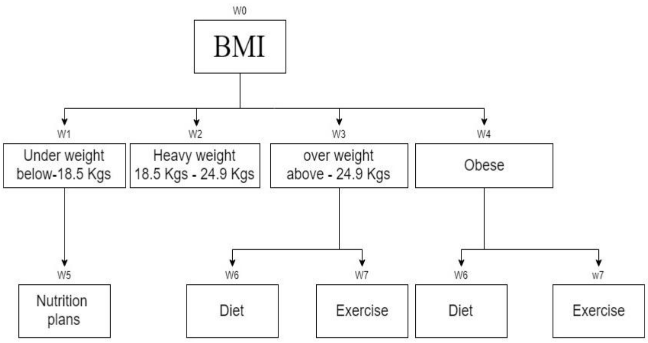

Fig. 3 Web Services

Body Mass Index is used by the medical career to rapidly and simply determine a person's weight with respect to their height. The various BMI of 25 to 29.9 is called overweight, or BMI of 30-39.9 influenced and affected by obesity those with severe obesity of more than 40 BMI. A highly common QoS prediction problem of web service recommendation for diabetes prediction and type was conducted and validated.

BMI	MEANING
Below 18.5	Underweight
18.5 to 24.9	Healthy weight
25 to 29.9	Above ideal range
30 and above	Obese

III. AN OPTIMIZATION PROBLEM

The composite service is a set of web services that are combined to attain one abstract service. In the given application of Healthcare there are three possible ways of execution to attain the available composite services which are given below in the figure 4. For the health care application in this work the EWS data set with the nonfunctional Qos parameters are used.

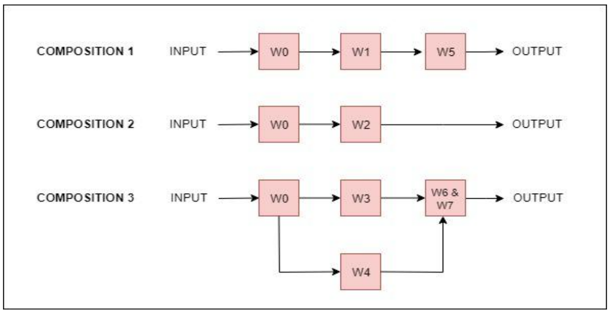

Fig. 4 Possible combination of Web Services

QoS are parameters of two types, which are the maximum parameters and the minimum parameters. The max parameters (speed) must be high in number and the min parameters (cost) which requisite to be low in numbers. All the parameters are normalized such that their values are amid the range 0 to 1. According to the formulation of the objective function whether to find minimum or maximum one of the two parameters are kept constant and the other parameter is inverted within the range. Thus, the total cost can be calculated just by adding all the parameters along with their weights

The fitness function is given in the below eqn.

$$C = \sum_{i=1}^{n} K_i * W_i \tag{23}$$

Where W defines web service and K defines its respective weight. The proposed algorithm is tested against the existing algorithms.

IV. RESULTS AND DESCRIPTION

The proposed algorithm is compared with the existing algorithm with the metric of the least cost. The experimentation is carried out in three phases for the three possible compositions respectively. The convergence curve of the algorithms are also given to analyses the behavior of the algorithm

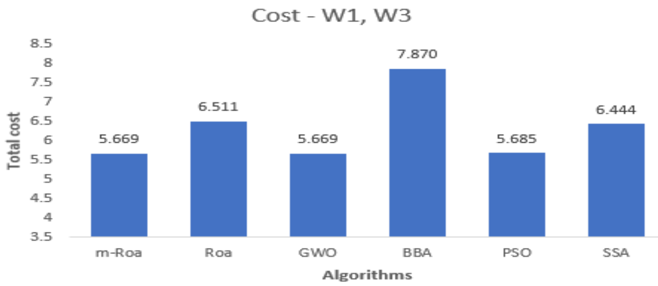

Fig. 5 Cost of Composition 1 – Comparison

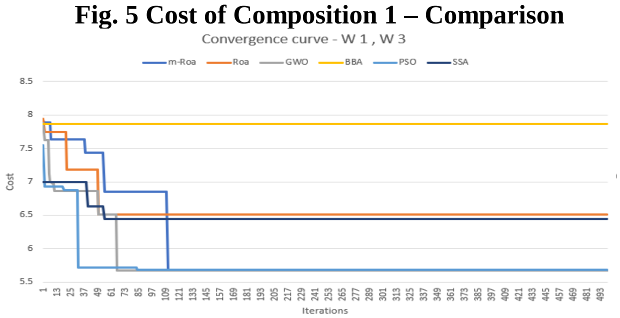

Fig. 6 Convergence Curve Comparison for cost of Composition 1

Given the needed services, the algorithm could find the optimal web services with the minimal cost as per the given weights, In this health care application all the weights are considered to be 1.

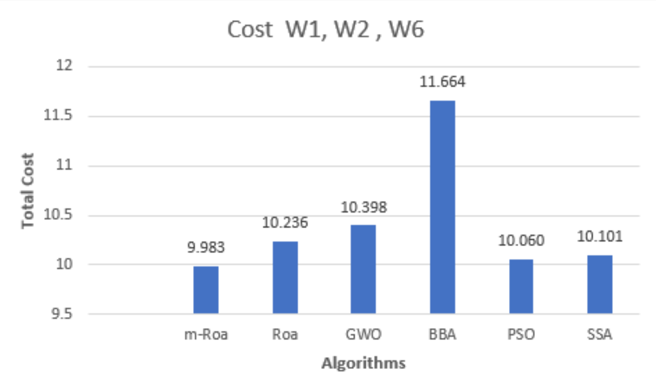

Fig. 7 Cost Of Composition 2- Comparison

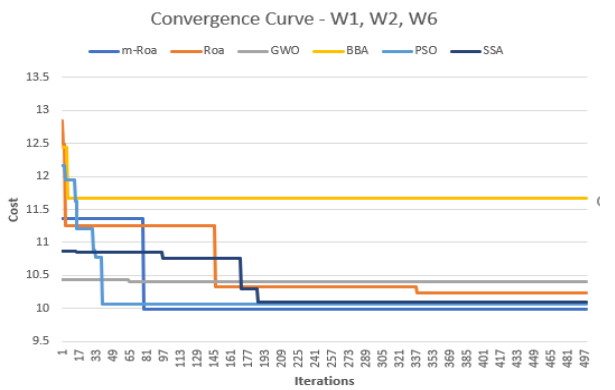

Fig. 8 Convergence Curve Comparison for cost of Composition 2

In Fig. 5 and Fig. 6 the cost of the composition 1 [W1 and W3] obtained by the proposed algorithm with the existing approaches are being compared. Likewise in the figures 7 and 8 the cost of composition 2 [W1, W2 and W6] and the respective convergence curve are shown.

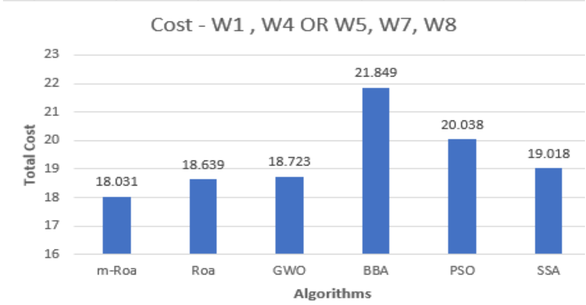

Fig. 9 Cost of Composition 3- Comparison

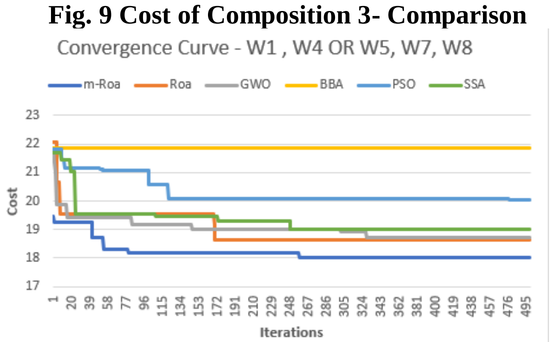

Fig. 10 Convergence Curve Comparison for cost of Composition 3

The Fig. 9 and Fig. 10 provide the comparison and the convergence curve for the Compostion 3 [W1,W4 Or W5, W7 and W8]. From all the above illustrative diagrams we could observe the better performance of the proposed algorithm. The proposed modified RoA algorithm outbeats all the other existing algorithms in all the three cases. From the given convergance curve, the well balanced exploratory and the exploitation behaviour of the proposed algorithm is clearly visible. The overall comparison for all the three compositions are shown in the graph.

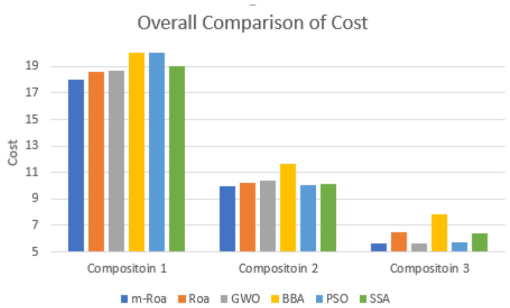

Fig. 11 Overall Cost comparison

V. CONCLUSION

This research presents an application of ROA for addressing QoS driven web service composition for health care. It is also evident that the proposed modified ROA outperforms the existing approaches with the least cost than the other algorithms. The proposed algorithm is capable of finding the best services on all the possible composite services. Even though web-services are massive in existence this approach has a better yield towards promising scalability and adaptability.

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