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# AN INTELLIGENT WATER DROPS ALGORITHM BASED SERVICE SELECTION AND COMPOSITION IN SERVICE ORIENTED ARCHITECTURE

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**ABSTRACT**

Web services are defined as the pieces of software components, which are distributed over the internet using some standard protocols. With more and more web services become available, QoS is a decisive factor for selecting the most suitable service from a set of candidate services with the identical functionality. Thus the approach about the computation of the QoS is also becoming more important in the service selection. In this paper, we use an algorithm called “Intelligent Water Drops” or IWD algorithm which is inspired from natural science. It is based on the processes that happen in the natural river system. The actions and reactions that take place between the water drops are also considered. The river often chooses an optimal path regarding the conditions of its surroundings to get its ultimate goal, which is often a sea. These ideas are embedded into the web service selection and composition for providing efficient QoS web services. This proposed algorithm provides better computing performance than Particle swarm optimization algorithm (PSO).

**Keywords:** *Computation, IWD algorithm, PSO algorithm, QoS.*

## 1. INTRODUCTION

A service is a sequence of activities of more or less intangible nature that normally take place interaction between customer and service system of the service provider, which are provided as solution to the customer problems.[1].A service provider offers the service and a service consumer utilizes the service in service oriented architecture[2].

Web service is typically a web application programming interface that is accessed via HTTP and executed on a remote system, hosting the requested services, composing atomic web services to provide the value added service. Web service composition attracts wide spread concern, because more and more organization provide their business in the form of web service.

The service oriented architecture consists of service provider and service consumer. The service provider provides the service to the user. And the service consumer utilizes service.

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### 1.1 Architecture of Web Services

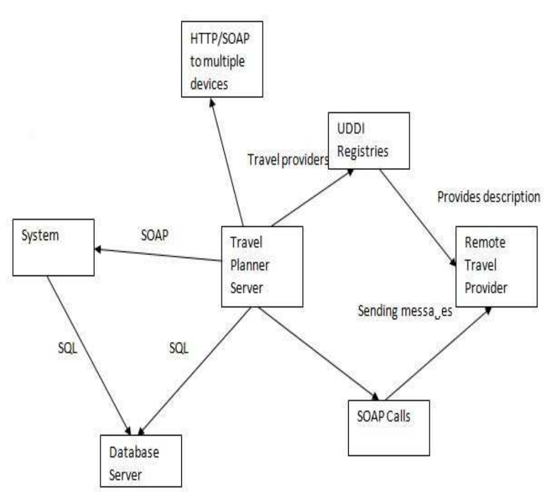


*Figure 1: Architecture of web services based travel planner.*

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Figure 1 provides an outline of this web service architecture. The travel planner is comprised of an application server, database server and interface devices. The travel planner can directly communicate with the database via SQL. The travel planner provides customer profile management, that maintains a copy of available providers travel services, items (flights, cars, hotel rooms etc) and package deal information and travel bookings made. Remote travel providers are located using UDDI registries, which provide a description of the remote web services. The travel planner application server communicates via SOAP messages with located provider web services via interface adaptors to obtain copies of travel items, to place bookings and to confirm bookings. The remote providers can send messages back to the travel planner asynchronously., for example Requested booking not longer available, quote about to expire etc[3].A series of tasks are tied together to form a composite web service. Such composition is a challenging task because a number of Web services with the same or similar functions are increasing rapidly. QoS plays a vital role in the problem of selecting the most appropriate web service for composition. It is a measure for how well the composite web service serves the requester. Intelligent water drops (IWD) algorithm can be used to resolve this problem of optimal service selection.

### 1.2 Web Service Selection and Composition

In a Composed web service, in addition to QoS of individual services, the overall aggregate QoS of the composite service should also be considered. Web service selection is the selection of particular web service based on the QoS factors.

Service composition involves the development of customized services often by discovering, integrating and executing existing services. It is not only about consuming services, but also about providing services.

Web service composition framework is in high level abstraction, without considering a particular language, algorithm used in composition process. A web service can be accessed in a transparent way through messages by standard tools like SOAP, WSDL and UDDI.

Web service composition is gaining a considerable momentum as an approach to the effective integration of distributed, heterogeneous application.

The Web service composition framework can be viewed as a three step process:

- Composite Web service specification,
- Selection of component Web services,
- Execution of composite Web services.

A travel domain is considered, which integrate service components such as

- Flight reservation
- Hotel reservation
- Taxi reservation.

In travel domain, the clients want to reserve a trip including flight, taxi and car which has the effective and improved response time.

### 1.3 Non Functional Properties of Web Services

The non functional properties of a web service are basically classified into the following categories.
**Availability:** The availability of a service refers to the probability that the service is accessible.
**Execution Time:** The execution time of a service refers to the time span from the moment that service requester sent the request to the moment that the service executed result returned.
**Reliability:** The reliability of a service refers to the probability that the service returned the correct result to the user's request.
**Execution Price:** The price of service refers to the fee that the service requester needs to pay for using the service [4].

### 1.4 Web Service Composition Problem

Consider a travel plan application domain.
The travel may propose the following lists of activities:
The travel may be a holiday or a business assignment scheduled for a week. The traveler may possibly leave on any day.
Stay around some days in hotel.
Based on the distance from the airport to hotel, make a decision on whether by taxi to hotel.
This task is far trivial as it involves many services, including the booking of flights, hotels and cars and it requires a lot of co ordination among these services.
The traveler decides to schedule the travel plan through an agent using web services to have a better control of the budget.

## 2. RELATED WORK

The optimization problem of how to select the web service so that the overall QoS and cost

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requirements of the composition are satisfied is discussed by few researchers. In a heuristic approach to solve the QoS aware web service composition problem, backtracking algorithm is used and results are computed by a relaxed integer program. The proposed algorithm is extremely fast and lead to result that is very close to the optimal solution [5].

In a Meta heuristic framework for the Qos -aware composition problem, an approach provided coherent implementation of common Meta heuristic functionalities, such as the objective function, improved mutation. Three Meta heuristic algorithms namely Genetic algorithm, simulated annealing, Tabu search, that leverage these improved convergence behaviour compared to purely randomized Meta heuristic operators [6].

Ant Colony optimization have been mainly concerned with solving ordering problems. The computational study involves the multiple knapsack problems. The experiments with the ACO algorithm are connected with ordering problems such as traveling salesman problem. The Experimental results indicate the potential of the ACO approach for solving constrained subset problems. The various local heuristics, which can be used for constructing solutions and examine their influence on the performance of Ant system [7].

Adaptation of parameters and operators represent one of the recent important and promising areas of research in the evolutionary computations. The asymptotic convergence properties of the adaptive memetic algorithms are analyzed according to the classification. Empirical studies on representatives of adaptive memetic algorithm for different level using continuous benchmark problems point outs that global-level adaptive memetic algorithms exhibit better search performances [8].

The model of a web services is based on particle swarm to resolve dynamic web services selection with QoS global optimal in web services composition. It can select and bind the best suitable web services to meet their requirement of different users dynamically. The essence of the model is that the problem of dynamic web service selection [9].

The particle swarm optimization algorithm is used to solve the complex combinatorial optimization problems. Grouping particle swarm optimization can analyze user's gentle preference in web services. This algorithm is used for the particle clustering, and to improve the global search capability in web services and to avoid rapid convergence or premature. The Experimental results show that this algorithm can effectively improve the performance of service selection [10].

The IWD algorithm is proposed for solving the global optimum problem in various environments. The proposed IWD optimization algorithm is more effective and feasible for solving the air robot path planning problem. The experimental results show that the proposed IWD optimization algorithm can find the optimal path. This method provides a new way for path planning of air robot in exact application. The simulation experiments show that this proposed method is a feasible and effective way for solving this problem [11].

Works were carried using The Intelligent Water Drops (IWD) algorithm for solving vehicle routing problem (VRP). The IWD algorithm is a population based algorithm that imitates the flow of waters in river bank. Vehicle routing problem is an NP-hard combinatorial optimization problem in the field of transportation, seeking to serve a number of customers with a fleet of available vehicles. It is described a finding the minimum distance of the combined routes of a number of vehicles that must service a number of customers [12].

An Intelligent water drops (IWD) algorithm has been proposed to solve Economic Load Dispatch (ELD) problem with an objective of minimizing the total cost of generation. The primary goal of economic dispatch is to minimize total cost of generation while honoring operational constraints of available generation resources. The new approach is proposed to solve non smooth ELD problem with valve-point effect using the IWD algorithm. The feasibility of the proposed IWD algorithm for solving ELD problem is demonstrated using 6-unit thermal systems [13].

## 3. PARTICLE SWARM OPTIMIZATION ALGORITHM ON WEBSERVICE

Particle Swarm Optimization (PSO) algorithm can be used to resolve this problem of optimal service selection. It is the collection of particles that move around the search space.

In this algorithm, the parameters are initialized. And then calculation of fitness value is calculated based on quality factors such as availability, reliability, cost and execution time.The evolution only looks for the best solution.

All the particles tend to converge to the best solution quickly and then update the particle position and velocity. Figure 2 provides the steps of PSO algorithm. First, initialize all particles with random position and velocity vectors. For each particle's position, evaluate the fitness value. The

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calculation of local best value is based on the pbest value. The gBest is the global best value, which is the best value of pbest. And then update the particle's velocity and position. Finally, the gBest value is the optimal solution, which is used to retrieve the best web services.

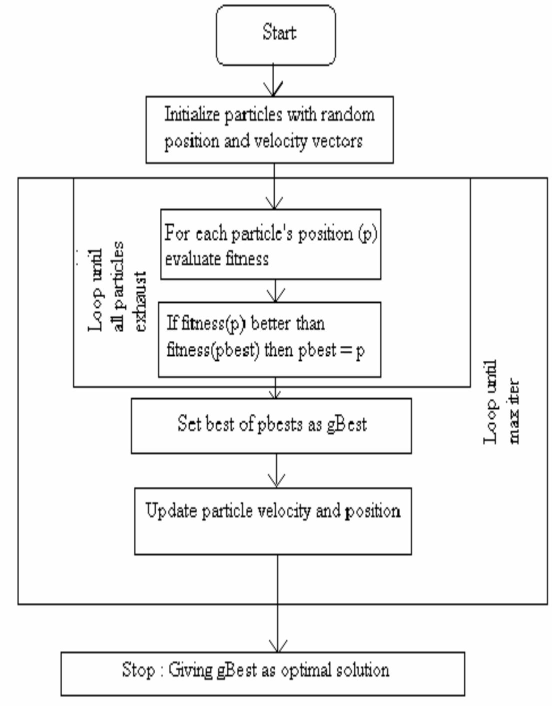


*Figure 2 PSO algorithm*

## 4. INTELLIGENT WATER DROPS ALGORITHM

It is very promising problem solving algorithm and it is improved to apply more engineering problems [14].

**Intelligent Water Drops** (IWD) algorithm is a best choice for finding optimal solutions. The soil and velocity IWD are also considered. A swarm of IWDs flows in the graph for finding optimal or near optimal solutions. Every IWD in this algorithm searches and changes its environment. IWD algorithm consists of two types of parameters:

- Static parameters
- Dynamic parameters

Static parameters are those that remain constant during the lifetime of the IWD algorithm. Dynamic parameters are reinitialized at the end of iteration of the IWD algorithm.

The IWD algorithm is specified in the following steps:

**Step 1:** Initialize soil updating parameters as=1,bs=0.01 and cs=1 and velocity updating parameters av=1,bv=0.01,cv=1. The quality of total best solution, $q(T^{TB}) = \infty$. The maximum number of iterations ($iter_{max}$) is specified by the particular user. And the iteration count ($iter_{count}$) is set to zero. The local soil updating parameter $\rho^{n}$=0.09, which is small positive number less than one. The global soil updating parameter $\rho^{IWD}$=0.9, which is chosen from [0, 1]. The initial soil on each path is denoted by initsoil and the initial velocity is denoted by initvel. Both parameters are selected by the user.

**Step 2:** Every IWD has visited node of list Vc (IWD), which is initially empty. The IWDs velocity is set to InitVel and the entire IWDs are set to have zero amount of soil.

**Step 3:** Spread the IWDs on the nodes of the graph and then update the visited nodes.

**Step 4:** Repeat Steps 5 to 8 for those IWDs with the partial solutions.

**Step 5:** For the IWD in node i, select the next node j, which doesn't violate any constraints of the problem and make certain it is not in the visited node list Vc (IWD). By using the following probability p (j)

$Pi^{IWD}(j) = f(soil(i, j)) / \sum f(soil(i, k))$

Such that,

$f(soil(i, j)) = 1/(€s + g(soil(i, j)))$

Where €s = 0.001 and $g(soil(i, j)) = soil(i, j)$

If min (soil (i, l)) >=0,

Else soil (i, l)-min (soil (i, l)).

And then add the recently visited node j to the list Vc (IWD).

**Step 6:** For every IWD from node i to node j, updating its velocity Vel(t) by

$Vel(t+1) = Vel(t) + (a_v / (b_v + c_v * soil^{2\alpha}(i, j))$

Where Vel (t+1) is the updated velocity of the IWD on the next node j.

**Step 7:** For the IWD moving on the path from node i to j calculate the Δ soil (i, j) that the IWD loads from the path by using the formula.

$\Delta soil(i, j) = (a_v / (b_v + c_v * time^2(i, j; Vel(t+1)))$

Such that time (i, j; vel (t+1)) = HUD (j) / Vel (t+1), here the heuristic undesirability HUD (j) is defined appropriately for this given problem.

**Step 8:** Update the soil (i, j) of the path from node i to j traversed by that IWD, and also update the soil that IWD carries $soil^{IWD}$ by

$soil(i, j) = (1 - \rho_n)\, soil(i, j) - \rho_n \Delta soil(i, j)$

$soil^{IWD} = soil^{IWD} + \Delta soil(i, j)$

**Step 9:** Find the iteration based best solution $T^{IB}$ from all the solutions $T^{IWD}$ found by the IWDs using

$T^{IB} = \arg\max q(T^{IWD})$. Where, function $q(T^{IWD})$ gives the quality of the solution.

**Step 10:** Update the soils on the paths that form the current iteration based best solution $T^{IB}$ by

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$soil(i, j) = (1+\rho_n)\ soil(i, j) - \rho_{IWD}\ soil^{IWD} / (N_{IB}-1)$ For every $T^{IB}$.
Where $N_{IB}$ is the number of nodes in solution $T^{IB}$.

**Step 11:** Update the total best solution $T^{TB}$ by the current iteration-best solution $T^{IB}$ using the following formula.
$T^{TB} = \{ T^{TB}$ if $q(T^{TB}) >= q(T^{IB})$, $T^{IB}$ otherwise.

**Step 12:** Increment the iteration number by one. $Iter_{count} = Iter_{count} + 1$
And then, go to step 2 if $Iter_{count} < Iter_{max}$.

**Step 13:** The algorithm stops with the total-best solution $T^{TB}$.
The total best solution is used to select the best web services.

### 4.1 Importance of IWD Algorithm

The following three reasons provide the necessity and importance of the IWD algorithm:

- It provides good quality solutions using average values.
- IWD algorithm has fast convergence when compared to other methods.
- It is also flexible in the dynamic environment and pop-up threats are easily incorporated.

IWD algorithm is applicable for more applications such as Vehicle Routing, Robot path planning, Travelling Salesman Problem (TSP).

## 5. EXPERIMENTAL RESULTS

The QoS-based service selection problem involved in service composition is, how to select one service for each involving task from its corresponding existing candidate service group, so that the overall QoS of the constructed composite service can be maximized. The values for QoS parameters are randomly chosen for the first time and updated on every single evaluation. For the evaluation process three abstract web services and four candidate web services for each web service are considered.

Figure 3 shows the full work flow of this paper. The most suitable web services will be retrieved from the database, based on the fitness value. Design of the database includes the values assigned for each parameters of the candidate web service. The parameters considered for evaluation are price, response time, availability and reliability.

Thus for each individual web service, the QoS vector is given as, **QoS(s) =<Qcost (s), Qresponse(s), Qavailability(s), Qreliability(s)>.** For the optimization problem, a composite web service of travel domain is considered.

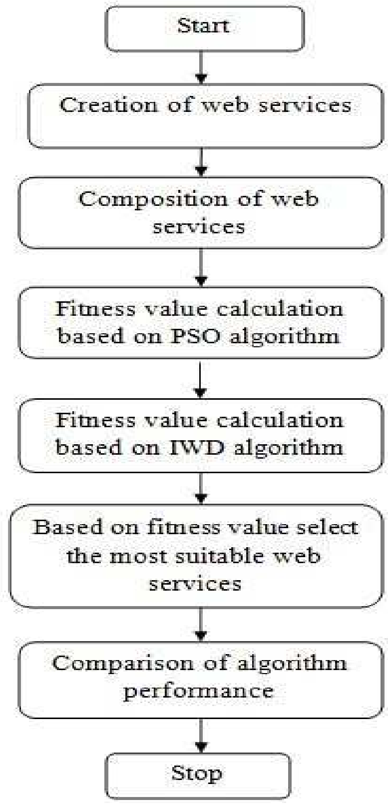


*Figure 3 Work Flow chart*

The abstract services are flight, hotel and Taxi booking services. Each of these services consists of four candidate services. Therefore, 64 combinations are available for selection. The objective relies in finding the best service among these 64 combinations by the use of optimization algorithm, calculating the fitness value. The PSO algorithm initializes a group of random particles, and then finds the optimal solution through iteration. The particles update their extreme values in iteration. The services will be retrieved based on global best value. In IWD algorithm, the final fitness value is the optimal value to provide the good solution to the given problem. The experimental results show that the IWD method is a feasible and effective way to find the optimal solution to the problem.

### Comparison between PSO and IWD Algorithm

The experiment validates the validity of the algorithm by means of executive time of this algorithm. The PSO algorithm spends more time for retrieving the best web services, when compared to IWD algorithm. The IWD algorithm spends less time and it reaches the required time of

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QoS index of the optimal solution. This algorithm can provide the best quality service to users.

The execution time for PSO algorithm is 23,687 milliseconds and 8,768 milliseconds for IWD algorithm.

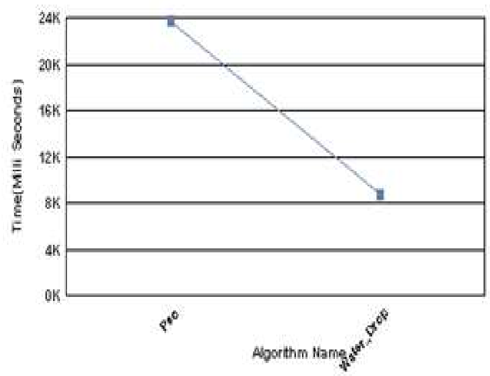


*Figure 4.a Performance Comparison using graph.*

Figure 4.a represents the performance comparison of PSO and IWD algorithm using graph. Figure 4.b represents the performance comparison of PSO and IWD algorithm using bar chart. Based on the execution time, the graph and bar chart are plotted in the web service selection.

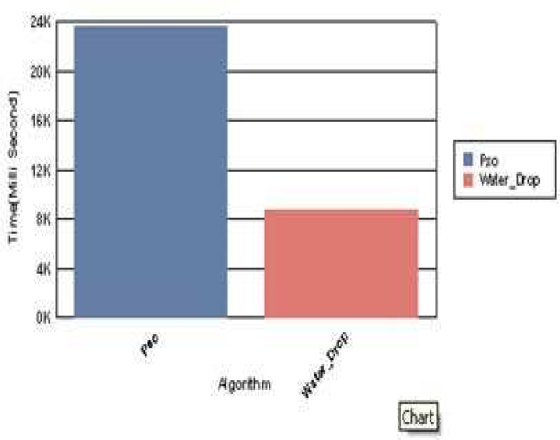


*Figure 4.b Performance Comparison using bar chart*

## 6. CONCLUSION

With the increasing of the number of web services, it is necessary to solve the problem of service selection of meeting users need in the web service composition .Web services composition is a new software development paradigm, and it is a key point to achieve service oriented computing currently. For meeting the QoS requirements of consumers, In order to solve services composition, PSO algorithm and Intelligent Water Drops Algorithm are used. To verify the best web service decomposition algorithm, these above two PSO and IWD are compared. The experimental comparison result shows that, the Intelligent Water Drops Algorithm is the best algorithm for web service composition. From that, the IWD algorithm having the higher correctness value, feasibility, and effectiveness than the existing PSO algorithm. Computational overhead for service composition with more than 50 services is left behind for future work.

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