A SURVEY ON EFFICIENT EVOLUTIONARY ALGORITHMS FOR WEB SERVICE SELECTION

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Summary

The web service selection mechanism plays an essential role in service composition; because most of the business applicants are in a situation to share their information's through online in a composite manner. Everyday the importance of web services is more. Based on the customer requirements the copious services are created and published as web services. The selection of an optimal service turns out to be an NP-hard problem. Inoder to tackle the NP-hard problem, we applied Efficient Evolutionary Algorithms (EEAs). It is the most powerful evolutionary algorithm to tackle the real world optimization problems. Since it achieves a tremendous success by making use of the random decisions in different modules. The applications of EA's are computational biology, Engineering, logistics and telecommunications. The EEA's are Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Bee Algorithm (BA) and Firefly Algorithm (FA), Shuffled Frog Leaping Algorithm (SFLA), Memetic algorithm etc., works effectively on optimization problems. The four most efficient algorithms such as GA, PSO, and SFLA, MA are taken and compared the various quality of each algorithm in order to provide an efficient service.

Keywords: *Efficient Evolutionary algorithms; Genetic algorithm; Particle swarm optimization algorithm; Memetic algorithm; Shuffled frog leaping algorithm; Web Service Selection*

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1. Introduction

The Web service selection mechanism is the process of selecting single or composite services. The selection mechanism utilizes the service framework and service classes from the other related service. Under the user requirements, the services with same functional characteristics and different non-functional characteristics are combined to make the optimal performance [1].

The composition of web services consisting of many atomic web services, while selecting, the services has to address multiple service providers. In order to provide the seamless service from the encapsulated services an efficient selection mechanism is required. The optimization models can reach the optimum solution, optimizing real life problems is a challenging task, because of their big domain. Finding exact solutions to these problems turn out to be NP-hard problem with large number of services.

By using mathematical programming approaches such as, integer programming, linear programming, dynamic programming techniques the optimum solutions can be reached, but this techniques does not met near optimal solutions. To overcome these problems, researchers have proposed EEAs for searching near optimum solutions to the WSS problems [2], [3], [4].

The remainder of this paper organized as follows: In section II the related work discuss about the evolutionary algorithm and application of PSO and GA for WSS, the difficulties are overcomes and we suggest that efficiency of SFLA and MA are suitable for WSS, the reasons, characteristics and application s of both the EAs are discussed. In section III. Comparisons between the four EEAs are discussed based on WSS. In section IV. The procedures for WSS using the four EEAs are shown. In section 5 conclusion and future works are discussed.

2. Related work

2.1 Evolutionary algorithm

Evolutionary algorithms are stochastic search methods that mimic the natural and social behavior of animals and species. The advantages over evolutionary algorithms are, it is robust and easy to use as a global optimization method. They work on a set of solutions at a time instead of a single solution and thus facilitate them to search the whole space of the problem [5].

The main difference between evolutionary algorithms and other optimization algorithms are EA's work at each step with a set of solutions called population. This population produces a set of solutions called the offspring by doing an evolution process called crossover and mutation. A new population is created by selecting the individuals from parent and offspring population as a result of fitness function. In each search it produces a positive probability; the positive result can be continued in the next process depending upon the current solution and the neighborhood search process. In complex optimization problem EA seems to b a good heuristic approach to obtain optimal results

2.2 GA for WSS

The evolutionary based GA was introduced by J.Holland in 1975 for optimization problem [6]. It was developed based on the Darwinian principle of the 'survival of the fittest' and the natural process of evolution through reproduction. It has the ability to reach near optimum solution for large problems. Despite their benefits, it takes long processing time to reach the near optimum solution [7].

GA was applied to WSS problem, due to the weakness of prematurity; it falls into the local minima. The relation matrix coding is presented; it is based on the characters of the web service selection. It can simultaneously represent all the paths of the service selection, re-planning and cyclic paths. The web service composition has many scenarios such as probabilistic invocation, sequential activation and so on. The relation matrix coding scheme can not express all the scenarios at a time. So the diversity control with Simulated Annealing [SA] was applied to improve the local minima problem by holding the diverse factors among the individuals. It

presents the diversity of population between the current population and existing population based on fitness value [8].

In service selection, binary strings of chromosome were proposed and every gene in the chromosome represented as candidates who provide service with values of 0 and 1.By increasing the genes, chromosomes also gets increased and thus gives more service candidate or web service clusters.

Gene expression makes difficult in representing the high dimensional classification [9]. It applies a modified GA called an immune algorithm. It results in higher priority with the higher fitness and lower priority with lower fitness of the individual. In order to calculate the selection probability a hamming distance is taken between the common individual and the one which has the best fitness value was used as a main criterion. This satisfies the global optimum without falls into local minima

In order to maintain the normal population diversity during the GA's operation a fuzzy controller is used to change the crossover as well as mutation rate by using population diversity measurements.

2.3 PSO for WSS

PSO was developed by Kennedy and Eberhart in 1995[10]. It is inspired by the social behavior of flock of migrating birds trying to reach an unknown destination. Each bird looks in a specific direction, and then when communicating together, they identify the bird that is in the best location. Accordingly, each bird using speeds towards the best bird using a velocity [9]. PSO is the process of involving both intelligence and interaction as well does the local search efficiently by their intelligence.

PSO was applied to WSS, it efficiently does the local search, but it takes more iteration time to do the global search. By applying the QoS scheduling algorithm it dynamically selects the composite service.

In PSO, the web service composition itself is carried in dynamic way to support the distributed systems. PSO satisfies the local optimization but it is hard to express the robustness because if its iteration ability. Inoder to reduce the iteration the operators such as crossover and

mutation of GA are mix with PSO for a better solution. Thus it estimates the best route to achieve QoS service and also provides the position and the velocity of the services [10].

2.4 MA for WSS

MA is a combination of EA with one or more local search technique within it evolutionary cycle. It has been more efficient and effective in finding higher quality solutions, while applying to different optimization problems [11]. Genes in GA are similar to memes; genes hold a set of values for optimization [7]. Memes automatically improves itself by holding the ideas or information. Memes represents it current position and compares with its objective function so as to improve its position towards goal [12].The embracing applications of MA are spacecraft trajectory design, frequency allocation, multiperiod network design, degree constrained minimum spanning tree, vehicle routing etc.,[13].

MA and GA both are EA's; GA has been applied to optimization and web service selection problems. The premature convergence of GA results in incapable of searching in a high dimensional domain [14]. MA is an extension of tradional GA; it reduces the premature convergence in local search itself. This method is widely used in the problems of combinatorial optimization

In the first step, MA generates an initial population of random solutions from that problem starts which is to be solved and improving these solutions through local search method. Then this problem is formulated in vectorial or chromosome representation. In second step, the fitness value for each of the chromosomes is derived so the solution is classified from best to worst based on the objective function and from the initial population the subset of the nsel best solutions is selected. In third step, the memetic algorithm applies the crossover and mutation operators are applied where exchanging the information's in the former solution and mutated. Then the local search procedure is applied in order to improve the obtained solution which is so called as child solution.

In final stage, the worst solution in population is improved by the child solution then this solution is replaced. [15] MA uses meta-heuristic strategy where the use of meta-heuristic allows us to obtain reasonably better solutions without having to take the whole solution space. The

crossover operator is the most essential element in the functioning of memetic algorithm. During search, the uniqueness between the highly suited (fitness) strings found. Thus the subset of similar strings is placed in a particular position as similarity template called schema. In parent chromosomes, the schemata's are hidden behind it. In order to extract them as an evolved population from the parent population efficiently the crossover operator is used.

Let s1 and s2 be The solutions from that the child solution s3 is derived where the crossover operator is works as a single point crossover so the crossover points are generated between 1 and m-1 or 0.The mutation operator helps to maintain the diversity. From each offspring, each of the elements can mutate which is in the probability . If a needed element is changed then the random value is generated in (0, 1) and if mutation is greater than the given value then change the elements. And this change makes selecting the new element which is not present in the solution.

2.5 SFLA for WSS

To select an optimal web service SFLA is applied. **S**FLA is a memetic–metaheuristic algorithm has been developed for solving combinatorial optimization problems [16]. SFLA contains the process of local search and global information exchange. The SFLA was proposed by Eusuff and Lansey in 2003[17]. The local search is completed using a PSO and global search using the Memetic algorithm. The application and benefits of SFLA in optimization problems such as: In general large scale water supply system it minimizes the total system cost [2]. In clustering problem, it gives the quality solution on various clusters [5]. In lot-streaming flow-shop scheduling problem it minimizes the weighted mean completion time and the weighted mean tardiness [18], [19], [20]. In bridge- deck problem it gives significant results on rehabilitation infrastructure [21].

SFLA is a hybrid algorithm. It combines the benefits of a gene based Memetic algorithm (MA) and social behavior based PSO.PSO is an evolutionary algorithm in which individual solutions are called Particle. It does not create gene or meme instead of that it follows the social behavior to reach the destination. The SFLA algorithm contains process of local search and global information exchange. The SFLA has the virtual population of frog's .From the population the random populations is selected and represent the set of solutions. Each frog is distributed to a

different subset of the whole population called memeplex.The memeplex evolution is carried out by doing the local search of independent memeplex.After the evolution the frogs are shuffled among the memeplexes.This shuffling process ensures that the frogs with the worst fitness can be improved to the best optimal position.

Local search and shuffling continues until the convergence criteria are met. It has proved its effectiveness in number of global optimization problems. Compared with the above optimization algorithms, experimental results in terms of possibility of convergence to a global optimal solution and the solution speed suggest that the SFLA can be an effective one.

The WSS problem can be solved by applying the SFLA. From a service set it selects the initial population randomly and divided into various service groups. Each service in the group can be represented as x_1, x_2, x_3…..x_n. SFLA performs local and global search, in local search it satisfy the QoS parameters such as accuracy and availability of the services by applying the fitness function. The randomly selected services are evaluated and sorted in the form of descending order. After a number of iterations of local search, the memetic evolution is carried out to determine the global optimal service. Shuffle the service groups inoder improve or eliminate the non qualified service based on the fitness function. Shuffling and local search continues until convergence to an optimum service id reached or a user defined services are obtained.

2. Comparison of GA, PSO, MA, SFLA for WSS

Table 1: GA, PSO, MA, AND SFLA FOR WSS

GA	***PSO***	***MA***	***SFLA***
-Introduced by J.Holland in 1975, based on Darwinian	-Introduced by Kennedy and Eberhart in 1995, based on social	-Introduced by Dawkins in 1980s, based on Principle of “Survival of	-Introduced by Eusuff and Lansey in 2003,based on “Idea

Principle, "Survival of the fittest"	behavior of "Flock of migrating birds"	the fittest and more experienced"	exchange between frogs"
-Services are represented as chromosomes	-Services are represented as particle	-Services are represented as memes	-Services are represented frogs
-Initial services are called genes	-Initial services are called swam	-Initial services are called genes	-Initial services are called memeplex
-Used to solve combinatorial optimization	-Used to solve continues non-linear optimization	-Used to solve combinatorial optimization	-Used to solve combinatorial optimization
-It can use the Simulated Annealing, Hill climbing for local search	-It use only it particles for local and global search	-It is the extension of GA,it can use the same for local search	-It uses MA for global and PSO for local search
-It falls into local minima, in WSS	-Iteration time is more in WSS	- It reduces the prematurity of GA in WSS	-It reduces both prematurity and iteration time in WSS

-Crossover and mutation makes an efficient selection.	-Swarm intelligence makes an efficient selection	-Crossover and mutation makes an efficient selection	Memetic evolution and shuffling makes an efficient selection

Procedure for WSS using GA

Step1: Generate random services of G (chromosomes)
Step2: Fitness to be evaluated for each service (i) to produce a best service: i-G.
Step3: Select a crossover or mutation operator randomly to improve a best service
Step4: select crossover operator to combine the best service with the worst one
Step5: Select mutation operator to improve the worst service itself.
Step5: Calculate fitness for each new service.
Step6: The new service is better than the initial service then replaces best one
Step7: Repeat steps 2, otherwise, stop.

Fig. 1 Procedure for WSS using GA

Fig.1 Depicts that from the random number of selected services, fitness is evaluated for each service, and then the crossover and mutation operator is used to generate a new service, again the fitness evaluation is carried out to eliminate or replace the best service. The GA for WSS was applied and the prematurity problem is eliminated by applying the simulated annealing technique.

Procedure for WSS using PSO

Step1: Generate random services of P (Particles)
Step2: Fitness to be evaluated for each service (i) to produce a best service: i-P.
Step3: Initialize the weight factor (f).
Step4: Select the service which provides the best route and compare with i.
Step5: Inoder to find the global best service, calculate the fitness each particle.
Ste65: Update the particle position towards the best service
Step7: The new particle provides better than the initial service, then update the weight factor (f)
Step8: otherwise, repeat step4

Figure 2. Procedure for WSS using PSO

Fig.2 Depicts that from the random number of services, fitness is calculated for each individual, the weight factor is initialized to update the best fitness value. Selected service is compared with the existing one if the service is best, then the best position is updated and also update the weight factor. The PSO was applied to WSS problem; the iteration time is more, to find the best service for every time. This problem was reduced by applying the QoS scheduling technique.

The EA's such as MA and SFLA are based on the GA and PSO. The MA is a hybrid or parallel algorithm; it has more experience in handling the optimization by literature.

Procedure for WSS using MA
Step 1: Generate random services of M (memes). *Step 2: Improve these solutions through local search.* *Step 3: Repeat the following steps:* *(a) Select the subset of nsel elements of the population with the highest fitness value.* *(b) Cross reproduction: cross a pair of these parent solutions to derive the new child solutions. From each pair of parent a new pair of child solutions is generated.* *(c) Mutation: the child solutions can change some of their elements with a small probability of p_mut.* *(d) Improve child solutions with local search.* *(e) Population replacement: substitute the worst solutions of the population with the new child solutions.* *Until reaching a number of n_iter iterations.* *Step 4: Choose the highest fitness value solution as the final solution.*

Fig.3 Procedure for WSS using MA

Fig. 3 Depicts that, the prematurity problem is solved in the local search itself, after that to reach the global solution the cross reproduction and mutation is carried out. The worst solutions are replaced with the new solution. MA shows it effectiveness in local search itself. The MA is more experienced than GA. So the problems in GA are eliminated and it can provides good decisions on optimization problems. Based on the performance and experience of MA, we suggest that it can be applied for WSS problem

Procedure for WSS using SFLA
Step1: Generate random services of S solutions (i frogs) *Step2: For each individual i- S: calculate fitness (i)* *Step3: Sort the services S in descending order of their fitness* *Step4: Divide S into m service groups;* *Step5: For each service group, find the best and worst service;* *Step6: Improve the worst service by combine with best service* *Step6: Repeat for a specific number of iterations* *Step7: Combine the evolved service groups;* *Step8: Again Sort the services S P in descending order of their fitness;* *Step9: repeat step5, otherwise eliminate the worst service.*

Fig. 4 Procedure for WSS using SFLA

Fig. 4 Depicts that, the hybrid approach of SFLA (i.e.) the PSO and MA can definitely gives good results comparing with the other algorithms. The MA is referred as genetically more experienced algorithms. The embracing applications in optimization problem results more efficient and accurate. According to literature, we suggest that SFLA is a most experienced evolutionary algorithm for WSS.

3. Conclusion and Future work

In this paper, four evolutionary algorithms were presented. These include GA, PSO, MA and SFLA. The benefits and efficiency of the all the algorithms are shows that those algorithms Efficient Evolutionary algorithms (EEAs) for solving the Web Service selection (WSS) Problems. Inorder to select an optimal service based on various quality factors, these more experienced algorithms are much suitable. The evolutionary algorithms have been successfully applied in this a paper, large optimization problems takes more computational time especially with GA and PSO, those algorithms can be integrated with many local search algorithms like Simulated Annealing, Hill climbing, fuzzy controller and decision making algorithms. Many Evolutionary algorithms can works efficiently on WSS those algorithms are founded and applied for future work.

References

[1] Xiao-Qin Fan,Xian-Wen Fang,Chang-Jun Jiang, "Research on Web Service Selection based on cooperative evolution", An International journal on Expert Systems and Applications, vol.38, Issue.8, pp.9736-9743, 2011.

[2] E. Elbeltagi, "Evolutionary Algorithms for Large Scale Optimization in Construction Management", The Future Trends in the Project Management, Riyadh, KSA, pp.7-11, April 2007.

[3] Ping Wang, Kuo-Ming Chao, Chi-Chun Lo, "On optimal decision for QoS-aware composite service selection ", An International Journal on Expert Systems with Applications, vol. 37 , pp. 440–449, 2009.

[4] Vuong Xuan Tran, Hidekazu Tsuji, Ryosuk Masuda, "A new QoS ontology and its QoS-based ranking algorithm for Web services", Journal on Simulation Modeling Practice and Theory, vol.17, pp.1378-1398, 2009.

[5] Babak Amiri, Mohammaed Fathian, Ali Maroosi, "Application on shuffled frog-leaping algorithm on clustering", International Journal on Advanced Manufacturing and Technology, vol.45, pp.199-209, 2009.

[6] Poonam Garg, "A comparison between Memetic algorithm and Genetic algorithm for cryptanalysis of simplified Data Encryption standard algorithm", International Journal of Network security and its applications, vol.1, No.1, pp.34-42, 2009.

[7] Emad Elbeltagi, Tarek Hegazy, Donald Grierson, "Comparison among five evolutionary based optimization algorithms" Journal on Advanced Engineering Infomatics,Elsevier,vol.19,pp.43-53, 2005.

[8] Chengwen Zhang, Sen Su, Junliang Chen, "DiGA: Population diversity handling genetic algorithm for QoS-aware web services selection", Journal on Computer Communications, vol. 30, pp. 1082–1090, 2007.

[9] Cheng- San Yang, Li-Yeh Chuang, Chao-Hsuan Ke, Cheng-Hong Yang, "A Combination of Shuffled Frog-Leaping Algorithm and Genetic Algorithm for Gene Selection", Journal on

Advanced Computational Intelligence and Intelligent Informatics, vol.12, No.3, pp.218-226, 2008.

[10] HU Chun-hua, CHEN Xiao-hong, LIANG Xi-ming, "Dynamic services selection algorithm in Web services composition supporting cross-enterprises collaboration", Journal on Central South University and Technology, Springer, vol.16, pp. 43–53, 2009.

[11] Salvador Garcia, Jose Ramon Cano, Francisco Herrera, " memetic algorithm for evolutionary prototype selection", Pattern Recognition, vol. 41, pp, 2693-2709, 2008.

12] Gunhui Chung · Kevin Lansey, "Application of the Shuffled Frog Leaping Algorithm for the Optimization of a General large-Scale Water Supply System", Journal on Water Resource Management, Springer, Vol. 23, pp.797–823., 2008.

[13] Pablo Moscato, Carlos Cotta, "A Gentle Introduction to Memetic Algorithms", pp.1-36, 2002

[14] Ping Wang, "QoS-aware web services selection with intuitionistic fuzzy ser under consumer's vague perception", An International

Journal on Expert Systems with Applications, vol. 39, pp. 44600–4466, 2009.

[15] Silvia CasadoYusta "Different meta-heuristic strategies to solve the feature selection problem", Patten Recognition Letters, vol. 30 pp.525-534, 2009

[16] Muzaffar Eusuff, Kevin Lansey, Fayzul Pasha, "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization, Engineering Optimization", vol.38, No.2, pp, 129-154, 2006.

[17] E.Elbeltagi, "A modified Shuffled –Frog- Leaping-Algorithm for optimizing bridge-deck repairs", International Conference on Management System_Monitoring, Assesment and Rehabilitation, 2007.

[18] Alireza Rahimi-Vahed, Ali Hossein Mirzaei, "Solving a bi-criteria permutation flow-shop problem using shuffled frog-leaping algorithm", Journal on Soft Computing, vol.12, pp.435-452, 2008.

[19] Quan-Ke Pan, Ling Wang, Liang Gao, Junqing Li, " An effective shuffled frog-leaping algorithm for lot-streaming flow shop scheduling problem", Springer-Verlag, International Journal of Advanced Manufacturing and Technology, vol. 10, pp.18-30, 2009.

[20] Alireza Rahimi-Vahed,Mostafa Dangchi,Hamed Rafiei,Ehsan Salimi, "A novel hybrid multi-objective shuffled frog-leaping algorithm for a bi-criteria permutation flow shop scheduling problem ", International Journal on Advanced Manufacturing and Technology, vol.41,pp.1227-1239, 2009.

[21] Emad Elbeltagi, Tarek Hegazy, Donald Grierson, "A modified shuffled frog-leaping algorithm: applications to project management", Structure and Infrastructure Engineering, vol.3:1, pp.53-60, 2007.