Multi-objective Evolutionary Optimization of Service Provider Selection Problems with Dynamic Demands

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ABSTRACT

In this paper, a multi-objective evolutionary approach for solving cloud computing service provider selection problems with the demands of service requests change over the given periods. The objective of this problem is to select a number of cloud service provider while optimizing the quality of service (QoS) indicator, the total number of serviced demand points and the total service purchase costs simultaneously in the given continuous time periods. A multi-objective genetic approach with a seeding mechanism is proposed to solve the investigated problems. A real benchmark problem is examined and solved using the proposed multi-objective evolutionary algorithm. The results indicate that the proposed approach is capable of obtaining a number of non-dominated solutions for decision makers.

Categories and Subject Descriptors

G.1.6 [**Opitmization**]

General Terms

Algorithms, Management, Design.

Keywords

Evolutionary algorithms, cloud computing, provider selection, dynamic optimization.

1. INTRODUCTION

Recently, the advantages and features of cloud services has arisen the interests of digital entertainment/media/content suppliers to integrate cloud computing services into their content delivery networks. Consider a national-wide area with a number of service request points, the requests at each point usually changes in time; and within this area, a number of cloud service providers with different locations and pricing options of services are available for chosen. From the point view of content suppliers, it is important to select suitable cloud computing service providers, which can deliver their contents to massive customers rapidly and smoothly. As a result, considering the requirements of content supplier and the conditions of cloud service providers, we formulated such problems to multi-objective dynamic *p*-median problems [1].

2. MULTI-OBJECTIVE EVOLUTIONARY OPTIMIZATION

Mathematically, MOOPs can be represented as the following vector mathematical programming problems

$$\textit{Minimize} \quad F(Y) = \{F_1(Y), F_2(Y), ..., F_i(Y)\}, \qquad (1)$$

where Y denotes a solution and $f_i(Y)$ is generally a nonlinear objective function. An efficient approach based on multi-objective genetic algorithm (MOGA) [2, 3] for content providers is proposed to determine the selection of service providers in different periods and satisfying the dynamic demands of customers, as shown in Figure 1.

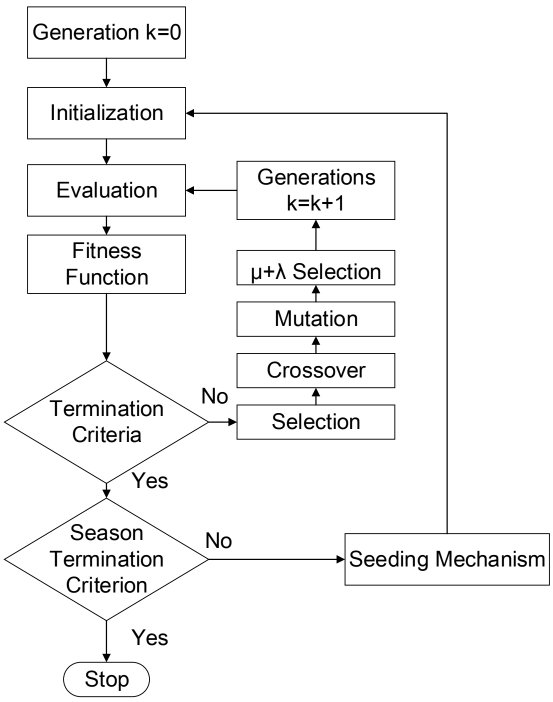

Figure 1. Flowchart of the proposed MOGA with seeding mechanism

3. DYNAMIC SERVICE PROVIDER SELECTION PROBLEMS

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In this paper, the investigated dynamic service provider selection problem (DSPSP) is to select p service providers from n service providers in each season, in order to satisfy the dynamic demands of m service requests from end-users, content supplier may select p different service providers in the next following season. However, each service provider has different pricing options for purchasing services and network transmission. Each service provider has a pre-assumed maximum QoS distance. Each demand point can only serviced by a nearest service provider. The objectives of DSPSP are the total QoS indicator in Equation (2), the total service purchase costs in Equation (3), and the total number of serviced demand points in Equation (4).

$$Minimize\ F_1 = \sum_{j=1}^{n}\sum_{i=1}^{m} w_{ij} \times md_{ij} \times X_i \times Z_j. \quad (2)$$

$$Minimize\ F_2 = \sum_{j=1}^{n} C_j \times Z_j. \quad (3)$$

$$Maximize\ F_3 = \sum_{i=1}^{m} X_i. \quad (4)$$

i : The index of demand points, $L_i = i$.

S_j : The index of the service provider points. Service providers points usually co-locate with some demand points, therefore $S_j \in \{L_1, L_2, \ldots L_m\}$.

T : The total service periods. In this paper, T=4 seasons (Q1-Q4).

t_j : The time period that the service provider S_j served, $0=t_1<t_2<\ldots<t_p<t_{p+1}<T$.

d_{ij} : The distance between L_i and S_j.

md_{ij} : The nearest distance of the demand point L_i between the nearest service provider point, $md_{ij}=min\{d_{ij}\}$.

$w_i(t)$: The demanding function of the demand points L_i at time t, $0 \leq t<T$.

w_{ij} : The total demanding amount of the demand point L_i from time t_j to time t_{j+1}, $w_{ij} = \int_{t_j}^{t_{j+1}} w_i(t)\,dt$.

C_j : The monthly service purchase cost of the service provider point S_j.

X_i : The serviced index of the demand point L_i. If the demand point service L_i is serviced within the maximum QoS distance of a provider point, then $X_i = 1$, otherwise $X_i = 0$.

Z_j : The selection index of the service provider point S_j. If the service provider point S_j is chosen and serves demand points in the specific time period, then $Z_j = 1$, otherwise $Z_j = 0$.

4. EXPERIMENTAL RESULTS

A benchmark with 83 demand points and 30 suppliers is used for demonstrated in this paper. The parameter settings of MOGA are : population size N_{pop}=100, recombination probability p_c=0.9, mutation probability p_m=0.1, the number of maximum generations G_{max}=100. Thirty independent runs are conducted using MOGA with seeding mechanism (WS) and MOGA without mechanism (WOS). Figures 2 and 3 depict the set coverage metric [2, 3] of these two algorithms. The results of Figure 3 indicate that the non-dominated solutions obtained by WS dominated near 50% of non-dominated solutions obtained by WOS.

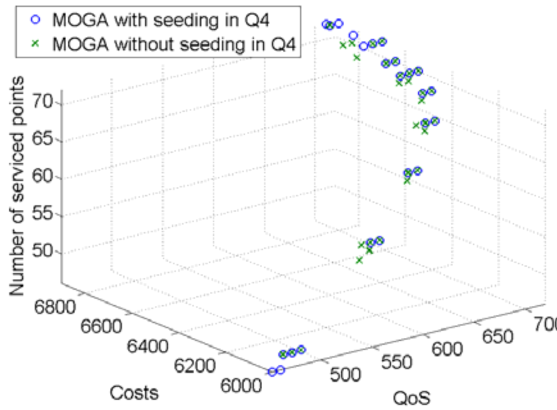

Figure 2. Non-dominated solutions in the final season Q4, merged from 30 runs.

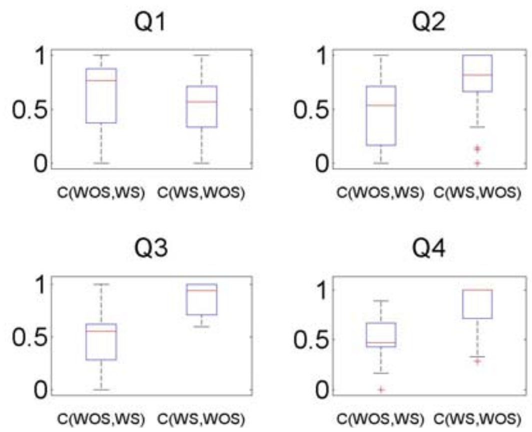

Figure 3. Coverage metric of both algorithms in 4 seasons.

5. CONCLUSIONS

A multi-objective evolutionary approach is proposed to solve dynamic service provider selection problems. Experimental results demonstrated the proposed approach is capable of optimizing the QoS indicator, the total number of demands points, and the total service purchase cost simultaneously. Moreover, the proposed approach can provide mission planers a set of non-dominated solutions for construction plan of service facilities.

6. REFERENCES

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