UDC 004.42

ONE METHOD OF RANKING WEB-SERVICES IN THE PROCESS OF THEIR DESCOVERING AND MATCHING

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Abstract

One of the actual problems of Web-services usage is the choosing among Web-services with similar functional properties that have the best non-functional characteristics. We have proposed a method of Web-services ranking by the non-functional qualities using the Logic Scoring Preference (LSP) method and Ordered Weighted Averaging (OWA) operators.

Анотація

Однією з актуальних задач застосування Web-сервисів є задача вибору серед Web-сервисів зі схожими функціональними властивостями таких, що мають найкращі нефункціональні характеристики. Ми запропонували метод ранжирування Web-сервісів за нефункціональними характеристиками, який використовує метод LSP та OWA оператори.

Introduction

The purpose of Service Oriented Computing (SOC) is to provide a set of methods and tools to create and execute applications based on Web-services. In most cases, the selection of Web-services for particular applications is related to the problem of choosing the appropriate Web-services among those which have similar functionality. One approach to discovery and matching of functionally similar Web-services is to rank them by their non-functional parameters (Quality of Service, QoS).

A starting point for the grounding of the proposed method is the assumption that the ranking of the services with similar functionality is performed using QoS-parameters of services and taking into consideration the service customer preferences. QoS-parameters of each service are evaluated according to certain criteria, then these evaluations are aggregated by some aggregation function, finally the ranking of values of this function is the result of ranking of the services. Choosing the aggregation function, we can consider some consumer preferences using the logical relations of *simultaneity* and *replaceability* between the criteria.

Logic Scoring Preference method

It is known the method Logic Scoring Preference (LSP) proposed by J. Dumović [1], which by adding parameter allows to reconfigure aggregation function. This parameter influences on combination of *simultaneity* (conjunction) and *replaceability* (disjunction) and referred to as *degree* or *orness degree*.

To compute the elementary preference in case we want to evaluate with increasing function, this function can be defined as follows:

$$E(x)=\begin{cases}0, & \text{if } x \le x_{\min};\\ (x-x_{\min})/(x_{\max}-x_{\min}), & \text{if } x_{\min} < x < x_{\max};\\ 1, & \text{if } x \ge x_{\max}.\end{cases} \quad (1)$$

In case we want to evaluate preference by decreasing function, this function can be defined as follows:

$$E(x)=\begin{cases}1, & \text{if } x \le x_{\min};\\ (x_{\max}-x)/(x_{\max}-x_{\min}), & \text{if } x_{\min} < x < x_{\max};\\ 0, & \text{if } x \ge x_{\max}.\end{cases} \quad (2)$$

The aggregation function is $\mathrm{L}:[0,1]^n \to [0,1]$

$$L = \left(w_1 E_1^r + w_2 E_2^r + \ldots + w_n E_n^r\right)^{1/r}, \quad (3)$$

where E_i – evaluation function for scoring web service on i^{th} criterion and $0 \le E_i \le 1$; w_i is the weight i^{th} criterion and $0 \le w_i \le 1$, $\sum_{i=1}^{n} w_i = 1$; power r is a real number selected so to achieve desired logical relations between criteria.

Power r depends on parameter *orness* (hereinafter denote as α) which can range from pure "and" (conjunction or simultaneity) to pure "or" (disjunction or replaceability). If the aggregation function comprises 2 to 5 criteria, a value of r can be taken from the table in [1], in the general case the following numeric approximation for r can be used [2]:

$$r = \frac{0{,}25 + 1{,}89425x + 1{,}7044x^2 + 1{,}47532x^3 - 1{,}42532x^4}{\alpha(1-\alpha)}, \quad (4)$$

where $x = \alpha - 1/2$ and $0 < \alpha < 1$.

Obtaining maximal entropy weights and execution of aggregation

The Ordered Weighted Averaging (OWA) operators are defined as follows:

Definition. An OWA operator of dimension n is a mapping $\mathrm{F}: R^n \to R$ such that

$$\mathrm{F}(E_1, E_2, \ldots, E_n) = \sum_{j=1}^{n} w_j E_{\sigma(j)}, \quad (5)$$

where σ is a permutation that orders the elements: $E_{\sigma(1)} \ge E_{\sigma(2)} \ge \ldots \ge E_{\sigma(n)}$.

A fundamental aspect of this operator is the re-ordering step. An aggregate E_j is not associated with a particular weight w_j but rather a weight is associated with a particular ordered position of the aggregate [3]. The *orness* measure of OWA operator is defined as follows:

$$\alpha(E_1, E_2, \ldots, E_n) = \sum_{j=1}^{n} w_j \frac{j-1}{n-1}. \quad (6)$$

One important issue in the theory of OWA operators is the determination of the associated weights [3, 4]. In [3] discussed some methods to choosing OWA operator weights: methods based on data, methods based on a measure of dispersion and methods based on weight generating functions.

Yu and Reiff-Marganiec in [5] have proposed to use to calculate *orness* by the formula (5) the average values of the scores for each criteria across all evaluated services. At the same time they order weights in accordance with the order of the average values of criteria (by descending). So, this method can be attributed to the methods of choosing OWA operator weights based on data.

When the number weights are unknown a priori it is possible to apply the Yager's functions Q to generate OWA operator weights, called Regular Increasing Monotone (RIM) quantifiers, using [4]:

$$w_j = Q\left(\frac{n-j+1}{n}\right) - Q\left(\frac{n-j}{n}\right). \quad (7)$$

Usually the consumer does not have sufficient advance information about the QoS criteria of Web-services candidates to choose from. So we suggest using the methods based on a measure of dispersion. These methods maximize the dispersion of the vector of weights to account all the information on selected criteria.

Along with the measure *orness* of OWA operator Yager suggested the measure of *dispersion* (entropy) of aggregation that characterizes the degree to which vector of weights takes into account all criteria in the aggregation. This measure is defined as

$$\text{disp}(w) = -\sum_{i=1}^{n} w_i \ln w_i \,. \quad (8)$$

One approach to determine the weights of OWA operator is to solve the following mathematical programming problem [3, 4]: *maximize the dispersion* (8) *subject to*

$$\frac{1}{n-1}\sum_{i=1}^{n}(n-i)w_i = \alpha,\ 0 \le \alpha \le 1\,, \quad (9)$$

$$w = (w_1, w_2, \ldots, w_n),\ 0 \le w_i \le 1,\ \sum_{i=1}^{n} w_i = 1\,.$$

The solving of this problem and formulae for calculating optimal weights of OWA operator are presented in [4]:

$$w_1[(n-1)\alpha + 1 - nw_1]^n = ((n-1)\alpha)^{n-1}[((n-1)\alpha - n)w_1 + 1], \quad (10)$$

$$w_n = \frac{((n-1)\alpha - n)w_1 + 1}{(n-1)\alpha + 1 - nw_1}, \quad (11)$$

$$w_j = \sqrt[n-1]{w_1^{n-j} w_n^{j-1}}\,,\ 1 < j < n\,. \quad (12)$$

To rank the Web-services we propose the following sequence of aggregation of evaluated QoS criteria. First, calculate according to the formulae (10)–(12) the optimal values of weights on basis of the given measure *orness* α and number of criteria n. Then, calculate the parameter r of logic relation between the criteria by formula (4). Finally, using the calculated weights and parameter r execute the aggregation by formula (3).

Conclusion

In this paper we outlined the method that uses the advantages of the LSP method and the techniques of the OWA operators. It allows us to rank the Web-services with the maximum information from the evaluation criteria, to take into account the preferences of the consumer via *orness* measure and to use the LSP method for stepwise aggregation of criteria to yield a global preference.

References:

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