Modelling Quality and Spatial Characteristics for Autonomous e-Service Peers

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Abstract. In this paper, we present an autonomous and scalable WSMO-based methodology to describe quality of service (QoS) and geographic features of e-services in a peer-to-peer based environment. To fully explore the usability of service mining and categorisation, we designed an algorithm to select the most appropriate peers to improve effective service composition.

1. Introduction

It is problematic that traditional methodologies can not effectively and autonomously conduct service discovery and composition in a complex dynamic environment. Even though quite a few groups proposed numerous QoS specifications, most of them are extremely difficult to clarify the correlation between one another consistently.

In this context, we present an intelligent, autonomous and scalable ontology-based methodology to describe QoS and geographic features of Web services in a P2P-based environment. Moreover, semantic Web services selection is a process to automatically find appropriate Web services that effectively fulfil the requestor’s requirements. Hence, we design and implement an algorithm to reasonably deal with the correlation between those requirement specifications, and select the most appropriate peers to foster a better service composition. In section 2 we introduce the design steps of modelling method. After comparing the related work in Section 3, our conclusions will be addressed with future work in Section 4.

2. Design and Modelling

In order to evaluate different non-functional properties of e-service peers, there are three important concepts in our design: *PreferedValueType*, *Weight*, and *Unified Value. PreferedValueType* has two kinds of values: “low” and “high”. With regard to “*Weight*”, it indicates the importance and priority of certain properties during the service composition. “*Unified Value”* indicates the each peer’s overall quality with numerically indicating results.

If "*PreferedValueType*" = "high", then the property ratio (PR) of a peer's service should be calculated by:

$$PR(i, j) = \frac{nf(i, j) - nf(min)}{nf(max) - nf(min)} \quad (1)$$

"*PR(i,j)*" presents the ratio value of non-functional Property(j) of Peer(i), and "*nf*" stands for non-functional. nf(min) and nf (max) refer to the minimum and maximum value of the Property(j) among all relevant peers. On the contrary, if "*PreferedValueType*" = "low", then the ratio should be determined according to:

$$PR(i, j) = \frac{nf(max) - nf(i, j)}{nf(max) - nf(min)} \quad (2)$$

Our main aim is to scale the value ranges with the maximum and minimum values by this means. Hence, any value with different "*PreferedValueType*" can be converted into the standardised value between 0 and 1. Through this approach, every property of each peer can be compared and evaluated fairly and also quickly. Subsequently, all candidate peers' non-functional properties would be put in a matrix, looks like (for *n* properties in *m* peers):

$$Mnf = \begin{bmatrix} PR(1,1) & PR(1,2) & PR(1,3) & \dots & PR(1,n) \\ PR(2,1) & PR(2,2) & PR(2,3) & \dots & PR(2,n) \\ PR(3,1) & PR(3,2) & PR(3,3) & \dots & PR(3,n) \\ \dots & \dots & \dots & \dots & \dots \\ PR(m,1) & PR(m,2) & PR(m,3) & \dots & PR(m,n) \end{bmatrix}$$

"*Mnf*" refers to matrix of non-functional properties. For uniformity, matrix *Mnf* has to be normalised to map all real values to a relatively small range through equations (1) (2), i.e., all elements of the final matrix are real numbers in the closed interval [0, 1]. Having *Weight (W)* values assigned to each property, we apply the following equation to generate the "*Unified Values (UV)*" for each peer:

$$UV = Mnf \times W, \ i.e., UV(i) = \sum_{j=1}^{n} (PR(i, j) \times w(j)), i = 1..m \quad (3)$$

w(j) stands for a weight value of different property (j^{th}) for service composition. As a result, it is reasonable to indicate which peer (i^{th}) would be able to conduct a specific task more effectively, by means of achieving the highest value *UV(i), i* ranges from *1 to m*. With regard to WSMO [4] extension, based on [6], we define an extensible class QoSProperty which aims to extend nonFunctionalProperties class in WSMO for P2P-based service selection [7].

```
Class nonFunctionalProperties
      ...other existing properties...
      hasQoSProperty type QoSProperty

Class QoSProperty sub-Class nonFunctionalProperties
```

```
        hasPropertyName type string
        hasPropertyValue type {int, float, long, others}
        hasPreferedValueType type {low, high}
        hasWeight type float
```

In order to effectively enhance services' quality regarding accessibility in P2P network, we herein consider basic geographic information about a would-be task-allocated peer and incorporate it into the QoS profile as an extension of previous QoS specification

```
    Class GeoProperty sub-Class QoSProperty
        hasGeoName type string
        hasGeoValue type {int, float, long, others}
        hasPreferedValueType type {low, high}
        hasWeight type float
        isEssential type boolean
```

For a peer selection process, we designed an algorithm. This algorithm aims to address the selection method with multiple peer profile specifications, and facilitate the above modelling approach. The algorithm can also be used for service/peer matchmaking, since we may set a goal for each QoSProperty if necessary. The following is the pseudo code:

```
Begin Function Mining Peers (P1, P2, … Pm)
    for i=1 to m do
        getQoSProperties(Pi);
        normalise input (Pi) using equation (1)/(2);
        then store the normalised value into array (Mnf);
    end
    getWeight() for the different properties;
    calculate the unified values by using equation (3;
    choose Pi with maximum unified value;
    return (Pi);
end function
```

3. Related Work

Functionality and non-functional properties are two essential aspects for semantic Web service. Functionality is used to measure whether this Web service meets all the functional requirements of an anticipated Web service, i.e. Web services matchmaking; while non-functional properties are qualified to evaluate the performance of the Web service. This has been viewed as a sufficient means to distinguish functionally similar Web services. For example, [3] and [1] emphasized a definition of QoS aspects and metrics. In [3], all of the possible quality requirements were introduced and divided into several categories, including runtime-related, transaction support related, configuration management and cost related, and security-related QoS. Both of them shortly present their definitions and possible determinants. Unfortunately, they failed to present a practical methodology for real applications. In [2] and [6], authors focused on the creation of QoS ontology models, which proposed QoS ontology frameworks aiming to formally describe arbitrary QoS parameters. From their on-going work, we are aware that they did yet consider QoS-based service selection. Additionally, our approach is built by taking considerations of new intuitive correlations between various service quality measurements and also testified upon a well-founded peer-to-peer e-service workflow system, which the authors have developed in the past [5].

4. Conclusion and Future Work

In this paper, we discussed the importance of QoS and spatial specification for P2P-based service mining and selection, and presented a comprehensive analysis on non-functional properties in WSMO. We augmented WSMO description by involving QoS perspectives and geographic profiles. We also designed and implemented an effective algorithm to facilitate the peer selection. Within the near future, our service peer selection model is expected to be modernized by focusing on concrete and detailed geographic features for location-based services, and we will improve our prototype for P2P-based workflow under a dynamic circumstance more effectively.

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