

(続紙 1)

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論文題目	Composing and Organizing Language Services (言語サービスの合成と組織化)		
(論文内容の要旨)			
This thesis contributes to Web service research by elucidating the service development stages necessary for language services. The enhancement of the stages mainly focuses on centering the services to the users. This thesis consists of seven chapters as follows. Chapter 1 is an introduction of the thesis. It includes the research objective and issues as well as the thesis outline. This chapter also describes the relations between the research topics that include service discovery, composition, organization, and application. Chapter 2 is a review of the major advances in the quality of service and linguistic architecture that form the background of this thesis. It begins with some general approaches to quality of services together with a specification and infrastructure. It then briefly describes several aspects of the architecture for linguistic application as developed in two main software streams: services computing and component systems. The purpose is to provide the reader with a basic insight into linguistic architecture. This review facilitates the reader's understanding of the work in the rest of the thesis. Chapter 3 discusses a formula for semantic similarity in language service discovery. Current Web service discovery techniques have degrees of discovery, which are discrete and exhibit a rather coarse level of granularity. Language service discovery can be enhanced through the use of measures that quantify the semantic similarity between concepts in language services ontology. Basing the discovery process on semantic similarity can overcome the issues of refining and quantifying the degrees of Web service discovery. It can also produce a better ranking of relevant language services. When the required service is not available, similar extant language services can be delivered to users. An evaluation is also provided to confirm that semantic similarity is suitable for determining the similarity between requested and provided Web services. Chapter 4 discusses the integration of different service composition approaches for natural language processing. The use of more than one natural language processing tool is limited since tools are implemented on specific architectures. This limitation could cause a problem when a task requires a combination of several tools found in different architectures. The two main architectures are the service composition approach for composite Web services and the component pipelining approach for multiple linguistic components. One representative is chosen for each approach, Heart of Gold for component programming and the Language Grid for service composition. Based on several experiments on what kind of integration scenario is the best or these two approaches, Heart of Gold is wrapped as an atomic service in the Language Grid's environment. This hybrid architecture is then extended to be able to accommodate the needs of the composite language service. The combination of composite services in one workflow and pipelined components in one processing flow is able to deliver many adva			

ntages to a linguistic application. An evaluation of selected language services and natural language components run as both atomic and composite services is provided to identify the overhead imposed by the integration.

Chapter 5 proposes a new language service organization for user-centered quality of service (QoS). Its concept is based on constraint optimization, a well-known technique in artificial intelligence. The proposed modification of constraint optimization approach can be divided into two phases: inter-workflow and intra-workflow service organization. Intra-workflow service organization is used to calculate the optimal QoS value for each composite service. Inter-workflow service organization is used to identify the optimal combination of composite services by utilizing the QoS values obtained from intra-workflow service organization. An architecture and algorithm are provided to support our proposed framework of user-centered quality of service. Our motivation example is a real problem in a chat language service. An evaluation of the framework involves different numbers of variables of inter-workflow and intra-workflow service organization. Further, a comparison with related works is presented in terms of how well they accommodate users during language service organization.

Chapter 6 describes an application of service composition and organization in cultural language services. A motivation of this application is the existence of cultural differences in language services. From a linguist's point of view, culture is strongly represented in the native language. The major behaviors inside community are explicitly and implicitly drawn in the jargon, common sentences, mottos and so on. In analyzing the culture contents and texts, a semantic similarity approach is required to discover the suitable language services and wrapped linguistic components. Two critical issues associated with cultural difference are culture analysis and contents. These issues require integration between language services and natural language components. The main problem raised by cultural difference is reduced by centering service quality on the culture of the user.

Finally, the thesis is summarized in Chapter 7 by presenting the results obtained through this research and addressing future works.

(論文審査の結果の要旨)

本論文は、言語サービスを応用領域として、Webサービス技術に関するサービスの発見、連携、組織化の効率化を図ったものである。研究のアプローチとしては、サービス利用者の視点を中心に据える「利用者中心設計」に基づいている。得られた主要な研究成果は以下のとおりである。

1. 言語サービスを特徴付ける用語の概念階層（言語サービスオントロジー）に基づき、用語間の意味的類似度を計算し、その類似度を用いたサービス発見手法を提案している。評価の結果、言語サービスオントロジーにより、利用者の要求する言語サービスと、利用可能な言語サービスの類似度が効率的に計算可能であることを示している。
2. 現存の言語サービス連携アーキテクチャを分析し、それらを統合する方式を提案している。実際に、ドイツの研究機関で開発された「Heart of Gold」と呼ばれるソフトウェアコンポーネントのパイプライン化の枠組と、京都大学で運営されている「言語グリッド」と呼ばれるWebサービス連携の枠組みの統合を試みている。この言語サービス連携統合アーキテクチャを用いて、ソフトウェアコンポーネントとWebサービスを適切に組み合わせることにより、多様な言語サービスの相互運用性の向上に加え、翻訳サービスの性能と精度の向上が認められている。
3. 言語サービスが実際に役立つかどうかは、サービスが持つ客観的な品質（QoS: Quality of Service）だけではなく、サービスを受ける利用者の言語能力にも依存する。そこで、サービス提供者とサービス利用者のインタラクションに基づいて定義される「利用者指向QoS」という新たな品質指標を提案している。利用者指向QoSは、例えば言語能力の違う多国籍の利用者のコミュニケーションの場で、複数言語対の翻訳サービスを選択する場合などに評価基準を与えるものである。
4. 本論文で示した、サービスの発見、連携、そして組織化に関わる研究成果を組み合わせ、文化依存の言語サービスに適用することを提案している。文化依存の言語サービスでは、サービス発見のために言語サービスオントロジーが拡張され、その連携には言語サービス連携統合アーキテクチャが用いられている。また、利用者指向QoSの概念が拡張され、文化的多様性を反映した言語サービスの選択と組織化が行われている。

以上、本論文は、言語サービスにおいて重要な課題であるサービスの発見、連携、組織化に貢献するものである。なお、本論文の研究成果は言語サービスだけでなく他の領域のサービスへも一般化できるため、本論文はWebサービス全般の進歩に寄与するものと言えることができる。

よって、本論文は博士（情報学）の学位論文として価値あるものと認める。また、平成23年2月9日に実施した論文内容とそれに関連した試問の結果合格と認めた。