Smart Cloud Services Marketplace based on NLU Technologies

Samer Hasan¹, Prof. Kuda Nageswara Rao²

¹² Department of Computer Science & System Engineering, College of Engineering (A), Andhra University, India.

Abstract: Cloud computing makes our life easy by delivering computing resources as utility like telephony, water and gas. In cloud computing users should pay only for what they consumed. Nowadays, cloud service providers deliver a huge number of cloud services with almost the same features which makes the cloud services discovery and selection process as a big challenge for the end consumers. Using existing search engines results in a lot of unrelated outcome which increases the cloud service discovery and selection process time and effort. In this paper, we present an enhanced cloud services marketplace framework to facilitate the cloud services trading between providers and consumers and to make cloud services more visible for all consumers. Proposed framework receives users’ requests as a voice commands or flat-text then translates them based on Natural Language Understanding technologies. In additional, we enhanced the matching algorithm by adding different weights for attributes based on consumer preferences. Experiments showed an enhancement in the overall user experience and better matching for user request.

Keywords: Cloud computing, cloud services, service matching, cloud marketplace, cloud architecture.

I. INTRODUCTION

Cloud computing [1] is a paradigm that enables access to a shared computing resources where consumer should pay only for what he consumed. There are three different levels of cloud services. Infrastructure as a Service (IaaS) where users hire an infrastructure resources from another party, Platform as a Services (PaaS) where users develop applications on a hailed platform and Software as a Service where users use an applications developed and operated by another party based on pay as you use model. Nowadays, there are big number of cloud service providers who provide a huge number of similar cloud services which makes the process of finding and selecting the appropriate cloud service a tedious task for the users. Using general search engines like Google increases the time and effort of finding the cloud services. In this paper, we present an enhanced architecture for cloud services marketplace based on the work proposed on [2]. Enhanced architecture allows users to enter the cloud service requests as a voice commands or as plain texts. In addition, enhanced architecture improved the matching algorithm by applying different weights for user requested attributes based on user preferences. Experiments showed an enhancement in the overall user experience and better matching for user requests. The rest of this paper is organised as following: section 2 surveys the related work, section 3 presents the enhancement architecture, section four displays the results of the experiments and section 5 is a conclusion and future work.

II. RELATED WORK

ontology. Search engine provide clients with interface to enter queries and receive the results based-on service characteristics and AHP mechanism. Afify et al. [10] developed a unified ontology that serves as semantic based repository to facilitate SaaS publication, discovery and selection processes. To overcome the limitation of SPARQL language, WordNet ontology is used to semantically expand the service description and user request. In [11] User agent provides a user interface to the cloud consumers.

III. ARCHITECTURE

This work is an extension for work presented in [2]. We enhanced the user interface to accept the user requests as a flat-text or voice commands based on NLU technologies. On the other hand, we enhanced the matching algorithm by adding different weights for each cloud service attribute based on user preferences. As shown in fig. 1 enhanced cloud services marketplace added four new components to User Interface Sub-System as following:

A. Voice Receiver is responsible for receiving the user commands as a voice.
B. Speech to Text is responsible for converting voice commands into text.
C. Text receiver is responsible for receiving the user commands as a flat-text.
D. NLU is responsible for extracting the commands meaning based on CFG rules.

E. Natural Language Understanding

Natural Language Understanding (NLU) is a field of artificial intelligence that attempts to understand the complete meaning of the text by adopting different technologies like Context-Free Grammars (CFG) [12]. CFG generates patterns from strings based on recursive rewriting productions. CFG is consisting of a set of grammar rules as following:

1) Start symbols $S$
2) set (N) of non-terminal symbols
3) set (T) of terminal symbols
4) set of rules (P)
There are two approaches to draw a different derivation tree: Top-down Approach and Bottom-up Approach. Fig. 2 shows parsed tree for the command “please find virtual desktop price 10 USD per month storage 10 gb location India” based on CFG rules.

F. Enhanced Matching Algorithm
As an enhancement for the work proposed in [2], we improved the matching algorithm by adding different weights for each cloud service attribute in user request. This improvement helps cloud consumers to find the appropriate cloud services by focusing on specific attributes more than others. Enhanced matching algorithms for cloud services marketplace is improved as following.

\[
m_s = \prod_{i=1}^{n} DSim(cs^a_i, ur^a_i) \cdot \frac{\sum_{j=1}^{m} w_j PDSim(cs^a_j, ur^a_j)}{\sum_{j=1}^{m} w_j}
\]

Fig. 2 NLTK parsed tree for user command

IV. RESULTS AND DISCUSSION
CFG is implemented in Python using NLTK [14] library. Dataset is collected from cloud provider’s websites and stored in repository. Results are compared with work proposed in [2] refers it as MP for the user request (VCPU=4, Price=30 USD/month, Storage=75GB, Ram=10GB, Availability=99%). Two different set of weights are used for the same user request attributes EMP1 = (3, 5, 2, 4, 1), EMP2 = (3, 1, 4, 2, 5) respectively. Two parameters are used for comparison: Number of matched services and average matching score as following.

A. Number of Matched Services
Number of matched services determine the time that consumer should spend to find the best matched service. As shown on Fig. 3, Enhanced cloud services marketplace showed higher number of matched cloud services for user request with weights 2 (EMP2) in compare with unweight query MP. On the other hand, Enhanced cloud services marketplace showed lower number of matched cloud services for user request with weights 1 (EMP1) in compare with unweight query MP. As a result, changing the weights for user requested attributes will directly affect the number of the matched services and user can get best matched queries by using the appropriate weight for each attribute.

B. Average Score
Average score represents the mean of score of all matched services at specific threshold. It affects the number of cloud services that will be displayed as results of the user queries. User can change the requested attribute’s weights to change the matching score and
the number of matched services. As shown in Fig. 4, all requests showed almost the same values for all thresholds. EMP1 showed Zero value for threshold = 0.9 because the number of matched services for this threshold is zero.

![Graph showing number of matched services per threshold](image1)

Fig. 3 number of matched services per threshold.

![Graph showing average score per threshold](image2)

Fig. 4 Average score per threshold

V. CONCLUSION

Cloud computing changes our life and the way that we use computing resources. The current process for finding the appropriate cloud services is hard and time consuming. This work, presented an enhanced architecture for cloud services marketplace based on NLU technologies. In proposed architecture, user can enter requests by voice commands or pain texts. On the other hand, this work improved the matching algorithm by adding different weights for requested attributes based on user preferences. Experiments showed an improvement in the overall user experience with cloud services marketplace with better matching results. As a future work, we plan to use Artificial Intelligence and Machine Learning technologies to extract the requested attributes from user requests.

REFERENCES

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