Research on the Method of Context Modeling Based on Ontology ——a Case Study of Tea Sales

Zhanzhan Mao*
School of business, Xijing University, Xi'an , China
*Corresponding author e-mail: 283725379@qq.com

Abstract. With the raise of the Belt and Road strategy and the development of ubiquitous computing, the cross-platform context data coming from the wireless network, mobile computing and sensor network is increasing rapidly. How to shield the distribution and heterogeneity of context information so that users and their context information can be understood by computers has become a hot topic in current research. This paper takes tea sales as the research object. By building an ontology-based context model, this paper explores the effectiveness of the modeling method in solving semantic interaction and information fusion, and then promotes the organic integration of cross-platform and cross-industry scenario information in the new era.

1. Introduction
Along with the development of wireless network, sensor technology, Internet of things, etc, the amount of context data flow is showing a trend of exponential growth in recent years. Meanwhile, cross-platform interaction and fusion of heterogeneous information becomes the basis of context information service.

Taking the tea industry as an example, this field involves tea production and processing, tea pest diagnosis, tea supply and demand information services, tea sales consulting and other links. How to promote the fusion of tea information and realize the knowledge discovery under heterogeneous network environment has become an important issue.

This paper will take context information modeling for tea sales as the research focus. Through the context modeling based on ontology, the effective solutions are explored so that we can promote the organic combination of cross-platform and heterogeneous information of tea industry.

2. Analysis of Context Information Value in Tea Sales Environment
According to Professor DEY's definition[1], “Context is any information that can be used to describe the characteristics of an entity's situation, which is a person, place, or object associated with interaction between a user and an application, and also includes the user and the application itself.”

Context information is the data source of pervasive computing. After the acquisition of context data from sensors and the transmission, abstraction, interpretation, storage and retrieval, the original rough context data is gradually transformed into a rich semantic connotation, called advanced context information, which can be understood by the application. It can be used as a direct parameter to guide the adaptive decision of the system.

By the analysis of the sales status of tea products, the extensive and batch marketing model of traditional tea industry can not meet the needs of users under the background of the Belt and Road strategy. The current users' choices of tea present a multi-channel, multi-type and multi-drive...
individualized features. In the tea sales environment, the context elements related to the users' choices will become the important decision basis of tea sales service. Part of the context data come from logical sensors such as user browsing records, user personal information, etc. And the other part come from physical sensors, such as space-time information, environmental information, etc.

3. Research Status of Context Modeling Methods

According to Bettini's analysis of context modeling, an excellent context modeling approach requires to consider the following factors[2]:

1. Heterogeneity and Mobility. Context information has a wide range of sources, so its expression and abstraction are heterogeneous. The heterogeneity and mobility of context information requires that different context awareness systems have the ability to transform heterogeneous scenarios, and also need to be able to correctly represent the hierarchical relationship between context information with different abstract degrees.

2. Relationships and Dependencies. Context information exists on an open platform, and several scenarios may be interrelated in some form. Correct understanding of their associations is essential for understanding the current user's behavior and state. The relationships and dependencies of context information require context awareness system to effectively express the relationship and dependence between different levels of scenarios.

3. Timeliness. Context information is not invariable, which will change with the change of time and space. Different scenarios have different life cycles. Once beyond the life cycle of context information, it loses its timeliness. Therefore, only by defining the dynamic characteristics of different types of context information can we make rational use of the value of the context information.

4. Imperfection. Context information is distorted from collection to processing due to sensor errors, differences in technical standards followed, and loopholes in transmission. The imperfection of context information is its essential feature. It will lead to "bullwhip effect" in subsequent context transformation, reasoning and distribution, which will affect the system to make correct and effective judgments. In view of this situation, we need to provide a mechanism to evaluate and control the quality of context information, minimize the imperfection of the situation, and ensure the normal development of context application services.

5. Inference. Most of the original context information is low-level information. After a series of relationship dependency settings and inferences, high-level context information can be obtained to support complex application services.

6. Availability. Context information is often closely related to the user's state, and the user's state will change with time. Therefore, the vast majority of scenarios are also migrating and evolving. When it comes to the development of context aware applications, the design of context model can not only support a specific scenario, but also support the dynamic definition, extension, reusability, sharing and interaction of scenarios based on the characteristics of users' phased changes.

Among these factors, (1)-(4) requires context modeling to address the standardization and formalization of context information performance. Item (5) requires context modeling technology to support consistency testing and reasoning of complex scenarios, so as to provide decision-making basis for context aware applications. Item (6) requires context models to achieve knowledge reuse and sharing, so as to achieve interaction between context models.

At present, there are many context modeling methods, including key-value pair model, tag configuration model, object-oriented model, logic-based model, ontology model and so on. Based on the analysis of the research status of the above-mentioned context modeling methods, and considering the principles of context modeling proposed by Bettini, the ontology method, with its formal, semantic, structured and standardized expressive ability, a variety of reasoning tools for consistency checking, clearly defines the normative semantic description and provides lots of the general ontology research results to promote the interactive sharing of context information. Ontology modeling becomes the best tool and the entrance to the next step.
4. Analysis of Constructing Elements of Context Model Based on Ontology

Before constructing the context ontology, context information needs to be classified. Many scholars have done a lot of research on the classification of context information according to their understanding of different degrees of scenarios and combined with practical application.

Schilit first classified scenarios into three categories, namely computing context, user context and physical context [3], but such classification is prone to confusion. Schmidt divides scenarios into human-related context (including user information, user tasks and social information) and physical environment-related context (including location, physical conditions and infrastructure)[4]. Chen Yuanyuan divides scenarios into three categories according to the interaction process of human-computer system: user context (including individual and group attributes), environment context (including natural and social environment) and task context (including equipment status and program status)[5].

On the basis of summarizing the above context models, this paper draws lessons from the classification methods and terminology expression of some context information, refines and integrates important context elements, and strives to build a more comprehensive, clear, reusable and easy-to-expand context ontology.

In tea sales environment, users are the core of context awareness. All the context-aware behaviors start from perceiving users' status and needs, and then adjust the adaptability of service content of application system. Therefore, in classifying the elements of constructing ontology-based context model, this paper takes user needs as the starting point and combines the domain knowledge of tea sales to form three categories of context information: (1) tea field information; (2) internal context elements that affect user needs; (3) external context elements that affect user needs.

4.1. Tea Field Information

Tea field information, which refers to the knowledge in the field of tea sales, including tea varieties, tea culture, tea policy, etc[6]. Among them, tea varieties include green tea, black tea, oolong tea, white tea, yellow tea, reprocessed tea, etc. Tea culture includes tea ceremony, tea morality, tea spirit, tea couplets, tea books, tea sets, tea paintings, tea science, tea stories, tea art, etc. Tea policy includes economic policy, legal policy, technical policy and market policy.

4.2. Internal Context Elements

Internal context elements, which refer to the internal elements that affect user's needs, including user's personal information and current situation. Among them, user's personal information includes user's age, gender, income, educational background, experience, preferences, beliefs and so on. It is based on the traditional user model. User's current situation includes user's physical condition, mood, mentality, activity, etc.

4.3. External Context Elements

External context elements, which refer to the user-related surrounding context elements, including temporal and spatial information, environmental information, computing entity information and service information. Among them, spatio-temporal information includes two elements: time information of the user and spatial information of the user. Environmental information includes the physical and logical environment conditions obtained by various sensors, such as noise, temperature, light, online shopping environment, etc. Computing entity information includes all the information of computing entity which is valuable for decision-making of application system in the process of interaction between users and application system, such as device performance, parameters, solutions, capacity, plug-ins, etc. Service information is the service decision made by the application system after perceiving the user's needs and states, including service conditions, service policies, service constraints, etc.

5. Ontology-based Context Modeling in Tea Sales Environment

This paper constructs an ontology model, which consists of three sub-ontologies: (1) user context sub-ontology, which refers to the construction method of CACOnt ontology to a certain extent[7], mainly describes the user's demand state under the influence of internal and external scenarios. (2) tea
sales domain sub-ontology, referring to the domain ontology construction method to build, mainly describes the basic domain knowledge of tea sales. (3) service context sub-ontology, which links the above two sub-ontologies as an application-oriented tea sales context model through specific service request.

The construction of ontology model uses OWL ontology description language and Preggregate ontology construction tool. By defining ontology concepts, relationships, attributes, axioms and examples, it gradually clarifies user-related context knowledge and domain knowledge related to tea sales, and establishes conceptual hierarchical relationship. The specific construction process is as follows.

5.1. User Context Sub-ontology

User context sub-ontology (Fig. 1), which takes users as the core concept, is associated with user internal context elements and external context elements.

In user context sub-ontology, “User” mainly includes user profile and user’s current state. “UserProfile” describes the basic characteristics of users, such as demographic factors (name, age, gender, contact number, etc.). The information recorded by user profile is relatively static and the update cycle is long.

The user’s current state refers to the user’s current state, which is related to his behavior, such as “Task”, “Activity” and so on. These elements belong to high-level scenarios. Although they are important for the adaptability of context aware application services, they are difficult to obtain directly. They need to be combined with other context information in the model, such as “LocationCondition”, “ComputationCondition”, “EnvironmentCondition” and “ServiceCondition.

Compared with other sub-ontologies, user context sub-ontology is more subjective and application-oriented, and it is difficult to describe all aspects of a user in a general way. Therefore, the user models of existing systems based on their respective perspectives differ greatly. As a general model, considering its availability and scalability, user context sub-ontology only needs to define user identification information and status information simply, while other information such as user’s interest preferences can be customized and extended in specific applications according to the purpose of application developers.

5.2. Tea Sales Domain Sub-ontology

Tea sales domain sub-ontology (Fig. 2), based on the knowledge of tea sales field, determines five upper classes, including “TeaType”, “TeaCulture”, “TeaPolicy”, “TeaBrand” and “BasicInfo”. On this basis, the concepts and attributes of each level are expanded and perfected in turn, and the constraints and case information are added.
5.3. Service Context Sub-ontology

Service context sub-ontology (Fig. 3) is closely related to user and tea sales sub-ontology. Service context is the key to realize the adaptability of context awareness system. It assists users to complete their own activities or satisfy their preferences by using standardized defined interfaces based on the current status and user preferences of tea entities.

The service context sub-ontology designed in this paper refers to OWL-S service ontology [8]. “ServiceProfile” mainly introduces what services are, including three types of basic information: (1) information about service providers; (2) the functions and other attributes of the service, such as the input and output of the service, the prerequisites for service execution and the expected results of service execution; (3) service characteristics, classification and quality information.

“ServiceGrounding” explains the details of how to access services. It handles operations by specifying communication protocols, information formats, and other specific details of information. “ServiceStrategy”, “ServiceInterface” and “ServiceInterfaceComponent” show the specific service operation process. By providing control flow and data flow information in the process of using the service, users or agents can determine whether the service meets their needs.

Through the context modeling method provided in this paper, user context sub-ontology, tea sales domain sub-ontology and service context sub-ontology are constructed, and a complete context model is constructed for specific application services.

This method is conducive to the sharing and reuse of context ontologies in different domains, reducing the heterogeneity and complexity of context modeling, and facilitating the interaction and fusion of context information in multi-network and cross-platform environments.

6. Conclusion

Taking tea sales as the research object, this paper constructs an ontology-based context model to explore how to effectively solve the problem of heterogeneous and cross-platform information sharing and interaction, help to realize the integration of user context information and tea sales domain knowledge, and provide a solution for the problem of how to deal with complex situation information under the background of the Belt and Road strategy. However, there are still some shortcomings in the specific implementation process, such as: how to realize the sharing and reuse of tea domain ontology.
in the tea industry, how to accurately and normatively express user context data, how to improve the quality of sensor data collection, etc. These are all problems to be considered and solved, which provide direction for further research.

7. Acknowledgments

This work was financially supported by Xijing University Research Fund Project (XJ160213).

References

[1] Dey A K, Understanding and using context, Personal and ubiquitous computing, 2001, 5(1): 4-7.
[2] Bettini C, Brdiczka O,Henriksen K, et al, A survey of context modelling and reasoning techniques, Pervasive and Mobile Computing, 2010, 6(2): 161-180.
[3] Schilit B, Theimer M, Disseminating active map information to mobile hosts, IEEE Network 1994; 8: 22 - 32.
[4] Schmidt A, Aidoo K, Takaluomo A, et al, Advanced interaction in context, Proc of the 1st International Symposium on Handhelds and Ubiquitous Computing, London: Springer-Verlag, 1999:89-101.
[5] Chen Yuanyuan, Liu Zhengjie, Research on Mobile Context Perception and Its Interaction, Computer Applied Research, 2011, 28 (12).
[6] Yang Xiaokang, Design and Implementation of Network Informatization Tea Industry System Based on SSH2, Journal of Harbin University of Technology (Social Science Edition), 2015,(06):173-175.
[7] Xu N, Zhang W S, et al, CACOnt: a ontology-based model for context modeling and reasoning, Applied Mechanics and Materials, 2013, 347: 2304-2310.
[8] Rui C, Shi Y, Zhi-Hao Z, et al, An Approach to Construct and Parse the OWL-Based Service Ontology, 2009 International Symposium on Intelligent Ubiquitous Computing and Education, IEEE, 2009: 465-468.