

A New Context-Aware Learning System for Predicting Services to Users in Ubiquitous Environment

Jieun Lee, Sanghoun Oh and Moongu Jeon

Abstract — This paper represents a new context-aware learning system to provide services in ubiquitous computing environment. The aim is to precisely decide which services each user provides. To achieve this goal, we design a preprocessing method (i.e., context modeling) to obtain good information which represents user's characteristics from context-aware information (i.e., user profiles) which consists of states: who, when, where, why, what, and how: 5W1H. The proposed system applies the state-of-the-art naïve Bayesian Decision Theory, which is one of the statistical analyses based on probability theorem.

Index Terms — context-aware application, naïve Bayesian classifier, and user's preference learner

I. INTRODUCTION

RECENTLY, many context-aware applications (CAAs) have been developing to provide various services to each user in ubiquitous computing environment. CAAs help each user to decide his or her decision as extracting meaningful information from many kinds of contexts such as locations, identifications, activities, states of users, and so on. These services apply most of the real world entertainments such as health, education, accident, rescue, and shopping.

To provide more efficient services, most of the CAAs have tried to employ machine learning (ML) techniques with learning data. From this integration of context-aware and ML technologies, we can configure artificial intelligent service systems.

In this paper, we propose a new context-aware learning system using a naïve Bayesian classifier which is one of the most popular ML methods. The main goal of the proposed system automatically recommends suitable services to each user. To learn this system, we employ 6 kinds of contexts (i.e., user profile: who, when, where, why, what, and how (5W1H)) [1].

F. Author is with the Gwangju Institute of Science and Technology (GIST), MS student, Korea (corresponding author to provide phone: 82-62-970-2410; fax: 82-62-970-2384; e-mail: jieun@gist.ac.kr)

S. Author is with the Gwangju Institute of Science and Technology (GIST), Ph. D. student, Korea (corresponding author to provide phone: 82-62-970-2410; fax: 82-62-970-2384; e-mail: oosshoun@gist.ac.kr).

T. Author is with the Gwangju Institute of Science and Technology (GIST), professor in Mechatronics, Korea (corresponding author to provide phone: 82-62-970-2406; fax: 82-62-970-2384; e-mail: mgjeon@gist.ac.kr).

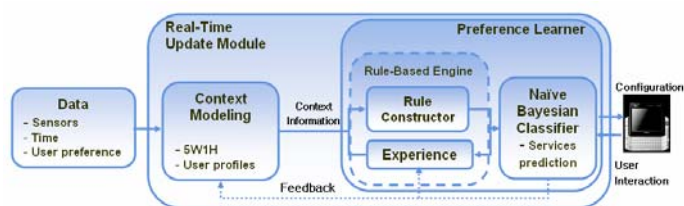


Figure. 1 Overall procedures of the proposed context-aware learning system

The paper is organized as follows. In section 2, we introduce the proposed context-aware learning system. The paper concludes in section 3.

II. PROPOSED CONTEXT-AWARE LEARNING SYSTEM

This research is the sub-system of user profile management system which plays a role in managing all data for personalizing users [1]. A proposed context-aware learning system is to provide high quality services to each user as automatically learning based on user's preference. Figure. 1 shows overall procedures of the proposed context-aware learning system which is classified by two parts: context modeling and preference learner.

First, the context modeling processes context-information from data collected by many kinds of sensors, time, and user preference [2]. Table. 1 describes items and types of user profiles using in the proposed system.

Who (Identity)	Name
When (Time)	Morning, Daytime, Afternoon, Evening, Midnight
Where (Location)	Entrance, Sofa, Window, MRTable
How (Behavior)	In, Out, StandUp, SitDown, Moving
Why (Stress)	VeryLow, Low, Middle, High, VeryHigh
What	Services
	Functions
	TV, DVD, WEB, MUSIC, IMAGE, MR, LIGHT
	On, Play, Pause, Stop, Off

Table. 1 Data types and values

The second part is preference learner for users. This process consists of a rule-based engine and a naïve Bayesian classifier. The rule-based engine generates (Rule Constructor), saves, and manages rules (Experience) [4]. Especially, this engine makes new rules in order to apply some information not represented by user profile into learning scheme. The primary role of the naïve Bayesian classifier is to provide the appropriate services to users using those rules. This classification system is useful in our learning system based on user's preference because naïve Bayesian classifier is the simplest form of Bayesian networks and is able to easily calculate probability as assuming whole attributes in context-information is independent [3]. In the proposed system, whole data are categorized by 6 items considering dependency between each attribute in the context modeling process; therefore, these attributes is independent. For example, when daddy turn a television on in the morning, there is not a correlation among attributes (i.e., who (Dad) and when (Morning), or who and what service (TV.on). Therefore, 6 items of context-information are independent in each other.

However, there are 3 constraints in the proposed context-aware learning system. Firstly, we should control the number of training data due to limitation of resources. Next, we should prevent needless update because of efficient computation time. In the above constraint, we divide 3 learning modes [4] [5]: Monitoring mode (Collecting user information), Control mode (Considering new and changed information), and Stable mode (Providing services until users satisfy). All of the modes are classified by reliability which is settled by the number of training data and variation of rules. Finally, we define top priorities (emergency, disasters) [5].

III. CONCLUSIONS

In this paper, we have introduced a context-aware learning system to recommend services into each user in ubiquitous environment. The proposed system is divided by two parts: the context modeling process and the naïve Bayesian classification process to predict services for extracting high level information from low level data. In the future, we will apply various statistical machine learning methods such as advanced naïve Bayesian methods (e.g., selective Bayesian classifier, a tree-augmented naïve Bayesian classifier (TAN), etc) and Bayesian neural networks to improve the performance for providing highly qualitative services [4]. Also, in the procedure of context modeling, we will study correlations among contexts for the personalization of services.

ACKNOWLEDGMENT

This research is supported by the UCN Project, the MCI 21st Century Frontier R&D Program in Korea

REFERENCES

- [1] Youngjung Suh and W.Woo, "User Profile Management for Personalized Service in Smart Environments," KHCI, pp. 672-677, 2006.
- [2] Andreas Krause, Asim Smailagic, and Daniel P. Siewiorek, "Context-Aware Mobile Computing: Learning Context-Dependent Personal Preferences from a Wearable Sensor Array," *IEEE Transactions on Mobile Computing*, vol. 05, no. 2, pp. 113-127, Feb., 2006.
- [3] Nurmi, Petteri, "Bayesian classifiers for context-aware computing," Research Themes in Context-Aware Computing - seminar, Department of Computer Science, University of Helsinki, Finland, January 2004.
- [4] Hani Hagrais, Victor Callaghan, Martin Colley, Graham Clarke, Anthony Pounds-Cornish, and Hakan Duman, "Creating an ambient-intelligence environment using embedded agents," *IEEE Intelligent Systems Magazine*. v19 i6. 12-19.
- [5] J.-H. Hong and S.-B. Cho, "기계학습과 지능형 에이전트(인공비서)," *정보과학회지*, vol. 25, no. 3, pp. 64-69, 2007.