Chapter 8  

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Abstract. We propose a context-aware guide application, which provides appropriate information selected by a machine learning algorithm according to the preference and the situation of each user. We have designed and implemented the proposed system using the off-the-shelf mobile phones with a built-in GPS module. The machine learning algorithm enables our system to select an appropriate spot based on the user’s real-time context such as preference, location, weather, time, etc. As a machine learning algorithm, we use the support vector machine (SVM) to decide the appropriate information for the users. In order to realize high generalization performance, we introduce the principal component analysis (PCA) to generate the input data for the SVM learning. By our experiments in real environments, it is shown that the proposed system works correctly and the correctness of recommendation can be improved by introducing the PCA.

Keywords: Context-Aware Applications, Ubiquitous Computing, Mobile Networks, Machine Learning Algorithms, Support Vector Machines.

1 Introduction

Various wireless network systems have been developed and commercialized, and ubiquitous network access has been available. As new applications which effectively utilize such ubiquitous network access, various ubiquitous computing applications have been studied and developed [1]-[3]. As one of the targets of those applications, context-aware recommendation applications to provide useful information to the mobile users have been proposed [4]-[7]. Although the conventional recommendation applications select information to be provided to the user based only on the static context information such as the user profile and the preference, recently proposed context-aware recommendation applications based on ubiquitous computing technology decide appropriate information based not only on the static information but also on the real-time and real-world context information, such as location, weather and so on. As such a context-aware recommendation application, Blue Mall[5] is a recommendation system that notifies
the mobile users of advertisements about nearby shopping stores based on the
user’s location estimated by the Bluetooth RSSI. A system called Bookmark
Handover[6] is a context aware reminding application, which reminds mobile
phone users about the events or the visiting spots which they had registered
before with the notifying timing context information, such as location, timing,
etc. A system called i-concir[7] is one of examples of commercialized services,
which provides useful information in daily life based on user’s context. In these
systems, appropriate information selection from huge amount of candidate data
is very important, because too much uninteresting information annoys the users.
In order to select appropriate information correctly according to user’s context,
various algorithms have been developed[8]-[13]. As one of such approaches, the
Context-Aware SVM[13] using the machine learning algorithm to decide appro-
priate information from context data has been proposed, and it has been shown
that the support vector machine (SVM)[14] has better performance than other
learning algorithms for context-aware information selection[15].

In our research, we apply this context-aware recommendation technique to the
real environment. We design and implement a context-aware guide application
called Kagurazaka Explorer, which guides mobile users about the Kagurazaka
street in Tokyo, Japan according to their context. It provides appropriate infor-
mation about visiting spots in the Kagurazaka street area selected by a machine
learning algorithm. However, the conventional recommendation algorithms using
machine learning algorithms for the context modeling require very large amount
of training data to achieve high performance, because the feature space of the
learning model, which deals with so many types of the context, becomes very
high dimensional. This problem becomes so serious for the users who use the
system only a few times, or for the recommendation systems for a local area
where it is difficult to collect training data in adequate amount. As one of the
approaches to solve such an issue, reduction based methods which reduce the di-
mensions of the feature space, have been proposed. In Ref. [15][16], the reduction
based methods removing the non-effective features from feature space by using
exhaustive searches to detect features, which do not affect the user’s decision,
are proposed for context-aware recommendation. However, such approaches us-
ing exhaustive searches take much processing time for large feature space because
these approaches have to calculate the performance in all combination patterns
of the feature parameter. As another approach to reduce the feature space for
the SVM, Ref. [17] applied the principal component analysis (PCA) to extract
the low-dimensional feature of the training data, and showed that it improves
the precision of the estimation and reduces the processing time by decreasing
the number of dimensions of feature space. In the proposed guide system, we
introduce the PCA to construct an appropriate low-dimensional feature space
from the high-dimensional and the small number of the training samples.

The rest of this paper is organized as follows. In section 2, we describe the
overall concept of our proposed guide system. In section 3 and 4, we show the
detailed technique and the design of our proposed guide system. We evaluate
the implemented system in section 5. We conclude the paper in section 6.