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An Intelligent Exhibition Rule Management System using PMML*

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Recently, the exhibition industry has developed rapidly with the development of information technologies. Most exhibitors in an exhibition plan and deploy many events that may provide advantages to visitors as a method of effective promotion. The growth and propagation of wireless technologies is a powerful marketing tool for exhibitors. However, exhibitors still rely on domain experts who are costly and time consuming because of the manual knowledge input procedure. Moreover, it is prone to biases and errors and not suitable for managing fast-growing and tremendous amounts of data that far exceed a human's ability to comprehend. To overcome these problems, data mining technology may be a great alternative, but it needs to be fit to each exhibition. This study uses data mining technology with the Predictive Model Markup Language (PMML) to suggest a system that supports intelligent services and that improves stakeholder satisfaction. This system provides advantages to the exhibitor, show organizer, and system designer, and is first enhanced by integrating data mining technologies through the knowledge of exhibition experts. Second, using the PMML, the system can automate the process of applying data mining models to solve real-time processing problems in the exhibition environment.

Keywords : PMML, Data Mining, Predictive Model, Exhibition Marketing, Rule Management System

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Ⅰ. Introduction

Along with the development of technologies, the exhibition industry, which is commonly used by marketers, has received significant attention [Bellizzi and Lipps, 1984; Rosson and Seringhaus, 1995; Smith *et al.*, 2003]. In particular, exhibitions can deliver a selling message to a large number of interested people at a time, can be used to introduce new products to a large number of people, and can help uncover potential customers [Herbig *et al.*, 1998]. Given these advantages, the Center for Exhibition Industry Research (CEIR) reported that exhibitions are allocated the second largest portion of marketing dollars in the U.S. However show organizers are being driven by a competitive environment, are attempting to adjust to an ever-changing business climate, and are considering high-value services. In this environment, their customers, i.e., visitors and exhibitors, also face new problems. For example, visitors must select booths based on the purpose of their visits because an exhibition has many booths. Exhibitors also need to search for proper visitors with whom they can maintain relationships. Therefore, to provide high-value services that can solve these problems, most exhibitioners adopt and utilize information technologies. In particular, the growth and propagation of information technologies such as smart phones provides powerful tools to exhibitioners [Sumi *et al.*, 1998; Oppermann and Specht, 2000; Mathes *et al.*, 2002; Hsi and Fait, 2005]. Most efforts that use information technologies are based on the rule-based system, a computer program that manipulates experts' domain-specific knowledge and heuristics that are organized in a knowledge base to solve problems in a realistic problem area. However, despite all of these efforts, most systems still fail to meet visitors' and exhibitors' satisfaction because they typically rely on users or domain experts to manually input knowledge into the knowledge bases. Unfortunately, the manual knowledge input procedure is prone to biases and errors and is extremely costly and time consuming. Moreover, because the exhibition environment generates significant data from wireless technologies, this fast-growing and tremendous volume of data far exceeds a human's comprehension ability.

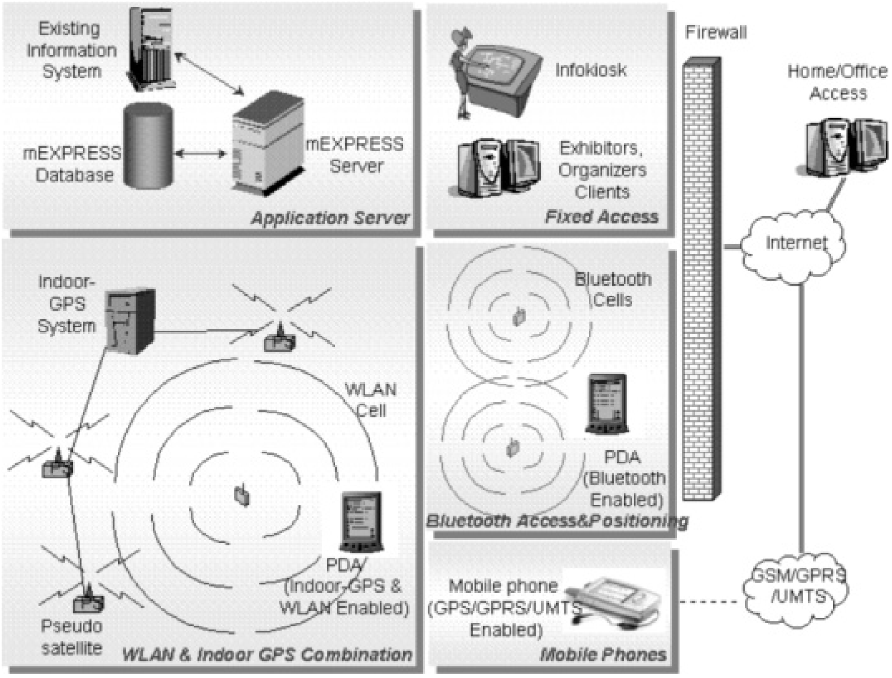
The studies conducted to overcome these limitations [Jacobs, 2009; McAfee *et al.*, 2012] found that the most successful application is data mining technologies [Kim, 2008]. Data mining often refers to the entire knowledge discovery process and the process of discovering interesting patterns and information from large amounts of data [Han *et al.*, 2011]. When a marketing issue exists and is to be solved using data mining, a predictive model is built and a solution is suggested for it based on the existing data. Because these processes need a specific data structure and are complex, they are typically batch operations. Utilizing suitable data mining technologies in an exhibition environment can solve the problems previously mentioned. However, few studies suggested a method for adopting data mining technologies in exhibitions given the major issues faced by such environments.

An exhibition is defined as a marketing event with a specific purpose and duration that is held in intervals [Browning and Adams, 1988]. Therefore, even in the case of annual exhibitions, their purpose could vary from former exhibitions because exhibitors and visitors change. Moreover, new visitors necessarily swarm during an exhibition because of its specific duration. In addition, because a new exhibition brings a large number of companies and introduces new products or services, knowing or predicting visitors' preferences is not easy. As a result, a data mining application for exhibition environments needs additional real-time processing and heuristic methods.

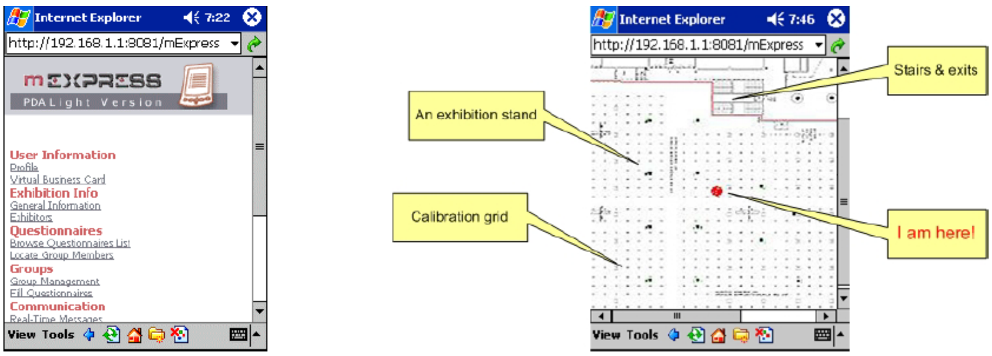
Therefore this study suggests an Intelligent Exhibition Rule Management System (IERMS) and realizes it in an actual exhibition environment. As a type of rule-based system, IERMS attempts to solve the problems previously mentioned. First, as groundwork, we conducted an expert survey analysis to define the data to be collected and how it will be collected in an intelligent exhibition environment. This groundwork allowed us to identify managerial tasks from businesses and provided an understanding of the data to enable a decision on the model most suitable to them. As a result, IERMS is enhanced by integrating data mining technologies from the knowledge of exhibition experts. Second, it can solve real-time processing problems in an exhibition environment. By using the Predictive Model Markup Language (PMML), the system can automate the process of applying data mining models. The PMML is one of the industry's most widely supported standards to represent and exchange data mining applications. Because the PMML represents models in eXtensible Markup Language (XML), it is supported in a variety of operating environments and contains a rich set of features that allows a wide range of predictive models to be presented and applied in applications. Therefore, through the information it represents, IERMS is able to conduct real-time processing. Consequently, it establishes the effect of marketing events in an actual exhibition environment and can improve stakeholder satisfaction (show organizers, exhibitors, and visitors).

Ⅱ. Related Work

In recent years, although the rule-based system in exhibitions has been intensively researched along with the development of wireless technologies, studies using data mining technologies have yet to be presented. Representatively, the purpose of the mEXPRESS research project [Mathes *et al.*, 2002] was to develop an integrated system that consists of software components, mobile terminals, wireless/mobile network infrastructure, and indoor positioning technology. mEXPRESS is a part of a European-funded project to support and facilitate the professional exhibition industry in a context-aware manner. Its architecture, as revealed in <Figure 1>, has a server in an application server that acts as an intermediary between an existing information system and its database. Therefore, given plentiful data resources, it is possible to utilize an existing information system regardless of whether or not it is supported in a context-aware manner, to enable a show organizer to easily adopt the mEXPRESS architecture and improve services. This system is expected to improve business communications with customers using a variety of devices (e.g., info kiosks, PDAs, and mobile phones) and promotions within an exhibition by exploiting wireless technologies (e.g., indoor GPS system, WLAN, Bluetooth, and mobile devices) and extending the effectiveness



<Figure 1> The mEXPRESS Architecture [Mathes *et al*., 2002]



<Figure 2> Screenshots of Wireless Exhibition Guide [Pateli *et al*., 2004]

of promotions through home and office access after an exhibition.

The Wireless Exhibition Guide [Pateli *et al*., 2004], a mediation platform as part of the m-EXPRESS project, provides several services for reaching a visitor-defined point at an exhibition. The Guide enhances visitors' experiences in terms of interaction and functionality at an exhibition by providing information, navigation, and communication services. That is, the platform attempts to provide practical services for the architecture previously mentioned. <Figure 2> is a screenshot of indicative Wireless Exhibition Guide services. The left image is of the initial screen of a visitor's terminal and the right image reveals the navigation system on the terminal.

The location collected is only used in navigation plans. In other words, because the system manually inputs information, a significant amount of data is not used to support managerial tasks. The abundance of data triggers the need for powerful data analysis; therefore, these systems should consider implementing recently developed data mining technologies [Han *et al*., 2011]. Many researchers and executives agonize over using these technologies given the dynamic and rapidly expanding nature of the field. The PMML appeared as a result of research co-works [Guazzelli *et al*., 2009; Pechter, 2009] and is one of the industry's most widely supported standards for representing and exchanging mining models. Because the PMML represents models in XML, it is supported by a wide variety of operating environments and by many of the leading industry vendors. In particular, the PMML contains a rich set of features that allows a wide range of predictive models to be presented and used in applications. <Table 1> shows overall structure of the PMML.

This study introduces the PMML to exhibitions and reveals the advantages of doing so. First, because wireless technologies are adopted in an exhibition environment, data generated at an exhibition are shifted from stable data repositories into dynamic data streams. In this environment, the PMML enables the management of complex data structures because it contains data transformations. Second, because the exhibition environment requires tracking the dynamic preferences of visitors, relevant data mining applications require real-time processing. Even if general data mining is a batch process and not a real-time process, the PMML is expected to support an exhibition's managerial tasks because it contains features of data mining models and supports most platforms, as revealed in previous studies.

Ⅲ. Procedure of IERMS

Although many managerial tasks occur during an exhibition, IERMS is suggested to provide solutions for the following examples.

(1) Predicting visitors who respond well to events: The decision tree and the artificial neural network model are well-known classification methods. Therefore, using these models, we can predict and suggest target visitors for each event.

<Table 1> Overall structure of the PMML

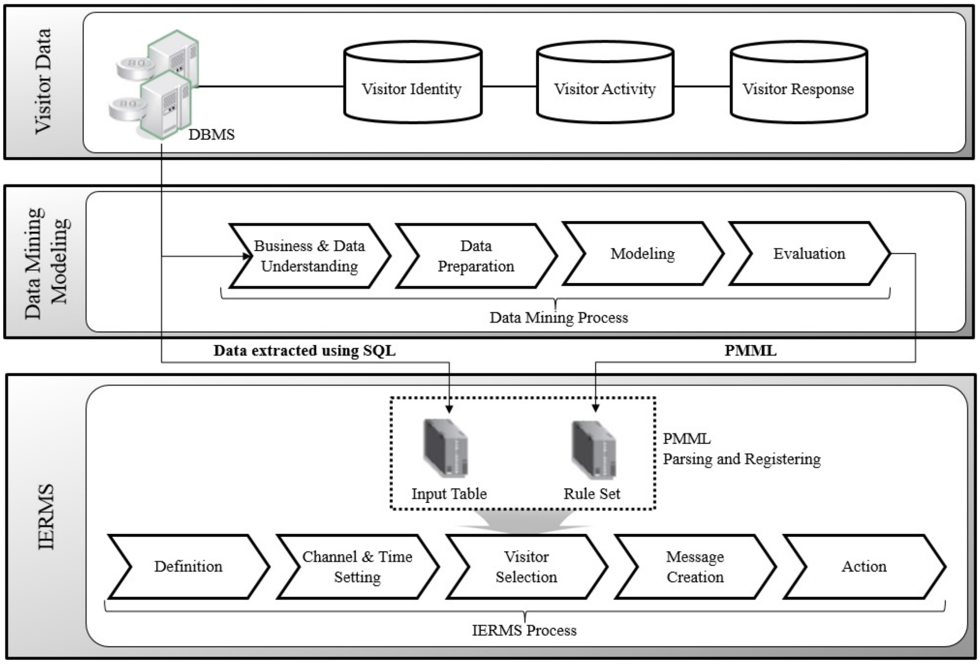
Name	Description
Header	Version and timestamp Model development environment information
Data Dictionary	Definition of variable types, valid, invalid, and missing values
Data Transformations	Normalization, mapping and discretization Data aggregation and function calls
Model	Description and model specific attributes
Mining Schema	Definition of usage type, outlier and missing value treatment and replacement
Targets	Score post-processing-scaling

(2) Segmentation of visitors: Segmentation is a basic process for strategic marketing activities. Although former marketing studies usually segment customers based on demographic information, cluster analysis is used in the data mining concept without regard for data types. That is, we can classify visitors through cluster analysis and make use of the cluster to market activities.

(3) Personalization services (e.g., booth recommendation): As an exhibition grows, a visitor may encounter information overload problems. That is, they have difficulty selecting the proper booths based on their preferences. Using the association rule, IERMS suggests proper booths for visitors based on visit records to increase visitor satisfaction.

<Figure 3> shows the overall IERMS procedure, which consists of these three stages: Visitor Data, Data Mining Modeling, and IERMS.

As previously mentioned, many log data exist in the exhibition area through wireless technologies. In particular, data related to visitors are similar to "context" in many studies. Context is any information that can be used to characterize the situation of an entity, where the entity is a person, place, or object considered relevant to the interaction between a user and an application, including location, time, activities, and the preferences of each entity [Abowd *et al.*, 1999; Yau and Karim, 2004]. Using proper data mining techniques, context can be used to predict preferences and personalization services. However, for actual uses of context data, classifying and summarizing raw context data is necessary [Kim *et al.*, 2005; Lee and Kwon, 2010]. Therefore, our study defined visitor context da-



<Figure 3> Overall IERMS procedure

ta as follows: visitor identity, visitor activity, visitor reaction. Visitor identity contains basic information on visitors such as ID, phone number, gender, age, occupation, and so on. Visitor activity contains the characteristics of each visitors' behavior (e.g., visited booths, current locations). Finally, visitor reaction contains the characteristics of each visitors' reaction for marketing activities. This context information can be used in data mining modeling.

Based on these contextual data from former exhibitions, we use a general data mining modeling process. To apply the data mining model, we first understand the business domain and the characteristics of the data. In other words, we determine problems with respect to stakeholders when understanding the characteristics of an exhibition and decide on the model that is proper for the problem and the data to use. Then, we implement the model using the data and decide on the features of the model through evaluation. For example, we assume that a manager wants to classify his or her visitors according to contextual data. The IERMS manager decides that clustering analysis is appropriate for solving the problem. Using former exhibition data, the manager implements the cluster model and selects clusters based on evaluation metrics for the model.

After data mining modeling, to adopt the model to the actual exhibition environment, we lay the groundwork, which consists of PMML parsing and registering. Because PMML represents the model's features, we parse PMML and translate it to SQL to create an input table and rule set. For instance, in the cluster model, we assume that cluster 1 contains men in their 20s as a result of the clustering when the input variables are set as gender and age. This result is a feature of our model. Although these features are different according to the mining models, they are revealed as SQL (e.g., select gender, age from visitor identity) and "if-then" rules (e.g., if age >= 20 and age <= 29 and gender = "male" then cluster 1).

During actual use, a manager first defines the campaign and sets the channel and time. Then, he or she selects the model and creates a message. When implementing a campaign, IERMS automatically analyzes visitors based on the selected model and sends a message to the visitors that correspond to the model. That is, using PMML and not batch processing, IERMS can adopt the model in real time to be able to cover the exhibition environment.

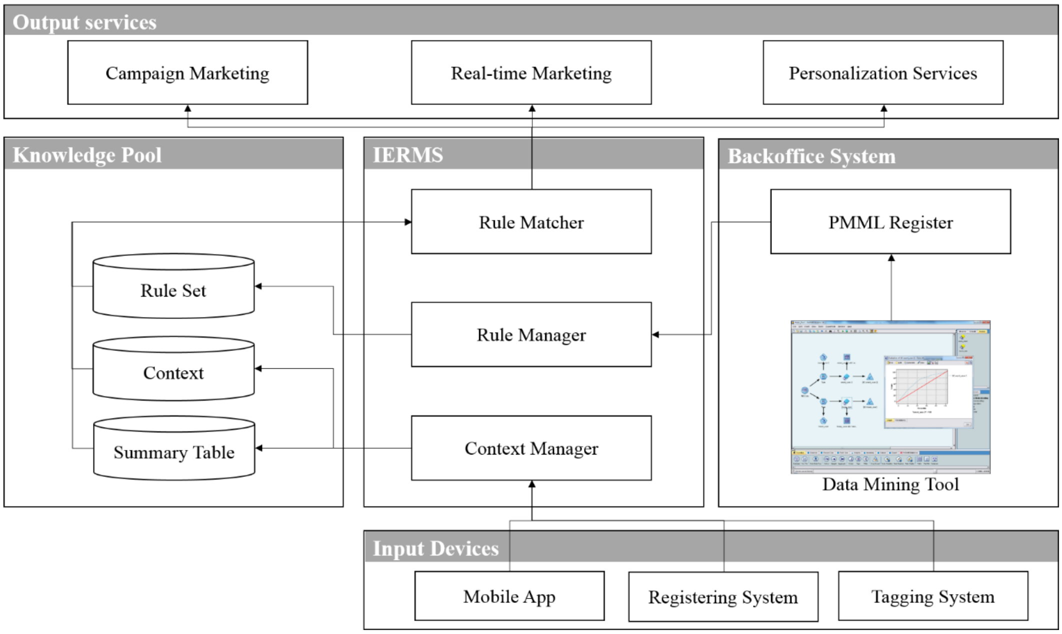
Ⅳ. Applications of IERMS

To evaluate the performance of IERMS, we create a prototype and adopt it to an exhibition, the Korea Franchise Expo 2012 held at SETEC in Korea. The exhibition was held from March 15 to 17 in 2012. From the exhibition, we obtained 1,208 visitor profiles. During the exhibition, we used IERMS to provide a service that supports the campaign management process.

4.1 System Architecture

The system architecture of our prototype is revealed as <Figure 4>.

As <Figure 4> shows, it has three major components; Knowledge Pool, IERMS, Backoffice system. First after the IERMS manager had generated data mining models using a data mining tool, *PMML register* in Backoffice system inter-



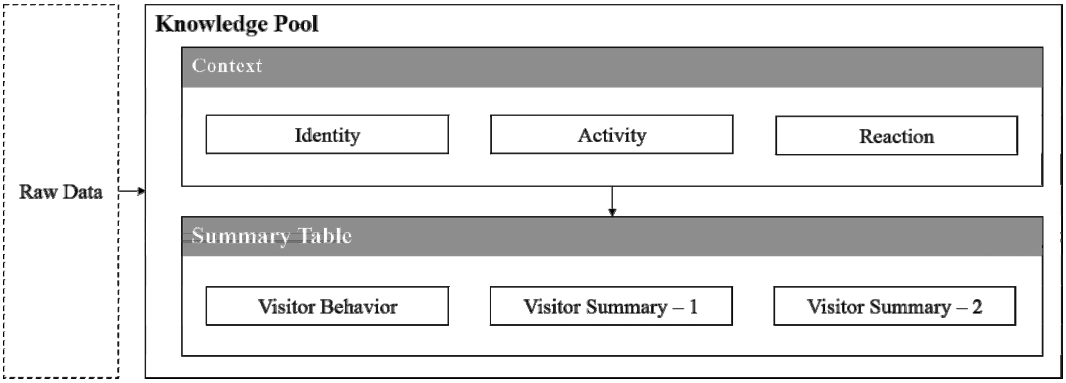
<Figure 4> System architecture of IERMS

prets them and deliver interpretation results to *Rule Manager* in IERMS. Second, when raw data is collected from Mobile App, Registering System, and Tagging System (e.g., QR Code, NFC, and so on), *Context Manager* translate it to preprocessed data. Finally, when *Rule Manager* and *Context Manager* save their data to Knowledge Pool, the changes trigger *Rule Matcher*. And it explores rules and visitors which are suitable for their services.

4.2 Knowledge Pool

Before the Korea Franchise Expo 2012, we collected visitor data on similar exhibitions according to our structure (visitor identity, activity, and response). Generally, a visitor should register by filling out a questionnaire before he or she enters the exhibition hall. Thus, the visitor identity data (e.g., age, gender, and so on) was collected through the questionnaires, and data on visitor activity were collected using wireless technologies. To collect data on visitor activity, we induced visitors to tag the booths they visited using a tagging solution (bar code, QR, RFID, and NFC) with their smartphones. A visitor downloaded the application for an exhibition and then tagged booths, and the data were collected on our server system. Finally, data on visitor reaction were also collected through smartphones. Visitors who downloaded the application were transmitted messages for events. When a visitor received a message, he or she selected between “show details” and “close.” After receiving a message, the visitor may have visited the booth that sent the message. These data on reactions to events were classified at three levels (dislike, like, and visit) and were collected on our server.

As mentioned above, knowledge pool is a



<Figure 5> Structure of Knowledge Pool

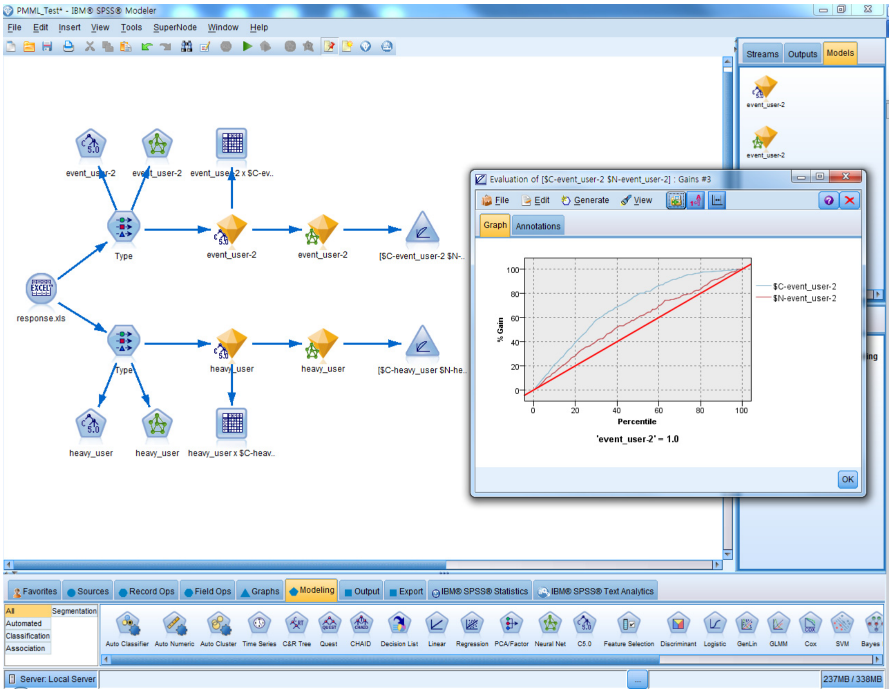
storage for these visitor data. In particular, such as <Figure 5>, it has two classes for visitor data; *Context* and *Summary Table*. First, *Context* means data related to visitors. That is, *Context* covers all data from visitors' identities, activities, and reactions. Second, *Summary Table* summarizes these context data. For example, booth visit logs in the exhibition are summarized into *Visitor Behavior*. In other hands, *Visitor Summary-1* summarizes visit patterns in the exhibition (e.g., the number of booth visits), and exhibition visit patterns (e.g., the number of exhibition visits) are summarized into *Visitor Summary*-2.

4.3 Data Mining Modeling

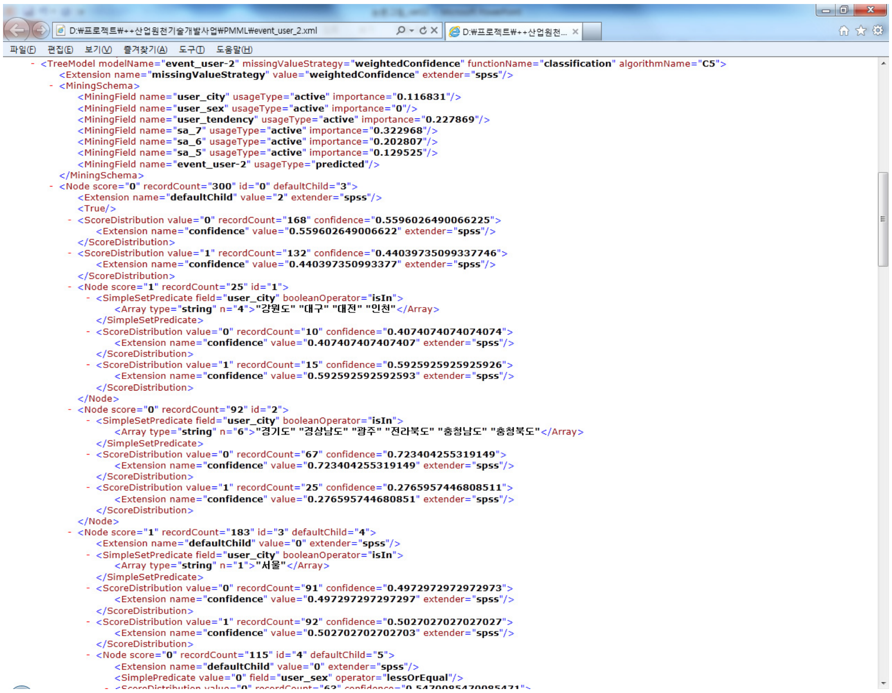
For the collected data, we first decided on the information to obtain. At an exhibition such as the Korea Franchise Expo, their exhibitors plan and implement various promotions to attract visitors. However, they do not know who their target visitors are, i.e., their real customers. Moreover, because their promotions consume time and money, predicting the visitors who may visit their booths and react well to their events is important. To support this managerial task, we implemented two data mining models (Decision tree model and Artificial neural network). As <Figure 8> shows, to implement these models, we used the data mining application IBM SPSS Modeler 15.0.

In <Figure 6>, predicting visitors who react well to events defines "event_user" as an event reaction to the possibility of visitors. To apply the model, the event reaction rate is used as an output variable and indicates whether a visitor visited booths from which he or she received an event message. For example, if a visitor receives 10 event messages and visits five of the related booths, his or her event reaction rate is 0.5. Therefore, the data mining models decides on the weights of the input variables (e.g., gender, age, and so on) for the event reaction rate and predicts the value of "event_user." Consequently, in <Figure 6>, the evaluation indicates that the decision tree model (blue line) shows the higher performance for predictions than artificial neural network (red line). Moreover, it is a typical classification model which shows a flowchart-like tree structure for ease of understanding.

As a result, we choose the decision tree model for predicting the value of "event_user". <Figure 7> shows the features of the model as represented by PMML.



<Figure 6> Implementation of the Data Mining Models Using IBM SPSS Modeler 15.0



```
<TreeModel modelName="event_user-2" missingValueStrategy="weightedConfidence" functionName="classification" algorithmName="C5">
  <Extension name="missingValueStrategy" value="weightedConfidence" extender="spss"/>
  <MiningSchema>
    <MiningField name="user_city" usageType="active" importance="0.116831"/>
    <MiningField name="user_sex" usageType="active" importance="0"/>
    <MiningField name="user_tendency" usageType="active" importance="0.227869"/>
    <MiningField name="sa_7" usageType="active" importance="0.322968"/>
    <MiningField name="sa_6" usageType="active" importance="0.202807"/>
    <MiningField name="sa_5" usageType="active" importance="0.129525"/>
    <MiningField name="event_user-2" usageType="predicted"/>
  </MiningSchema>
  <Node score="0" recordCount="300" id="0" defaultChild="3">
    <Extension name="defaultChild" value="2" extender="spss"/>
    <True/>
    <ScoreDistribution value="0" recordCount="168" confidence="0.5596026490066225">
      <Extension name="confidence" value="0.559602649006622" extender="spss"/>
    </ScoreDistribution>
    <ScoreDistribution value="1" recordCount="132" confidence="0.4403973509933746">
      <Extension name="confidence" value="0.440397350993377" extender="spss"/>
    </ScoreDistribution>
    <Node score="1" recordCount="25" id="1">
      <SimpleSetPredicate field="user_city" booleanOperator="isIn">
        <Array type="string" n="4">"강원도" "대구" "대전" "인천"</Array>
      </SimpleSetPredicate>
      <ScoreDistribution value="0" recordCount="10" confidence="0.4074074074074074">
        <Extension name="confidence" value="0.407407407407407" extender="spss"/>
      </ScoreDistribution>
      <ScoreDistribution value="1" recordCount="15" confidence="0.5925925925925926">
        <Extension name="confidence" value="0.592592592592593" extender="spss"/>
      </ScoreDistribution>
    </Node>
    <Node score="0" recordCount="92" id="2">
      <SimpleSetPredicate field="user_city" booleanOperator="isIn">
        <Array type="string" n="6">"경기도" "경상남도" "광주" "전라북도" "충청남도" "충청북도"</Array>
      </SimpleSetPredicate>
      <ScoreDistribution value="0" recordCount="67" confidence="0.723404255319149">
        <Extension name="confidence" value="0.723404255319149" extender="spss"/>
      </ScoreDistribution>
      <ScoreDistribution value="1" recordCount="25" confidence="0.2765957446808511">
        <Extension name="confidence" value="0.276595744680851" extender="spss"/>
      </ScoreDistribution>
    </Node>
    <Node score="1" recordCount="183" id="3" defaultChild="4">
      <Extension name="defaultChild" value="0" extender="spss"/>
      <SimpleSetPredicate field="user_city" booleanOperator="isIn">
        <Array type="string" n="1">"서울"</Array>
      </SimpleSetPredicate>
      <ScoreDistribution value="0" recordCount="91" confidence="0.4972972972972973">
        <Extension name="confidence" value="0.497297297297297" extender="spss"/>
      </ScoreDistribution>
      <ScoreDistribution value="1" recordCount="92" confidence="0.5027027027027027">
        <Extension name="confidence" value="0.502702702702703" extender="spss"/>
      </ScoreDistribution>
      <Node score="0" recordCount="115" id="4" defaultChild="5">
        <Extension name="defaultChild" value="0" extender="spss"/>
        <SimplePredicate value="0" field="user_sex" operator="lessOrEqual"/>
```

<Figure 7> PMML Description of Event_user Model

4.4 IERMS

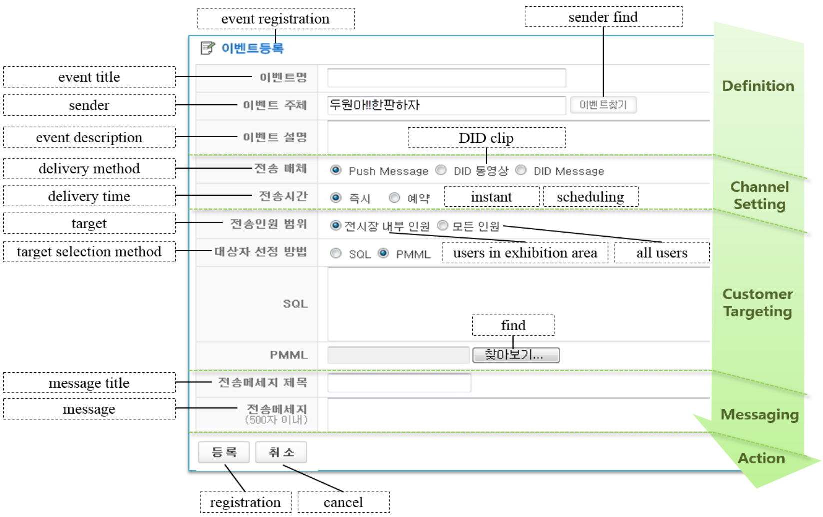
As <Figure 7> shows, PMML contains all of the features of the model, and we need to parse the PMML description to use this information. Such groundwork is called the model parsing process, which consists of a model parsing module and a data parsing module. These modules parse from PMML and translate actual expressions to systems. First, the model parsing module extracts the rule set from PMML, reveals some rules, and stores the proper rule set in a database such as that in <Table 2>.

In contrast, the data parsing module parses the data transformation structure of PMML. Because PMML has a data structure that the model needs, the data parsing module represents the data transformation structure to structured query language (SQL). Therefore, the database management system (DBMS) can use SQL to create the input table for the rule set.

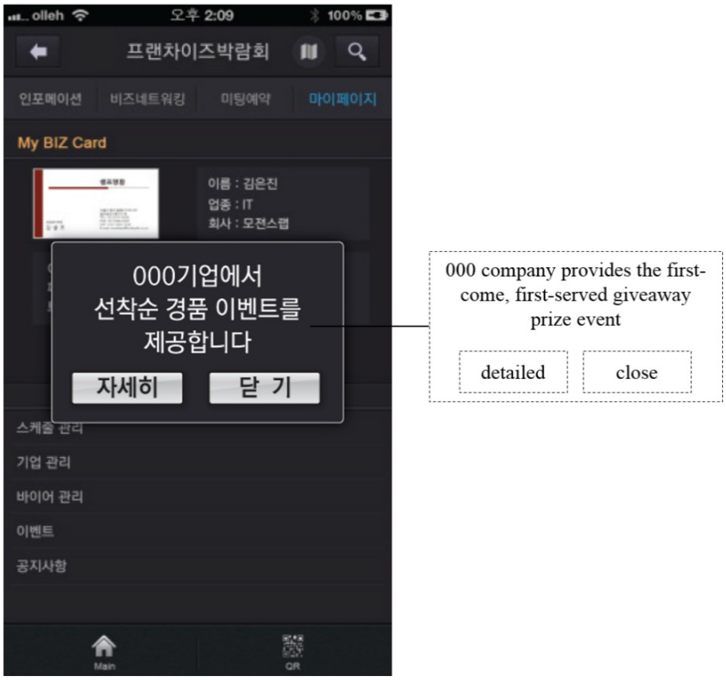
During the Korea Franchise EXPO 2012, when an exhibitor plans an event, IERMS supports his or her marketing activity through the client system, as shown in <Figure 8>.

<Table 2> Example of Translating PMML Description to a Rule Set

PMML	Rule set
<Node id="3" recordCount="34" score="0"> **<SimplePredicate field="user_age" operator="lessOrEqual" value="20"/>** **<ScoreDistribution confidence="0.6388888888888888"** recordCount="22" value="0"> <Extension extender="spss" name="confidence" value="0.638888888888889"/> </ScoreDistribution> <ScoreDistribution confidence="0.3611111111111111" recordCount="12" value="1"> <Extension extender="spss" name="confidence" value="0.3611111111111111"/> </ScoreDistribution> </Node>	IF … and **user_age<=20** and … THEN confidence=**"0.6388888888888888"**



<Figure 8> IERMS client system



<Figure 9> Screenshot from a Target Visitor's Device Who Received an Event Message

In the client system, an exhibitor first defines the event (event name and agent) and then selects the message channel (smart phone and Digital Information Display) and time schedule. After that, to predict the target visitors, the exhibitor loads the suitable PMML file, which has the features of the model. Lastly, he or she creates a message and selects an action.

In this application, because we implement the decision tree model based on real-time analysis, IERMS automatically sends an event message to target visitors with higher event reaction possibility than others. <Figure 9> provides a screenshot of a target visitor.

Ⅴ. Conclusion

Exhibitions receive attention as a notable marketing promotion method. Exhibitions' organizers and exhibitors are driven to a competitive environment and must consider the provision of high-value services for their customers (i.e., visitors). In particular, the growth and propagation of information technologies provides powerful tools to organizers and exhibitors to improve business communications and promotions within exhibitions. However, adopting these technologies is extremely expensive and time consuming because they typically rely on domain experts to manually input knowledge. Moreover, the fast-growing and significant volume of data generated from wireless technologies in an exhibition environment far exceeds a human's ability to process. Research undertaken to overcome these limitations showed that the most successful application is data mining technology. If we can utilize suitable technologies in an exhibition environment, the previously mentioned problems can be solved.

Therefore, this study recommends using PMML and suggests IERMS to support exhibition environments through information technologies and realizes it in an actual exhibition environment. This approach has advantages in such environments. First, it is designed to support intelligent events using them and is enhanced by integrating these technologies with the knowledge of exhibition experts. Second, using PMML, the approach automates the process of applying data mining models to enable problems to be solved in real time in the exhibition environment. Third, in addition to the studies related to exhibitions, many of the researchers try to adopt their studies to practical use such as the marketing strategy. Therefore, as the approach established its ability to market events in actual environments, we expect that this study give some insights to them.

Future studies will first examine the performance of IERMS. Although we designed and deployed a pilot system in an exhibition, careful experiments that measure system performance, exhibitors' satisfaction, and visitors' reactions are needed. Next, the approach in this study was revealed in a one-direction process; however, numerous recent studies on intelligent services showed that interactive systems are receiving increasing attention. That is, our architecture requires an evolutionary concept based on the performance of models. Therefore, through literature reviews, we will develop our system to interact with customers, i.e., visitors and exhibitors.

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