Recommendation Algorithm of the App Store by Using Semantic Relations between Apps

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Abstract. In this paper, we propose a recommendation algorithm for recommending mobile application software (app) to mobile user using semantic relations of apps consumed by users. To do that, we define semantic relations between apps consumed by a specific member and his/her social members using Ontology. Based on the relations, we identify the most similar social members from the reasoning process. In the experimental section, we show feasibility of our algorithm using a specific scenario.

Keywords: app, recommendation, mobile, semantic relation, social members.

1 Introduction

A report commissioned by mobile application store GetJar in 2010 [1] said that the mobile app (application software) market will reach $17.5 billion by 2012, having grown to 50 billion downloads from just 7 billion in 2009. The mobile app market definitely has tremendous room to grow, which takes the mobile app paradigm and slaps it onto a bigger, tablet device. Mobile app recommendation services have sprung out of a growing need to filter, rank and recommend the best apps from the hundreds of thousands now available for download onto mobile phones or tablet PCs. With iTunes now carrying 225,000 apps and Android up to 100,000, it is no wonder users have turned to other resources beyond the search box and category listings found in the official vendor-specific app stores. For the end users, recommendation services like these prove useful, even necessary at times.

Personalization is defined as the ability to provide content and services tailored to individuals based on knowledge about their preferences and behavior [2]. The main

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goal of personalization is to help users find the information they are interested in, what can significantly enhance their mobile experience. Most of personalization systems try to filter available content by user's preferences and recommend only content found potentially interesting for that particular user. Personalized apps recommendation services analyze app purchases made by users, and then recommends similar apps that users may find useful for their mobile devices. The same approaches are used for recommended music and video purchases.

Each service offers its own feature set and ranking algorithm. Some, for example, not only take into account an app's popularity, but also its media coverage when ranking the apps. Others use a combination of signals including apps you own and members' reviews in their algorithms. AppStoreHQ [3] is a site featuring apps for Android, iPhone, and iPad and even Web-based HTML apps. Here, a user can find what apps are hottest on the Web, what are hottest on Twitter and it offers app reviews. Appolicious [4] ranks and recommends iPhone, iPad, Android and Yahoo applications using a number of mechanisms, including reviews, likes, and friend recommendations. Users can follow their friends on the site and train the recommendation engine by sharing what apps they already have installed. Then, when signed in, the site can recommend new apps to try based on your preferences, what apps you own and other signals. Smokin Apps [5] features the top mobile apps for iPhone, Android, Blackberry, Nokia, Palm and Windows Mobile. Its recommendation engine matches a user with apps he would like based on apps similar to those his own. It then combines that information with other members' recommendations using an algorithm that tracks every way user’s rate apps on the site. Apple adds Genius recommendation tab to iPad App Store [6]. A mobile version of Apple's Genius recommendation feature, which suggests applications to users based on their account activity.

The most difficult aspect of recommendation service is to understand user's preferences and to use them in an intelligent way for app filtering. In order to solve the problem, we define semantic relations between apps consumed by a specific member and his/her social members using Ontology [7]. Based on the relations, we identify the most similar social members from the reasoning process. The reasoning is explored from measuring the common attributes between apps consumed by the target member and his/her social members. The more attributes shared by them, the more similar is their preference for consuming apps. Once the similar members are identified, then the consumed apps by the members are recommended to the target member.

The remainder of this paper is organized as follows. Section 2 introduces related works of our work. Section 3 explains our proposed algorithm. Following this, we demonstrate our algorithm using a scenario in Section 4. Finally, we conclude in Section 5.

2 Related Work

According to [8] and [9], personalization techniques are classified in four classes: content based filtering, collaborative filtering, model based techniques, and hybrid techniques. Content based filtering uses an individual approach which relies on user's ratings and item descriptions. Items having similar properties as items positively rated by user are being recommended to the user. The most common problem of content based filtering is the new user problem. This problem occurs when a new user is added to the system, hence has an empty profile and cannot receive recommendations.

Collaborative filtering recommends a target user the preferred content of the group whose content consumption mind is similar to that of the user. Problems in collaborative filtering occur when new content item is added to the system, because the item cannot take place in personalization without being rated before. It has been attractive for predicting various preference problems such as net-news, e-commerce, digital TV, digital libraries, etc. Model based techniques are usually implemented by using a predetermined model. They represent an improvement in scalability issues, because part of data is pre-processed and stored as model, which is used in the personalization process. Hybrid personalization techniques combine two or more personalization techniques to improve the personalization process. In most cases, content based filtering is combined with collaborative filtering.

Traditional personalization techniques can provide very suitable solution for tailoring apps according to user's preferences. On the other hand, traditional personalization has limitations in accuracy of modeling user's behavior. In this paper, we use the semantic relations among apps using Ontology concept. From the following section, we demonstrate our reasoning algorithm in detail.

3 Reasoning Algorithm Using Semantic Relations

In this subsection, we describe the reasoning algorithm to provide personalized app to each social member in a collaborative manner. The approach is explored under the assumption that the interests in app of each member tend to agree with those of the social members.

We first define the semantic relations between the apps a specific (or target) member and his/her members used and attributes of each app consumed by each member through social network. Fig. 1 is a part of the semantic relationship established from interrelating the specific apps of the target member and the apps of his/her social members. The semantic relations are defined by extracting the common instances for each attribute of the apps using WordNet [22]. In the figure, the target member’s apps and the app of social member are represented on the left side and on the right side respectively. Also, the yellow ellipse, blue ellipse, and gray square denote sub-class, attribute class, and attribute respectively.

Due to the diversity of general social concepts, our ontology is built with a multiple hierarchy of classes that represents domain concepts such as *Food* and *Social network*. Each class contains sub-classes such as *Recipe*. Also, the classes and instances of the apps are linked through their semantic attributes according to their semantic similarity. Based on the links, we can infer the semantic similarity between the target’s apps and the apps of social members. If the classes or instances in the target’s apps and the apps of the social members are connected to each other with a link, then we consider the apps to be semantically similar. The more common links

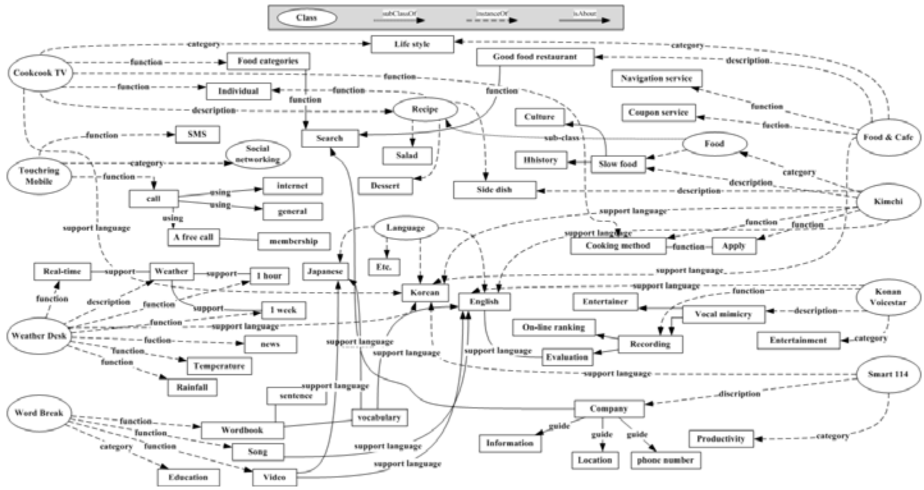

Fig. 1. A part of the semantic relationships established by interrelating the shopping product the stereotyped and the ontology of commercial advertisements

there are between them, the more similar they are in terms of the semantic relation. Consequently, the more relations we can infer between them (and the more relations from that set are established through common attributes), such as *Life style* of the instances in Fig. 1, the greater their semantic similarity is. Also, the same semantic metric is established through sibling attributes if they have attributes belonging to the same class, such as *Recipe* of classes. For example, let's assume four app are consumed, such as Cookcook TV, Touchring Mobile, Weather Desk, and Word Break. The app Cookcook TV has the instances such as *Life style*, *Food category*, *individual*, *Recipe, and Korean*. The instance *Life style* is shared with Food&Cafe in the app of member. Also, *Recipe* is connected to Food&Café and Kimchi, because *Recipe* is included in the sub-class of class *Food*, which is connected to the instance *Food* in Kimchi. The instance *Food categories are* connected the instance *Search* and the instance *Search* is connected the instance *Company* of Smart 114. Therefore, Cookcook TV and Smart 114 have the equal *function* relationship.

Once the semantic relations among apps consumed by social members as above are defined, then for each target member, we can identify the social members who have similarity preference in consuming apps from the measurement of the number of links in the semantic relations. The more links are shared between the target member and his/her social member, the more similar they are for consuming apps.

4 Experiment

In this section, we describe the reasoning process of our recommendation system using a specific scenario. In order to demonstrate our reasoning process, we first collected 24 apps from a social network in which there five members as seen in Table 1.

Table 1. Attributes of apps consumed by members in the social network

Member	Apps	Attributes
A	Cookcook TV, Touchring Mobile, Weather Desk , Word Break	life style, food categories, cooking method, Individual, SMS, call, weather, real-time, temperature, song, rainfall, wordbook, video, education, Korean, Japanese, English
B	Chinese-character Study, Driver´s License Pretest, Sign Language Dictionary, YBM English Dictionary, TOEIC Speaking	Chinese character, a qualifying examination, study, vocabulary, writing, driver's license, pretest, an item pool, sign language, life style, TOEIC, English, Korean
C	Smart Dial, Kimchi, Clip English, Kakaotalk, Film Lab, sGeoNotes	phone, study, slow food, cooking method, photo, social network, memo, schedules, English
D	Food&Café, Konan VoiceStar, Kimchi, Smart114	life style, good food restaurant, navigation service, coupon service, food, slow food, side dish, cooking method, vocal mimicry, entertainment, apply, company, productivity, Korean, English
E	Weather Star, mFAX, One Lock, My Photo Album, iSharing	weather, a weather forecast, smart-card, security, economy, fax, real-time, GPS tracking, location, call, photo, social network, English

From the table, there are 3 common attributes between the member A and the member B, 2 common attributes with the member C, 7 common attribute with the member D, and 2 common attribute with E. From the result, we consider the member D is the most similar to the member A because the number of common attributes shared between member A and the member D is the largest compared to the other members. Therefore, we recommend the apps consumed by the member D to the member A as shown in Fig. 2. Table 2 shows the list of the identified similar member for consuming apps.

Fig. 2. The recommended apps thru the member A's mobile

Table 2. Attributes of apps consumed by members in the social network

Member	Identified similar member
A	D
B	C
C	E
D	A
E	C

5 Conclusion

In this paper, we proposed the recommendation algorithm using semantic relations between apps consumed by social members. For showing the feasibility of our algorithm, we developed a prototype of a personalized apps recommendation system using OWL by defining ontology-based semantic relations among mobile apps consumed by social members.

As a further work, we need to do further experimental analyses using more data. This is necessary because the reasoning performances depend on the richness of the data. If the population in a social network is large, then the identification performance will be improved.

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