Study of Context-based Personalized Recommendations for Points of Interest

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Location-based services are essential to delivering information for users in the context of travel, leisure, and sports application. Nevertheless, these services are often implemented as recommendations and suggestions that may overwhelm users, or fail to adapt to their goals, behavior, and context. To address these limitations, this paper presents NEARME , an application that provides tailored recommendations of Points of Interest surrounding the user. Beyond existing approaches, NEARME allows the generation of dynamic recommendations from heterogeneous service providers, and the definition of regions to which notifications are related. Moreover, it allows to fine-tune notifications, thus preventing over-information and noise. A preliminary study has been conducted involving a heterogeneous group of potential users and service providers that elaborates on their vision, expectations, features desiderata, and possible interfaces.

1 INTRODUCTION

A whole new generation of travelers wonders aware of having the whole world in their pockets. Smartphone are seen as a gateway for any piece of information that might be needed. For instance, while searching for restaurants, users screen their geographical locations, offers, and reviews. Recovering such information has been made incredibly easy by multiple applications such as TripAdvisor, the Fork, and Google Maps, to name a few. Existing services go beyond providing information on demand about restaurants or other services. Indeed, recommendations based on the recent users' behaviors are often provided via newsletters or notifications (from multiple apps) trying to nudge the attention of potential customers.

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Although intended to provide a service to the traveler, those interactions mostly cover the service providers' marketing interests, neglecting the users who are only passive receivers (i.e., unable to finely tune or personalize the received contents). Moreover, such existing approaches to share services/commercial information do not consider context information such as the time and the location of the user, which are of outstanding relevance for the consumption of touristic-related services. Unless actively looking for a given service, a wandering tourist (or just a general person walking around) might miss relevant services/products that could just be *behind the corner*. Therefore, the overall time-, position-, and other context-related limitations of the existing services demand a new system that embraces overlapping opportunities.

This paper presents NEARME , an application that provides contextualized fine-tuned recommendations of Points of Interest (POIs) surrounding the user. The added value of NEARME is two-folded: From a service provider perspective, it allows the generation of services recommendation and the definition of a region in which the user can receive the related notifications. From a user perspective, it allows to fine-tune the system parameters and notifications to be shown (e.g., types of cuisine, activities, and museums) to prevent over-information and noise. To do so, we have conducted a preliminary study involving a heterogeneous group of potential users and service providers that elaborate on their vision, expectations, features desiderata, and possible interfaces. The outcome of such a study supported the outline of the system design and the definition of the testing paradigm.

The rest of the paper is organized as follows. Section 2 presents the state of the art of location-based push notification applications and the related challenges left open. Section 3 details the design, the implementation, and the recommender engine of NEARME app. Section 4 discusses the survey conducted in order to understand users' needs and to optimize NEARME functionalities. Finally, Section 5 concludes the paper and introduces ongoing and future works.

2 STATE OF THE ART & CHALLENGES IDENTIFICATION

NEARME seats at the intersection of domains such as geofencing [10, 11] and push notification-based marketing [16]. A geo-fence is a virtual boundary for a real-world geographic area (either polygonal or a circular) [13]. Usually, the global positioning system (GPS) as-is or in combination with other technologies such as radio frequency identification (RFID) and WiFi are used to refine the geographical boundaries. Practically, geo-fence-based applications monitor mobile devices as they enter/exit a given geo-fenced area. Such a

technique is commonly used to communicate to the administrators of a given area that a transition has happened, thus triggering contextual actions.

Leveraging such an approach, multiple Location-Based Services (LBS) emerged to offer services through mobile phones according to the devices' geographical location. Such services can either *push* (passive reception) or *pull* (intentional and active request) information via a simple subscription in one or more dedicated platforms. The LBS advertisement is an example of a push service [16]. LBS span over marketing, emergency, information services, navigation, location-based social media, mobile gaming, sports, billing, geo-tagging, tracking, and job alerts [13, 14]. LBS can be (i) static (w.r.t. a fixed area) – the notifications are sent to specific mobile users when they enter into a geo-fenced area, (ii) dynamic (w.r.t. a changing data stream) – the notifications are sent to *passing-by* users, even if briefly entering and leaving the area, or (iii) Peer-to-Peer-based (w.r.t. the positions of other users) – notifications triggered by the proximity with a given user. The most relevant LBS features are location accuracy, tracking rate, device speed, device route, and geo-fence size [13]. Google Maps is one of the most popular apps that leverage on geo-fenced approach for GPS navigation as well as a map viewer for POIs in a selected area.

Traditional marketing strategies were mainly limited to mass media such as television, radio, newspapers, magazines, billboards, and the traditional Internet without location determination [7]. Moreover, mobile devices have been largely exploited to gather information about nearby businesses including reviews, directions, contacting the business, and using commercial applications. Nevertheless, advertising notifications about shops via traditional media often reaches consumers who are hardly interested in them, or not in the position of making a given transaction (thus, missing the offer [2]).

Analyzing the current state of the art, it is possible to formalize the following open challenges: CH1 - To realize an app that federates the services notification of local businesses. CH2 - To provide the user with tools to fine-tune the information, henceforth notification, that they receive w.r.t. item/service and context. CH3 - To improve the trade-off for draining battery lifetime.

3 DESIGN AND IMPLEMENTATION

This section presents the design of our context-aware personalized POI recommendation app named NearMe . Figure 1 illustrates the main actors of NearMe . In particular, service providers such as shops' and museums' owners can allocate POIs (e.g., deals and exhibitions) in specific geographical areas within defined time intervals. When users enter/cross a POI area (expressed as a geo-fenced area), they can be notified with the related POIs information (e.g., deal of the day or menu for dinner).

3.1 Architecture

The app has been developed in Flutter[6], which crafts natively compiled applications for mobile, web, and desktop from a single codebase. Accessing the app, service providers can allocate their POIs. In order to store POIs, the app is connected to the database
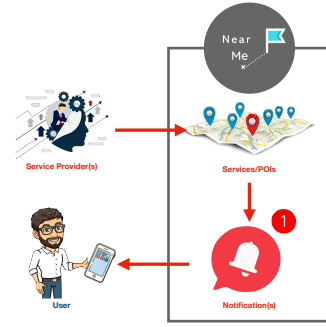

Fig. 1. NearMe app overview

Cloud Firestore[1], a NoSQL database to store, sync, and query data for mobile and web apps at a global scale. However, some POIs, such as parks and lakes, are not related to a specific service provider. Therefore, the NearMe app enriches Cloud Firestore using third-party datasets coming from FourSquare [15], OpenStreetMap [12], and tourist organizations. In order to provide personalized POIs recommendations, NearMe enables users to select (i) specific types of resources such as food or activity, (ii) the volume and the time to be notified, (iii) and the satisfaction level of suggested POIs. With the mentioned data and the context-based data such as the day of the week, time, and weather conditions, NearMe can provide custom POIs suggestions efficiently. Notice that context-based information is not related to users, and therefore, no tracking is needed. For privacy concerns, users' data are stored locally using Hive, a database technology that can define databases and tables to analyze structured data [4]. It is an offline database (store data in local devices) committed to protecting the privacy of the users. Therefore, no user data exportation is allowed.

3.2 System Pipeline

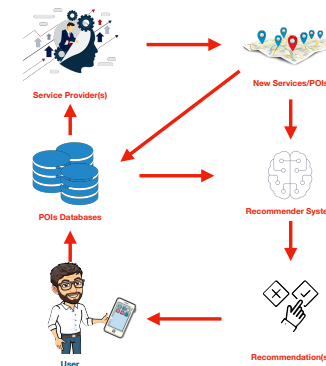Figure 2 introduces the proposed personalized POIs recommendation pipeline described below.

Fig. 2. NearMe app recommendation pipeline

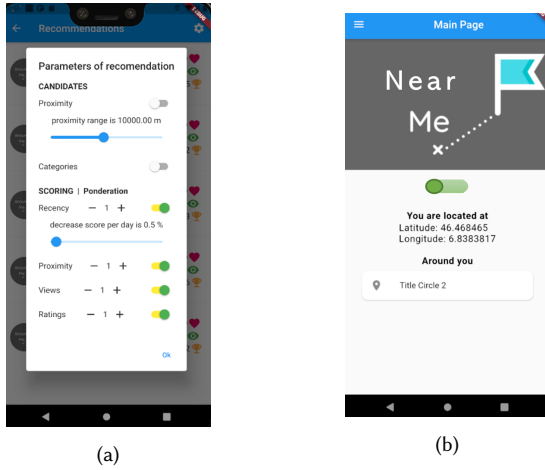[1]https://cloud.google.com/firestore/

(a)   (b)

Fig. 3. App recommendation parameter and homepage

The source of the data required for the recommender engine can be explicit (i.e., selected by the user) or implicit (i.e., based on the user context). As explicit data, we consider POI category (e.g., food-related), POI rating (e.g., best rated), notifications limit (e.g., max 5 per day), notification timing (e.g., only morning or from 9 to 10), and max user radius (e.g., POI within 1 km). As implicit data, we consider the user proximity to the POI, the number of POI views, time and day of the week, number of POI suggested, and the POI lifetime. As shown in Figure 3a, users can tune the recommendation parameters by selecting features and their respective weights. Indeed, users can personalize their recommendations by changing the weight of the respective features. Therefore, some users can decide to receive POIs with the most views rather than POIs with the best rating. It is worth noticing that the POIs scores decrease during to their lifetime of a rate factor selected by the user.

NEARME app implements a collaborative-content-based filtering recommendation model, which considers both user and POI features. On the one hand, the recommender system provides POI suggestions based on the user-content interaction (i.e., recommend similar POIs based on user preference). On the other hand, the app suggests POIs based on other users interested in similar POI categories. The collaborative-filtering recommender system allows users to discover POIs out of the primary user area of interest. In other words, it fosters serendipity.

To overcome the cold-start issue (i.e., missing data for new users), the app starts recommending the most popular and rated POIs near the user. As the user tunes the recommendation parameters, the recommender system begins to provide POIs related to the user's preferences.

In order to improve the quality and relevance of a recommendation, it is essential to leverage all information available. Therefore, to enable a personalized recommender system besides the user's preference, the system considers context data such as time and day of the week. Context is any environmental, temporal, or otherwise variable that influences a decision a user might make [8]. The context-aware recommender system is known as CARS [8],

and it is used in movie recommendation systems since users provide different ratings based on the day of the week (i.e., no regular user behavior patterns). Therefore, two NEARME users having the same preferences can receive different notifications even if they are in the same location but at a different time or day of the week. Frappe [1] is the first mobile app to provide context-aware recommendations, which improves recommendation quality due to its smart context adaption. However, the NEARME app combines CARS with user interaction, enhancing the accuracy of the recommendations. Interactive-context-aware recommendations systems or I-CARS was introduced in [9]. Given a target user u and an item set I, I-CARS exploits the interaction between u and the system for capturing the dominant contexts and preferences of u returning a list of items with the best relevance to u in the dominant context subspace. In the NEARME app, the recommender engine provides a score for each item, which indicates the relevance of I given u. The score is evaluated as follow:

$$r_{i,u,t} = X_i Z_u \Lambda_i$$

where $r_{i,u,t}$ is the score of a POI i given the user u at time t, X_i is POI feature vector (e.g., rating, views, and category), Z_u is the user preference vector, which incorporates user feedback, and Λ_i is the context feature vector such as time of the day, weather condition, and day of the week. The output of our recommender system is a list of POIs to suggest sorted by the respective score. As presented, the score includes user preferences, POI information, and context data. Finally, the user feedback enables NEARME to reevaluate the suggestion improving the quality of recommendations.

3.3 Functionalities

NEARME is available on the Google PlayStore in beta version. In the homepage shown in Figure 3b, the app enables users to visualize the list of POIs suggested and the related information by clicking on them. NEARME switches off the recommendation engine when low battery is detected. However, a dedicated switch is provided for the users.

Service providers must sign-in into NEARME to select the circular geographical area for a specific POI and the respective radius as shown in Figure 4a. Moreover, service providers can monitor the evolution of their POI(s), such as rating, views, and feedback. POIs refer to service provider themselves or to the service they offer in a particular time frame, such as deal of the week or Saturday dinner menu. POIs must have a title, a description (e.g., special deal of the day), a category, and time information (lifetime, day of the week, time of the day, and recurrence). Please notice that POI description is available in multiple languages.

Users receiving the recommended notification can open its description and reach it via the third-party app Google Maps. Figure 4b shows the list of recommendations and the respective rating, views, and score. The navigation drawer helps users to navigate between the different screens, such as Settings, Notifications History, and Admin area followed by the Login button. The Settings page allows users to filter and sort notifications by category and to personalize the recommendations. Given that NEARME works in background mode as well, to efficiently notify the user (i.e., avoiding spamming
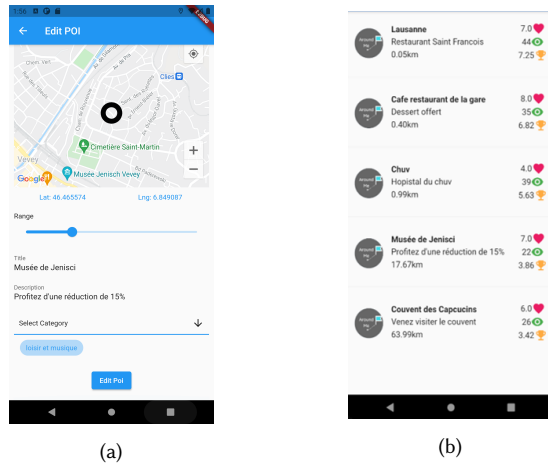
(a)   (b)

Fig. 4. App service provider POI edit and POI recommendations

the user), multiple personalized POI suggestions are grouped in a single notification.

As mentioned above, users can control the volume of notification, select their preferences, and provide feedback to the POIs suggested, allowing the NearMe to improve its recommendations. In order to understand the needs of service providers and users, and to improve the design and the functionalities of NearMe , we have conducted a survey presented in the next section.

4 USER STUDY

This section presents a two-folded survey. First, we focus on service providers, including tourism, entertainment industries to local actors and businesses. Then, we investigate the user demands to elicit key requirements to shape the design, functionalities, and recommendation algorithm of the NearMe app.

4.1 Service Providers Analysis

The descriptive study was carried out through semi-structured interviews and forms based on the various types of questionnaires. These latter are structured to gather information on how stakeholders communicate points of interest, the technologies adopted, and how NearMe can be beneficial for them. Initially, the sample population composes of public and private tourism organizations with a particular focus on the cantonal and regional authorities of Switzerland. In a second step, the population includes cultural, commercial, and entertainment actors (e.g., museums, parks, restaurants, and shops). For this purpose, about 20 semi-structured interviews were carried out, some by telephone and others during face-to-face meetings.

The communication strategy of promotional organizations depends strongly on whether or not they are dependent on public authorities. Some depend exclusively on federal and cantonal subsidies. Others are partially or not public-founded. This distinction with regard to public and private financing affects the promotional strategy of the actors and, therefore, the support that NearMe can

offer. Indeed, there are two distinct strategies that are complementary but particularly dependent on finding: (i) the strategy based on the notoriety and the affluence; (ii) the strategy based on conversion and POI.

4.1.1 Awareness-based strategy. The primary goal of the strategy based on the notoriety of a point of interest is to provide visibility to the heritage and local actors without expecting a return on investment (e.g., promoting a tourist monument, a walk in the forest, or local events). For instance, the municipality of Montreux, Switzerland, does not have financial objectives nor depends on other sources of financing to feed its budget. They just promote places and increase the visibility of their platform on the internet and social networks. They mainly use analytic tools to be able to ascertain the origin and the number of visitors. Therefore, the way they promote points of interest is strongly dependent on their ability to communicate through their channels. However, they do not have their own technical solutions to encourage to gain visitors and promote special deals. NearMe is still interesting for these players as a real-time POI promotion tool as long as the solution can be integrated with their current solution.

4.1.2 Strategy based on conversion and investment return. The second approach is to extract value and financial revenue from the points of interest promoted. In other words, the strategic objective is defined by the ability of the actors to bring new clients to their partners. Indeed, promotional organizations that are not fully funded by public institutions must find a way to generate revenue. To do this, organizations define their strategies according to the interests of their partners. In this case, a commercial relationship is created between the entities that can make sense of a shared promotion system, such as the NearMe application.

In order to have an exhaustive view on the potential of use and functionalities chosen for the design of the NearMe application, a survey was conducted among local economic actors. These actors were separated into four categories of businesses to obtain a heterogeneous and representative sample of the sector needs. The categories are (i) bar and restaurant, (ii) store non-food, (iii) store food or perishable, and (iv) service company. For each category, we have summarized the most important points concerning the problems faced by the stakeholders and their assessment of the NearMe application.

4.1.3 Bar and Restaurant. Bars and restaurants have been hit hard by the COVID-19 pandemic. They unanimously expressed a need to return to their former activities as quickly as possible. In addition, circumstances have forced them to conform to technology, increase their digital visibility via social networks and reinvent themselves with new concepts. For instance, the owner of Reflet des Isles (Lausanne, Switzerland) emphasized his openness to services that could support and facilitate his business. The manager of the Burger, Moudon, Switzerland, has shown a great interest in proposing solutions that could improve its visibility and increase clientele without paying too much commission.

4.1.4 Store non-food. Store non-food businesses include clothing industries, sports, cosmetics, decoration, etc. The communication and promotion strategy differs strongly according to the type of

industry, its size, and most importantly its shopkeeper and manager. More precisely, according to their ability to use technologies and social networks. Indeed, young designers or independent clothing sellers are extremely turned to social networks, such as Instagram, to promote their products. Other actors are less inclined to use digital tools, and this seems to be correlated to age. For instance, Aubert Sport, a very well-known store in Lausanne, has seen its revenues melt away given its lack of communication on the networks. The lack of an online store has made them vulnerable to the effects of the crisis. Therefore, the NearMe application can be of more interest to traditional merchants than to the new generation who seem to find sufficient comfort in social networks. For the latter, the NearMe application would be a complement to their strategy rather than a central tool.

4.1.5   Store food or perishable. Businesses such as grocery stores, flower shops, bakeries, or those with perishable goods differ in their approach to the application. They often deal with essential goods with time constraints in their consumption period. For example, the Bird's Grocery Store in Lausanne had difficulty making itself known beyond its neighborhood. Moreover, they experience daily problems with their inventory management. The Bird's Grocery store suffers from this technical shortcoming and seems very open to the use of the NearMe application as a redistributed tool such as the TooGoodToGo app. In this context of fighting against waste or localized promotion, the NearMe application seemed interesting for retailers to sell unsold products through promotion.

4.1.6   Service Company. The last category includes several heterogeneous service companies. The one that can be interesting to analyze is the Bewell-Pass project [3], which offers a marketplace that connects health and wellness professionals with their users. During the discussion with the project manager, various issues were raised concerning which platform might already offer some tools for presenting services and offering promotions. In addition to these functionalities, it seemed interesting to make a link with the NearMe application, which can bring an additional brick to the current Bewell-Pass application. Indeed, the Bewell-Pass application does not include a notification system that considers users' profile or their geographical location. The idea of implementing the NearMe application into the existing system seems an opportunity for Bewell-Pass. Marco, the founder of Bewell, would be willing to test the integration of this module into his application, especially if it would not be prohibitively expensive for the company.

Most of the service providers are interested in using tools to promote their establishment to relaunch their activities after the COVID-19 pandemic. The geolocalized offer and event promotion tool has been approved by the majority of businesses. They have shown interest in the NearMe application as a simple and effective way to gain visibility through digitalization.

4.2   Users Analysis

The user survey [5] was conducted online aiming to define the visitor needs and the application design. The questionnaire contains questions that allow both quantitative and qualitative analyses to be carried out in order to obtain a comprehensive view of the user's

needs. The questionnaire is realized with Google Forms solution, which allows building free questionnaires. Finally, we obtained 69 answers by spreading our questionnaire online.

Figure 5 reports the range of age of 69 interviewees (43 women, 25 men, and 1 other gender). As shown in the figure, most users are between 25-30 years old, which is the generation feeling more comfortable using technology. Indeed, with no surprise, most of the users find their information on social media or web-search engines as reported in Figure 6. Please notice that users could provide multiple answers to the question "What do you mainly use to find activities, tips, or events?" in Figure 6.
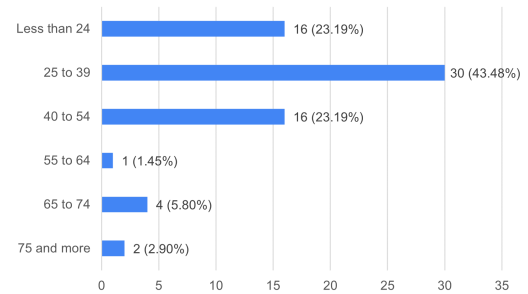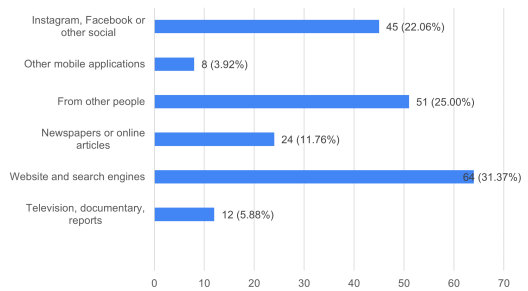

Fig. 5. Age of the interviewees

Fig. 6. Source of main activities

Overall, we observe a great heterogeneity of interests with a marked infatuation of the visitors for the restoration activities (79%) and entertainment, such as cinemas (62%), theaters, and museums. We notice that users find activities mostly on social networks, websites, and search engines (82%). Moreover, the majority of users do it from mobile devices (80%). This shows that there is a real threat for merchants who do not exploit the new channels to promote their activities. In the previous study, we found that the local merchants who were most interested in using NearMe were those who were not using online solutions. Finally, it appears that it remains quite difficult for people to find good deals around them (62%), but especially to be aware of local events and cultural offers (63%). The application would therefore be a perfect answer to these needs by proposing promotional and cultural offers as well as information about local events.

In order to understand if NearMe is beneficial for the user, Figure 7 reports the difficulty level in finding POIs nearby the user.
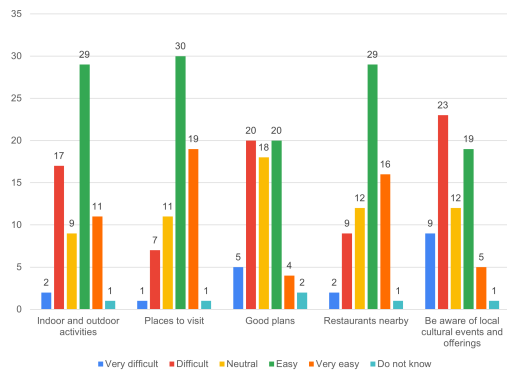

Fig. 7. How difficult is to find information on the following activities

Among the responses, there was a great deal of interest in the NearMe application. Indeed, 80% of the users are interested in the NearMe app and 90% would be likely to use the application or test it. The idea of the founders of the project is in line with the expectations of the users. Figure 8 illustrates the main use of NearMe according to the interviewees.Among the points of the application that arouse the most enthusiasm, we find access to exclusive offers around us (discounts, promotions, and exclusive offers) for more than 79%, but also the discovery of place, products, or services (75%), as well as local businesses and activities for more than 70%. Among the elements cited that can slow down the approval of the application, we found: (i) Price, if it is free or not. (ii) Data protection, if it asks for too much personal information other than interests. (iii) Tracking, if the user is tracked without their consent. (iv) Market, there are already other applications that can play a similar role.
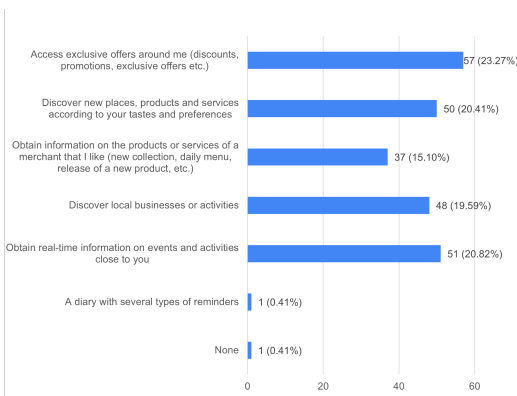

Fig. 8. Main advantages using NearMe

5 CONCLUSIONS AND FUTURE WORKS

This paper introduced the NearMe app, which provides a novel location-based service targeting personalized recommendations of

Points of Interest. NearMe goes beyond existing approaches, targeting not only end-users but also service providers, offering the possibility of integrating an extensive range of interconnected offers. Moreover, we have shown how the combination of context-based and collaborative-content-based filtering can help to adapt to the users' needs and preferences, with the added value of serendipitous recommendations. Further fine-tuning is integrated into the core of NearMe , which provides end-users with a large number of customization options. Complementary to the implementation of the system, we have performed user studies with both potential service providers and users, which has provided valuable information that corroborates the main driving principles of the NearMe app.

As ongoing work, we are testing the app using several configurations of the recommender engine parameters. This will allow suggesting users special configurations that have shown a high quality of recommendations. Moreover, given the interest raised by the service providers in the user study, we are implementing an API to integrate NearMe with the existing app. As future work, we plan to integrate a chatbot system within NearMe interacting with the user via natural language to improve the understanding of their preferences, improving the notification presentation, and enhance the overall quality of experience.

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