A Personalised Interactive Mobile App for People with Autism Spectrum Disorder

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Abstract. The PIUMA app aims at allowing users with autism to explore their city, finding new places that can be interesting for them but at the same time do not annoy them. Users can navigate the city through an interactive map that is both personalized and crowdsourced.

Keywords: Autism · Mobile App · Crowdsourcing · Recommender Systems

1 Introduction

Autism Spectrum Disorder (ASD) is characterized by the presence of persistent deficits in social communication and interaction, and deficits in social-emotional reciprocity, accompanied by the presence of restricted, repetitive behavior, interests or activities and hypo/hyper reactivity to sensory stimuli [4]. Moreover, several studies [3, 2] reported that people with autism tend to avoid places that may negatively impact on their senses. Sight, smell and hearing are relevant with reference to mobility in urban environments. Such sensory aversions may result in anxiety, fatigue, disgust, sense of oppression or distraction [2].

In this paper, we describe the app resulting from the PIUMA project (Personalized Interactive Urban Maps for Autism)[4], which aims to support ASD people in moving and living their city by means of an interactive map. The map guides everyday movements by providing tailored suggestions, i.e., by recommending items (Points of Interest - PoIs) suitable to ASD people according to their interests and aversions. Moreover, the map is crowdsourced. In other words, it is populated with PoIs, comments, and reviews by people with autism, and caregivers, as well as by anyone wishing to contribute to make ASD people's lives

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[4] The project involves a collaboration among Computer Science and Psychology Departments of the University of Torino and Adult Autism Center of Torino, Italy.

easier. The app provides the user with different modalities of content fruition. The user can navigate the map to find interesting places for her/him, or (s)he can use the search tool or apply filters for category and sensory features.

In the following, we discuss three main aspects of the app: the recommendations (Sec. 2), the crowdsourcing features (Sec. 3), and exploration modalities (Sec. 4). Section 5 concludes the paper with technical details.

2 Personalization

A key feature of our app is the possibility to provide the user with personalized recommendations (as you can see in Fig. 1a). We consider both user preferences, and item compatibility in the identification of the most relevant items for a user. We assume that the overall compatibility of a user with a PoI depends on her/his compatibility with each of the PoI's sensory features. Regarding preferences, we assume that the user's interest in a PoI depends on her/his preference for the category to which the item belongs [1]. We combine the compatibility ($comp$) and preference ($pref$) evaluation of an item to estimate its rating ($\hat{r}$) by means of a weighted model that balances these two components in a way that is personalized to the individual user. For this purpose we introduce the α parameter, which takes takes decimal values from 0 to 1:

$$\hat{r} = \alpha * comp + (1 - \alpha) * pref \tag{1}$$

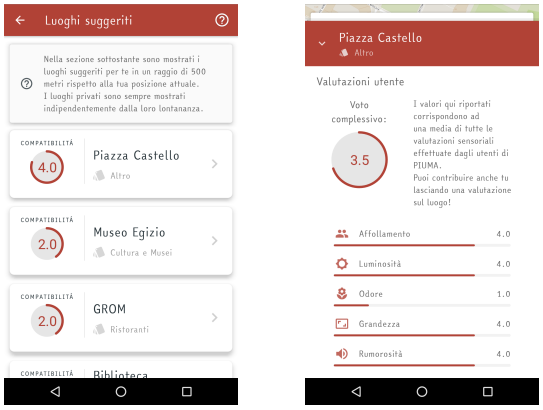
In order to receive any recommendations, a user has to fill in a short questionnaire where (s)he declares which category of place (s)he likes, and which sensory features of places bother her/him. This step is not mandatory: if the user decides to skip it, (s)he is still able to use all the functions of the app, but without the personalized suggestions.

3 Crowdsourcing

The app enables users to extend the knowledge about places by adding evaluations of their sensory features. This is crucial for two very different reasons:

- The first one concerns user empowerment. Enabling users to provide their opinions does not only improve their life, favouring independent living, but also their participation in urban life. This can impact on the sense of self-efficacy and empowerment of persons with cognitive problems who, by contributing to the crowdsourced data collection, can actively work for a collective goal that may bring benefits to other people as well as to themselves.
- The second reason is technical, i.e., in order to recommend places that are compatibile with the user's aversions, we need sensory information about items. As the Open Data made available by geo websites like OpenStreetMap[5]

[5] https://www.openstreetmap.org/



(a) Visualization of recommendations with compatibility values.

(b) Features evaluations of item "Piazza Castello".

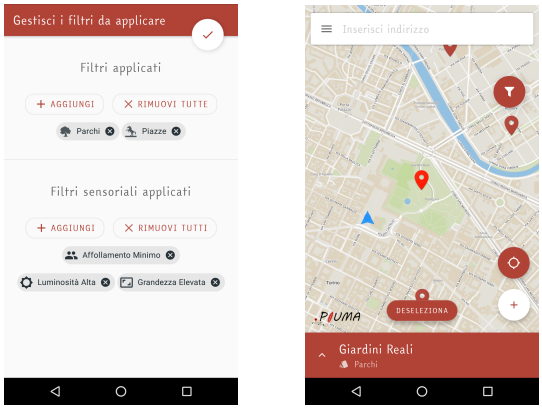
Fig. 1: User interface of the PIUMA app - personalized recommendations.

lack such information, a possible solution is that of acquiring sensory features directly from people, a task that perfectly fits the previously discussed user empowerment goal.

The user interface of our app is thus designed to gather sensory features of places [2]. For each place, the user can rate each of its features, and in particular its level of i) brightness, ii) crowding, iii) noise, iv) smell and v) openness; see Fig. 1b. Ratings take values from 1 to 5. These features have been defined based on findings collected in a user study carried out by some of the authors of the present paper [2], and of state-of-art research [3]. By interacting with the app, the user can also provide a global evaluation of the place. For each PoI, the system returns the average of the collected evaluations. Such information represents the domain knowledge base to be used as a source for the generation of personalized recommendations. Finally, people can insert new places. In the case of Torino (Italy), more than 200 markers were placed on the map by real users.

4 Filters

We provide users with different content fruition modalities. They can navigate the map to discover interesting places (by clicking on a marker of the map, the app shows information about the place, and the values of its sensory features), they can use the topside search box to find specific locations, or they can apply filters to select the PoIs to be displayed in the map. Users can customize the content of the map concerning PoIs that are near to their current location by applying filters. We provide two types of filters: by category and by sensory features. Using the category filter, the user can select the types of places to



(a) Categories (top) and sensory (bottom) filters.

(b) Map with PoIs based on the filters of Fig. 2a.

Fig. 2: User interface of the PIUMA app - filters.

be shown in the map (e.g., bars, and parks), while sensory filters are used to select PoIs conforming to them (e.g., in relation to noise, light, etc.). See Fig. 2a. Multiple filters can be jointly applied. For instance, users can search for low-crowded, bright and large squares and parks, as in Fig. 2b.

5 Technical details

The PIUMA app has been developed to run on Android smartphones and tablets. The minimum supported Android version is 7.0 Nougat (API Level 24) that, according to the latest data from Google[6], can bring PIUMA to 73.3% of Android devices. Users' data are stored into a MongoDB server.

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