How to not be Annoying: Adjusting Persuasive Interventions Intensity when Nudging for Sustainable Travel Choices

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Abstract. The intensity of persuasive interventions is a key factor in the design of persuasive systems, as the frequency of persuasive attempts for changing users' behaviour can affect their effectiveness. In this paper, we de-scribe our approach for adjusting the intensity of personalized persuasive interventions to support sustainable mobility behaviours. More specifically, we leverage the trip purpose and trip characteristics in order to set the frequency of displaying persuasive messages that nudge users to select environmentally friendly transportation modes. Our approach is integrated in a persuasive route planning application used in every day travel decisions. Our next steps include the evaluation of the proposed approach.

Keywords: Personalization, persuasive interventions intensity, mobility, behavioural change, trip purpose.

1 Introduction

The intensity of persuasive interventions is a key factor in the design of persuasive systems as the frequency of persuasive attempts for changing users' behaviour can affect the effectiveness of interventions. For example, energy feedback research suggests that frequent feedback is preferred and is more effective compared to less frequent feedback [1]. It is also possible that frequent feedback can become repetitive to such an extent that users are annoyed [2]. The problem of personalizing the intensity of persuasive interventions has been gaining interest over the last years under the hypothesis that adapting the frequency of interventions to the needs of an individual recipient, the effectiveness of interventions will be increased. This is because individuals may differ in how much support they want in general but also around specific moments in behaviour change [3]. For example, when changing behaviours some people may prefer only low frequency contact, others may want more intense support, while still others may need more support under specific situations.

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Related studies have provided preliminary results which show that adapting the intensity of the persuasive interventions to the preferences and characteristics of individual users upgrades the interventions' persuasive capabilities [4]. In our recent work [5], we have also confirmed that the intensity of persuasive attempts matters. More specifically, we have implemented a personalized persuasion service which is integrated in a route planning application and nudges users to make more sustainable travel choices with the use of persuasive messages. Our service leverages persuadability profiles com-prising of users' personality and mobility type in order to identify the persuasive strategy that fits best to the user's profile, and generates messages which try to persuade users to follow specific routes that cause low CO2 emissions. We have evaluated our service in a pilot case where users used the route planning application for every day transport decisions and we found that some participants complained about the frequency of the persuasive messages, reporting them as annoying. In more details, they reported that the application presented persuasive messages that repeatedly urged them to follow certain modes of transportation although they didn't follow these modes nor had the intention to follow them. To resolve this issue and to improve the effectiveness of the personalized persuasive interventions, in this work in progress paper we present our approach to personalize the intensity of persuasive interventions aiming to nudge users towards sustainable mobility choices, by considering the trip purpose and trip characteristics. In the next section, we provide the details of our approach including the methodology we followed for determining situations that require high or low intensity of persuasive attempts, the methodology for identifying the trip purpose and the process for adjusting the persuasive interventions intensity. In Section 3 we describe how we are going to evaluate our approach and provide our final remarks and conclusions.

2 Our Approach for Intensity Adjustment of Persuasive Interventions

Our approach rests on the premise that a traveller's decision on transport mode selection depends upon the value of travel time savings (VTTSs) [6], a measure used in the domain of transportation to define the value of every minute (time) that individuals save during their travels. The value of VTTSs varies for different trip purposes. For example, if an individual travels (commutes) to her/his work, the VTTSs is high since the individual wants to minimize the travel time as much as possible. Instead, when s/he travels for leisure purposes, the VTTSs is lower than commuting. To adjust the intensity of persuasive interventions that nudge users to take more environmentally friendly modes, a persuasive system for route planning applications can take into account the VTTSs. Especially, when the VTTSs is lower than usual, it is more likely that the individual selects a more environmentally friendly route, which could take longer time to reach a destination (e.g. use of public transportation instead of a car). Following this line of thinking, the intensity of the interventions can be higher in such

situations since the probability that an individual selects a more environmentally friendly route is higher.

Past research [7] has provided evidence on the variation of the VTTSs by country, travel purpose, mode and distance. Specific models are applied to produce VTTSs for leisure travel, commuting, and for other purposes in passenger transport, for 25 European Union Member states. In our past study [5], we focused on the countries of Austria, Slovenia and UK, where it is observed that the VTTSs for commuting travels is higher than for leisure ones. Another key factor that affects the VTTSs is the mode of travel, while an individual's VTTSs also depends on the trip length. According to meta-analyses, the VTTSs for short distance bus routes is lower than for other mobility modes used for both leisure and commuting purposes in the countries of our focus. In this work, we consider the factor of trip purpose and certain trip characteristics in order to adjust the intensity of persuasive interventions. Following the findings mentioned above, the persuasive interventions should be less pressing when nudging towards non-leisure activities.

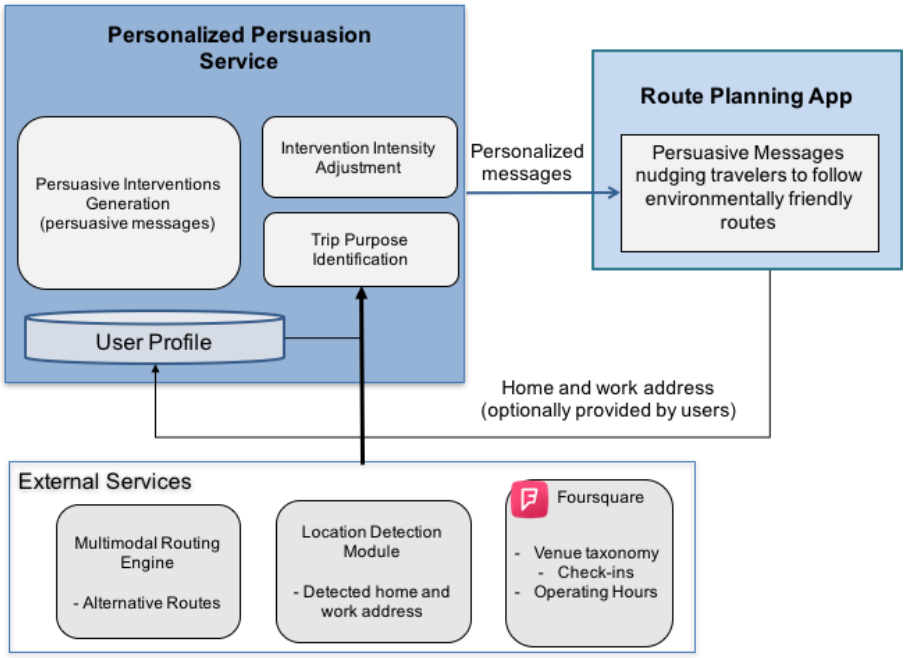

Fig. 1. Conceptual Architecture of our Approach.

2.1 System Design

The overall design of the architecture of our approach is presented in Fig. 1. The base component is our personalized persuasion service which generates personalized messages that consider users' persuadability profile in combination with contextual parameters and nudge users to follow environmentally friendly routes. The service is

integrated in a route planning app (see [5] for a detailed description). In order to be able to adjust the intensity of the interventions (i.e. the persuasive messages), two additional services are considered, namely the Trip Purpose Identification service (the details of which are provided in Section 2.2) and the Interventions Intensity Adjustment service, which is described in Section 2.3. When a user issues a route planning request, a set of alternative multimodal route results are provided by an external routing engine (the results are multimodal in the sense that each route may include one transport mode (e.g. car) or combinations of two or more transport modes (e.g. car and public transport)). For inferring the trip purpose of the user, we make use of information from external services which include Foursquare, and a location detection module which can automatically infer the users' home and work address. This information can also be provided explicitly by the users through the settings page of the route planning app. Note that based on our experience, users commonly do not set their home and work address in the application, which has led us to plan the use of a specific module for the automated detection of such information, as by knowing the home and work address should improve the trip purpose identification results (see Section 2.2).

2.2 System Design

Various methods to identify trip purpose have been investigated [8] in past research, which can be divided into three main categories: i) the rule-based methods that match locational and user information, ii) the statistical methods that generate probabilities of trip purposes and iii) the machine learning methods that rely on pattern recognition models. In our approach, the trip purpose is identified with a rule-based approach, by using a location detection module that identifies users' home and work address, the Foursquare service that provides venues, checkins and operating hours of venues near the destination that the user sets, and the home and work address which are optionally provided by the user and stored in the user's profile. When a user issues a route request from an origin point A to reach a destination point B, firstly we check if the destination location is the user's home or work place. If the destination location is user's home or work place, then the trip purpose is set to be commuting, else we continue to the second step.

Given a destination location, in the second step we retrieve all Foursquare venues within a pre-specified radius parameter (e.g. 50 meters) and try to identify the trip purpose by using an extended version of the 'Check-in Algorithm' described in [8]. More specifically, the algorithm assigns a weight to each venue and selects the venue that is most likely to be the destination of the trip based on this weight. The category of the most likely venue is identified and used to derive the trip purpose through a set of rules that map venue categories to trip purpose. It should be noted that venues which are currently closed (based on opening hours) are filtered out. The venue's weight considers the area's land use, the venues' distance to the destination point B and the venues' check-in counts and opening hours as reported by Foursquare. The land use, which is according to many studies often correlated to the trip purpose, is

determined by finding the most frequent category of the retrieved Foursquare venues in the pre-specified radius. For example, if the land use around a specific destination location is mostly shops or a major shopping mall this will increase the likelihood that the user will visit a venue of that category and therefore a bigger weigh is assigned to the corresponding venues. Venues check-in counts are used as a measure of venue popularity, since it is more likely that a trip concerns a venue attracting the most trips to this location. Moreover, it is more likely that a trip concerns a venue that is closer to the destination point B. The set of venues' categories is provided by Foursquare and we have rules mapping them to leisure and commuting trip purposes as follows: if the category is Arts & Entertainment, Food, Nightlife spot, Outdoors & Recreation, or Shop & Service then the trip purpose is leisure; if the category is States & Municipalities, Professional & Other Places, Residence, Travel & Transport, College & University or Events then the trip purpose is commuting.

2.3 Interventions Intensity Adjustment

Our approach for adjusting the intensity of persuasive interventions is presented in Fig. 2. The routing engine provides a set of routes among which one is optimized in terms of duration and cost (hereafter referred as 'optimal', while our personalized persuasive system (see [5]) selects a route, in which the persuasive message is attached to. That route is environmentally friendly and within the user's preferences (hereafter referred as 'suggested'). In most cases these two routes are different. The frequency of persuasive interventions is determined with the use of the trip purpose, as well as the cost and duration of these two routes. The cosine similarity between the two vectors representing the two routes in the cost and duration space is estimated. E.g. the cosine similarity between an 'optimal' route that costs 5 euros and lasts 20 minutes and a route that costs 3 euros and lasts 23 minutes, is 0.6. The more similar a route is to the 'optimal' route, the easier it is to nudge the user to follow it, and vice versa. Our approach is to always display persuasive messages attached to routes that are adequately similar to the 'optimal' and adjust the intensity of interventions for similarities below a threshold. We use different similarity thresholds depending on whether the trip purpose is leisure (T1) or commuting (T2). Since it is harder to nudge users away from the 'optimal' route when commuting, T1 is lower than T2. In other words, for similarities between T1 and T2, we always show interventions for leisure trip purposes, while we adjust their intensity of interventions for commuting trip purposes. It should be noted that the trip purpose is identified by using the approach described in Section 2.2.

In the cases where the similarity between the suggested and the optimal route is lower than the defined thresholds, the interventions are presented to the users based on an intensity function which "throttles", i.e. controls the display of the intervention (in our case the persuasive messages), within a given period. A higher throttling rate *R1 (*leading to a lower intensity of persuasive interventions) is used if the trip purpose is leisure and a lower throttling rate *R2* is used if the trip purpose is commuting *(*leading to a higher intensity of persuasive interventions). E.g. the throttling rate for leisure

purposes *R1* can be set to 0.33, corresponding to the display of a message every 3 attempts, while the throttling rate for commuting purposes *R2* can be set to 0.2, corresponding to the display of a message every 5 attempts.

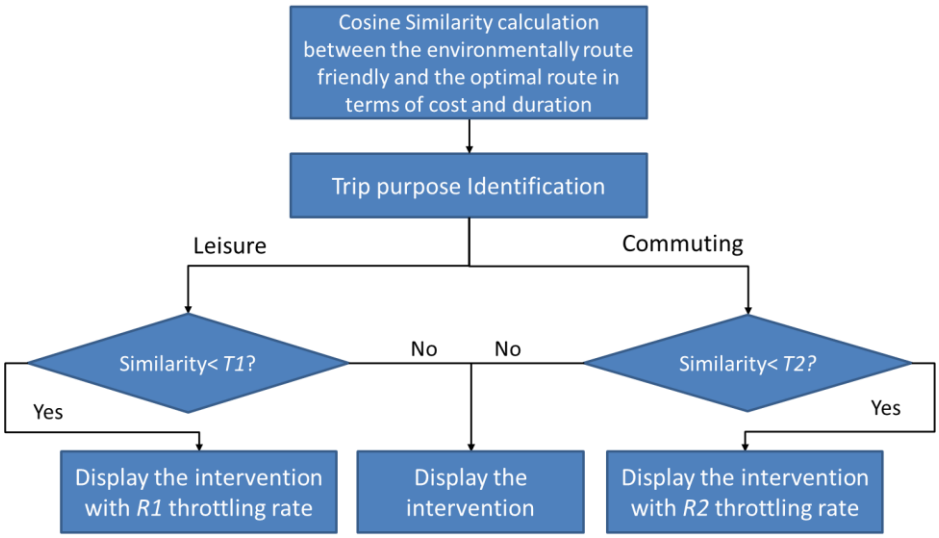

Fig. 2. Flowchart of the interventions intensity adjustment process.

3 Conclusions

In this paper, we presented our approach for adopting the intensity of personalized persuasive in-terventions aiming to nudge users towards selecting environmentally friendly routes for urban trips. Our approach adapts the intensity of persuasive messages display to the trip purpose of individual users. The proposed approach is expected to improve the effectiveness of persuasive interventions for behavioural changes in the domain of mobility.

Our next step is to implement our approach and integrate it into a mobile application that nudges users to make more environmentally friendly mobility choices. More specifically we are going to ex-tend the persuasive service which we present in [5]. Furthermore, we plan to evaluate our approach in real life situations where travellers from the cities of Vienna, Ljubljana and Birmingham will use the route planning application integrating our approach for everyday trips, for a period of 8 weeks. The evaluation will be organized such that a control group will receive interventions without intensity ad-justments and an experimental group will receive interventions with intensity adjustments. Moreover we plan to test different levels of interventions intensity in order to uncover potential relationships between persuasive power and intensity. Our aim is to gather data regarding the user experience and compare the effectiveness of the interventions between the two groups.

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