Choice Architecture for Environmentally Sustainable Urban Mobility

Efthimios Bothos
National Technical University of Athens
Athens, Greece
mpthim@mail.ntua.gr

Dimitris Apostolou
University of Piraeus
Piraeus, Greece
dapost@unipi.gr

Gregoris Mentzas
National Technical University of Athens
Athens, Greece
gmentzas@mail.ntua.gr

CHI 2013 Extended Abstracts, April 27–May 2, 2013, Paris, France.
ACM 978-1-4503-1952-2/13/04.

Abstract
Personal transportation greatly contributes to environmental pollution from CO2 emissions and persuasive technologies could assist travellers in reducing their ecological impact. In this work we focus on the design of persuasive travel recommenders in order to support travellers, who have a pre-existing interest in taking action to lessen their impact on the environment, adopt green transportation habits. Our approach examines recommender systems under a choice architecture framework and aims at providing urban travellers with a personalized travel recommender that helps them plan routes while considering the environmentally friendliest travel modes.

Author Keywords
Choice Architecture; Travel Recommenders; Lifestyle change

ACM Classification Keywords
H.5.m [Information interfaces and presentation]: Miscellaneous.

Introduction
In recent years we observe a new paradigm of technology use for lifestyle and behavioural changes. The motivation rises from the realization that in today's society a number

of choices are not sustainable and are made without caring about their negative long-terms effects [3]. For example on the individual level we experience an increase of lifestyle related diseases (e.g. diabetes and obesity) due to lack of physical exercise and bad nutrition whereas on a societal level, our activities greatly impact the environment and lead to effects such as climate changes.

Lifestyle changing technologies aim at 'nudging' users towards decisions that serve their own long-term interests. This is achieved through proper structuring of the available choices, a task also known as 'choice architecture' [9]. Choice architecture refers to designing and incorporating small features or nudges in the choice making process. Choice architects assist individuals to overcome cognitive biases by highlighting the better choices for them, without restricting their freedom of choice.

In our work we focus on environmental pollution caused by CO_2 emissions due to citizens' activities from traffic and mobility. Studies show that urban transport in the European Union accounts for 15% of all greenhouse gas emissions [8] and this problem is becoming increasingly concerning as work and leisure life become progressively geographically distributed. Thus we need to apply methods and tools able to support and guide citizens towards pro-environmental behaviours with respect to their travelling habits and decisions. More particularly, we want to encourage lifestyle changes towards green transportation habits among travellers who have a pre-existing interest in taking action to lessen their impact on the environment. In order to achieve this goal, we suggest a personalized travel recommender that incorporates choice architecture design elements and nudges users to plan multi-modal routes while considering the environmentally friendliest travel modes.

The paper continues as follows. After a short overview of recommender systems for route suggestions we examine the basic principles of choice architecture and through an illustrative scenario we describe our envisaged solution. Then we show how choice architecture can inform the design of a recommender for nudging travellers towards environmentally friendly choices. Finally we summarize our plan for future work.

Travel Recommender Systems

Commonly, recommender systems generate prioritized lists of unseen items, e.g., music, books, by trying to infer users' preferences based upon their profile. Travel recommender systems are designed to support travel planning decisions before travel or while on-the-move [6]. These systems capture user preferences, either explicitly or implicitly and suggest destinations to visit, points of interest (POIs), events or activities and/ or alternative routes. The main objective of a travel recommender system is to ease the information search process of the traveller and to convince her of the appropriateness of the proposed services [7]. With respect to route suggestion, certain systems consider multi-modal itineraries (i.e. routes that involve the use of more than one transportation means, for example reaching the destination with a combination of car, bus and walking), see e.g. Tumas and Riccie [10] and Zenker and Bernd [13]. The consideration of recommender systems as a method for persuading and nudging users is emerging [11], and for successful systems we need to provide appropriate frameworks.

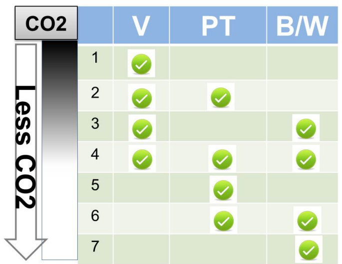

Figure 1: Travel profiles for route lists generation (V:personal vehicle, PT: Public Trasnportation, W/B: Walking or Bicycle).

Choice Architecture Principles [9]

Defaults refer to the pre-configured options people usually make use for reasons of laziness, fear or distraction.

Expect Error is based on the fact that humans make errors thus choices have to be designed such that they are error forgiving.

Give Feedback assists users to increase their performance by constantly reminding their achievements.

Choice Architecture for Route Suggestions

Decisions are not made in isolation; instead they are influenced by numerous noticed or unnoticed factors [9] enforced by the environment where the decision is being made. Individuals base their choices on the attributes of the choice set (content) as well as the presentation of information (context) [4]. So if we properly design and incorporate small features or nudges in the choice making process, we can assist individuals to overcome cognitive biases while highlighting the better choices for them, without restricting their freedom of choice. This is known as a "choice architecture" task. Effective choice architecture is based on a set of principles which when considered carefully can affect human decision making. Namely, following Thaler et al. [9] these principles are: Defaults, Expect Error, Give Feedback, Understanding Mappings, Structure Complex Choices and Incentives (see sidebar for their definition). Furthermore, in our case, past research has demonstrated that information regarding transport-related attributes such as travel time, travel costs and carbon emissions can lead to changes in travellers' choices [2].

Having the above in mind, we provide an illustrative scenario for route selection that highlights how the choice architecture principles can be used. Assume that John, our user, wants to meet his friends at the city centre. John is 35 years old, familiar with smart phones, owns a car and is accustomed at using it very often. Nonetheless he would be willing to reduce his carbon footprint and use greener transportation means. John opens his eco-travel application in his smart phone to plan his route. He has already configured his preferences and information about his profile (e.g. that he owns a car and he uses it regularly). Moreover John has configured a goal for his weekly CO2 reduction, a setting that provides a form of *incentives*. Having this kind of personal information already configured reduces the chances of *erroneous input* during route planning and results to a finer user experience. John enters his destination and the application generates a list of alternative routes that *include by default* public transportation, walking and/or bicycle. For each route, the savings in CO2 compared to the highest emitting route are displayed in order to allow John understand and weigh his decision. Moreover a message box *provides feedback* and reminds John that by selecting a route with public transportation he can achieve his weekly goal. The list of displayed routes includes three alternatives, *filtered and structured* properly in order to balance John's preferences and the CO2 emissions.

Implications for a Travel Recommender

In this section we show how each of the choice architecture principles can be induced in recommendation systems design elements in order to deliver a system that effectively nudges users towards pro-environmental transportation choices.

Defaults

Every system where a choice has to be made normally has a default option set that is selected when the user does nothing. In our case, we introduce a pre-configured default mixture of alternative routes including all possible combinations of transportation modes. We derive itineraries from travel profiles [10] which are combinations of one or more of the major transportation modes (personal vehicle, public transportation, walking or bicycle; see also Figure 1). This means that e.g. a user who regularly drives a car will receive as output a list of routes with a combination of car and public transportation together with routes he normally expects and involve only the use of a car.

Understanding Mappings refers to weighing decisions and align them with personal welfare.

Structure Complex Choices is about helping users to identify the alternatives that correspond to their preferences.

Incentives provide the motivation for behavioural changes.

Expect Error
To avoid user input errors during their trip planning we consider a profile configuration process when the application is initialized for the first time. We ask users to provide their preferences over preferred transportation means by assigning themselves in one of six groups of drivers following [1] - Hard driver, Complacent car addict, Malcontented motorist, Aspiring environmentalist, Car-less crusader, Reluctant rider (for a thorough description see [1]). This categorization is used by the recommendation algorithm in order to filter and display routes that the user will most probably choose.

Personalization is dependent on the available transportation means i.e. car/motorcycle and bicycle and considers any disabilities the user may have. Considering this information, a query personalization component augments the user routing query to match already configured parameters in the profile. Two rules are defined for these cases: If the user owns a vehicle then routing results involving car/ motorcycle should be considered. If the user owns a bicycle, results involving a bicycle should be considered. If the user has disabilities then bicycle and public means of transportation without amenities for persons with disabilities should be avoided. This approach avoids errors that user may enter when seeking a route to reach her destination.

Moreover, we define a query contextualization component which further assists the identification of the optimal route set. To automate this task we follow an approach where the Microsoft™on{X}[1] application is used to gather contextual information. We combine information from a set of contextual parameters residing in the users' mobile device: - calendar: based on the appointments the user has set we infer the trip purpose: business, leisure and with family. - current location: it is used to automate queries. - geofencing: once the user leaves a location the system combines traffic information and proactively suggests routes to avoid. - current mode of transport: route results may differ according to the current transportation mode: 'at rest', 'walking', 'driving', and 'running'.

[1] https://www.onx.ms/

Give Feedback
In our case the recommender system generates reminders with feedback on the CO2 emissions, calculated by tracking the users' travel behaviour, and highlights the routes which will reduce them. This kind of functionality employs elements of proactive recommenders since messages should be displayed in a timely manner to avoid annoyance. Moreover it is coupled with gamification approaches where users set personal goals for changing their transportation habits towards reducing their CO2 footprint. The recommender provides feedback in the context of the game and assists them to achieve their goals.

Understanding 'Mappings'
The selection among a list of routes can be cumbersome if the effect is not directly mapped to one's own interests. To address this issue and help users understand why the routes are suggested, the application provides explanations. The explanations consider user preferences and contextual information e.g. 'With this route you can save CO2 and delay x minutes compared to taking your car'. Furthermore we pay special attention to the text and form of the route's presentation. We include information on the emissions and the extra loss of comfort the user may experience if s/he chooses itineraries that include the use of public transportation or walking/bicycle.

Choice Architecture design principles	Implications for route suggestion	Implications for route recommender systems
Defaults	Include the use of public transportation walking or bicycle	Provide by default routes that include the use of public transportation / walking/ bicycle
Give Feedback	Reminders and notifications that assist users to reduce CO2 emissions	Proactively report user's CO2 emissions status as indicated by past travel behavior
Expect Error	Identify errors in user entries and replace them with correct values	Rely on user profiles and contextualization for preferences elicitation
Understanding Mappings	Provide explanations and understandable comparisons of the alternative routes	Provide explanations that clearly show why the recommendation is generated
Structure Complex Choices	Generate route lists that balance the perceived utility and CO2 emissions	Diversify results and balance users' preferences and CO2 emissions
Incentives	Gamify the route selection process with personal and social competitions	Generate suggestions for reaching game goals

Figure 2: Choice architecture principles and implications for ecologically-friendly route suggestions and travel recommender systems.

Structure Complex Choices
The recommender system has to filter and rank the routes according to a user perceived route utility and the route CO2 emissions. The perceived route utility is based on user preferences and on a set of criteria which are asked from the user when planning a new trip. A selection of criteria are: preferred trip duration, preferred walking or bicycling time and travel comfort whereas the route utility value is calculated with Multi-Attribute Utility Theory (MAUT) methods. Using MAUT methods, the route selection can be modelled as finding the best alternative from a decision matrix $M \times N$ with N alternatives and M criteria whose elements contain the utility of alternatives provided from the user preferences on the selected criteria.

In order to generate lists of suggested environmentally friendly routes, recommendation diversification algorithms are employed. Similarly to diversification solutions which attempt to identify relevant yet diverse items, we want to suggest relevant yet eco-friendly routes (see [5]). More formally, given a set of candidate routes $AvailableRoutes(u)$ and a given threshold K of final desired number of recommendations, the optimal recommendation is finding a set of routes, with the highest perceived utility and the lowest CO2 emissions. Relevant algorithms can be optimal, i.e. the MaxUtil which maximizes the utility of the K routes presented and the MinCO2 that minimizes the CO2 emissions of the K routes or heuristic e.g. the Swap and the Greedy similarly to [12] and [14].

Incentives
They can be social or personal which can be established through contests or setting personal goals. Providing social incentives means to compare ones' behaviour with others and setup an environment where participants compete on achieving better results from those of their peers. Currently we focus on personal incentives which refer to 'intra personal' competitions. The user sets personal goals that s/he wishes to achieve within a given time-frame. If s/he deviates the system provides recommendations in the form of notifications, in order to align oneself with the goals.

A summary of the aforementioned implications is provided in Figure 2.

Conclusions

The impact of citizens' urban mobility on the environment demands new methods and applications able to nudge them towards pro-environmental travel choices. We suggest an approach that infuses nudges in the route selection process and incorporates the principles of choice architecture in travel recommender systems.

A prototype system is under development and we are going to evaluate our proposed approach in real life situations. The evaluation will be user-centric and metrics will include the effect of the choice architecture design on users' behaviour as well as users' satisfaction with respect to recommendation artefacts (routes and goals). Two field trials in Vienna and Dublin have been planned, where a set of 40 users will use and evaluate our recommender system in their everyday life for a total duration of two weeks.

Acknowledgements

This research has been partially funded by the European Commission project PEACOX: Usable Persuasive Trip Advisor for Reducing CO2-consumption.

References

[1] Anable, J. Complacent car addicts or aspiring environmentalists? identifying travel behaviour segments using attitude theory. *Transport Policy 12*, 1 (2005), 65–78.

[2] Avineri, E., and Waygood, E. Applying goal framing to enhance the effect of information on transport-related co2 emissions. In *Conference on Environmenal Psychology, The Netherlands* (2011).

[3] Baum, P. A new track for technology: Can ict take care for healthier lifestyles? In *22nd European Regional ITS Conference, Budapest* (2011).

[4] Ben-Akiva, M., and Lerman, S. *Discrete choice analysis: theory and application to travel demand*, vol. 9. MIT press, 1985.

[5] Bothos, E., Apostolou, D., and Mentzas, G. Recommending eco-friendly route plans. In *First International Workshop on Recommendation Technologies for Lifestyle Change* (2012).

[6] Fesenmaier, D., Werthner, H., and Wober, K. *Travel Destination Recommendation Systems: Behavioural Foundations and Applications*. CABI, 2006.

[7] Mahmood, T., Ricci, F., Venturini, A., and Höpken, W. Adaptive recommender systems for travel planning. *ICT in Tourism 2008* (2008), 1–11.

[8] May, A., Page, M., and Hull, A. Developing a set of decision-support tools for sustainable urban transport in the uk. *Transport Policy 15*, 6 (2008), 328–340.

[9] Thaler, R., Sunstein, C., and Balz, J. Choice architecture. *Available at SSRN 1583509* (2010).

[10] Tumas, G., and Ricci, F. Personalized mobile city transport advisory system. *ICT in Tourism 2009* (2009), 173–183.

[11] Yoo, K., Gretzel, U., and Zanker, M. *Persuasive Recommender Systems*. Springer, 2012.

[12] Yu, C., Lakshmanan, L., and Amer-Yahia, S. It takes variety to make a world: diversification in recommender systems. In *12th EDBT*, ACM (2009), 368–378.

[13] Zenker, B., and Ludwig, B. Rose–an intelligent mobile assistant. *Proceedings of ICAART* (2010).

[14] Zheng, Y., and Xie, X. Learning travel recommendations from user-generated gps traces. *ACM TIST 2*, 1 (2011), 2.