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# IMPROVING CONSUMER DECISIONS THROUGH PREFERENCE RELAXATION

## ABSTRACT

In online shopping scenarios, it can be difficult for consumers to process large amounts of information and make a good purchase decision, particularly for multiattributed products selection. Interactive decision aids that support preferential choice using information filtering are a potential solution to this problem. However, current methods that enable filtering based on initial customer preferences may eliminate potentially valuable alternatives early in the decision process, and possibly negatively impact decision quality. Drawing from recent developments in recommender systems and query rewriting, we propose a new method that minimizes the elimination of high quality alternatives early in the decision-making process. We develop a model of such a decision aid and provide an evaluation scenario based on 56915 adverts gathered from popular used car advertising website. We discuss the potential impact of our method and describe the experimental methodology designed to evaluate our research propositions. Finally, we give an overview of the implications of our study for practitioners and researchers.

## KEYWORDS

e-Commerce, Interactive Decision Aids, Decision Making.

## 1. INTRODUCTION AND MOTIVATION

Consumers online often face a task to select a best option from a large set of alternatives, such as choosing a car to buy, an apartment to rent, or a plane ticket to book using popular websites (e.g. *orbitz.com*). E-commerce sites provide the possibility to search for or filter products, usually by asking a user to fill a form enquiring about the requirements that a desired product has to satisfy (preferences). This process is used is also referred to as *preference-based search* (Viappiani et al., 2008) or *parametric search* (Burke, 2002). Although such choice-based approaches are common, both users and retailers can find them unsatisfying (Hagen et al., 2000). One of the major reasons is that users are often not able to correctly transform their preferences into requirements using online forms, and thus they are rarely provided with the information they need (Viappiani et al., 2008). Furthermore, customers are usually not familiar with all available products and their characteristics: it is therefore important that consumers are aware of possible options.

One group of approaches addressing the above problems relates to decision aids based on recommender systems. Numerous studies propose the use of recommendations to improve consumer decision-making (Bridge and Ricci, 2007). Providing a consumer with a relevant (similar to his stated preferences) yet diverse (so that he can discover new opportunities and adjust his preference model) set of suggestions has become an important research problem (Smyth and McClave, 2001). According to the *Look-ahead principle* (Viappiani et al., 2008), “suggestions should not be optimal under the current preference model, but should provide high likelihood of optimality when an additional preference is stated”.

Another group of approaches draws from query rewriting methods applicable to failing queries. Mirzadeh (2007) highlighted two types of failing queries: (a) the result set for the query is too big to deal with (b) the result set for the query is empty. In case of (a) *query tightening* methods are used so that additional constraints are provided and size of the result set is reduced. In case of (b) *query relaxation* methods are

applied to eliminate or relax particular constraints from the query and to return a nonempty result set (Ricci et al., 2002). McSherry (2004) argued that the extent of value relaxation in failing queries (compromise) is important and should be researched in more detail. One of the main limitations of these query relaxation methods lies in their application only to cases of *empty failing queries*.

We propose to further investigate these problems in a decision support context. However, our research differs in a number of ways from existing approaches. Firstly, we primarily focus on reduction of type I error by improving the preferences provided by a consumer (which can lead to discovering interesting alternatives and an improvement of the elicited preference model). Secondly, many of the existing approaches require prior knowledge (Viappiani et al., 2008) or history of user interactions and preference models (Pu and Faltings, 2000): these are not required in our approach. Thirdly, query relaxation methods are typically applied in case of *empty failing queries* (Mirzadeh and Ricci, 2007) whereas our method does not have this limitation. Finally, in *query relaxation* methods all items satisfying a relaxed query are included in the result set, whereas in our approach only selected high quality items are included replacing low quality items from the initial result set.

In this paper we argue that our approach will positively impact decision making by increasing the diversity and quality of a result set presented to a user after filtration, and enabling users to decide if further adjustments to their stated preferences are necessary.

## 2. PREFERENCE RELAXATION MECHANISM

The method proposed here is designed to allow customers consider selected alternatives (e.g. cars) that were initially eliminated according to stated preference in order to make better decisions. Let us assume a consumer who is planning to buy a car. She would like to spend between €7000 and €8000 for a car that is well equipped and with reasonable mileage (between 25,000 and 75,000 km). However, she might be willing to pay slightly more (say €100) for a car with the same features but with a lower mileage (21000 km) than expected in the preference model.

In this short paper we present our approach using numerical attributes. However, our method can be also applied to other types of attributes. Typically, preferences on numerical attributes are expressed using value ranges. The attribute value range preference for an attribute is defined as  $d = (d_L, d_U)$  where  $d_L$  and  $d_U$  are the lowest and the highest acceptable values respectively. Our method assumes variables  $e_U$  (upper),  $e_L$  (lower), and a relaxation factor  $\delta$  where  $e_i = \delta * d_i$ , which relax the value preference  $p$  causing the filtering rule to be less restrictive. Following suggestions in Mirzadeh (2007) we assume three values of  $\delta = 0.1, 0.05$  and  $0.02$ , however we note that  $\delta$  should be tuned with the user sensitivity to changes in the relaxed feature. Products that satisfy the less strict preference  $d^* = (d_L - e_L, d_U + e_U)$  may be included in the result set and can be considered by the decision maker.

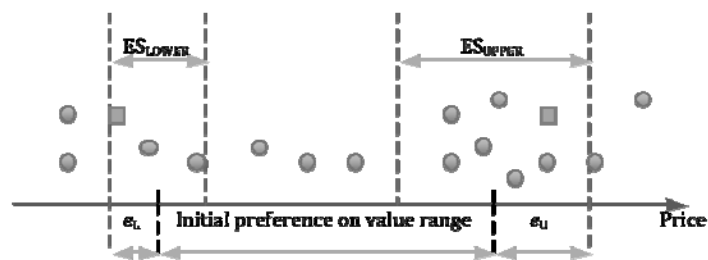


Figure 1 Example of *edge sets* on price preference with items selected for inclusion in the result set (squares).

The inclusion of all items satisfying the relaxed criteria significantly increases the number of items presented to the user, resulting in higher information overload. To prevent these negative effects we incorporate a selection mechanism into our relaxation method that includes only some of those cases. To explain this strategy we introduce the concept of an *edge set*. We conceptualize an *edge set* as a set of alternatives that fall into a value range constructed based on the initial consumer preference with relation to a given attribute. For every preference value range two *edge sets* (ES) can be constructed (lower and upper), respectively:  $ES_{LOWER} = (d_L - e_L, d_L + e_L)$  and  $ES_{UPPER} = (d_U - e_U, d_U + e_U)$  (see Figure 1). We explain this

concept based on an example of price range preference  $p_{\text{PRICE}} = (\text{€}3000, \text{€}4000)$ . For example, assuming variables  $e_U = 200$  and  $e_L = 150$  (for  $\delta = 0.05$ ) two *edge sets* can be constructed:  $ES_{\text{LOWER}} = (2850, 3150)$  and  $ES_{\text{UPPER}} = (3800, 4200)$ . Thus  $ES_{\text{LOWER}}$  will contain items that fall into the  $(\text{€}2850, \text{€}3150)$  price range. More specifically, our approach involves three steps:

- 1) First, we create *edge sets* for every interval boundary (e.g.  $ES_{\text{LOWER}} = (d_L - e_L, d_L + e_L)$  for lower preference boundary) using selected  $\delta$  (e.g. 0,05).
- 2) For every *edge set* we identify the set of all *non-dominated* items also referred to as *skyline* (Borzsonyi et al., 2001). An item is *non-dominated* if no other item is better for any preference on attribute without being worse for at least one preference on other attributes (Häubl and Trifts, 2000).
- 3) If any item from the *skyline* does not satisfy the initial (not-relaxed) preference it is included in the results set. To prevent increase in cognitive load the total size of the set is kept constant, thus the items with lowest utility according to current preference model are substituted with items from *skyline*

## Hypotheses

We expect that the method we propose will impact various aspects of decision making, in particular decision quality. We propose to measure decision quality by analyzing the consideration sets formed in the decision making process; such sets may comprise dominated or non-dominated (superior) alternatives. Sets with largely superior alternatives are better. Moreover, decision quality can also encompass a decision maker's degree of confidence in the correctness of his decision Haubl et al. (2000). Thus, we propose to examine decision confidence in light of how often decision makers change their initial decision when they are offered a switching opportunity. Furthermore, it is possible that both the quality and the size of consideration sets are affected by the use of soft-boundary decision aids. The size of the consideration set represents the number of alternatives that a decision maker is seriously considering. The share of considered products that are *nondominated* (that is, superior) indicates the quality of a consideration set (Häubl and Trifts, 2000). Thus, we plan to investigate the following hypotheses:

- H1: The preference relaxation positively influences decision quality.**
- H2: The preference relaxation positively influences decision confidence.**
- H3: The preference relaxation leads to higher quality consideration sets.**

## Evaluation

To illustrate the potential benefits of the decision aid, we develop a use case based on the task of buying a used car using an online car market. The dataset for our evaluation consists of 56915 real car advertisements from a dedicated online car-advertising site. Based on the study of relevant literature we identified two methods for evaluating our approach.

Firstly, we propose to evaluate our propositions through a controlled user-based laboratory experiment. The apparatus will consist of a website that will provide users with access to 56915 available car adverts with pictures, and the task for subjects to buy a car. We performed a pilot study with 24 subjects to identify the most prominent attributes (from 30+ in our dataset) to be included in our main experiment. For the main experiment we have implemented a website that functionally resembles popular used-car advertisement websites (e.g. range filtering, sorting) with two implementations: the treatment website offering preference relaxation mechanism, and a control website with no decision aid, following the approach suggested in Viappiani et al (2008). We plan to draw the participant sample from students of different programs at a university. Although the reliance on college students has been criticized by many studies in applied research, it was shown that it is appropriate to use student subjects in evaluation tasks that do not require prior knowledge, e.g. accommodation-to-rent search (Garrity et al., 2005). Moreover, many valuable research studies in e-commerce have proposed students as a representative sample of the Internet users (Viappiani et al., 2008, Todd and Benbasat, 2000, Pu et al., 2006).

Secondly, following suggestions in (Viappiani et al., 2008) we plan to perform a set of simulations using user query logs acquired from one of the most popular online used car sellers in Europe. Simulations will enable us to contrast our method to other popular existing approaches in terms of quality. For every user

query in the log we will assess the quality of items in the result set for that query in terms of the share of *nondominated* alternatives in the set, average utility and the size of the set.

### 3. CONCLUSIONS

This research-in-progress paper introduces a new decision aid illustratively applied to an online used car advertisement environment. We argue that during the process of filtering of the initial, very large set of products, customers eliminate alternatives they could later consider, by providing inaccurate preferences for attributes and attribute values. In this paper we introduce a model for a decision aid that can limit the potentially negative effects of the dynamic preferences of consumers addressing the limitations of existing methods. We also hypothesize about the impact of such a decision aid on decision quality and consideration sets, and discuss methods used for evaluation of these propositions.

If our method increases the overall quality of the consideration set, and enables alternatives to be retained in that set that would otherwise be lost in an early elimination stage, decision quality may be increased. If it positively impacts decision quality, the decision aid might result in higher decision confidence. As such, it is worthy of study. We believe that the e-commerce application of such a decision aid can be highly beneficial to providers of online shopping services: increased confidence of consumers leads to higher customer retention and, typically, higher profits (HennigThurau and Klee, 1997). Moreover, increased average quality of the alternatives considered by a decision maker would reduce decision-making effort. This would have direct relevance to online consumers, as well as having value to e-commerce providers.

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