Towards Compositional Design and Evaluation of Preference Elicitation Interfaces

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Abstract. Creating user preference models has become an important endeavor for HCI. Forming a preference profile is a constructive process in the user's mind depending on use context as well as a user's thinking and information processing style. We believe a one-style-fits-all approach to the design of these interfaces is not sufficient in supporting users in constructing an accurate profile. We present work towards a compositional design approach that will lead designers in the creation of preference elicitation interfaces. The core of the approach is a set of elements created based on design principles and cognitive styles of the user. Given the use context of the preference elicitation suitable elements can be identified and strategically combined into interfaces. The interfaces will be evaluated in an iterative, compositional way by target users to reach a desired outcome interface.

Keywords: Compositional Design, Preference Elicitation, Interface Design.

1 Introduction

Knowing what a user likes and dislikes, i.e., his preferences, is important for intelligent systems in many domains. Preferences are part of an accurate user model needed to create system responses (e.g. recommendations or decision-theoretic advice) adapted to the user. Eliciting preferences from users is not a simple task. Traditional assumptions of economists that people have known, stable and coherent preferences are not correct [18]. People, confronted with a new decision task do not possess stable preferences, but have to construct them [19]. This construction process depends on the goal of the decision and the decision context (e.g., alternatives in an outcome set, how information is presented to the person).

Several techniques have been developed to elicit preferences, from implicit ones that learn preferences from the user's behavior [12], to explicit ones that ask users a long list of elicitation questions. However, only a few researchers [22] have explicitly put the focus on the user and the interaction between the user and the system and taken the constructive nature of preferences into account.

Given that the process of constructing preferences is important for people to arrive at an understanding of their own preferences and as the flow of process influences the outcome, we argue that more focus should be put on the design of preference elicitation interfaces. Apart from the constructive nature of preferences, one should also

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take into account the application goal and contextual factors, such as the importance of the decision, available time, number of alternatives and people involved as this influences the applicability of the elicitation technique. For example, a product recommender embedded in an online shopping environment has a different goal and offers a different environment than a system supporting an individual in taking a difficult medical decision. The interfaces will look completely different in terms of their interaction elements, but both can be equally successful in creating a useful preference profile.

In this paper we present a first outline of a compositional design approach for preference elicitation interfaces together with an example how we applied the approach. In addition, we provide design guidelines and discuss open issues offering directions for future research.

1.1 Research Hypothesis

As people construct their preferences when needed, a successful preference elicitation interface should be situated; i.e. based on a careful analysis of the purpose and the use context of the application. *H1: The purpose and use context of the application that elicits preferences determines the preference elicitation interface.*

The importance of information processing during preference construction by users, leads us to the next aspect: People's differences in information perception and processing leading to misinterpretations and wrong preferences. To be sure the user has a chance of understanding relevant information in an optimal way, an interface needs to support each user's cognitive style in an adaptive/-able way. Depending on the purpose of the application, (e.g. decision or negotiation support, tutoring system), different types of styles could be relevant (thinking styles, learning styles etc.). *H2: The use context determines the set of relevant cognitive styles to be considered for preference elicitation interfaces.*

Once the use context and the relevant styles are identified we can proceed with designing interfaces. There have been few attempts to create principles to guide the preference elicitation design [22]. Therefore, one of our contributions will be a set of design principles relevant for preference elicitation interfaces which has to be proven. *H3: Preference elicitation interfaces should satisfy the proposed set of design principles.*

The question remains how to design a successful preference elicitation interface, i.e. one creating an accurate profile, for a particular application in an efficient way? Do we have to start from scratch for every new task? As interfaces are composed of interaction elements, the question arises whether it is possible to reuse elements and combine them for a given use context, similar to component-based software engineering [14]. If the environments are sufficiently similar, it should be possible. Thus we propose a compositional approach in which new interface designs are built out of elements fitting particular user styles and contextual factors and iteratively improved. *H4: Preference Elicitation Interfaces can be designed and evaluated in a compositional manner.*

2 Background

2.1 Constructive Preferences

Studies in behavioral decision making have confirmed that preferences are not stable but constructive [19], i.e., people do not have well-defined preferences in most situations but construct them in the decision making context. Furthermore, people are not entirely rational, but also emotional and social beings. Therefore, besides aiming at maximizing the accuracy of their decisions they try to reduce cognitive effort and negative emotions while enhancing positive emotions and the ease of justifying a decision. While reducing cognitive effort, people might undergo several faults in the preference construction process [18], e.g., avoidance of trade-offs or focusing on too little information. There are different views on how people construct their preferences [15,26]. Simon and colleagues [27] found that while people processed the decision task, their preferences of attributes in the option that was chosen increased whereas those for attributes of rejected options decreased. Similar effects have been found in negotiation settings [7]. This is in line with one of the meta-goals named by Bettman and Luce [1], i.e. trying to maximize the ease of justifying a decision. Another aspect of constructing preferences has been brought forward by Fischer et al. [11] focusing on the goals of the decision task in relation to a so-called prominence effect. This effect occurs when people prefer an alternative that is superior only on the most important, attribute. In order to avoid unwanted effects we have to think carefully about the way we pose a preference elicitation task to the users. Payne and colleagues [18] have developed guidelines for measuring preferences taking people's behavior into account. Work focusing on the user side has been presented by Pu et al. [22].

2.2 Preference Elicitation Interfaces

Techniques commonly used in preference elicitation interfaces include knowledge-based find-me techniques [2], example critiquing and tweaking [8,24], active decisions and clustering or collaborative filtering [6]. The latter two are used mainly to create profiles for new users based on clusters of existing users and similarity [23]. There are also hybrid systems combining different approaches [3]. In knowledge-based systems, preferences are elicited by example-similarity; the user rates a given item and requests similar items. Tweaking can be used to limit similar items to only those satisfying the tweak. In example-critiquing approaches the user is presented with a set of candidates (e.g. products) to be critiqued. The user can either choose one of them or critique some of their attributes. In the Apt Decision Agent [24], e.g., people initially provide few criteria for an apartment to get a selection of sample apartments. Next, they can give feedback on any attribute of any apartment.

Not all techniques mentioned are relevant for decision support systems due to a lack of user-involvement. The user will be less likely to understand advice by a system, if the system has created a user profile implicitly [5]. A majority of the literature presenting these systems focuses on technical implementations and not the user. Few researchers proposed guidelines for user-involved preferences [18, 22].

3 Design Principles for Preference Elicitation Interfaces

The following design principles are derived from the diverse literature influential to the success of a preference elicitation interface.

(1) Support of human process of constructing preferences. The work of [22] provides a number of more detailed guidelines addressing this criterion: (1.1) show decision context, that also allows people to see the consequences of their decisions.(1.2) provide examples that can be critiqued by the users to refine their preferences. (1.3) give immediate visual feedback.

(2) Affective feedback. There is interplay between cognition and affect when people construct their preferences. Therefore, combining cognitive (e.g. choosing from a list of values) and affective (e.g. emoticons) elements in an interface might lead to more insights into the user's preferences.

(3) Value-Focused Preferences. In value-focused thinking [16] proposes a focus on fundamental values relevant for a decision before identifying possible alternatives and assessing their desirability. Generally, values are seen as more stable than preferences over attributes [25] preference elicitation interfaces [9, 29].

(4) Transparency. A major aspect influencing the success of decision support systems is the user's trust in the system [21]. System transparency is one aspect that can enhance users' trust [28]. By transparency we mean that the user understands what the system is doing, why it asks certain questions and how the current profile looks. Implicit elicitation methods often restrict the user from constructing preferences and suggestions based on the created profile are hard to understand [5].

(5) User-System Collaboration. Designing user interfaces means designing the interaction between the system and the user. For decision support it is important that the user and the system collaborate in establishing a good user profile. We define three criteria for the interaction: *(5.1) Natural Interaction.* Natural interaction refers to the usual way in which the users act in the physical world applied to computer systems. People use gestures, expressions, speech and movement to communicate. *(5.2) Real World Metaphors.* Part of designing the interaction with a system as natural as possible is using real-world metaphors that users can relate to. *(5.3) Mixed Initiative* [10] is a popular approach for collaborative problem solving (e.g. constructing a preference profile).

4 Proposed Approach

Use context is important in deciding what the interface should be like to support the user's construction of an accurate profile. We define use context in terms of the measurable aspects (to be extended) task goal, importance of the decision, available time, the number of alternatives and people involved (for an example in a negotiation support system see section 4.3).

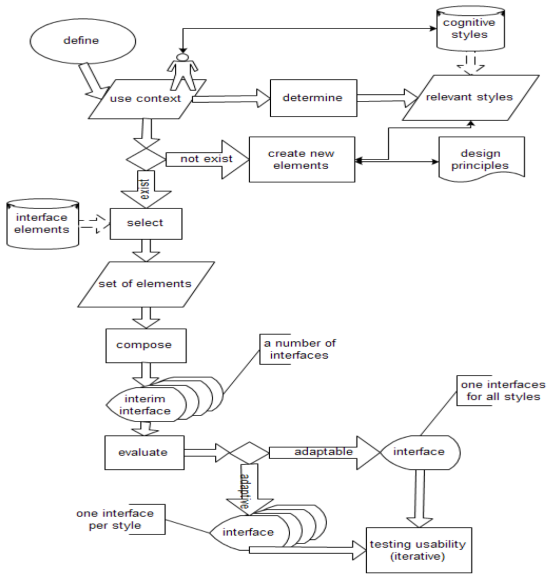

Fig. 1. Flowchart of the approach

4.1 Interface Elements

The core of our approach form so-called interface elements. Generally, an interface can be seen holistically or as a collection of elements. Simple elements (widgets) like buttons, list boxes, and comboboxes, fit all cognitive styles. These can be embedded in more complex elements, e.g. a spell checker in a word processor. Complex elements often represent a concept or an idea rather than just a simple way of entering data. Complex elements are meaningful in terms of a particular user goal, cognitive style and fit with a particular environment. We focus on combining complex elements. The ultimate goal is to develop and store many elements in a database with information on how each element relates to contextual factors, styles, and design principles. This database should contain only evaluated elements and be available to interface builders to speed up the design process.

4.2 The Approach Step-by-Step

Step 1: Defining the use context. The starting point of our compositional approach is the definition of the application's use context, i.e. aspects such as the general purpose or task goal, e.g. recommendation or personalized decision advice, the number of people involved, time constraints, the size of outcome space and the decision importance.

Step 2: Determining relevant type of styles. To assure optimal adaptation to the user's way of handling information the next step is to determine the type of style that is most relevant in the given use context. This knowledge could be asked from a database containing all types of styles and their relations to context factors. As this is not available currently the designer has to extract knowledge from literature.

Step 3: Defining target group's styles. Next, the designer needs to define whether the target user group consists of people with all styles in the chosen set of styles or whether to focus on a specific subgroup that shares one style. In the latter case it is enough to design one interface. Otherwise, it is possible to design one interface for each style or an adaptive interface covering all styles and can be adapted by the user.

Step 4: Selecting/Creating interface elements. Given a database with usable interface elements and their relationships to the use context factors, styles, and design principles, this step contains of asking the database to return all elements fitting the use context defined in step 1 and the type of style in step 2. In case the query does not return enough elements to cover all styles and design principles, the designer has to create new elements. In case these elements end-up in the final design due to positive evaluation these elements will be added to the database. The question is 'how to create these elements?' We propose a participatory design process. Since an element needs to fit a certain type of style and more specific different styles of that type, we suggest assessing each participant's style (e.g. by questionnaire) and grouping the participants per style. A leader of the design sessions needs to assure that the design principles are represented in the final designs. For the design sessions standard creative techniques can be applied (brainstorming, thinking hats, etc.). Another option is that the designer creates the elements herself using theories of the identified styles and following the design principles.

Step 5: Composing interim interfaces. The set of elements needs to be combined into complete interfaces. Ideally all possible combinations should be developed and evaluated by the target users to find the optimal one. However, with a high number of elements this is an impossible endeavor. Therefore, the designer should pick a subset of all possible interfaces that covers the design principles and styles. The concrete combination relation is still an open issue for research. One idea is to focus on combining elements addressing different styles in each interface allowing for creative, constructive feedback by users in the next step.

Step 6: Compositional evaluation. As the core of the approach is the compositionality of elements, we evaluate the interfaces also compositionally. That means the goal of the evaluation should not be to find the best interface in the designed set but to ask users to evaluate the different elements and offer ideas of how to combine them. (As elements may not be useful by themselves it is not possible to only evaluate elements by themselves.) In the compositional evaluation the participants interact with all interim interfaces. We suggest a formative evaluation (e.g. think aloud) to encourage discussion of ideas and constructive feedback.

Step 7: Composing stable interfaces. After participants interacted with the interfaces user feedback needs to be applied to the design of a new set of interfaces. This is done by combining the elements using a different composition relation. In case the designer chooses to let the system adapt its interface to its user based on a style, it is useful to create one interface per style. In case the designer creates one interface for all styles, the interface should be adaptable. Given the first case we suggest a participatory design approach in which the participants are grouped per style. Each group is asked to help in the design of an optimal preference interface. The outcome of this process is a set of stable interfaces, one per style. Given the second case (one interface) it is possible to group participants per style and let them negotiate a new interface or use mixed groups and combine the outcomes into a new interface. These are just suggestions. What way will lead to the best desired outcome(s), still needs to be shown by future research.

Step 8: Usability Testing and Optimization. The last step is an iteration of standard usability testing with target users to refine the end-design(s).

4.3 The Approach Applied: Preference Elicitation for the Job Domain

To clarify our approach we give an example of a current design case, i.e. a preference elicitation interface of an application that gives advice on job (contract) offers.

Step 1: The goal of the system is to support people deciding on a job offer that best matches their preferences. The importance of the final decision is high. Typically a job offer contains a number of attributes, e.g. salary, salary growth, vacation days, company car, and the combination of them to concrete offers leads to large number of alternatives. There are no time-constraints and the system is focused on a single user.

Step 2: For our example we selected the mind styles theory by Gregorc [15] which categorizes people based perceptual and ordering preference. Perceiving information can be abstract (based reason and intuition) and concrete (using senses). The order of information processing can be sequential or random. This leaves us with four types *concrete sequential*, *concrete random, abstract sequential* and a*bstract random.*

Step 3: Our application is directed at people with diverse mind styles.

Step 4: We designed elements and took some existing elements from the literature.

Virtual agent: The abstract random thinker likes to listen to and work with others and thinks best in personalized environments. This combined with principle 5.1 and 5.3 (mixed initiative) led to a virtual agent element asking the user about his preferences.

Tag Cloud is an interface element we used to reach system transparency (4) and for the abstract random thinker, because tagging as a social activity fits his preference for group activities.

Post-it notes serve as a real-world metaphor (5.2) for collecting information by writing it on the notes and structuring it by moving the notes around. This fits with concrete random thinkers, who like experimenting to find answers.

Outcome Cluster: Using design principle 1.1 and 1.3 we designed an element that gives an overview over how well job offers score given a preference profile. Using clusters instead of complete orderings serves the concrete random thinker, because it leaves room for interpretation.

Interest Profiling: Value-focused thinking (3) was the inspiration for this element. We use four profiles visualized by a set of images each reflecting a life-goal. Each profile represents a set of preferences. As value-focused thinking is a step-wise process from considering interests to choosing alternatives to compare, it fits sequential thinkers.

Decision Matrix: Decision or comparison matrixes are often used on product comparison websites (1.1). Preferences and offers are ordered by importance, from top to bottom and left to right respectively. Users can adjust preference values as well as the ordering and get visual feedback of the consequences (1.3).

ValueChart [4] gives an immediate visual feedback (1.3) on how well the five job offers in our system match the user's interests.

Affecttive Example Critiquing shows the details of a given job offer in form of a table with attribute-value pairs and allows users to critique (1.2) any pair with a set of smileys allowing affective feedback (2).

Preference Summary adds to system transparency (4). It fits the concrete sequential thinker as it represents the input in a factual way. It is basically a list of issues and their preferred values ordered by importance (like, want, dislike, do not want).

Step 5: Composing interim interfaces. We combined the elements into four prototypes each one serving one mind style. Together the prototypes cover all design principles. For a detailed description see [20]. (Design principles listed in brackets).

Abstract Random: *Conversational Interface:* In this interface we combined a virtual agent with a tag cloud because they fit the abstract random thinker and the tag cloud is a good representation of the internal "thinking" of the system. Putting the tag cloud into a thought bubble connects the elements. (4, 5.1, 5.3.)

Concrete Random: *Post-it notes Interface:* Both post-its and job offer clusters serve the concrete random thinkers preference for trial-and-error. Especially by combining the two elements in one interface we can offer the possibility to move post-its and immediately see the effects the preferences have on the job offers. The interface does not limit the user to any order or amount of input. (1.1, 1.3, 5.2)

Abstract Sequential: *Offer Comparison:* The decision matrix is a way to analyze the relationship between job offers and preferences. The downside of the matrix is that the preferences need to be filled in to a certain extend before the matrix gives any results. To shorten that process we added the interest profiling element. After choosing a profile the user gets pre-set preferences that can be adjusted. (1.1, 1.3, 3)

Concrete Sequential: *From interest to issue*: This interface supports a concrete, sequential style. It consists of four steps that the user is led through: selecting 3 most important interests, using ValueCharts to see how good job offers fit the interests, critiquing the attributes of job offers with smileys and getting a summary. (1,2,3,4)

Step 6: We did eight individual formative evaluation sessions and a group discussion with all participants. They had diverse backgrounds including IT, design disciplines and linguistics and by that different mind styles. In each individual session (1 hour) a participant interacted with all four prototypes (10 minutes each). We asked people to think aloud and conducted a semi-structured interview at the end of the session in order to get qualitative feedback on the prototypes. During the sessions and the interview we asked people to give constructive feedback on the different interface elements. We emphasized that it is not about finding the best interface, but informing the design process to compose new interfaces [25].

Step 7: We conducted a creative design session with the same participants. We asked two mixed styles groups of four people to compose a new interface. They were given a set of magnetic interface elements (the ones described and basic ones) and a magnetic board to assemble them on (inspired by PICTIVE [17]). In steps 6 and 7 we found that most participants preferred elements that explicitly let them construct preferences and explore results of those manipulations (e.g. post-its, job clusters). Both interfaces constructed in step 7 used multiple views, i.e. values, preferences, outcomes on the data which adapt as soon as one of the views is changed.

Step 8: We have combined the two interfaces and implemented the outcome in a prototype of our system. The user testing still needs to be completed.

5 Discussion and Future Work

We argued for the necessity of careful design of preference elicitation interfaces taking into account factors of the application's use context and different cognitive styles of the users. The background literature on people's construction of preferences and the diversity of techniques used in different domains supports our first hypothesis (H1). We extracted a set of design principles from the literature on human preferences in psychology, social sciences, economy and HCI. The usefulness of these design principles (H3) needs further empirical proof. Furthermore, we propose a first outline of a compositional approach for the design and evaluation of such interfaces. The core of the framework is a set of interface elements fitting the given use context and styles of the users. These elements can be composed into interfaces. With a handful of interfaces one can test a large number of elements that can be recombined in different ways for the next iteration. As interface elements can be reused across applications a database of evaluated elements can be built up to give guidance in future designs.

Our design of an interface eliciting job preferences showed that it was possible and efficient to combine several interface elements and evaluate them in a compositional way. Several research questions are still open. At this moment the optimal composition relation used for step 5 and 7 to combine the elements into interfaces is unknown. We have provided initial ideas of combining the elements. Further research is needed to find a ready-to-use way leading to consistent and usable interfaces. Concrete research questions are: (1) In case too many elements exist, which are the most suitable ones to combine? (2) Does a deliberate mixing of cognitive styles in the first composition step lead to more creative feedback in a formative evaluation? (3) Does the composition of elements into interfaces speed up the design time? We encourage readers to build on these first ideas in their own research.

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