The Shopping Scout: A Framework For An Intelligent Shopping Assistant

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Abstract. The growing availability of mobile devices leads to a new area of applications which give support to human users in situations they could previously not benefit from. In this paper we would like to describe the concept of proactive user interfaces, exemplified in the realization of a shopping scout. By this we mean an application on a mobile computational device which can act as a recommender system for an optimized shopping experience. The shopping scout guides users in a supermarket to those places where products on their shopping list are located. Additionally, the route planned to be pursued during shopping can be modified according to user preferences with regards to properties of certain items. By using capabilities of WIFI communication, we are able to guide users on their way through a store and provide the possibility to call for assistance.

1 Introduction

The main goal of our research consists of finding ways to conceptualize and realize user interfaces for complex applications. Applications become more accessible and usable by exposing users to a high degree of navigation-, selection- and decision-support, by making interfaces available on diverse computational platforms, and by considering a variety of user needs and preferences, [1, 5]

As a result of our endeavors in this area, we have developed a framework of intelligent user interfaces which we will outline and briefly apply to a familiar scenario: shopping in a supermarket.

The core of our approach is the ability of interfaces to intelligently reason about the content which they are communicating to human users. This presupposes a domain model including objects, relations and properties of things that are subject to the human-computer discourse as well as actions and goals that can be carried out and achieved [6, 7].

It is our goal to use the content awareness of the interface to automatically or semi-automatically adapt the communication including the choice and configuration of presentation modalities and formats according to user needs and preferences.
In section two describe the objective and benefits proactive user interfaces. In section three we highlight what content proactive user interface provide to support users. In

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section four we outline a common application scenario. Section five will describe this scenario in the context of proactive user interfaces. We will conclude with a brief discussion of future work in section six.

2 Objectives and Benefits of Proactive User Interfaces

In order to build highly accessible and usable human-computer interfaces we have to face vital challenges in today's software development: Most powerful applications are not appreciated if users cannot take advantage of their power in a reasonably easy way [5].

Our work in the field of advanced user interfaces resulted in the framework of intelligent content-driven interfaces which we call proactive user interfaces. Based on knowledge about the domain, tasks and goals, proactive UI's provide information about the domain, help to perform tasks and to achieve goals [3, 6, 7].

With our approach we address the following objectives:

- Accessibility for users with special needs and preferences
- High usability for all users, whether novice or expert
- Consistent applicability and behavior on diverse hardware, from the desktop to the smart phone
- Easy adaptability across interaction modalities, from GUI's to voice to natural language communication

The special focus in our research is on cognitive support for all users, not just for people with disabilities [4]. We think this is valuable at least for the following two reasons:

1. The cognitive support users need depends on their cognitive capabilities in relation to the cognitive load imposed by the task or problem to be solved. This means cognitive support is not only justified for disabled or specially challenged users but even for a Nobel Prize Laureate given a complex enough issue.

2. Computers have strengths partially complementary to those of humans. An important point we want to make is to use computer devices to enhance cognitive capabilities by providing complementary aid to the human problem solver. An example of a more trivial kind would be using a pocket calculator instead of mental arithmetic.

We think of cognitive support as timely help given by the computer with respect to different stages in the problem solving process. This means that we view HCI as a manifestation of a problem-solving process, in which human users try to solve a

problem by exploiting the capabilities of the software to optimize the problem solving results [8].

The computer will be of greatest help for users if it

1. Supports exactly those stages of the problem solving process in which users are currently in, and
2. Does not itself pose a problem, thus adding to the problem solving tasks instead of reducing them.

3 How Proactive User Interfaces leverage Cognitive Support

Proactive interfaces comprise the following main functionalities to provide cognitive support:

1. Situational Awareness

Proactive user interfaces have the capability of describing the users' situations with special focus on those objects, properties and relations which are relevant for achievable goals. Realizing situation awareness directly satisfies one of the components of accessibility. It is important and therefore explicitly stated here that situational awareness does not necessarily mean a complete description of all situational constituents. If the interface has the capability to do so only those constituents are communicated which directly will or can influence the further actions of users. Situations are described in terms of the domain lingua, i.e., in a way users can understand without any application-specific technical knowledge.

2. Recommendation of feasible Goals

Based on situation descriptions, the next step is to explore feasible options. Relevant options to be pursued in a domain depend on the users' expertise and goals [12]. Users' final goals are accomplished by achieving a number of sub-goals. Therefore, our next feature of proactive user interfaces consists of the recommendation of sub-goals that are the best next choice on the way of achieving the users' final goals.

3. Guidance towards accepted Goals

Once an option in the form of a feasible goal based on the users' current situation has been chosen, the interface will provide step-by-step guidance to realize this goal [9]. This feature is a major part of cognitive support in the human problem-solving process.

4. Generation of Instructions, Justifications, and Explanations

If an interface can actively provide cognitive support it should justify its selection of relevant situational constituents in order to induce trust and believability in users.

Furthermore, the interface should be able to explain why a goal was recommended, instruct how to achieve a goal and justify each step. The crucial idea is that the knowledge provided by the cognitive supportive interface must relate to the current knowledge of users to allow users to reconstruct the "thinking" of the supportive interfaces.

Offering explanations during the human-computer interaction is of great value as a just-in-time learning approach. While solving an actual problem, users are most motivated to learn about solving this problem. As opposed to learning offline, giving justifications and explanations dynamically constitutes a flexible form of help that can adapt to individual needs and preferences. In contrast to other forms of help such as hypertext documents or paper manuals, online explanations can be generated just in time when the user needs information. This all helps increase the efficiency and usability through the learning experience, thereby increasing user satisfaction. Compare also [10, 11].

After the content to support users has been generated, the question is how to present it. We use templates stored in template libraries. These templates are filled with the content based on parameters describing special user needs and preferences, as well as parameters describing device constraints and modalities. Innovative mapping techniques are used to transform the content into the optimal presentation format on different devices and modalities. Content generated for a desktop interface using mouse, keyboard and a monitor can now easily be presented in a PDA interface using stylus and a small display, or even to an interface using voice as input and output. While using the devices they prefer, users can be supported based on their individual needs and preferences.

4 The Application Scenario

We would now like to describe how a proactive user interface can improve the shopping experience which can be quite challenging since a number of questions have to be solved such as:

1. Where am I currently and where can I find the next item on my list?
2. What would be the best and shortest route to get all items?
3. How can I optimize my shopping so that I do not need to carry around products I prefer to buy as late as possible, like frozen goods or heavy things?
4. With all this hassle, how do I still remember what I wanted to buy?

In order to provide an intelligent user interface that can answer all of the questions above, we have to represent several knowledge sources in the interface:

- Domain knowledge about products and product properties such as weight, and storing temperature
- Location knowledge including store map, locations of products and customer

- Customer-specific knowledge including shopping list and preferences which determine the shopping behavior as well as the preferred presentation format
- Device-specific knowledge about the device used by the customer

Shopping list and preference have to be entered manually by the costumers. The interface allows customers to create new shopping lists, as well as reuse and modify existing once. Alternatively, it recommends shopping items or adds items automatically based on the customers' previous shopping behaviors. When entering preferences, templates and previous settings can be used. Preferences influence the path taken to pick up products: e.g. sequential according to the shopping list, using the shortest path through the supermarket, or by considering product properties such as weight and temperature.

Domain knowledge and store map are dynamically loaded to the device when entering the store. The location of customers is dynamically determined and permanently updated using WIFI. Details on the technologies used for location sensing will not be addressed in this paper. For further information please see [2].

Shopping list, customer preferences, store map including location and availability of products, and location of customers are used to generate optimal routes through the supermarket. Presentation-preferences as well as device-specific knowledge are used to identify the best presentation format for the customers: e.g. using a map displayed on the PDA screen or voice output.

While the algorithm of how to generate the optimal route is not our concern, we focus on how proactive user interfaces can provide cognitive support of users. We have identified five ways to support customers:

1. After generating the optimal route, the interface can recommend which item to purchase next.
2. After approving the recommendation of the interface, the user gets instruction on how to find the item.
3. The user can request justification of why certain items have been recommended.
4. The interface provides the possibility to call customer service for further inquiries.

5 In Dialogue with the Proactive User Interface

Let us consider Mary who intends to go shopping in a supermarket. She needs different kinds of products: cosmetic articles, spaghetti, sugar, bread, some items from the refrigerated section such as cheese, milk, and meat, some frozen goods like ice cream and frozen pizza, as well as heavy beverages like sodas, beer, and wine. She

would like to get her shopping done in a rational way. Mary does not want to go back and forth but rather pick up things along the shortest route possible through the store.

However, she has some preferences regarding when she wants to put certain goods into her shopping cart:

- The light products first.
- The cooled and especially the frozen things last.

Mary uses a PDA which provides a supportive user interface that will guide her through the supermarket. Before starting her shopping experience, Mary's preferences and shopping items need to be stored on the PDA. Since she does not wish to change her defaults settings, the interface will use preferences and shopping list from Mary's previous shopping trip.

After preferences and shopping list are set, the interface is still missing the map of the store and Mary's position in the store. The map of the store and the product knowledge base are automatically transferred to Mary's PDA when entering the store. Using WIFI, Mary's position in the store is identified, allowing the interface to describe her current situation. Based on shopping list, preferences, and location data the system dynamically generates the optimal path for Mary. The interface then proactively guides her through the store by giving directions according to Mary's movements.

The following example shows a possible interaction between Mary and the supportive interface:

```
Interface: "Welcome Mary. You are now close to the
frozen products and the cosmetics you want to buy."
```

Now follows the goal recommendation. On the knowledge the interface has it recommends to get the cosmetics first.

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Interface: "According to your preferences, I recommend
to buy the cosmetics first."
```

The interface now enters the guidance phase and leads Mary to the cosmetic section.

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Interface: "I will guide you to the cosmetic products.
Turn left and proceed to the next aisle. … Now turn
left again and you will enter the cosmetics section."
```

Mary follows the instructions and upon arrival receives new directions:

```
Interface: "You have picked up the cosmetic products as
noted on your shopping list. You are close to the aisle
containing bread. I recommend going to the aisle with
bread."
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Mary accepts.

```
Interface: "Proceed to your left. … Turn right please.
… Now walk down the aisles. … Stop, the bread is right
in front of you."
```

Mary follows the instructions and on arrival receives further directions. The interface will next guide her to the spaghetti, to the sugar, then to the frozen section and finally to the beverages, as specified in Mary's preferences. When arriving at the beverage section, Mary cannot reach her favorite red wine and approaches the interface.

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Mary: "I need assistance."

Interface: "I will inform customer service. An
assistant will be with you momentarily."
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While Mary waits, a message is send to the closest customer assistant who finds Mary and offers his service. After receiving the red wine, Mary continues to collect her items, proceeds to the cashier, and leaves the store.

6 Conclusion and Future Work

The goal of this paper was to outline and illustrate the core idea of proactive user interfaces, which provide timely cognitive support in accordance with the phases of problem solving in which users engage. We find this approach to be a promising means to improve accessibility, usability and adaptability of interfaces for diverse input/output devices and presentation styles. We stressed the fact that cognitive support is valid for any kind of user rather than only to users with disabilities. Finally, we showed how proactive user interfaces can be utilized in everyday scenarios where they can help simplify human-computer interaction as well as assist with effective, efficient and satisfactory achievement of complex goals. Our future work will be targeted towards efficient implementation of proactive user interfaces, thorough testing, and verification of their benefits in terms of accessibility and usability.

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