A Visualization Concept for Mobile Faceted Search

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Abstract. Nowadays, people are increasingly using their mobile devices to find different kinds of information, for example, about products, trips or latest news. Therefore, mobile devices such as smartphones and tablets have become a constant companion for many users to have access to information at any time and any place. The large amount of data and information that is provided to the user by mobile devices differs in its feature set and visual representation. To ensure the success of an app and to keep the user from an information overload by presenting too much information, a wise preparation and visualization of the data is necessary. Faceted search provides an opportunity to focus on specific information by filtering. In this paper we present a general visualization concept for faceted search on mobile devices, especially on smartphones.

Keywords: visualization, faceted search, mobile devices, design patterns.

1 Introduction

People are continuously looking for different kinds of information at any time and any place. To act location- and time-independent most people use their mobile devices such as smartphones or tablets. Since mobile devices usually have small displays, all information has to be adapted to these kinds of display. Consequently, the importance of proper search tools rises to achieve desired search results. Our approach is to adapt information by using faceted search to filter the given data. Faceted search is a technique of progressively refining search results by selecting filter criteria in any combination [1, 2].

While many mobile applications currently offer the possibility to filter results, most of them cannot be compared to desktop solutions [1]. Often there is an attempt to reduce search refinement options to a minimum for the mobile version due to the limited screen size. The developers' intent is to keep the user interface simple, which results in the limitation of functionality. To avoid this limitation we present a concept to visualize faceted search on mobile devices.

This paper is structured as follows: In section 2 some related work is presented. In section 3 we summarize a short survey that is the basis for our visualization concept. Section 4 describes our visualization concept for mobile faceted search in detail. We introduce different design patterns and facets that are extracted from various current applications. Section 5 presents a prototype that was implemented to show the feasibility of our concept. Section 6 concludes our paper and shows some future work.

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2 Related Work

Ben Shneiderman summarized the following fundamental principle as the “Visual Information Seeking Mantra”: “Overview first, zoom and filter, then details-on-demand” [3]. This general guideline emphasizes how users can be supported in exploring data. The use of filtering techniques provides dynamic queries that can reduce large data amounts and highlight relevant items. Filters are usually organized by independent properties (facets) with several options (facet values) appearing under each facet [4]. For example, a product might be classified by using a color facet in which green is an exemplary facet value.

A few research projects such as FaThumb [5] have already covered the topic of faceted search on mobile devices. FaThumb enables query refinement displaying a 3x3 grid with filter options in the lower part of the screen, which is grouped in nine zones corresponding to the nine numeric keys on mobile phones. However, in the age of touchscreens these solutions are not appropriate anymore. The e-commerce company Amazon was among the first to establish a mobile application that enriches mobile search with faceted navigation [2]. By now several apps on mobile market places exist that provide faceted search following desktop versions.

There are general principles for designing effective faceted search experiences, for example, displaying only currently available facet values [4]. Furthermore, when designing the query refinement for mobile devices the following aspects should be taken into account:

- Refinement Page: Dedicating a separate filter layer (a dialog or even an entire screen) to faceted navigation, which can be accessed from the search result view, for presenting more than a handful of facets [4, 6]. The refinement page should not contain more than ten facets, arranged by importance, in order to avoid confusing the user [7].
- Facet Value Entry: Matching the displayed input format to the semantics of the facet values is particularly relevant to mobile devices. There are numerous data entry patterns with different intended use, e.g.:
  - Checkboxes for displaying multi-select facets,
  - Sliders for displaying quantitative data with specific ranges. Depending on the context, two types can be distinguished: single-ended and double-ended,
  - Stepper for entering a number between 0 and 5 via a Minus button and a Plus button. [4, 6]
- Navigation: Using a hierarchy as flat as possible to avoid deep drilling (more than three levels) [8]. In this way, facet values can be selected with just a few taps.

The mobile experience strategist Greg Nudelman outlines an experimental pattern in his book “Android Design Patterns”: Slider with Histogram [6]. The idea behind this suggestion is to visualize the distribution of results with a histogram above the slider (cf. Fig. 1). Thus, the user gets an overview of the distribution and could select a wider range. For example, a user would normally place the slider position of a price range at $100 as the limit, not knowing that there are most of the results in the range of $103 -$105. The visual representation of the quantity of results can be a helpful tool for supporting faceted search and is part of the following visualization concept.

Fig. 1. Price slider with histogram pattern according to Greg Nudelman [6]

3 User Survey

To investigate filters we conducted a brief user study with thirteen participants. The participants were asked to evaluate the following three different types of filters for mobile devices:

- Vertical tabs (cf. Fig. 2 left),
- Spinner wheels (cf. Fig. 2 middle), and
- Dropdown lists (cf. Fig. 2 right) with plain text options.

The three examples given in Fig. 2 visualize these three types of filters. The first example on the left side shows a tab filter that represents a selection of a single value or a range of values. In the middle there is a spinner wheel that can be rotated by swipe gestures. On the right side, a dropdown list allows the selection of a single value for each facet.

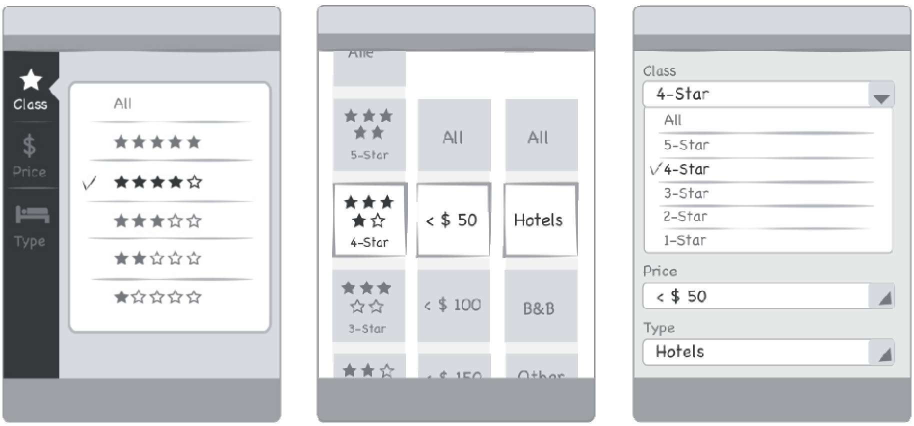

Fig. 2. Examples of three different types of filters: vertical tabs (left), spinner wheels (middle) and dropdown list (right)

The test persons were selected based on their experience with smartphone apps. In general, with a higher experience with apps we implied more experience in using different filter forms to find specific information, too.

The users were asked to evaluate the three kinds of filters by answering an online questionnaire about the visualization in general, the effort to use these filters, the suitability of the filter to specify data and the range of selection options. The test participants got Likert scales from “suits best” to “does not suit at all” (or “very good” to “not good at all”) to choose the rate of the filters or to select what filter they prefer.

The main result of the survey is that tabs were rated best. Dropdown lists were considered suitable to filter data, too. Spinner wheels were evaluated as least appropriate to solve a filtering task. Some of the key characteristics of these three kinds of filter forms are summarized in Table 1. Dropdown lists have the advantage that the entire filter view can be scrolled, which therefore means that many facets can be displayed one below the next. Spinner wheels give an overview of all selected values for each facet and even the other selectable facet values are visible in the same view. Nevertheless, spinner wheels only allow single selection and the number of facets is limited by screen size. Vertical Tabs also offer a limited number of facets but the area besides the tabs provides enough space for the appropriate display format.

Table 1. Comparison of different types of filter forms

	Vertical Tabs	**Spinner Wheels**	**Dropdown Lists**
Number of facets that can be displayed	limited by screen size (mostly up to 5)	limited by screen size (mostly up to 3 or 4)	infinite
Display of facet values	all selected and selectable values for 1 facet	all selectable and selected values for each facet	all selected values for each facet
Selection of facet values	single and multiple	single	normally single

Furthermore, the participants were asked to evaluate different possibilities to visualize quantitative data according to recognizability and also appearance. Besides usual visualization methods such as bar graph and pie chart, other forms of graphical representation were taken into account. In the field of nutrition, which was taken as an application example, an illustration of a beam balance could be used as an example to demonstrate weight control.

Nearly all participants rated the bar graph the best representation of quantitative data due to the fact that this solution is generally known and permits immediate comparisons between numerical values.

The evaluation indicated that vertical tabs are appropriate to represent facets, even though they are limited by screen size. Moreover, bar graphs were identified as a suitable solution to visualize quantitative data. These results have been considered in the following visualization concept.

4 Visualization Concept

Within the scope of this work, we developed a general visualization concept for faceted search on mobile devices, especially on smartphones. This concept is based on the analysis of several existing apps and visualization methods, also taking into account current mobile design patterns. Furthermore, different mobile design solutions for filtering information were evaluated by users in the aforementioned survey. The results of this survey were taken into account in our visualization concept, too.

As already mentioned, many mobile apps represent facets in filter forms as drop-down lists or cascading lists with plain text options. This method causes difficulties in dealing with a large number of facets since users may need to scroll through a long list of values or navigate through more hierarchy levels. In order to simplify this selection, we developed a design concept for filter forms, which is shown in Fig. 3. The filter form is organized by tab controls which can be scrolled vertically and therefore contain a large number of facets.

Another advantage of this method is that the user receives an overview of multiple facets and also sees the values of the selected tab. Fig. 3 also illustrates visual aids supporting the user with information seeking:

- Facet Icons: the use of appropriate icons for each facet (e.g., a currency symbol for the *price* facet) and for a facet value subset (e.g., stars for ratings),

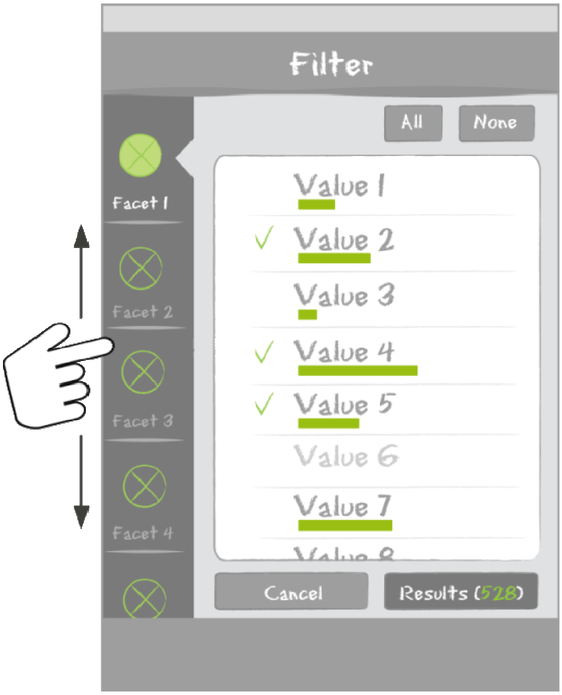

Fig. 3. Visualization concept for filter forms organized by vertical tabs

- Display Formats for Values: the selection of an appropriate display format with respect to the semantics of the facet values (e.g., checkboxes for displaying multi-select facets),
- Number of Results: the presentation of the number of results to support dynamic queries and to avoid returning empty results.

Icons have become increasingly popular due the fact that they are the most common form of images used in mobile design [9]. These simplified graphics can be memorized easily and, thus, provide users with additional visual assistance [10]. In our visualization concept icons for facets and, if appropriate, facet values are used to become memorable images for the user, too. In this way, recurrent facets can be identified quickly.

Using appropriate data entry patterns is particularly important for mobile devices. The developed visualization concept provides enough space for display formats of any kind while still allowing the user to keep an overview of the facets on the left side.

Although updating results dynamically might slightly increase the loading time, an immediate response can be guaranteed. This is important to display only the currently available facet values and, hence, to avoid empty results. A striking example is the selection of amenities values, e.g. *restaurant* or *swimming pool*, in the filter options for finding a suitable hotel. These values applied within the same facet *amenities* are combined conjunctively. A user might select *restaurant* and *swimming pool*, not knowing that there are no results that match his selection. It would be better to dynamically set the value *swimming pool* disabled after the user selected the value *restaurant*. This dynamic aspect is also part of our visualization concept.

The bars below the different values in Fig. 3 indicate the quantity of results for each value and allow immediate visual comparisons. This histogram will dynamically update as soon as facet values are selected. With the help of these visual components, the user can compare the respective number of results at a glance. In addition, the *Results* button displays the exact number of the filtered results.

In addition to the refinement page we already presented, according to Shneiderman, the following two components (or views) are also important parts of a comprehensive concept to support users in exploring data:

- Overview of results (*"Overview first…"*)
- Detail view of a result item (*"…then details-on-demand"*).

Therefore, we included these views into our visualization concept, too.

5 Prototype

In order to demonstrate and evaluate the visualization concept, we developed the Android advisory app *NutriGuide* for smartphones, which is based on the visualization concept applied to the domain of healthy nutrition. NutriGuide enables the user to receive relevant information about groceries and nutrition. In Fig. 4 two screenshots of the prototype are shown. The left view in Fig. 4 gives an initial overview of the food categories. The recognizable icons of different color provide users with additional visual assistance. By selecting a food category, the user switches to the next hierarchy level with an overview list of results (cf. Fig. 4 right).

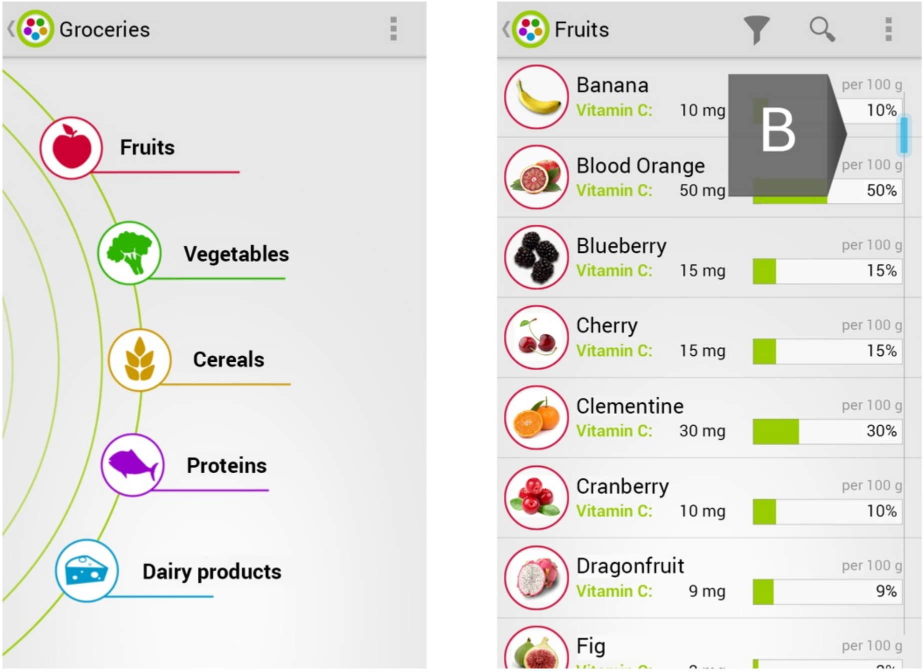

Fig. 4. Category view (left) and overview list of results (right)

The refinement page can be opened by selecting the filter symbol in the upper action bar (cf. Fig. 5). Similar to the concept in Fig. 3, facets are organized in vertical tabs and suitable domain specific icons are used to give a better overview. A histogram of the exemplary *Nutrients* facet visualizes the number of results for each facet value dynamically, retrieved from a database containing information on food and its nutrient content. In this example, the user can see quickly that the results include no low calorie items and only a few low fat items when selecting the value *Vitamin C-rich*.

This prototypical filter form currently offers only three facets with respect to healthy nutrition, but could be easily extended to include additional aspects such as special dietary needs for faceted search, too.

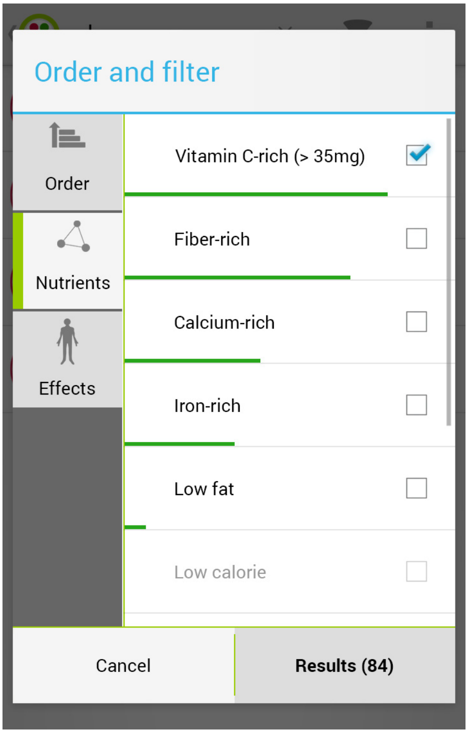

Fig. 5. Filter form with bar chart in the *Nutrients* facet

6 Conclusions and Future Work

In our paper, we presented a general visualization concept for mobile faceted search. We analyzed different applications that use filter forms to specify the amount of data. Furthermore, we conducted a brief user survey to include ideas and experience in dealing with filtering on mobile devices. As a result of our study, vertical tab filters were evaluated best for mobile usage. Due to the fact that this approach can only represent a limited number of facets, we extended this solution by enriching the tabs with scrolling. In addition we stressed visual aids supporting the user with information seeking. An important part of our filter concept is that there is no search that leads to empty results. Users only see selection values to which results are available. Our visualization concept complies with the basic principle of Shneiderman's "Visual Information Seeking Mantra". In general, it can be applied to an unlimited number of data and facets and is therefore scalable with respect to the amount of information that can be displayed. However, if possible the filter form should not contain more than ten facets. Otherwise, the user would be unable to cope with too many filter options.

Although the presented visualization concept is based on the analysis of several existing apps and takes into account current mobile design patterns, it will be necessary to evaluate this approach in a user study. To this end, the current prototype needs to be further developed. The filter form requires more facets to demonstrate and evaluate the scrollable vertical tabs. Another aspect of our future work is the visual representation of the quantity of results for each facet value via bars within the filter form. Even if Nudelman considers histograms suitable, an evaluation with potential users is necessary to confirm this approach.

Faceted search also provides the possibility to inspire the user to take advantage of new search options. However, for presenting reasonable refinement pages, the data must be well structured in appropriate facets. Thus, data preparation is also an important point when thinking about faceted search.

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