Facet Folders: Flexible Filter Hierarchies with Faceted Metadata

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Abstract
Facet Folders are a visualization and interaction concept for filtering collections of personal data. Although visually derived from the ubiquitous folder hierarchies of file managers, Facet Folders explicitly expose the faceted metadata used for filtering. Facet Folders can be arranged into persistent hierarchies, enabling the construction of dynamically updating views across multiple facets. If demands change, the hierarchy can be easily rearranged.

Keywords
Faceted browsing, filtering, folder hierarchy, PIM

ACM Classification Keywords
H5.2 Information interfaces and presentation: User Interfaces - Graphical user interfaces (GUI).

Introduction
For more than a decade, tools for Personal Information and Media Management (PIMM) have relied on folder hierarchies for organizing files, a concept familiar to millions of users. As personal data collections grow in size, frequently exceeding hundreds of thousands of items, the predominance of folders has however been challenged by search tools. Given a sufficiently precise target description, these tools ideally retrieve any de-

sired item on command. Although conceptually powerful, the utility of search tools is however often mitigated by a lack of semantic context during retrieval [6]. Furthermore, search tools suggest that the classification of items in a collection is superfluous, while in fact, users may gain substantial insight from the problem decomposition required to construct a folder hierarchy [2].

More recently, with data retrieval based on faceted classification schemes [7], an additional concept suitable for PIMM has been introduced. Facets are orthogonal dimensions in the space of metadata values of data in a particular domain. When used as data retrieval criteria, users are able to specify and refine metadata values in any order. However, we have observed that facet-based tools tend to suffer from visual clutter when multiple facets are utilized, additionally consuming large amounts of screen estate. This also makes scaling to mobile devices with small screens difficult. Furthermore, dynamic placement of facet values on screen prevents users from re-access based on their spatial memory which is arguably one of the greatest strengths of traditional, static folder structures. Despite that, such folder hierarchies still entail several significant shortcomings:

- Once users' needs change, folder structures cannot be adapted easily [2].
- Tension exists between content organization for current use vs. future re-use [2].
- Items often cannot be sufficiently filed under one single category [4].
- A subordination is imposed on folders although there is often no single "correct" hierarchy [1].

Therefore our goal was to develop a novel interactive folder visualization concept which improves upon these shortcomings and offers users flexible views on their data based on dynamically updating folders. We approach this task by semantically augmenting folder hierarchies with data filtering facilities using faceted metadata. The resulting user interface is sketched in figure 1.

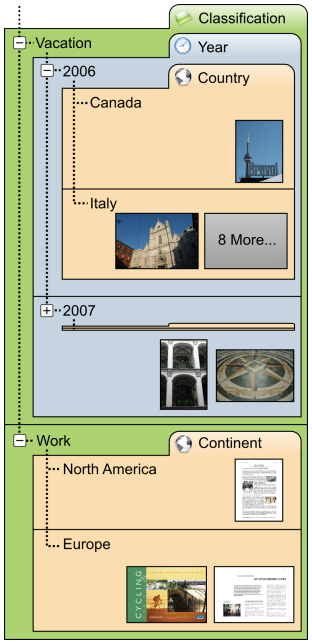

Figure 1: A Facet Folder hierarchy with vacation photos structured by year and country, and work documents structured by continent.

Related Work

MediaFinder [3] offers semantic regions for filtering personal media data based on metadata attributes selected by users. Regions are visualized as freely arrangeable rectangles, allowing users to construct hierarchical layouts reflecting their mental model of a dataset. The system's design is aimed at increasing retrieval performance, as it supports users in building structural and spatial familiarity. Furthermore, users can manually reassign data items to update metadata with attributes of the target region. Although filtering is a central concept of the interface, selected filter attributes are not easily visible and restructuring regions is tedious.

Visualization and interaction techniques for hierarchical data structures have been extensively researched over the years. Robertson et al. [5] highlight several works in the area and present Polyarchies, a technique for discovering relationships in aggregated datasets, which could be applied to PIMM. The approach presented here differs in that it is specifically targeted at personal data and provides means of modifying metadata.

Although several systems for browsing based on faceted metadata exist, e.g. [7], they are generally subject to the shortcomings pointed out in the introduction. In [1], Henderson proposes to evaluate folder hierarchies in the context of faceted browsing, as a maximum of 8% of folder names were observed to be coded with multiple (metadata) dimensions in a study of conventional folder hierarchies. Folder hierarchies of personal data therefore already bear some, albeit implicit, structural similarities to facet-based tools where metadata dimensions are always treated individually.

Basic Conception

Collections of personal data such as documents, music, and movies possess rich sets of metadata which can be constituted of absolute (e.g. "Jan. 8th") and relative (e.g. "two days ago") values [1]. These sets can be partitioned so that every single value is assigned to one of several mutually independent dimensions or facet types. Among the most relevant are Time, Location, Person, Object, Event, Rating, or (conceptual) Classification. Based on one metadata value of a facet, filters can be defined which we call "Facet Folders". A Facet Folder is a folder permitting users to filter their collections for items with metadata matching the filter attribute, for example, all items associated with Florence. By nesting Facet Folders into a hierarchy, different views on the dataset can be constructed. An example depicted in figure 2 shows that vacation-related data items could be separated into different time-based views while work-related items could be separated by customers on different continents.

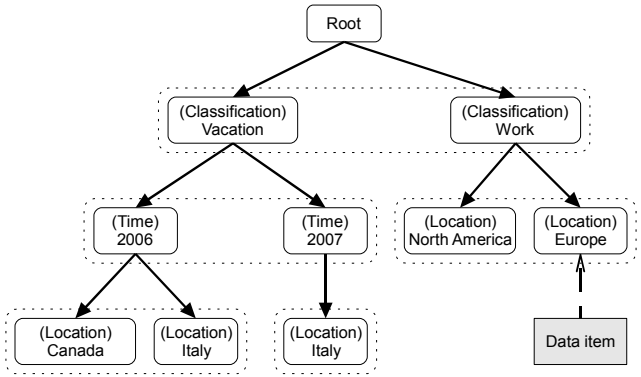

Figure 2: Example of a conceptual hierarchy of Facet Folders.

However, the Facet Folder hierarchy can additionally contain hierarchical metadata, where metadata values within some facets share a parent-child relationship. Two types of these metadata hierarchies can be differentiated: implicit hierarchies composed of values from mutually independent levels of granularity, such as time (e.g. "Day, Hour, Minute"), and explicit hierarchies such as location metadata, where values on higher levels determine possible values on lower levels (e.g. "Italy" > only Italian cities). Facet Folders support implicit hierarchies by permitting filter attributes composed of multiple granularities while explicit hierarchies may only provide values of one granularity. When backed by an appropriate knowledge base, the system would then be able to derive relationships, e.g. that Florence is located in Italy. This enables users to specify filter attributes with varying levels of precision.

Structural Modification of Hierarchies

One goal of the Facet Folder approach is to support users in adapting the filter hierarchy to changing needs. This can be achieved by rearranging levels of the Facet Folder hierarchy. For example, if a user wanted to structure her vacation view by time instead of country, one of the child Facet Folders currently filtering by time could be moved one level upwards in the hierarchy as illustrated in step (1) of figure 3. The result visible in step (2) shows that all time-based Facet Folders of related branches have been automatically moved up as well. This is done to facilitate rearranging from within multiple child branches of a Facet Folder. Furthermore, the number of Facet Folder instances is automatically extended based on the metadata of items available in the target folder. An additional example is provided in step (3), where a classification-based Facet Folder was moved down from the top level.

As indicated with dashed outlines in figure 2, Facet Folders with filter attributes of identical type and granularity are grouped together when placed on the same hierarchy level. These groups enable users to quickly change the filter order of entire levels in the structure.

Facet Folder creation

When manually creating Facet Folders, users need to define the folder's filter attribute by selecting a facet type, and if applicable, a facet granularity and then one of the provided metadata values. As previously stated, only data items with metadata matching the filter attribute pass the filter, but more precisely, a match exists in two cases. One, if an item's metadata value is equal to the filter attribute or, two, if the value is contained on a finer granularity in explicit metadata hierarchies. If in contrast, no items match a filter attribute, a Facet Folder is empty.

Item assignment

As data items in the Facet Folder system are filtered by metadata, a set of metadata values associated with each item must be maintained. An initial set could be derived from inherent metadata (e.g. file creation time) or be obtained through content analysis. Users can indirectly modify these metadata sets by assigning items to or removing them from Facet Folders.

Upon assignment to a Facet Folder, the set of filter attributes aggregated on the path to the folder is computed and then added to the item's metadata. For example, assigning an item to the "Europe" Folder in figure 2, its metadata set would be extended with "Work, Europe". Users are therefore not required to manually assign individual metadata values to items. By not placing a restriction on the amount of metadata

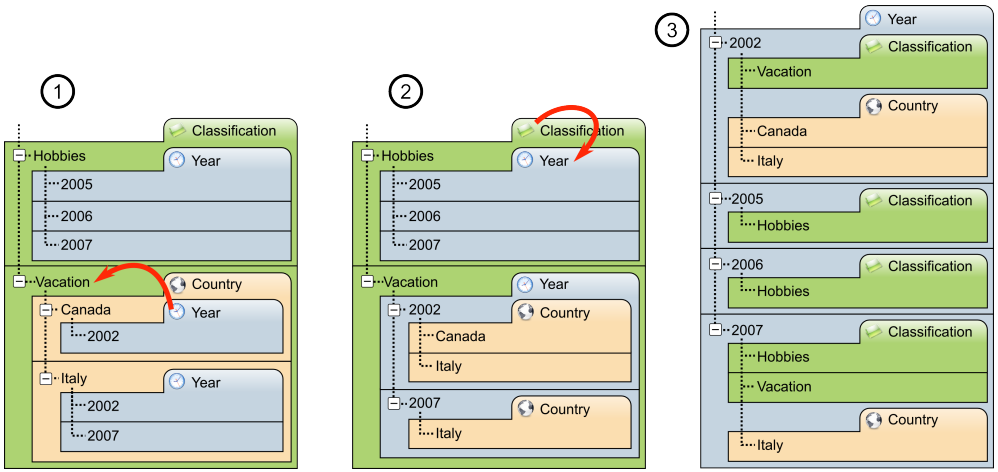

Figure 3: Two examples for rearranging Facet Folder hierarchies.

for each facet type, users may also assign items to multiple locations in the hierarchy. Consequently, on removal from a Facet Folder, the item's related metadata is removed.

In the future, this design could be expanded to support multiple separate sets of metadata. Items could then be related to different metadata values depending on the branch in the Facet Folder hierarchy.

Visual Design

Visually, Facet Folders are derived from the familiar design of folder-based tools such as file managers by also integrating thumbnail previews of filtered folder content as shown in figure 1. In addition, all visual changes are animated to minimize the loss of context during transitions.

Individual Facet Folders are represented by rectangles labeled with the folder's filter attribute and use a background color based on the folder's facet type. Folders on the same hierarchy level of a branch are vertically stacked and grouped by filter attributes using facets of identical type and granularity. In figure 2 these groups are outlined using dashed lines. Visually, a facet handle is attached to the top right edge of each group, presenting the facet type with an appropriate icon which is followed by a text label indicating the facet granularity. Subfolders are rendered inside their parent Facet Folder, connected by dashed lines familiar from today's folder managers.

Facet Folder containing child folders differentiate two visual states: collapsed, which shrinks any subfolders to a short bar symbolizing a Facet Folder group, or expanded, where subfolders are fully rendered. In the collapsed state, thumbnail previews of all data items in the folder are displayed. While expanded, only thumbnails of items not filtered into one of the child folders remain visible. For Facet Folders without children, thumbnails of their contained data items are always shown.

To accommodate for the display of contained items and folders, Facet Folders adapt in size. However, in order to prevent visually overloading the interface, the number of visible data items is constrained to a threshold depending on the available screen size. Items exceeding the threshold can be displayed and hidden again on command using a “n More...” placeholder item, where n is the number of hidden items which is illustrated for the “Italy” folder in figure 1. Overall, this design simplifies scaling between devices with different screen sizes.

Interaction Design

The choice of interaction techniques for Facet Folders is dependent on several factors, mainly the size of displays as well as the available input modalities. Currently, we are using a standard desktop PC with mouse input. In this chapter we present the interaction concepts which we implemented in our screen mock-ups and Flash-based prototypes.

In order to switch Facet Folders between the collapsed and expanded state, small boxes in the upper left corner of a folder showing a "+" or "-" can be selected. Additionally, parent folders can be expanded by selecting the bar representing the shrunk child folders. Vertical scrolling is performed using mouse wheel or a right-aligned scroll bar. One goal for the interaction design is to increase the efficiency when rearranging multiple folders compared to current file managers. In particular, rearranging entire Facet Folder groups should be quick. Performing an intuitive drag & drop interaction with the facet handles works well for this task.

Conclusion and Future Work

We have presented Facet Folders, a visualization and interaction concept which unifies conventional folder hierarchies with filtering of personal data based on faceted metadata. Informal user feedback from our first prototypes is encouraging and we are currently refining the design based on the critiques given.

Major benefits of the Facet Folder approach are the ability to construct different views on the same dataset as well as the flexibility associated with rearranging filter hierarchies. Furthermore, Facet Folders adapt according to available data but also allow for the classification of data by simple assignment to folders. The approach is best suited for hierarchies where different metadata dimensions are hierarchically stacked.

For the future, we are envisioning the integration of marking menus for rapid creation of folders and are investigating methods to enable standard applications to access the Facet Folder hierarchy. Finally, we need to perform an overall rigorous evaluation and user study with a full-featured implementation and would like to test the design on mobile devices.

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