Adaptive Mobile Content Personalization

By Carol A. Taylor (ctaylor.next.ui@gmail.com)

Summary

Introduction – Adaptive interfaces and content displays employ various methods of tracking either an individual user's behavior or a groups' behavior and tailoring the navigation and content offered to users in different contexts. The assumption is that users can have a more productive and satisfying experience if the information available to them is personalized to make it as relevant as possible. A variety of adaptive technologies and approaches have been tried in both research environments and commercial mobile deployments. We examine these techniques and the tradeoffs involved in utilizing each for enhancing the mobile user experience.

Opportunities – Providing access to vast amount of Internet information holds great promise for mobile users and mobile business operators. Industry experts believe individual personalization will be important in order for Internet access to be widely adopted by mobile users. A number of techniques for personalizing information access and content display offer potentially relevant customization capabilities. Which personalization approaches hold the most promise for a great mobile internet user experience?

Challenges –

1) Personalization technologies can be resource intensive and significantly impact system performance. The most efficient technologies do not necessarily bring the greatest value to the end user.
2) Technologies and user profile data span across different parts and players in the mobile ecosystem, making it difficult to deliver a unified experience for all information access via the mobile device.
3) Mobile operators and end users have different and sometime conflicting goals for personalization (monetization vs. usefulness).
4) There are limits to the level of personalization that users will tolerate before feeling a loss of control or violation of privacy.

Future Research Areas – How much personalization do users want and need? Is there is a threshold of personalization beyond which there is diminishing value to the user and the mobile operator? Are there unifying technical frameworks that will allow the customization to occur consistently across different mobile web sites, portals, and applications?

Introduction

The technical and user experience limitations of accessing Internet content on mobile devices pose many challenges due to small screen sizes and limited input methods. The prospect of maintaining separate mobile-friendly versions of Web sites is an expensive and time consuming proposition. Technologies for adapting information access and content display offer possible solutions for making Internet content access more efficient and relevant on mobile devices.

The promise of the mobile Internet is access to any information anywhere, anytime. Users bring expectations from PC Internet browsing forward to the limited medium of the mobile device. But instead of exhibiting classic open-ended PC Web browsing behavior, mobile users demand quick access to the right information at the right time. [1]

Methods of Personalization

Configuration

Many applications rely on rules pre-defined by developers or configured by users to determine application behavior in different contexts. The first method is time consuming to set up and hard to customize once deployed. It also relies on the assumptions made by the application authors about what kinds of personalization users want and need. The second method, while it gives the users more control, can require a significant investment of time and learning which deters user adoption.

Adaptive Content Display

Much research and effort has been devoted to figuring out how to adapt content developed for other mediums (e.g., the Web) for display on mobile devices. Multiple studies have focused on extracting, parsing, and reorganizing Web pages to customize the display of information. Techniques that are commonly used to adapt web content for display on mobile devices include the following: [1] [2]

1) Device-specific authoring where the content is uniquely adapted on a per device basis.
2) Multi-device authoring, where a single adaptation is deployed across multiple devices.
3) Automatic page formatting/summarization, where selected elements of the page are displayed or removed automatically.

4) Keyword summarization, where metadata about the page is extracted and displayed in addition to its content.
5) Automatic page scaling, where thumbnails or portions of pages are displayed. Scaling a page down to a thumbnail image increases satisfaction but requires significant computational and power resources.
6) Client-side navigation, where the full page is delivered to the device and the mobile browser determines how to adapt the content. This approach is memory and download intensive.

Adaptive Interfaces

Adaptive user interfaces (AUIs) change over time based on user choices and behavior. User behavior is captured, stored, interpreted, and used to personalize navigation choices, content display, and even application behavior. AUIs are very flexible because they react to a wide set of modalities depending on user interactions to support the needs of users in a more tailored way. [2] Two fundamental ways of retrieving information about user preference are explicit (requires considerable configuration effort and so is usually motivated by profit) and implicit (happens naturally based on user actions). [3]

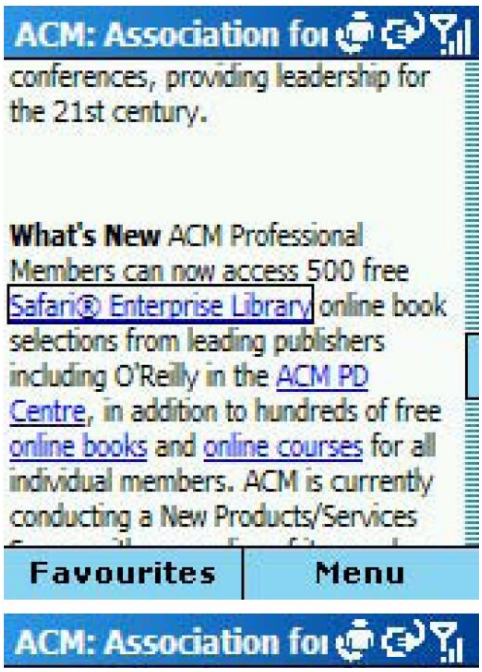
Adaptive Personalization Technologies and Approaches

Adapting Really Simple Syndicated (RSS) Feeds

A technique that is widely employed today by mobile operators is to repurpose RSS feeds to display a shortened, text only content on mobile devices with links to more detail. Some content providers make RSS feeds of Web content readily available either through contractual arrangements or for free in the public domain. One drawback to this approach is that it can be expensive for providers to maintain a separate RSS content feed.

Often the metadata and summary information available with the RSS feeds are also used for displaying navigation or additional contextual information. Commonly, the content is adapted for mobile devices on the fly on a proxy server. [1] The suitability of using RSS feeds in mobile depends on the availability and type of content (for example, not suitable for transactional content).

Original Web Site



Equivalent RSS Feed on a Mobile Phone

Transcoding

Another approach to adapting Web sites for mobile display is a commercially available technology commonly referred to as transcoding. With this approach, the system contains intelligent logic that reviews the layout and contents of a Web page and infers a logical hierarchy and order for displaying the hyperlinks and the information. The page is then reformatted to optimize the display on a mobile phone. My company (InfoSpace) works with this type of technology (www.InfoGin.com) to make full sized Web sites accessible to mobile users for our carrier partners.

Example Web page before and after transcoding for mobile display.

Context in Adaptive Systems

Adaptive hypermedia and adaptive Web systems belong to the class of user-adaptive software systems. Adaptive systems collect data to form a user model using various methods including observation of user behavior and directly requesting user input. The adaptation effect tailors interactions to different users in the same context.

On the Web, the adaptive effect is limited to adaptive content selection, adaptive navigation support, and adaptive presentation. Adaptive navigation support can increase the speed of navigation and learning, while adaptive presentation can improve content understanding. One of the big differentiating factors for the mobile user experience is the addition of location. Many newer mobile devices include GPS or other similar technologies that can identify the physical location of the user. This adds a rich dimension to adapting a mobile experience to a specific context of use.

Earlier generations of adaptive Web interfaces explored adaptive content selection and recommendations based on modeling user interests. The newer generation (mobile) interfaces are extending this concept by adding in models of context (location, time, computing platform, and bandwidth) to adapt to both an individual user and the context of a user's work. [4] Context includes human factors (information about the user, social environment, and user tasks) and physical environment (location, infrastructure, and physical conditions).

Context-Aware Collaborate Filtering

Collaborative filtering is the process of adapting the content displayed for a user based on choices made by other similar users in the same context. It has been used extensively in the commercial Web domain to determine what promotional content todisplay for a particular type of user (think Amazon's "people who bought x also bought y" recommendation engine). With collaborative filtering, all the neighboring like-minded users' ratings for the same context are combined into a prediction by computing a weighted average.

Mobile devices could assist users better by anticipating their preferences in a dynamic environment through a combination of context and collaborative filtering. [5] User choices and preferences would need to be associated with the context in which they are made. Every user choice would need to be captured in context and compared with the composite choices of other users in the same context. This approach would need to be trialed for different contexts of use to determine the most appropriate applications (for example, for a mobile tour guide application).

Collaborative filtering originated with the automated word of mouth concept. Two basic approaches emerged: 1) user-user CF algorithm based on the collective behavior of a group of users, and 2) item-item CF algorithm based on the context in which an item is used. With the user-user approach, the user needs to make use of the system for awhile before the personalization effect begins to take place. With the item-item approach users can immediately enjoy the personalization benefits of the system. [3]

Personal Information Agents

Personal information agents are programs that comb through vast amounts of information, extracting content of particular interest to display for users based on user profile, current situation, and feedback from user routines and behaviors. Personal information agents can deliver the right information at the right time by accessing, filtering, and presenting the appropriate information for each situation.

In one mobile research study, a Personal Information Agent (PIA) was developed to cull the relevant information throughout the day and deliver it via the most appropriate mode

of delivery (SmartPhone, PDA and Web browser). [6] Information sources included WWW, SMS, MMS, and J2ME application sources. Users had the choice of either searching through information (pull) or having information of interest delivered to them (push).

In this application, users specified preferences for their content interests and for various formats for delivery. In addition, profile information and feedback was gathered explicitly based on user behavior. If the system detected that content-based filtering was not providing sufficient results, additional support was offered based on collaborative filtering. The system used four classes of agents: information extracting agents, filtering agents, presentation agents, and one personal agent per user. The authors identified the addition of location based services, a natural speech interface, and ways to motivate users to give more explicit feedback as areas for further research.

Several factors may inhibit users from adopting an agent system modeled after PIA. First, it relies fairly heavily on users specifying their preferred content, medium, and display format. Second, it requires users to interact with content using a separate application rather than favorite content sites or sources. A trial would be needed to determine whether users would readily use PIA over already established access methods and information sources.

Adaptive Hypermedia Systems Using Web-Based XML Files

Another approach to adaptive personalization is to extract content from web-based XML files to create information streams for mobile Internet access on PDA devices. An advantage of XML files is that they have the ability to include rich metadata about their contents. Details within the document can be used to create a relatively rich adaptive hypermedia system for mobile devices. This approach is only applicable in situations where the source content is available as XML files, which limits its application.

One research project employed a selector interface to allow users to choose attributes for displaying XML-derived information according to their preferences. [2] The authors tested this approach and found that it increased the overall effectiveness and satisfaction of information viewing on a small screen. They identified use for small group information systems based on XML documents as an area of opportunity for further research.

Adaptive Hypertext in Personal Portals

Another form of adaptive hypermedia is personalized hyperlink navigation within a mobile portal based on the behavior exhibited by the user. For example, if a user frequently checks sports scores for a favorite soccer team, or prices for a favorite stock, links to that information get moved up in the navigation hierarchy. This intelligent navigation makes commonly accessed information more readily accessible, reducing click distance and theoretically increasing usage of the portal. One commercially available example of this mobile technology is the ClixSmart Intelligent Portal Platform (www.ChangingWorlds.com).

Combining User Profiles, User Configuration, and Collaborative Filtering

Combining different approaches together improves the overall experience of mobile content personalization significantly and helps offset the users' perception that the system is manipulating the experience for the publishers' best interest. Systems can combine 1) a predetermined logic set up by the authors that alters the type and sequence of information based on how the user behaves; 2) the more traditional method of asking users to answer configuration questions in an up-front set up; and 3) comparing user behavior with the choices of others who exhibit similar behavior (collaborative filtering). [7]

Potential applications for this approach include wireless portals, voice portals, wired Web, prioritizing email messages, finding applications to download, keeping track of sales leads, shopping product catalogs, searching real estate listings, and browsing online data services.

Combining Collaborative Filtering with Autonomous Agents

Autonomous agents are computational systems that inhabit some complex dynamic environment, sense and act autonomously in this environment, and by doing so realize a set of goals or tasks for which they were designed. [3] One study explored a model where media (music files) are autonomous entities that carry their own individual information. The authors are developing a mobile recommender system (Push!Music) where media (such as music, photos, and movies) can find people rather than the other way around. Push!Music runs on a Pocket PC using WiFi for ad hoc communication between peers. Users rate and exchange songs and playlists directly and anonymously.

Collaborative filtering behavior could emerge out of large ensembles of interacting agents, which are distributed over mobile devices through social networks. These rule-following agents would be capable of building their own identities from interaction with other users and other agents.

This approach warrants considerable additonal research, in particular in the areas of protecting user privacy and artists' copyright. A user study examining whether people want others to anonymously send them unsolicited songs and play lists would be needed to determine the viability of the concept. In addition, while the PocketPC may be a suitable medium for testing user interaction and concepts, it is unlikely to be adopted as a music player. Such a system would need to run on a popular music player such as

an iPod in order to be adopted by a sufficient number of people to make this type of social networking concept successful.

Use of Web Personalizers

Web site personalizers observe users' behavior and customize and adapt web sites for each individual visitor. One study describes the implementation of such a personalizer (Proteus) and the results of experiments evaluating its behavior on a number of different academic and commercial web sites. Results indicate that automatically adapting Web content for mobile visitors saves users a considerable amount of time and effort when seeking information "on the go." [8]

Information-goal seeking behavior is predicable. Users tend to have the same goals in the past as in the future and follow the same links and view the same pages each time. Visitors also tend to view pages with similar content as those viewed in the past. By mining a user's past interactions with a web site for navigation and content patterns, the experience can be automatically personalized for each individual visitor.

One area related to this approach that warrant further research includes automated methods for separating web content into data, structure, and presentation elements. Another is an exploration of methods for combining information from multiple sites into a single view for the user.

Future Research Opportunities

PDAs/SmartPhones vs. Mobile Phones

In reviewing the body of research, many studies focused on adapting content for Personal Digital Assistants (PDAs). Examples of PDAs include RIM Blackberries and SmartPhones running the Windows Mobile operating systems. These mobile devices often have a stylus or other additional input controls, a full keyboard, or a higher screen resolution. However, the experience of information access on a true mobile phone is much more common and much more limited. While some of the user experience research questions may be similar between the two, there are fundamental differences that need to be researched separately.

How Much and What Type of Personalization Do Users Want?

A big question remains whether it possible to have too much personalization on a mobile device. Is there a threshold where it ceases to be useful and becomes uncomfortable or annoying? What are the barriers to user adoption of mobile adaptive systems? Which adaptive methods do users prefer and embrace? What type of information is most suitable for personalization?

User Control of Personalization

How do users respond when they are given the option of opting in to personalization vs. when it happens automatically? I suggest that one of the best ways to increase user adoption of adaptive mobile personalization is to allow users to enable/disable adaptive techniques (such as expanded results displays, thumbnails, or full page downloads) to accommodate their preferences for speed and device style (e.g., Simple RSS on a small normal phone, full thumbnails on a PDS phone).

Combining User Profile Data from Multiple Sources

If user behavior data could be gathered from different information contact points (for example PCs, PDAs, and Mobile phones) and aggregated into a single profile, it would provide a rich resource for more closely tailoring Internet content based on both individual interest and context of use. The applications and methods for such a unified user profile and multi-channel adaptive system would require new technologies and considerable research in to cross-channel user information access and consumption.

Implicit Cross-Ecosystem Personalization

My belief is that a personalization method which can be applied to favorite and already familiar content sites and sources would be greatly preferred by users over a separate, proprietary system. In addition, in commercial mobile applications, a very small percentage of users who have access to personalization settings make use of them. A system that does not rely on user configuration but rather adapts content automatically would reach a much broader audience. And a system that does so across the entire mobile content experience would create a unified and highly useful mobile user content experience.

References

[1] Alexander Blekas, John Garofalakis, Vasilios Stefanis (May 2006), Mobile web/accessibility overlaps: Use of RSS feeds for content adaptation in mobile web browsing. In the proceedings of the 2006 international cross-disciplinary workshop on Web accessibility (W4A): Building the mobile web: rediscovering accessibility (Edinburgh, U.K), p. 79 - 85. New York: ACM Press.

[2] Kwang Bok Lee, Roger A. Grice (October 2003), Getting and giving information: An adaptive viewing application for the web on personal digital assistants. Proceedings of the 21st annual international conference on Documentation SIGDOC '03 (San Francisco, CA, USA), p. 125-132. New York: ACM Press.

[3] Mattias Jacobsson, Mattias Rost, Lars Erik Holmquist (January 2006), Short papers: When Media Gets Wise: collaborative filtering with mobile media agents. Proceedings of the 11th international conference on Intelligent user interfaces IUI '06 (Sydney, Australia), p. 291 – 293, New York: ACM Press.

[4] Peter Brusilovsky, Mark T. Maybury (May 2002), From adaptive hypermedia to the adaptive web. Communications of the ACM, Volume 45, Issue 5, Special Issue: The adaptive web, p. 30-33, New York: ACM Press.

[5] Annie Chen (April 2005), Doctoral consortium: Context-aware collaborative filtering system: predicting the user's preferences in ubiquitous computing. CHI '05 extended abstracts on Human factors in computing systems (Portland, OR, USA), p. 1110 – 1111. New York: ACM Press.

[6] Sahin Albayrak, Stefan Wollny, Nicolas Varone, Andreas Lommatzsch, Dragan Milosevic (March 2005), Agents, interactions, mobility, and systems (AIMS): Agent technology for personalized information filtering: the PIA-system. Proceedings of the 2005 ACM symposium on Applied computing (Sante Fe, NM, USA), p. 54-59. New York: ACM Press.

[7] Daniel Billsus, Clifford A. Brunk, Craig Evans, Brian Gladish, Michael Pazzani (May 2002), The adaptive web: Adaptive interfaces for ubiquitous web access. Communications of the ACM, Volume 45, Issue 5, Special Issue: The adaptive web, p. 34-38, New York: ACM Press.

[8] Corin R. Anderson, Pedro Domingos, Daniel S. Weld (2001), Personalizing web sites for mobile users. Proceedings of the 10th international conference on World Wide Web, (Hong Kong, Hong Kong), p. 65-575, New York: ACM Press.