Visualizing the Thematic Update Status of Web and WAP Sites on Mobile Phones*

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Abstract. The primary goal of people accessing the Web from mobile phones is to find specific pieces of information (PoI, hereinafter), not to surf. Well-designed sites for mobile users help them by minimizing the path needed to reach the desired PoI. We propose a further improvement, based on visualizing thematic update status (i.e., how many PoI have been added in each category and when). This can prevent unfruitful navigation of the site and also allow users to compare different sites to choose which one better suits their needs.

1 Introduction and Motivations

All recently proposed guidelines [3,5,6,7] for designing Web and WAP sites aimed at mobile users agree that minimization of navigation time to reach information is crucial. Moreover, they stress that mobile users have different goals, tasks, and constraints than users sitting in front of a computer, and their primary goal is to find specific pieces of information (PoI, hereinafter), not to browse the Web [5,6]. Well-designed sites for mobile users focus thus on rationally organizing the different PoI into meaningful categories and minimizing the length of the navigation path needed to reach any category and PoI. In this paper, we concentrate on a further improvement that aims at saving additional time by making the user aware of the thematic update status (i.e., how many PoI have been added in each category and when) of the site.

As a representative case study of mobile sites, we analyzed the most popular international news sites for mobile phone users [1,2,4,8,10]. Their design solutions and navigation path to access PoI are identical. Fig. 1 illustrates an example of a user accessing an information that is important for investments. The user selects (Fig. 1a) the proper category (if there are subcategories, additional selections are needed); she is presented with a list of titles for the selected category (Fig. 1b); she scrolls until she finds a specific title and chooses it; date and text of the chosen PoI appear in a new page (Fig. 1c). The only differences among the sites concern date information (two sites [4,8] do not show dates of the news) and advertising (based on light graphics) that lasts a couple of seconds before the selected news is shown (only in [2]).

Although this design is well-thought, there is still room for improvement, especially

* This work has been partially supported by the MIUR COFIN 2003 program.

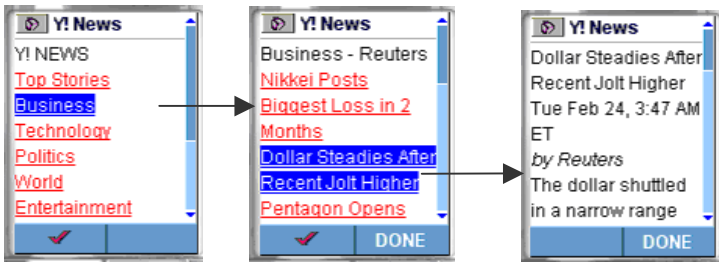


Fig. 1. Accessing a PoI on mobile news sites from a mobile phone.

to meet the needs of regular, frequent users of sites (this class of users is considerable for sites that are continuously updated such as news, finance, sports, weather sites,…). A problem that comes up when using these sites over a period of time is insufficient awareness about thematic update status. As a result, when the user visits the site, she has to check the desired categories and title listings for new PoI, even if she has already seen them in previous visits. As a practical scenario, consider a manager on a trip to a meeting in a distant city, who needs to periodically visit different sites to: (i) read the latest business news, (ii) look for possible changes affecting her flights or those of the people she has to meet, (iii) be informed about the latest weather forecasts to decide if she wants to book a tour to the park close to the destination. Knowing *if* categories of interest have been updated after the last visit would prevent useless navigation. More generally, users should be also made aware of *when* categories have been updated. For example, if a user is looking for the results of on-going sports competitions or shares in the stock-market or the progress of a military crisis, knowing that updates have been made in the last minutes makes them more relevant than those made hours ago. This is thus useful also to users who are not frequent visitors of sites, and can help in choosing what is the best site to visit for the purpose.

A traditional solution to the considered problem could be based on alerting services, but requires users to register to the service and choose which updates could possibly be interesting and should trigger alerts. The user has to repeat the process on all the sites she visits. Alerting can have the undesired effect that users interested in many topics and/or sites might find their mobiles flooded by alerts (and possibly additional unwanted messages). Moreover, it would be very difficult to get a picture of the status of interesting sites by trying to relate a list of separate alerts that concern only some changes (limited screen space makes this task even harder, forcing users to jump around through multiple screens). A more sophisticated solution would maintain a database that tracks what each user has read. Although this could allow the user to get a detailed account of the unread updates of interest, it could be inconvenient both for users (not everyone would be willing to register and login to all the sites she visits) and sites (not every site would be glad to maintain large databases of individual usage information and force users to register and login to get the new functionality).

For the above reasons, we studied a solution that is not based on alerting, is available to any site visitor without registering and aims at quickly communicating a clear picture of thematic update status. Users should be able to stop at the first of the 3 phases in Fig. 1, and proceed to the following phases only if the status information in

the first phase motivates them to do so. Besides time savings, instant awareness of thematic update status allows the user to compare different sites to choose which one better suits her needs (e.g., the one that devotes more attention to a given category of information, the one with more recent updates to a given category,…). The solution we describe can thus be useful also for users who are not frequent visitors of sites.

2 Visualizing Thematic Update Status

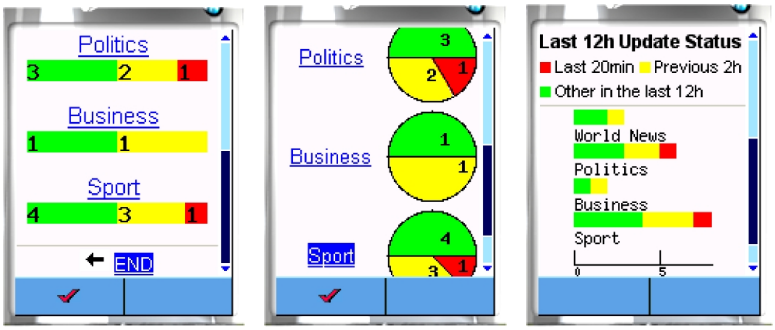
We employ simple but informative graphics to present thematic update status at-a-glance, in the same page that lists categories. Graphics have to be small and simple [5,6], so that they can be drawn on a limited display and quickly downloaded. We also: (i) base our visualizations on well-known graphic elements (such as bar and pie charts) that are familiar to users, avoiding to extend them with unnecessary graphics that harm their readability (see [9] for a discussion), and (ii) use a limited number of colors that are easy-to-distinguish (also on those color phones that do not render well).

2.1 Representing Temporal Information

Communicating thematic update status requires to refer to time, choosing (i) the most appropriate time intervals, (ii) the most appropriate words to name the intervals. Time intervals can be either *disjoint* (e.g., the last 5 minutes and the 25 minutes that preceded them are disjoint intervals) or *overlapping* (e.g., the last 5 minutes and the last 30 minutes are overlapping intervals). The intervals extent is also important: how many intervals, and how wide, are both useful and easy-to-understand for users? To define temporal aspects, we interviewed 30 subjects who use mobiles and computers, asking them to imagine a fictitious site that provides thematic update status in the format they would find more useful. Most interviewed subjects organized information in 3 intervals of time. The average periods of interest were around the last 20 minutes, around 2 hours and around 12 hours. There was less consensus about the type of intervals: although more than half of users reasoned in terms of overlapping intervals, a considerable part of them referred to disjoint intervals. We thus designed some visualizations based on overlapping and some on disjoint intervals. With disjoint intervals, we divide the chosen 12-hours timespan into 3 intervals called *Last 20min* (corresponding to interval [-20,0] in minutes, where 0 is current time), *Previous 2h* ([-141,-21]), *Other in the last 12h* ([-720,-142]). With overlapping intervals, the 3 intervals are *Last 20min* ([-20,0]), *Last 2h* ([-120,0]), *Last 12h* ([-720,0]).
The interviews also explored color coding for the 3 intervals. The preferred approach was a traffic light scheme, with red indicating the most recent interval. A color legend was introduced at the top of the page for each visualization, e.g., see Fig. 2C for the disjoint intervals legend and Fig. 3F for the overlapping intervals legend.

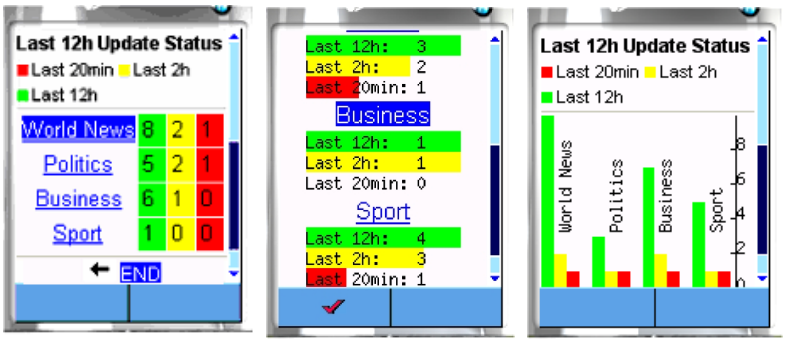
2.2 The proposed visualizations

Figures 2 and 3 show the solutions based on disjunct and overlapping intervals, respectively. All examples use 4 typical categories of a news site, but categories can



Visualization A **Visualization B** **Visualization C**

Fig. 2. Visualizations based on disjunct intervals.



Visualization D **Visualization E** **Visualization F**

Fig. 3. Visualizations based on overlapping intervals.

obviously be different and more than 4. The software that generates the visualizations from the number of PoI in each interval and category has been implemented by embedding calls to GD 2.0 (public graphics library that produces files in various formats, such as PNG and JPEG) into PHP scripts to allow for server-side dynamic image generation and inclusion into XHTML MP (Mobile Profile) pages.

Visualizations based on disjunct intervals (Fig. 2). These visualizations highlight the relative proportions of the numbers associated to the 3 mutually exclusive intervals by using a single graphic element divided into 3 subparts, one for each interval.

The graphic element in *Visualization A* is an horizontal bar. The number in each subpart tells how many PoI have been added to the category during the corresponding interval. Width of bars always spans the whole screen, and width of subparts is proportional to the numbers, e.g. the 3 bars in Fig. 2A represent different situations where 50% of the updates have been made during the oldest of the 3 intervals.

Visualization B is similar to A, but employs pies instead of bars.

Visualization C employs stacked bar charts that refer to a common axis. Only the bar with the highest number of updates spans the whole screen, and it becomes possible to visually compare the width of bars among categories. The height of bars is smaller, so that more categories can be related on a single screen (also minimizing the replications of the reference axis to always have it displayed in case of scrolling).

Visualizations based on overlapping intervals. Reusing the previous visualizations also for overlapping intervals is not a good solution. Indeed, in the overlapping case, *Last 2h* contains *Last 20min*, and *Last 12h* contains both *Last 2h* and *Last 20min*, i.e. PoI associated to *Last 2h* include PoI of *Last 20min*, and so on. The previous visualizations show relative proportions of the numbers by dividing single graphic elements into 3 parts. Using them for overlapping intervals would produce charts where the *Last 12h* part would tend to fill most of the graphic element, making *Last 2h* and *Last 20min* visually disappear. We thus propose other visualizations (Fig. 3).

Visualization D employs a table: columns correspond to the 3 overlapping intervals and their colors, lines to categories; cells contain the number of PoI.

Visualization E employs a separate colored bar for each interval. Number of PoI is shown by text and by the width of bars. A bar spans the whole screen if it contains the highest number in its category. The 3 separate bars allow one to visually relate sizes inside a category and consider the inclusion relations that exist among intervals (e.g., from the business category in Fig. 3E, one notices that *Last 2h* and *Last 12h* coincide, i.e. PoI that arrived in the last 12h are precisely those that arrived in the last 2h).

Visualization F also employs 3 separate bars for the intervals, but draws bars with reference to a common axis (shown at the right of the page). It thus becomes possible to visually compare bars among categories. Since the usage of horizontal bars made it difficult to draw 4 categories in a single screen as we did in visualization C, we used here vertical bars so that more categories can be related on a single screen.

3 Conclusions

This paper motivated and proposed visualizations of thematic update status for sites aimed at mobile phone users. The next step in our research concerns a thorough evaluation of the proposed visualizations on users. In the remaining space, we can just briefly summarize the current main findings, i.e. (i) the results of the evaluation tend to encourage the use of visualizations based on overlapping rather than disjoint intervals, (ii) the presence of explicit numbers attached to each graphic element in some visualizations is another factor that proves to impact positively the results.

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