Efficient Information Seeking on a Mobile Device

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ABSTRACT

Interaction with a mobile device remains difficult because of the inherent physical limitations of the devices – they are small. This difficulty is particularly evident for mobile search. If documents were extensively interlinked then fewer searches might be needed, and browsing might be improved. If these links targeted a best entry point (BEP) within a document from which the user should start reading and not the start of the document then scrolling and unnecessary reading of irrelevant material could also be reduced. We call this a *One Search Only* system because the information seeking task could potentially be reduced to a single search followed by browsing. Automatic link discovery systems might be used to achieve this extensive interlinking so we propose extensions to the INEX Link-the-Wiki task to accommodate anchor-to-BEP link discovery and discuss assessment and evaluation. Finally we propose a mobile user interface and discuss how to measure its performance, and suggest INEX 2008 adopt this as the Interactive Track experiment.

Categories and Subject Descriptors: H.4.3 [**Communications Applications**]: Information Browsers

General Terms: Measurement, Documentation, Design, Experimentation

Keywords: Link-the-Wiki, Link Discovery, Mobile Interaction, Assessment, Evaluation

1. INTRODUCTION

1.1 Background

Telecommunication companies now offer access to the Internet through mobile devices. Services such as email, web search, blogs, and instant messaging are now available on PDAs and mobile phones. Because of this the nature of mobile information seeking has changed. Marketing campaigns by communications companies have persuaded us that we should be able to access information wherever we are, and we now can, and do. Commentators believe that most people will utilize their handheld devices to perform tasks such as reading newspapers, examining reports, watching videos, seeking maps, and accessing bank accounts. Presently this could only be conveniently done on a desktop.

Despite the dramatic improvements in mobile device sophistication, there remain physical constraints on the devices.

1. The network connection is bandwidth limited, intermittent, and sometimes expensive. Delivering large amounts of data (a graphically rich web page) is time consuming and sometimes unreasonable due to undue monetary expense.

2. Input methods are limited. Since the mobile device is small, so too are the keyboards. The screen is small making handwriting recognition awkward to use. Voice activation can be ineffective in a noisy (crowded) environment. In short, standard input mechanisms do not effectively enhance the user experience, particularly in web browsing (and especially text input associated with it).

3. When on the move mobile users have limited attention available for device operation yet browsing and typing are time consuming.

Despite the difficulty of using mobile devices (they are slow, it is hard to enter information, and limited attention is available for operation) many people increasingly face pressure to use them. Browsing web pages and Internet searching are common ways to find information, but several queries and long browsing sessions may be necessary before the information need is fulfilled. On a mobile device these information seeking sessions can become frustrating due the special physical limitations of a mobile device.

In this short position paper we propose a method of reducing the time (and frustration) in web search and browse. Evaluating this mobile system is of utmost importance to us and our contribution herein is a discussion of evaluation methods, in particular we propose essential changes to the INEX Link-the-Wiki Track and INEX Interactive Track that must occur before an effective mobile system can be built. Because our discussion focuses on changes to INEX we illustrate our work using the INEX Wikipedia collection.

1.2 Motivation

Information Retrieval (IR), and especially web-IR developed as a discipline in an environment of desktop networked computers. It is convenient for people to use a keyboard to type a query and a mouse to navigate results lists and browse documents. On a large screen a user can easily navigate a long document and even instantiate multiple browsers to compare different information from different documents. Unfortunately (with a few notable exceptions such as Google), web site implementers expect mobile users to use a desk-top interface on a screen of only a few square inches. Queries are entered on a tiny keyboard and an excess of scrolling is necessary to navigate a results list.

We already know that the user experience using desk-top search interfaces on a mobile device is quite different from the experience using the same interface on a desk-top [1] [2]. User interfaces designed for desktop computers generally have a

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negative impact on user performance when used on a mobile device. Excessive scrolling of result lists and awkward navigation of documents are obvious points of issue. In order to aid use on mobile devices, long search results lists might be divided into several individual pages, and documents might be presented without assumptions on the width of a page (for example, with one column of text in place of multiple columns of text). Browsing *between* pages and navigating *between* parts of a document are still awkward, though, and users can easily become disoriented.

The adaptation of the content to the particular device is often required in order to overcome these limitations. Page structure is an important factor in determining usability and a one-column approach is used by some mobile browsers as a method to reduce horizontal scrolling [5]. Web content adaptation techniques analyze the page structure and split it into smaller, constituent parts exploiting the HTML data structure [6]. An XML based converter has been proposed to handle information streams for mobile user requests [3]. A Cascading Style Sheet-compatible mechanism has also been used to designate layout [4].

Automatic document summarization [7, 8] might be used to reduce the length of a document, or to summarize a results list. An assessment of the effectiveness of hierarchical query-biased summaries shows that it, indeed, enhances the presentation of search results on small mobile screens [8]. Other methods such as novel sentence presentation have proven sufficient for users to understand document context on mobile devices [9]. Document length reduction techniques such as these do not provide document context which we believe is essential for understanding and trust.

We make no assumptions about the content of a document (i.e. that it can be effectively summarized or that the presentation can be changed) and instead allow users to freely interact with the (superficially) unaltered document. We, instead, examine efficient browsing and navigation of the information directly in context. That is, we address the problem of inter-document and intra-document disorientation.

In the proposed method, when a document is presented to a user it is annotate with automatically identified hypertext links pointing to other documents within the collection. To avoid the long document navigation problem we link not to whole documents, but to a link-specific Best Entry Point (BEP [12]) within the target document. This is the point from which the user should read in order to expand on the context of the anchor. For this to happen, the user must have an initial document into which links can be added. This might be identified with an initial (traditional) mobile search, so only one search is necessary.

2. MOBILE LINK IDENTIFICATION

Central to our proposal is the automatic identification of hypertext links. INEX has examined document-to-document link discovery and we now propose extensions for anchor-to-BEP links.

2.1 The INEX Link-The-Wiki Track

In 2007 INEX examined the automatic identification of hypertext links in the Wikipedia. The track examined document-to-document linking [11]. For 2008 we propose it examine the automatic identification of anchor texts and associated targets – where a target is both a relevant document and a location within that document from which a user should start reading (a BEP).

BEP targets are more versatile than whole-document links (especially for a mobile device) because the user is directed to the part of the document which satisfies their information need. They are not required to scroll through irrelevant material and to skim-read the document in order to fulfill their information need.

The INEX Link-the-Wiki track methodology proceeds as follows: participants nominate topics (documents from within the Wikipedia); these documents are extracted from the collection and all links between them and the collection are removed (from both the topic and the collection). Participant's link discovery systems then identify links for the topic documents.

In 2007 (document-document linking) the participant's systems were measured against a ground truth of the links that were removed from the documents.

For anchor-text to BEP linking participant-identified links will have to be pooled and assessed by human judges. The metrics will also have to change to reflect the dual task of identifying anchor-texts and BEPs.

It should be noted that as a consequence of our proposed methodology two systems might both identify the same anchor-text but different target documents (and BEPs), both of which are judged as relevant. Generalizing this, we propose multiple-target per anchor linking as a method of mobile navigation.

3. MOBILE LINK BROWSING

In this section we briefly describe the user interface we propose for small mobile screens.

3.1 User Interface

We do not (currently) concern ourselves with how a user enters a query into the mobile device or the navigation of the results list – we leave that for future work. We start with the presentation of the first document the user has clicked.

Figure 1 shows a page from the Wikipedia complete with hypertext links as it will appear after link discovery. Link discovery will be applied to all text (left) including image descriptions (right). Once the document has been presented the user will navigate from it to related documents automatically identified through link discovery – no additional searching is required.

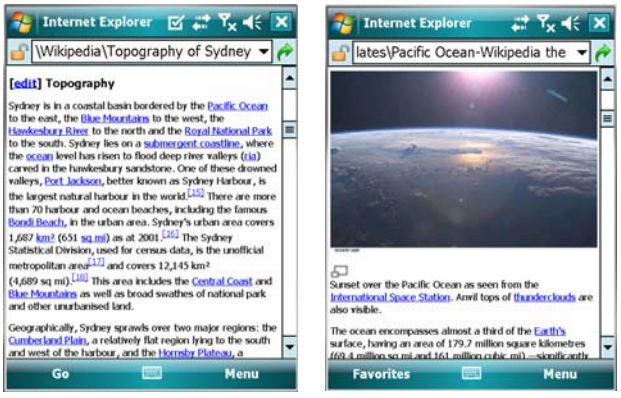

Figure 1. Wikipedia on a small mobile screen.

3.2 User Interaction

Figure 1 (left) displays a document on the *Topography* of Sydney, Australia. If the user clicks on an anchor (for example, *Ocean*) then one of two possible actions will be performed: if only one BEP for the anchor has been identified then the user will be presented with the target document with the BEP at the top of the screen (figure 2, left). If there are multiple BEPs the user will be presented with a list of targets and text snippets for each (figure 2, right). Of course, once the user navigates to another document, that document, too, will be annotated with links identified through link-discovery.

Since the words on a small screen are often small, it is sometimes inconvenient to click on the links. We propose to address this by using speech recognition to aid the clicking of links. We note, without further discussion (due to space limitation), that it is a much simpler task to match voice input against the limited set of pre-defined anchors in a page than it is to solve the generic problem of speech recognition. We leave for further work the investigation of voice recognition for performing the search and navigation.

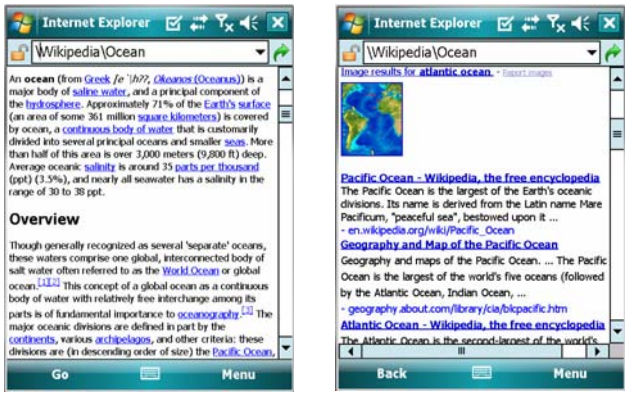

Figure 2. Screen shots of the relevant content and the following relevant links

4. ASSESSMENT AND EVALUATION

An outline of the mobile system has been given in the previous sections. In this section we examine methods of evaluating both the quality of link-discovery and the user interface.

4.1 The Test Collection

The Wikipedia is composed of millions of interlinked articles in numerous languages and offers many attractive features for retrieval tasks [13]. The current INEX Wikipedia collection contains a snapshot of the English Wikipedia taken in 2006. It contains 660,000 text documents, is about 4GB in size, and images are available for it.

4.2 Assessment

Using Wikipedia links as the ground-truth, as was done in INEX 2007, is obviously not perfect. Some links in the Wikipedia are already automatically generated and the validity is questionable. *Year* links, for example, are very often unrelated to the content of the document, but are easy to discover. Problematically these bad links may also lead to optimistic evaluation results when identified by link-discovery systems.

Many potentially good links that have not been identified by Wikipedia users are amenable to automatic discovery – but will not be scored using the current INEX protocol. Such good links (which are missing from the ground truth) could result in poor evaluation scores for highly effective link discovery systems, leading to pessimistic evaluation results.

Automated generation of assessments produces an incomplete and biased ground truth, biased on what users did, not what they might (or should) have done. This bias is not dissimilar from that seen with relevance feedback experiments in which a user can only improve on results they have seen, and is not able to identify better and more relevant documents they have not seen. Furthermore, the existing Wikipedia links do not have anchor-to-BEP functionality, nor do they have multiple links per anchor. In short, the INEX protocol in which existing links are considered the ground truth cannot be used for evaluating anchor-to-BEP runs. For this it is necessary to employ a manual assessment procedure. We have implemented an assessment tool to aid this process and offer its use to INEX. In manual assessment view, a list of topics will be presented on the top section of the interface. Once an anchor is clicked, a list of anchors is displayed on the left hand side of the bottom section and the content of the anchor will be displayed on the right hand side when each anchor is pointed. The user can just use right and left button on the mouse to switch between relevant and irrelevant options as well as go into next anchor or even next topic. The topic content will be automatically scrolling to the anchor accessed currently. It allows the user to view the content corresponding with the anchor. The tool aims to eliminate unnecessary obstruction and speed the process.

4.3 Evaluation

The goal of the anchor-text to BEP task is to perform focused retrieval. That is, to link anchors in one document to focused units (e.g. *sections*, *images*, *elements*, *or passages*) in another. An anchor link click should, ideally, lead a user not only to a relevant document, but also to the best entry point within that document with respect to the anchor's context. This requires far more elaborate assessment and evaluation than seen in INEX previously. In automated link discovery there are two simultaneous ranking requirements: first a candidate list of anchors, second a candidate list of target documents for those anchors. In order to derive a single performance score over all proposed anchors and targets, the performance of each must be combined.

Anchors must be matched against the assessments with some flexibility. An anchor may be defined in several slightly different equally correct ways. For instance, *The Theory of Relativity*, *Theory of Relativity*, and *Relativity* may well be conceptually identical anchors. Furthermore, if the anchor text occurs several times in a document one would expect only one instance to be anchored (as seen in the Wikipedia) and so the location of the anchor may vary without being logically incorrect. In deriving a relevance score for an anchor a match has to be defined as conceptual, requiring only some minimal term overlap with an anchor. Such scoring techniques have been used in Question Answer evaluation and metrics for anchor text identification should be developed with this in mind.

Similarly, a BEP cannot be defined with absolute accuracy. Some reasonable proximity to a designated BEP in the assessments

should be allowed. So a BEP might be considered relevant if, when viewed on a mobile screen, it is no more than some distance (*N* words) away from a point chosen by an assessor. Such a metric would be similar to that used to score BEPs in the INEX Best-In-Context task. In summary, an anchor-to-BEP link can be assessed as relevant on the basis of approximately matching both ends of the link (the anchor and the BEP).

If INEX adopts our proposal we will have a quantitative method of evaluating link discovery systems for mobile devices. Remaining is the evaluation of the user interface.

The user interface will be evaluated by volunteers who have similar user profiles in terms of information technology (IT) expertise. None will have used this mobile system previously. Each will be asked to use the mobile system to perform the same information seeking tasks using the Wikipedia. We aim to examine two issues: First, we want to quantify the detrimental effect of a small mobile screen on task completion. Second, and most importantly, we want to obtain qualitative information on how the small mobile screen affects the operation of the mobile link browsing system.

In the experiment the participants will use the mobile device and the stylus to interact with the mobile system. The amount of time it takes to answer some information seeking tasks will be measured. A second set of participants will perform the same tasks on a desk-top computer using a keyboard and mouse. A third groups will perform the same task using the desktop interface but on the mobile device. All participants will be given an exit questionnaire. An examination of the difference in behavior between the groups will give some insights into the difficulty of using mobile devices without custom interfaces. It will also give insights into the improvements (or not) of the mobile systems over these un-adapted systems.

A substantial number of participants are necessary if any conclusions are to be drawn from a user-interface experiment. In order to achieve this we propose this mobile system as the experiment for the Interactive Track of INEX 2008. If each participating group supplies a relatively small number of participants (per the customary 8), then only a small number of groups will be necessary in order to obtain a big enough result set. We offer our mobile link-discovery system for such an evaluation task.

Separately, and similarly we will examine whether or not voice recognition improved the interface or not.

5. CONCLUSIONS

Search and navigation on a mobile device is awkward, especially as many service providers do not adapt their services to the small screen of a mobile device. We believe that if related documents are extensively interlinked then the quantity of manual searching performed by a user can be reduced substantially. If this is the case then this will, in turn, help the user in their information retrieval task by reducing the number of searches the user has to perform in order to satisfy their information need.

The only practical method of achieving this high level of document interlinking is to use automatic link-discovery systems as it is unreasonable to assume users will manually add such links and keep them up to date.

If we are to build such systems then it is essential to quantitatively measure them – but this is not trivial as anchors and destinations are both soft and evaluation must take this into consideration. We offer some insights into how this might be done and suggest the INEX Link-the-Wiki Track in 2008 (and beyond) adopt multiple-target anchor-to-BEP linking as the preferred task. We also propose an interactive experiment to quantify the performance gain of mobile link discovery and propose the INEX Interactive Track adopt this as the experiment in 2008.

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