

Repeat Visits to Vivisimo.com: Implications for Successive Web Searching

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ABSTRACT

We investigate the occurrence of Web searchers returning the same information course, in this case the Vivisimo Web search engine. We analyze data from a transaction log spanning a roughly 8-day period with approximately 1,200,000 records. During this time 40,227 users made repeated daily visits to the search engine, submitting 648,897 queries. Our findings show that repeat users make up about 21% of the user base. These repeat users account for over 45% of all sessions and nearly 60% of all queries submitted. Most repeat users (46%) visited the search engine on two days during the data collection period, but a sizeable percentage (17%) made 5 or more daily visits to Vivisimo. We discuss the implications for successive searching and future research.

Introduction

The study of online successive searching (i.e., a user searching in digital environments over time to address a common information need) is developing as an area of research. As Web search engines has become a major source of information for many people, we need to understand how people seek and retrieve information in the Web environments. It appears that searchers repeatedly search an information source for answers to an information problem, and they may seek information during extended periods from a variety of Web and other online information resources. The study outlined in this paper is currently investigating this relative unexplored explored line of inquiry for Web searching by investigating repeated visits to the same online information source by a set of Web searchers.

This research can help address the issue of designing Web information repositories that assist users in their successive searches, which is an important research question if the Web is to support complex information searching. Current Web search engines interfaces, algorithms, and personalization features offer little support for information needs requiring successive searching. Most existing Web search engines are designed for the single search paradigm, (.e.g, every search session by an individual searcher is independent). The results reported here contribute to an increasing body of research aimed at design Web searching systems to support more complex searching behaviors.

Literature Review

As the most popular information repository, the Web is used in a variety of situational settings, including the home and work environment. The Web is now a, if not the, major information source for many people (Cole, Suman, Schramm, Lunn, & Aquino, 2003), used more than newspapers, magazines, and television. People are expanding their use of the Web for all sorts of information and commercial purposes (National Telecommunications and Information Administration, 2002). Searching for information is one of the most popular Web activities, second only to the use of email (Nielsen Media, 1997).

Many of these users have straightforward information needs, requiring simple and single interactions with Web search engines (Jansen & Spink, Forthcoming). However, there are information needs that transcend a single session. Recent Web research shows that some Web users have broader information needs (A. Spink, Wilson, Ellis, & Ford, 1998) and often seek information in stages over extended periods, and these searchers may use a variety of information resources (A. Spink, Bateman, & Jansen, 1998). As time progresses, users tend to search the same or possibly different online systems (digital libraries, IR systems, Web services), as well as offline sources, for answers to the same or evolving information problem. This process of repeated, successive searching over time in relation to a given, possibly evolving, information problem (including changes or shifts in beliefs, and cognitive, affective, and situational states), is called a *successive search phenomenon* (Amanda Spink, Wilson, Ford, Foster, & Ellis, 2002).

Spink, Bateman and Jansen (1999) found one third of respondents to a survey on the Excite Web search engine homepage were first time users, conducting their first search of Excite on their current topic. However, two-thirds reported a pattern of successive searches of between 1-5 Excite searches on their current topic; thirty percent (30%) reported more than five (5) Excite searches on their topic; and thirty-eight (38) reported conducting more than 20 searches on their topic. *Successive Web search episodes* are an important user behavior when interacting with Web search engines. The further modeling of users in successive searches is then *successive user modeling*.

A key dimension for successive searching is time, and the key variable is changes or shifts in successive search episodes over time on a single or multiple information sources. The key constant is the same or evolving information problem. The evolution of an information problem and other cognitive, affective and situational variables can be mapped, and the history of successive search episodes can be recorded and analyzed (i.e., the phenomenon can be a subject of research).

The successive search phenomenon is just beginning to be investigated by Web researchers. Prior work has noted that people conduct repeated searches on the same or related topics over time (Lin, 2002; A. Spink, Jansen, & Park, 2004). Some of these information needs may have a short temporal component (e.g., planning a vacation) while other have a much longer temporal aspect (e.g., critical health issue). There has been some research into successive searches and multitasking search behaviors (Lin, 2002; Miwa, 2001; Ozmutlu, Ozmutlu, & Spink, 2003a, 2003b; A. Spink et al., 2004; A. Spink, Jansen, Park, & Pedersen, 2002; A. Spink, Ozmutlu, & Ozmutlu, 2002).

A key indicator of successive searching is repeated visits to an information source. Of course, successive searchers may use a variety of information sources; however, survey data shows that they often return the same information source to investigate their information need (A. Spink, Bateman et al., 1998). There have been several snapshot studies of people's searching behavior in a variety of situational settings (for a review of this literature see Jansen & Spink, Forthcoming), but there have been few longitudinal studies of how people continue and sustain multiple searches over time and how this information is integrated into a person's overall process of information seeking.

From this brief literature review, it is apparent that there has been considerable interest in successive searching. However, there has been much less research into evaluating how often searchers return to the same information source and how they interact with that information source over time. Do their expressions of their information need change? How often do they conduct successive searching on an information topic versus exploring other information needs? It is these questions that drive this research.

We conducted a transaction log study analyzing repeat visits and possible successive searching on the Vivisimo (<http://www.vivisimo.com>) search engine over an approximately 8-day period.

Research Questions

The research questions examined were:

1. What is the occurrence of repeated searching by Vivisimo users?
2. What are the characteristics of Vivisimo repeated searching?

We next provide a short description of the search engine data collected and the data analysis we employed to address our research questions.

Research Design

To address the research questions we quantitatively and qualitatively analyzed queries submitted to Vivisimo in 2004.

Data Collection

The queries examined for this study were submitted to Vivisimo over an approximately one week and one day period beginning at 04:02:56 on Sunday, 28 March 2004 through 04:02:38 on Sunday, 04 April 2004. The transaction log recorded 100% of the traffic on the Vivisimo Web site during this time period.

The transaction log examined contains approximately 1,200,000 records. Each record contains a variety of fields, including:

- *User Identification*: a user code assigned by the Vivisimo server based on the searcher's computer Internet Protocol (IP) address.
- *Date*: the calendar day as recorded by the Vivisimo server.
- *Time of Day*: the clock time as recorded by the Vivisimo server.
- *Query Terms*: terms exactly as entered by the given user.

Overview of the Vivisimo Search Engine

The Vivisimo interface contains a search box for inputting queries, as should in Figure 1, and supports Boolean and exact phrase matching. The default search source is the Web and a drop down box provides options for additional source selection (e.g. CBC, CNN, Wisenut). Searches can be limited by domain or host name, by link content, Web page or Uniform Resource Locator (URL) information.

Vivisimo offers an "Advanced" search form containing options for source and language selection, defining the number and display of search results, deciding how links should be opened, and whether or not the content filter is applied. After a user submits a query, Vivisimo presents the clusters using the tree metaphor, which is similar to that used by Windows Explorer for file directories. The clusters appear on the left side of the page and the results pages are featured on the right of the main search page.

Vivisimo's clustering feature creates dynamic post-search categories in a meta-searching environment. Users can click on cluster labels to retrieve results pages. Clusters can be expanded to reveal sub-clusters and the cluster tree may be elongated by clicking on the "More" option. Keywords can be entered in the "Find in clusters" search box to search the clusters. The results pages are initially displayed as a result of a search. Results pages are retrieved when the user clicks on the clusters and additional results pages may be selected at the bottom of the window. Hyperlinks may be accessed for individual items and Web pages may be previewed, opened in the results frame, or opened in a new window.

An item on the results pages may be identified within the clusters by clicking on the "show in clusters" option next to the item. This highlights the clusters on the tree which contain the item. The "Details" feature shows the number of results for the sources searched. Some of these features were analyzed quantitatively to study user interaction with Vivisimo.



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ASIST the Web [Search](#) [Advanced](#) [Help!](#)

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Clustered Results

ASIST (151)

- ▶ [Information Science](#) (26)
- ▶ [Suicide, Training](#) (24)
- ▶ [University](#) (13)
- ▶ [Integration, Technologies](#) (6)
- ▶ [Scholarship](#) (6)
- ▶ [Blog](#) (5)
- ▶ [Employment-Intensive Investment Programme](#) (2)
- ▶ [Health, Education](#) (4)
- ▶ [Stormwater, NPDES](#) (2)
- ▶ [Designed](#) (4)

[More](#)

Find in clusters:

Enter Keywords

Top 151 results retrieved for the query ASIST (Details)

1. [American Society for Information Science](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
Information on committees, programs, publications, membership and chapters from this professional organization.
URL: [WWW.ASIS.ORG](#) - [show in clusters](#)
Sources: [Lookout4.1](#), [Lycos.1](#), [MSN.1](#), [Wiseut.1](#)
2. [Asist Translations Services](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
Translation, typesetting and interpreting in Columbus, USA, in Spanish, French, Chinese, German, Somali, Japanese, Korean and Arabic.
URL: [WWW.ASISTTRANSLATIONS.COM](#) - [show in clusters](#)
Sources: [Open Directory.2](#), [Lycos.6](#), [MSN.6](#)
3. [Books.infoday.com - ASIST](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
ASIST Conferences ASIST Monograph Series ARIST: Annual Review of Information Science and Technology Advances in Classification Research
URL: [books.infoday.com/asist](#) - [show in clusters](#)
Sources: [Lycos.3](#), [MSN.3](#), [Wiseut.21](#)
4. [ASIST Programme - Employment Intensive Investment Programme \(EIIP\)](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
crisis, reconstruction
URL: [WWW.ILO.ORG/public/english/employment/recon/eiip/asist](#) - [show in clusters](#)
Sources: [Lycos.2](#), [MSN.2](#)
5. [mail.asis.org Mailing Lists](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
mail.asis.org Mailing Lists Welcome! Below is a listing of all the public mailing lists on mail.asis.org.
URL: [mail.asis.org/mailman/listinfo](#) - [show in clusters](#)
Sources: [Lycos.2](#), [Wiseut.6](#), [MSN.9](#)
6. [ASIST - Making Stormwater Simple](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
Managing your NPDES Stormwater Program just got easier! Click here to see why and discover how more than 1,000 other people are managing their programs
URL: [WWW.ASIST.NET](#) - [show in clusters](#)
Sources: [MSN.7](#), [Lycos.8](#), [Wiseut.16](#)
7. [About ASIST - European Chapter](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
About ASIST - European Chapter The European Chapter of ASIS was established in 1993, turning the North European Chapter (which existed before) into a pan-european chapter.
URL: [WWW.ASIS.ORG/Chapters/europe/About.htm](#) - [show in clusters](#)
Sources: [Lycos.5](#), [MSN.9](#)
8. [Employment-Intensive Investment Programme - Contact us](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)
Employment-Intensive Investment Programme
URL: [WWW.ILO.ORG/employment/recon/eiip/asist/document.htm](#) - [show in clusters](#)
Sources: [Lycos.5](#), [MSN.5](#)
9. [Aviation Security International Systems Training](#) [\[new window\]](#) [\[frame\]](#) [\[preview\]](#)

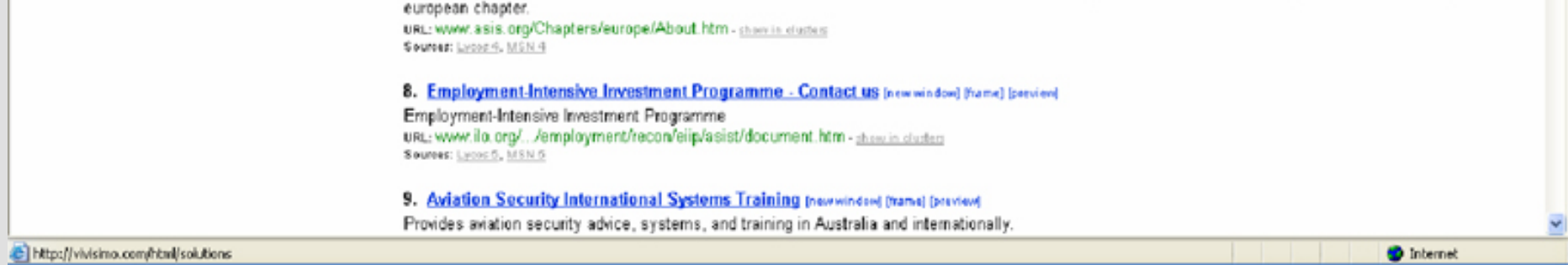


Figure 1: Vivisimo Search Engine Interface.

Data Analysis

The transaction log is a flat ASCII file, which we imported into a relational database in order to conduct the analysis. We generated a unique identifier for each record.

Using the four fields (*User Identification*, *Date*, *Time of Day*, and *Query Terms*), we located the initial query and then recreated the chronological series of actions in a session:

- A *term* is any series of characters separated by white space or other separator
- A *query* is the entire string of terms submitted by a searcher in a given instance
- A *session* is the entire series of queries submitted by a user with the Web search engine on a given day.

We conducted both quantitative and qualitative analysis on the transaction log data. The Vivisimo transaction log contained Web searches from both human users and agents. We were interested in only those queries submitted by humans rather than by some automated process. Given that there is no way to accurately identify human from non-human searchers, most researchers utilizing transaction logs for data collection must either ignore it (Cacheda & Viña, 2001) or assume some temporal or interaction cut-off (Montgomery & Faloutsos, 2001).

We separated all sessions with 100 or fewer queries into an individual transaction log. We chose this cut-off because it is almost 50 times greater than the reported mean search session (Jansen, Spink, & Saracevic, 2000) for human Web searchers, assuring that we were not excluding any human searches. Although this cutoff probably introduced some agent or common user terminal sessions, we were satisfied that we had retrieved a subset of the transaction log that contained queries submitted primarily by human searchers,

yet broad enough not to introduce bias by too low of a cut-off threshold.

When a searcher submits a query, then views a document, and returns to the Vivisimo search engine, the Vivisimo server logs this second visit with the identical user identification and query, but with a new time (i.e., the time of the second visit). This is beneficial information in determining how many of the retrieved results pages the searcher visited from the Vivisimo search engine, but unfortunately it also introduces duplicate queries.

To address this issue, we collapsed the Vivisimo transaction log by combining all identical queries submitted by the same user to give us the unique queries for analyzing sessions, queries and terms, and pages of results viewed.

Table 1. Vivisimo 2004 Transaction Log Aggregate Data.

| | | |
|---------------------|-----------|--------|
| Unique IP Addresses | 193,377 | |
| Total Queries | 1,082,431 | |
| Terms | | |
| Unique | 350,504 | 10.3% |
| Total Terms | 3,394,989 | 100.0% |

We utilized the complete un-collapsed sessions in order to obtain an accurate measure of the session duration and the number of results pages visited. When we collapsed the sessions, we recorded the number of identical queries by the same user in a separate field within the remaining records.

We then removed all IP address that occurred only on one of the eight days. We now had a database of only those users who had visited the search engine on more than one day during the eight day period. We analyzed the data from these four tables to

investigate our research questions. We conducted the analysis using a series of layered queries, Visual Basic for Applications scripts, or a combination of the two. We report the results of our analysis in the follow section.

Results

In this section, we present the results of the empirical analysis.

Overview of Entire Data Set

From Table 1, there were 193,377 unique users of the Vivisimo search engine over the day collections period. These users submitted a total of 1,082,431 queries composed of 3,394,989 total terms.

Of the 193,377 unique users, we isolated the users that made repeated visits to the Vivisimo search engine over the data collection period. There were 40,227 (20.8%) users who visited the Vivisimo search engine two or mores times during this period.

We examine these repeat users further.

Sessions

We first examine the number of sessions of these 40,227 users. We isolated these unique user identification codes to see how many times these users visited the Vivisimo search engine during the 8-day period.

From Table 2, we see that 68% of the users visited the search engine 2 or 3 times, accounting for 50% of the sessions. There were

just less than 1% of the users who visited the search engine on all 8 days of the collection period. However, the last day of the data collection was not a full day (i.e., only slightly more than four hours). There were 2.5% of the users who made seven repeated visits to the search engine, so this percentage may be a better indicator of percentage of daily repeat users.

We next examined the usage levels by day, shown in Table 3.

In Table 3, rows three and four show the number of session each day and the percentage respective for the entire data set. Rows three and four show the same for the repeat users. Looking at the all users rows, there are 279,995 total sessions generated by 193,377 unique users. The mean number of sessions per day is 34,971 sessions with weekdays showing a higher percentage of sessions. If we ignore the 4 hour period on Sunday, 4 April, the mean is 39,461 sessions.

Examining repeat users, there are 126,616 sessions from 40,227 users. So, 21% of Vivisimo users accounted for 45.2% of the sessions. The mean sessions per day is 15,827 sessions (17,839 sessions ignoring 4 April), again with the weekdays showing a higher percentage of sessions.

We next examine the query level of analysis.

Queries

We calculated the number of queries that the 45,227 repeat searchers submitted during the data collation period, as shown in Table 4.

Looking at the all users rows, there are 1,082,431 queries generated by 193,377 unique users. The mean number of queries per day is 135,304 queries with weekdays showing a higher percentage of sessions. If we ignore the 4 hour period on Sunday, 4 April, the mean is 153,279 queries. Approximately 80% of queries were entered during weekdays, with about 5% fewer queries submitted per day on the weekends.

Examining repeat users, there are 648,897 sessions from 40,227 users. So, 21% of Vivisimo users accounted for 59.9% of the queries. The mean queries per day is 81,112 sessions (91,991 queries ignoring 4 April), again with the weekdays showing a higher percentage of queries.

At the query level of analysis, we also examined how many queries individual users submitted over the data collection period, as shown in Table 5. Examining Table 5, we see that the majority (56%) of users submitted 10 or less queries over the 8 day period. Although the mean was 162 queries for the 8 day period, a small percentage (1.3%) of users skew the average and standard deviation.

Table 2: Sessions by Repeat Users of Vivisimo

| No. of Days User Visited Search Engine | No. of Users | % | No. of Sessions During Time Period | % |
|--|--------------|--------|------------------------------------|--------|
| 2 | 18,442 | 45.8% | 36,884 | 29.1% |
| 3 | 9,022 | 22.4% | 27,066 | 21.4% |
| 4 | 5,813 | 14.5% | 23,252 | 18.4% |
| 5 | 4,048 | 10.1% | 20,240 | 16.0% |
| 6 | 1,511 | 3.8% | 9,066 | 7.2% |
| 7 | 1,020 | 2.5% | 7,140 | 5.6% |
| 8 | 371 | 0.9% | 2,968 | 2.3% |
| | 40,227 | 100.0% | 126,616 | 100.0% |

Table 3. Sessions per day by Repeat Users of Vivisimo.

| | | Sessions Per Day | | | | | | | |
|-----------------|---------|------------------|---------------|----------------|---------------|----------------|--------------|--------------|--------------|
| | Total | Sun 28-Mar | Mon 29-Mar | Tues 30-Mar | Wed 31-Mar | Thurs 1-Apr | Fri 2-Apr | Sat 3-Apr | Sun 4-Apr |
| All Users | 279,995 | 29,576 | 45,582 | 45,388 | 43,968 | 42,897 | 39,430 | 29,384 | 3,541 |
| | 100% | 10.6% | 16.3% | 16.2% | 15.7% | 15.3% | 14.1% | 10.5% | 1.3% |
| Repeat Users | 126,616 | 9,936 | 21,253 | 21,734 | 21,704 | 21,083 | 19,003 | 10,157 | 1,746 |
| | 100% | 7.8% | 16.8% | 17.2% | 17.1% | 16.7% | 15.0% | 8.0% | 1.4% |

Table 4. Queries per day by Repeat Users of Vivisimo.

| | | Queries Per Day | | | | | | | |
|-----------------|-----------|-----------------|---------------|----------------|---------------|----------------|--------------|--------------|--------------|
| | Total | Sun 28-Mar | Mon 29-Mar | Tues 30-Mar | Wed 31-Mar | Thurs 1-Apr | Fri 2-Apr | Sat 3-Apr | Sun 4-Apr |
| All Users | 1,082,431 | 105,803 | 184,012 | 181,074 | 177,900 | 169,933 | 150,893 | 103,340 | 9,476 |
| | 100% | 9.8% | 17.0% | 16.7% | 16.4% | 15.7% | 13.9% | 9.5% | 0.9% |
| Repeat Users | 648,897 | 49,150 | 114,932 | 115,609 | 114,614 | 107,997 | 93,186 | 48,448 | 4,961 |
| | 100% | 7.6% | 17.7% | 17.8% | 17.7% | 16.6% | 14.4% | 7.5% | 0.8% |

Table 5. Number of Queries by Repeat Users

| No. of Queries | No. of Users | % of Repeat Users |
|-------------------|-----------------|-------------------|
| 2 | 3,046 | 7.6% |
| 3 | 3,424 | 8.5% |
| 4 | 3,226 | 8.0% |
| 5 | 2,522 | 6.2% |

| | | |
|----------|--------|--------|
| 2 | 3,040 | 7.0% |
| 3 | 3,424 | 8.5% |
| 4 | 3,226 | 8.0% |
| 5 | 2,726 | 6.8% |
| 6 | 2,632 | 6.5% |
| 7 | 2,348 | 5.8% |
| 8 | 2,036 | 5.1% |
| 9 | 1,728 | 4.3% |
| 10 | 1,507 | 3.7% |
| 11 - 20 | 8,883 | 22.1% |
| 21 -30 | 3,594 | 8.9% |
| 31 - 50 | 2,796 | 7.0% |
| 51 - 100 | 1,777 | 4.4% |
| 100+ | 504 | 1.3% |
| | 40,227 | 100.0% |
| Mean | 162 | |
| St Dev | 511 | |
| Max | 503 | |

| | | |
|--------|-----|--|
| Mean | 162 | |
| St Dev | 511 | |
| Max | 503 | |

Discussion

There were 40,227 repeat users of Vivisimo, which account for 20.8% of the 193,377 unique users. Of these repeat users 27,464 (68%) visited the search only two or three times during the period of data collection, which accounted for 50% of the sessions generated by all repeat users. So, even repeat users do not visit the search engine daily. Less than 1% of the users visited the search engine on all eight days. However, the last day of the data collection was not a full day (i.e., only slightly more than four hours). Using a seven day period, there were 2.5% of the users who made daily visits to the search engine.

There are 126,616 sessions from 40,227 users, meaning that 21% of Vivisimo users accounted for 45.2% of the total sessions. The mean sessions per day for repeat users is 15,827 sessions, with percentages on weekdays and weekends fairly mirroring that of the overall population. So, the repeat users generate a substantial percentage of the engine's traffic.

Looking at the queries from repeat users, there are 648,897 sessions from 40,227 users. Repeat searchers accounted for 648,897 (59.9%) of the 1,082,431 total queries executed on Vivisimo during the time period. The mean number of queries per day is 81,112 sessions, again with repeat users mirroring that of the overall population. The majority of repeat users submitted 10 or less queries over the 8 day period, with a small percentage (1.3%) of repeat users submitted a large number of queries.

Returning to our research questions (*What is the occurrence of repeated searching by Vivisimo users? What are the characteristics of Vivisimo repeated searching?*), it appears that repeat searchers are an important component of the Vivisimo user population.

These repeat users are a small but noticeable percentage of Vivisimo users. However, they account for a sizeable percentage of all sessions and queries. In fact, these repeat users account for nearly a majority of all sessions and do account for a majority of all queries.

In some ways, these repeat users mirror that of the overall population of Vivisimo users in terms of patterns of submissions and short sessions.

Conclusion and Future Research

The results of the research conducted so far are very promising. Results indicate repeat searchers are an important part of a Web search engine user base. Our research provides quantifiable numbers to this population segment and is continuing in this area to further examine aspects of repeat visits to Web search engines. Future research is being conducted to qualitative analysis a representative sample of these repeat sessions to isolate the successive searching sessions.

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