Characterizing and Predicting Search Engine Switching Behavior

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What is Engine Switching?

- Voluntary transition from one search engine to another search engine
  - e.g., Query Google then query Yahoo! or Bing

- We study within-session switching in this paper

- Other variants include:
  - Between-session switching: switch for different tasks
  - Long-term switching: suddenly or gradually over time
Outline

- Motivation
- Methods
  - Log analysis
  - Large-scale survey
- Characterizing search engine switching
  - Overview of log and survey data
  - Pre-/post-switch behaviors
- Predicting search engine switching
- Conclusions
Motivation

- Engine switching is important to search engine users
  - Half of search engine users switch between engines
- Engine switching is important to search providers
  - Represents customers (+ revenue) lost and gained
- Little is known about:
  - Rationale behind switching
  - Switching behavior
  - Features most useful in predicting switching events
- We address these open questions in this paper
Methods

- **Log analysis**
  - 6 months of toolbar logs (Sep 08 – Feb 09)
  - Hundreds of thousands of consenting toolbar users
  - Search sessions extracted from logs
    - Start with query and end with 30-minute inactivity timeout
    - May contain queries to multiple engines

- **Survey**
  - 500 Microsoft employees
  - Targeted switching rationale (to complement log analysis)
  - Also asked about recent switching episodes and patterns of behavior prior to switching
Overview of Switching - Logs

- 4% of all search sessions contained a switching event

Switching events:
- 58.6 million switching events in 6-month period
  - 1.4% of all Google / Yahoo! / Live queries followed by switch
  - 12.6% of all switching events involved same query
  - Two-thirds of switching events from browser search box

Users:
- 72.6% of users used multiple engines in 6-month period
- 50% of users switched search engine within a session
Overview of Switching - Logs

- Switching is more frequent in longer sessions
Overview of Switching - Survey

- 70.5% of survey respondents reported having switched
  - Remarkably similar to the 72.6% observed in logs
- Those who did not switch:
  - Were satisfied with current engine (57.8%)
  - Believed no other engine would perform better (24.0%)
  - Felt that it was too much effort to switch (6.8%)
  - Other reasons included brand loyalty, trust, privacy
- Within-session switching:
  - 24.4% of switching users did so “Often” or “Always”
  - 66.8% of switching users did so “Sometimes”
Reasons for Engine Switching

- Three types of reasons:
  - Dissatisfaction with original engine
  - Desire to verify or find additional information
  - User preference

Other reasons included:
- Loyalty to dest. engine
- Multi-engine apps.
- Hope (!)
How do users behave before and after switching?
Pre-switch Behavior

- Analyzed switching events in the logs to determine the frequency of pre-switch actions

- Consider six actions:
  - Query
  - Pagination (request next result page)
  - Click result (SERP)
  - Click other (non-SERP)
  - Navigate to page without click (e.g., address bar)
  - Start session
Pre-switch Behavior

- Most common are queries and non-SERP clicks
- This is the action immediately before the switch
- What about pre-switch activity across the session?
Pre-switch Behavior

- Re-visititation also increases rapidly just before a switch
- Also represent behavior as sequence motifs ($qRcP^*qR$)

Oscillations due to bucketing noise
Pre-switch Behavior (Survey)

“Is there anything about your search behavior immediately preceding a switch that may indicate to an observer that you are about to switch engines?”

- Common answers:
  - Try several small query changes in pretty quick succession
  - Go to more than the first page of results, again often in quick succession and often without clicks
  - Go back and forth from SERP to individual results, without spending much time on any
  - Click on lots of links, then switch engine for additional info
  - Do not immediately click on something
Post-switch Behavior

- Analyzed switching events in the logs to determine the frequency of post-switch actions

- Consider six actions:
  - Click result (SERP)
  - Navigate to page without click (e.g., address bar)
  - Re-query destination engine
  - Re-query origin engine (switch back)
  - Query on other engine (switch to a third engine)
  - End session
Post-switch Behavior

- Extending the analysis beyond next action:
  - 20% of switches eventually lead to return to origin engine
  - 6% of switches eventually lead to use of third engine
  - > 50% led to a result click. Are users satisfied?
Post-Switch Satisfaction

- Measures of user effort / activity (# Queries, # Actions)
- Measure of the quality of the interaction
  - % queries with No Clicks, # Actions to SAT (>30sec dwell)

<table>
<thead>
<tr>
<th>Activity</th>
<th># Queries</th>
<th># Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Origin</td>
<td>Destination</td>
</tr>
<tr>
<td>All Queries</td>
<td>3.14</td>
<td>3.70</td>
</tr>
<tr>
<td>Same Queries</td>
<td>3.08</td>
<td>3.73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Success</th>
<th>% NoClicks</th>
<th># Actions to SatAction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Origin</td>
<td>Destination</td>
</tr>
<tr>
<td>All Queries</td>
<td>49.7</td>
<td>52.7</td>
</tr>
<tr>
<td>Same Queries</td>
<td>54.5</td>
<td>59.7</td>
</tr>
</tbody>
</table>

- Users issue more queries/actions; seem less satisfied (higher %NoClicks and more actions to SAT)
- Switching queries may be challenging for search engines
Can we predict switching?
What features are important?
Predicting Switching - Overview

- **Task:** Predict whether next action in session is switch
- **Learning model using logistic regression**
- **Feature classes:**
  - Query – the last query issued in current session
  - Session – the current session
  - User – the current user

- **Aim of experiment not to optimize model**
  - Determine predictive value of query/session/user features
  - Model held constant, features combinations varied
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>abandonmentRate</strong></td>
<td>Fraction of times query has no SERP click</td>
</tr>
<tr>
<td><strong>avgClickPos</strong></td>
<td>Average SERP click position (starts at zero)</td>
</tr>
<tr>
<td><strong>avgNumClicks</strong></td>
<td>Average number of SERP clicks</td>
</tr>
<tr>
<td><strong>avgNumAds</strong></td>
<td>Average number of advertisements shown</td>
</tr>
<tr>
<td><strong>avgNumQuerySuggestions</strong></td>
<td>Average number of query suggestions</td>
</tr>
<tr>
<td><strong>avgNumResults</strong></td>
<td>Average number total search results</td>
</tr>
<tr>
<td><strong>avgTokenLength</strong></td>
<td>Average length of query tokens</td>
</tr>
<tr>
<td><strong>followOnRatio</strong></td>
<td>Fraction of times query leads to another query</td>
</tr>
<tr>
<td><strong>frequencyCount</strong></td>
<td>Total query frequency</td>
</tr>
<tr>
<td><strong>hasAlteration</strong></td>
<td>True if alteration applied (e.g., remove plurals)</td>
</tr>
<tr>
<td><strong>hasOperators</strong></td>
<td>True if query has operators (e.g., site:)</td>
</tr>
<tr>
<td><strong>hasQuotes</strong></td>
<td>True if query contains quotation marks</td>
</tr>
<tr>
<td><strong>hasSpellCorrection</strong></td>
<td>True if spell correction fires</td>
</tr>
<tr>
<td><strong>paginationRate</strong></td>
<td>Fraction of times request next page of results</td>
</tr>
<tr>
<td><strong>queryLength</strong></td>
<td>Query length in characters</td>
</tr>
<tr>
<td><strong>queryTokens</strong></td>
<td>Query length in tokens</td>
</tr>
</tbody>
</table>
Session features

avgTimeBetweenQueries: Average time between queries

currentTimeEngine: Current search engine name

currentSequenceAdvanced: Advanced string representation of session so far

currentSequenceBasic: Basic string representation of session so far

hasMotifAdvanced: True if currentSequenceAdvanced has seq. motif

hasMotifBasic: True if currentSequenceBasic has sequence motif

numBacks: Number of revisits in the session so far

numPaginations: Number of paginations in session so far

queriesInSession: Number of queries in the session so far

ratioQueriesWithNoClicks: Fraction of queries with no clicks

ratioQueriesWithOneClick: Fraction of queries with one click

ratioQueriesWithMultipleClicks: Fraction of queries with many clicks

timeInSession: Time in the session so far (in seconds)

URLsInSession: Number of URLs in session so far
User features

\begin{itemize}
\item \texttt{avgSessionLengthQueries}: Average session length in queries
\item \texttt{avgSessionLengthTime}: Average session length in time
\item \texttt{avgSessionLengthURLs}: Average session length in URLs
\item \texttt{avgQueryLength}: Average query length in characters
\item \texttt{avgQueryTokens}: Average query length in tokens
\item \texttt{propPreferredEngine}: Fraction queries issued to preferred engine
\item \texttt{sessionCount}: Total number of sessions
\end{itemize}
Predicting Switching - Method

- Task: Predict if next session action is engine switch

- Used session states, where state =
  - Observed interaction in a session to a given point
  - Also includes most recent query and user id (to get history)

- Trained on 100K states randomly sampled from logs
  - Ratio during sampling 1 : 99 (switch : no-switch)
  - Artificially re-balanced the training data and used bagging

- Tested on 100 x 10K random samples from unseen logs
- Precision and recall computed over 100 samples
Predicting Switching - Results

- Models trained on all features best; Session best class
- Performance improves for longer sessions
  - More session information available
Predicting Switching - Usage

- Switch predictions seem useable, especially at low recall
- What can we do with switch predictions?

- **Origin engine** – predict switch away from them
  - Offer additional query suggestions, reduce number of ads
  - Enhance UI with richer support for sorting or filtering
  - Devote more computational resources to ranking

- **Destination engine** – predict switch to them (via toolbar)
  - Pre-fetch search results in anticipation of incoming user
Conclusions

- Characterized switching behavior using logs and survey
- Showed that:
  - Switching is important and increases for long sessions
  - Switching mainly associated with dissatisfaction
    - Also related to coverage/verification, user preferences
  - Important patterns in exist in pre-switch behavior
  - Switching does not improve search success
  - Features of query, session, and user can predict switching
    - Session features are most useful
    - Sufficient signal to provide some search support
- Future: improve predictions, study long-term switching