Search Engine Switching Detection Based on User Personal Preferences and Behavior Patterns

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Search engine switching
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Search engine switching

**World's Best Bars in Dublin**

The Irish capital is one of Europe's most down-to-earth and friendly cities. In recent years large numbers of stylish bars and cocktail spots have sprung up alongside the more traditional Irish pubs for which Dublin is famous. The Temple Bar quarter has the highest concentration of drinking establishments, but there are plenty of great night spots to be found if one is willing to explore the city slightly further. Indeed, many of the choicest new bars are to be found on or around Dawson Street. Let World's Best Bars guide you to them.

City Guide Map for Dublin
Search engine switching

best bars in dublin

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Best bars Dublin - Yelp
www.yelp.com/search?find_desc=best+bars&find_loc=Dublin
Reviews on Best bars in Dublin Dice Bar, No. 27 Bar & Lounge, The Bar With No Name, The Porterhouse Temple Bar, Bruxelles, The Ivy House, The Black ...

Top 5 Dublin pubs | Gadling.com
www.gadling.com/2011/03/07/top-5-dublin-pubs/
Mar 7, 2011 - Dublin is the land of the pub. Several Irish revolutions began in Dublin’s public houses and many of Ireland’s literary giants frequently socialize.
Why do people switch search engines?

57% dissatisfaction
23% coverage
12% user preferences
8% other

Courtesy of Guo et al. SIGIR 2011
Motivation

- **57%** of switching cases is about user dissatisfaction
  - can be used to improve search engine on problematic queries

- Caveat: not always possible to monitor directly
  - could be monitored using web browser (or toolbar)
  - could be monitored from search logs for navigational queries switching to another search engine

- Can we reliably detect switching? [our work]
  - e.g. can be used to improve search experience in such cases
Motivation

- High switching rate may indicate user dissatisfaction with the search engine
- Switching rate can be used for automatic search quality evaluation
- Search engines could focus on improving user experience for searches followed by switching
Yandex Switching Detection Challenge

- **Data:** 30 days of **anonymized** search logs
  - 8,595,731 sessions (1,457,533 switching sessions)
  - 10,139,547 unique queries

- **Task**
  - detect search engine switching from user actions recorded in the search engine log

- **Evaluation**
  - area under the ROC curve (AUC)
Related work

- Characterization of user actions specific to search engine switching
  [A. Heath and R. White, WWW 08]

- Prediction of search engine switching in online settings
  [R. White and S. Dumais, CIKM 09]

- Understanding and predicting switching rationales
  [Q. Guo et al., SIGIR 11]

- Personalized switching prediction and extensive experimentation
  [Our work]
Insight: some users switch more frequently than others

possible reasons:
- user search experience varies
- switch depends on a search task
Insight: switching is more likely in longer sessions, but varies for users.

Caveats:
- the effect is different for different users
- for some users the opposite is true

\[ \# \text{queries}_{\text{switch}} - \# \text{queries}_{\text{nonswitch}} \]
Switching detection: Main Idea

- switching is a *personal choice* of a user

- users are different
  - some users don't switch at all
  - some users are more persistent and could spend more time studying search results

- **Main Idea:** build personalized model that will learn user's personal habits and behavior patterns and use it for switching detection
Evaluation setup

- Data
  - 24 days of search log data for training
    - 1-21 days used to calculate features
    - 22-24 days for machine learning
    - 25-27 days for validation

- Evaluation Metric
  - Area under the ROC curve (AUC)
Search Trails

- Sequence of user's action in a session
  - type-I: \( Q = \text{query}; \ C = \text{click}; \ E = \text{end of session} \)
  - type-II:
    - \( q/K/Q = \text{query with short/medium/long pause before next action} \)
    - \( D/P/S = \text{click with short/medium/long dwell time} \)
    - \( E = \text{end of session} \)
- Markov model for switching detection

[A. Hassan et al, SIGIR 2012]
Search trails Markov model

Session with switchings
- contain less transitions to SAT click state
- more transitions back to query
General VS. Individual Markov Model

Model built for particular user can differ from aggregated model

But: Most users have little or no history

We use combination between general and personalized model
Performance of Personalized Markov Model

Personalized markov models significantly improve the performance of the generative model for switching detection.
Machine Learning Approach to Switching Detection

- Machine learning approach was shown to be useful for switching detection

- We tried 3 personalization approaches:
  a. build a model for each user and use personalized model prediction as a feature
  b. add user ids to the feature set
  c. add personalized user statistics as a feature set
Types of features

1. **Session features**
   a. session duration, number of queries, number of clicks, average dwell time of click, last action, maximum pause between actions, etc.

2. **Statistics-based features**
   a. average values of all features described above in switch and non-switch sessions separately
   b. use these averages for normalization
   c. session duration divided by the average duration of switch sessions

3. **Personalized statistics-based features**
   a. average values of session features for each user in switch and non-switch sessions
   b. use them separately as well as for normalization
Results: Personalized Statistics Improves Prediction Performance

- Per-user models and model with user-ids as features are prone to overfitting
- Using per-user aggregated statistics significantly improves detection performance
# Best Performing Features (Gini index)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>probability of switch under 3-gram model</td>
</tr>
<tr>
<td>2</td>
<td>total number of switches for a given user</td>
</tr>
<tr>
<td>3</td>
<td>average click position</td>
</tr>
<tr>
<td>4</td>
<td>user switching rate (smoothed)</td>
</tr>
<tr>
<td>13</td>
<td>time to first click in a session</td>
</tr>
</tbody>
</table>

**Takeway**: Features based on users statistics are among the top by importance
Feature Ablation Experiments

**Takeway:** User statistics-based features are the most important.
Feature importance: another perspective

- Session statistics and search trails features are 2 most useful groups
- url statistics are more useful than query statistics (urls triggering switching behavior?)
Performance boosted by personalization

Figure 5: Precision-Recall curve for the positive class (switch sessions)
How much is enough?

Even for user with history as small as ~5 sessions user statistics based features improves switching detection performance.
## Model comparison

<table>
<thead>
<tr>
<th>Model</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline: # queries</td>
<td>0.6710</td>
</tr>
<tr>
<td>Baseline: session duration</td>
<td>0.7257</td>
</tr>
<tr>
<td>Baseline: user switching rate</td>
<td>0.7306</td>
</tr>
<tr>
<td>Semi-supervised model from [A.Hassan at al, 2012]</td>
<td>0.7081</td>
</tr>
<tr>
<td>Personalized generative model</td>
<td>0.7725</td>
</tr>
<tr>
<td>Online prediction model trained on subset of features from [R.White et al. 09]</td>
<td>0.7206</td>
</tr>
<tr>
<td><strong>Our model</strong></td>
<td><strong>0.8450</strong></td>
</tr>
</tbody>
</table>
Conclusion

- We showed that utilizing individual user behavior models drastically improves switching detection performance.

- Described personalized model won 1st place in Yandex Switching Detection Challenge.  
  code: [http://mathcs.emory.edu/~dsavenk/switch_detect](http://mathcs.emory.edu/~dsavenk/switch_detect)

- We believe the same strategy has potential to be useful for other log analysis tasks, such as relevance prediction, satisfaction prediction, etc.
Thank You!
Happy Switch

Questions?