Future Research Issues:

Recommending Tasks to Search Engine Users

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Background

- From Web task
  - A “template” for representing any (atomic) activity that can be achieved by exploiting the information available on the Web, e.g., “find a recipe”, “book a flight”, “read news”, etc.

- To Web mission
  - Each single search task may subsume a complex task, namely a mission, that the user aims to accomplish throughout the SE.

- Task/Query Recommendation
  - Common query suggestions can be classified as intra-task recommendations (query rewriting, specialization, generalization, etc.)
  - We argue that people are also interested in task-oriented (query) suggestions, which can bring us to provide inter-task recommendations, i.e. related to another task in a given mission

Example

- Example of inter-task suggestion

- Alice starts interacting with her favorite SE by submitting the query “new york hotel”, i.e. a query belonging to a simple search task related to the booking of a hotel room in New York.

- Current query suggestion mechanisms provide alternative related queries, by only focusing on the task behind this original single query (intra-task query suggestions), such as “cheap new york hotels”, “times square hotel”, “waldorf astoria”, etc.

- Assume that you can recognize that the current Alice's task is included in a mission, including more tasks, concerned with “planning a travel to New York”

- This means to recommend to Alice other tasks whose underpinning queries look like: “mta subway”, or “broadway shows”, or “JFK airport shuttle” (inter-task query suggestion)
QC-htc: from long-term sessions to task-based sessions

Crowd-based Task Synthesis

• We already used an unsupervised strategy to identify tasks in the long-term sessions of the different users

• We still use an unsupervised method to identify tasks common to many users

• we further use a cluster tool to identify “similar” tasks performed by distinct users just identified by the previous method

• eventually replacing each task $\theta_i^j \in \Theta_i$ in a long-term session of a user with a synthesized task $T_h$
Crowd-based Task Synthesis

- Each synthesized task $T_h$ can be considered as a representative for an aggregation composed of similar tasks, performed by several distinct users.

- We can rewrite each task-oriented session in terms of the new tasks identifiers: $T_h$
  where $T_h = \{T_1, \ldots, T_K\}$

- The various long term sessions thus become sets/sequences of synthesized tasks.

![Image of tasks performed by different users](image-url)
Task-based Model Generation

• Produce a Task Recommendation Model
  a weighted directed graph $G_T = (T, E, w)$, where the weighting function $w(.)$ measures the “inter-task relatedness”
• if they are related, they are probably part of the same mission

$G_T = (T, E, w)$
Task-based Recommendation

- Generate a Task-oriented Recommendations
- given a user who is interested in (has just performed) a task $T_i$
- retrieve from $G_T$ the set $R_m(T_i)$, which includes the $m$-top related nodes/tasks to $T_i$
- the graph nodes in $R_m(T_i)$ are directly connected to node $T_i$ and are the $m$ ones labeled with the highest weights
How to Generate the Model

• Various methods to generate edges in $G_T$ and the associated weights
  
  • Random-based (baseline): an edge for each pair, whose weights are uniform
  
  • Sequence-based: the frequency of the pairs wrt a given support threshold, by considering the relative order in the original sequences

• Association-Rule based (support): the frequency of the rule wrt a given support threshold. We do not consider the relative order in the original sequences to extract the rules

• Association-Rule based (confidence): the confidence of the rules wrt a given confidence threshold. We do not consider the relative order in the original sequences to extract the rules

$G_T = (T, E, w)$
Data Set: AOL 2006 Query Log

Original Data Set

Sample Data Set

✓ 3-months collection
✓ ~20M queries
✓ ~657K users

✓ Top-600 longest user sessions
✓ ~58K queries
✓ avg 14 queries per user/day
✓ two subsets A and B

✓ A : 500 user sessions (training)
✓ B : 100 user sessions (test)
Experimental results

- We measured **precision** (proportion of suggestions that actually occur in the 2/3 suffix) and **coverage** (proportion of tasks in the 1/3 prefix that are able to provide at least one suggestion).

- changing the weighting in each model, by tuning the corresponding parameters, modifies the coverage ...

- we thus plot **precision vs coverage** to permit the different models to be fairly compared.

\[ G_T = (T, E, w) \]

- We used the log subset \( B \) for evaluation (test query log).
- we divided each long term session in \( B \) (with synthesized tasks) into a **1/3 prefix** and **2/3 suffix**.
- the prefix is used to retrieve from \( G_T \) the sets \( R_m(T_i) \).
- for each \( T_i \) belonging to the 1/3 prefix of each session in \( S \) in \( B \), retrieve \( R_m(\{T_i \ | \ T_i \text{ in } S\}) \).
Experimental results
Recommendation Models

Top-1 suggestions in medium-size sessions

Top-1 suggestions in large-size sessions
Experimental results
Recommendation Models

Top-3 suggestions in medium-size sessions

Top-3 suggestions in large-size sessions
## Anecdotal Evidence

<table>
<thead>
<tr>
<th>Performed Task/Query</th>
<th>Recommended Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home Furnitures</td>
<td>Home Gardening</td>
</tr>
<tr>
<td>beach house</td>
<td>cottage garden</td>
</tr>
<tr>
<td>...</td>
<td>cottage garden roses</td>
</tr>
<tr>
<td>...</td>
<td>decor garden</td>
</tr>
<tr>
<td>beach house vanity</td>
<td>best garden blogs</td>
</tr>
<tr>
<td></td>
<td>vegetable garden ideas</td>
</tr>
<tr>
<td></td>
<td>open garden</td>
</tr>
<tr>
<td></td>
<td>antiques store*</td>
</tr>
<tr>
<td></td>
<td>book stores*</td>
</tr>
<tr>
<td>Kitchen Decor</td>
<td>Kitchen Supplies</td>
</tr>
<tr>
<td>dining room</td>
<td>stoves</td>
</tr>
<tr>
<td>...</td>
<td>country stoves</td>
</tr>
<tr>
<td>...</td>
<td>country cooking stoves</td>
</tr>
<tr>
<td>country music gossips*</td>
<td>country music gossips*</td>
</tr>
<tr>
<td>canyon country parkway*</td>
<td>canyon country parkway*</td>
</tr>
</tbody>
</table>

Table 1: Recommended and performed tasks.
Anecdotal Evidence

<table>
<thead>
<tr>
<th>Performed Task/Query</th>
<th>Recommended Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child Entertainment</td>
<td>Child Games</td>
</tr>
<tr>
<td></td>
<td>baby shower games</td>
</tr>
<tr>
<td></td>
<td>baby horse</td>
</tr>
<tr>
<td>fables</td>
<td></td>
</tr>
<tr>
<td>…</td>
<td>Child Clothes</td>
</tr>
<tr>
<td>…</td>
<td>baby gap</td>
</tr>
<tr>
<td>baby fables</td>
<td>Child Health</td>
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<tr>
<td></td>
<td>baby emotional disease</td>
</tr>
<tr>
<td></td>
<td>cuddling couch picture*</td>
</tr>
<tr>
<td></td>
<td>husband became parents boy*</td>
</tr>
</tbody>
</table>

| University          | University Sports                                      |
|                     | university sports                                      |
| university          | university basketball                                  |
| …                   |                                                       |
| …                   | University Information                                 |
| duke university      | university tuition                                     |

Table 2: Recommended and surprising tasks.
Questions?