The TROOTH Recommendation System

Keno Albrecht
Roger Wattenhofer
Motivation

Keno

?!?

Keno

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Motivation

• Taking advice of friends makes “vacation” more pleasant.

• In general: Listening to somebody with more experiences is a great idea.

• But listening to strangers also bears some problems: beware of liars!
Recommendation of Books

Customers who bought this also bought

Eldest (Inheritance, Book 2) by Christopher Paolini
Harry Potter Paperback Boxed Set (Books 1-5) by J.K. Rowling
Harry Potter and the Goblet of Fire (Book 4) by J.K. Rowling
Harry Potter and the Prisoner of Azkaban (Book 3) by J.K. Rowling
The Opal Deception (Artemis Fowl, Book 4) by Eoin Colfer

Explore similar items: in Books, in DVD
Reputation of Users

Seller information
the_antiquarium (136 ✾) me

Feedback Score: 136
Positive Feedback: 100%
Member since Apr-12-00 in United States

Read feedback comments
Add to Favorite Sellers
Ask seller a question
View seller’s other items
# Rating of Software

<table>
<thead>
<tr>
<th>Editor’s rating</th>
<th>Average user rating</th>
<th>Downloads</th>
<th>Publisher</th>
<th>Date added</th>
</tr>
</thead>
<tbody>
<tr>
<td>★★★★☆</td>
<td>★★★★★ (96 votes) Rate it!</td>
<td>426,714</td>
<td>Search for Extraterrestrial Intelligence Home</td>
<td>January 5, 2006</td>
</tr>
</tbody>
</table>
Popularity of Topics & Web Pages

tagging, blogging, blogs, books, business, cms, comics, computer, development, diy, download, education, film, finance, firefox, gtd, hardware, history, howto, html, humor, im, links, linux, literature, mac, maps, math, media, mp3, music, podcast, politics, productivity, programming, python, rail, tip, software, tech, technology, tips, tool, tool, design, webdev, wiki, windows, wordpress, work, writing.
Legitimacy of Emails

1. Cloudmark DESKTOP checks an email.
2. Cloudmark SERVICE verifies the email and marks it as legitimate.
3. Email is received in the inbox.
4. User blocks or unblocks email.

Cloudmark Community decision.

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Recommendation Systems

Learn from people’s experiences.
Different Flavors of Voting

- What? Users & “items”
- How? Implicit & explicit voting
- Why? Recommendation, rating, trust
- Where? Server-side vs. client-side data
TROOTH

• Implicitly create trust values for users by explicitly rating items.
• Store few data on servers; evaluate items on clients.
• Derive decision about items by considering ratings of most trusted users.
Overview

• Items are either *good*, *bad*, or *unknown*.
• Users classify items to be *good* or *bad*.
Simple Evaluation

• If a majority of all users votes good (bad), the item is good (bad), otherwise unknown.

• More general:

\[
eval(Votes) = \begin{cases} 
  \text{good} & \text{if } h_g < \rho_g \leq 1, \\
  \text{bad} & \text{if } 0 \leq \rho_g < h_b, \\
  \text{unknown} & \text{if } h_b \leq \rho_g \leq h_g.
\end{cases}
\]
Weighted Evaluation

• Consider users with different trust values, separating them into good and bad users.
• Weight votes with trust values before evaluating item.

• Additive Increase, Multiple Decrease:

\[
\forall u \in U^i : \quad t'_u := \begin{cases} 
  t_u + inc & \text{if } v_u^i = e_i, \\
  t_u \cdot dec & \text{if } v_u^i \neq e_i.
\end{cases}
\]
TROOTH - Assumptions

• Evaluation of items is subjective.
• Users are not good/bad but just have different opinions.
• Implicitly separate users into groups of similar interests.
• Trust those people most who are in the same group.
TROOTH - Organization

- Users have unique IDs organized as ring.
- Store (item, user, vote)-tuples server-side.
- Calculate user specific trust values and final evaluation client-side.
TROOTH – Voting & Evaluation

• **Voting**: When a user votes for an item, she sends her opinion (*good* or *bad*) to the TROOTH server and locally adapts the trust values for other users who voted for the same item.

• **Evaluation**: To classify an item, *good* and *bad* votes from the server are weighted with the client-side stored trust values.
TROOTH - Voting

<table>
<thead>
<tr>
<th>Item</th>
<th>User</th>
<th>Vote</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>good</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>good</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>bad</td>
</tr>
<tr>
<td>1</td>
<td>83</td>
<td>good</td>
</tr>
<tr>
<td>1</td>
<td>114</td>
<td>bad</td>
</tr>
<tr>
<td>1</td>
<td>189</td>
<td>good</td>
</tr>
<tr>
<td>1</td>
<td>242</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Trooth Server

vote (1, 0, bad)
(22, bad)
(114, bad)
(1, good)
(4, good)
(242, good)

Trooth Client “0”

<table>
<thead>
<tr>
<th>User</th>
<th>Trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>4</td>
<td>0.5</td>
</tr>
<tr>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>114</td>
<td>3.7</td>
</tr>
<tr>
<td>242</td>
<td>2.2</td>
</tr>
</tbody>
</table>

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TROOTH - Evaluation

<table>
<thead>
<tr>
<th>Item</th>
<th>User</th>
<th>Vote</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>bad</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>83</td>
<td>bad</td>
</tr>
<tr>
<td>2</td>
<td>114</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>129</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>189</td>
<td>bad</td>
</tr>
<tr>
<td>2</td>
<td>242</td>
<td>bad</td>
</tr>
</tbody>
</table>

Trooth Client “0”

<table>
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<tr>
<th>User</th>
<th>Trust</th>
<th>Vote</th>
</tr>
</thead>
<tbody>
<tr>
<td>189</td>
<td>1</td>
<td>bad</td>
</tr>
<tr>
<td>242</td>
<td>2.2</td>
<td>bad</td>
</tr>
<tr>
<td>22</td>
<td>13</td>
<td>good</td>
</tr>
<tr>
<td>114</td>
<td>3.7</td>
<td>good</td>
</tr>
</tbody>
</table>

\[
eval(2, 0)
\]

\[
\begin{align*}
1 + 2.2 &= 3.2 \text{ bad} \\
13 + 3.7 &= 16.7 \text{ good}
\end{align*}
\]

\[
\Rightarrow \frac{16.7}{19.9} = 0.84 > h_g \Rightarrow \text{good}
\]
TROOTH - Discussion

• Configurable on client-side
  – Voting for same type of items

• Number of “known” users is bounded
  – Voting for same type of items

• High burdens for malicious users
  – Voting for same type of items as victim
  – Impact only in direct neighborhood
  – Play by the rules for a long time

• Spamato:
  – SAAS uses challenge/response to assign IDs
  – Votes are signed
Conclusion & Future Work

• TROOTH is a robust, partially decentralized, collaborative, and personalized recommendation system.

• Server-side data could be stored in P2P system

• System is open-source and available for download as part of the Spamato spam filter system: http://www.spamato.net.
Questions?

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