May 8th, 10:30 AM - 12:00 PM

Recommender Systems For Computer Tailored Health Communications

Rajani S. Sadasivam
University of Massachusetts Medical School

Et al.

Let us know how access to this document benefits you.
Follow this and additional works at: https://escholarship.umassmed.edu/cts_retreat

Part of the Health Information Technology Commons, Health Services Research Commons, Public Health Education and Promotion Commons, Substance Abuse and Addiction Commons, and the Translational Medical Research Commons

Repository Citation

Creative Commons License
This work is licensed under a Creative Commons Attribution-Noncommercial-Share Alike 3.0 License. This material is brought to you by eScholarship@UMMS. It has been accepted for inclusion in UMass Center for Clinical and Translational Science Research Retreat by an authorized administrator of eScholarship@UMMS. For more information, please contact Lisa.Palmer@umassmed.edu.
Recommender Systems For Computer Tailored Health Communications

Rajani Sadasivam\textsuperscript{1}, Benjamin M. Marlin\textsuperscript{2}, James Allan\textsuperscript{1} and Thomas Houston\textsuperscript{2}

\textsuperscript{1}: UMass Medical School, Dept. of Quantitative Health Science
\textsuperscript{2}: UMass Amherst, School of Computer Science
Computer Tailored Health Communication (CTHC)

- Personalizing health communications to individual patients using computer programs

- Collect baseline subject “profiles” consisting of demographic and domain specific information

**Subject Profile**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20-29</td>
</tr>
<tr>
<td>Readiness to Quit</td>
<td>High</td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>2</td>
</tr>
</tbody>
</table>

**Subject Profile**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>60-69</td>
</tr>
<tr>
<td>Readiness to Quit</td>
<td>Medium</td>
</tr>
<tr>
<td>Cigarettes per day</td>
<td>6</td>
</tr>
</tbody>
</table>
Example CTHC Intervention

Our Advice
Useful hints from ex-smokers and experts! Check back often for updates.

A Message from Decide2Quit
Take two deep breaths and call me in the morning
If you are having trouble with stress, your healthcare provider is there to help. They are a valuable resource and have options that can help you stay smoke-free while dealing with stress.

A Message from your peer
Stop, think, learn: A Message from Your Online Community
Wendall, a 49-year-old, found that when he slipped and smoked it was helpful to think about what made you pick up and then get back on track by fixing that problem and starting over again. If you happen to slip and smoke, remember that this is a normal part of the quitting process. Reflect on what made you smoke and prepare for how you can handle the situation without smoking.

My Mail
Communicate with your advisor! Use the boxes below to type your message. Don’t forget to check your inbox to reply to received messages!

Subject
(You are limited to only 100 characters including spaces.)

Message
(You are limited to only 1500 characters including spaces. Red background indicates you have exceeded the limit.)

SEND MESSAGE

Recent Mail from Advisor
Subject: test
Message: test

Your Online Community
Decide2Quit partnered with Become An Ex - an online community of people helping others quit! Here are a few recent posts. Use the link below to read more.

- Setting up profile in preparation
- I am 50 yrs old and soooo sick of being a smoker. When I wake in the morning I will begin my 3 days of tracking cigarettes. In the past, I just quit. I like this programs 3 days of...
- New Here
- New here today and thinking about quitting

View All >>
Behavioral experts write rule-based systems to select messages by matching subject profiles to message content.

- Gender = F
- Age < 30
- Ready to Quit
- Not Ready to Quit

Current CTHC are **Effective**, but can they be more effective?
Limitations of CTHC Systems

- The rules may fail to capture concepts that are important and relevant to individual subjects or patient sub-populations.

- There is no mechanism for adapting the rule to better serve the users over time.

- Cannot easily develop high-tailoring interventions
Explicit or implicit user feedback from a large community of users has been used successfully to personalize product recommendations in internet-based systems.
Collaborative filtering systems work by identifying users with similar preferences. The assumption is that if a user like you liked an item, you’ll like it too.
Deploying collaborative filtering recommender systems in the CTHC case involves several challenges:

- Unclear what aspect of messages users should be rating (preference, relevance, influence, emotional impact, ...)
- Small data set sizes when system first starts operating
- Limited interaction with user (one message rating per day)

We are exploring several solutions to these issues:

- Pre-pilot study to assess four possible questions
- Development of a hybrid system that uses explicit ratings, implicit data from website visits, user profile information and message content information.
Pre-Pilot Data Collection

- 100 subjects each supplied ratings for four aspects of five randomly selected messages from a pool of 50 messages.
- We had subjects rate the following four message aspects:
  - Question 1: This message influences me to quit smoking
  - Question 2: This message affected me emotionally
  - Question 3: This message was relevant to my everyday life
  - Question 4: I would like more messages like this one
- Analyzed the resulting data for quantitative difference between questions as well as ability to predict ratings.
Initial Results: Marginal Rating Distributions

Question 1 Rating Distribution

Question 2 Rating Distribution

Question 3 Rating Distribution

Question 4 Rating Distribution
Initial Results: Joint Rating Distributions
Initial Results: Variance vs Mean by Message

Mean Rating vs Rating Variance (Q1)
Initial Results: Rating Prediction

We assess rating prediction accuracy by holding out some rating values, using a model to predict their values and then computing the average prediction error. The model can base predictions on different information sources.

<table>
<thead>
<tr>
<th>Question</th>
<th>B</th>
<th>BU</th>
<th>BM</th>
<th>BF</th>
<th>BUM</th>
<th>BUF</th>
<th>BMF</th>
<th>BUMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Influence</td>
<td>0.8783</td>
<td>0.8663</td>
<td>0.8783</td>
<td>0.7672</td>
<td>0.8667</td>
<td>0.7612</td>
<td>0.7734</td>
<td>0.7612</td>
</tr>
<tr>
<td>Q2: Emotion</td>
<td>0.8929</td>
<td>0.8746</td>
<td>0.8929</td>
<td>0.7893</td>
<td>0.8747</td>
<td>0.7547</td>
<td>0.7766</td>
<td>0.7538</td>
</tr>
<tr>
<td>Q3: Relevance</td>
<td>0.7648</td>
<td>0.7649</td>
<td>0.7648</td>
<td>0.7655</td>
<td>0.7637</td>
<td>0.7556</td>
<td>0.7656</td>
<td>0.7510</td>
</tr>
<tr>
<td>Q4: Preference</td>
<td>0.8844</td>
<td>0.8915</td>
<td>0.8860</td>
<td>0.8327</td>
<td>0.8913</td>
<td>0.8551</td>
<td>0.8350</td>
<td>0.8506</td>
</tr>
</tbody>
</table>

B: Bias term, U: User profile information, M: Message content information, F: Latent factors
Conclusions

- Rating data from different questions are highly correlated
- The data indicate that there is a possibility for personalization
- Initial predictive results are positive
Next Steps

- Launched an expanded rating data collection effort - 20 ratings per user from 700 users

- Estimate a more detailed model which will be deployed and tested as part of a recommendation system within Decide2Quit.org.

- Evaluate the system in terms of the ratings users supply for the messages the system selects for them.
Induce the adoption of healthy behaviors by sending personalized health communication messages to individual subjects.
Computer Tailored Health Communication (CTHC)

**CTHC Applications:** There are many possible applications of CTHC systems.

- Healthy Eating
- Medication Compliance
- Smoking Cessation
Computer Tailored Health Communication (CTHC)

Example Messages:

**Breathing gets easier:** Everyone knows that smoking is bad for you. However, after you quit you may notice that you can breathe better and that you have more energy. Quitting also lowers your risk of getting cancer from smoking.

**Why quitting makes you look younger:** Smoking ages. It ages women's skin more than men's. After you quit smoking, your skin will begin to look younger. Your complexion will be a healthier color within weeks.

**Dying from Smoking:** Did you know? Each year 440,000 U.S. adults die from smoking. This means that smoking plays a part in 1 out of every 5 deaths.