Expanding Trusted Neighborhood for Effective Recommendation in Virtual Reality Environments

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Outline

• Introduction
  – Background
  – Motivation
• Research progress
• Future work
Background

- Personalized Recommendation in VR
  - Recommend useful information
    - Information overload: large amount of info => difficult to manage: selection, filtering, ...
  - Improve the interactions
  - 2D versus 3D
    - Different recommendation objects
      - 2D: books, news, article, movie, etc.
      - 3D: 3D virtual objects
Background

• Recommender System (RS)
  – Collaborative Filtering
    • Find a group of like-minded users (neighborhood) based on similarity
    • Aggregate neighbors’ opinions to do recommendations
  – Issues
    • Suffers from data-sparsity, cold-start problem
    • Performance is not good in accuracy and coverage
Background

• Trust aware RSs (TARSs)
  – Social relationship is easily available
    • Friendship (Konstas et al. 2009), membership (Yuan et al. 2009), trust list (Massa et al. 2007)
  – Trust is good for
    • Word-of-mouth marketing => more trustable systems
    • Transparent recommendation => more user control
    • Alleviate CF’s suffering
      – Users without ratings but involved in trust network => cold start users
      – Trust propagation => data sparsity
      – Better performance (accuracy and coverage)
      – More robust (assist copy, pushing/nuking attacks)
Motivation

• Problems of existing TARSs
  – Cold-start problem
    • Users may only specify few or none trusted peers
  – Bottleneck: how to find out more neighbors?
    • Mechanism for 2D & 3D environments

• How far are we in TARSs? (Shi, 2011)
  – By comparing state-of-art trust models with naïve ones
    • Coverage is better
    • Accuracy is better in a sense, sometimes worse
  – Trust is not well-exploited yet
Current progress

- A computational model for trusted neighborhood expansion
The computational model

– Confidence

\[ c(w_1, w_{-1}) = \int_0^1 \left| \frac{x^{w_1} (1-x)^{w_{-1}}}{\int_0^1 x^{w_1} (1-x)^{w_{-1}} dx} - 1 \right| dx \]

– Similarity

\[ w_{u,v} = \frac{\sum_{i \in I_{u,v}} (r_{u,i} - \bar{r}_u)(r_{v,i} - \bar{r}_v)}{\sqrt{\sum_{i \in I_{u,v}} (r_{u,i} - \bar{r}_u)^2} \sqrt{\sum_{i \in I_{u,v}} (r_{v,i} - \bar{r}_v)^2}} \]
The computational model

**Performance of Approaches for Uniform, Ideal, Sparse and Sufficient Information Scenarios**

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPGP</td>
<td>0.49</td>
</tr>
<tr>
<td>MPG</td>
<td>0.62</td>
</tr>
<tr>
<td>EPG</td>
<td>0.63</td>
</tr>
<tr>
<td>EPG+</td>
<td>0.83</td>
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<table>
<thead>
<tr>
<th>Views</th>
<th>CF</th>
<th>MT1</th>
<th>MT2</th>
<th>MT3</th>
<th>TrustAll</th>
<th>ENMT</th>
<th>ETMT</th>
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</thead>
<tbody>
<tr>
<td>All</td>
<td>0.876</td>
<td>0.845</td>
<td>0.852</td>
<td>0.832</td>
<td>0.821</td>
<td>0.711</td>
<td>0.646</td>
</tr>
<tr>
<td></td>
<td>51.24%</td>
<td>26.34%</td>
<td>57.64%</td>
<td>71.68%</td>
<td>88.20%</td>
<td>77.87%</td>
<td>67.37%</td>
</tr>
<tr>
<td>Cold Users</td>
<td>1.032</td>
<td>0.756</td>
<td>0.916</td>
<td>0.890</td>
<td>0.857</td>
<td>0.672</td>
<td>0.621</td>
</tr>
<tr>
<td></td>
<td>3.22%</td>
<td>6.57%</td>
<td>22.06%</td>
<td>41.73%</td>
<td>92.92%</td>
<td>47.20%</td>
<td>44.50%</td>
</tr>
<tr>
<td>Heavy Users</td>
<td>0.873</td>
<td>0.847</td>
<td>0.848</td>
<td>0.827</td>
<td>0.818</td>
<td>0.716</td>
<td>0.649</td>
</tr>
<tr>
<td></td>
<td>57.41%</td>
<td>29.28%</td>
<td>62.40%</td>
<td>75.36%</td>
<td>87.50%</td>
<td>80.87%</td>
<td>69.26%</td>
</tr>
</tbody>
</table>

**Table 3. Performance on Epinions**

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPGP</td>
<td>0.50</td>
</tr>
<tr>
<td>MPG</td>
<td>0.63</td>
</tr>
<tr>
<td>EPG</td>
<td>0.644±0.005</td>
</tr>
<tr>
<td>EPG+</td>
<td>0.827±0.017</td>
</tr>
</tbody>
</table>
Future work

• E-commerce in VR
  – Limitless time and space
  – Avatar, real world-like, real-time interactions
    • Cognitive trust is needed

• Future work: A cognitive model for virtual reality environments
Cognitive Trust Theory

• Trust from computational perspective
  – Emphases only on ability/competency (O’Donovan 2005)
  – Trust approaches in 2D are not suitable for VR

• Trust from cognitive perspective
  – Trust is a complex cognitive procedure
    • May be affected by internal, external, self factors
    • Internal factors: competency, willingness, un-harmfulness
    • External factors: risk, opportunity
    • Self factors: confidence
**Trust Cognitive Models**

- ...

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[Logo: Nanyang Technological University]

[Logo: Institute for Media Innovation]
Issues with cognitive trust models

• General cognitive trust models
  – Possible, but not easy to implement, not useful
    • FCM (Venanzi et al., 2011), BDI (Hubner et al, 2009)
    • Incomplete information to model all factors
  – More concrete models are needed!
Our proposal

• Concrete cognitive trust model
  – Incorporating cognitive factors
    • Competency, Willingness, Risk, Uncertainty
  – Model these factors and inspect their impacts
  – Formalize our cognitive model
  – Evaluations
    • Build up virtual reality environment
    • Volunteers to participate in
Reference


Q & A

Thank you!

Any comments?