Bartering Books to Beers:
a Recommender System for Exchange Platforms

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What is barter?

Def. Barter is a system of exchange where goods or services are directly exchanged for other goods or services without using a medium of exchange.

First written mention of barter around 100'000 B.C.
It’s hard to compete with money

Need of a double coincidence

No common measure of value
No common measure of value

Solution: Online bartering platforms are specialized

- RateBeer: 20’000 daily visitors
- BookMooch: 250’000 registered users
- GamesWap: 18’000 registered users
Double coincidence of wants

Typical setting

Potential transactions

Tom
Chimay

Tom’s wish list
Heineken Duvel

Jack Heineken

Jane’s wish list
Duvel

Rick’s wish list
Brewdog
Double coincidence of wants

Solution: Matching?

85K active users

2M items
Double coincidence of wants

Solution: Matching?

85K active users
85K active users

2M items

only 0.2% of users have at least one swapping partner
Predictor - Matrix Factorization

\[ \hat{y}_{u_j,u_l,i_k} = p_{u_j}^T q_{i_k} \]

Unidirectional interest

Positive signals: wish-list + past transactions
Predictor - Bidirectionality

\[
\hat{y}_{u_j, u_l, i_m, u_i, i_k} = f(\hat{y}_{u_j u_l i_m}, \hat{y}_{u_l u_j i_k}) \\
= \frac{1}{2}(\hat{y}_{u_j u_l i_m} + \hat{y}_{u_l u_j i_k})
\]

Make recommendations for one user but take into account reciprocal interest.
Predictor - Social Bias

\[ \hat{y}_{u_j, u_l, i_k} = p_{u_j}^T q_{i_k} + \langle s_{u_j u_l} \rangle \]

Some pairs of users perform recurring trades.

\[ S \in \mathbb{R}^{|U| \times |U|} \] models a bias from one user to another.
Predictor - Temporal Dynamics

\[ \hat{y}_{u_j, u_l, i_k} = p_{u_j}^T q_{i_k} + s_{u_l} u_l + \tau_{u_j} \delta(t; t_{u_j}) + \tau_{i_k} \delta(t; t_{i_k}) \]

Discard users/items that have been inactive for a long period
Experiment

Bayesian Personalized Ranking (BPR)
see Rendle 2009

Maximizes AUC with positive examples only
## Results

<table>
<thead>
<tr>
<th></th>
<th>MF</th>
<th>MF+B</th>
<th>MF+B+S</th>
<th>MF+B+T</th>
<th>MF+ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bookmooch</td>
<td>0.758</td>
<td>0.798</td>
<td>0.849</td>
<td>0.938</td>
<td><strong>0.958</strong></td>
</tr>
<tr>
<td>Gameswap</td>
<td>0.790</td>
<td>0.842</td>
<td>0.863</td>
<td>0.890</td>
<td><strong>0.903</strong></td>
</tr>
<tr>
<td>Ratebeer</td>
<td>0.824</td>
<td>0.892</td>
<td>0.962</td>
<td>0.969</td>
<td><strong>0.983</strong></td>
</tr>
</tbody>
</table>

**AUC**

- **B**: Bidirectionality
- **S**: Social bias
- **T**: Temporal dynamics
Contribution & Conclusion

- Reciprocal interest model for bartering recommendation.
- 3 new datasets extracted from online bartering platforms.
- Improving recommendations with social and temporal information.