Recommender Systems: User Experience and System Issues

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About me …

Professor of Computer Science & Engineering, Univ. of Minnesota
Ph.D. (1993) from U.C. Berkeley
◆ GUI toolkit architecture
Teaching Interests: HCI, GUI Tools
Research Interests: General HCI, and …
◆ Collaborative Information Filtering
◆ Multimedia Authoring and Systems
◆ Visualization and Information Management
◆ Medical/Health Applications and their Delivery
A Quick Introduction

What are recommender systems?
Tools to help identify worthwhile stuff
- Filtering interfaces
  - E-mail filters, clipping services
- Recommendation interfaces
  - Suggestion lists, “top-n,” offers and promotions
- Prediction interfaces
  - Evaluate candidates, predicted ratings

Scope of Recommenders

- Purely Editorial Recommenders
- Content Filtering Recommenders
- Collaborative Filtering Recommenders
- Hybrid Recommenders
Wide Range of Algorithms

Simple Keyword Vector Matches

Pure Nearest-Neighbor Collaborative Filtering

Machine Learning on Content or Ratings

Classic Collaborative Filtering

- MovieLens*
- K-nearest neighbor algorithm
- Model-free, memory-based implementation
- Intuitive application, supports typical interfaces

*Note – newest releases use updated architecture/algorithm
Request Recommendations

Identify Neighbors

C.F. Engine

Ratings
Correlations

find good … Neighborhood
Select Items; Predict Ratings

C.F. Engine

Predictions
Recommendations

Ratings
Correlations

Neighborhood

Understanding the Computation

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Welcome to the new MovieLens!

This is a new interface for MovieLens. Feel free to try all the new features and let us know what you think about it.

Have questions? Read the new MovieLens FAQ!

Shortcuts
- Your Ratings
- Your Wishlist
- Newest additions
- New Drama
- New DVDs
- New Movies
- How to create your own shortcuts

Search Titles

Search Genres
- Comedy
- Drama
- Use selected buddies!
- Select Genres

Select Buddies
- konstan@cs.umn.edu

New Movies for You
- Man Without a Face (The) (Les Visiteurs) (1992)
- Cowboy Bebop: The Movie (Cowboy Bebop) (2001)
- Piano (1993)
- Corner Office (1999)
- Spider (2002)
- Wings 2 (Lu-Lu #2) (Hi-Fly United) (2002)
- Board B Like Beckham (2002)
- House of 1000 Corals (1978)
- Night of the Living Dead (1979)
- Better Luck Tomorrow (2002)

New DVDs for You
- Spirited Away (Sen to Chihiro no Kamikakushi) (2002)
- Rabbit-Proof Fence (2002)
- Europe Europe (Hellerange Saloon) (1990)
- Salam Bombay! (1988)
- Day the Earth Caught Fire, The (1953)
- Boat, The (Das Boot) (1991)
- Of Hox and Men (1992)
- Reservoir Dogs (1992)
- Ram (1998)
- Day for Night (La Nuit Americaine) (1973)

For more information, visit the MovieLens website at movielens.umn.edu.
### Predictions for you

<table>
<thead>
<tr>
<th>Predictions</th>
<th>Your Ratings</th>
<th>Movie Information</th>
<th>Wish List</th>
</tr>
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<tbody>
<tr>
<td>Ghost World (2000)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
</tr>
<tr>
<td>Not seen</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Annie (2001)</td>
<td>Comedy, Romance</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<td>Not seen</td>
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<tr>
<td>Monsters, Inc. (2001)</td>
<td>Animation, Children, Comedy</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<tr>
<td>Not seen</td>
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<td>Almost Famous (2000)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<td>Not seen</td>
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<tr>
<td>American Beauty (1999)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<tr>
<td>Not seen</td>
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<tr>
<td>You Can Count on Me (2000)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<td>Not seen</td>
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</tr>
<tr>
<td>Life is Beautiful (La Vita è bella) (1997)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<tr>
<td>Not seen</td>
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<tr>
<td>About a Boy (2002)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
</tr>
<tr>
<td>Not seen</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Being John Malkovich (1999)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
<td>mb</td>
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<tr>
<td>Not seen</td>
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<tr>
<td>And Your Mother Too (Y Tu Mamá)</td>
<td>Comedy, Drama</td>
<td>DVD, VHS, info</td>
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### Ratings and Information

  - Comedy, Drama
  - DVD, VHS, info
  - mb
- **Annie (2001)**
  - Comedy, Romance
  - DVD, VHS, info
  - mb
- **Monsters, Inc. (2001)**
  - Animation, Children, Comedy
  - DVD, VHS, info
  - mb
  - Comedy, Drama
  - DVD, VHS, info
  - mb
- **American Beauty (1999)**
  - Comedy, Drama
  - DVD, VHS, info
  - mb
  - Comedy, Drama
  - DVD, VHS, info
  - mb
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  - mb
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  - mb
- **And Your Mother Too (Y Tu Mamá)**
  - Comedy, Drama
  - DVD, VHS, info
  - mb
Introduction
• Algorithms
• Influencing Users
• Current Research
Collaborative Filtering Algorithms

- Non-Personalized Summary Statistics
- K-Nearest Neighbor
  - user-user
  - item-item
- Dimensionality Reduction
- Content + Collaborative Filtering
- Graph Techniques
- Clustering
- Classifier Learning

Item-Item Collaborative Filtering

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Item-Item Collaborative Filtering

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Item-Item Collaborative Filtering

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Item Item Matrix
Formulation

Target item

5 closest neighbors

Raw scores for prediction generation
Approximation based on linear regression

Used for similarity computation

\[ s_{ij} \]

\[ \text{Used for similarity computation} \]

\[ \text{Raw scores for prediction generation} \]

\[ \text{Approximation based on linear regression} \]
Item-Item Discussion

Good quality, in sparse situations
Promising for incremental model building
- Small quality degradation
- Big performance gain

Collaborative Filtering Algorithms

- Non-Personalized Summary Statistics
- K-Nearest Neighbor
- Dimensionality Reduction
  - Singular Value Decomposition
  - Factor Analysis
- Content + Collaborative Filtering
- Graph Techniques
- Clustering
- Classifier Learning
Latent Semantic Indexing
- Used by the IR community
- Worked well with the vector space model
- Used Singular Value Decomposition (SVD)

Main Idea
- Term-document matching in feature space
- Captures latent association
- Reduced space is less-noisy

---

The reconstructed matrix $R_k = U_k S_k V_k'$ is the closest rank-$k$ matrix to the original matrix $R$. 
**SVD for Collaborative Filtering**

1. Low dimensional representation
   
   $O(m+n)$ storage requirement

2. Direct Prediction

---

**Singular Value Decomposition**

Reduce dimensionality of problem

- Results in small, fast model
- Richer Neighbor Network
- Incremental Update
- Folding in
- Model Update
Collaborative Filtering Algorithms

Non-Personalized Summary Statistics
K-Nearest Neighbor
Dimensionality Reduction
Content + Collaborative Filtering
Graph Techniques
  • Horting: Navigate Similarity Graph
Clustering
Classifier Learning
  • Rule-Induction Learning
  • Bayesian Belief Networks

Talk Roadmap

✓ Introduction
✓ Algorithms
  • Influencing Users
    Cosley et al, CHI 2003
  • Current Research
Does Seeing Predictions Affect User Ratings?

RERATE: Ask 212 users to rate 40 movies

- 10 with no shown prediction
- 30 with shown predictions (random order):
  10 accurate, 10 up a star, 10 down a star

Compare ratings to accurate predictions

- “Prediction” is user’s original rating
- Hypothesis: users rate in the direction of the shown prediction

The Study

Please rate the movies listed below. These ratings will not be saved to your profile.

<table>
<thead>
<tr>
<th>PREDICTED RATING</th>
<th>YOUR RATING</th>
<th>GENRE</th>
<th>TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>★★★★</td>
<td>don’t know</td>
<td>Action, Adventure, Horror</td>
<td>Army of Darkness (1992)</td>
</tr>
<tr>
<td>★★★★</td>
<td>don’t know</td>
<td>Action, Adventure, Science-Fi</td>
<td>Bill &amp; Ted’s Bogus Journey (1989)</td>
</tr>
<tr>
<td>★★★★</td>
<td>don’t know</td>
<td>Drama</td>
<td>Green Kana (1941)</td>
</tr>
<tr>
<td>★★★★</td>
<td>don’t know</td>
<td>Action, Thriller</td>
<td>Die Hard 2 (1990)</td>
</tr>
<tr>
<td>★★★★</td>
<td>don’t know</td>
<td>Horror</td>
<td>Forrest, The (1977)</td>
</tr>
<tr>
<td>★★★★</td>
<td>★★</td>
<td>Crime, Drama</td>
<td>Heist (2001)</td>
</tr>
<tr>
<td>★★★★</td>
<td>★</td>
<td>Action, Adventure</td>
<td>Inception’s Tale, A (2001)</td>
</tr>
<tr>
<td>★★★★</td>
<td>★★</td>
<td>Action, Adventure</td>
<td>Ninotchka (1939)</td>
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</tbody>
</table>
**Seeing Matters**

![Graph showing the relationship between prediction shown and ratings.](image1)

- **Prediction shown?**
  - Not shown
  - Showed

**Accuracy Matters**

![Graph showing the relationship between prediction manipulation and ratings.](image2)

- **Prediction manipulation**
  - Down
  - Accurate
  - Up

- **Ratings %**
  - Below
  - At
  - Above

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Domino Effects?

The power to manipulate?

Rating, Unrated, Doesn't Matter

Recap of RERATE effects:
- Showing prediction changed 8% of ratings
- Altering shown prediction changed 12%

Similar experiment, UNRATED movies
- 137 experimental users, 1599 ratings
- Showing prediction changed 8% of ratings
- Altering shown prediction changed 14%
But Users Notice!

Users are often insensitive…
UNRATED part 2: satisfaction survey
- Control group: only accurate predictions
- Experimental predictions accurate, useful?
- ML predictions overall accurate, useful?
Manipulated preds less well liked
Surprise: 24 bad = MovieLens worse!

Talk Roadmap

- Introduction
- Algorithms
- Influencing Users
- Current Research
Current Research Themes

• Beyond Accuracy: Metrics and Algorithms
• New User “Orientation”
• Influence and Shilling
• Eliciting Participation in On-Line Communities
• Reinventing Conversation
• Beyond Entertainment: Recommending Research Papers

Beyond Accuracy

What affects user satisfaction?

◆ Novelty
◆ Confirmability
◆ Diversity
◆ Value

How to measure?

Custom tuned algorithms

_Herlocker et al., ACM TOIS 1/2004_
New User “Orientation”

How do we start new users?

- Interface (McNee et al., UM’2003)
  - System-initiated
  - User-initiated
  - Mixed
- Content (Rashid et al., IUI 2002)
  - Popular
  - Entropy
  - Mix
  - Predict Seen

Influence and Shilling

Influence (Rashid et al., SIAM Data Mining 2005)
- Who has it?
- How much?
- Measurements?

Shilling (Lam and Riedl, WWW 2004)
- Attacks
- Defenses
- Algorithm Differences
Eliciting Participation: An Initial Study

A study of participation in discussions with two factors controlled:
- Similarity of tastes
- Awareness of own uniqueness

Results:
- Dissimilarity increased contribution
- Awareness of own uniqueness increased contribution
- Active discussants were not highly-active raters
- Participants rated more than a control group

Motivational Follow-Up

Class projects at CMU used an e-mail campaign to elicit ratings to discover:
- Making users aware of their uniqueness increased rating
- Giving users specific, achievable goals increased rating
- But...
  - Reminding users of their self-benefit or benefit to others actually decreased the number of ratings!
Other Projects

Self-Maintaining Communities
◆ What happens when you let the masses maintain the database?

Social Preference
◆ Using economic models to study user behavior

Reinventing Conversation

Goal: More comprehensive engagement
◆ Full-factorial design around entities, people, comments/discussion entries
Welcome konstan@cs.unm.edu (Log Out)
You've rated 59 movies.
You're the 16th visitor in the past hour.

Welcome!
How are your recommendations?

MovieLens Team Member

Jun 13, 2005 12:43:04 PM

I'm curious to hear users' thoughts about our movie recommender system. Does MovieLens help you find interesting, good movies to watch? How much do you trust MovieLens predictions? Also, how does MovieLens compare to other, commercial ventures out there (e.g. Netflix, Yahoo Movies, Amazon) in terms of the quality of recommendations you receive?

Max

airwatcher

Re: How are your recommendations?

Jun 13, 2005 1:15:39 PM

Hi Max:

My wife and I have rated 263 movies so far. I tell people that it is dead-on accurate about 85% of the time. The remaining 14% (ML isn't quite perfect) are rarely more than 1/2 star off. In other words, ML is amazingly accurate. We love and use ML frequently.

Larry

Deadman

Re: How are your recommendations?

Jun 13, 2005 4:02:04 PM

I'm very happy with MovieLens :D

Been using it for 3-4 years now (I think). The recommendations are usually right on the money or maybe half a star off.

1632 movies rated so far and counting :P

Keep up the good work :)
Recommending Research Papers

Using Citation Webs
• For a full paper, we can recommend citations
  ◆ A paper “rates” the papers it cites
  ◆ Every paper has ratings in the system
• Other citation web mappings are possible, but many are have problems

Results Thus Far

Off-line studies showed promise
On-line study showed different algorithms met different needs
  ◆ General positive attitude from users
  ◆ Typically one or two useful recommendations in a set of five
    ➔ That’s enough to be useful
Specific value for hybrid content/collab algorithms
Current work: ACM Digital Library
TechLens ACM DL Demo

Please enter an author’s name

Please give us the name of an author whose work you are familiar with, and enter it in the form it is usually written, for a paper. Looking up all the papers a person has published from our database may take a little while. Please be patient.

Author name: georg lassen
Submit Name

Maximal concurrency by locking
Olof Lausen, Elias Bodal-Stoimen, Peter Widmayer
20 pages, 2000-01-01

T-knowledge-driven computation of product recommendations
Car-Michael Daspler, Georg Lausen, Lars Schmidt-Thieme
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F logic: a higher-order language for reasoning about objects, inheritance, and scheme
Michael Olyer, Georg Lausen
20 pages, 2000-01-01

Parallelizing Database update by generalized pivoting
Jurgen Selg, Georg Lausen
20 pages, 2000-01-01

Referential actions as logical rules
20 pages, 2000-01-01
Recommender Systems

CSCW 2000
Directions

Application-Focused Research

- Awareness service
- Paper and proposal-writing support
- Find people (reviewers/experts)
- Overview of a field
Conclusions

From humble origins …

◆ Substantial algorithmic research
◆ HCI and online community research
◆ Important applications
◆ Commercial deployment

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Recommender Systems:
User Experience and System Issues

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