

## *Recommender Systems: User Experience and System Issues*

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University of Minnesota

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<http://www.grouplens.org>



UNIVERSITY OF MINNESOTA

## *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



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## *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



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## *Scope of Recommenders*

- Purely Editorial Recommenders
- Content Filtering Recommenders
- Collaborative Filtering Recommenders
- Hybrid Recommenders



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## *Wide Range of Algorithms*

- Simple Keyword Vector Matches
- Pure Nearest-Neighbor Collaborative Filtering
- Machine Learning on Content or Ratings



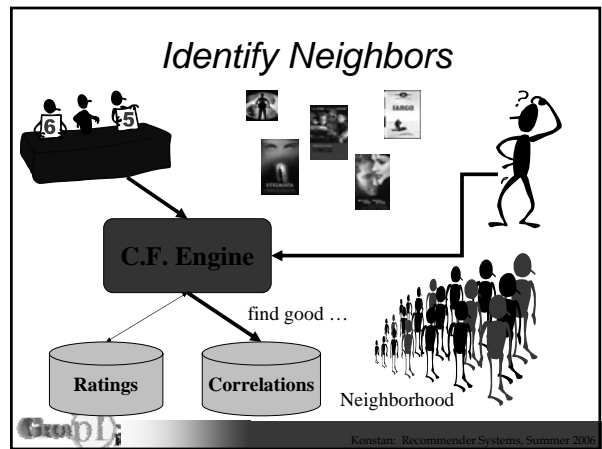
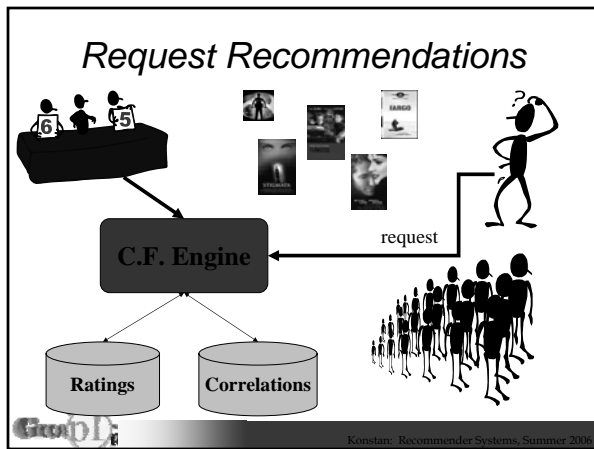
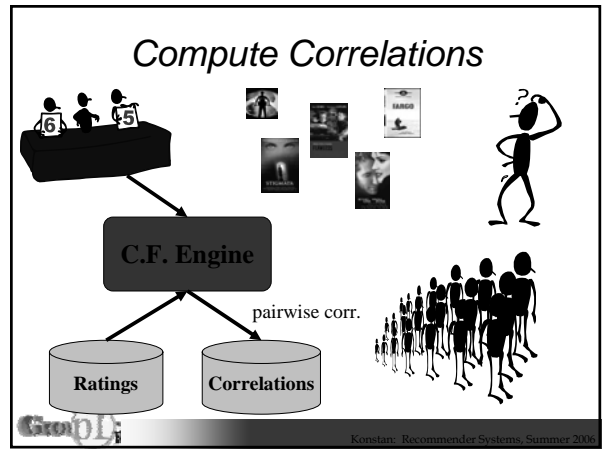
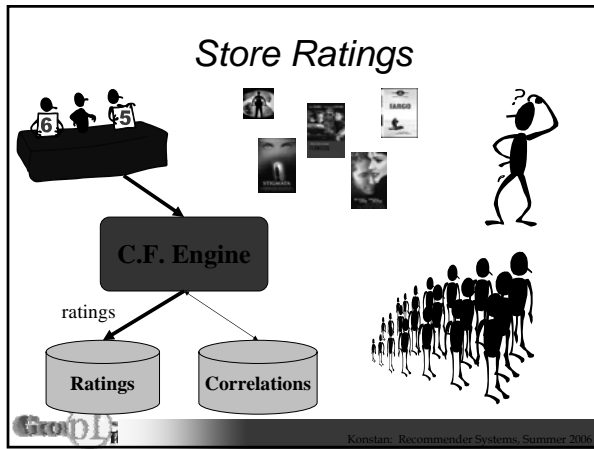
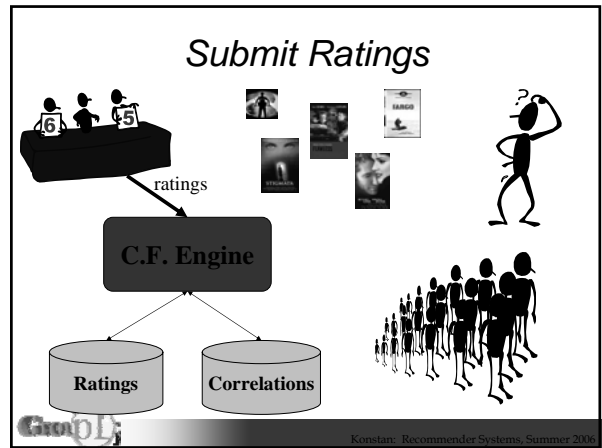
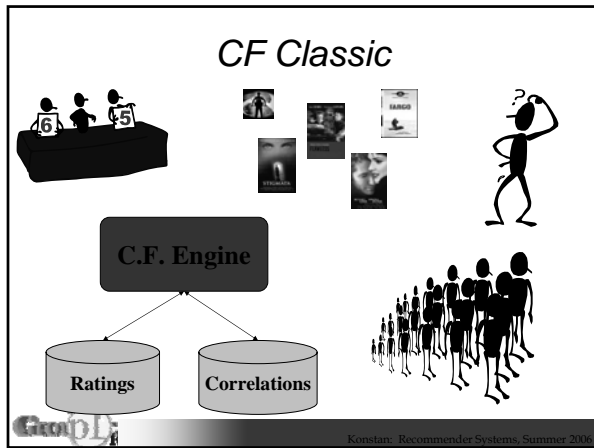
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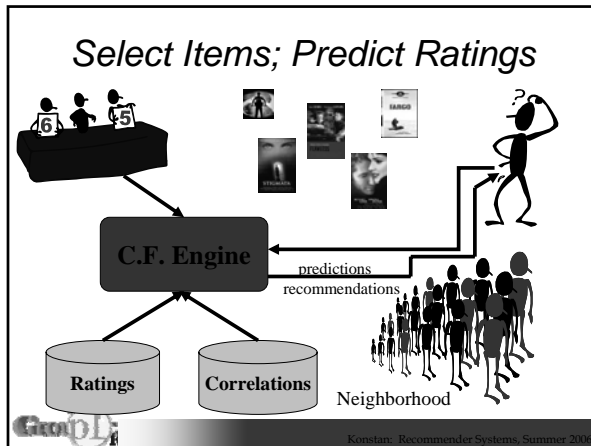
## *Classic Collaborative Filtering*

- MovieLens\*
- K-nearest neighbor algorithm
- Model-free, memory-based implementation
- Intuitive application, supports typical interfaces
- \*Note - newest releases use updated architecture/algorithm



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### Understanding the Computation

	Hoop Dreams	Star Wars	Pretty Woman	Titanic	Blimp	Rocky XV
Joe	D	A	B	D	?	?
John	A	F	D		F	
Susan	A	A	A	A	A	A
Pat	D	A		C		
Jean	A	C	A	C		A
Ben	F	A				F
Nathan	D		A		A	

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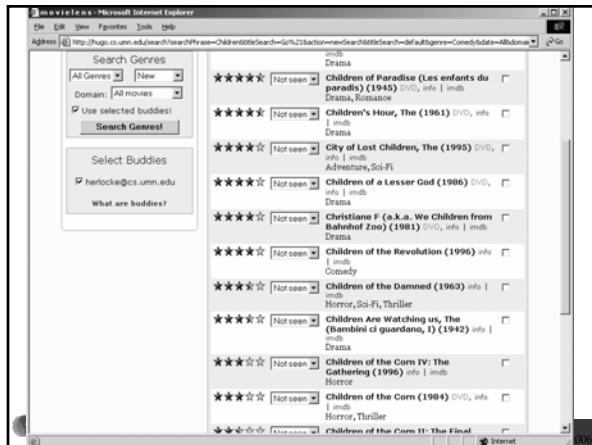
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Ben	F	A				F
Nathan	D		A		A	

## MovieLens

Freely accessible at: <http://www.movielens.org>



## Talk Roadmap

- ✓ Introduction
- Algorithms
- Research Overview
- Influencing Users
- Recommending Research Papers
- Rethinking Recommendation

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## Collaborative Filtering Algorithms

- Non-Personalized Summary Statistics
- K-Nearest Neighbor
  - user-user
  - item-item
- Dimensionality Reduction
  - LSI
  - PLSI
  - Factor Analysis
- Content + Collaborative Filtering
  - Burke's Survey of Hybrids
- Graph Techniques
  - Horting
- Clustering
- Classifier Learning
  - Naïve Bayes
  - Bayesian Belief Networks
  - Rule-induction

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ZAGAT SURVEY: BY POPULAR VOTE - Microsoft Internet Explorer

Address: http://www.zagat.com/SearchDetails.asp?VID=1&PID=1&ID=306L&W=1826888R&W=218&DPH=San+Jose&RID=30610

**ZAGAT SURVEY** HOME NEWS BROWSE INDEXES VOTE

location: San Francisco go restaurant search:

**ZAGAT SHOP** on sale now in the ZAGAT SHOP **2003/04 ATLANTA RESTAURANTS**

Click here to start shopping

**REVIEW**

Food Decor Service Cost

La Forêt 25 26 26 \$57

San Jose  
21747 Bertram Rd. (Almaden Rd.) San Jose, CA, 95120-4329 (408) 997-3458

☑ "Hidden in the boonies" of San Jose, this converted historic boarding house with a "beautiful" "creekside setting" pampers patrons with "excellent" (if "heavy") French cuisine highlighted by "creative sauces" that, together with "great service", create such a romantic ambiance that devotees "defy you not to kiss on the way in or out or over the soufflé"; gripes about the "overpriced" menu dampen the ardor of many, however.

**VOTE**

Please select your ratings for Food, Decor, Service on a scale of 0-3 (0=worst, 3=best). Click here for help.

Food Decor Service

Favorite dish: \_\_\_\_\_

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### Item-Item Collaborative Filtering

B. Sarwar et al. Item-based collaborative filtering recommendation algorithms. Proc. WWW 2001.

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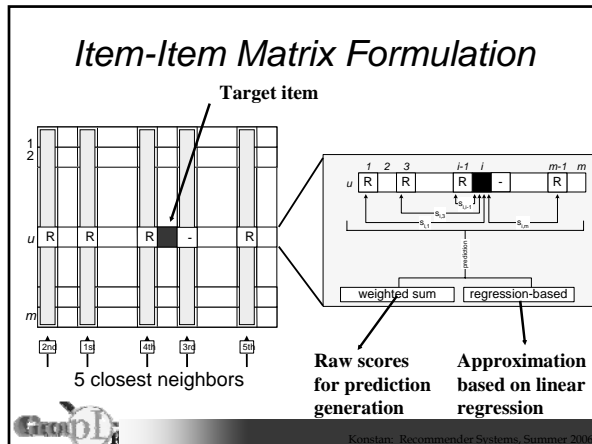
### Item-Item Collaborative Filtering

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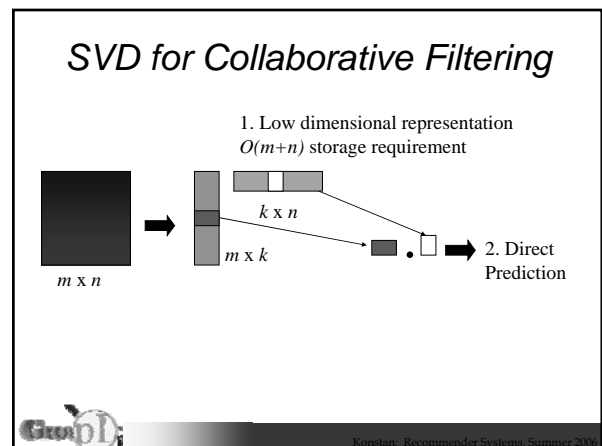
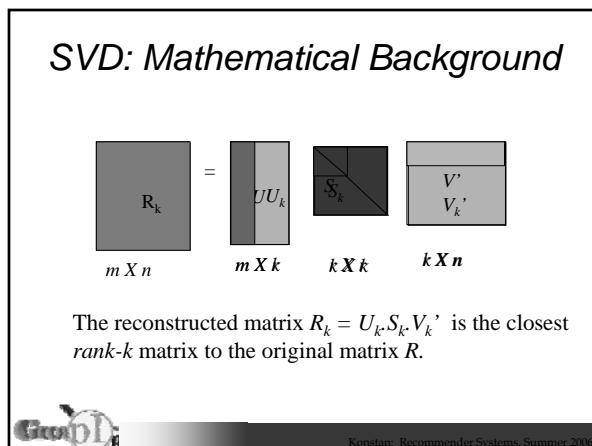
Used for similarity computation



- ### Item-Item Discussion
- Good quality, in sparse situations
  - Promising for incremental model building
    - Small quality degradation
    - Big performance gain
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- ### Dimensionality Reduction
- 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
- B. Sarwar et al. Incremental SVD-Based Algorithms for Highly Scalable Recommender Systems. Proc ICCIT 2002. Konstan: Recommender Systems, Summer 2006



## Singular Value Decomposition

Reduce dimensionality of problem

- Results in small, fast model
- Richer Neighbor Network

Incremental Update

- Folding in
- Model Update



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## Current and Recent Research

- User Experience
  - Impact of Ratings on Users
  - New User "Orientation"
  - Confidence Displays
  - Interface Design
  - Human-Recommender Interaction
- Algorithmic and Systems Issues
  - Beyond Accuracy: Metrics and Algorithms
  - Buddies and Multi-User Recommendations
  - Influence and Shilling
- Eliciting Participation in On-Line Communities
  - Reinventing Conversation
  - User-Maintained Communities
- Extending Recommendation to New Domains
  - Recommending Research Papers



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D. Cosley et al. Is Seeing Believing? How Recommender Systems Influence Users' Opinions. *Proc. CHI 2003*.

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## 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



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## The Study

Progress: Mozilla (Build ID: 2002031104)

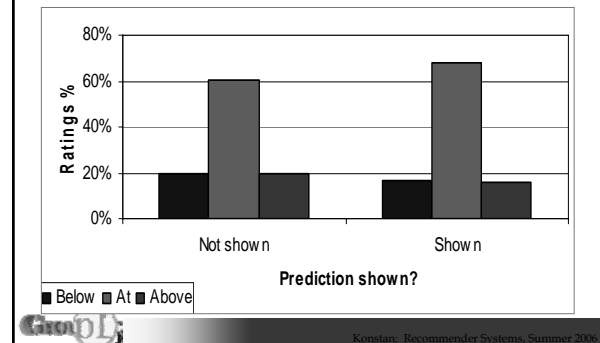
Please rate the movies listed below. These ratings will not be saved to your profile.

PREDICTED RATING	YOUR RATING	GENRE	TITLE
★★★	[don't know]	Action, Adventure Comedy, Horror Sci-Fi	Army of Darkness (1992) (IMDb)
★★	[don't know]	Adventure, Comedy Fantasy	Bill & Ted's Bogus Journey (1989) (IMDb)
★★★★	[don't know]	Drama	Citizen Kane (1941) (IMDb)
★★★★	[don't know]	Action, Thriller	Die Hard 2 (1990) (IMDb)
★★★★	[don't know]	Horror	Exorcist The (1973) (IMDb)
★★★★	1	Crime, Drama	Heist (2001) (IMDb)
★★★★	2	Action, Adventure	Knight's Tale A (2001) (IMDb)
★★★★	3	Comedy	Morky Python and the Holy Grail (1974) (IMDb)

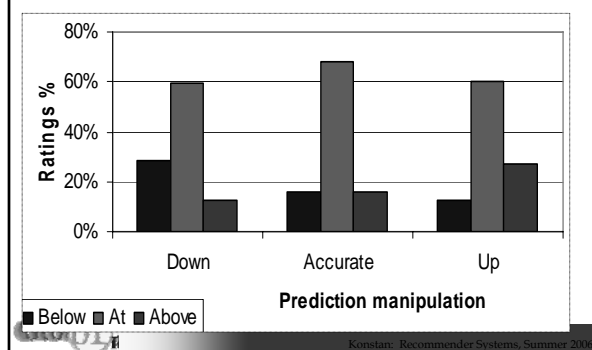
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## Seeing Matters



## Accuracy Matters



## Domino Effects?

• The power to manipulate?

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## Rated, 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%
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## 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!
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## Recommending Research Papers

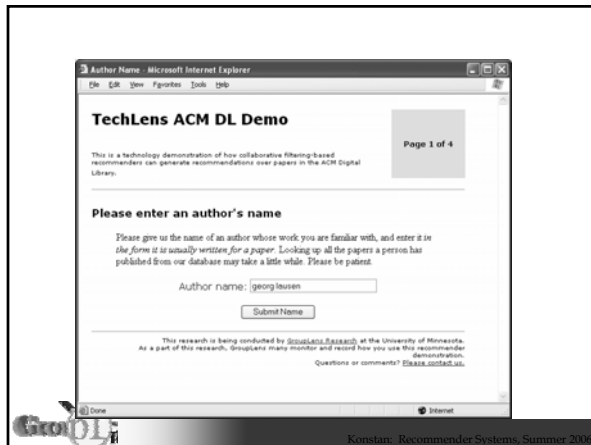
- Using Citation Webs
- For a full paper, we can recommend citations
  - A paper "rates" the papers it cites
  - Every paper has ratings in the system
- Other citation web mappings are possible, but many are have problems



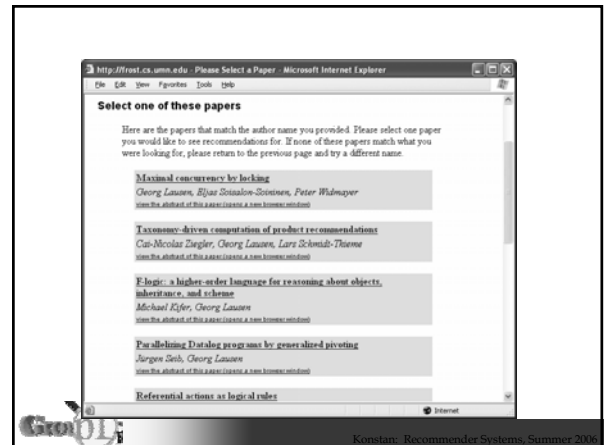
S. McNee et al. "On the Recommending of Citations for Research Papers", in Proc. CSCIV 2002 and R. Torres et al. "Enhancing Digital Libraries with TechLens\*", in Proc. JCDL 2004.



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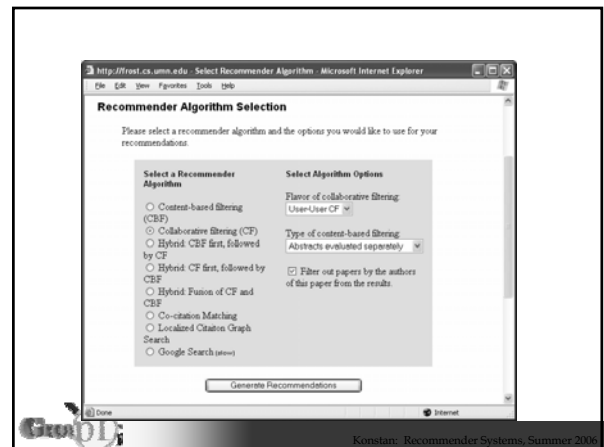
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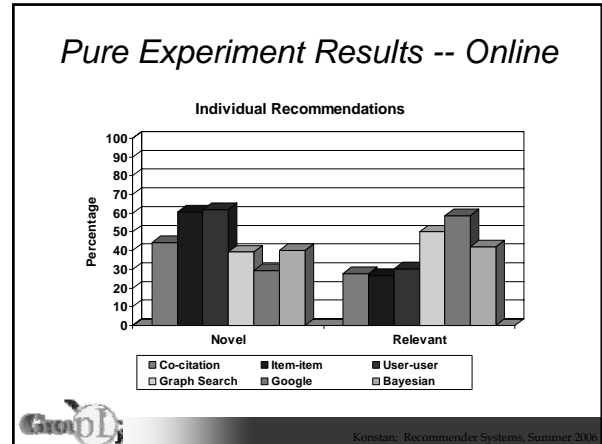
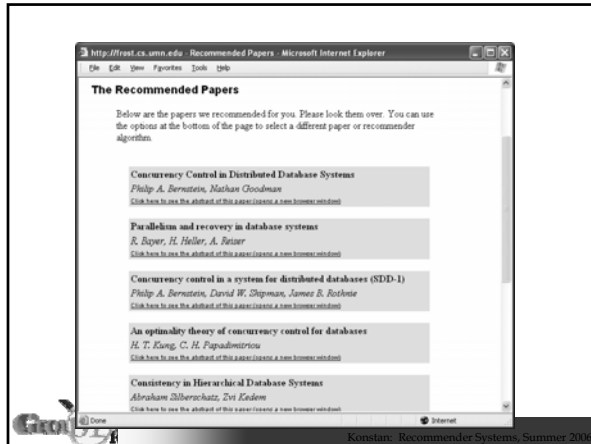
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- ### Pure Experiment Results -- Online
- Worst algorithm returned good results over 25% of the time
  - 76% of users got at least one good recommendation
  - Users happy with one good recommendation in list of five

- ### What's Next?
- Short-Term Efforts
    - Task-specific recommendation
    - Understanding personal bibliographies
    - Privacy issues
  - Longer-Term Efforts
    - Toolkits to support librarians and other power users
    - Exploring the shape of disciplines
    - Rights issues

- ### Task-Specific Recommendations
- Many different user needs
    - awareness in area of expertise
    - find specific work in area of expertise
    - explore peripheral or new area
    - find people with relevant expertise
      - reviewers, program committees, collaborators
    - reading list for students, newcomers
      - individuals or groups
  - Different algorithms fulfill different needs

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## Evaluating Recommendations

- Prediction Accuracy
  - MAE, MSE,
- Decision-Support Accuracy
  - Reversals, ROC
- Recommendation Quality
  - Top-n measures
- Item-Set Coverage



J. Herlocker et al. Evaluating Collaborative Filtering Recommender Systems, ACM Transactions on Information Systems 22(1), Jan. 2004.

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## From Items to Lists

- Do users really experience recommendations in isolation?



C. Ziegler et al. "Improving Recommendation Lists through Topic Diversification", in Proc. WWW 2005.

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1. **Sauron Defeated**  
By J.R.R. Tolkien, Christopher Tolkien (Editor)  
Average Customer Review: 4.8/5.0 This is the 6th item in *The History of Middle-earth Series*. From *Book News, Inc.*, Christopher Tolkien continues to present his father's previously unpublished work. In part one, Sauron Defeated, the account of the writing of the Lord of the Rings is completed and ends with a new dialogue. Part two contains... [Read More](#)  
Our Price: \$29.49 Used & new from \$9.99

2. **The War of the Ring (The History of the Lord of the Rings, Part Three) (The History of Middle-earth, Volume 4)**  
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Our Price: \$6.99 Used & new from \$2.99



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## Making Good Lists

- Individually good recommendations do not equal a good recommendation list
- Other factors are important
  - Diversity
  - Affirmation
  - Appropriateness
- Called the "Portfolio Effect"  
[Ali and van Stam, 2004]



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## Topic Diversification

- Re-order results in a rec list
- Add item with *least* similarity to all items already on list
- Weight with a 'diversification factor'
- Ran experiments to test effects



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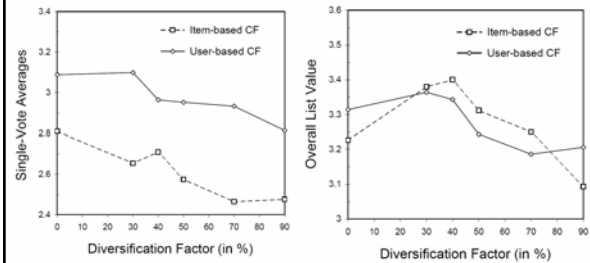
## Experimental Design

- Books from BookCrossing.com
- Algorithms
  - Item-based CF
  - User-based CF
- Experiments
  - On-line user surveys
  - 2125 users each saw one list of 10 recommendations



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## Online Results



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## Diversity is Important

- User satisfaction more complicated than only accuracy
- List makeup is important to users
- 30% change enough to alter user opinion
- Change not equal across algorithms



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## Human-Recommender Interaction

- Three premises:
  - Users perceive recommendation quality in context; users evaluate lists
  - Users develop opinions of recommenders based on interactions over time
  - Users have an information need and come to a recommender as a part of their information seeking behavior

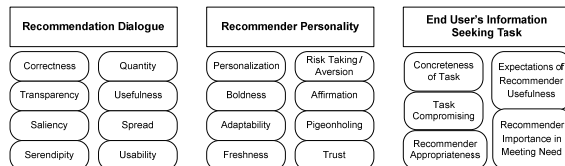


S. McNee et al. "Making Recommendations Better: An Analytic Model for Human-Recommender Interaction" in *Ext. Abs. CHI 2006*



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## HRI Pillars and Aspects



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## HRI Process Model



- Makes HRI Constructive
  - Links Users/Tasks to Algorithms
- Need New Metrics



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## New Metrics

- Benchmark a variety of algorithms
- Need several metrics inspired by different HRI Aspects
- Examples:
  - Ratability
  - Boldness
  - Adaptability



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## Metric Experimental Design

- ACM DL Dataset
  - Thanks to ACM for cooperation!
  - 24,000 papers
  - Have citations, titles, authors, & abstracts
  - High quality
- Algorithms
  - User-based CF
  - Item-based CF
  - Naïve Bayes Classifier
  - TF/IDF Content-based
  - Co-citation
  - Local Graph Search
  - Hybrid variants



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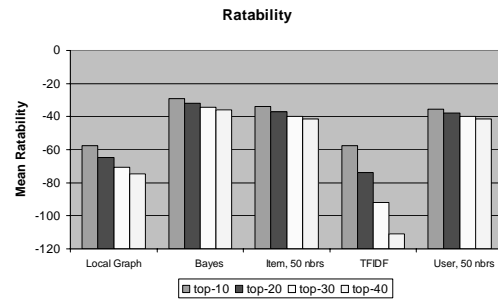
## Ratability

- Probability a user will rate a given item
  - “Obviousness”
  - Based on current user model
  - Independent of liking the item
- Many possible implementations
  - Naïve Bayes Classifier



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## Ratability Results



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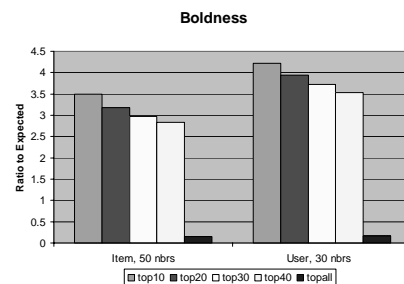
## Boldness

- Measure of “Extreme Predictions”
  - Only defined on explicit rating scale
  - Choose “extreme values”
  - Count appearance of “extremes” and normalize
- For example, MovieLens
  - 0.5 to 5.0 star scale, half-star increments
  - Choose 0.5 and 5.0 as “extreme”



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## Boldness Results



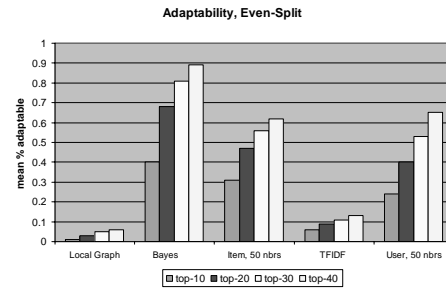
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## Adaptability

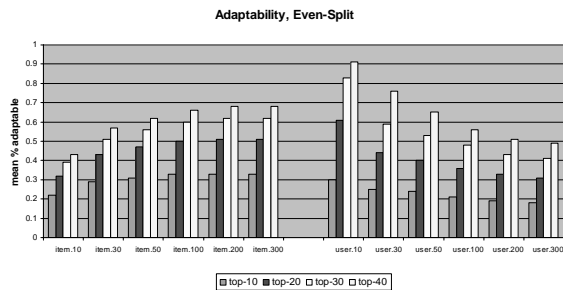
- Measure of how algorithm changes in response to changes in user model
  - How do users grow in the system?
- Perturb a user model with a model from another random user
  - 50% each
  - See quality of new recommendation lists



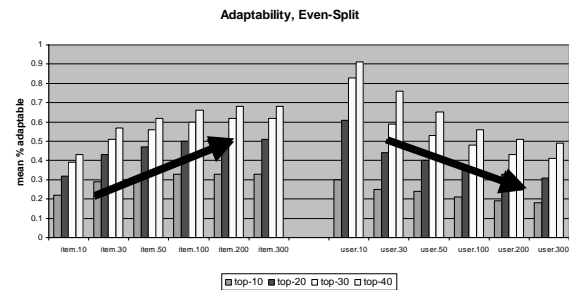
## Adaptability Results



## Adaptability Results



## Adaptability Results



## 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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