Recommender systems

What are they ?

They are software tools and techniques providing suggestions for items to be of use to a user

How are they different from a search engine?

Information Retrieval
Information filtering and discovery

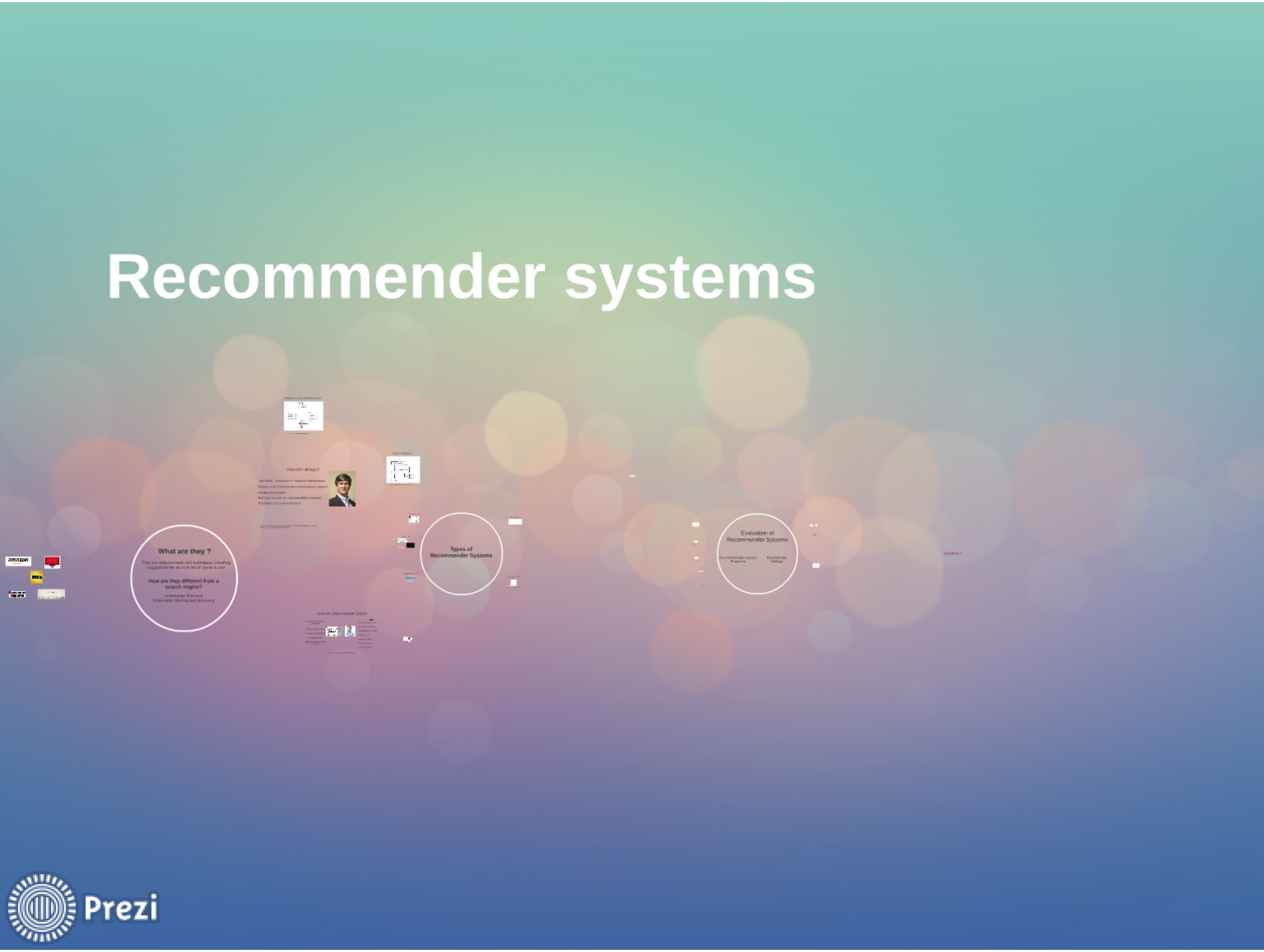
Types of Recommender Systems

Evaluation of Recommender Systems

Recommendation System Properties

Experimental Settings

Prezi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amazon

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IMDb

Consumer Reports

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Meet your next favorite book.

Prezi

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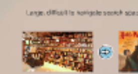
Information filtering and discovery

Goals of a Recommender System



rease the number of items sold

ell more diverse items

rease user satisfaction

Increase user trust

er understand what the user wants

Find some good ite

Information overloa

Complex search spa

Express self

Influence others

Help other users

Just browsing

Source : http://dl.acm.org/citation.cfm?id=963772

Prezi

Large, difficult to navigate search spaces

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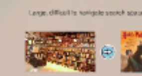
Y FEATURES

- effective mega-pixels in an APS-C sized CMOS sensor
- stest continuous shooting at 8.3FPS
- lectable Anti-Aliasing Filter
- FOX11 Autofocus Module
- al Time Scene Analysis with 86,000 pixel sensor
- U, Eye-fi Wireless, and SDX Memory card compatibility
- ofessional H.264 video
- NTAX body-based Shake Reduction (SR)
- al SD card slots
- ntaprism Optical Viewfinder for 100% FOV and .95 gnification
- ly weather sealed
- lti-pattern white balance
- 0-51200 ISO
- MI port
- R Image Capture
- gnesium alloy body w stainless steel chassis

Prezi

Goals of a Recommender System



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How did it all begin?

John Riedl - A professor in University of Minnesota

Pioneer in the field of recommender system research

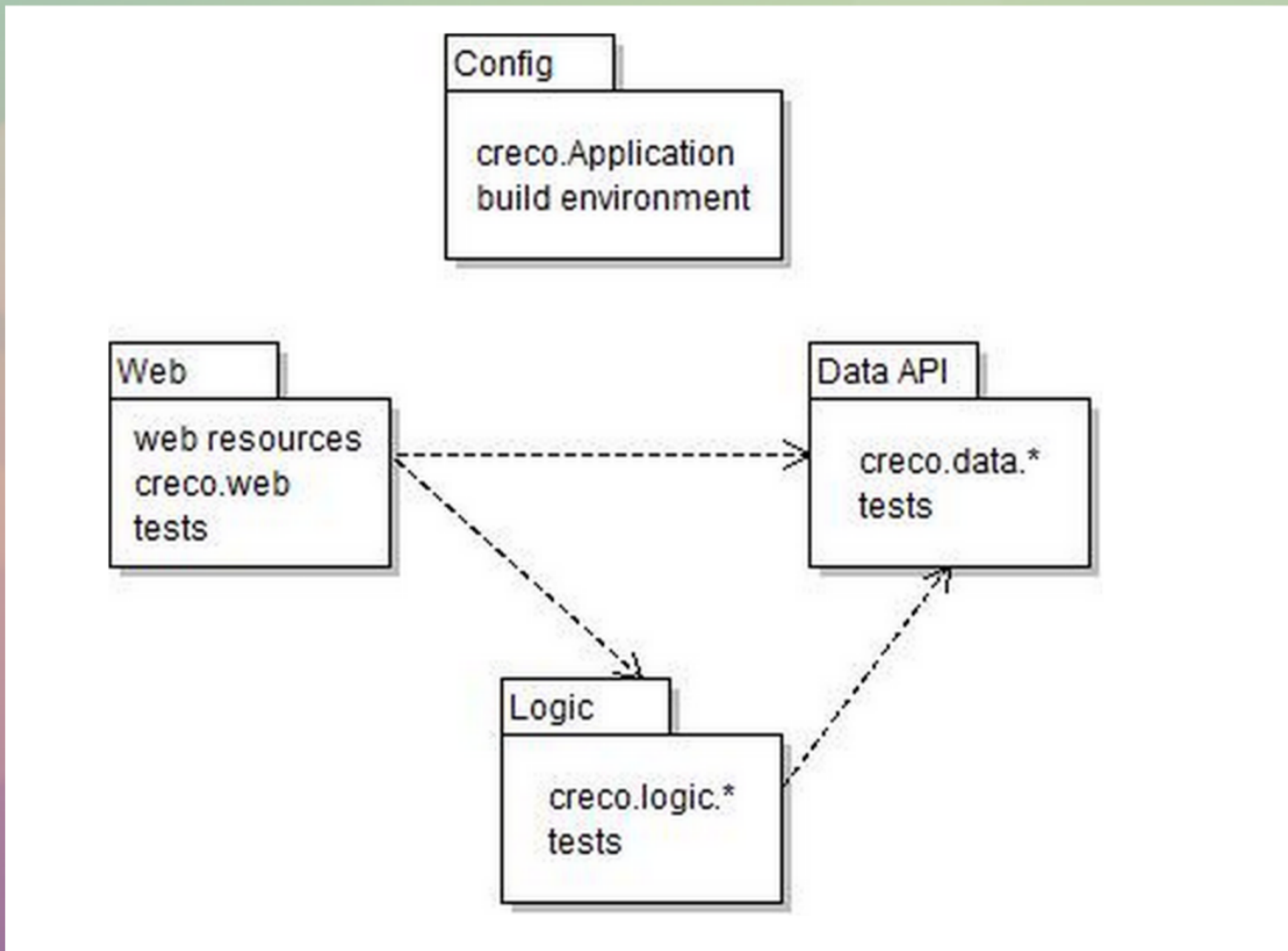
Developed GroupLens

Built key data sets for recommendation research

Key paper cited over 4298 times

Source : GroupLens: an open architecture for collaborative filtering of netnews
http://dl.acm.org/citation.cfm?id=192905

Structure of a Recommender System



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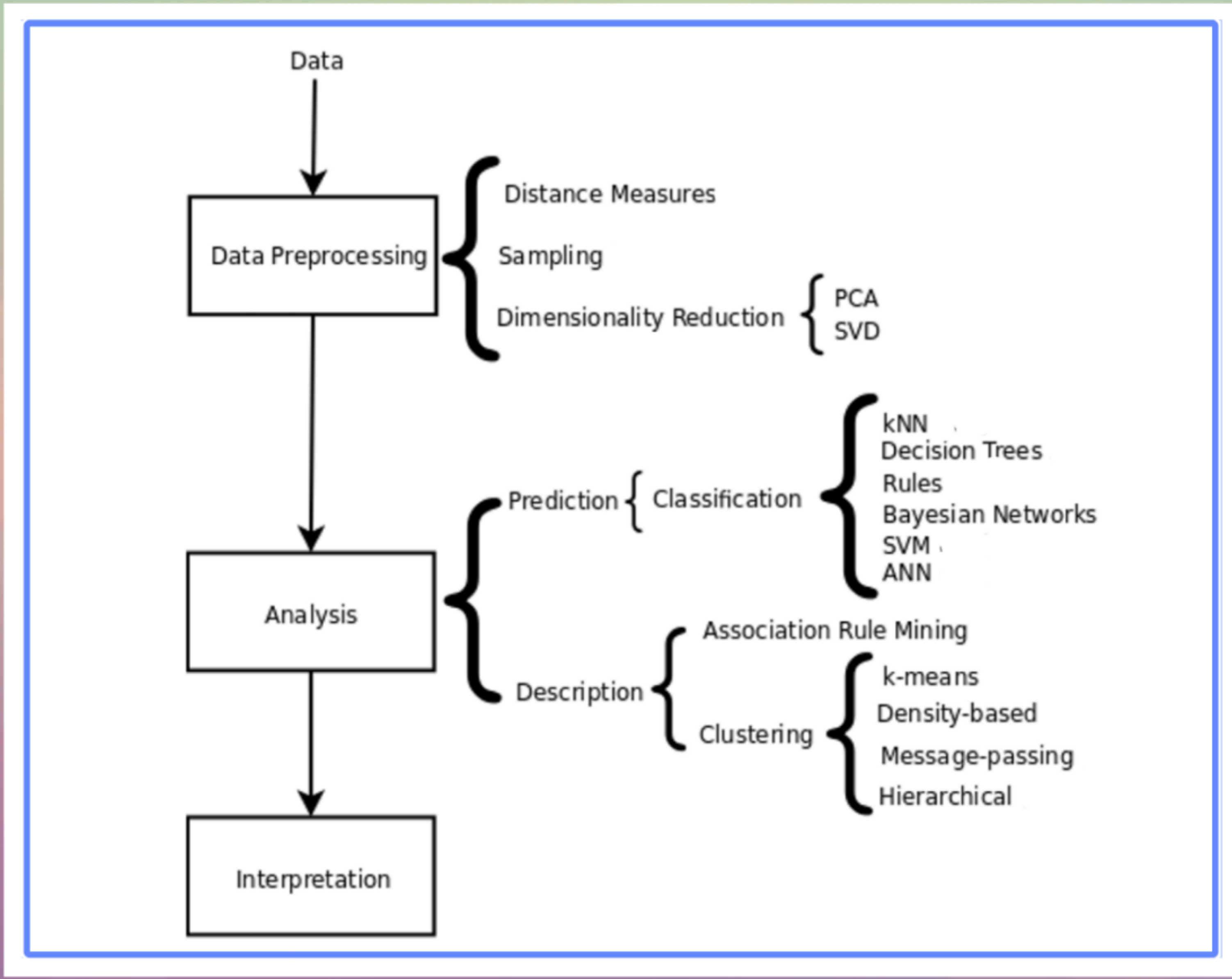
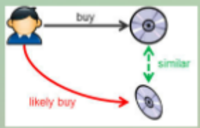
Source : CRECO : https://github.com/prmr/Creco

Data for a RecSys



Source : Recommender Sytems Handbook: Francesco Ricci et al.

Content Based Recommenders



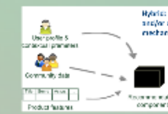
ve Filtering

ge Based Recommender System

st users and items but context too......

Types of Recommender Systems

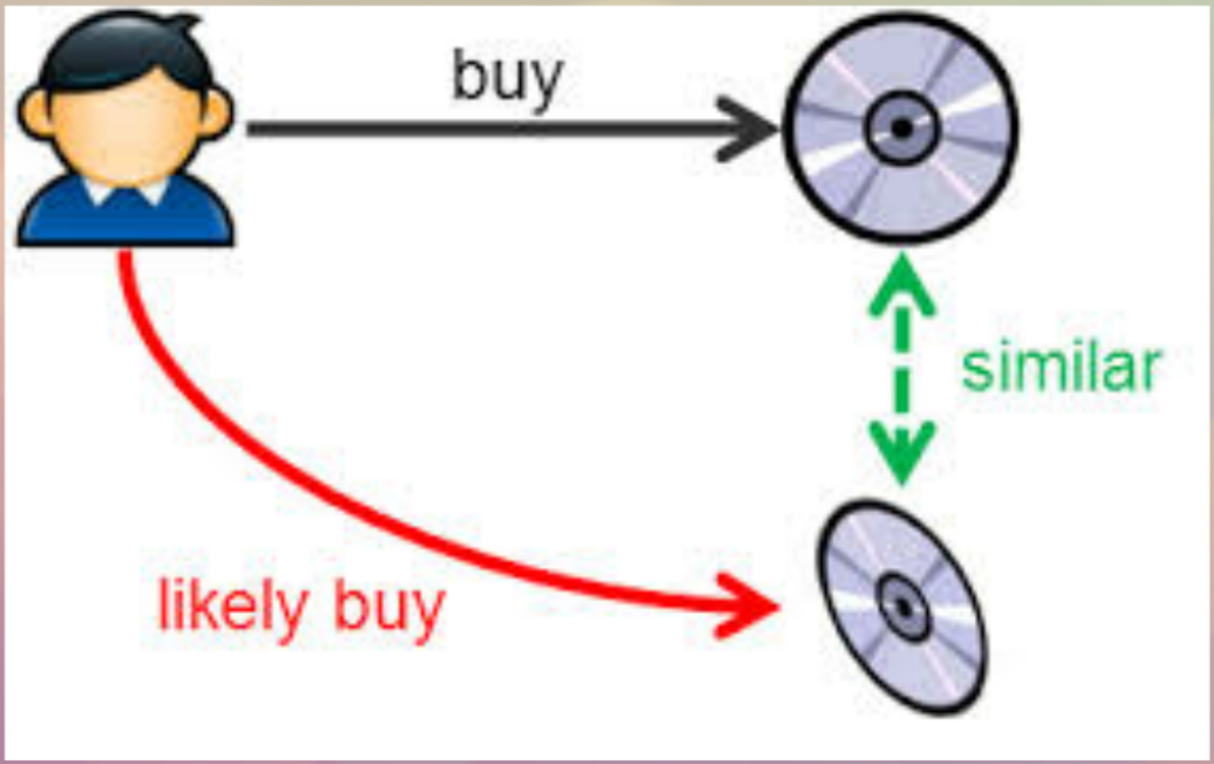
Hybrid Recommenc



Critiquing Recommender

So far, we have this

Content Based Recommenders



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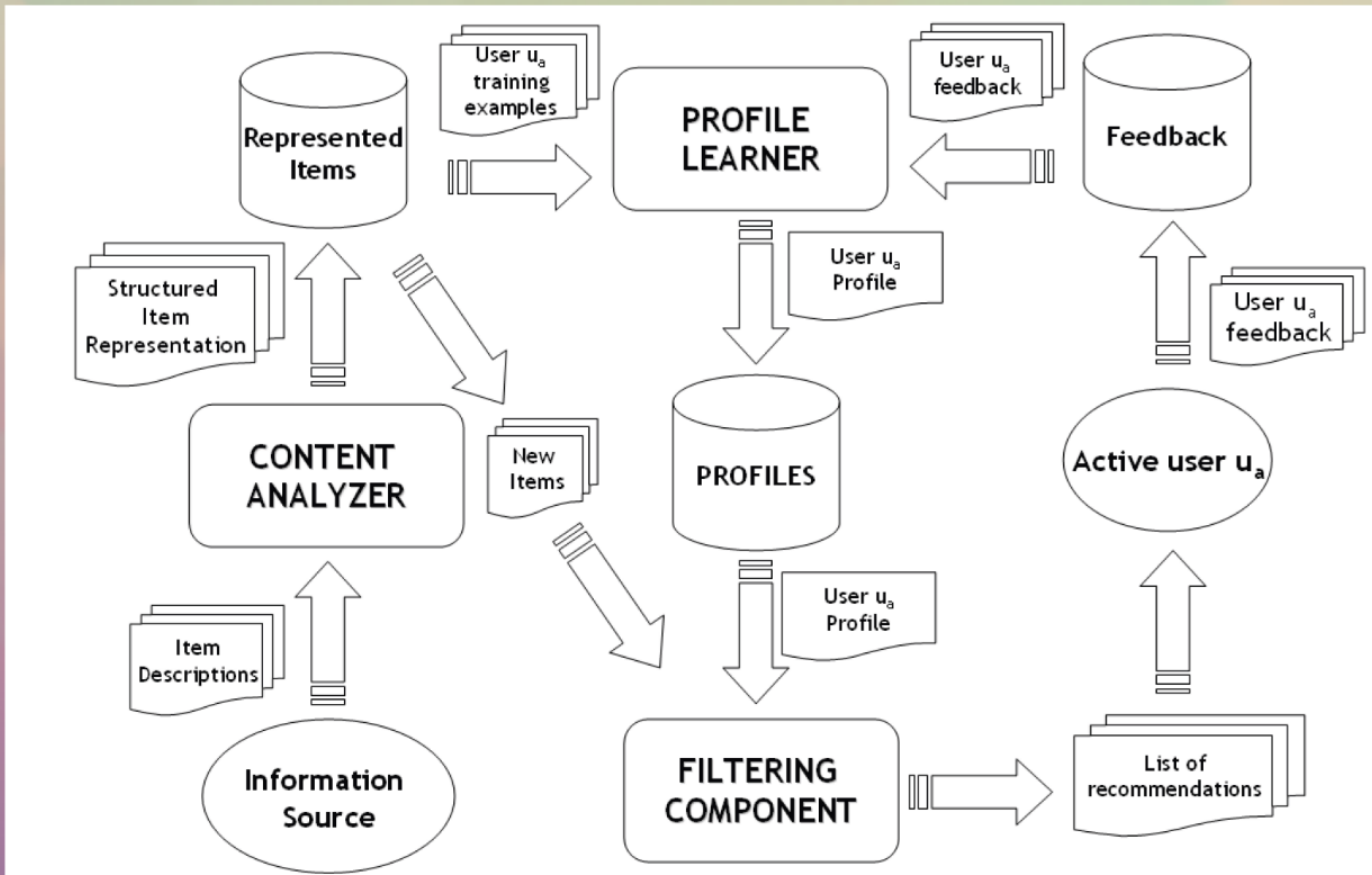
1) Analyze items previously rated by the user

2) Build a user profile based on the items rated by him

3) Recommendation process - Basically match the attributes of the user profile against the attributes of a content object.



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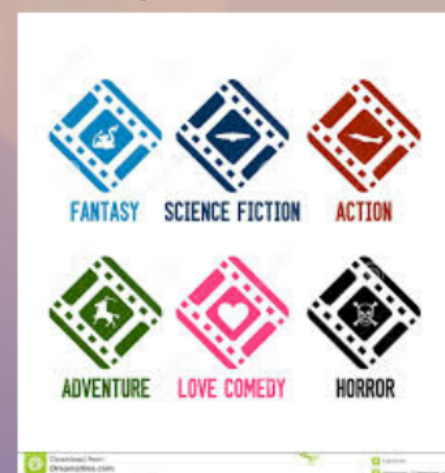
Items

Features



Feature Comparison Matrix Chart Template

	Product 1	Product 2	Product 3	Product 4
Feature 1	✓	✓	✓	
Feature 2	✓		✓	✓
Feature 3	✓	✓	✓	✓
Feature 4		✓	✓	✓

Classical problem

1) Keyword matching - TF-IDF

2) Automatic feature extraction

3) Ontology based approaches (Context based matching)

SiteIF

Semantic web

- Term coined by Tim Berners Lee
- Led by world wide web consortium (W3C)
- Web of data that can be accessed by machines
- Make it accessible to bots, Active learning machines

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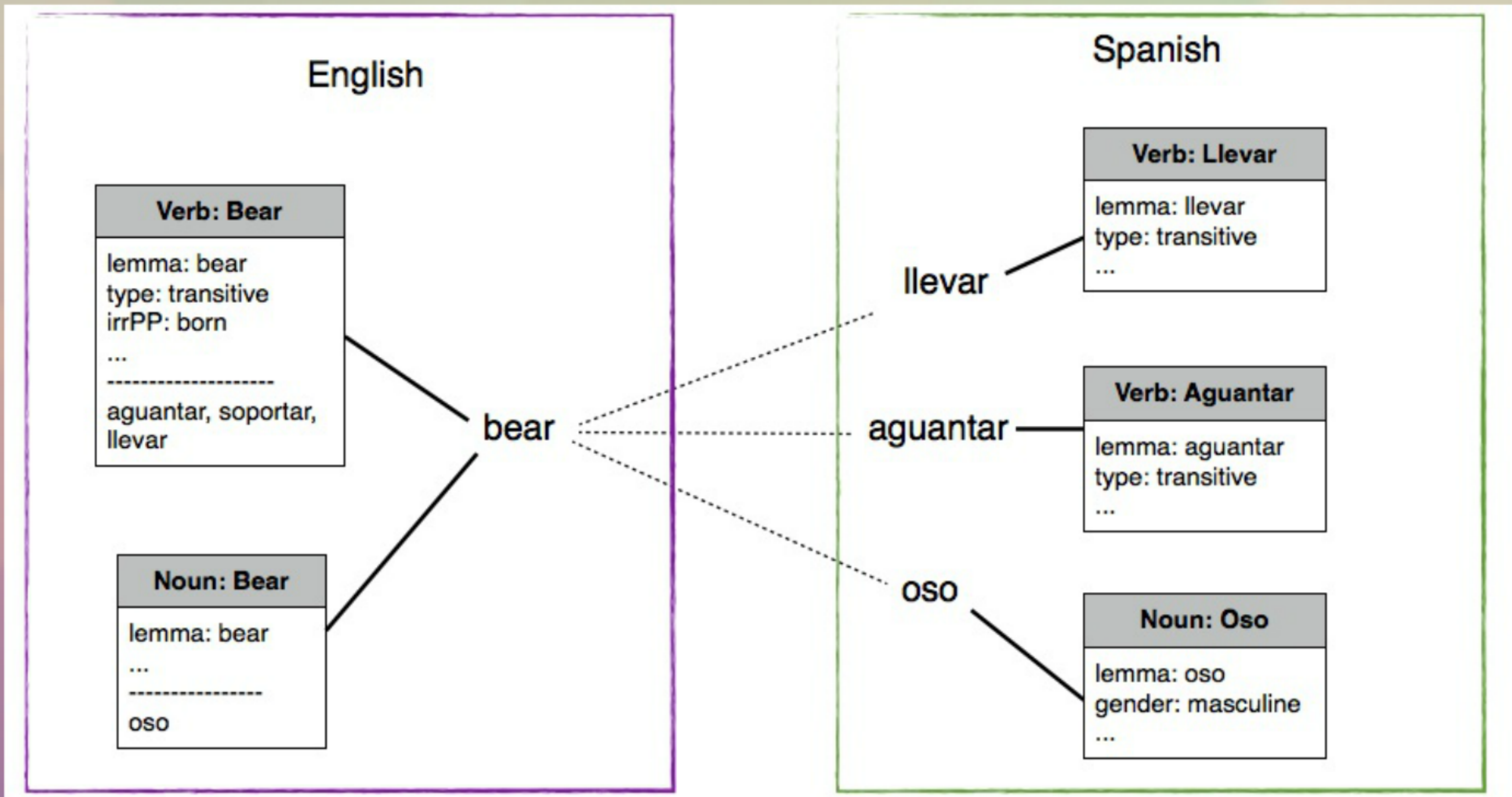
SiteIF



Source : Improving User Modelling with Content-Based Techniques, http://link.springer.com/...007%2F3-540-44566-8_8

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Advantages

1) Very personalized
2) Transparency

Disadvantages

1) Cold start problem
2) Limited content discovery
3) Over-specialization

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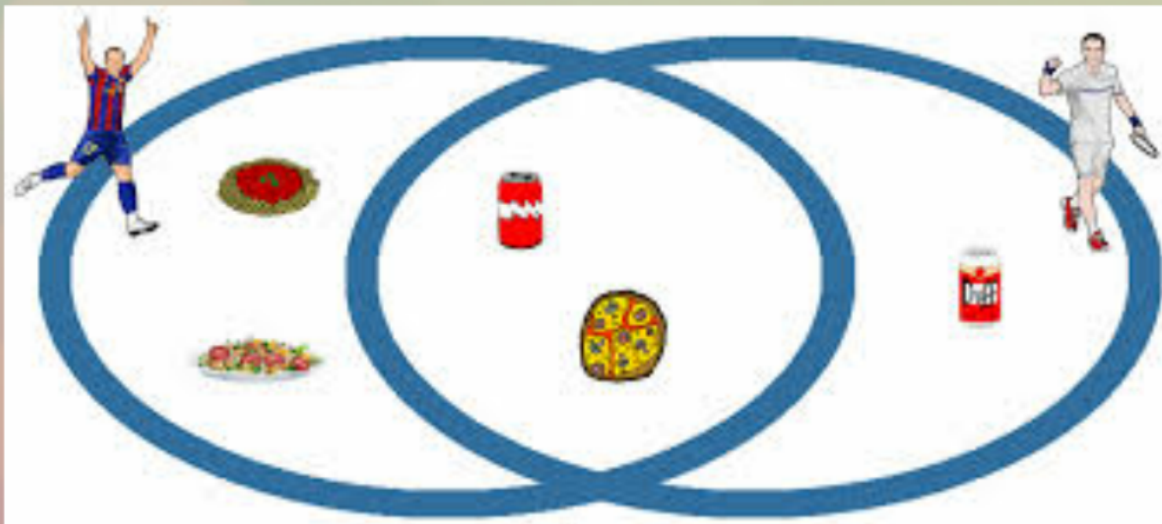
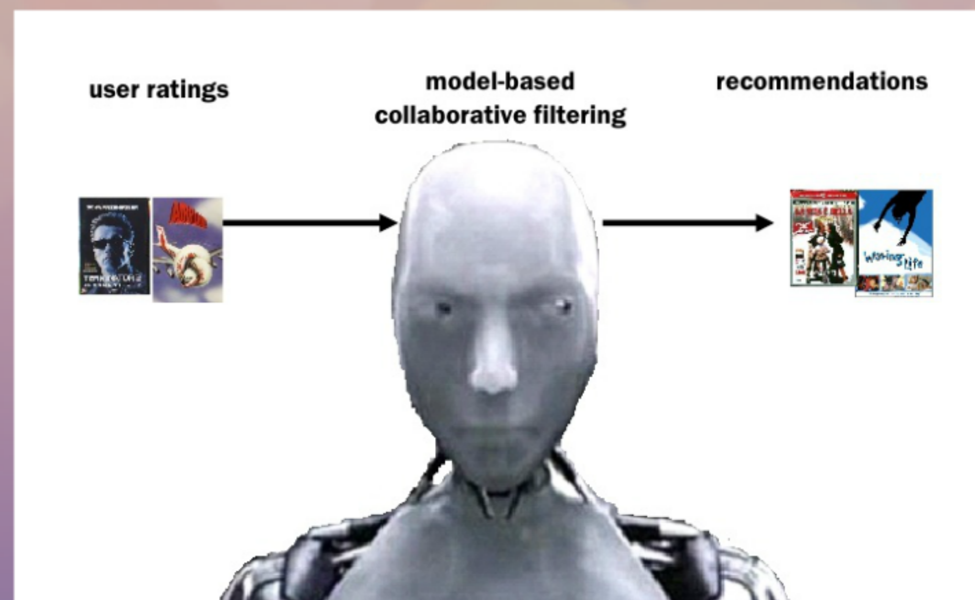
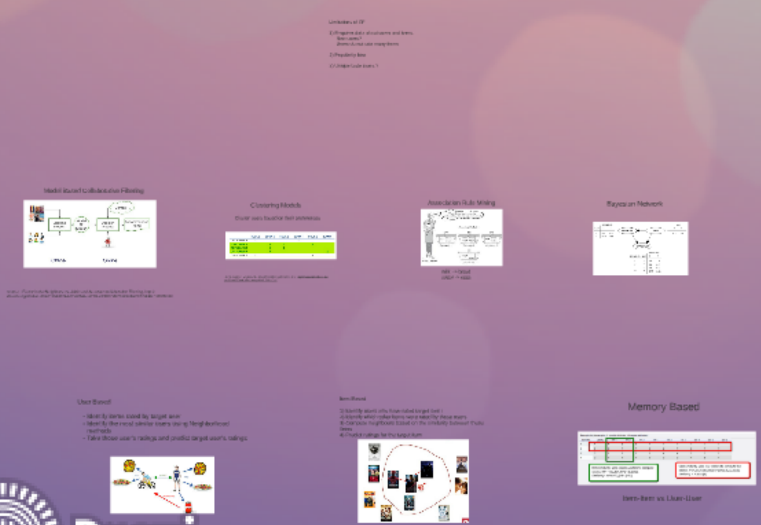
Collaborative Filtering



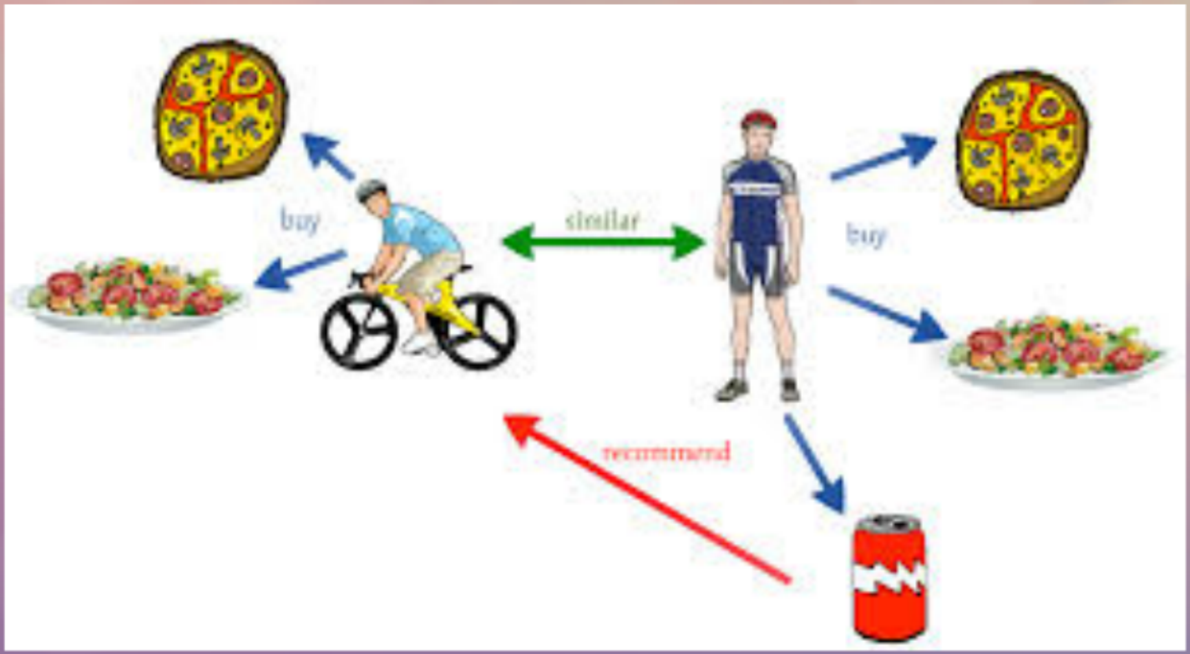
Memory Based





User Based

- Identify items rated by target user
- Identify the most similar users using Neighborhood methods
- Take those user's ratings and predict target user's ratings



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Item Based

1) Identify users who have rated target item i
2) Identify which other items were rated by those users
3) Compute neighbours based on the similarity between these items
4) Predict ratings for the target item

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Memory Based

ExampleSet (4 examples, 0 special attributes, 10 regular attributes)

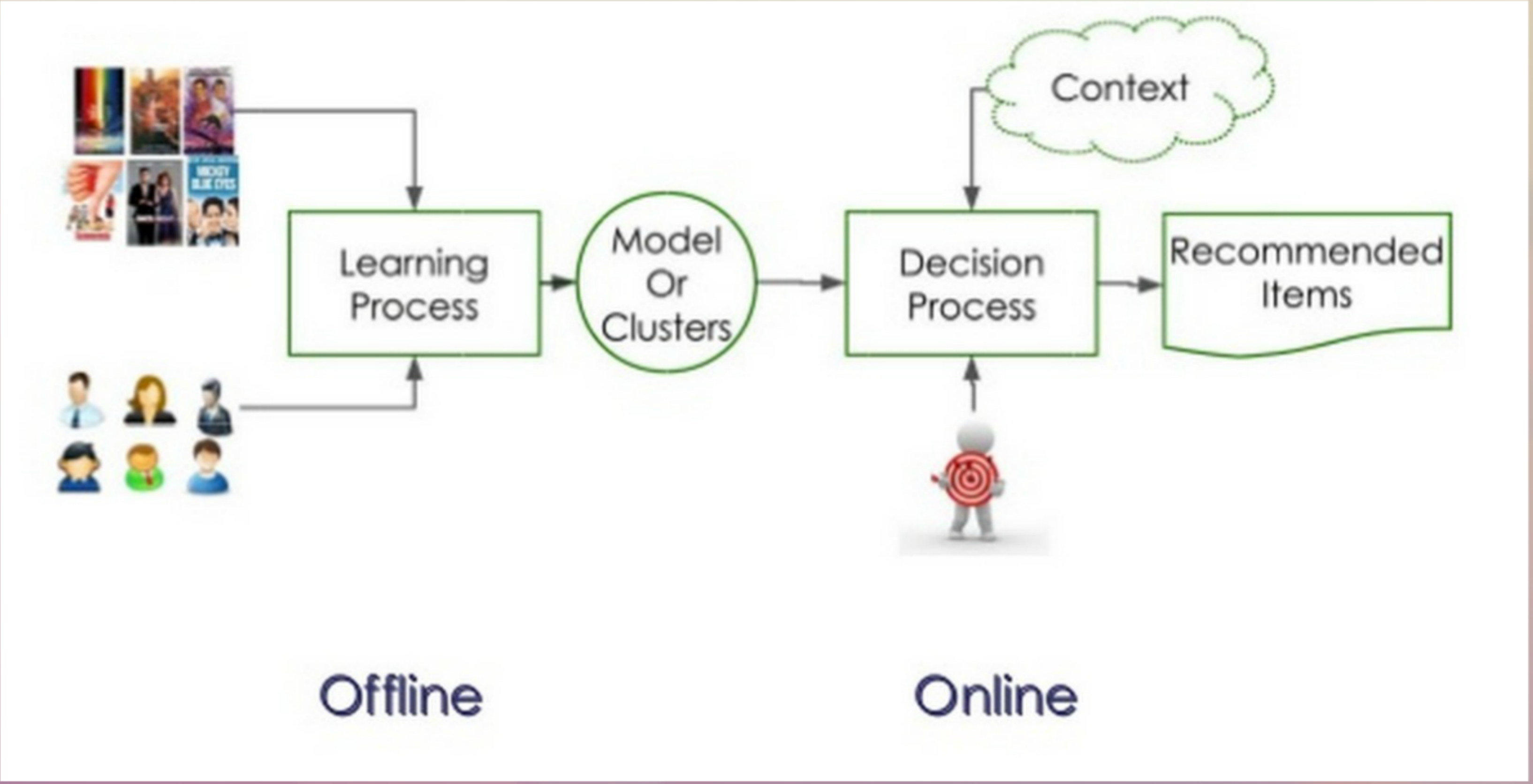
Row No.	UserID	HP 1	HP 2	HP 3	TW 1	TW 2	TW 3	SW 4	SW 5	SW 6
1	A	4	5	5	1	?	?	?	?	?
2	B	2	?	?	3	2	?	3	?	?
3	C	3	?	?	5	4	4	?	?	?
4	D	?	?	?	3	2	2	4	5	4

Item similarity: uses column vectors to compute cosine. HP1=(4,2,3,0), HP2=(5,0,0,0). Similarity= HP1.HP2/|HP1||HP2|

User similarity: uses row vectors to compute the cosine. A=(4,5,5,1,0,0,0,0,0) B=(2,0,0,3,2,0,3,0,0). Similarity = A.B/|A||B|

Item-Item vs User-User

Model Based Collaborative Filtering



Source : Factor in the Neighbors: Scalable and Accurate Collaborative Filtering, http://
...cm.org/citation.cfmid=1644874&dl=ACM&coll=DL&CFID=457612124&CFTOKEN=15805810

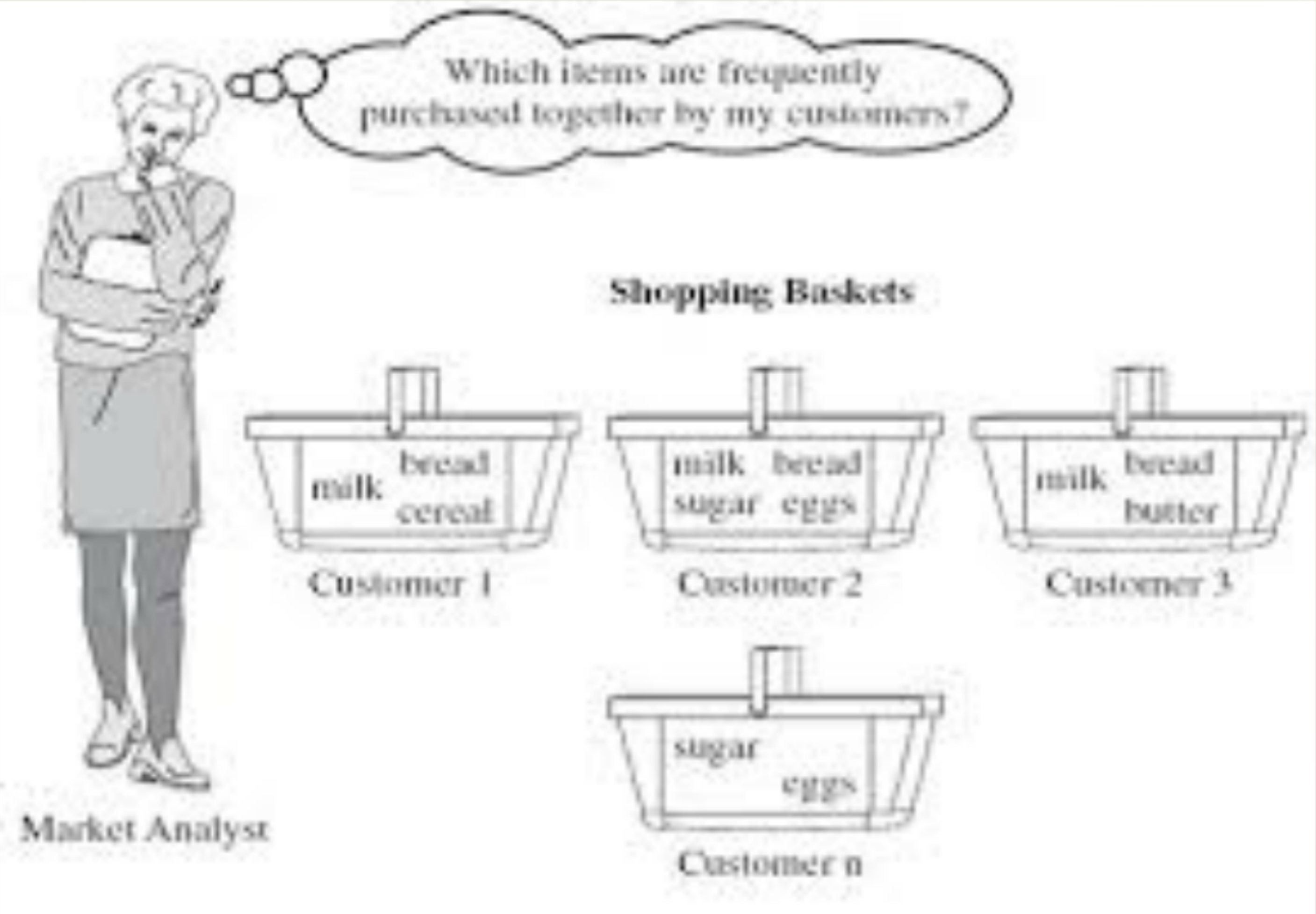
Clustering Models

Cluster users based on their preferences

	BOOK 1	BOOK 2	BOOK 3	BOOK 4	BOOK 5	BOOK 6
CUSTOMER A	X			X		
CUSTOMER B		X	X		X	
CUSTOMER C		X	X			
CUSTOMER D		X				X
CUSTOMER E	X				X	

Image Source : ESSIR 2013 Recommender Systems tutorial, http://www.slideshare.net/
erveros99/essir-2013-recsysfinal-25957057

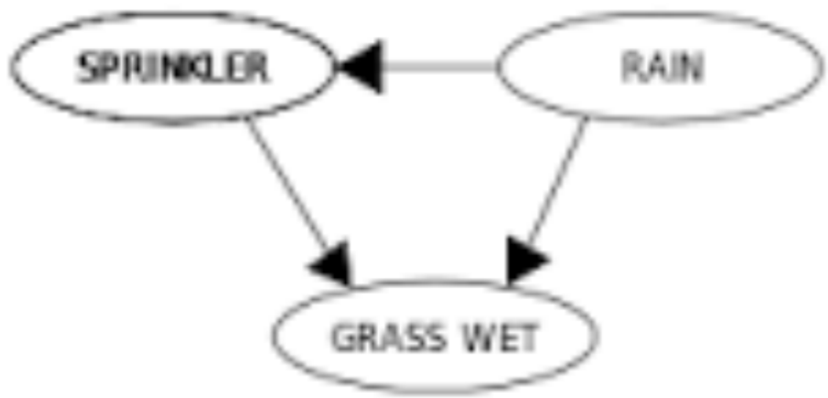
Association Rule Mining



milk -> bread
sugar -> eggs

Bayesian Network

	SPRINKLER	
RAIN	T	F
F	0.4	0.6
T	0.01	0.99



RAIN	
T	F
0.2	0.8

		GRASS WET	
SPRINKLER	RAIN	T	F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01

Limitations of CF

1) Requires data about users and items.
   - New users?
   - Users do not rate many items

2) Popularity bias

3) Unique taste users ?

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Knowledge Based Recommender System

Not just users and items but context too......

Life stages of a customer

Intent to purchase

What is context?

weather

companion

Source : Understanding context before using it, http://dl.acm.org/citation.cfm?id=2136852

User * Item * Context -> Rating

Movie(MovieID, Title, Length, ReleaseYear, Director, Genre).

User(UserID, Name, Address, Age, Gender, Profession).

Also consider,

Theater(TheaterID, Name, Address, Capacity, City, State, Country).

Time(Date, DayOfWeek, TimeOfWeek, Month, Quarter, Year).

Source : Recommender Sytems Handbook: Francesco Ricci et al.

Can reason about the relationship between a need and a possible recommendation

Real time - no long-term models

Relatively new and unexplored field

Pitfalls ?

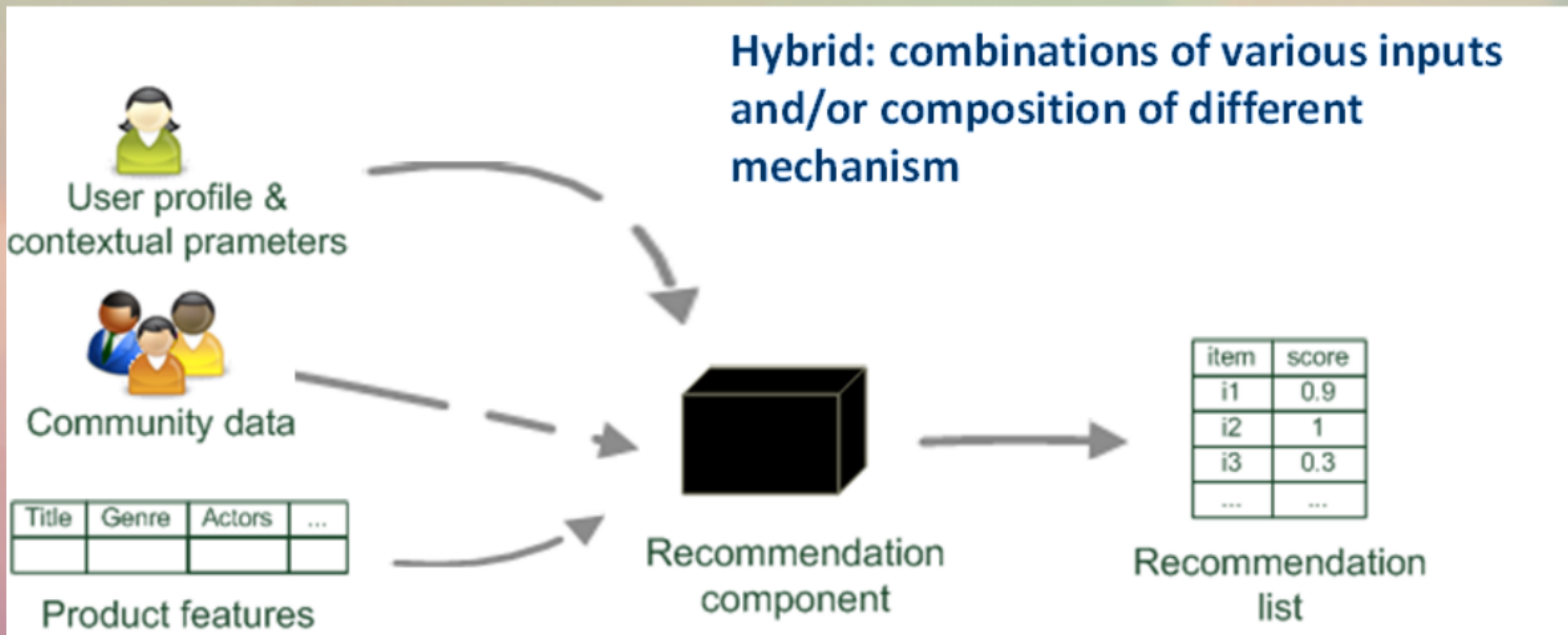
- More complex to build

- Lots of data to store and process

- How to obtain context? (Social media, Ask user questions)

- How to generate generalized recommendations?(For a general set of users)

Hybrid Recommender System



Combine multiple methods in order to take advantage of strengths and alleviate drawbacks

- **Weighted**
  scores/votes of several recommendation techniques combined together to produce a single recommendation

- **Switching**
  system switches between recommendation techniques depending on the current situation

- **Mixed**
  recommendations from several different recommenders presented at the same time

Source : Hybrid Recommender Systems: Survey and Experiments, http://dl.acm.org/citation.cfm?id=[illegible]2

Critiquing Recommender System

So far, we have this

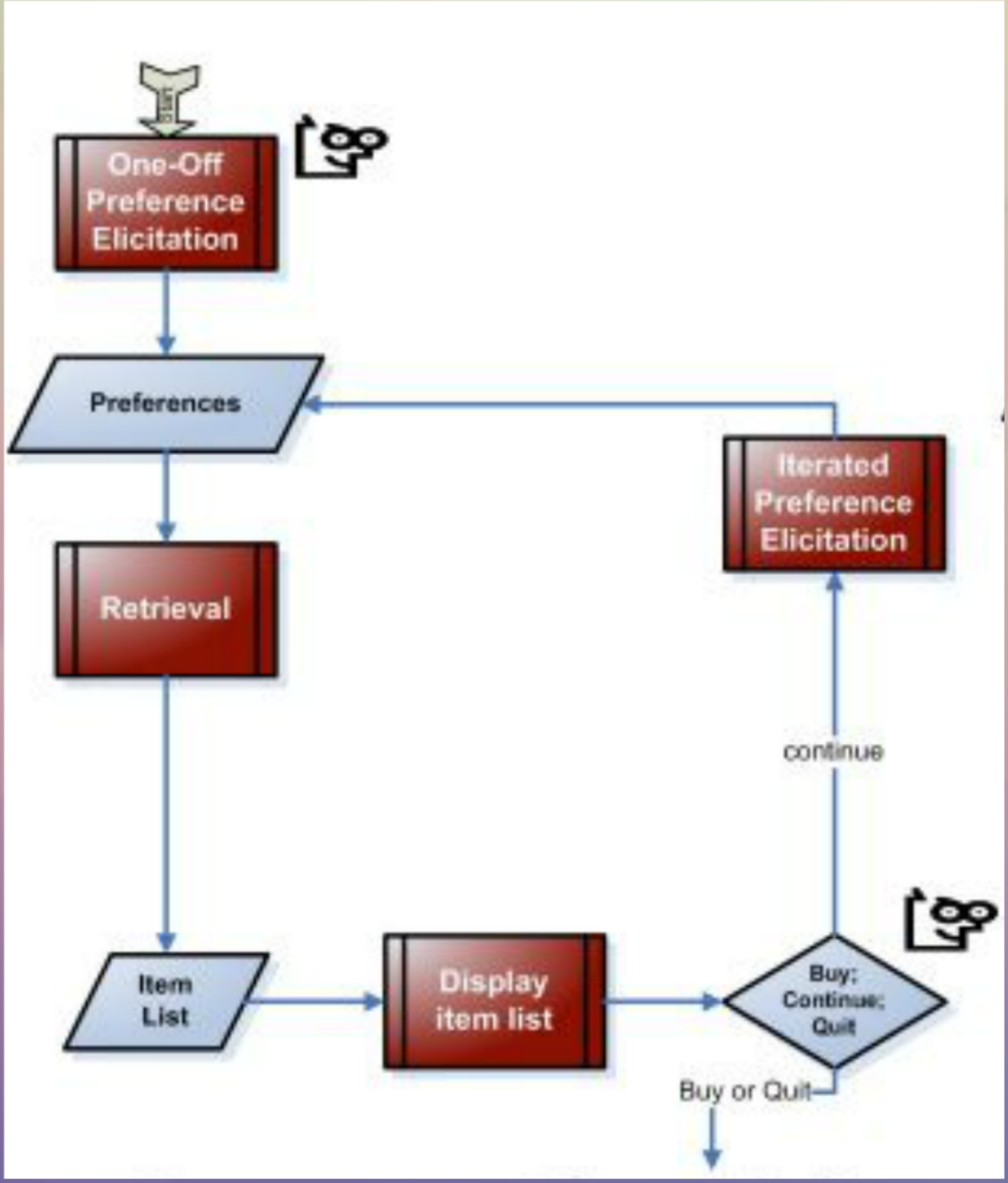
Image Source : ESSIR 2013 Recommender Systems tutorial, http://www.slideshare.net/kerveros99/essir-2013-recsysfinal-25957057

If no product of interest in recommended set, start over with reformulated search?

"NARROWING" PROBLEM

Image Source : ESSIR 2013 Recommender Systems tutorial, http://www.slideshare.net/kerveros99/essir-2013-recsysfinal-25957057

Conversational Recommenders



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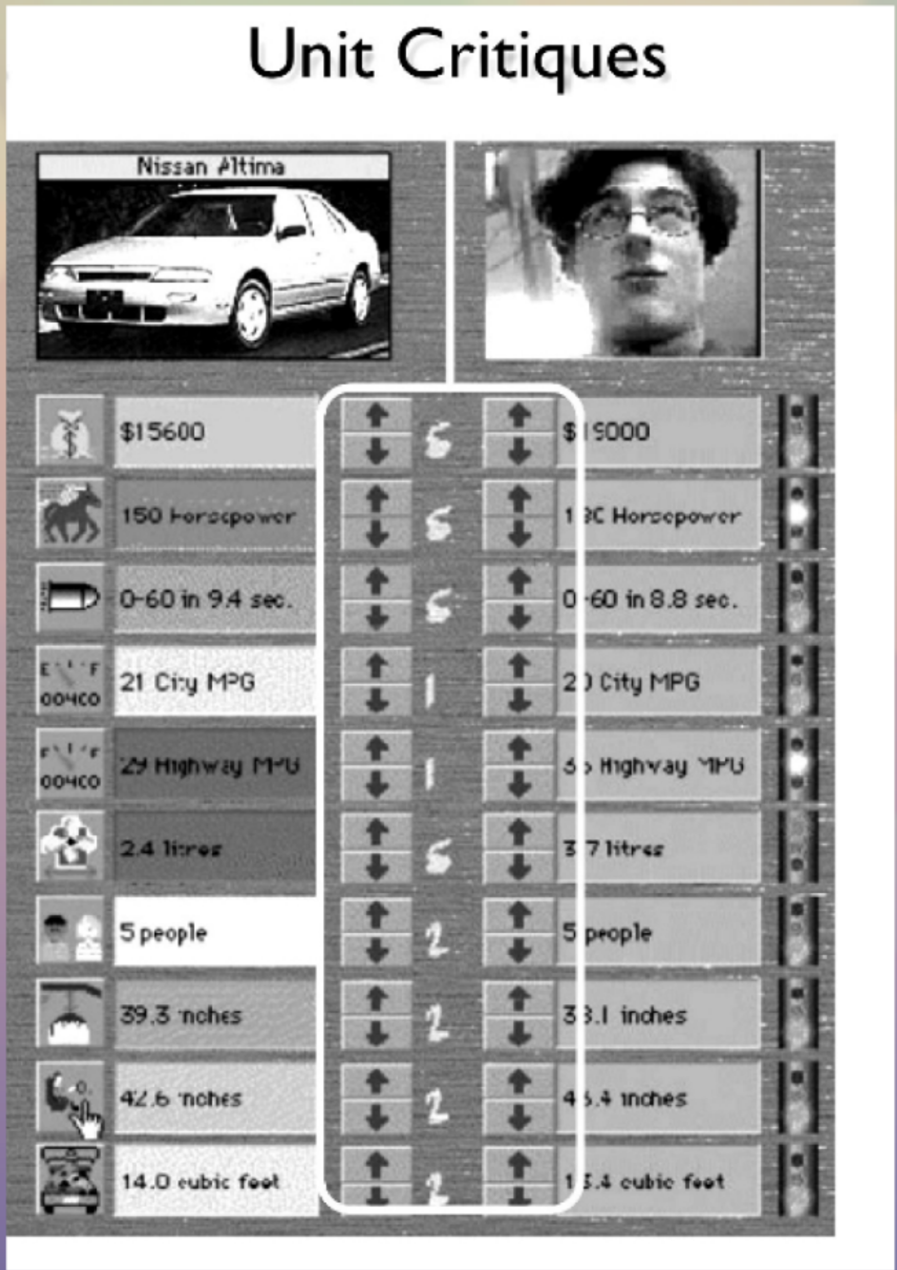
How to elicit user feedback?

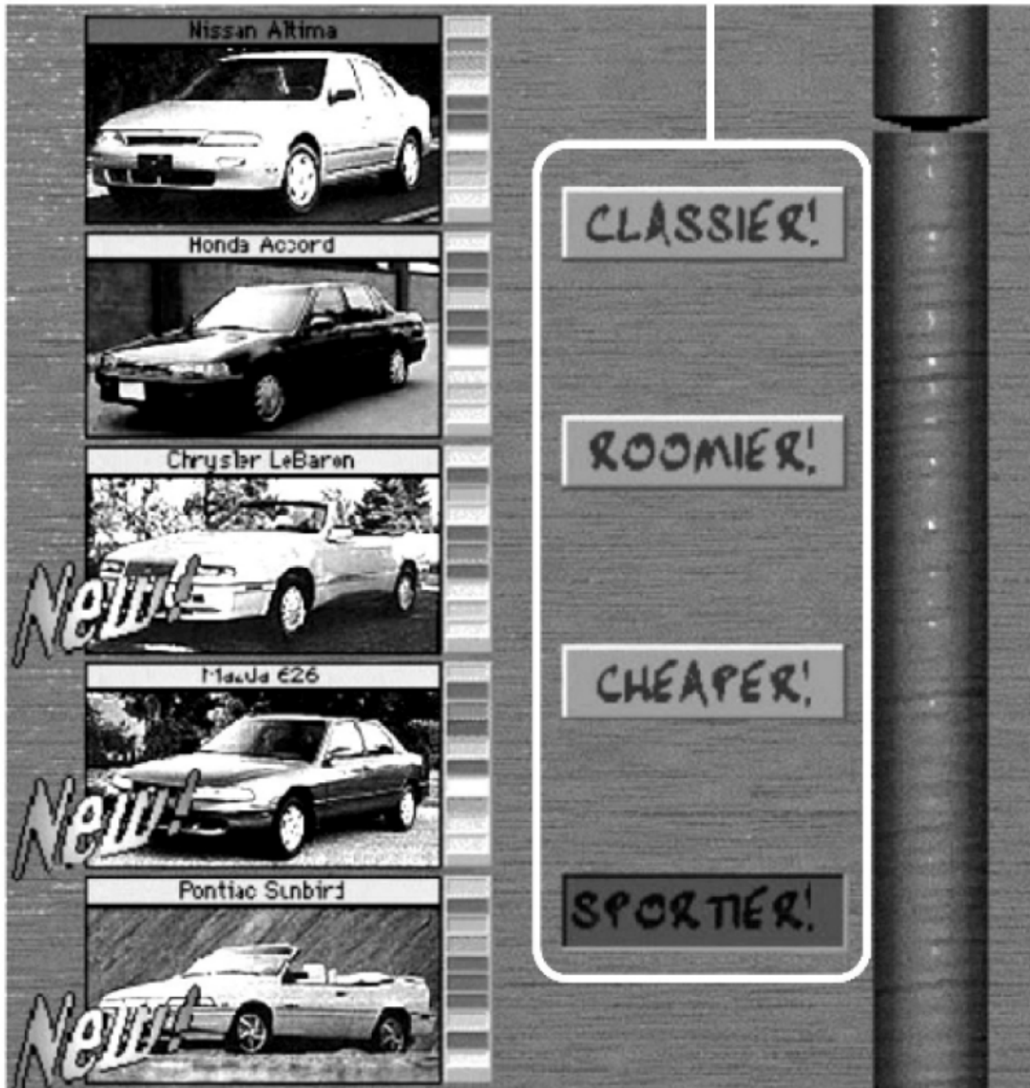
Fundamental unit
 - critique

Feedback is now a
part of the system



S : Recommender Sytems Handbook: Francesco Ricci et al.

Compound Critiques



Conversational Recommenders

Source : Critiquing with Confidence,http:link.springer.comchapter/10.1007/11536406_34

Problems?

- Limited product space discovery

- Assumes that the user knows exactly what he wants

- Long winded ?

Evaluation of Recommender Systems

Recommendation System Properties

Experimental Settings

Prediction Accuracy

$$accuracy = \frac{number\ of\ successful\ recommendations}{number\ of\ recommendations}$$

$$accuracy = \frac{\sum_{(\forall u,i/r(u,i)=1)} 1 - |p(u,i) - P(u,i)|}{R}$$

$p(u,i)$ Preferences of a user

$P(u,i)$ Predictions of a Recommender system

$R = \sum_{u,i} r(u,i)$ Number of recommended items shown to users

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Good recommendation?

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Serendipity

Solution : Systems that penalize for recommending popular items - since they are less novel.

Must be balanced with similarity !

Source : Metrics for Evaluating the Serendipity of Recommendation Lists, http://link.springer.com/chapter/10.1007%2F978-3-540-78197-4_5

Trust

Solution

1)Trust Network based RecSys

2) Social RecSys

3) Explanation Based

Why was this item recommended?

- Increases user's trust in the system

- More personal feel

Pitfalls

- Not always easy to answer

- Not always necessary

User Interactiveness

- Most important

- Know your users (experienced, novice)

- Is it easy to use

- Is it visually appealing?

-HCI(Human Computer Interaction)

- Changing needs (Netflix)

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Other factors

- Confidentiality
- Privacy
- Maintainability
- Item space coverage

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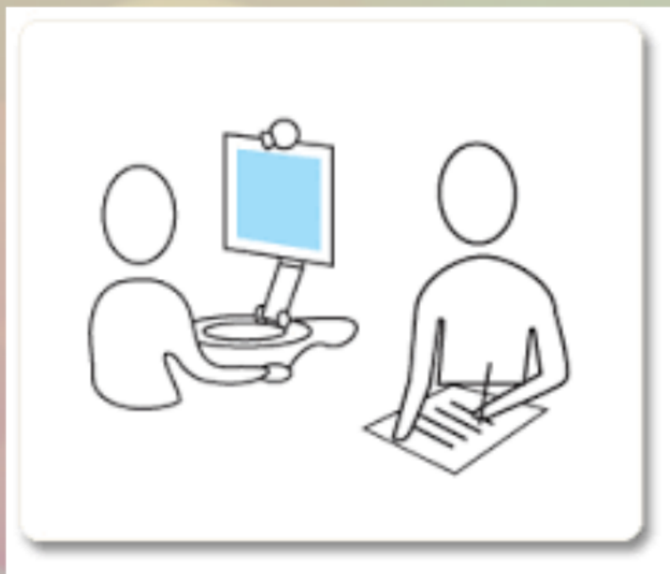
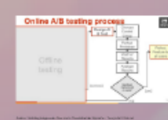
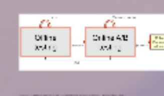
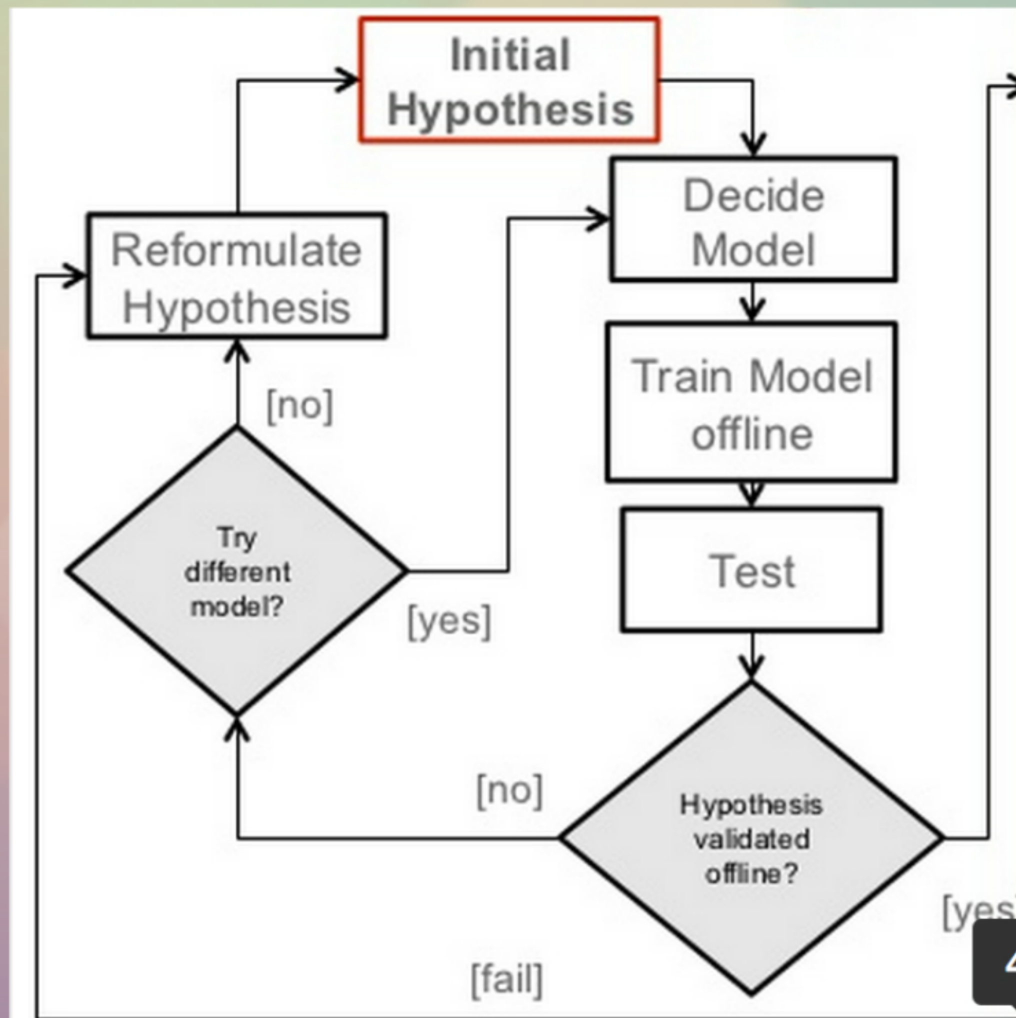
Under Experimental Settings







Offline Experiments



Source : Building Large-scale Real-world Recommender Systems - Recsys2012 tutorial
http://www.slideshare.net/xamat/building-largescale-realworld-recommender-systems-recsys2012-tutorial

Offline Testing

- Low cost.
- Test a number of different approaches

- Simulate user behavior. How?
 1)Take previous data (outdated?)
 2)Algorithm to generate user data (close to real world?)

- Test the core functionality of the recommender

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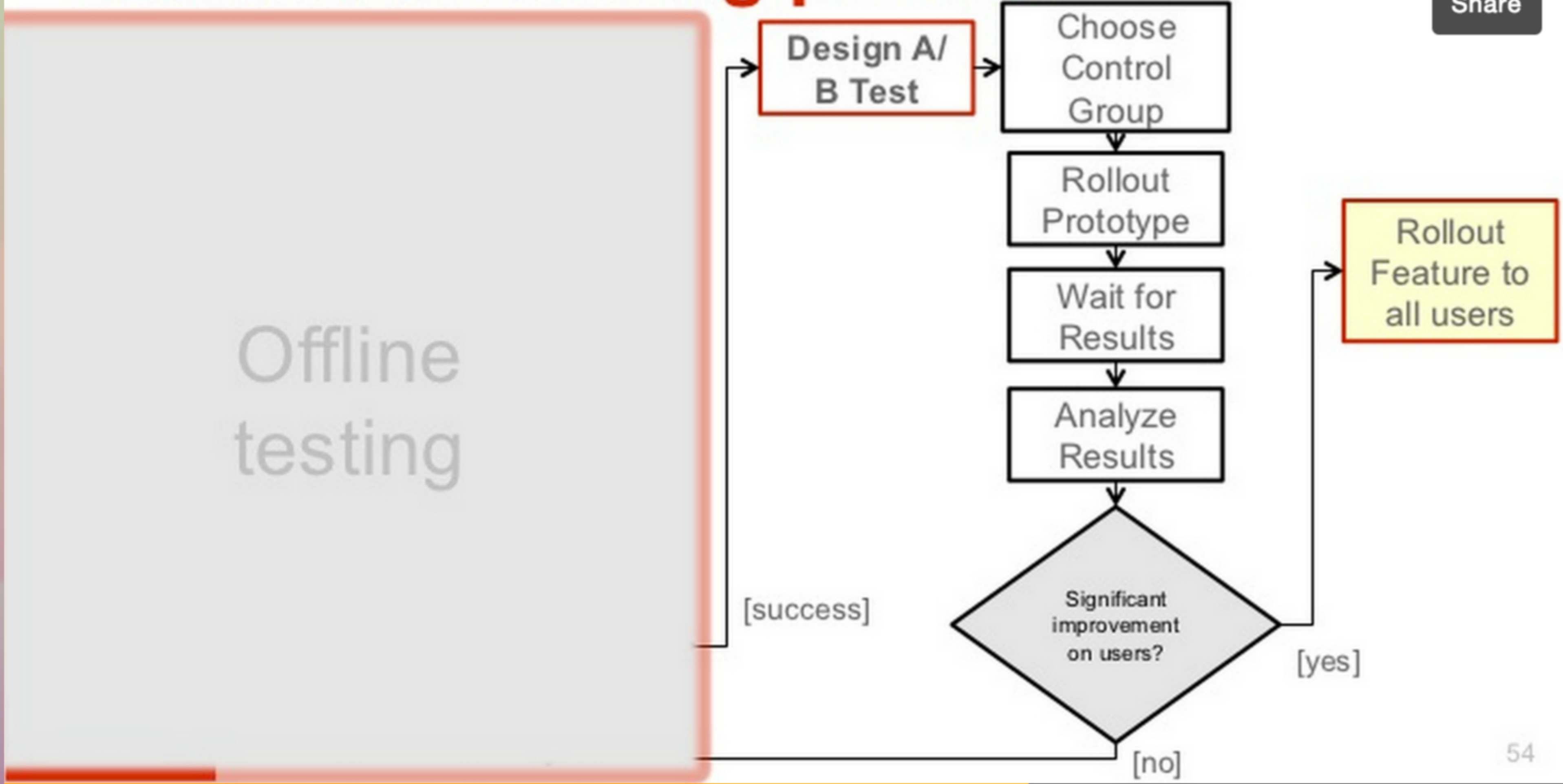
Online A/B testing process



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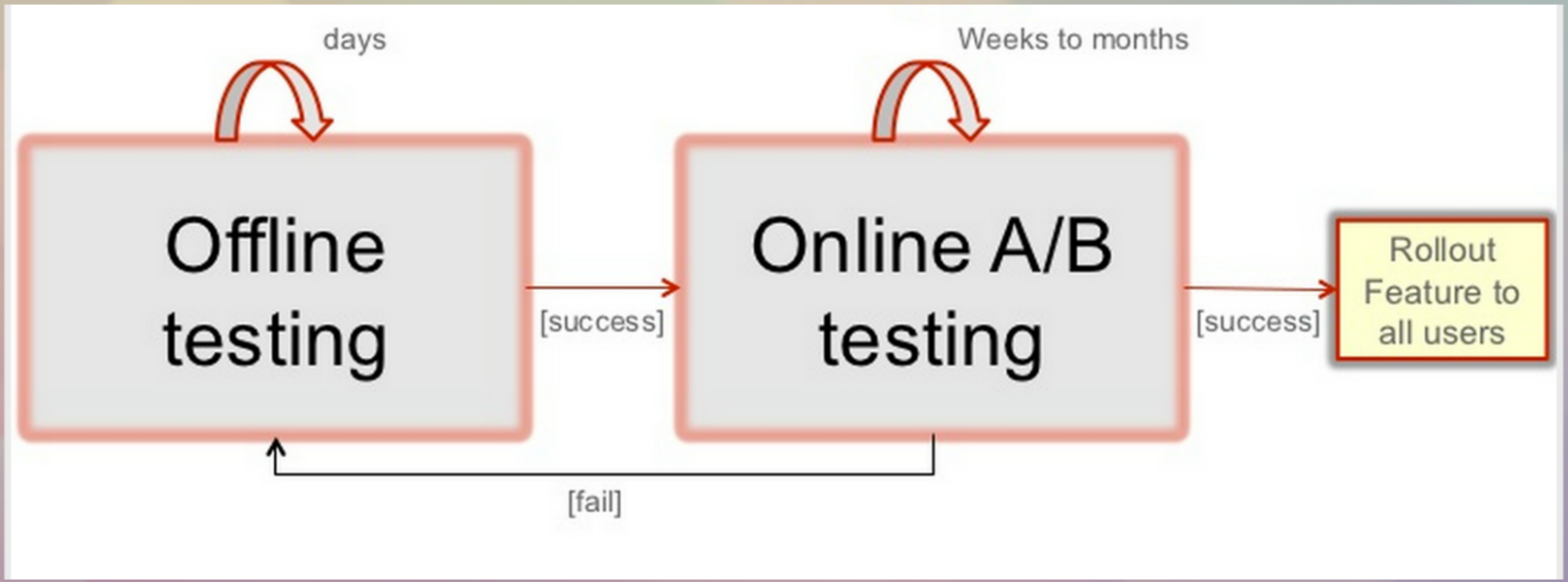

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USER
RATINGS
TRUST
ITEMS
RECOMMENDERS
PERFORMANCE
SIMILARITY
RECOMMENDATION
COVERAGE
RECOMMENDER
TRUST-AWARE
ACCURACY
RECOMMENDATIONS
APPROACHES
REPUTATION
POPULARITY
VALUES
RATING
RATED
TRUSTED
FRIENDS
APPROACH
RS
HYBRID
CLUSTER
CF
SYSTEM
STRATEGIES
METRICS
CORPUS
RATE
PREDICTION
MAE
UMAE
EVALUATION
ITEM
FILTERING
FEATURES
ABNORMALITY
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SOCIAL
MODEL
MATRIX
SCORE
FUNCTION
QUALITY
PREDICT
POPULAR
USER'S
RELATIONSHIPS
RANGE

Questions ?

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