Novelty and Diversity Enhancement and Evaluation in Recommender Systems and Information Retrieval

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IRG

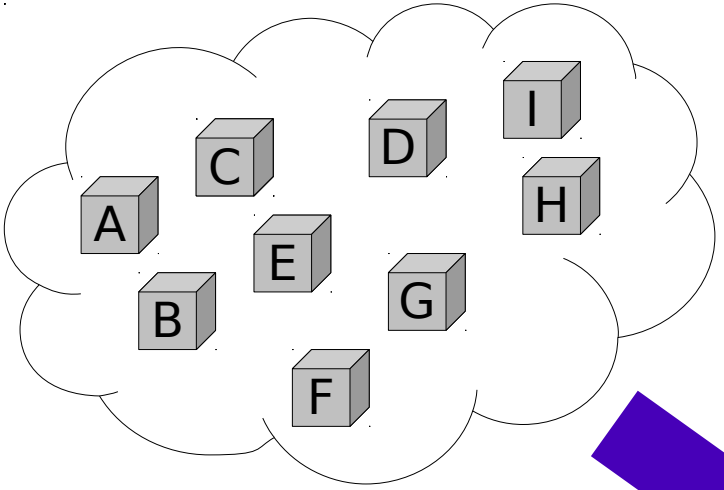
UAM

About me

- PhD student and Teaching Assistant at Universidad Autónoma de Madrid (Spain).
- Supervised by Professor Pablo Castells.
- In 2012 I presented my Master Thesis, which started this doctoral research.

Recommender Systems (1/2)

User

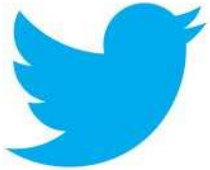


User profile

last·fm
the social music revolution

NETFLIX

amazon.com



You may also like...

X Y Z

Recommendation

LinkedIn

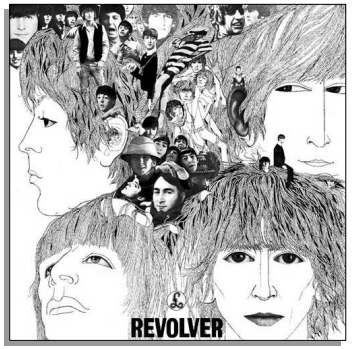
Recommender Systems (2/2)

- Personalized Information Retrieval Systems.
- No query, information need is implicit:
  - *"I would like to listen to (new) music."*
  - *"I would like to watch a movie."*
  - *"What products would I be interested in buying?"*
- Previous interactions as indicator of user preferences.

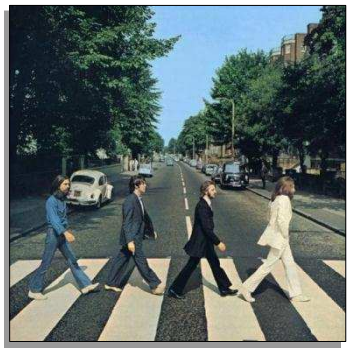
Diversity and Novelty in Recommendations

You bought

Revolver



Abbey Road



Recommendations:


Rubber Soul


With The Beatles

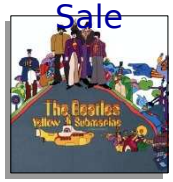

Beatles for Sale

Let it be

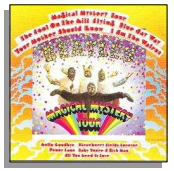
Help!

A Hard Day's Night


Sgt. Pp's Lonely Hearts Club Band



Yellow Submarine



Magical Mystery Tour

The White Album

Please Please me


1967-1970 (Blue)


1962-1966 (Red)

Past Masters

Past Masters Vol 2


Dark Side of the Moon


Some Girls

Bob Dylan

...

Diversity in Search

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State of the Art

"Each diversity or novelty paper in RS has its own definition, metrics and methods"

- Lack of formalization and standardization in Recommender System.
- There are few studies connecting Search Result Diversification with Diversity in Recommender Systems.

Research Methodology

- Comprehensive study of the State of the art for both IR and RS.
- Definition and formalization of tasks.
- Development of metrics and algorithms.
- Offline experiments:
  - Publicly available data sets:
    - MovieLens1M (movies, 6K users, 4K items, 1M ratings).
    - Netflix (movies, 480K users, 18K items, 100M ratings).
    - MSD (music, 1M users, 380K items, 48M play counts).
- Online evaluation:
  - Crowdsourced evaluation (Crowdflower, Amazon Mechanical Turk)

Research Goals

- Unification and formalization of novelty and diversity metrics for Recommender Systems.
- Connection between principles in Search Result Diversification and Diversity in Recommender Systems.
- New novelty and diversity enhancement methods.

Unified Framework for Diversity and Novelty Metrics (1/2)

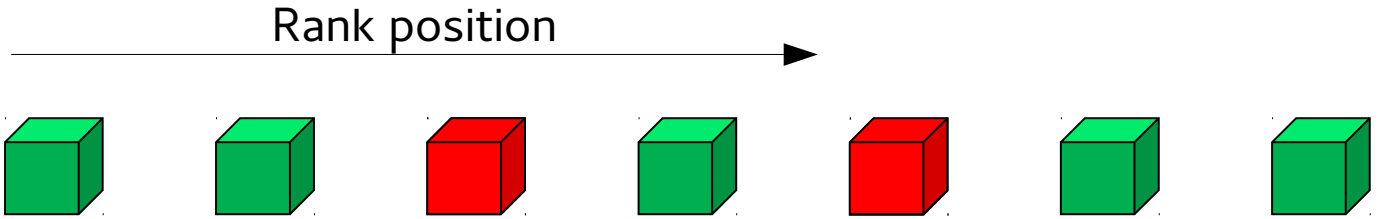
- (**RecSys 2011**) Expressing many novelty and diversity metrics for RS and incorporate rank and relevance awareness:

$$m(R|\theta) = C \sum_{i \in R} p(choose|i)\, nov(i|\theta)$$

- Item novelty models:
  - θ="all users" ➡ global novelty (anti-popularity)
  - θ="user profile" ➡ personalized novelty
  - θ="previous recommendation" ➡ temporal diversity
  - θ="other items in recommendation" ➡ intra-list diversity

Unified Framework for Diversity and Novelty Metrics (2/2)

- Choice model: rank and relevance-aware!
  - An item is chosen if it is seen and found relevant.
  - Items not chosen, however novel, do not contribute to the recommendation novelty.



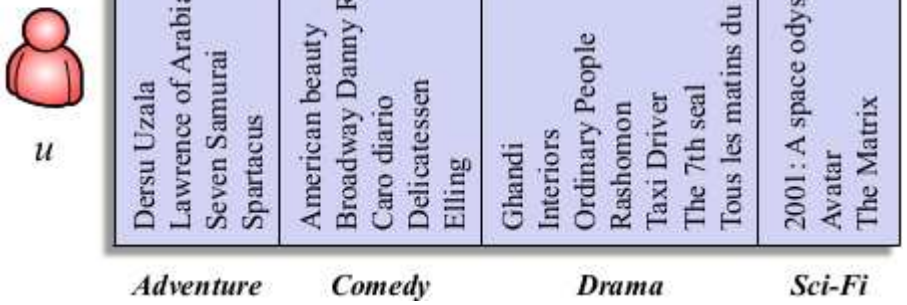
$\boldsymbol{disc(k) = 0.9^{k-1}}$	1	0.90	0.81	0.73	0.66	0.59	0.53
$\boldsymbol{p(rel\|i,u) = r_{u,i}}$	1	1	0	1	0	1	1
$\boldsymbol{p(choose\|i,u,R)}$	1	0.9	0	0.73	0	0.59	0.53

Connection between IR and RS (1/3)

- Search Result Diversification:
  - Avoiding redundant documents.
  - Coping with query ambiguity.
  - Coping with query underspecification.
- Diversity in Recommendation Lists:
  - Avoiding redundant items.
  - Users usually have different tastes.
  - Users expect varied recommendations.

Connection between IR and RS (2/3)

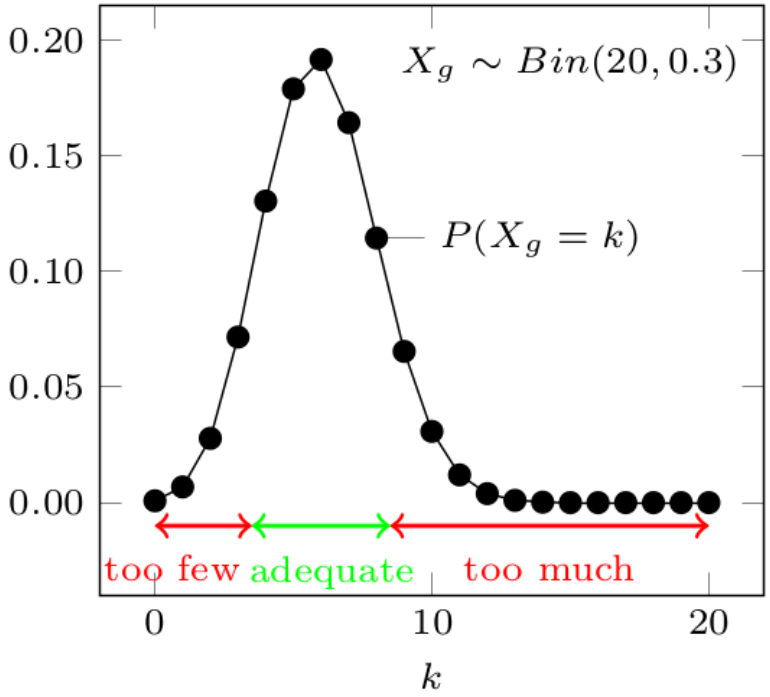
- A straightforward translation of concepts...
  - Document ➡ Item
  - Query ➡ User
  - Subtopics ➡ Tastes



- ...allows to adapt IR diversity metrics and diversification techniques to RS (**SIGIR 2011**):
  - Metrics: ERR-IA, α-nDCG, S-recall, ...
  - Algorithms: MMR, IA-Select, xQuAD, ...

Connection between IR and RS (3/3)

- IR diversity metrics present some inconveniences:
  - They consider a infinite size ranking of documents, they do not "target" small, fixed-size results lists.
  - Presenting a redundant document w.r.t. some subtopics is fine as long as it covers other non-redundant subtopics.
- We propose a **Binomial Framework** for considering coverage, redundancy and size-awareness in diversity in RS (**RecSys 2014??**).



Novelty and Diversity Enhancement (1/3)

- Explicit relevance models for intent-oriented search result diversification (**SIGIR 2012**).
  - Alternative formulation of well-known aspect-based diversification algorithms: IA-Select and xQuAD.
  - From a generative model to a relevance model.

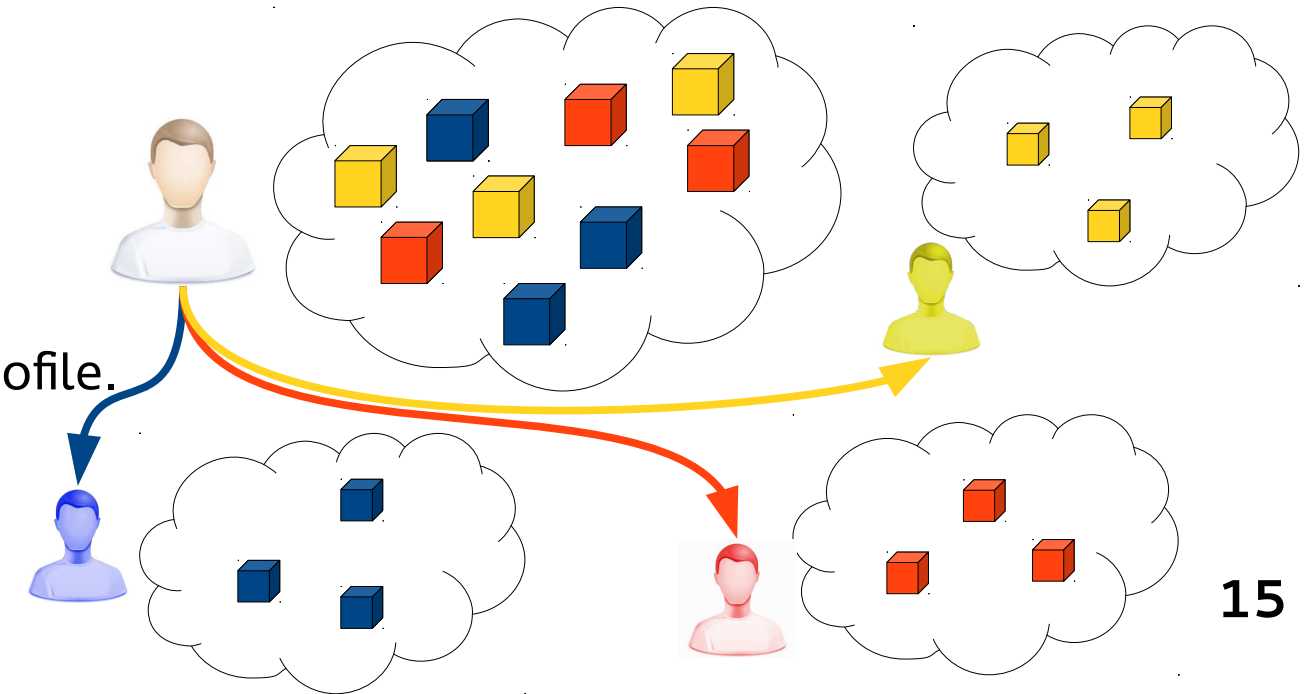
$$p(d|c,q) \rightarrow p(rel|d,c,q)$$

$$p(i|c,u) \rightarrow p(rel|i,c,u)$$

  - Competitive or better performance than the original algorithms.

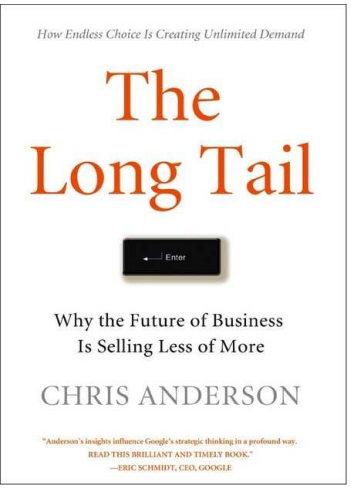
Novelty and Diversity Enhancement (2/3)

- RS diversification with user-sub-profiles (**OAIR 2013**).
  - xQuAD: query reformulations (sub-queries) as proxies for subtopics.
  - We propose sub-profiles as an analogy to sub-queries.
- Method:
  - Profiles are partitioned.
  - Recommendations are created for each sub-profile.
  - Combined with xQuAD.



Novelty and Diversity Enhancement (3/3)

- Recommending users to items in Collaborative Filtering (**RecSys 2014??**):
  - Improving Item novelty
  - Improving Sales diversity
  - Concept: recommending users to items.
  - Two approaches:
    - User-item rating matrix transposition: inverted neighborhoods for nearest neighbors approaches.
    - Probabilistic reformulation: isolate the popularity bias by means of the Bayes rule.



$$p(i|u) = \frac{p(u|i)}{p(u)}p(i)$$

Open Issues

- Connection between IR diversity and RS diversity:
  - Further analysis required?
  - Other ways to exploit the similarities between them?
  - What other fundamental differences are there?
  - Ideas from RS to IR?
- Conducting online evaluations:
  - How to do perform them?
  - What to evaluate? Metrics, algorithms?

Thank you for you attention!