

Approaches to Recommendations (and beyond)

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Recommender Systems

RSs are reshaping the world of e-commerce, helping customers find and purchase products, such as songs, books, movies, or news

The aim is to transform a regular user into a buyer

As the volumes of information grow, the importance of RS is likely to continue to grow and to have a key role in many different industry domains

- Amazon
- Netflix
- Google News
- Pandora

“We are entering the **age of recommendations**” [Henrik Schinze, Google Intelligence]

Some examples from content optimization

- Simple version
 - I have a content module on my page, content inventory is obtained from a third party source which is further refined through editorial oversight. Can I algorithmically recommend content on this module? I want to improve overall click-rate (CTR) on this module
- More advanced
 - I got X% lift in CTR. But I have additional information on other downstream utilities (e.g. advertising revenue). Can I increase downstream utility without losing too many clicks?
- Highly advanced
 - There are multiple modules running on my webpage. How do I perform a simultaneous optimization?

Recommendation Systems

bohemian rhapsody

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#29S Policia antidistur...

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Minecraft SNAPSHOT ...

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DESCARGA:
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De sniper va la cosa!! - ...

Destacados

iPhone 5: Review pe...
sole **DONNE!**
de Makeupdelight2009
140333 reproducciones

C'era una volta in America torna al cinema
de bonsaitv
4664 reproducciones

Siria 06 - Howor
de pulsemediadoc
428 reproducciones

Recommendation Systems

- Choose your clip
- ... coming back to the youtube home page...

sesión para
canales a la
principal

lar sesión

on YouTube

mento

enimiento

es

lia

animación

s

ltv



De YouTube



Whatsapp

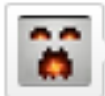
Video hace 1 día



1204

Video de Arturo
<http://www.youtube.com/watch?v=...>

cia anti-distur...



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Minecraft SNAPSHOT ...



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De sniper va la cosa!! - ...

Mostrar anuncio

Recomendaciones »



**Bohemian Rhapsody
by Queen FULL HD**

de KORNTAILAND

5983641 reproducciones



**Queen - 'Who Wants
Live Forever'**

de queenofficial

6361322 reproducciones



**Queen - Elton John &
Axl Rose - Bohemian**

de Matias Der Meister

1477682 reproducciones



**The Muppets:
Bohemian Rhapsody**

de MuppetsStudio

27990367 reproducciones



**Queen - 'The Show
Must Go On' (Music**

de VVasp

37058651 reproducciones

YAHOO! SITES

Edit

- Mail
- Autos
- Chat
- Fantasy Sports
- Finance
- Games
- Horoscopes
- HotJobs
- Maps
- Messenger
- Movies
- omg!
- Personals
- Shopping
- Sports
- Travel
- Updates
- Weather

More Yahoo! Sites

MY FAVORITES

Edit

- eBay

TODAY - July 14, 2010



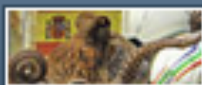
World Cup octopus could make millions

Paul the octopus is in high demand after a perfect run of predicting soccer game winners. » Possible opportunities

More on the octopus
Cup winners and losers
U.S.'s top moments



Salsa tied to food illness



Octopus could be worth millions



Lottery winner rich in mystery



High schooler's impressive dunk

5 - 8 of 28

NEWS WORLD LOCAL FINANCE

- 9 killed, 10 missing as typhoon lashes Philippines | Photos
- Testing delayed on tighter cap for Gulf oil well | Photos
- W.Va. mine disaster prompts bill to toughen worker safety rules
- Military won't establish 'separate but equal' housing for gays
- Small banks struggling despite gov't bailouts, watchdog reports
- Tiny mushroom blamed for 400 deaths in southwest China
- CHP pursuit ends in two-car crash in San... - SJ Mercury N...
- Oakland talks break down: layoffs for 80... - S.F. Chronic...

TRENDING NOW

- | | |
|------------------------|------------------------|
| 1. Kourtney Kardash... | 6. Susan Boyle |
| 2. Anna Chapman | 7. Job Search |
| 3. Al Pacino | 8. Yogi Berra |
| 4. French Toast Rec... | 9. Philippines Typh... |
| 5. Nina Garcia | 10. Sunscreen |

Recommend search que

Recommend packages

Image

Title, summary

Links to other pages

general

Example applications
Search: Web, Vertical
Online Advertising
Content

Item Inventory

Articles, web page,
ads, ...



Context

query, page, ...

USER



Use an automated algorithm
to select item(s) to show

Get feedback (click, time spent,..)
Refine the models

*Repeat (large number of times)
Optimize metric(s) of interest
(Total clicks, Total revenue,...)*

Items								
i_2	i_3	i_4	i_5	i_6	i_7	i_8	i_9	i_{10}
	1	4	4		5		3	2
1			5	4	4	3	1	
1	1	5	4		4	2		3
2		2	1	3		3	5	
	2		1		3		5	5
2			3	4	5	2	3	3
	5	3	3	2			1	
5	5	3		3	2	1	1	
1	2	5	4		4		2	
1		5	5	3	5	3	2	3
		2		3	3		5	5
2	2	2	1		3	3		5
4				3	3	1		1
4	5	3	3	3	3	1	1	
	5	3	3	3			1	1

Rating Matrix

- RSs provide users with a list of products that meet their interests
- As the volume of the catalog increases, **Collaborative Filtering** is becoming the effective approach
- Users' unobserved preferences are estimated by considering only past preference observations
- The recommendation list can be built by drawing the (predicted) highly-ranked items

Evaluating Recommendations



It is one of the biggest challenge in the area

Current techniques are far from measuring the real impact of recommendations on users' purchasing activities

Offline evaluation rarely match up to online results

Probabilistic topic modeling provides a powerful framework for the unsupervised mining of a large collection of grouped data

Mixed membership assumption

Each entity can exhibit multiple topics

Each **topic** specifies a probability distribution over a finite number of possible objects (words of a vocabulary)

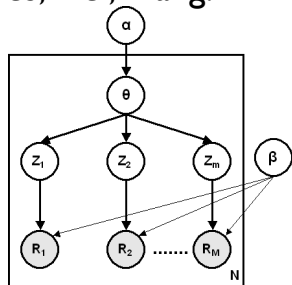
Topic modeling techniques can uncover the underlying **semantic themes** of a collection

Recommendations

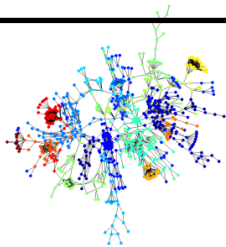


User Rating Profiles for Collaborative
Marlin. In NIPS 2003

Active Topic Modeling for Recommending
Articles, Blei, Wang. In KDD 2011



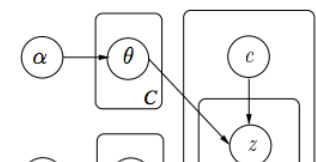
Community Detection



Based Community Structure Discovery
for Large-Scale Social Networks, H.
al. In IEEE Intelligence and Security
2007

Stochastic models for discovering e-
structures, D.Zhou et al. In WWW 2006

Membership Stochastic Blockmodels, E.
al. In Journal of Machine Learning 2008



Text Analysis



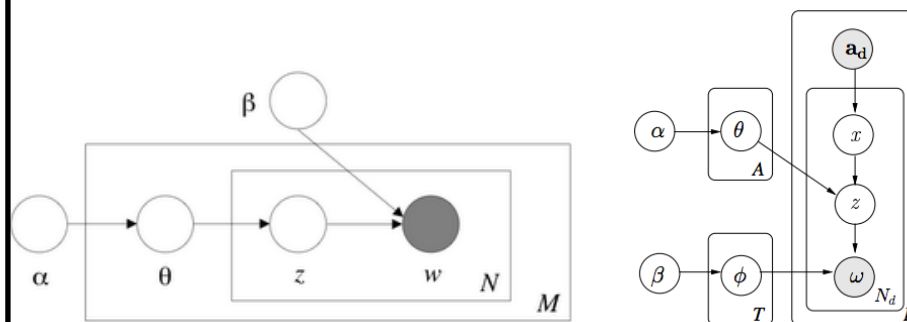
• Probabilistic latent semantic analysis, T. Hofmann. In UAI,
1999

• Latent Dirichlet allocation, D. Blei, et al. In Journal of
Machine Learning Research, 2003

A correlated topic model of Science, D. Blei and J. Lafferty. In
Annals of Applied Statistics, 2007.

• Dynamic topic models, D. Blei and J. Lafferty. In ICML, 2006

• The author-topic model for authors and documents, M.
Rosen-Zvi, et al. In UAI, 2004

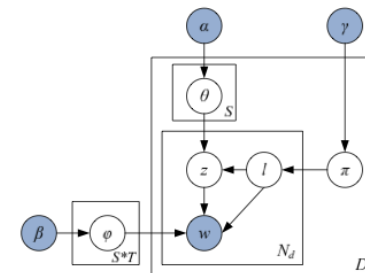


Sentiment Analysis

• Joint sentiment/topic model for sentiment analysis,
C. Lin, Y. He. In CIKM 2009

• [Topic sentiment analysis in twitter: a
hashtag sentiment classification approach](#). In CIKM 2011

• Topic Sentiment Change Analysis, Y. J.
2011



Multimedia

• Matching words and pictures, K. Barni
Journal of Machine Learning Research

• Video fingerprinting using latent
allocation and facial images, N. Vret
Pattern Recognition, 2012

Name that Song: A probabilistic approach
querying on music and text. [E. Br](#)

[Freitas. In NIPS](#)



Will the girl like
Titanic?



She likes
romance

Other genres

Other genres

Romance

Titanic is a
popular
romantic

Exploiting Users' Behavior in Social

Users' behavior on web is always more influenced by its social interaction with other users

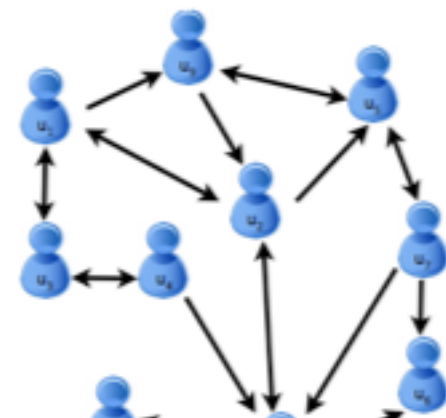
The traditional independence assumption does not hold on social based information systems:

- users activities are the direct product of the influence exerted by their friendship network

Exploiting Social Influence in
Recommender Systems

Influence Propagation in

		Items									
		i_1	i_2	i_3	i_4	i_5	i_6	i_7	i_8	i_9	i_{10}
Users	u_1	1		1	4	4		5		3	2
	u_2	2	1			5	4	4	3	1	
	u_3		1	1	5	4		4	2		3
	u_4	2	2		2	1	3		3	5	
	u_5			2		1		3		5	5
	u_6	1	2			3	4	5	2	3	3
	u_7	5		5	3	3	2			1	
	u_8		5	5	3		3	2	1	1	

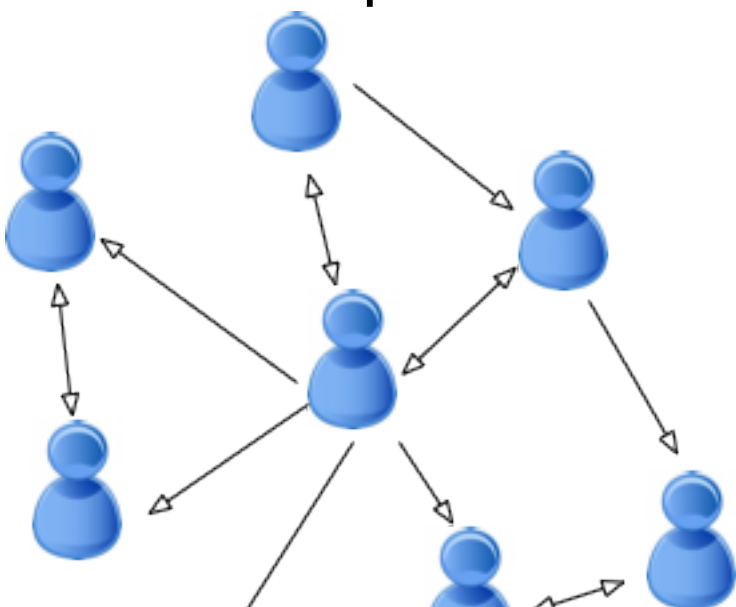


Propagation Models

Despite the fact that users' authoritativeness, expert trust and influence are topic-dependent, the research on social influence has largely overlooked this aspect

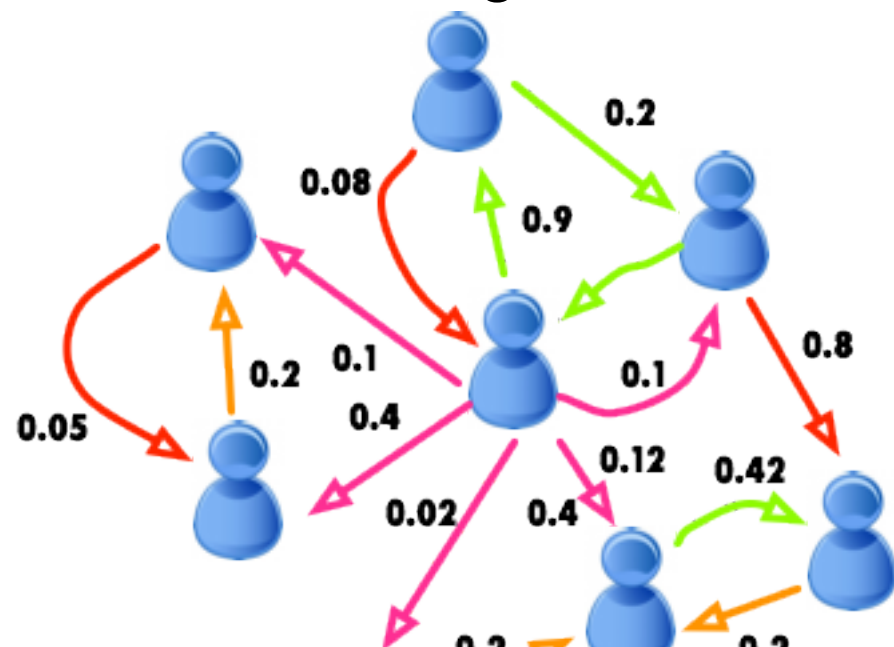
Input:

Social Network + Action Log
Information + number of
topics K



Output:

Topic-Aware Influence
Strength



Propagation Models

Probabilistic Topic Models

Mixed Membership assumption
(Users exhibit different interests)

Co-occurrence patterns identify
semantically related objects

Bag-of-words

Independence: The behavior of
each user is assumed independent
from the others

Often the time dimension is not
considered

The vocabulary (item-set) is fixed

Influence Propagation Models

A social network plays a fundamental role
medium for the spread of information

The action of individuals can induce their friends
to act in a similar way

At a given timestamp, each node is either active
or inactive

The node's tendency to become active increases
monotonically as more of its neighbors become
active

Time unfolds deterministically in discrete steps

Desired property of a diffusion model: the
expected spread is sub-modular and monotonic

The **AIR** Propagation Model

Authoritativeness of a user in a topic: how strong is the influence of a user on the topic

Interest of a user for a topic: how much a topic meets a user's interest

Relevance of an item for a topic: the weight measuring how items relate to topics

Social Communities

Users may participate in different and **overlapping communities**

Each community is a subset of users characterized by high **link density** and **interests homogeneity**

Users influence is estimated at community-level

1) Who are the most influential nodes on a topic for a given community?

2) Who are the **innovators** and the “**parrots**” in each community?

Thanks!!