

Applying Topic Model in Context-Aware TV Programs Recommendation

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Introduction

In IPTV systems, users' watching behavior is influenced by contextual factors like time of day, Live/VOD condition etc.. Yet modern context-aware recommending models (e.g. tensor) only consider general contextual influences while overlook users' reliance on various contextual factors. In this work, we utilize Latent Dirichlet Allocation (LDA) to overcome this issue. An extension to user-oriented LDA is proposed by adding a probabilistic selection node in the probabilistic graphical model, so that detecting users' inclination on different contextual factors is achieved.

Contributions

- Involving contextual factors in LDA model for TV programs recommendation to detect the variation of users' preference;
- Defining corresponding probabilistic query strategies under specific algorithm and watching scenario;
- Conducting experiment on the data from a campus TV content delivery system "Vision" in Lancaster University;
- Representing the effect of the model w.r.t. both relevance and diversity;
- Visualizing the clustering effect on TV programs of this topic model.

Query Strategies

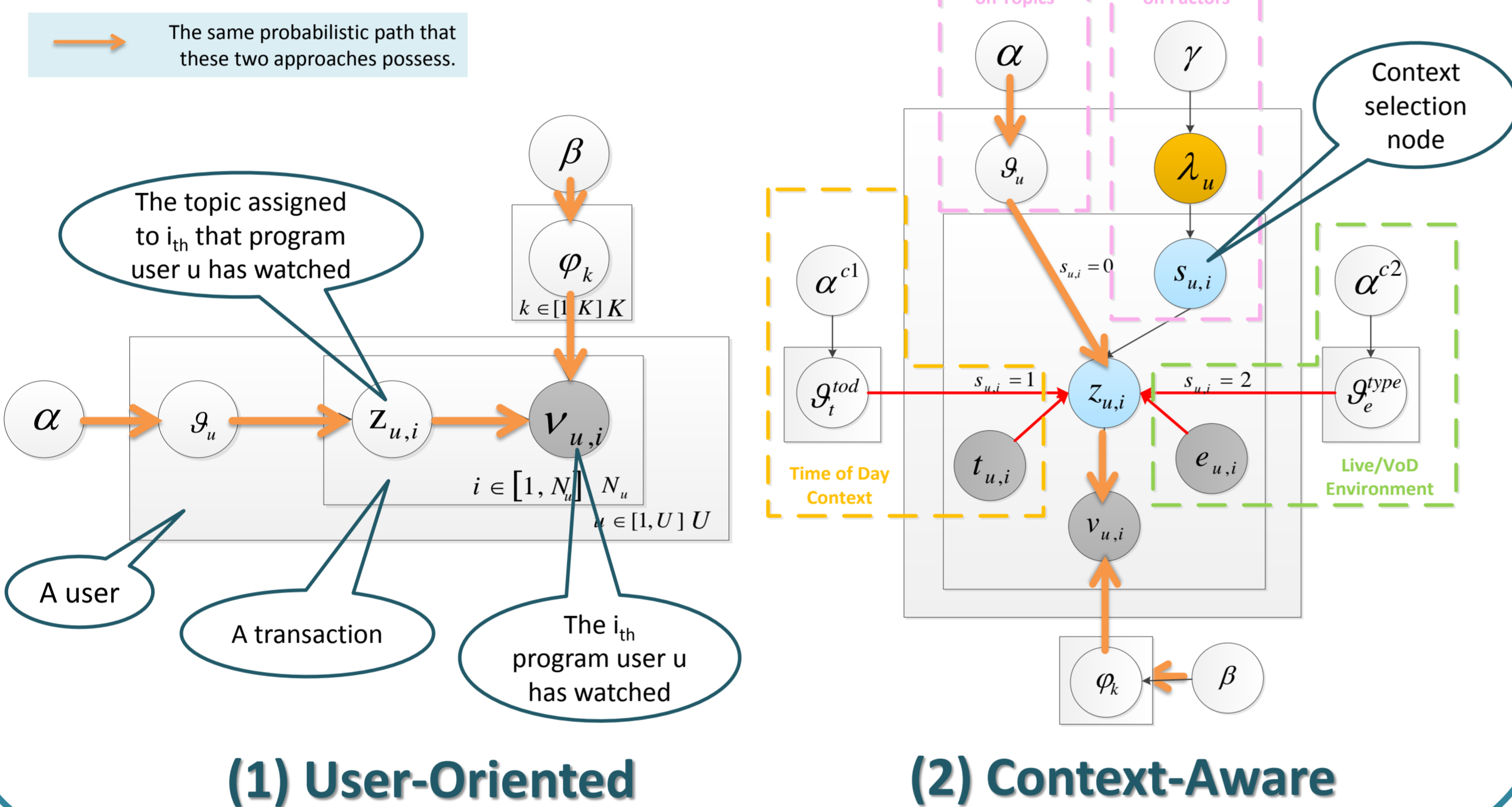
Query Vector Generating

Algorithms	Segment with Single Program	Segment with Given Program p
user-oriented LDA	$\vec{q}_u = \hat{\vartheta}_u$	$\vec{q}_{u,p} = \hat{\vartheta}_u \cdot \hat{\varphi}_{:,p}$
context-aware LDA	$\vec{q}_{u,t,e} = \hat{\lambda}_u * [\hat{\vartheta}_u; \hat{\vartheta}_t; \hat{\vartheta}_e]$	$\vec{q}_{u,t,e,p} = \vec{q}_{u,t,e} \cdot \hat{\varphi}_{:,p}$

Query Executing

Query	Score Calculation for Program v
\vec{q}_u	$p(v u) \propto p(u,v) = \hat{\vartheta}_u \cdot \hat{\varphi}_{:,v}$
$\vec{q}_{u,p}$	$\text{cosine}(\vec{q}_{u,p}, \hat{\varphi}_{:,v})$
$\vec{q}_{u,t,e}$	$p(v u,t,e) \propto \sum_c \lambda_c \cdot p(u,t,e,v s=c) = \vec{q}_{u,t,e} \cdot \hat{\varphi}_{:,v}$
$\vec{q}_{u,t,e,p}$	$\text{cosine}(\vec{q}_{u,t,e,p}, \hat{\varphi}_{:,v})$

Expansion on LDA



Query Results

userid:517	userid:135
The Simpsons	UEFA Champions League
The Big Bang Theory	ITV News at Ten & Weather
BBC News	ITV News & Weather
You've Been Framed!	BBC News
The IT Crowd	Football: England v Germany
Pointless	UCL: Manchester City v Barcelona
How I Met Your Mother	Emmerdale
Take Me Out	The Big Bang Theory
North West Tonight	Football: England v Denmark
Family Guy	heute-journal

○ **User-Oriented LDA**
For users (userid: 517) and (userid:135), the programs recommended reflect their different preferences. It's quite clear that user with id 517 prefers comedies and talk shows, while user with id 135 focuses more on news and sports.

userid:1105	
path_lambda:[0.00025 0.9995 0.00025]	time of day
9:00-12:00	18:00-21:00
The Big Bang Theory	The Big Bang Theory
BBC News	Coronation Street
This Morning	The Simpsons
The Jeremy Kyle Show	Hollyoaks
Frasier	Emmerdale
How I Met Your Mother	How I Met Your Mother
Rules of Engagement	Come Dine with Me
Top Gear	EastEnders
The Simpsons	BBC News

○ **Context-Aware LDA**
For user with id 1105, her/his propensity on contextual factors is told by vector $path_lambda$. The high value 0.9995 shows a higher influence of "time of day" factor than "live/vod" or his/her usual preference. The table provides variant query result under different timing slots for this user.

Experimental Results

- **Converge on Perplexity** (The lower the perplexity is, the better effect the model reaches.)

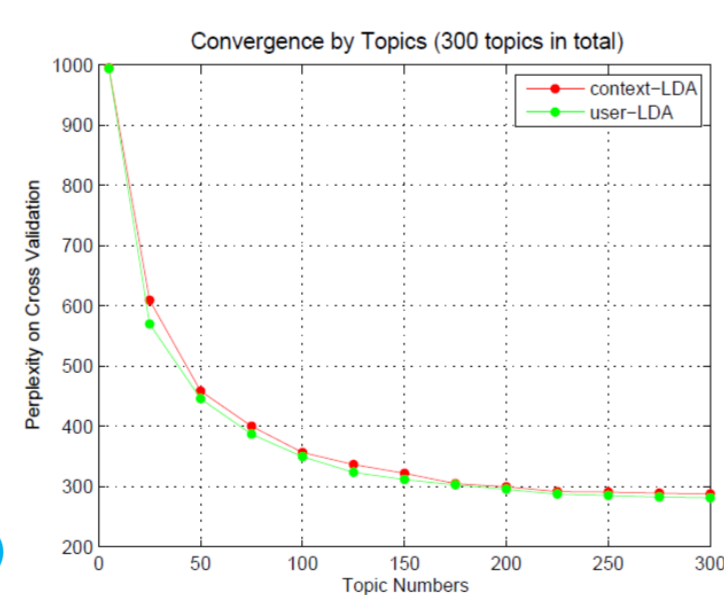
$$\text{perplexity}(v|M) = \exp\left(-\frac{\sum_{u=1}^U \log p(v_u|M)}{\sum_{u=1}^U N_u}\right)$$

For user-oriented LDA:

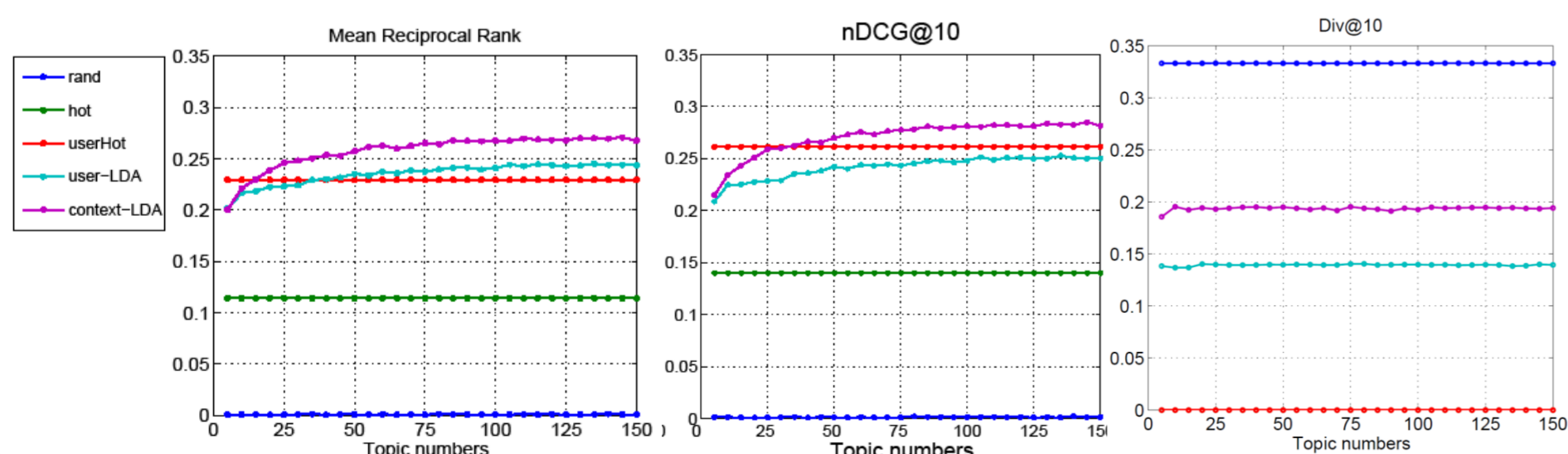
$$p(v_u|M) = \prod_{i=1}^{N_u} \sum_{k=1}^K p(v_{u,i}|z_i=k) \cdot p(z_i=k|u) = \prod_{v=1}^V \sum_{k=1}^K \hat{\phi}_{k,v} \cdot \hat{\theta}_{u,k}^{N_{u,v}}$$

For context-aware LDA:

$$p(v_u|M) = \prod_{i=1}^{N_u} \sum_{k=1}^K \sum_{s=1}^S p(v_{u,i}|z_i=k, s_i=c) \cdot p(s_i=c|u) = \prod_{v=1}^V \sum_{k=1}^K \sum_{s=1}^S \hat{\phi}_{k,v} \cdot \hat{\theta}_{u,k} \cdot \hat{\lambda}_{u,s}^{N_{u,v,s}}$$



- **Relevance and Diversity**



Clustering Effect

Topic1	Topic2	Topic3	Topic4	Topic5	Topic6	Topic7	Topic8	Topic9	Topic10
The Big Bang Theory	Family Guy	How I Met Your Mother	BBC News	Coronation Street	The Simpsons	Come Dine with Me	Top Gear	Match of the Day	I'm a Celebrity...
New: The Big Bang Theory	New: Family Guy	New: How I Met Your Mother	Sportsday	ITV News & Weather	The Simpsons Movie	Supersize vs Superskinny	Best of Top Gear	Match of the Day 2	I'm a Celebrity Get Me Out of Here
Big Momma's House	Ja'mie: Private School Girl	The Tomorrow People	The Papers	I Never Knew That About Britain	Accepted	Double Your House for Half the...	Top Gear: India Special	The Football League Show	The Jonathan Ross Show
New Girl	Sun	The Simpsons Movie	Click	The Martin Lewis Money Show	The Inbetweeners Movie	The Incredible Hulk	Dragons' Den	FA Cup Highlights	ITV News at Ten & Weather
17 Again	Sex and Suspicious Parents...	New: The Call Centre	HARDtalk	Welsh Adventure - Griff Rhys Jones	Fresh Meat	Come Dine with Me Christmas	Top Gear USA Special	UEFA Champions League: Extra Time	I'm a Celebrity... Get Me Out of Here!
Suits	EastEnders	Bruce Almighty	BBC News at Ten	A Great Welsh Adventure	Up All Night: Britain on Call	37 Days	Top Gear Vietnam Special	Rugby League: World Cup Highlights	Britain's Secret Treasures
Rude Tube: Bad Trips	New: Cinderellas of the Slums...	Hairspray	BBC News at Six	Off the Beaten Track	Secret Eaters	Harry's South Pole Heroes	Motorway Cops	Film 2014	Mystery Map
New: Troy	Disney's The Fox and The Hound	Crocodile Dundee II	The Film Review	Northumberland with Robson Green	The Repo Man	Great TV Mistakes	Top Gear Africa Special	The Sky at Night	I'm a Celebrity... Coming Out
Dads	2 Fast 2 Furious	The Island with Bear Grylls	Meet the Author	National Television Awards 2014	The Sorcerer's Apprentice	Big Fat Gypsy Christmas: Carols...	Top Gear: Burma Special	The Cube	The Royal Variety Performance
Horizon: Swallowed by a Sinkhole	Would I Lie to You?	The Big Bang Theory: It All...	The Budget 2014	A Great Welsh Adventure with Griff...	Hairy Bikers' Cookbook	Disney's Holes	Top Gear Special	UEFA Champions League Highlights	The Jump

Context-Aware LDA with 200 topics, first 10 topics listed, 38 literally similar programs caught, similar program names are tinted within the same color inside each topic.

Conclusions

- We extend LDA by adding a probabilistic selection node such that either contextual influence or users' inclination on different contextual factor can be learned.
- We visualize the query result and clustering effect of TV program recommender under this probabilistic framework.

Acknowledgement

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