LARS: A Location-Aware Recommendation System

Jae Yong Kim

Contents

- 1. Introduction / Motivation
- 2. Contribution
- 3. LARS Overview
 - a. Spatial User Ratings for Non-Spatial Items
 - b. Non Spatial User Ratings for Spatial Items
 - c. Spatial User Ratings for Spaital Items
- 4. Experiments / Results
- 5. Conclusion

Introduction / Motivation

- Previous Methods:

Collaborative filtering(CF) to suggest personalized items

Community opinions (user, rating, item)

- New form of SNS such as Foursquare and Facebook Places started gaining popularity in 2012

- Why not use location data? (location-based ratings)







Facebook Places Who. What. When. And now where.

Why would Location data be useful?

Preference Locality

South Korea	Nov 6, 2014	\$12,412,781	\$68,974,677
United Kingdom	Nov 7, 2014	\$8,534,697	\$34,452,006

- users from a spatial region prefer certain items



Travel Locality

- The closer it is, the better

AND KT LITE You are now discovering Sinchon & Idae v	9:18 PM	re∢c C	94%	at st				2:25 P	м	· @ +	U \$ 15	156 🕞	You are now discovering Mapo/Gongdeok ~	Q (🛔
Not getting of	out of b	ed.			Sugges	ted							(5.7.) 28882	Near Me
Best Take-O		Dap is	(the		<u>첫</u> 편	2면M3	티인트							nis Baquette + NOLDE Deltrins
	2.4	TE	-		서움	1284	ধ							SK Energy SK # # 2
Rating ~		500m	€ Filter		EAT	말았는 4	48						6525 7-Ekw ME-91-01113	DMC和01단지아파트
						8							CU WHWEERIARE ACTORNE B WHWEERIARE HEROORE HEROORE	O Dohe Mai Oh D Shashing Shashing Shashing Shashing Hi Mari Hi Mari
1. Hanlim Donga Sinchon & Idae 173m ⊕ 36117 ≠ 46	Sincho	to Loco (Ma 1 & Idae 246m 80 ≠ 112	···· 4.6	q	w	e	r	t	y I	1	0	р	성영월드립타크 3년치아학표	
	<u>ئ</u>	Sec. 1.	J.	а	s	d	f	g I	h .	i	11	ñ	Google	World Cup Stadum
ALC: N				\diamond	z	x	с	۷	b	n	m	\otimes	1. Trattor	*
8 内 [*]	Ð			123		ą.		esp	acio		But	scar	© 20,934 ×	·23 서울월드컵경기장

Why would Location data be useful?

Preference Locality

South Korea	Nov 6, 2014	\$12,412,781	\$68,974,677
United Kingdom	Nov 7, 2014	\$8,534,697	\$34,452,006

- users from a spatial region prefer certain items



Travel Locality

- The closer it is, the better

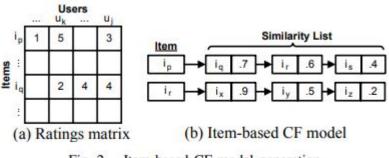
AND KT LITE You are now discovering Sinchon & Idae v	9:18 PM	re∢c C	94%	at st				2:25 P	м	· @ +	U \$ 15	156 🕞	You are now discovering Mapo/Gongdeok ~	Q (🛔
Not getting of	out of b	ed.			Sugges	ted							(5.7.) 28882	Near Me
Best Take-O		Dap is	(the		<u>첫</u> 편	2면M3	티인트							nis Baquette + NOLDE Deltrins
	2.4	TE	-		서움	1284	ধ							SK Energy SK # # 2
Rating ~		500m	€ Filter		EAT	말았는 4	48						6525 7-Ekw ME-91-01113	DMC和01단지아파트
						8							CU WHWEERIARE ACTORNE B WHWEERIARE HEROORE HEROORE	O Dohe Mai Oh D Shashing Shashing Shashing Shashing Hi Mari Hi Mari
1. Hanlim Donga Sinchon & Idae 173m ⊕ 36117 ≠ 46	Sincho	to Loco (Ma 1 & Idae 246m 80 ≠ 112	···· 4.6	q	w	e	r	t	y I	1	0	р	성영월드립타크 3년치아학표	
	<u>ئ</u>	Sec. 1.	J.	а	s	d	f	g I	h .	i	11	ñ	Google	World Cup Stadum
ALC: N				\diamond	z	x	с	۷	b	n	m	\otimes	1. Trattor	*
8 内 [*]	Ð			123		ą.		esp	acio		But	scar	© 20,934 ×	·23 서울월드컵경기장

Contribution

- Produce location-aware recommendations using each of the three types of location-based rating within a single classification framework
 - Spatial ratings for non-spatial items
 - non spatial ratings for spatial items
 - Spatial ratings for spatial items

LARS Overview

- Query Model
 - User id U
 - Numeric limit K
 - Location L
 - K recommended Items





- Item-Based Collaborative Filtering
 - Similarity Score for each object -> similarity list
 - Similarity : Cosine Similarity

$$P_{(u,i)} = \frac{\sum_{l \in \mathcal{L}} sim(i,l) * r_{u,l}}{\sum_{l \in \mathcal{L}} |sim(i,l)|} \qquad sim(i_p,i_q) = \frac{\vec{i_p} \cdot \vec{i_q}}{\|\vec{i_p}\| \|\vec{i_q}\|}$$

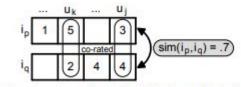


Fig. 3. Item-based similarity calculation.

Spatial User Ratings for Non-Spatial Items

(user, user_location, rating, item)

Preference Locality - User opinions are spatially unique

(1) Locality: recommendations should be influenced by those ratings with user locations spatially close to the querying user location

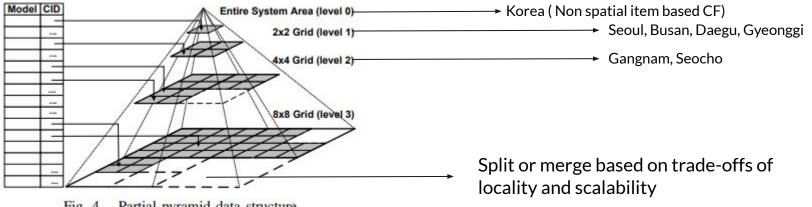
(2) Scalability: recommendation structure should scale up to large number of users

(3) Influence: users should be able to control the size of the spatial neighborhood that influences their recommendation

Spatial User Ratings for Non-Spatial Items

User Partitioning

Divide users into separate spatial neighborhoods then carry on with CF over the 3 attributes



Partial pyramid data structure. Fig. 4.

Spatial User Ratings for Non-Spatial Items

Maintenance

- Regard for new users!
- Rebuild CF model
- Merge / Split (scalability gain vs locality loss)

Query Processing

- (user, user_location, rating, item)
- 1. Use user_location to find its cell location in the pyramid (if cell does not exist due to merging or splitting, return the nearest maintained ancestor cell)
- 2. item-based CF technique using the model stored at its cell
- 3. For the *influence* factor let the user choose which level to process the recommendation

Non-Spatial User Ratings For Spatial Items

(user, rating, item, item_location)

travel locality - the closer, the better

- single system-wide item-based collaborative filtering model to generate the top-k recommendations RecScore(u, i) = P(u, i) - TravelPenalty(u, i)

Query Processing

- User id: U, location: L, limit: K, R: list of top-K items
- k-nearest-neighbor algorithm to populate list R with K items