

SEPHORA

Skincare Product Recommendation

DSL 24-2 MODELING PROJECT

24-2

DSL



SEPHORA

11기 김주연 박종락 송예원

12기 복지민 서지니

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한계점 및 향후 계획

우리 모두가 가지고 있는 그 병

FOMO "Fear of Missing Out"

FOBO "Fear Of Better Options"



우리 모두가 가지고 있는 그 병

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한마디로 결정장애.....

Product Recommendation currently provided by SEPHORA

1. **Chosen For You**

Knowledge-Based Recommendation

: 사용자가 제공한 정보와 아이템에 대한 정보를 바탕으로 Sephora 랜딩페이지(사용자가 보는 첫 화면)에서 추천

The screenshot shows the Sephora homepage with the 'Chosen For You' section highlighted. The section displays six recommended products in a grid:

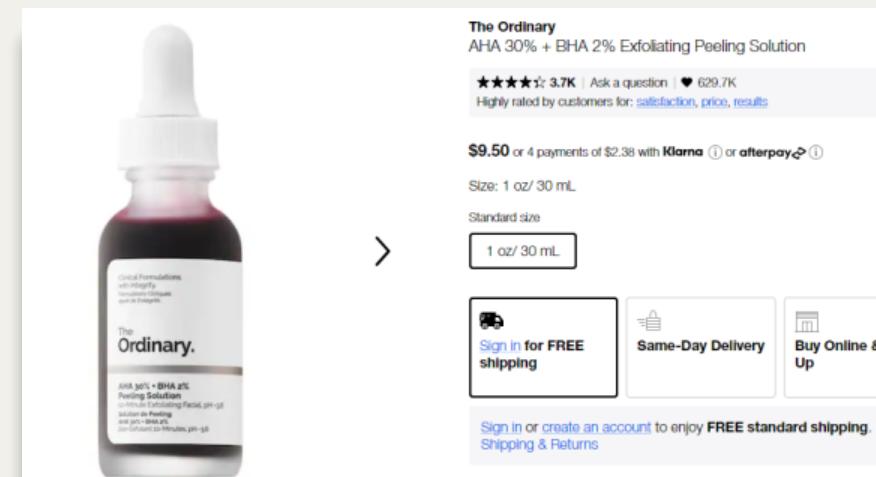
Product Image	Product Name	Price	Rating
	Summer Fridays Lip Butter Balm for Hydration & Shine	\$24.00	★★★★★ 10.9K
	Rare Beauty by Selena Gomez Soft Pinch Liquid Blush	\$14.00 - \$23.00	★★★★★ 11.7K
	Touchland Power Mist Hydrating Hand Sanitizer	\$10.00	★★★★★ 1.3K
	ONE/SIZE by Patrick Starr Mini On 'Til Dawn Mattifying Waterproof ...	\$17.00	★★★★★ 2K
	PATRICK TA Major Headlines Double-Take Crème & Powder ...	\$38.00	★★★★★ 3K
	HUDA BEAUTY Easy Bake Loose Baking & Setting Powder	\$22.00 - \$38.00	★★★★★ 11.2K

Product Recommendation currently provided by SEPHORA

2. **Similar Products**

Contents-Based Recommendation

: 사용자가 검색한 아이템의 정보를 활용해 검색 아이템과 비슷한 다른 제품들을 추천



이걸 검색하면?



Similar Products					
	The Ordinary AHA 30% + BHA 2% Exfoliating Peeling Solution \$9.50 or 4 payments of \$2.38 with Klarna or afterpay Size: 1 oz / 30 mL Standard size 1 oz / 30 mL Sign in for FREE shipping Same-Day Delivery Buy Online & Pick Up		The Ordinary Salicylic Acid 2% Exfoliating Blemish ... \$6.70 See Details		The INKEY List Salicylic Acid Acne + Blackhead Cleanser \$13.00 See Details
					Paula's Choice Skin Perfecting 25% AHA + 2% BHA Exfoliant Peel \$45.00 See Details
					Sunday Riley U.F.O. Salicylic Acid BHA Acne Treatment Face Oil \$40.00 - \$80.00 See Details
Price	\$9.50	Price	\$6.70	Price	\$13.00
Rating	★★★★☆ 3.7K	Rating	★★★★☆ 1.1K	Rating	★★★★☆ 2.1K
Ingredient Highlights	FSA/HSA Eligible, AHA/Glycolic Acid, Community Favorite, Vegan, Oil Free, Without Silicones	Ingredient Highlights	Vegan	Ingredient Highlights	Clean at Sephora, Cruelty-Free, Paraben-free, Salicylic Acid, Vegan
Ingredient Highlights		Ingredient Highlights		Ingredient Highlights	AHAGlycolic Acid, Cruelty-Free, Fragrance Free, Hyaluronic Acid, Oil-free, Paraben-free, Salicylic Acid, Silicone Free, Sulfate-free, Vegan
Ingredient Highlights		Ingredient Highlights	<th>Ingredient Highlights</th> <td>AHAGlycolic Acid, Clean at Sephora, Cruelty-Free, Paraben-free, Salicylic Acid, Vegan, Vitamin C</td>	Ingredient Highlights	AHAGlycolic Acid, Clean at Sephora, Cruelty-Free, Paraben-free, Salicylic Acid, Vegan, Vitamin C

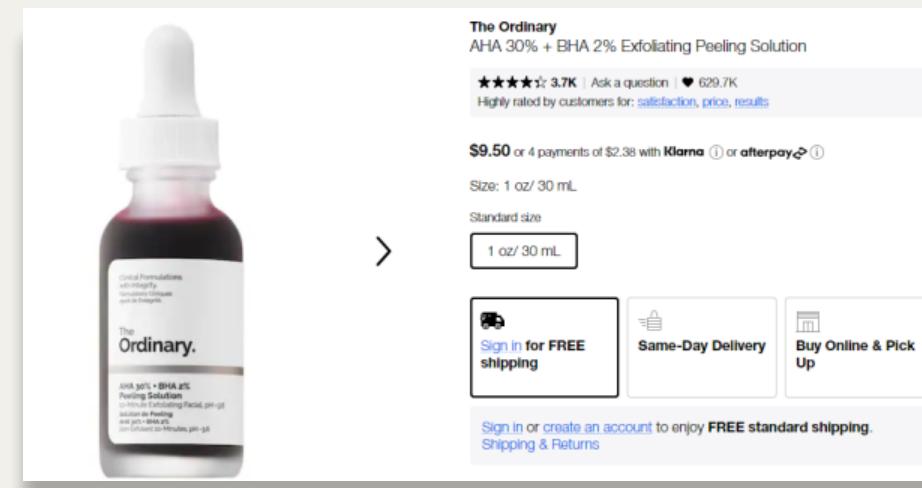
검색 페이지 하단에 검색한 것과 유사한 제품들을 추천

Product Recommendation currently provided by SEPHORA

3. You May Also Like

User-Item Model (추정)

: 사용자가 검색한 아이템의 정보 및 사용자의 기타 정보를 사용해 선호할 만한 제품 추천



이걸 검색하면?



You May Also Like

<p>The Ordinary Niacinamide 10% + Zinc 1% Oil Control Serum \$6.00 - \$10.80 ★★★★☆ 8.2K</p>	<p>SEPHORA COLLECTION Glowing Vitamin Eye Masks \$2.00 \$4.00 ★★★★☆ 221</p>	<p>Rare Beauty Soft Pinch Devy Liquid Blush \$14.00 ★★★★☆ 368</p>	<p>The Ordinary Glycolic Acid 7% Exfoliating Toner \$8.70 - \$13.00 ★★★★☆ 3.9K</p>	<p>The Ordinary Hyaluronic Acid 2% + B5 Hydrating Serum \$9.90 - \$17.50 ★★★★☆ 953</p>
---	--	---	--	--

검색 페이지 하단에 사용자가 함께 좋아할 만한 제품 추천

Sephora Skincare Product Recommendation

but *Only for Signed-Up Users!!!*

현재 Sephora의 추천 시스템은 검색에 따른 Contents-based 추천 시스템을 메인으로 사용하고 있어, 유저보다는 아이템에 집중된 추천 시스템을 사용하고 있음

즉, 비가입 유저와 차별화해 가입 유저에게만 제공할 수 있는 추천 서비스가 미비한 상태

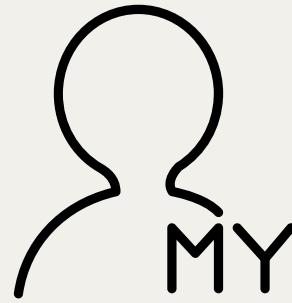


GOAL

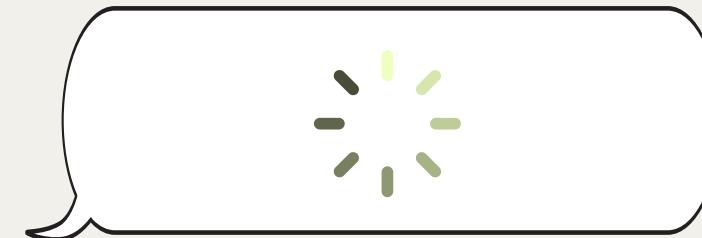
유저가 남긴 구매 및 리뷰 정보를 활용하여
가입 유저에게 특화된 Sephora의 추천 시스템 만들기!

Intro - What we're trying to do....

Hey Sephora u know I recently got these here & u have the reviews i wrote about them
 Now I wanna get some other things too but there's so many that I cant decide....
 Try surprise me!!!



MY



물론 다시 생각해보면 기업의 추천시스템은 당신의 결정장애를 해결해주기 위해서....라 쓰고
 당신의 지갑을 털어가기 위해서....라 읽어야 할 수도...있지만?
 일단 넘어가도록 하자

Sephora Products & Skincare Reviews

- Kaggle dataset 사용
- (1) Sephora Products info dataset

	product_id	product_name	brand_id	brand_name	loves_count	rating	reviews	ingredients	highlights	primary_category	secondary_category	tertiary_category
0	P473671	Fragrance Discovery Set	6342	19-69	6320	3.6364	11.0	['Capri Eau de Parfum:', 'Alcohol Denat. (SD A...]	['Unisex/ Genderless Scent', 'Warm & Spicy Scen...]	Fragrance	Value & Gift Sets	Perfume Gift Sets
1	P473668	La Habana Eau de Parfum	6342	19-69	3827	4.1538	13.0	['Alcohol Denat. (SD Alcohol 39C), Parfum (Fra...]	['Unisex/ Genderless Scent', 'Layerable Scent'...]	Fragrance	Women	Perfume
2	P473662	Rainbow Bar Eau de Parfum	6342	19-69	3253	4.2500	16.0	['Alcohol Denat. (SD Alcohol 39C), Parfum (Fra...]	['Unisex/ Genderless Scent', 'Layerable Scent'...]	Fragrance	Women	Perfume
3	P473660	Kasbah Eau de Parfum	6342	19-69	3018	4.4762	21.0	['Alcohol Denat. (SD Alcohol 39C), Parfum (Fra...]	['Unisex/ Genderless Scent', 'Layerable Scent'...]	Fragrance	Women	Perfume
4	P473658	Purple Haze Eau de Parfum	6342	19-69	2691	3.2308	13.0	['Alcohol Denat. (SD Alcohol 39C), Parfum (Fra...]	['Unisex/ Genderless Scent', 'Layerable Scent'...]	Fragrance	Women	Perfume
...
8489	P467659	Couture Clutch Eyeshadow Palette	1070	Yves Saint Laurent	2790	4.4286	7.0	['Talc, Synthetic Fluorphlogopite, Triethylhex...]	NaN	Makeup	Eye	Eye Palettes
8490	P500874	L'Homme Eau de Parfum	1070	Yves Saint Laurent	2319	4.6367	556.0	['Alcohol, Aqua / Water / Eau, Parfum / Fragra...]	['Layerable Scent', 'Woody & Earthy Scent']	Fragrance	Men	Cologne
8491	P504428	Mon Paris Eau de Parfum Gift Set	1070	Yves Saint Laurent	1475	5.0000	2.0	['Mon Paris Eau de Parfum:', 'Alcohol, Parfum/...]	NaN	Fragrance	Value & Gift Sets	Perfume Gift Sets
8492	P504448	Y Eau de Parfum Gift Set	1070	Yves Saint Laurent	840	NaN	NaN	['Alcohol, Parfum/Fragrance, Aqua/Water, Limon...]	NaN	Fragrance	Value & Gift Sets	Cologne Gift Sets
8493	P505461	Candy Glaze Lip Gloss Stick Duo with Hyaluroni...	1070	Yves Saint Laurent	193	NaN	NaN	['Diisostearyl Malate, Bis-Behenyl/Isostearyl/...]	['Hyaluronic Acid', 'High Shine Finish', 'Plum...]	Makeup	Lip	Lip Gloss

8494 rows x 12 columns

Sephora Products & Skincare Reviews

- (2) Sephora skincare reviews dataset

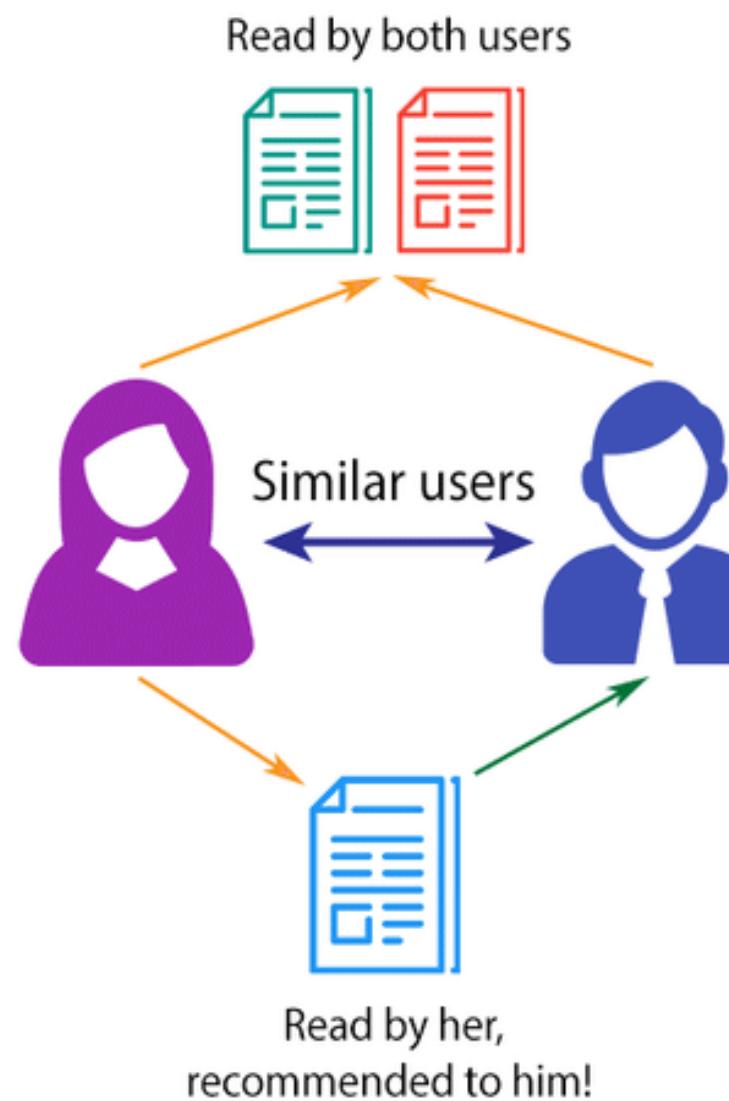
	author_id	rating	is_recommended	skin_tone	eye_color	skin_type	hair_color	product_id
0	1741593524	5	1.0	NaN	brown	dry	black	P504322
1	31423088263	1	0.0	NaN	NaN	NaN	NaN	P420652
2	5061282401	5	1.0	light	brown	dry	blonde	P420652
3	6083038851	5	1.0	NaN	brown	combination	black	P420652
4	47056667835	5	1.0	light	hazel	combination	NaN	P420652
...
49972	2276253200	5	1.0	fair	brown	combination	NaN	P505392
49973	28013163278	5	1.0	NaN	blue	combination	blonde	P505392
49974	1539813076	5	1.0	light	blue	combination	blonde	P505392
49975	5595682861	5	1.0	fair	hazel	oily	NaN	P505392
49976	27666075558	5	1.0	light	green	normal	NaN	P505392

1094411 rows × 8 columns

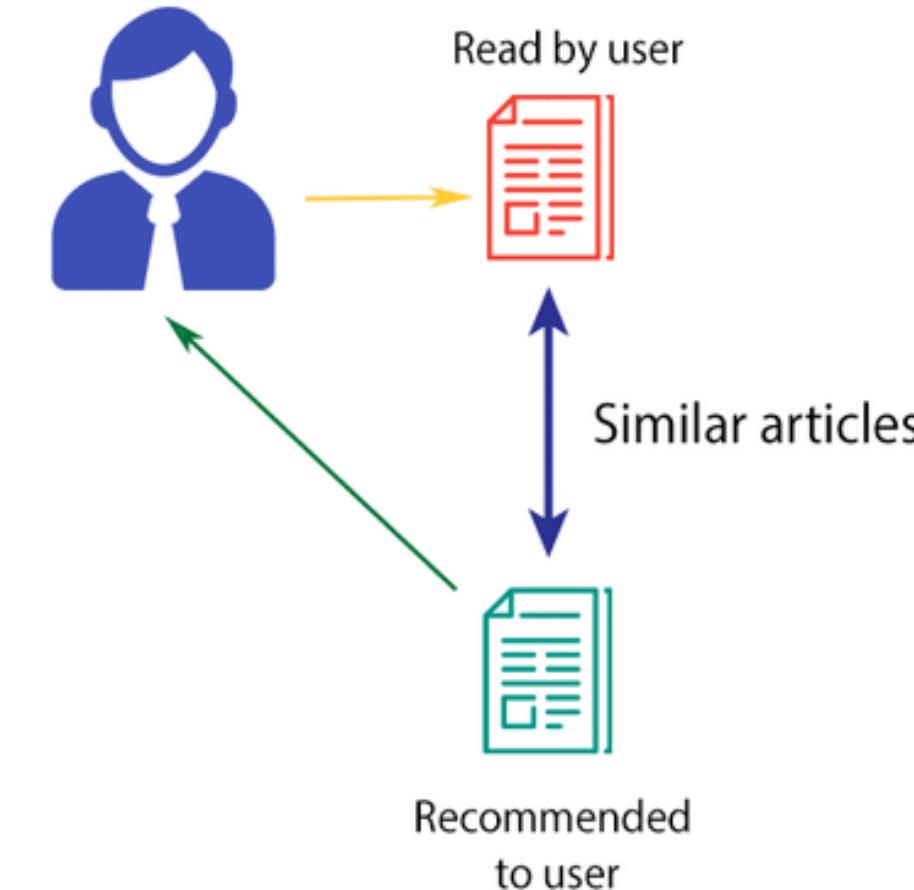
Traditional Recommendation System

- 유저 기반 협업 필터링
- 아이템 기반 협업 필터링

COLLABORATIVE FILTERING



CONTENT-BASED FILTERING

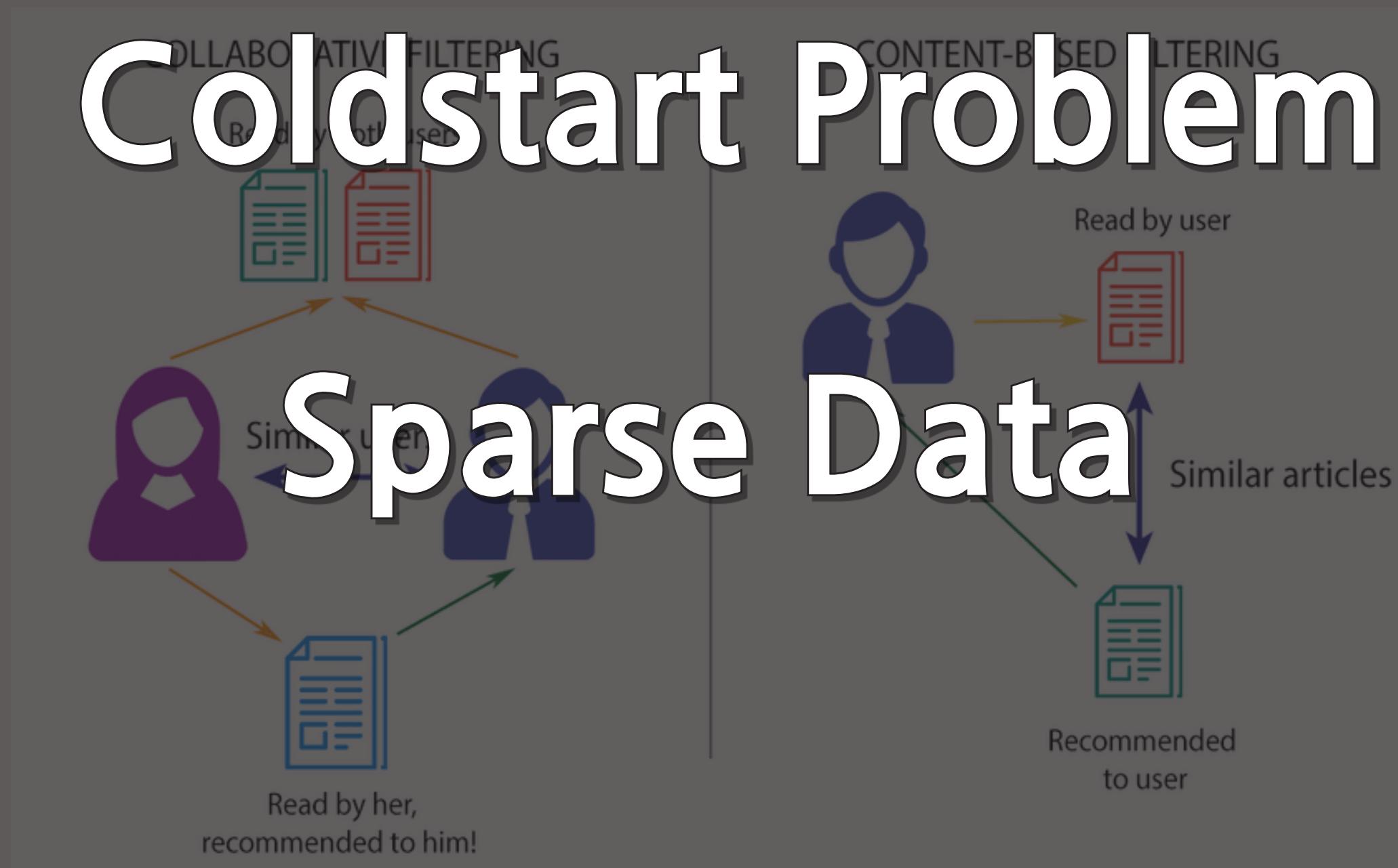


- 콘텐츠 기반 필터링

Traditional Recommendation System

Coldstart Problem

- 유저 기반 협업 필터링
- 아이템 기반 협업 필터링



Traditional Recommendation System

Coldstart Problem

- 유저 기반 협업 필터링
- 아이템 기반 협업 필터링

- 콘텐츠 기반 필터링



Traditional Recommendation System

Coldstart Problem

- 유저 기반 협업 필터링
- 아이템 기반 협업 필터링

- 콘텐츠 기반 필터링



Graph Neural Network

이분 그래프
(Bipartite Graph)

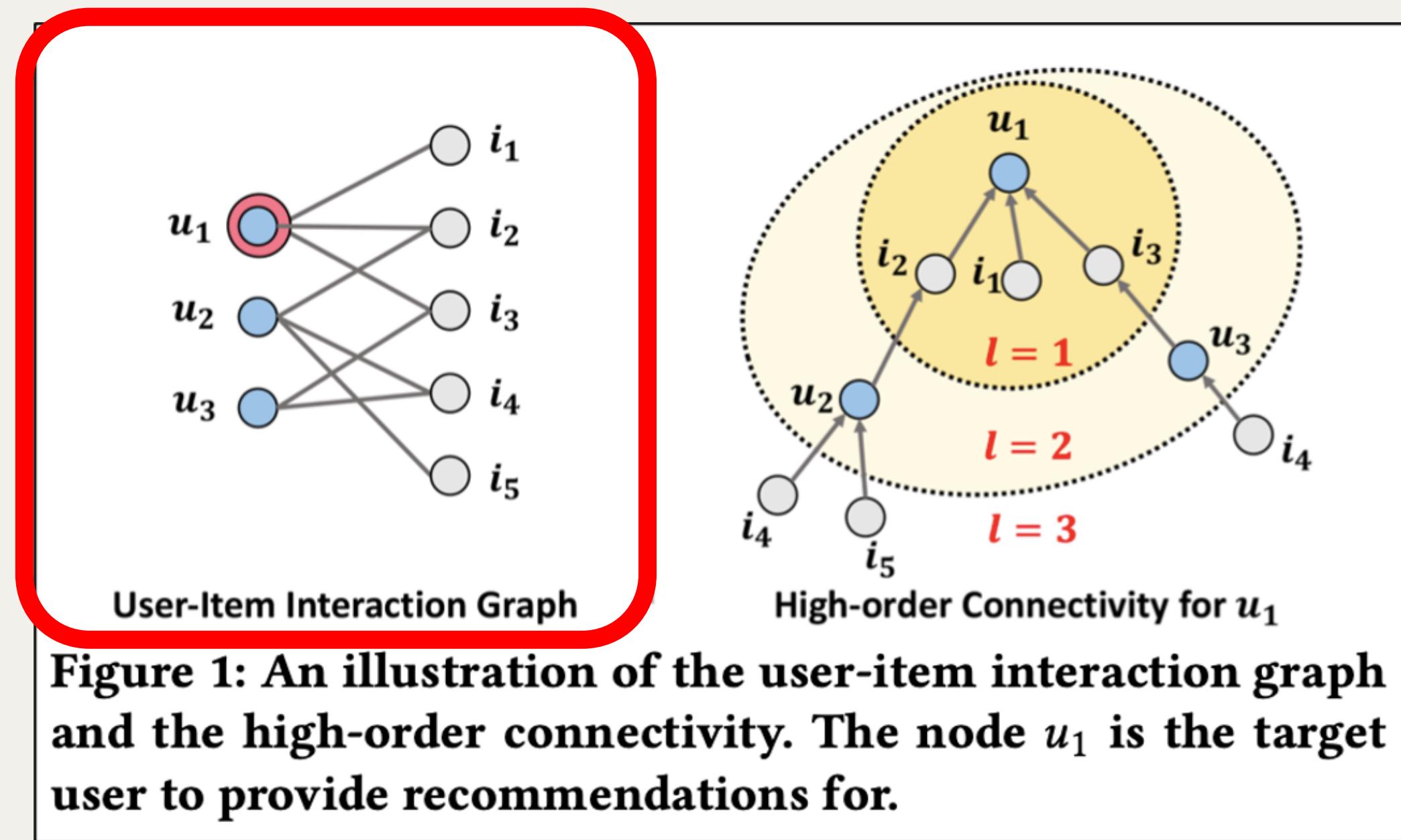
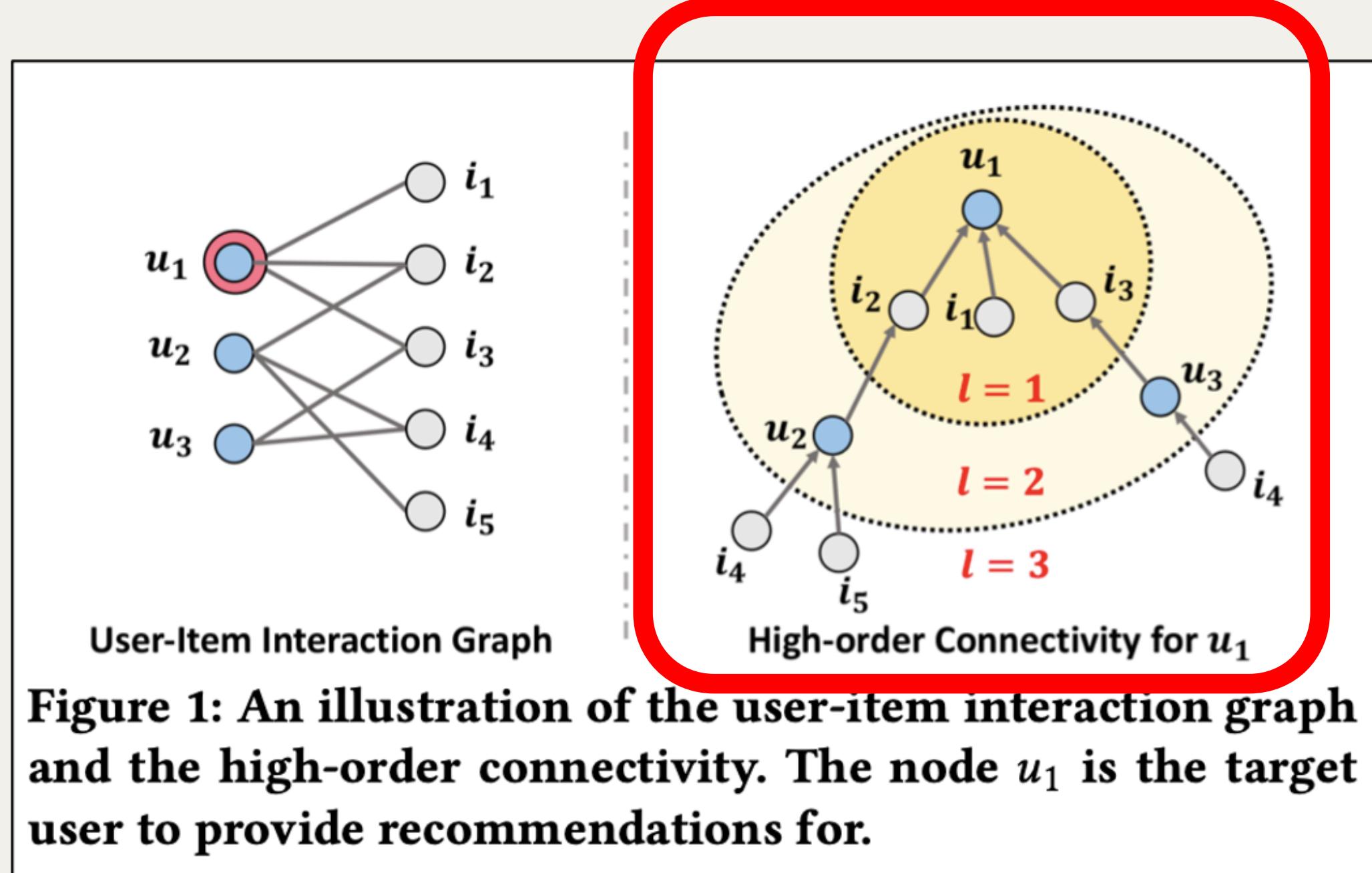


Figure 1: An illustration of the user-item interaction graph and the high-order connectivity. The node u_1 is the target user to provide recommendations for.

Graph Neural Network

이분 그래프
(Bipartite Graph)



다중 흡
(Multi-hop)
관계

Collaborative Signal
포착

Modeling

과도한 계산 비용

메모리 사용량 증가
학습 시간 지연

추천 다양성 감소

추천 품질 저하

Oversmoothing

GNN 계층이 쌓이면서 노드 표현이 서로 비슷해지는 현상

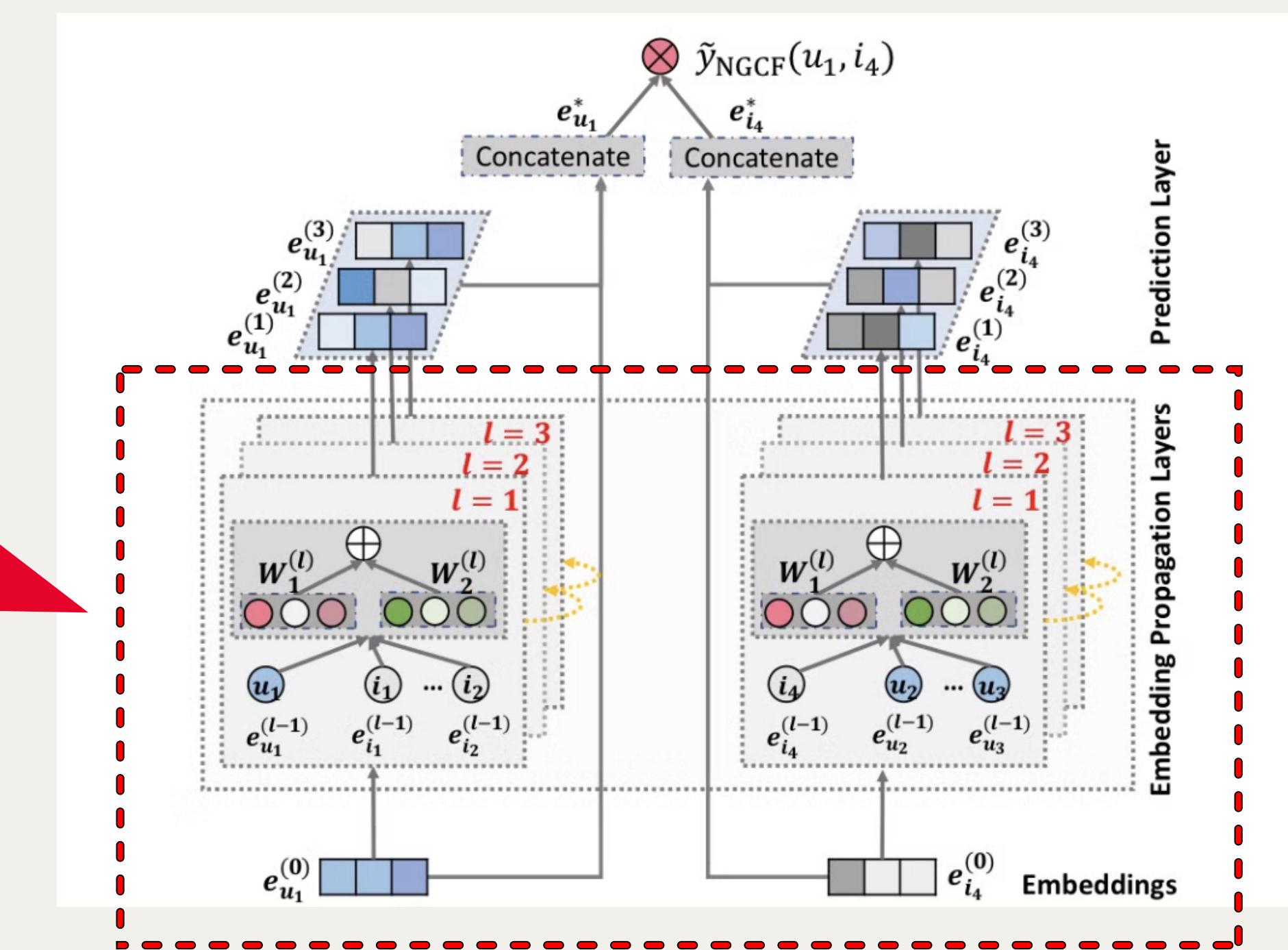
LightGCN

GNN의 복잡한 연산 구조 간소화

Modeling

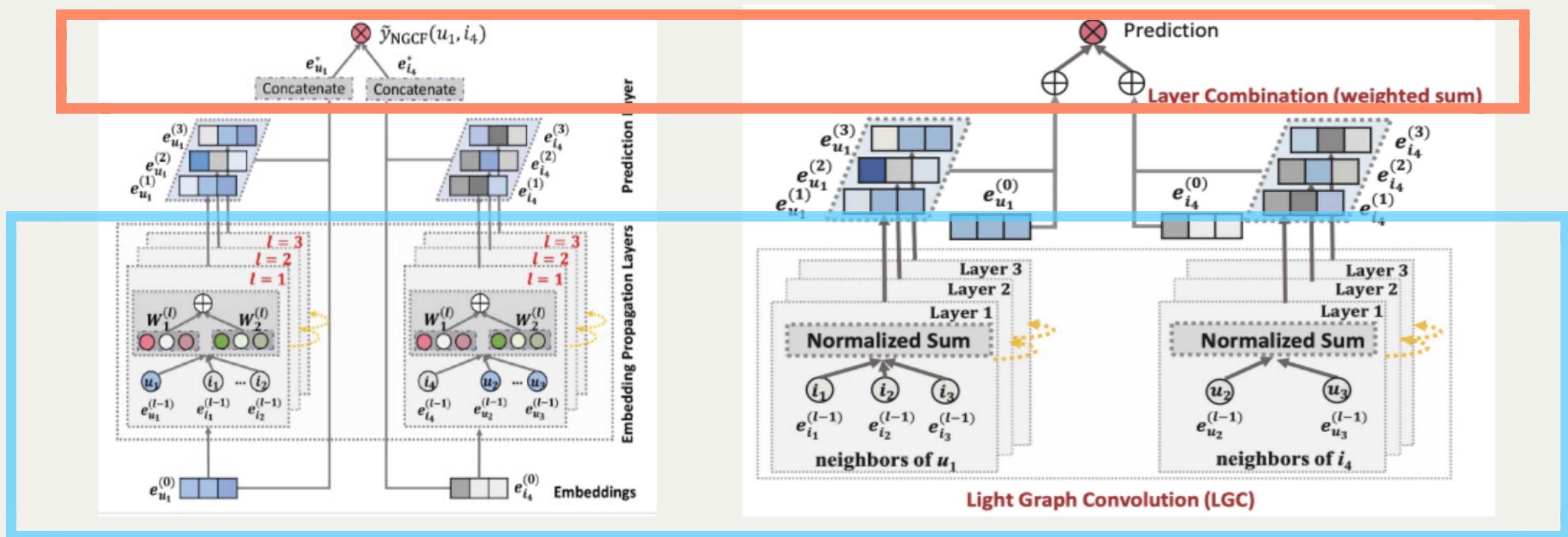
NGCF

$$\mathbf{E} = [\underbrace{\mathbf{e}_{u_1}, \dots, \mathbf{e}_{u_N}}_{\text{users embeddings}}, \underbrace{\mathbf{e}_{i_1}, \dots, \mathbf{e}_{i_M}}_{\text{item embeddings}}].$$



LightGCN

NGCF



LightGCN

- 평가지표: recall, ndcg

Table 4: The comparison of overall performance among LightGCN and competing methods.

Dataset	Gowalla		Yelp2018		Amazon-Book	
Method	recall	ndcg	recall	ndcg	recall	ndcg
NGCF	0.1570	0.1327	0.0579	0.0477	0.0344	0.0263
Mult-VAE	0.1641	0.1335	0.0584	0.0450	0.0407	0.0315
GRMF	0.1477	0.1205	0.0571	0.0462	0.0354	0.0270
GRMF-norm	0.1557	0.1261	0.0561	0.0454	0.0352	0.0269
LightGCN	0.1830	0.1554	0.0649	0.0530	0.0411	0.0315

- recall :

사용자가 사용한 모든 아이템 중에서 내가 추천한 아이템 K개가 얼마나 포함되는지 비율을 의미

예를 들어, 사용자가 사용한 아이템이 5개인데, 내가 추천한 아이템이 1개 포함되어 있으면, recall은 0.2가 된다.

- ndcg :

추천된 아이템들의 순서까지 고려한 지표

NDCG는 높은 순위에 있는 아이템이 사용자가 실제로 좋아하는 아이템이라면 더 높은 점수를 부여합니다. 쉽게 말해, '맞춘 아이템들이 얼마나 적절한 순서로 추천되었는가?'를 나타내는 지표

인덱싱 (평점 제외)

	user	item	rating	skin_type	category
0	0	0	4	0	0
35934	0	467	4	0	3
59993	0	1113	3	0	1
60040	0	1115	5	0	3
35689	0	462	3	0	1
...
61633	2263	1332	5	1	2
24861	2263	270	5	1	2
26157	2263	286	5	1	2
60048	2263	1118	5	1	0
60679	2263	1174	5	1	3

train, test, val

각 유저 당 80%, 10%, 10%

성능 평가

if 유저1

train set : 아이템 1,3,4 구매

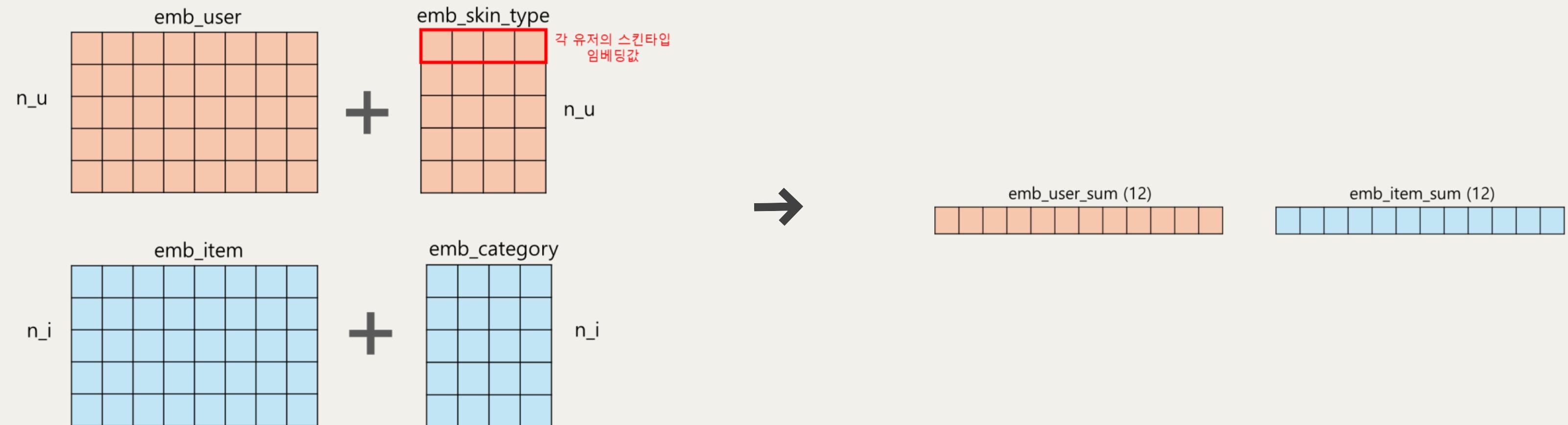
→

model : 2 구매 예측

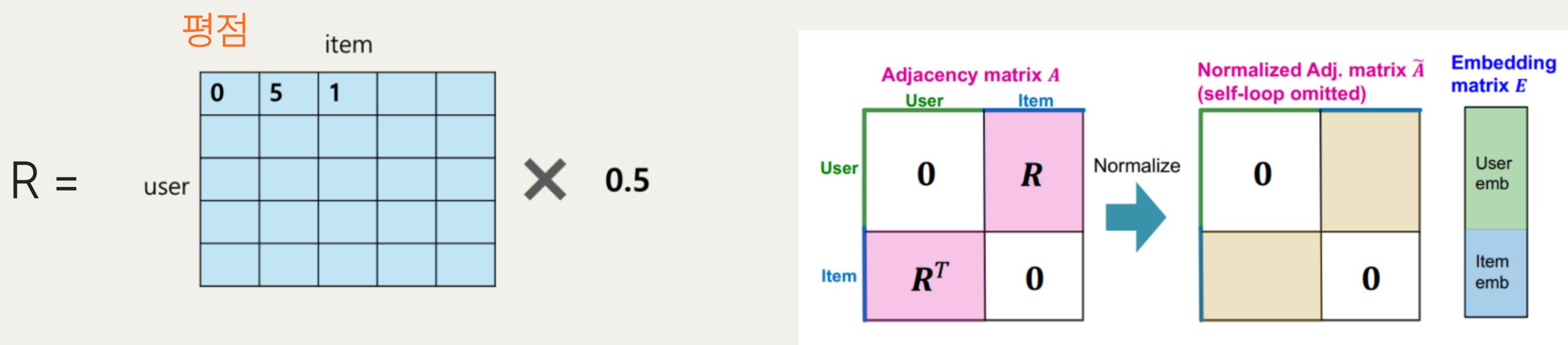
VS

val, true set : 실제로 2 구매했는가?

LightGCN 구현



라플라시안 행렬 생성



$$L^{\text{sym}} := D^{-\frac{1}{2}} L D^{-\frac{1}{2}}$$

라플라시안 행렬 정규화
 A 를 degree 값으로 나누어,
 상대적인 연결 강도 표현

degree

$n_u + n_i$

$D =$

2				
	3			
		1		
			4	
				5

각 노드의 degree
 Ex) item 2가 유저 5명에게 소비됨.

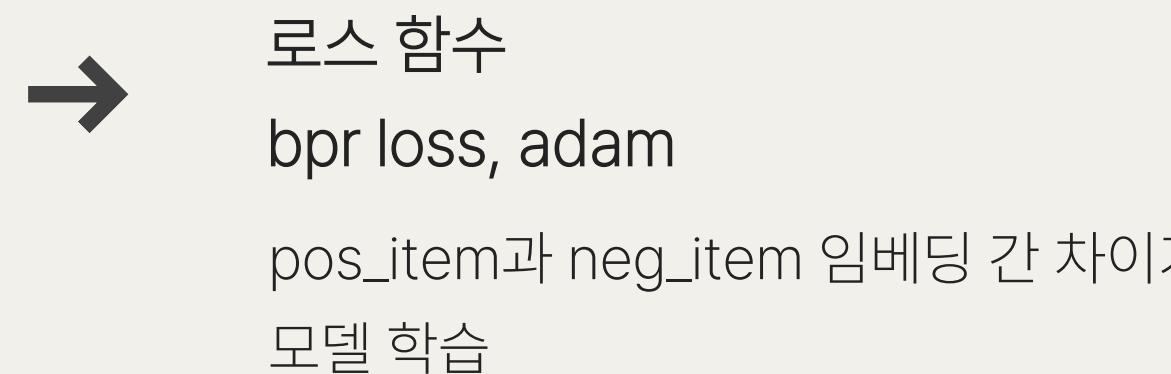
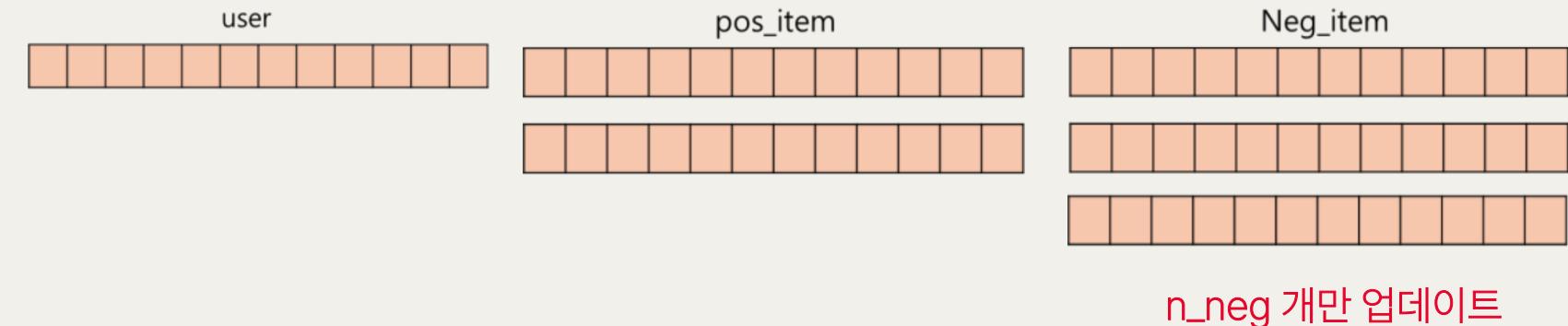
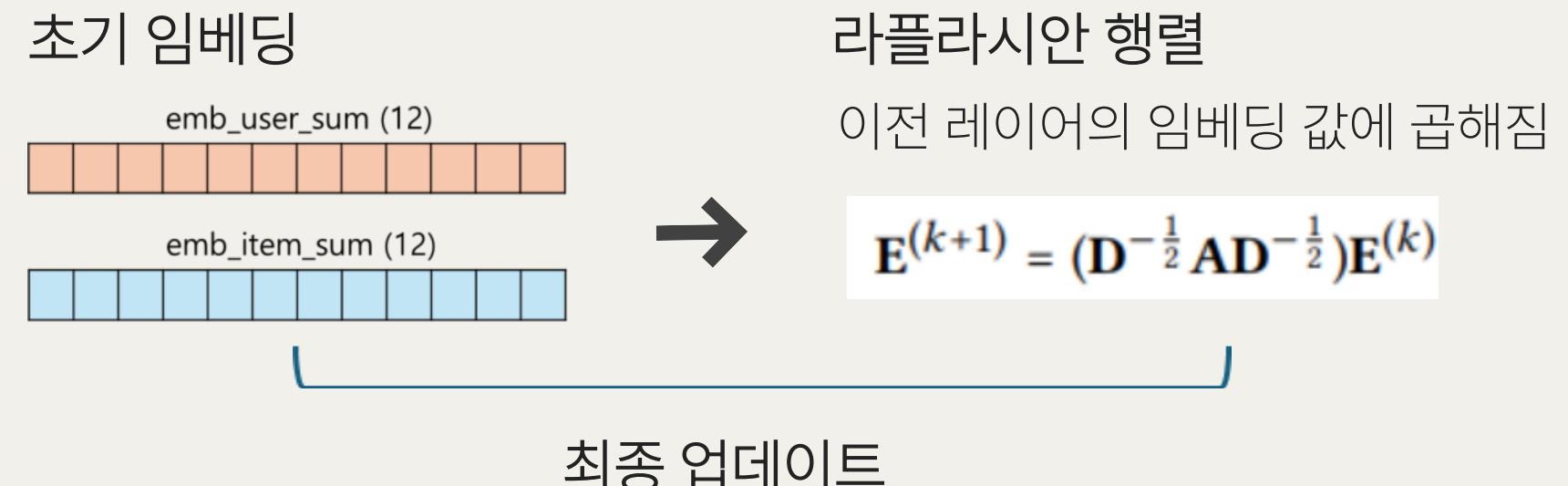
전파 과정

- negative sampling :

각 레이어마다 모든 노드를 업데이트 하지 않고
유저가 구매하지 않은 아이템 (유저와 거리가 먼) 은 일부
만 랜덤하게 업데이트하여 효율성 up

→ user 별 pos_items, neg_items로 나눠짐.

학습 시 에폭마다 각 유저에 대해 n_neg 개의 neg_items를 랜덤 샘플링



검증

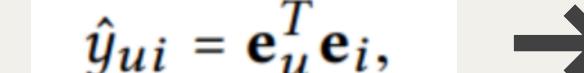
Train

유저별, unconsumed_items



Model

u가 i 살 확률 예측



$$\hat{y}_{ui} = \mathbf{e}_u^T \mathbf{e}_i,$$

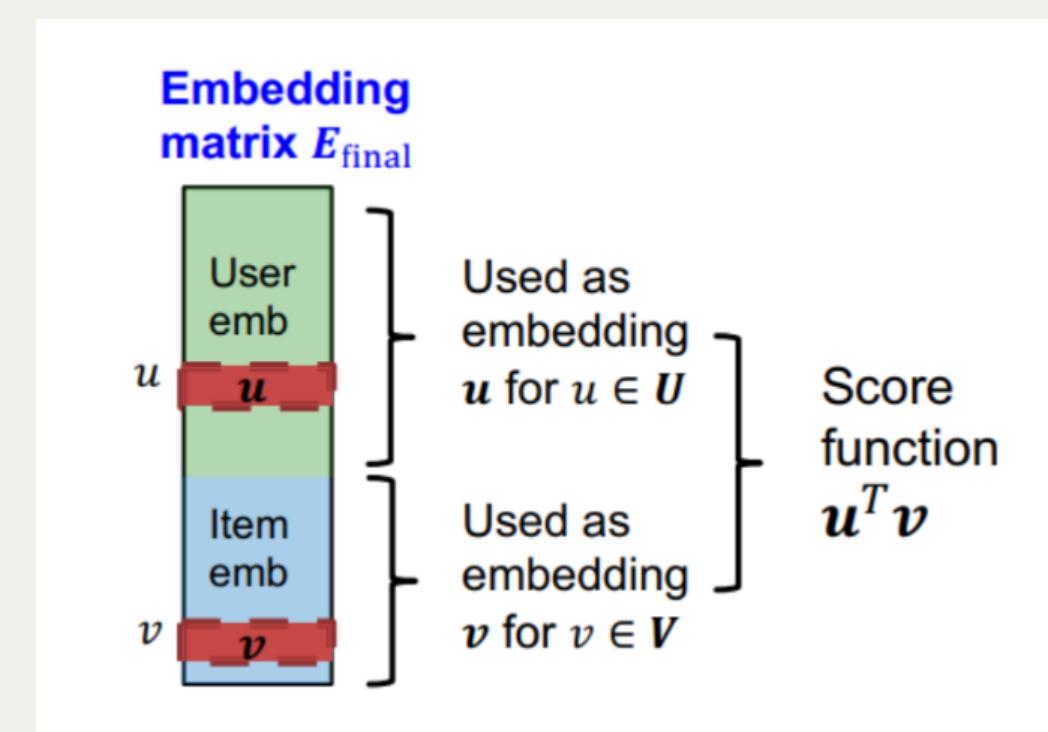
예측한
Top-K
items

VS

실제 소비한
items

Val, Test

비교하여 recall, ndcg 계산



성능 결과

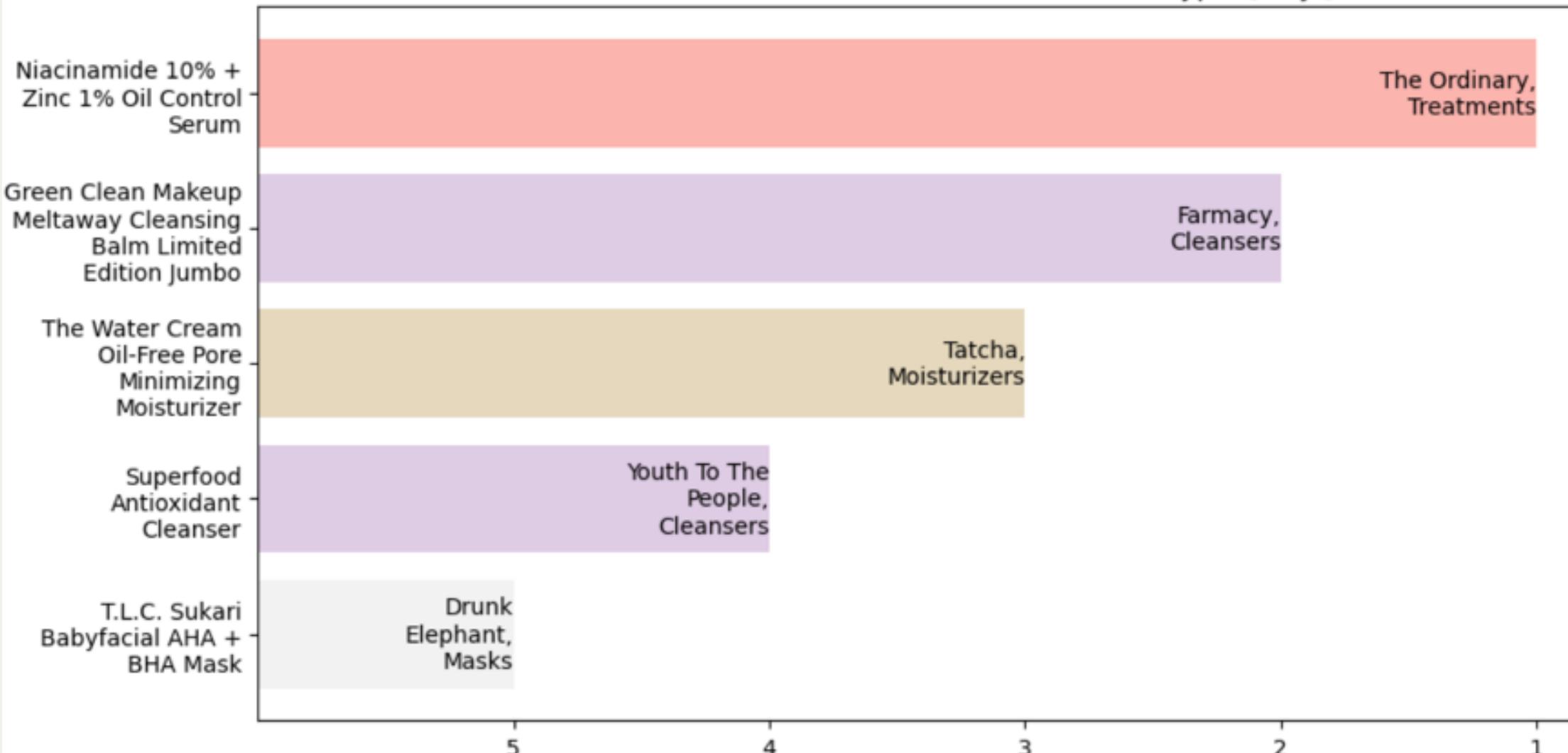
n_layer	1	2	3	4
4	recall : 0.2456 ndcg : 0.2180			
8	recall : 0.2309 ndcg : 0.2156			

추천 예시:

User with Oily Skin

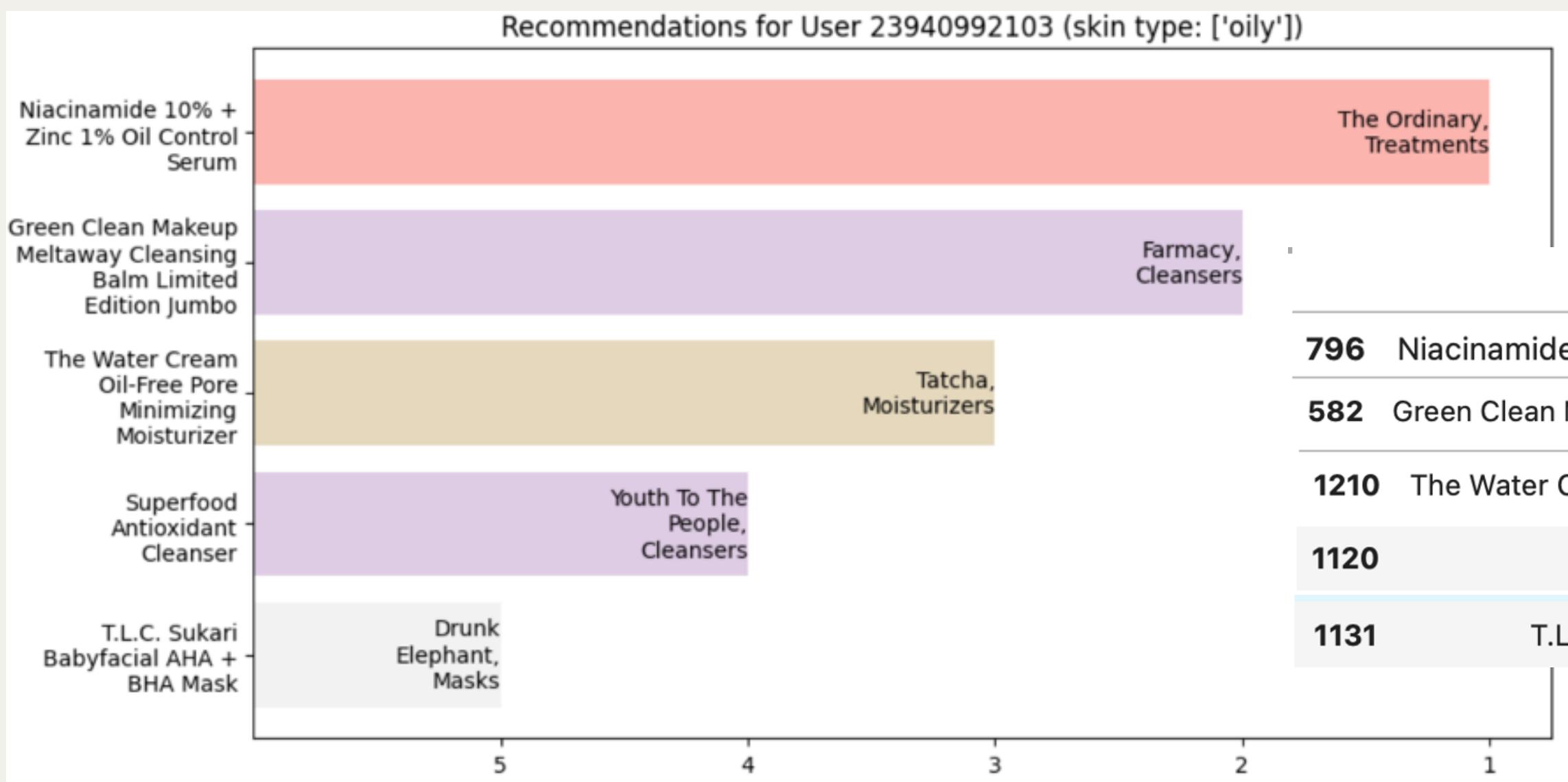
	User ID	Skin Type	Product Name	Brand	Highlights	Category	Ranking
0	23940992103	[oily]	Niacinamide 10% + Zinc 1% Oil Control Serum	The Ordinary	['Vegan', 'Community Favorite', 'Oil Free', 'W...']	Treatments	1
1	23940992103	[oily]	Green Clean Makeup Meltaway Cleansing Balm Lim...	Farmacy	['Good for: Dullness/Uneven Texture', 'Communi...']	Cleansers	2
2	23940992103	[oily]	The Water Cream Oil-Free Pore Minimizing Moist...	Tatcha	['Community Favorite', 'Good for: Pores', 'Hyd...']	Moisturizers	3
3	23940992103	[oily]	Superfood Antioxidant Cleanser	Youth To The People	['Vegan', 'Refill Available', 'Good for: Pores...']	Cleansers	4
4	23940992103	[oily]	T.L.C. Sukari Babyfacial AHA + BHA Mask	Drunk Elephant	['Good for: Dullness/Uneven Texture', 'Communi...']	Masks	5

Recommendations for User 23940992103 (skin type: ['oily'])



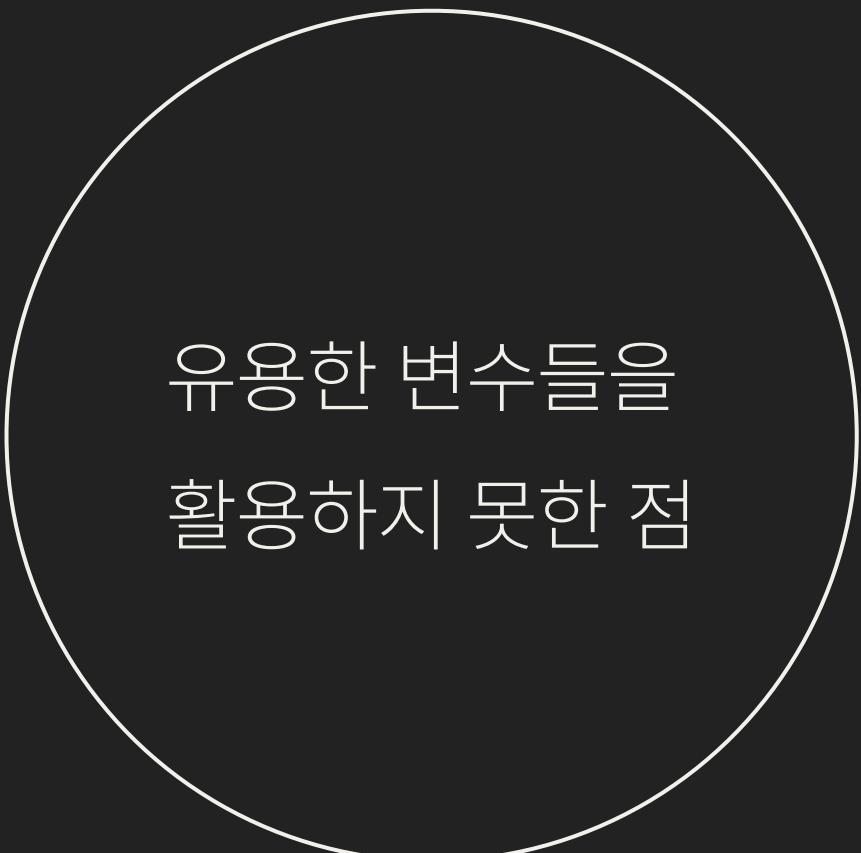
추천 예시:

User with Oily Skin



product_name	most_common_skin_type
796 Niacinamide 10% + Zinc 1% Oil Control Serum	oily
582 Green Clean Makeup Meltaway Cleansing Balm Lim...	oily
1210 The Water Cream Oil-Free Pore Minimizing Mois...	oily
1120 Superfood Antioxidant Cleanser	oily
1131 T.L.C. Sukari Babyfacial AHA + BHA Mask	dry

Limitation & Future Plans



**LGC-
ACF**

