HOP-Rec:
High-Order Proximitiy for Implicit Recommendation

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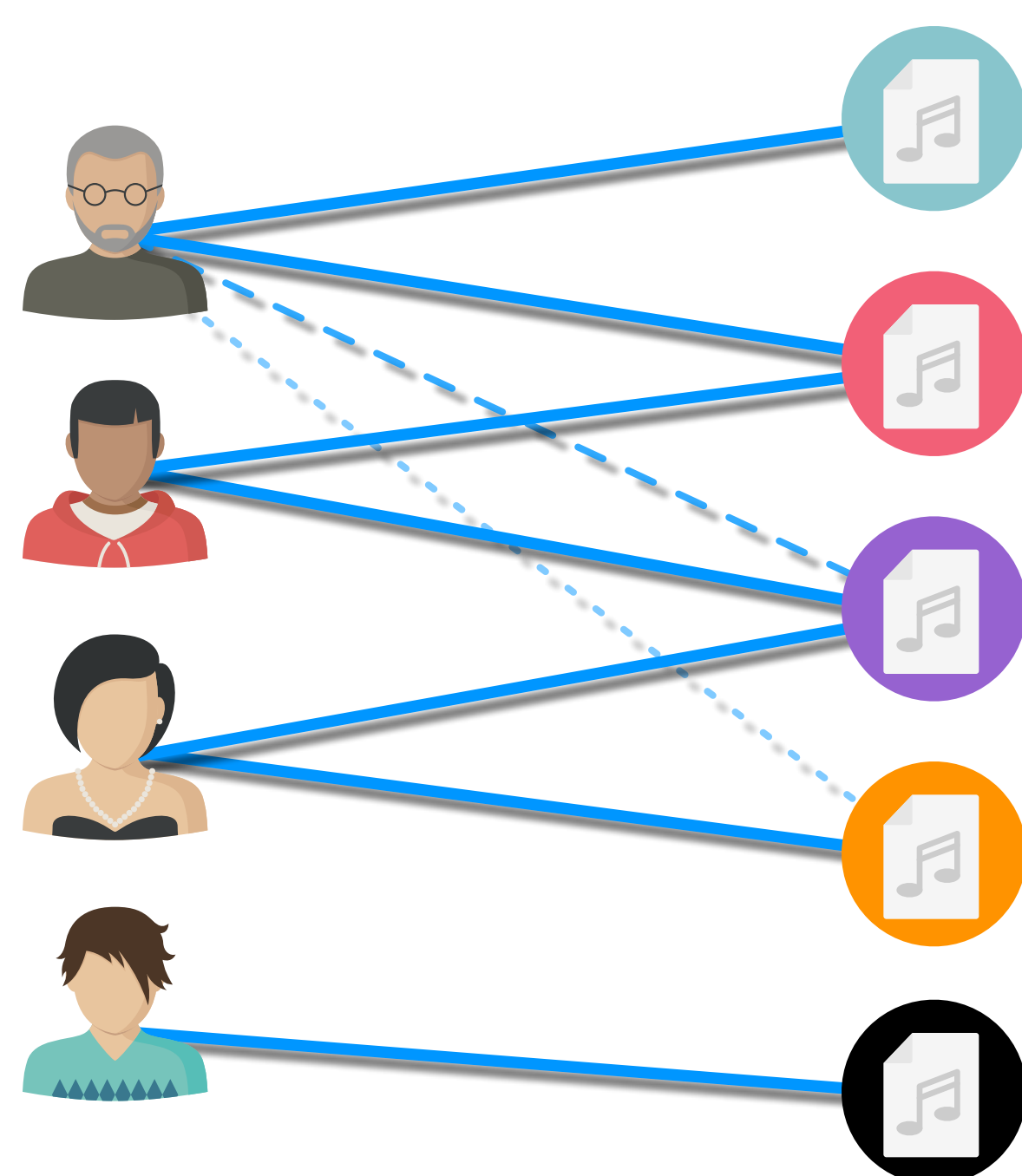[‡]National Chengchi University, Taiwan

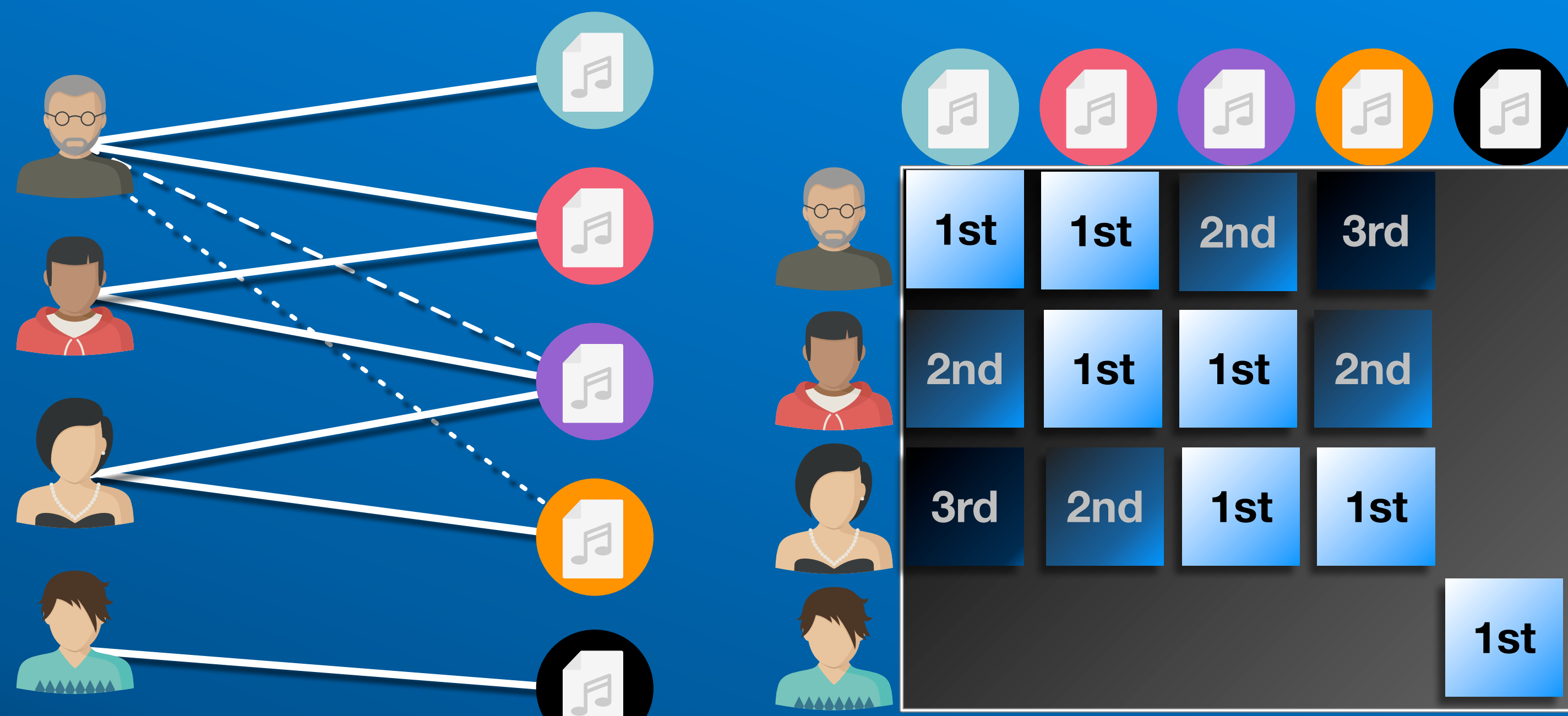CFDA-CLIP Labs Source Code: ProNet Paper

HOP-Rec: Graph + Latent Factor

✓ Estimate users' preference of unknown items from **indirect observations**

✓ **Order** estimations by **neighborhood proximities**

Graph-Based Model

✓ Explore **high-order proximity** between vertices within user-item bipartite graph

✓ **Rank** items **by neighborhood proximities** (transition probability or other scoring methods)

✗ Unconnected vertices will not be affected remotely (without sharing the same vector space).

Motivation

✓ There are plentiful information inherited in simple user-item bipartite graph.

✓ Graph-based model and latent factor model should be complementary to each other.

✓ Unify two approaches instead of computing features from independent frameworks

Latent Factor Model

✓ Decompose user-item interaction matrix to get shared latent factors of users and items

✓ Estimate **unknown** items **through shared latent factor**

✗ Focus only on **shallow observations**
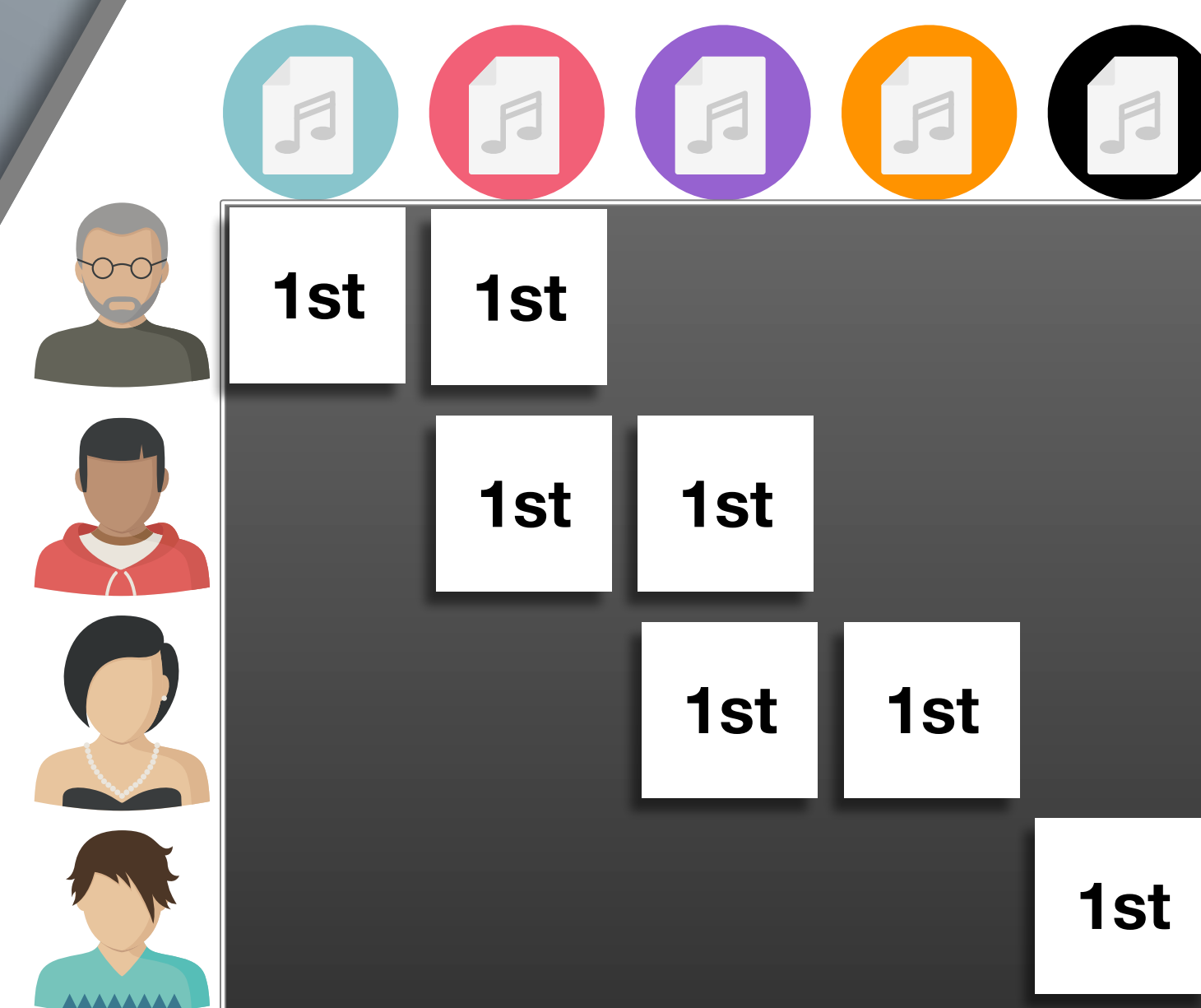
Objective Function

$$\mathcal{L}_{HOP} = \sum_{\substack{1 \leq k \leq K \\ u,(i,i')}} \overbrace{C(k)}^{\text{graph model}} \underset{\substack{i \sim P_u^k \\ i' \sim P_N}}{\mathbb{E}} \overbrace{\left[\mathcal{F}\left(\theta_u^\top \theta_{i'}, \theta_u^\top \theta_i\right) \right]}^{\text{factorization model}} + \lambda_\Theta \|\Theta\|_2^2,$$

$$\mathcal{F}(\theta_u^\top \theta_{i'}, \theta_u^\top \theta_i) = \mathbb{1}_{\{\theta_u^\top \theta_{i'} - \theta_u^\top \theta_i > \epsilon_k\}} \log\left[\sigma\left(\theta_u^\top \theta_{i'} - \theta_u^\top \theta_i\right)\right]$$

✓ Factorization model: personalized pairwise rank

✓ Positive sampling: degree sampled random walk

✓ Negative sampling: uniform from all items

Experiment

	CiteUlike			MovieLens-1M			MovieLens-20M			Amazon-Book		
	P@10	R@10	MAP@10	P@10	R@10	MAP@10	P@10	R@10	MAP@10	P@10	R@10	MAP@10
MF	4.1%	13.1%	6.7%	17.7%	13.1%	11.7%	14.9%	14.0%	11.3%	0.7%	3.7%	1.4%
BPR	3.8%	14.2%	6.4%	18.1%	13.2%	12.5%	13.3%	14.3%	10.4%	1.0%	5.3%	2.5%
WARP	5.4%	18.3%	9.1%	24.8%	18.5%	18.5%	20.7%	21.4%	17.2%	1.4%	7.6%	3.2%
K-OS	5.6%	19.4%	9.5%	23.0%	17.3%	16.4%	19.6%	20.5%	15.7%	1.5%	7.9%	3.5%
$RP^3(\beta)$	5.9%	21.2%	3.2%	22.8%	17.2%	14.2%	17.3%	19.4%	10.3%	-	-	-
HOP	5.9%	**21.3%**	*10.8%	*25.9%	*20.5%	*19.6%	*21.2%	*22.3%	*17.9%	1.5%	7.9%	*3.6%
%Improv.	0.0%	0.5%	13.7%	4.4%	10.8%	5.9%	2.4%	4.2%	4.1%	0.0%	0.0%	2.9%

Table 2: Performance comparison