Item-Item Collaborative Filtering via Graph Regularization

By: Melle Koper (M.M.M.KoperookGeschrevenJansen@student.tudelft.nl)
Supervisors: Maosheng Yang and Elvin Isufi

TUDelft

Background

- Recommender System → Predict how a user would rate an item
- Simple Methods > Machine Learning [1]
- Graph Regularization predict data from noisy graph signals [2]

Research Question

- How do Item-Item graph Regularizations techniques compare against a baseline?
  - Tikhonov Collaborative Filtering
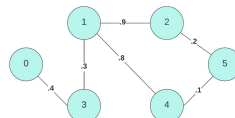 - Sobolev Collaborative Filtering

Collaborative Filtering

- Similarity Matrix
  - Pearson Correlation
- K Nearest Neighbors
- Prediction = Weighted Average of Neighboring items

Graph Regularization

$$W = \begin{bmatrix} 0 & 0 & 0 & .4 & 0 & 0 \\ 0 & 0 & .9 & .3 & .8 & 0 \\ 0 & .9 & 0 & 0 & 0 & .2 \\ .4 & .3 & 0 & 0 & 0 & 0 \\ 0 & .8 & 0 & 0 & 0 & .1 \\ 0 & 0 & .2 & 0 & .1 & 0 \end{bmatrix}$$

Similarity Matrix

Graph Representation

Tikhonov

$$X^* = (I + \mu L)^{-1} Y$$

Sobolev

$$X^* = (I + \mu * (L + \epsilon * I)^\beta)^{-1} Y$$

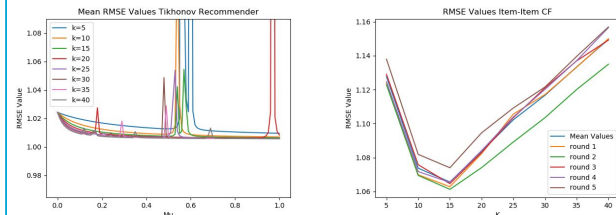**L** = Degree Matrix - Similarity Matrix

Methodology

Setup

- Test Data = MovieLens100k
- 80-20 Train Test split
- Hyper Parameter Tuning = GridSearch
- Compare on best mean results over 5 rounds

Metrics

- Root Mean Squared Error
- Precision
- Recall
- Normalized Discounted Cumulative Gain

Hyper Parameter Search + Results

	RMSE	Precision@5	Precision@10	Recall@5	Recall@10	NDCG@5	NDCG@10
Item-Item CF	1.066	0.600	0.580	0.480	0.683	0.834	0.869
Item-Item TK	1.006	0.688	0.635	0.521	0.713	0.889	0.910
Item-Item Sobolev	1.006	0.688	0.635	0.520	0.713	0.889	0.911

Table 1: Best mean results achieved over 5 rounds

Conclusion + Future Work

- Graph Regularization outperforms the baseline
- Expand on hyperparameter testing for Sobolev
- Use more sophisticated techniques for creating the similarity matrix.

References:

[1] M. Ferrari Dacrema, P. Cremonesi, and D. Jannach, "Are we really making much progress? a worrying analysis of recent neural recommendation approaches," 09 2019.

[2] E. Isufi, B. Das, A. Natali, M. Sabbaqi, and M. Yang, "Graph filters for processing and learning from network data," tech. rep., Delft University of Technology, 2021.