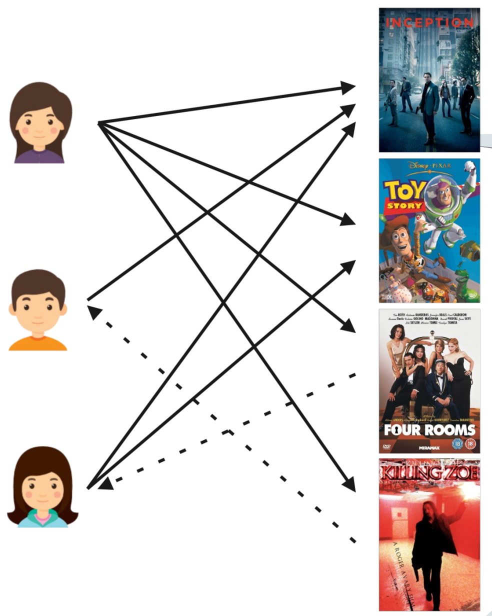
User-based graph regularisers

Research question: How the Tikhonov regulariser performs for user-based KNN collaborative filtering.
Additional research question: How the Sobolev regulariser performs for user-based KNN collaborative filtering



1.Collaborative filtering

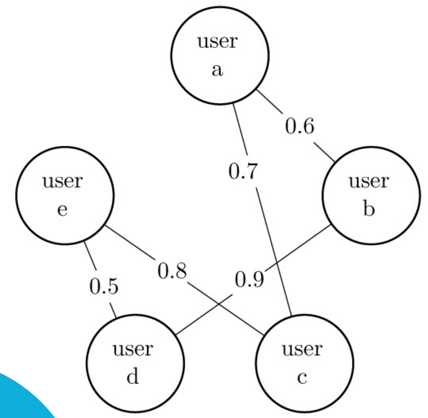
What:
Predicting ratings based on ratings of similar users.
How:
Taking the weighted average of the ratings of the most similar users

2. Similarity measure

Pearson correlation to meause the linear correlation between two users. Based on the movies they both rated.

3. MovieLens to Graph

Represent a user as node
The similarity between users are the edge weights
The ratings are represented as the graph signal



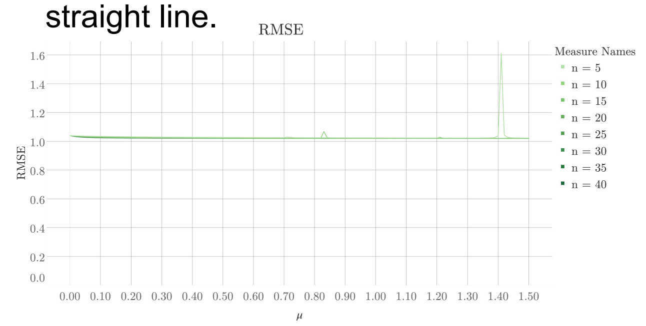
$$A = \begin{bmatrix} 0 & 0.6 & 0.7 & 0 & 0 \\ 0.6 & 0 & 0 & 0.9 & 0 \\ 0.7 & 0 & 0 & 0 & 0.8 \\ 0 & 0.9 & 0 & 0 & 0.5 \\ 0 & 0 & 0.8 & 0.5 & 0 \end{bmatrix}$$

$$D = \begin{bmatrix} 1.3 & 0 & 0 & 0 & 0 \\ 0 & 1.5 & 0 & 0 & 0 \\ 0 & 0 & 1.5 & 0 & 0 \\ 0 & 0 & 0 & 1.4 & 0 \\ 0 & 0 & 0 & 0 & 1.3 \end{bmatrix}$$

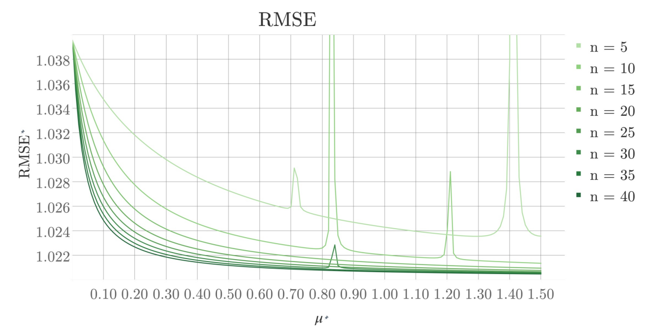
4. Tikhonov regulariser

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

The results for the different metrics for the Tikhonov regulariser are almost identical. The graphs show a nearly straight line.



Zoomed in we see some minor variation



5. Sobolev regulariser

$$\hat{\mathbf{X}} = \left(\mathbf{I} + \mu(\mathbf{L} + \epsilon\mathbf{I})^{\beta}\right)^{-1}\mathbf{Y}$$

The results show the same trends as Tikhonov. That is the variations between the different parameter sets on the different metrics are very small.

6. Comparison

Overview of the best performance for each algorithm for the different metrics.

	RMSE	Recall@5	Recall@10	Recall@20	Precision@5	Precision@10	Precision@20	NDCG@5	NDCG@10	NDCG@20
CF	1.092	0.521	0.715	0.864	0.640	0.692	0.593	0.914	0.892	0.932
Tikhonov	1.020	0.516	0.711	0.861	0.682	0.636	0.593	0.885	0.908	0.928
Sobolev	1.021	0.517	0.711	0.864	0.684	0.635	0.593	0.884	0.907	0.928

7. Conclusion

With RMSE of 1 on a scale of 1 to 5 and all the algorithms have almost identical results. It is a indication that the underlying assumption that the pearson correlation as similarity measure is usefull for prediction user ratings might not hold true for this data set.

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