Article Title

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Abstract

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1. Introduction

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1.1. Pre specialization paper

In preparation for our master thesis we spend a semester gaining knowledge in the field of recommendation systems. We wrote a paper called *Exploring Recommender Systems with Graph Convolutional Networks*. In this paper we studied recommendation systems using GCN's to achieve state of the art results. In particular we looked at the models NGCF, PUP and LightGCN. PUP and LightGCN is both inspired by NGCF, where LightGCN removes complexity operations from NGCF and PUP adds side information in form of prices and categories. Both achieved better performance in NDCG compared to NGCF. Because of this we thought it would be interesting to extend LightGCN with price and categories to see if it would improve performance.
Our initial extension of LightGCN where we changed the input by adding prices and categories to the user-item graph only made the model perform worse. It is our hypothesis that further changing how the embedding is performed can lead to performance increases.

2. Method

2.1. Neural Graph Collaborative Filtering

Neural Graph Collaborative Filtering (NGCF) was published in 2019, and was a state of the art method, that utilized graph convolutional networks for collaborative filtering [3]. The original use for GCN was proposed on node classification where each node has rich attributes, but for collaborative filtering it only has a node ID [2, 1, 3]. The embedding propagation for users is defined in Equation 1, and the embedding propagation for items can be defined similarly, where u is replaced with i, and i is replaced with u. [3]

$$\mathbf{e}_u^{(l)} = \text{LeakyReLU}(\mathbf{m}_{u\leftarrow u}^{(l)} + \sum_{i\in\mathcal{N}_u} \mathbf{m}_{u\leftarrow i}^{(l)}), \quad (1)$$

where $e_u^{(k)}$ and $e_i^{(k)}$ denotes the embeddings at the k layer for users and items respectively. $\mathbf{m}_{u\leftarrow i}^{(l)}$ is the message construction from users u to item i, and $\mathbf{m}_{u\leftarrow u}^{(l)}$ is the self connection. LeakyReLU is the nonlinear activation function. These are respectively defined in Equation 2 and Equation 3 [3].

$$\mathbf{m}_{u\leftarrow i}^{(l)} = \frac{1}{\sqrt{|\mathcal{N}_u||\mathcal{N}_i|}}(\mathbf{W}_1^{(l)}\mathbf{e}_i^{(l-1)} + \mathbf{W}_2^{(l)}(\mathbf{e}_i^{(l-1)} \odot \mathbf{e}_u^{(l-1)})), \quad (2)$$

$$\mathbf{m}_{u\leftarrow u}^{(l)} = \mathbf{W}_1^{(l)}\mathbf{e}_u^{(l-1)} \tag{3}$$

For Equation 2 and Equation 3 W_1 and W_2 are the trainable weight matrices used to perform feature transformation at each layer. $e_u^{(l-1)}$ and $e_i^{(l-1)}$ are the embeddings from the previous layer. $\frac{1}{\sqrt{|\mathcal{N}_u||\mathcal{N}_i|}}$ is the graph Laplacian norm used to normalize the embeddings, where $\mathcal{N}_u$ and $\mathcal{N}_i$ are the set of neighbours from user u and item i. The final embedding is calculated by concatenating each embedding layer [3].

3. Experiment

4. Related work

5. Future work

6. Conclusion

Appendices

Here should the first input to the appendix be

References

[1] Xiangnan He et al. "LightGCN: Simplifying and Powering Graph Convolution Network for Recommendation". In: SIGIR '20. 2020.

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[3] Xiang Wang et al. "Neural Graph Collaborative Filtering". In: *Proceedings of the 42nd International ACM SIGIR Conference on Research and Development in Information Retrieval* (2019).