Integrate KAN network in recommender system to solve cold-start problem

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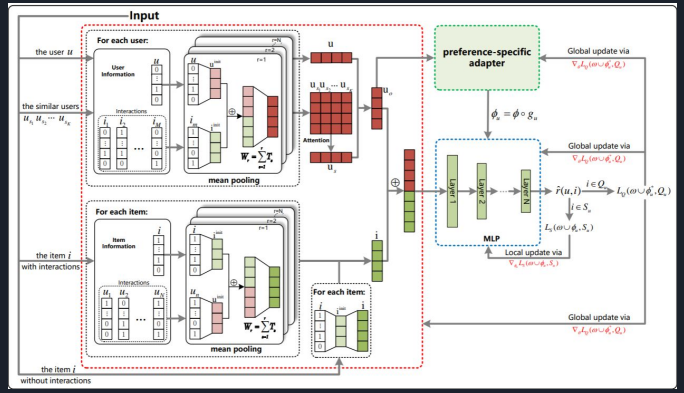
PROBLEM to SOLVE

In cold-start scenarios, most recommender systems have difficulties in predicting user preferences due to sparse user-item interactions that often bring some poor recommendations to users.

The project aims to alleviate the cold-start problem by leveraging rich data from similar users, and integrating the KAN network with the Meta-learning-based method.

Model	Multi-Layer Perceptron (MLP)	Kolmogorov-Arnold Network (KAN)
Theorem	Universal Approximation Theorem	Kolmogorov-Arnold Representation Theorem
Formula (Shallow)	$f(\mathbf{x}) \approx \sum_{i=1}^{N(\epsilon)} a_i \sigma(\mathbf{w}_i \cdot \mathbf{x} + b_i)$	$f(\mathbf{x}) = \sum_{q=1}^{2n+1} \Phi_q \left(\sum_{p=1}^{n} \phi_{q,p}(x_p) \right)$
Model (Shallow)	(a) *fixed* activation functions on *nodes*; *learnable* weights on *edges*	(b) *learnable* activation functions on *edges*; sum operation on *nodes*



Goals:

Replace the first layer of the prediction model with the KAN network to improve the recommendation performance. The method is designed to be adaptive and efficient in handling new user data with minimal prior interactions.

Metrics: Making a usable and better performance cold-start recommendation system. Having a completed and runnable model store in GitHub.

Project scope

WITHIN SCOPE

1. The project mainly focuses on cold start scenarios and optimizing performance for users with few interaction histories.

2. The project involves data processing, embedding, machine learning model training, KAN network integration, performance evaluation

3. Social network-based recommendations: user-clubs in the Goodreads dataset and user-friends in the Yelp dataset are trust networks for users with few user-item interactions. This network information is a strong feature to enhance user representations in our method.

OUTSIDE OF SCOPE

1, Live data update: This project is not optimized for streaming data since the model uses meta-learning and incremental learning techniques to adapt to new users or items by leveraging historical data.

2, Improving the embedding layer of the model, manage the data processing method in the pre-train stage. The current object is to focus on improving the MLP layer only.

3, Implementation KAN in software 2.0: in the current stage, KAN network is not industrial efficient. The result of the implementation may not be computationally optimized after the KAN integration.

Reference

REFERENCES

[1] Wu, Z., & Zhou, X. (2023). M2EU: Meta Learning for Cold-start Recommendation via Enhancing User Preference Estimation. Proceedings of the 46th International ACM SIGIR Conference on Research and Development in Information Retrieval, 1158–1167. https://doi.org/10.1145/3539618.3591719

[2] Z. Liu, P. Ma, Y. Wang, W. Matusik, and M. Tegmark, “KAN 2.0: Kolmogorov-Arnold Networks Meet Science,” Aug. 19, 2024, arXiv: arXiv:2408.10205. Accessed: Sep. 24, 2024. [Online]. Available: http://arxiv.org/abs/2408.10205

[3] Z. Liu et al., “KAN: Kolmogorov-Arnold Networks,” Jun. 16, 2024, arXiv: arXiv:2404.19756. Accessed: Sep. 24, 2024. [Online]. Available: http://arxiv.org/abs/2404.19756