"Enhancing Recommender Systems with LightGCN and Personalized Knowledge-Aware Attention Networks"

1. Introduction and Background

Graph Neural Networks (GNNs) are increasingly utilized in recommender systems for their strength in modeling graph-structured data. However, standard GNN approaches often lack the ability to capture fine-grained semantics from knowledge graphs and struggle to effectively represent complex user-item interactions. Recent advancements like Light Graph Convolutional Networks (LightGCN) [4] and knowledge-aware attention mechanisms [1] show promise in addressing these gaps by improving embedding quality and personalization.

2. Problem Statement

Despite progress, existing GNN-based recommender systems still face difficulties in precisely modeling semantic relationships within knowledge graphs and personalized user-item dynamics. This results in suboptimal recommendation accuracy, limiting user satisfaction and system effectiveness.

3. Objectives

1. Review the state-of-the-art in graph neural network-based recommender systems, focusing on LightGCN and knowledge-aware attention models.

2. Design a novel recommender system (LGKAT) combining LightGCN with a personalized knowledge-aware attention sub-network.

3. Implement and evaluate the proposed model on established datasets.

4. Benchmark the performance against current state-of-the-art methods using metrics such as F1-score and recall.

4. Proposed Methodology

The proposed methodology begins with a comprehensive literature review on Light Graph Convolutional Networks (LightGCN) and knowledge-aware attention mechanisms to identify existing gaps and foundational approaches [1][4]. Based on the findings, we will develop the LGKAT architecture, which combines LightGCN for learning efficient user and item embeddings with a personalized knowledge-aware attention sub-network to capture semantic representations from knowledge graphs [1]. The model will be implemented using machine learning frameworks such as PyTorch Geometric, which is well-suited for graph-based computation. We will use publicly available benchmark datasets that include both user-item interactions and corresponding knowledge graph data to train and evaluate the model. Model performance will be measured using standard evaluation metrics such as F1-score and recall, ensuring fair comparisons with baseline approaches [2]. Additionally, ablation studies will be conducted to evaluate the individual contribution of the LightGCN and attention components to the overall system.

5. Expected Outcomes

The project aims to achieve:

- The development of a novel recommender system architecture that effectively integrates LightGCN and personalized knowledge-aware attention mechanisms, addressing the limitations of existing graph-based models [4].

- Improved recommendation accuracy and personalization compared to traditional methods, including GNN-based hashing and shallow collaborative filtering approaches [2].

- Insightful analysis highlighting the value of semantic enrichment from knowledge graphs in enhancing recommendation performance and system interpretability [1].

6. Applications

- E-commerce platforms for product recommendation.

- Streaming services like movies, music, and media content personalization.

- Social networks for friend or content suggestions.

- Any domain requiring improved user-item recommendation leveraging semantic knowledge.

7. Timeline

Timeline	Task
Month 1-2	Literature review and requirement definition.
Month 3-4	Design LGKAT model model architecture integrating LightGCN and attention module.
Month 5-6	Model implementation and dataset preparation.
Month 7-8	Model training, experimentation, and refinement.
Month 9-10	Performance evaluation, ablation studies, and benchmarking.
Month 11-12	Thesis writing, completion and preparation for defence.

8. References

1. Fan, H., Zhong, Y., Zeng, G. & Ge, C. Improving recommender system via knowledge graph based exploring user preference. Appl. Intell. 52, 10032–10044 (2021).

2. Q. Tan, N. Liu, X. Zhao, H. Yang, J. Zhou and X. Hu, Learning to Hash with Graph Neural Networks for Recommender Systems, WWW '20: Proc. Web Confer. (2020).

3. Xiao, X. MMAgentRec, a personalized multi-modal recommendation agent with large language model. Scientific Reports 15, 12062 (2025).

4. Lee, S., Ahn, J. & Kim, N. Embedding enhancement method for LightGCN in recommendation information systems. Electronics 13, 2282 (2024).