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Machine Learning and Deep Learning Approaches for Recommendation Systems

Problem Statement:

Recommendation systems are now an important part of many modern applications, especially e-commerce platforms and content streaming services, where they help provide personalized experiences for users. In recent years, deep learning models have significantly improved recommendation accuracy. For example, models such as Wide & Deep Learning (Cheng et al., 2016), Neural Collaborative Filtering (He et al., 2017), and hybrid CTR models (Al-Hindy et al., 2019) are able to capture complex relationships between users and items, which leads to better performance.

However, these advanced models usually require high computational resources. This makes them difficult to use in real-time systems or on devices with limited resources, such as mobile phones. On the other hand, lightweight models like LightGCN (He et al., 2020) try to solve this issue by simplifying the model structure, making them more efficient. However, these models mainly focus on user–item interactions and often ignore important contextual factors such as time, location, and device type. They also do not fully capture how user preferences change over time.

In contrast, recent research on context-aware models (Al-Yafi et al., 2020) and sequential models based on self-attention (Al-Kasem & Shahrour, 2021) shows that including contextual and temporal information can improve recommendation quality. However, these approaches usually increase computational complexity, which makes them less suitable for real-time or large-scale applications.

As a result, there is still a clear gap in the literature. There is a need for a recommendation model that can balance accuracy and efficiency while also considering contextual information and the changing behavior of users over time. This research aims to address this gap by proposing a lightweight and efficient recommendation model.

Research Question:

How can a lightweight recommendation model be designed to achieve high accuracy while effectively incorporating both contextual and sequential user information for real-time applications?

Research Objectives:

This study aims to develop a recommendation model that is both efficient and accurate, while also considering contextual information and the temporal behavior of users.

1. To analyze and compare existing recommendation models in terms of accuracy, computational efficiency, and scalability.
2. To identify the main limitations of current approaches, especially their difficulty in handling contextual information, sequential user behavior, and efficiency at the same time.
3. To design a hybrid recommendation model that combines:
 - user–item interactions
 - contextual information (such as time, location, and device)
 - sequential user behavior
4. To develop a lightweight architecture that can be applied in real-time recommendation scenarios.
5. To evaluate the proposed model using standard metrics such as AUC, Recall, and NDCG, and compare its performance with existing baseline models.

References

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