University of Pittsburgh | School of Computing and Information

Dissertation Defense

Doctor of Philosophy in Intelligent Systems

"**KA-Recsys: Knowledge Adaptive Recommendation Technologies**" by **Khushboo Thaker**

Date: December 9, 2024
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https://pitt.zoom.us/j/99838874706

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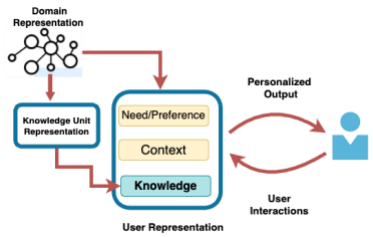
Abstract:
As digital technologies increasingly mediate learning and decision-making processes, there is a growing demand for personalized systems that adapt to individual user needs, particularly in specialized domains such as education and healthcare. Despite significant advancements, a critical gap remains in current recommender systems: they often overlook users' underlying knowledge levels, focusing primarily on preferences and behaviors. This oversight frequently results in content recommendations that do not match the user's knowledge level, leading to frustration and disengagement, especially in contexts requiring a deep understanding of complex material.

This dissertation introduces a novel framework for knowledge-adaptive recommender systems that effectively combines user knowledge with their preferences. By incorporating cognitive principles from educational psychology, the framework aligns recommendations with the user's current knowledge state, enhancing learning efficiency, user engagement, and the overall relevance of personalized content.



Building on the foundation of Intelligent Tutoring Systems (ITS), which have proven effective in adaptive learning, this research extends ITS-based knowledge models to intelligent textbooks. However, utilizing direct ITS models present with challenges. ITS models rely on direct assessment data, which is often sparse or unavailable in intelligent textbooks, and constructing a well-represented domain model is challenging due to the vast content in textbooks and the need for automated, cognitively grounded concept extraction. The work addresses these issues by developing (1) dynamic knowledge modeling techniques that infer user knowledge from interactions and reading behaviors, and (2) automated methods to extract better domain knowledge representations from textbooks, enabling more accurate user knowledge estimation and effective content recommendations.

This dissertation makes several significant contributions to the field of personalized recommender systems. First, it introduces a comprehensive knowledge-adaptive framework that merges user knowledge with preferences, enhancing the relevance and effectiveness of the recommendations. Second, it develops dynamic knowledge modeling techniques that infer user knowledge from non-assessment activities, addressing the critical challenge of limited assessment data. Third, it contributes a Framework for Concept Integration and Facet Specification (*FoCIF*), providing a fine-grained representation of domain knowledge that allows for precise measurement of user knowledge levels and supports effective adaptive recommendations. Finally, the work adapts and extends the knowledge-adaptive framework, demonstrating its application beyond traditional educational contexts, particularly in health recommender systems. These adaptations highlight the versatility of the proposed framework across diverse domains.

These contributions are thoroughly validated using real data as well as a user study. The findings indicate substantial advancements in the design of personalized recommender systems by positioning user knowledge as a central factor, with promising applications in both educational and health domains.