

Prerequisite Knowledge based Automated Course Planning with Hierarchical Knowledge Relationship

John Jung-Woon Yoo and Saeed Saboury

Department of Industrial & Manufacturing Engineering & Technology
Bradley University, Peoria, IL, USA
jyoo@bradley.edu and saboury@bradley.edu

Preamnath Balachandranath

Senior Industrial Engineer
Cummins Inc. Columbia, IN, USA
preamnath@gmail.com

Abstract

This research proposes the knowledge-based prerequisite framework (KPF) and presents a novel mathematical model that supports the KPF. Prerequisite knowledge of a course is defined as a set of knowledge that students should acquire in order to take the course, as opposed to a set of courses. The knowledge-based prerequisite framework is more flexible because it requires only essential prerequisite knowledge, while the course-based prerequisite framework is more rigid and students are usually required to take all prerequisite courses. Such flexibility can be obtained by verification of specific prerequisite knowledge terms for each course. However, flexibility can cause additional complexity in prerequisite verification. Furthermore, the knowledge-based prerequisite framework inevitably involves handling hierarchies of defined knowledge terms. This research presents a novel Artificial Intelligence (AI) Planning mathematical model that enables the knowledge-based prerequisite framework by automatically verifying prerequisite knowledge and incorporating hierarchical knowledge relationships among knowledge terms into the model. The proposed model finds hidden or better solutions that could not be obtained by earlier approaches. The results of the comprehensive experiments show the optimality of the solutions obtained by the mathematical model and demonstrate the outperformance of the hierarchical relationship incorporation into the mathematical model in terms of the quality of solutions. Finally, the experimental results on scalability show the necessity of the development of efficient heuristic algorithms.

Keywords

Artificial Intelligence (AI) Planning, Course Planning, Integer Programming, Hierarchical Relationship.

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Biographies

John Jung-Woon Yoo is an Associate Professor of the Department of Industrial & Manufacturing Engineering & Technology at Bradley University, Peoria, IL, USA. He received a B.S. degree in Industrial Engineering from Korea University, Seoul, Korea, a M.S. degree in Industrial Engineering from Seoul National University, Seoul, Korea, and a Ph.D. degree in Industrial Engineering from the Pennsylvania State University, State College, PA, USA. He has over six years of industry experience as a software designer, including his work at Electronics and Telecommunications Research Institute, Daejeon, Korea. His research focuses on Artificial Intelligence (AI) Planning

theory and applications. He has applied AI Planning to Web Service Composition, Modular Product Design, and Automated Course Planning. He is a member of IEEE and IISE (the Institute of Industrial and Systems Engineers).

Preamnath Balachandranath is a Senior Industrial Engineer at Cummins Inc. He received a M.S. degree in Industrial Engineering from Bradley University. His research area includes AI Planning, Association Rule Mining, among others. He was one of the four finalists in 2020 IISE-DAIS Mobile/Web App Competition with an automated course planner, supervised by the co-authors of this paper.

Saeed Saboury is an Associate Professor of the Department of Industrial & Manufacturing Engineering & Technology at Bradley University, Peoria, IL, USA. He holds a Ph.D. and a M.S. degree in Materials Science from the University of London, Imperial College, United Kingdom, and a B.S. degree in Metallurgical Engineering from the University of Tehran, Iran. He is an expert in curriculum design with more than a decade of experience as the chair of college-level and department-level curriculum committees. He has supervised AI Planning-based graduate research projects.