

Investigating State and Action Space Design in Reinforcement Learning for Dynamic Two-Stage Assembly Flow Shop Scheduling

Muhammet İkbāl Kaya

Research Assistant, Industrial Engineering Department
Gazi University, Ankara, Türkiye
mi.kaya@gazi.edu.tr

Selçuk Kürşat İşleyen

Full Professor, Industrial Engineering Department
Gazi University, Ankara, Türkiye
isleyens@gazi.edu.tr

Abstract

Dynamic scheduling in two-stage assembly flow shops represents a significant challenge in production management due to stochastic job arrivals and complex assembly constraints. While reinforcement learning (RL) has emerged as a promising approach for real-time decision-making in these environments, the performance of RL-based scheduling agents is inherently tied to the design of their state and action spaces. This study investigates the influence of state-action space design on the efficiency of RL-based scheduling policies aimed at minimizing total tardiness. In particular, the research explores potential refinements in state representations, specifically addressing possible feature redundancies, and evaluates the necessity of various dispatching rules within the action space. Comparative simulation experiments in a manufacturing environment are conducted to analyze how different levels of state granularity and action space complexity affect the agent's learning convergence and scheduling stability. The study aims to provide insights into the trade-off between model complexity and scheduling effectiveness, highlighting the importance of problem-aware state and action space design in reinforcement learning-based production scheduling.

Keywords

Two-stage assembly flow shop scheduling, Dynamic job arrivals, Reinforcement learning, State representation

Biographies

Muhammet İkbāl Kaya is a Research Assistant and PhD candidate in Industrial Engineering at Gazi University, Ankara. His research interests include machine scheduling problems, vehicle routing problems, and the application of reinforcement learning to combinatorial optimization problems.

Selçuk Kürşat İşleyen is a Full Professor in the Department of Industrial Engineering of Gazi University, Türkiye. He graduated from the Faculty of Engineering at Gazi University in 2001. He received M.Sc. and Ph.D. degrees in Industrial Engineering from Gazi University in 2004 and 2008, respectively. His research mainly focuses on optimization problems, logistics, and assembly line balancing problems.