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산업경영공학과
인공지능최적화 연구실
(8호관 472호)

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Scalable reinforcement learning approach for scheduling customer orders with missing operations

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ABSTRACT

This study addresses the customer order scheduling problem with missing operations, a complex combinatorial optimisation task with significant industrial relevance, aiming to minimise total tardiness. We propose an RL-based algorithm for solving this problem enhanced with curriculum learning to achieve strong scalability and generalisation. The model employs an encoder–decoder architecture that embeds missing operations, processing times, and due dates, and sequentially generates schedules in an autoregressive manner. A preference-based loss function is integrated into the training objective to align policy updates with performance ranking, further improving solution quality and convergence. An optional local search procedure can additionally be applied as a post-processing step when additional computation time is available. Experimental results on 640 test instances show that Proposed consistently outperforms traditional heuristics, state-of-the-art meta-heuristics, and a recent learning-based baseline in solution quality, while Proposed+LS provides further improvement when additional computation time is available. Proposed also demonstrates strong scalability, performing effectively across job sizes from 100 to 300 and machine sizes from 5 to 10. These findings demonstrate the effectiveness of curriculum-based RL on the considered benchmark instances and provide a basis for its further evaluation in practical industrial scheduling environments.

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인천대학교 산업경영공학과 인공지능최적화 연구실 임제원 학석사연계과정 학생(제1저자), 김정현 학석사연계과정 학생, 김재곤 교수(교신저자)가 생산관리 및 산업공학 분야의 세계적 권위 학술지인 International Journal of Production Research (SCIE, IF 8.7, JCR 상위 10% 이내)에 연구논문을 게재하였다. 본 연구는 고객 주문별로 필요한 생산 공정이 서로 다른 제조 환경에서 납기 지연을 최소화하는 인공지능 기반 생산 스케줄링 기법을 제안하였다. 연구진은 강화학습과 어텐션 기반 신경망을 활용하여 대규모 스케줄링 문제를 효율적으로 해결하고, 지역 탐색 기법을 결합하여 최적화 성능을 향상시켰다. 실험 결과, 제안한 방법은 기존 휴리스틱 및 메타휴리스틱 기법보다 우수한 성능을 보였으며, 최대 300개 작업과 10개 기계로 구성된 대규모 문제에서도 높은 성능과 빠른 계산 속도를 입증하였다. 이를 통해 제조 현장의 납기 준수율 향상과 생산 운영 효율화에 기여할 가능성을 제시하였다.



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