Enhancing Emergency Department Efficiency: Data-Driven Simulation and Agent-Based Modelling for Decentralized Resource Scheduling

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Résumé

Emergency departments (ED) are strategic sectors in the hospital chain as they provide first-stage care and immediate treatment to patients. Efficient patient flow management in the ED is essential to ensure quality in the treatment process. Challenges in EDs occur particularly due to various high degrees of uncertainties in EDs. Decision-making on the operational level is regularly required to react to unexpected situations to ensure efficient management of patient flows in the ED. This work proposes a new approach based on data-driven simulation of patient flows and agent-based modelling of the decision-making process to improve the decision-making in EDs. Initially, the event-centric event log from historical patient data gathered continuously from ED is required to provide a patient flow model. Then, this event log is transformed systematically into an activity-centric activity log using algorithms, and the activity log is used as the input for data-driven simulation. In this data-driven simulation of the patient pathway, the generic simulation model enables the execution of simulation experiments from structured simulation data or the activity log, which is obtained from process mining. The simulation in the dynamic queuing network also enables a dynamic view to understand the phenomena and behaviours that occur when treating patients in ED. The use of process-mining and data-driven simulation enables considering historic patient populations in system design and increases the accuracy of the patient flows. In this data-driven simulation, the resources are modelled, and their decision-making in ED is explored. The decentralised resource scheduling decisions are modelled using agent-based simulation to provide quick and good scheduling solutions that improve overall performance in ED.

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