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Sergey V. Kovalchuk, Anastasia A. Funkner, Oleg G. Metsker, Aleksey N. Yakovlev

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# Simulation of Patient Flow in Multiple Healthcare Units using Process and Data Mining Techniques for Model Identification

Sergey V. Kovalchuk<sup>1</sup>, Anastasia A. Funkner<sup>1</sup>, Oleg G. Metsker<sup>1</sup>, Aleksey N. Yakovlev<sup>1,2</sup>

<sup>1</sup> ITMO University, Saint Petersburg, Russia

<sup>2</sup> Almazov National Medical Research Centre, Saint Petersburg, Russia

[kovalchuk@mail.ifmo.ru](mailto:kovalchuk@mail.ifmo.ru), [funkner.anastasia@gmail.com](mailto:funkner.anastasia@gmail.com), [olegmetsker@gmail.com](mailto:olegmetsker@gmail.com), [yakovlev\\_an@almazovcentre.ru](mailto:yakovlev_an@almazovcentre.ru)

**Abstract. Introduction:** An approach to building a hybrid simulation of patient flow is introduced with a combination of data-driven methods for automation of model identification. The approach is described with a conceptual framework and basic methods for combination of different techniques. The implementation of the proposed approach for simulation of the acute coronary syndrome (ACS) was developed and used in an experimental study. **Methods:** A combination of data, text, process mining techniques, and machine learning approaches for the analysis of electronic health records (EHRs) with discrete-event simulation (DES) and queueing theory for the simulation of patient flow was proposed. The performed analysis of EHRs for ACS patients enabled identification of several classes of clinical pathways (CPs) which were used to implement a more realistic simulation of the patient flow. The developed solution was implemented using Python libraries (SimPy, SciPy, and others). **Results:** The proposed approach enables more a realistic and detailed simulation of the patient flow within a group of related departments. An experimental study shows an improved simulation of patient length of stay for ACS patient flow obtained from EHRs in Almazov National Medical Research Centre in Saint Petersburg, Russia. **Conclusion:** The proposed approach, methods, and solutions provide a conceptual, methodological, and programming framework for the implementation of a simulation of complex and diverse scenarios within a flow of patients for different purposes: decision making, training, management optimization, and others.

**Keywords.** clinical pathways, discrete-event simulation, process mining, data mining, acute coronary syndrome, electronic health records, classification.

## 1 Introduction

A detailed simulation of patient care provided in healthcare units requires analysis of this process from multiple points of view. The process involves multiple departments, many types of activities, different actors with particular roles, expertise level, knowledge, etc. Moreover, multiple scopes and aspects of the healthcare process can be considered (departments' resource load, hospital accounting practices, patients' personal experiences during the care process, and many others). One of the key reasons for growing interest in this subject is the recent attention to patient-centered

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