

# Abstract

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## **Resource Optimization in Emergency Departments**

Healthcare services are one of the fastest growing services, and the rising demand for such a service increases the pressure on healthcare managers to meet many conflicting objectives. The Emergency Department (ED) is one of the most commonly studied area in a hospital. The main problem that an ED faces is overcrowding, resulting in consequences as dramatic as increased mortality rates. Other issues arise including patients experiencing long waiting times, as a result increasing their total stay time, and causing them to even leave without being served, all in which jeopardizes a patient's health. Healthcare managers have to make effective decisions concerning capacity planning, to meet the high patient expectations. Accordingly, this subject has become very attractive to researchers, allowing them to seek Operations Research (OR) tools as a means of improving the performance of an ED. This work proposes a Simulation Optimization (SO) framework, adopted for an ED, in aims of improving its performance. Discrete Event Simulation (DES) modelling is used to replicate and analyse the patient flow and Genetic Algorithm (GA) is used to find the optimal resource levels within the ED. Data used to drive the simulation is based on a case study reported in literature for a University Hospital in Ireland, where the hospital managers claim that the ED does not perform up to standard. Results of the DES model confirm that the ED under study does not comply with given standards, and suffers from poor performance. ExtendSim™ suite V9.2, is chosen for this study, the suite incorporates an evolutionary optimizer and is thus used for both the simulation modelling and optimization. The code controlling the mechanism of ExtendSim™ evolutionary optimizer is studied in detail, in order to understand the optimization method, which is based on GA. Modifications are introduced to the optimizer code, in order to improve the different operators, allowing for greater exploitation and exploration of the solution space, and also making the optimizer a more flexible one. Different optimization experiments are conducted using both the original ExtendSim optimizer, and the modified one, aiming to improve the time a patient spends in the ED, as well as the resource utilizations. Optimization experiments using both optimizers resulted in improved ED performance, and prove that the modified optimizer leads to the near optimal solution much faster in terms of convergence.