

Chapter 68

Machine Learning for Emergency Department Management

Sofia Benbelkacem

Laboratoire d'Informatique d'Oran (LIO), University of Oran 1 Ahmed Ben Bella, Algeria

Farid Kadri

Big Data & Analytics Services, Institut d'Optique Graduate School, Talence, France

Baghdad Atmani

Laboratoire d'Informatique d'Oran (LIO), University of Oran 1 Ahmed Ben Bella, Algeria

Sondès Chaabane

University Polytechnique Hauts-de-France, CNRS, UMR 8201 – LAMIH, Laboratoire d'Automatique de Mécanique et d'Informatique Industrielles et Humaines, F-59313 Valenciennes, France

ABSTRACT

Nowadays, emergency department services are confronted to an increasing demand. This situation causes emergency department overcrowding which often increases the length of stay of patients and leads to strain situations. To overcome this issue, emergency department managers must predict the length of stay. In this work, the researchers propose to use machine learning techniques to set up a methodology that supports the management of emergency departments (EDs). The target of this work is to predict the length of stay of patients in the ED in order to prevent strain situations. The experiments were carried out on a real database collected from the pediatric emergency department (PED) in Lille regional hospital center, France. Different machine learning techniques have been used to build the best prediction models. The results seem better with Naive Bayes, C4.5 and SVM methods. In addition, the models based on a subset of attributes proved to be more efficient than models based on the set of attributes.

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1. INTRODUCTION

The management of emergency departments (ED) is crucial to get medical care within appropriate time frames. However, there is an increasing demand for ED services around the world (He, Hou, Toloo, Patrick, & Fitz Gerald, 2011; Baubeau, Deville, Joubert, & Fivaz, 2000; IMNA, 2006; Cours des comptes, 2007; Kadri, Chaabane, & Tahon, 2014). This growing demand leads to the overcrowding of ED (Boyle, Beniuk, Higginson, & Atkinson, 2012). This later is manifested by a prolonged waiting time and an increasing length of stay of patients in EDs. The increased length of stay (LOS) in EDs affects the quality of treatment and prognosis by medical staff who are often overloaded thus leading to a decrease in physician job satisfaction (Rondeau & Francescutti, 2005; Lin, Hsu, Chao, Luh, Hung, & Breen, 2008); it produces violence of angry patients against staff, reduced access to emergency medical services and increase in patient mortality (Sprivulis, Da Silva, Jacobs, Frazer, & Jelinek, 2006; Alexandrescu, Bottle, Jarman, & Aylin, 2014).

The aim of this study is to anticipate the occurrence of ED overcrowding by predicting the LOS at the ED. In order to achieve this objective, the authors propose a methodology guided by data mining methods. Data mining has been used widely in various areas. Murthy, Nagadevara, & De' (2010) used data mining techniques to treat cybercrime investigation in India. The aim of this study was to identify the factors that strengthen the existing investigation methods in order to improve the success rate of cybercrimes prosecution. Wang, Yan, Chen, & Xing (2010) presented a study where they summarized the applications of data mining in the public sector. These applications have been classified into several categories including the improvement of emergency management, the management of human resources, etc. Carr, Ravi, Reddy, & Veranna (2013) used decision tree, logistic regression, multilayer perceptron and SVM to profile mobile banking users. Decision trees outperformed the other machine learning techniques. Pabreja (2017) applied various classification techniques on the educational database of a Delhi state university. They used data mining techniques to better understand strengths and weaknesses of students.

Data mining techniques allow extracting useful knowledge and regularities which may be used as a tool for decision making in such establishments, in order to respond to the needs of ED managers in their daily decision-making activities (Benbelkacem, Kadri, Chaabane, & Atmani, 2014). The main objective of this work is to propose a prediction approach based on machine learning techniques to predict the patient LOS at the pediatric emergency department in Lille regional hospital centre, France.

The remainder of this paper is organized as follows. First, machine learning techniques are presented and how it can be used in hospital emergency departments. Then, an approach for predicting patient LOS in ED is proposed. The proposed approach is then applied in the prediction of patient LOS at the PED in Lille regional hospital centre, France. Finally, the last section reviews the main conclusions of this work.

2. MACHINE LEARNING AND PREDICTING PATIENT LOS IN ED

In recent years, there has been a dramatic increase in medical data being collected (Hermon & Williams, 2014). Data sets are frequently characterized by incompleteness, incorrectness, inexactness and sparseness. These problems are quite common in the medical field. This field requires human experts with a high level of expertise and able to maintain a high degree of concentration. Therefore, the use of machine learning techniques becomes indispensable for the development of medical decision support tools that model expert behavior, clinical interpretation and analysis, and to save time for practitioners. Machine

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