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Classification of Asthma Severity and Medication Using TensorFlow and Multilevel Databases

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Abstract

Escalating cost of treating chronic diseases demand that they be, to the extent possible, self-managed by the patients. In self-management of disease an imperative is to predict, the possible future state of morbidity (at time, T^1), given the present precursor conditions (at time, T^o) and expected precursor condition (at time, T^1).

This paper reports the results of a study to evaluate the potential use of using TensorFlow and Inpatient Databases at national level and hospital level for predicting the asthma severity. Methods of Deep Neural Networks (DNN) have been deployed in classification of morbidity conditions, as well as treatment options. The results indicate that training a DNN to predict asthma severity level or the imminence of an asthma attack is possible.

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Keywords: deep learning; neural networks; machine learning; asthma severity; asthma exacerbation

1. Introduction

The availability of electronic health data together with the use of Artificial Intelligence (AI) in general and Machine Learning (ML) techniques in particular suggest the potential meaningful use of this data to improve healthcare quality and reduce cost[1]. The challenge of using healthcare data remains in the data's volume, velocity, and the variety. Healthcare data's size is big and is produced at high speed. In addition, the variability in data type,

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content and format in different care settings lead to a huge complexity in dealing with this data. However, AI researchers are tackling this problem by developing new, efficient and scalable algorithms or pattern detection methods to be able to extract useful, invaluable knowledge from massive health data[1]. One of the first successful AI applications in healthcare was the Clinical Decision Support Systems (CDSS)[1]. The main feature of CDSS is diagnosing patients' condition based on patients' demographic condition and symptoms. Not only dealing with a small subset of patient population or a specific disease, the next generation of AI applications in healthcare focused on question-answering and large-scale anomalous pattern discovery. With the ability of combining and understanding big data of unstructured text data such as doctor's notes, medical literature, patient health records and apply its oncology training on a patient-specific case, IBM Watson can reply to natural language queries by providing a diagnostic test and a list of potential treatment options based on probabilistic reasoning that could help doctors in making evidence-based decisions[2]. Another approach is statistical, fast subset scanning ML methods[3,4] for anomalous pattern detection of big healthcare data, especially patterns of care that affect patient outcomes. This type of AI applications can help identify subset of data records (row) and features (columns) that maximize some measure interest like variations in care between groups that have significant better patient outcomes. Early examples of the process of sleuthing to discover patterns within data in diverse formats include the Semmelweis study on the link between puerperal fever and spread of bacteria through unwashed hands (by obstetrical staff). Through the process of eliminating other probable causes, Semmelweis determined the link to be cadaveric contamination. The aetiology of the problem having being discovered, a simple prophylaxis was prescribed: washing of hands with chlorinated lime solution. This example underscores the importance of hypothesis generation through pattern discovery from diverse data. ML is also employed to help chronic diseases patients such as asthma patients monitoring their conditions and treatments. Asthma is currently incurable but it symptoms can be controlled through quality care, proper medication, and good self-management[5]. For that reason, the main objectives of asthma care are monitoring symptoms and progression of the disease while avoiding asthma triggers and minimize asthma attack. AI technologies have been used to predict the potential asthma accelerations. There were many failures at the beginning. However, recent ML methods prove that it can be possible.

In this paper, we report the results of our study to predict the severity level of asthma, using data from two sources. Specific to this report is the comparison of prediction using two different datasets. We trained a Deep Neural Network (DNN) to predict asthma severity using data at National level and Hospital level. For National data, we used HCUP National Inpatient Sample 2011 Database (NIS). For Hospital data, we used the Medical Information Mart for Intensive Care III database (MIMIC III).

2. Background

1.1. A The Nature of Asthma Disease and its Treatment

A short narrative on the disease and its treatments are given in the Appendix A.

1.2. Asthma Exacerbation Prediction

Although asthma is indeed a common disease, and its onset can be probabilistically determined through a number of markers, including: (i) Airway Hyper Responsiveness (AHR), (ii) Dermatitis at baseline, and (iii) Record of wheezing[19]. For Chronic Diseases, it is recommended that to reduce cost but at the same time experience better outcomes the disease should be self-managed by the patient. In 1996, through a randomized trial study for the outcomes comparison between guided self-management and traditional treatment of asthma over 12 months of 115 mild and severe asthma patients, the researchers concluded that guided self-management reduced at least half of the incidents caused by asthma improved patients' quality of life[20]. In order to be effectively self-managed, asthma patients need to be able to tell whether the disease is under good control. Specifically, patients must acknowledge the progression of the disease and know whether, or not, their conditions are getting worse.

However, predicting the severity of asthma is difficult, even by physicians staffing the emergency department. Kelly, et al (2004) reports on a study on severity assessment at initial admission and at one hour later (after