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A Multi-model Approach in Developing an Intelligent Assistant for Diagnosis Recommendation in Clinical Health Systems

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Abstract

Clinical health information systems capture massive amounts of unstructured data from various health and medical facilities. This study utilizes unstructured patient clinical text data to develop an intelligent assistant that can identify possible related diagnoses based on a given text input. The approach applies a one-vs-rest binary classification technique wherein given an input text data, it is identified whether it can be positively or negatively classified for a given diagnosis. Multi-layer Feed-Forward Neural Network models were developed for each individual diagnosis case. The task of the intelligent assistant is to iterate over all the different models and return those that output a positive diagnosis. To validate the performance of the models, the performance metrics were compared against Naive Bayes, Decision Trees, and K-Nearest Neighbor. The results show that the neural network learner provided better performance scores in both accuracy and area under the curve metric scores. Further, testing on multiple diagnoses also shows that the methodology for developing the diagnosis models can be replicated for development of models for other diseases as well.

Keywords: artificial neural network; intelligent assistant; medical diagnosis; health intelligent systems

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1. Introduction

Medical diagnosis is an important task that requires a very accurate execution[1]. In recent years, challenges in accurate diagnosis have been more observable because of various factors such as increased number of elderly patients and, limited medical personnel and facilities. It is therefore now becoming more relevant to address this problem through development of innovative solutions that may help physicians in providing more accurate medical diagnosis[2]. Furthermore, more efficient solutions can be achieved by making available data more in influential in creating these solutions.

Healthcare institutions have already gained progress in the digitization of medical records[3]. The implementation of various clinical information systems has allowed health stakeholders to easily capture patient health data. However, insights from these data may not be easy to discover if there is no prior processing. Current technologies in the health ecosystem allow several patient records to be aggregated and analyzed[4] so that valuable and reliable information may be discovered.

Prior to this study, initial models were already analyzed to test on the idea of using Artificial Neural Networks for classification of unstructured clinical text data into a specific diagnosis[5]. This study focuses on improving on the previously analyzed models[5] for the development of an intelligent diagnosis recommender that can suggest possible diagnoses based on a given text input. Furthermore, it also focuses on its possible applications and integration opportunities into an existing clinical health system, more specifically, an Electronics Medical Records system.

Data collected from clinical health systems are utilized to create an accurate intelligent assistant. Automatic recommendation of possible diagnoses based on observable signs and symptoms is a promising solution in medical diagnosis, especially in the context of developing regions like the Philippines, where there are still a lot of shortcomings in the health ecosystem. It is important to note, however, that the diagnosis recommender is not meant to replace human decision-making, but rather, to help with physicians in making more informed decisions.

This article is organized as follows: in section 2 we present a review of previously conducted researches, and literature related to our study; in section 3 we identify the materials and methods used in the study; in section 4 we present the results and analysis of the initial models; and in last sections we state the conclusion and enumerate recommendations for further studies.

2. Related literature

2.1. Clinical Health Systems

Clinical health systems can be implemented in many forms which include, but are not limited to, Hospital Management Information Systems (HOMIS), Laboratory Information Systems (LIS), and Electronic Medical Records (EMR) systems. In this study, we focused more on EMR systems. EMRs are characterized as digital medical records used within a health facility[4]. It is believed to be at the center of any clinical information systems as it serves as the foundation for ICT-integrated routine clinical workflow. EMRs can replace paper-based medical recording, provide a single point of access for data, automate report generation and track information trails, thus, improving the clinical healthcare delivery[5,6].

An example of an operational Electronic Medical Record in the Philippines is SHINE OS+. SHINE (Secured Health Information and Network Exchange) was launched in 2011 to address the need for an integrated health information referral system. Its four main features include 4 Rs: recording patient health and medical information, reminding patients of appointments and medication schedules, referring patients to other health facilities, and producing aggregated and summarized reports[5,7]. Other existing EMR systems in the Philippines are CHITS, WAH, SegRHIS, iClinicSys and for mobile-based platforms, eHATID LGU. EMRs offer great potential for data analysis because of its capacity to collect large amounts of patient health data and its important contributions to the construction of patient electronic health records (EHR)[5,8].