Masters Research Proposal - Is it possible to increase accuracy and decrease execution time in the diagnosis of human bone fractures using deep learning whilst simplifying its complexity in the hidden layers?

Alice Yang (597609)

School of Electrical and Information Engineering, University of the Witwatersrand, Private Bag 3, 2050, Johannesburg, South Africa

Abstract: The objective of this paper is to investigate whether it is possible to increase accuracy and decrease execution time in the diagnosis of human bone fractures using deep learning. The paper looks at existing artificial intelligence algorithms and its different uses in the medical field with given data sets. Additionally, the paper looks are the problems faced with introducing AI into the medical field and the knowledge required in order to achieve the goal of the proposal question.

Key words: Neural Networks, Supervised Learning, Unsupervied Learning, Support Vector Machine, Bone Fractures, Medical Images, Deep Learning, Hidden Layers

1. Introduction

In medical the field there is an emphasis on the importance of medical diagnosis. In critical cases, an inaccurate diagnosis of a symptom can cost a patient's life. Many diagnosis are performed by trained medical doctors, however they are prone to making mistakes which can be influenced by external factors, such as fatigue and lack of training in the particular field. According to [1], automation of medical diagnosis was introduced in the early 1970s. There are many algorithms available in diagnosing patients. The basic algorithm consists of "if... then..." statements. Although the algorithm is simple, the list of conditions in the medical field are endless and as a result the execution time to diagnosis a patient's symptoms is not realistic. There are many pattern recognition algorithms available which are categorized in two categories, namely, unsupervised and supervised. The reasoning behind making use of artificial intelligence is to reduce costs.

2. Background

There are many simple implementations of programs that are proposed to diagnosis common medical conditions. These implementations requires a vast majority of the medical knowledge to express the different descriptions of possible diseases to be stored in the program's database. Although the program is simple to implement, it has no method of measuring the severity of the patient's illness. Another downfall to using a database to diagnosis an illness, is that it can mean that the database can grow exponentially otherwise it would be outdated.

An alternative approach in medical diagnosis is to focus on one disease to ensure accuracy and quick response. The use of artificial intelligences can be focussed in this area. The focus of this paper is to diagnosis the type of bone fracture from X-Ray images. There are a selection of tools that can be applied in order to achieve the desired outcome for this investigation. Support Vector Machine and Neural Networks are common tools used in artificial intelligence (AI).

Support Vector Machine (SVM) is a classifier mainly used for complex classification purposes. In order to separate new data into specified categories, SVM is trained with given labelled data making it supervised learning [2]. An implementation of SVM classifiers is done in [3] where the it is used to classify X-Ray images of the body into five categories, namely, head-neck, body, upper-limb and true-negative. Spatial Pyramid Histogram are used to decipher the medical images which is then used to train the Chi-Kernel based SVM. In general, SVM is used for binary classification [4].

Neural Networks in another common tool selection for AI, whereby it consists of three distinguished layers, the input, hidden and output layer. A general neural network consists of one or two hidden layers, according to [4]. The network

is trained before use, which deems it as supervised classification or predictions. In [5], the technique implemented is back-propagation neural network (BPNN). The network is trained using a Supervised Delta Learning Rule. The result from the developed technique is a binary outcome in which it indicates whether the subject is normal or abnormal.

Studies of improving the common tools in AI have been done by combining the tools. There are two types of combinations, hybrid and non-hybrid multiple classifiers. Hybrid multiple classifiers combines different types of AI algorithms, whereas non-hybrid multiple classifiers only consists of one base algorithm and is replicated multiple times. A hybrid multiple classifier is done by [**?**], in which the algorithms used are K-Nearest Neighbour, Back Propagation Neural Network (BPNN) and SVM. According to the authors, the each of the AI tools is trained with a different set of data. The decision is based on a voting scheme that is called fusion selection. However, the paper presented in [**?**] performs binary results. In other words, it indicates whether a fracture is present or absent.

Another AI algorithm to be considered for medical diagnosis is deep learning. According to the author in [6], deep learning has the ability to combat complex problems whereas SVM would not be able to, since SVM works better with small data sets that have few outliers. However, the downfall of deep learning is its learning process, in which it can become tedious and computational demanding. Thus for small data sets, it is more plausible to use an off-shelf classifier such as SVM.

3. Problem

The modern world has presented the technology to predict human speech as well as digitally categorizing handwritten numbers. However, this technology has not been fully utilized in the medical field. There are many debates surrounding the topic of whether machines are better than doctors. In many cases, the argument for doctors states that those who develop AI do not understand the complexity of medicine and those arguing for the machines say that not many understand how AI operates. However, at the end of the day there are still sick patients waiting to be treated with the right medication or medical care. In order to determine the type of medical care the patient needs a diagnosis must be performed. According to [7], where studies have been done around the United States, it was reported that doctors correctly diagnosed 55.3% for easier cases and 5.8% for more difficult cases. However, this is only one article and more investigation is needed to confirm these numbers. Even so, these numbers still indicate that doctors are not perfect and can mis-diagnosis patients. As a result of mis-diagnosis, the patient is subjected to stress or even life threatening situations should the disease be mis-treated. Therefore there is a large emphasis on accuracy and quick detection of diseases.

4. Knowledge Needed

The type of knowledge that is needed in order to solve this problem is what kind of existing systems or algorithms in machine learning that have attempted to solving the problem. Additionally, what is the accuracy and execution of the existing algorithms. Why are the existing systems not fully integrated into the medical field?

As stated by the author in [8], medicine is complex, the proposed research is only looking into the bone fracture field to simplify the research process. Thus, knowledge in the level of complexity involved with detecting a bone fracture is needed.

From the perspective of AI, the knowledge of the complexity and workings neural network and deep learning. Furthermore, the knowledge of how neural network compares with deep learning and how deep learning is compared to with SVM is needed.

For further knowledge in the path of utilizing deep learning in the diagnosis of bone fracture, the level of complexity in the hidden layers of deep learning is needed. The knowledge of the complexity can potentially solve the problem by developing knowledge on simplifying the complexity such that it is not computationally demanding.

5. Abstract Knowledge

The aim of the research is to propose an AI algorithm in which it has the ability to accurately

diagnosis a bone fracture within a short span of time (milliseconds), whilst minimizing the training time and complexity.

6. Evidence

The evidence needed in order to produce this abstract knowledge is to model the complexity involved in deep learning, specially in for training the process. Further evidence, involves the accuracy and execution time of existing algorithms as well as the complexity of the data that the system will be faced given. The complexity of the data has the potential to determine the number of hidden layers required in the deep learning algorithm. In other words, if the various characteristics of data is difficult to distinguish into a class then more hidden layers are needed in order to warp the data into multiple dimensions. A higher number of dimensions increases the complexity as well as computationally demanding.

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