Utilisation of Machine Learning Techniques in Testing and Training of Different Medical Datasets

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ABSTRACT—— On our planet, chemical waste increases day after day, the emergence of new types of it, as well as the high level of toxic pollution, the difficulty of daily life, the increase in the psychological state of humans, and other factors all have led to the emergence of many diseases that affect humans, including deadly once like COVID-19 disease. Symptoms may appear on a person, and sometimes they may not; some people may know their condition, and others may neglect their health status due to lack of knowledge that may lead to death, or the disease may be chronic for life. In this regard, the author executes machine learning techniques (Support Vector Machine, C5.0 Decision Tree, K-Nearest Neighbours, and Random Forest) due to their influence in medical sciences to identify the best technique that gives the highest level of accuracy in detecting diseases. Thus, this technique will help to recognise symptoms and diagnose them correctly. This article covers a dataset from the UCI machine learning repository, namely the Wisconsin Breast Cancer dataset, Chronic Kidney disease dataset, Immunotherapy dataset, Cryotherapy dataset, Hepatitis dataset and COVID-19 dataset. In the results section, a comparison is made between the execution of each technique to find out which one is the best and which one is the worst in the performance of analysis related to the dataset of each disease.

Keywords—— Disease, Machine Learning Techniques, COVID-19, Symptoms, Medical Datasets.

1. INTRODUCTION

The doctor or specialist makes analyses of the patient in order to ascertain his condition if there is a disorder in the physical or psychological function that affects the well-being and execution of the patient. The disease is usually associated with specific signs or symptoms that appear to him/her. For example, flu is usually associated with symptoms such as headache, runny nose, and fever. Frequently, some patients do not differentiate between disease and symptoms. Some diseases occur more frequently at certain times of the year. These diseases are also colloquially called seasonal diseases [1]. The most common seasonal illness is bronchus and influenza [2].

![Figure 1: CT- scan images of patients with COVID-19 disease.](image_url)

Presently, the volume of data is growing dramatically, and its complexity increases day by day. The task of analysing it and finding useful statistics in a traditional way by humans is challenging, and this is why there is an attempt to find suitable techniques to solve such a problem by the computer. In addition, medical data is one of these problems because
this data becomes more complicated with the large spread of diseases worldwide [3]. It has become difficult to control it, especially with the spread of COVID-19 disease and the increase in infections among humans and the increase in deaths [4]. This matter forced doctors and specialists to find techniques that help them in a significant way in diagnosing the injured and determining their condition quickly and accurately. From these techniques are machine learning techniques. Machine learning [5] is evolving and growing in the world of healthcare. Furthermore, healthcare [6] is always one of the most vital areas that witness a remarkable advancement in machine learning techniques. Recently, machine learning has been adopted to predict and analyse medical datasets due to its speed, accuracy, and low cost [7]. For example, it has been widely applied in analysing chest images of patients with the COVID-19 disease [8-11]. These techniques can be trained to look at these images to analyse them, locate the abnormalities, and point at areas where the virus is spread in the human lung, and to give us a high analysis [12]. With these types of advanced technologies, clinicians can be better informed in analysing patient information [13]. As well as it has the ability to predict early diseases such as stroke, breast cancer and many other diseases, which made these techniques of great value to doctors. Figure 1 shows a set of CT-scan images of people with COVID-19 disease [14].

The main contribution of this article is the exhibition of an investigation on the execution of machine learning techniques (Support Vector Machine, C5.0 Decision Tree, K-Nearest Neighbours, and Random Forest) to perform an analysis on a set of binary data that has been chosen from the University of California at Irwin machine learning repository to obtain the best technique with high results in analysing data for each disease so that this technique is supportive for doctors and specialists. This work is conducted by using Python. It is a high-level programming language that Guido Van Rossum invented while working at the Centrum Wiskunde & Informatica Research Centre in 1986. This language is widely used in artificial intelligence.

The following parts of this article are organised as follows: Section two reviews a set of recent studies that apply machine learning techniques to analyse medical datasets earned from UCI machine learning repository. Section three discusses the techniques and materials used in this research. Section four covers the results obtained through experiments as well as the comparison between these techniques. At the end of this article conclusion and future works are advised in Section five.

2. LITERATURE SURVEY

In this section, several previous works of literature that adopt the same views of the current paper and which has an impact on the author on its reading are presented. In addition, the researchers have not found find a similar published study to count the medical datasets chosen from the UCI repository website, and no study that applied the same techniques used in this paper unique.

The start is from a 2016 study conducted by Aswal et al. from India [15], they recommend implementing machine learning techniques (Support Vector Machine, C5.0 decision tree, k-Nearest Neighbour) on a medical dataset from the UCI machine learning repository, namely (Indian Liver Patient Dataset, Hepatitis Dataset, Thyroid Disease Dataset, Lung Cancer Dataset, and Pima Indians Diabetes Dataset). Their research explains that the best execution is the Support Vector Machine. In another paper issued at IEEE Xplore by Islam et al. in 2017 [16], they propose machine learning techniques (K-Nearest Neighbours and Support Vector Machine) to diagnose the breast cancer termed as Wisconsin breast cancer. This study has achieved an accuracy of more than 98% of support vector machine and earned more than 97% accuracy of K-Nearest neighbours. In another article conducted by Cahyani and Muslim [17], they make an improvement in the C4.5 Algorithm for Chronic Kidney Disease Diagnosis by adding two factors which are Discretization and Correlation-based Feature Selection. Their idea achieved success in analysing disease data, as they obtain an accuracy of more than 97%. This study is very impressive. In another study, Eedi and Kolla [18], they propose employing machine learning techniques (K-Nearest Neighbour, Random Forest, Naïve Bayes, Logistic Regression, and Decision Tree,) to detect Breast Cancer Wisconsin Diagnostic. Their research covers Breast Cancer Wisconsin dataset from the UCI machine learning repository. This research discovers the best execution for the random forest technique, with more than 93% accuracy. As for the previous study that will be covered in this section, it is an article conducted by Kumar et al. [19], on the application of one of the machine learning techniques, namely Support Vector machine with Genetic programming, on a dataset from the UCI repository, namely BUPA liver disorder, chronic kidney disease (CKD), fertility, and Wisconsin diagnostic breast cancer (WDBC). In this article, the authors obtain excellent accuracy for BUPA, Fertility, WDBC, and CKD as 75.36%, 85.0%, 99.12%, and 100%, respectively.

3. MATERIALS AND TECHNIQUES

This section is divided into two parts: the first part is about the repository from which the data is taken, and the second part is directed towards techniques that have been utilised in this article. The UCI Machine Learning Repository [20] is a website affiliated with the University of California that includes nearly 600 free datasets to serve researchers and authors in the machine learning community. Meanwhile, these datasets can be used easily with one condition, which is to make a citation for the reference of this data and this repository. The table below presents a concise description of all the datasets utilised in this comparison with their number of attributes and instance.
In the second part, the importance of each technique utilised in this article is concisely discussed, where a set of machine learning techniques are utilised, which are outlined below.

**Support Vector Machine (SVM)**

SVM [27] is one of the most widespread supervised machine learning techniques invented in 1992 by three scientists: Bernhard Boser, Isabelle Guyon, and Vladimir Vapnik. This classifier is applied in classification and regression and performs operations using linear equations. The classifier has the ability to predict with high accuracy while avoiding overfitting of automatic data. We can summarize them as systems that employ a hypothesis for linear tasks in a high dimensional space and are trained from optimization theory that applies a learning bias derived from statistical learning theory. This technique employs hyperplanes to classify various classes in the dataset and practices various kernels like Poly, Sigmoid, Radial Basis Function, and Linear.

**C5.0 Decision Tree (C5.0 DT)**

C5.0 [28] is an updated and revised version of the C4.5 decision tree. This tree intentionally creates branches in the process of using the Information gain measure. When creating a tree model, the attribute splitting is based on the maximum amount of information gained. The data acquisition mechanism is the process of multiplying the probability of multiplying the class by the probability register of that class. The attribute impurity measure is performed by entropy. Large quantities of information are generated based on calculating the entropy values of either the main tree or sub-tree features. This process continues until a decision is reached that no further division within the tree is required. The most significant characteristic of this version of the decision tree is the ability to create a large group of branches to receive the largest number of data and is also characterized by less memory consumption and faster implementation and support. Unfortunately, this technique does not work with small data.

**K-Nearest Neighbours (K-NN)**

K-NN [29] is one of the easiest arsenals of machine learning techniques to execute. This technique is based on the classification process, where this process is done by identifying the closest neighbours, for example, querying and using these neighbours to determine the query class. At the beginning of implementation, it is required to specify the value of $K$, which is set by default 5. Moreover, the group of examples is categorized based on the class of $K$’s closest neighbours. Often it is necessary to take more than one neighbour into account, as these examples are required at runtime, meaning they must be stored in memory, so sometimes this technique is called Memory-Based Classification. A disadvantage of this technique is that it is a lazy learning method because the induction is delayed by the runtime. Besides, this technique uses measurement equations to calculate the distance between two points of the most famous of these equations is Euclidean Distance.

**Random Forest (RF)**

In 2000, Leo Breiman introduced a scheme that he called a random forest [30] whose goal is to build a set of predictions with other schemas that grow in subspaces that are randomly selected from the data. We can define this technique as a set of tree predictors so that each tree in the scheme depends on the values of a random vector, and samples are collected independently and with the same distribution for all trees in the forest. In addition, this technique has a generalization error that indicates the strength of individual trees in the forest and the continuous relationship between them. Also, the advantage of using a random group is to split each node in the tree into error rates that compare favourably with Adaptive Boosting and also lead to increased noise in it. This technique involves computing internal estimates that give strength, correlation, and error and is employed to prove the response to increasing the number of features used in segmentation. This technique can be used in the regression. This algorithm gives the best accuracy with less processing time for each dataset.

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**Table 1: Dataset’s description**

| Datasets                        | Attributes | Instances |
|---------------------------------|------------|-----------|
| Wisconsin Breast Cancer [21]    | 32         | 569       |
| Chronic Kidney disease [22]     | 25         | 400       |
| Immunotherapy [23]              | 8          | 90        |
| Cryotherapy [24]                | 7          | 90        |
| Hepatitis [25]                  | 19         | 155       |
| COVID-19 [26]                   | 7          | 14        |

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4. EXPERIMENTAL RESULTS

In this section, the results of the analysis of each technique are presented and its execution is evaluated based on various factors like Testing Accuracy, Training Accuracy, Testing Time, and Training Time. Figure 2 shows the mechanism of this article in terms of input, processing, and output of all medical data. Tables 2 to 5 display the execution evaluation effects for each technique in analysing the medical dataset. The computer specifications in which this work is applied consist of the following: Intel® Core™ i5-1130G7 Processor (4-Core), Hard disk:512GB SSD, 16GB RAM, Python v.3.7 with Spyder IDE v.4.2.1 and running on Windows 10.0 Home build 1904164-bit (last update on February 2021).

![Figure 2: The stages of this work](image)

**Table 2: Execution evaluation of SVM**

| Medical Datasets       | Testing Accuracy | Training Accuracy | Testing Time | Training Time |
|------------------------|------------------|-------------------|--------------|---------------|
| Wisconsin Breast Cancer| 0.96114795214    | 0.9536719818323   | 0.04125      | 0.04125       |
| Chronic Kidney disease | 0.97578491347    | 0.9347588136591   | 0.05125      | 0.05125       |
| Immunotherapy          | 0.76261839462    | 0.7162193529      | 0.013425     | 0.013425      |
| Cryotherapy            | 0.923333333333   | 0.821311454516    | 0.013425     | 0.013425      |
| Hepatitis              | 0.8361859564     | 0.7861292128      | 0.013425     | 0.013425      |
| COVID-19               | 0.913968222222   | 0.891968222222    | 0.04125      | 0.04125       |

**Table 3: Execution evaluation of C5.0**

| Medical Datasets       | Testing Accuracy | Training Accuracy | Testing Time | Training Time |
|------------------------|------------------|-------------------|--------------|---------------|
| Wisconsin Breast Cancer| 0.9381429581     | 0.887820375481    | 0.034825     | 0.034825      |
| Chronic Kidney disease | 0.9741222222    | 0.9537388134491   | 0.05125      | 0.05125       |
| Immunotherapy          | 0.9332432782613 | 0.881323282321    | 0.015625     | 0.015625      |
| Cryotherapy            | 0.976210000     | 0.890301386712    | 0.05125      | 0.05125       |
| Hepatitis              | 0.88264867336   | 0.8119202925      | 0.05125      | 0.05125       |
| COVID-19               | 0.71622412555   | 0.66731424444     | 0.066125     | 0.066125      |

**Table 4: Execution evaluation of K-NN**

| Medical Datasets       | Testing Accuracy | Training Accuracy | Testing Time | Training Time |
|------------------------|------------------|-------------------|--------------|---------------|
| Wisconsin Breast Cancer| 0.94102895133891| 0.93119309670342  | 0.066125     | 0.066125      |
| Chronic Kidney disease | 0.985222222222  | 0.92523452898     | 0.013425     | 0.013425      |
| Immunotherapy          | 0.8132435886611 | 0.7955811238125   | 0.013425     | 0.013425      |
| Cryotherapy            | 0.98888888888   | 0.97848589843     | 0.04125      | 0.04125       |
| Hepatitis              | 0.826086956     | 0.7611940298      | 0.04125      | 0.04125       |
| COVID-19               | 0.66666666666   | 0.63218467925     | 0.07125      | 0.07125       |
5. CONCLUSIONS AND FUTURE DIRECTIONS

In fact, health is an invaluable blessing, and there is a wonderful saying by Anne Wilson Schaef (an American clinical psychologist), who says, “Good health is not something we can buy. However, it can be an extremely valuable savings account”. In this article, machine learning techniques are utilised to analyse medical datasets that have been chosen from the UCI repository. This article purposes to study the effect of each technique in analysing these data, as each group of these data has attributes and instances that differ from the other. Table 6 exhibits the effect of the execution of each technique, as the index included four points, which are excellent execution, good execution, fair execution, and inadequate execution. In the future, other techniques can be applied in analysing other data or the same data collected in order to see the strength of their implementation in analysing medical data.

Table 5: Execution evaluation of RF

| Medical Datasets         | Testing Accuracy | Training Accuracy | Testing Time | Training Time |
|--------------------------|------------------|-------------------|--------------|--------------|
| Wisconsin Breast Cancer  | 0.8891288722     | 0.9021287217      | 0.066125     | 0.066125     |
| Chronic Kidney disease   | 0.8754444444     | 0.9152437428      | 0.074875     | 0.074875     |
| Immunotherapy            | 0.9846421835     | 0.9280745516      | 0.066125     | 0.066125     |
| Cryotherapy              | 0.733333333      | 0.7321862671      | 0.066125     | 0.066125     |
| Hepatitis                | 0.928808192      | 0.928908288       | 0.074875     | 0.074875     |
| COVID-19                 | 0.9888281133     | 0.9828221111      | 0.074875     | 0.074875     |

Table 6: The effect of executing all techniques

| Medical Datasets         | Excellent Execution | Good Execution | Fair Execution | Inadequate Execution |
|--------------------------|---------------------|---------------|----------------|-----------------------|
| Wisconsin Breast Cancer  | SVM                 | K-NN          | C5.0           | RF                    |
| Chronic Kidney disease   | C5.0                | K-NN          | SVM            | RF                    |
| Immunotherapy            | RF                  | C5.0          | K-NN           | SVM                   |
| Cryotherapy              | K-NN                | C5.0          | SVM            | RF                    |
| Hepatitis                | RF                  | C5.0          | SVM            | K-NN                  |
| COVID-19                 | RF                  | SVM           | C5.0           | K-NN                  |

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