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Hepatitis Diagnosis By Artificial Neural Network

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***Abstract*— Due to the complexities of hepatitis diseases spreading increasingly all over the world, it became necessary to develop a system that helps diagnose the disease using modern technologies. Artificial intelligence is one of the main pillars of the technology industry in the current era. Many studies have been conducted to discover effective methods for the medical diagnosis of many diseases, including hepatitis. This paper reviews the methodologies and classification accuracy in diagnosing hepatitis and also reviews an approach to diagnosing hepatitis through the use of an artificial neural network.**

Keywords: Artificial Neural Networks, Hepatitis, Artificial intelligence, Machine Learning, Radial base function network, Recurrent neural networks

I. INTRODUCTION

The liver is affected by many diseases and infections, including hepatitis, which is caused by many causes, including viruses and others that interact with liver tissue and cause injury and irritation. Infection with hepatitis varies according to the virus that infects the disease as acute or chronic. Hepatitis infection lasts for less than six months, and its symptoms are more severe and painful for patients, but they are of limited duration and rarely last long. Chronic hepatitis is an inflammation of the liver that lasts for more than six month[1]. Hepatitis viruses classified according to the letters A through E.

Hepatitis may not cause any harm to the patient in the early stages, so the patient is far from diagnosis until the liver becomes damaged. Therefore, health problems increase in the advanced stages over time, and the liver fails to perform its health function due to chronic hepatitis. Besides, the liver suffers permanent scarring from hepatitis infection until it becomes damaged, and its functional performance gradually decreases until it is considered a chronic disease and difficult to treat. Also, hepatitis is considered one of the leading causes leading to liver cancer. Early diagnosis of viral hepatitis and its complications allows for other options for surgical and non-surgical treatment. Advanced stages require complex surgeries such as partial hepatectomy or even liver transplantation[2].

Diagnosis of the disease is considered the main gateway to obtaining preventive and curative services. Therefore, the diagnosis of the disease is one of the most critical features of medicine. It requires a high level by the doctor to analyze the physiological or biochemical cause of the disease[3]. Additionally, the modern technology of artificial intelligence has merged with the field of medicine in the past decades to create advanced systems that help doctors effectively and accurately diagnose disease [4]. Medicine, with the help of these modern artificial intelligence techniques, was able to reduce the effort used for diagnosis in the absence of sufficient experience and the wrong diagnosis and also reduce expenses.

Artificial neural networks are a type of artificial intelligence that works to mimic the neurons in the human brain to process information as it stores practical knowledge and experimental information to make it available to the user by adjusting the weights between neurons. Therefore, neural networks have witnessed a great revival and utilized in many applications, such as image analysis, prediction, diagnostics, etc [5]. As a result, artificial neural

networks used in the early detection of many diseases that plague human lives to increase the chances of a full recovery.

Hepatitis affects many people and has considered as the silent killer because the person infected does not have any symptoms in the early stages. Moreover, the hepatitis patient needs an accurate diagnosis and monitoring to reduce the risk of infection transmission. Diagnosing hepatitis requires expertise on the part of a physician to provide the correct treatment and prevention. However, diagnostic and testing facilities for hepatitis are limited. Therefore, there is a need for an assistant system that facilitates the diagnostic task of a hepatologist with little experience and helps relieve pressure on limited screening and diagnostic facilities and contributes to improving the management of hepatitis patients.

II. Hepatitis

Hepatitis is a reaction that occurs when a pathogenic substance or microbe attacks liver cells. The liver is an organ in the digestive system that aids in the digestive process and performs several different necessary functions. These functions involve providing bile to support separate down food in energy, producing required substances such as cleansing toxins from the blood, including those from narcotics, alcohol and drugs, hormones and regulating fat storage and cholesterol creation and release. There are different kinds of viral hepatitis identified, the most common being hepatitis A, B, C, D, and E, depending on the type. Viral hepatitis can spread over food or water contaminated with the stool from an infected person, contact with infected blood through infected needles, contaminated blood transfusions, or through sexual contact with an infected person, or transmitted from mother to child during childbirth. Symptoms of hepatitis can include a variety of body systems, with effects ranging from a low energy level to skin irritation to stomach and digestive symptoms [1]. Many people around the world live with hepatitis, and hepatitis causes the death of more than one million of them. Accordingly, the World Health Assembly has striven to create a plan to reduce infection with hepatitis. Hepatitis kills hundreds of thousands of lives around the world annually and is classified as a significant infectious disease-causing death [6].

III. Hepatitis in Oman

Researchers from the Sultanate of Oman in the medical field indicated in their study published in the Medical Journal of Sultan Qaboos University that the Sultanate requires a national awareness program to enhance early diagnosis and enhance public awareness of hepatitis. The researchers aimed to describe the pathological characteristics and the outcome of patients with hepatitis. The research team followed up and evaluated 603 Omani patients from 2010 to 2015. The study aimed to analyze and collect demographic, clinical, laboratory and radiological data for the age group of 16 years and over to study chronic hepatitis C. Moreover, the study indicated that there is a health problem that must be avoided, as, besides the usual known methods of transmission of the hepatitis virus, there are non-standard methods of transmission such as traditional healers in Oman. Additionally, many hepatitis patients did not feel symptoms in the first stage until they reached advanced stages such as decompensated cirrhosis and liver cancer, which makes them need adequate health care to stay away from deteriorating health.[6]. The Omani Ministry of Health stated that in its 2017 report, hepatitis is a common disease in Oman, which made the ministry take preventive measures and develop a plan to keep it under surveillance since 1991. Moreover, the sixth five-year plan monitoring control of individual types of viral hepatitis has continued from 2001 to 2005 in estimating the individual burden and assessing the impact of interventions. The report indicated that hepatitis A cases are declining in the Sultanate, and infection occurs early, mainly in childhood. Moreover, the prevalence of hepatitis B ranges at a rate of 2% to 7% in Omani society as medium endemicity, and the keenness to test blood for detection of hepatitis to avoid transmission of the virus. Finally, hepatitis C infection is not a significant public health problem in Oman since the ministry has undertaken monitoring of hepatitis C since 2005 and has included it with hepatitis B in the proposed national registry for long-term follow-up and treatment[7].

IV. ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is a branch of computer science and one of the main pillars on which the technology industry is based in the current era [5]. The integration between artificial intelligence and health care providers has improved the quality of patient care and also has the potential to advance disease diagnosis patterns and create a significant clinical impact. Moreover, artificial intelligence will lead to development in the field of health care, which makes hepatologists need to keep abreast of these developments [8]. The researchers conducted many studies related to the field of artificial intelligence for various diseases, such as biomedical analysis, diagnostic systems, and drug development, and it showed impressive results, such as monitoring health indicators and predicting the patient's response to treatment [9]. Furthermore, this fruitful research has

led to numerous studies in hepatitis that have made incredible breakthroughs in discovering hidden patterns and helping clinicians make the appropriate decision. Research by Moshkani and others also showed that accuracy in analyzing various classifier techniques of artificial intelligence is widely accepted and can assist hepatologists in making the decision for primary diagnosis and avoiding biopsy [10].

V. MACHINE LEARNING

Machine Learning, referred to as ML, the concept of machine learning can simplify as one of the branches emerging from the science of artificial intelligence (AL) based on programming computers of various forms to be able to perform tasks and implement the commands assigned to them by relying on the data available to them and analyzing them while restricting human intervention In directing it or completely absent. Machine learning has spread in recent years and has become used in many fields, including the medical field such as heart, diabetes, liver, dengue fever and hepatitis [11]. The levels of machine learning vary in terms of both inductive and deduction, where the inductive learning extrapolates general rules and provisions from big data, unlike deductive learning, which stems from general rulings and is applied in private examples [12]. Machine learning is the latest approach to digital and electronic transformation that makes computing operations more efficient, cost-effective and reliable. Moreover, machine learning has become sophisticated, which is required by many areas, including medical, which will ultimately make the decision-making process more data-dependent [13]. Machine learning categorized into several types, such as supervised, non-supervised, reinforcement learning etc. Supervised learning does not pay attention to the internal relationships of the data it is processing, but instead distinguishes well, which output you need from the model. In contrast, unsupervised learning normalizes the data in a logical format for comparison, then the model works on it and tries to find some relationships [11].

VI. Data Preprocessing

Data play a significant role in deep learning, as it forms the raw material used in the manufacture of information after undergoing processing. Usually, data obtained in its raw form that is not always arranged in the required form and is often not coordinated until the data is processed to come out in the form of relevant information a benefit must be available special handling to perform this purpose [12]. The importance of this process lies in the fact that it aims to prepare the data for processing in the next stages by tabulating data and to remove missing data and errors [8]. It also includes checking the quality of data and removing or correcting inappropriate data. Feature engineering, which is the process of converting metadata into features, is often used more to represent the potential problems of a prediction model and this can be achieved by identifying the most relevant features, extracting the features, and creating the features. Among them, construction features often implemented through dimensional reduction algorithms[14].

VII. DEEP LEARNING

Deep learning is one of the fundamental approaches in machine learning and AI and has the potential to support pioneering AI innovation in nearly every industry [11]. Over the years, the human mind has inspired developers to develop artificial intelligence and produce deep learning that consists of an artificial neural network. Deep learning was able to achieve value and meaning in the field of hepatology and was able to find solutions in a very accurate manner and avoid wasting time [15]. Moreover, deep learning allows systems to automatically improve their functionality by gaining knowledge from experience and then using the same thing in data processing and complex calculations. Deep learning is based on a set of algorithms that support deep learning and play a central role in many areas that depend on deep learning, inspired by the neurons that make up the human brain. The neural networks consist of layers that are linked in adjacent layers to each other, starting with a layer for data entry and ending with a layer to produce the result and between them, there are several layers for analysis and conclusion, it is called the hidden layers [16]. The uses of deep learning techniques have topped on a large scale in recent years, as they have made impressive achievements in several fields, including medicine and automatic classification. Deep learning depends on processing a massive amount of data by passing it through deep neural networks to train it to extract useful information from this data. Numerous investigations have conducted using deep learning on an automatic diagnosis of hepatitis[17].

VIII. DEEP LEARNING MODELS

Deep learning models are based on neural networks that contain a large number of parameters and layers in their network structure. Here are some deep learning models:

a. **Forward-Feed Neural Network (FNN)** is one of the most popular and simplest types of neural

networks, in which the transmission of information occurs across the layers by communicating forward and in one direction from the input layer to the hidden layer to the final layer, and it may sometimes not contain hidden layers [18].

b. **Radial base function network** (**RBFN)** consists of two layers except for the input layer, which is the hidden layer and the output layer, as the network is front-fed and contains both types of instructional and non-indicative training. The reason for its name the base function is because the middle layer cells represent a set of base functions such as the base function and the data propagation shape, from which it is similar to the ray, so it is called the radial base function network. RBFN is a hybrid of a set of properties found in some types of artificial neural networks[19]**.**

c. **Self-organizing neural map network (SOM)** is a type of neural network that depends on the principle of self-organizing maps used in the process of data classification and is distinguished by its lack of supervision in training, and Kohonen invented it in the eighties. Self-organizing neural map network is used for dimensional reduction as it takes a multi-dimensional data set that has many rows and reduces the dimensions to create a two-dimensional map for the data set and has no specific output (reducing the number of columns to the two-dimensional input) [20].

d. **Recurrent neural networks (RNN)** explore the serial nature of their input. This income may be text, speech, time series, or anything else so that the appearance of a specific element in the series relates to the elements that appeared before it. The Recurrent neural network can be thought of as a graph of iterative nodes since each node carries out the same operations on every element of the income chain. Recurrent neural networks are very flexible and have been used to solve language-related problems such as speech recognition, coding systems, and image characterization[21].

e. **The convolutional neural network** is a type of deep learning and a type of multi-layered feed-forward neural network. The convolutional neural network is inspired by biological processes occurring in the optic lobe, specifically in the brain of living organisms. CNN's are often used in computer vision applications and are good at dealing with problems with visual scenes. Moreover, it has been proven effective in various fields, such as image recognition and classification. A typical convolutional network consisting of a convolutional layer, a pooling layer, and a fully connected layer the convolutional layer and the pooling layer collaborate between them to form multiple convolutional groups, which extract features layer by layer, and finally the complete classification through several fully connected layers [17].

IX. Literature Review

Several methods of machine learning and deep learning have been used extensively in the field of medicine, and many algorithms have been used in hepatology, including Artificial Neural Networks (ANN), Multinomial Logistic Regression (MLR), Support Vector Machines (SVM) and Random Forests (RF) [22].

Nilashi et al. introduced a novel predictive method for diagnosing hepatitis using a variety of techniques so that SOM is unsupervised, and an adaptive neuro-fuzzy inference system is unsupervised. Besides, they used Nonlinear Iterative Partial Least Squares to improve SOM accuracy and used a real dataset taken from UCI to train the network. This proposed methodology has shown promising results with an accuracy of 93.06% [23].

Mishra et al. introduced a new hybrid model that mixes a multi-layered network with a genetic search algorithm so that the result is more efficient, thus increasing accuracy and reducing delay. The model sorts a hepatitis dataset from the UCI Machine Learning Repository using a genetic search method before it conducted using a multi-layered perspective to predict a patient's risk of developing hepatitis. As a result, the hybrid model gave 82.6% accuracy [24].

In 2013 and Thangaraju analyzed some classification algorithms applied to hepatitis patients (Bayes.NaiveBayes, Bayes.BayesNet, Bayes.NaiveBayes Scalable, J48, Random Forest, Multilayer Perceptron). The analysis is based on a hepatitis dataset from the UCI Machine Learning Repository. Also, the patient trait details were processed during data processing to obtain accurate data. The analysis achieved an accuracy of 84% for Bayes.NaiveBayes and Bayes.NaiveBayes for the update, 81% for Bayes.BayesNet, 83% for J48, Random Forest, and Multilayer Perceptron [8].

Moshkani, Rousta, and Farjami, they compared and evaluated decision trees, neural networks, and SVM using the UC Medical Database to test each method. The achieved results showed that the neural network algorithm had a higher accuracy compared to other algorithms which was 89.74%,

while the SVM algorithm and the decision tree got 74.4% [10].

No.	Authors	Year	Datasets	Method	accuracy
1	(Nilashi et al., 2019)	2019	UCI	ensembles of neuro-fuzzy	93.06%
2	(Mishra, Mishra and Tripathy, 2016)	2016	UCI	Multilayer perceptron network with a Genetic Search algorithm	82.60%
3	(Karthikeyan and Thangaraju, 2013)	2013	UCI	Bayes.NaiveBayes	84%
				Bayes.NaiveBayes updatable	84%
				Bayes.BayesNet	81
				J48	83%
				Random forest	83%
				Multilayer perceptron	83%
4	(Moshkani, Rousta and Farjami, 2016)	2016	university of california	neural network algorithm	89.74%
				SVM	74.40%
				Decision trees	74.40%

Table 1 COMPARISON OF PERFORMANCE OF HEPATITIS ALGORITHMS

X. The Artificial Neural Networks

Neural networks are considered one of the most important fields of artificial intelligence, which reflects an important and significant development in the human way of thinking, the focus of the idea of neural networks about mimicking the human mind using an electronic calculator[5].

Artificial neural networks (ANN) are computational techniques that depend in principle on simulating the work of brain neurons in order to process data and accomplish tasks in a variety of fields, with massive processing distributed in parallel and consisting of simple processing units. These units are nothing but computational elements called neurons or Nodes that have a neural property in that they store practical knowledge and empirical information to make them available to the user by adjusting weights[18].

The neurons in the artificial neural network are connected in the form of several layers as an input layer and an output layer and interspersed with several hidden layers. Every neuron in one of these layers communicates with all neurons in the next layer and all neurons in the layer that precedes it, receiving signals or values from neurons from the previous layer to process them and give a single output value that is transmitted to all neurons in the next layer. Therefore, each neuron receives multiple input values and gives one output value. Neurons are sometimes associated with fixed inputs that go into every processing process and have nothing to do with the input to the network, which is called bias[4].

The interconnectedness of the different units in an artificial neural network is of particular importance and plays a fundamental role in creating and training network intelligence. A value clearly

distinguishes each connection between a neuron and a single neuron called a weight that shapes how vital the connection between these two components is. The neuron multiplies each input value from the previous layer neurons by the contact weights of these neurons, then collects all the multiplication outputs, and then the result is subjected to a transformation method that varies according to the type of neuron. The output value is the output of the nerve cell that travels to the neurons in the next layer[25].

The network's readiness for actual use is verified by assessing the network once the training process is completed. This last step is essential so that it can be determined whether additional training is required. To properly validate the validation of the neural network validation data, a completely different aspect of the training data must be placed[12].

Approximately 70% of the total sample data was used for network training in this paper. Use about 30% of the total sample data to validate the system.

XI. METHODOLOY

Through searching the data set available from the "Kaggle" website, by identifying various factors such as input variables that considered to aid in diagnosing this disease, and the output variables reflected the probability of patient survival or death due to the hepatitis virus. Accordingly, carefully study these factors and process the data by scaling the feature to make it suitable for use in the neural network.

Input Attributes		
S. No	**Attributes**	**Values**
1	Age	numerical value
2	Gender	Male(1), Female(2)
3	Steriod	No(1), Yes(2)
4	Antivirals	No(1), Yes(2)
5	Fatigue	No(1), Yes(2)
6	Malaise	No(1), Yes(2)
7	Anorexia	No(1), Yes(2)
8	Liver Big	No(1), Yes(2)
9	Liver Firm	No(1), Yes(2)
10	Spleen Palpable	No(1), Yes(2)
11	Spiders	No(1), Yes(2)
12	Ascities	No(1), Yes(2)
13	Varices	No(1), Yes(2)
14	Bilirubin	0.39~4.00
15	Alkaline Phosphatase	33, 80~250
16	SGOT	13,100~500
17	Albumin	2.1~6.0
18	Prothrombin Time	10~90
19	Histology	No(1), Yes(2)

Table 2 Input Data Transformation

Output variables reflect the results of the hepatitis diagnosis the probability that the patient survives or dies from the hepatitis virus.

Output Class		
S. No	**Attributes**	**Values**
1	Class	Die(1), Live(2)

Table 3 Outcome Data Transformation

XII. NEURAL NETWORK DESIGN

The network of neurons is arranged in layers of artificial neurons using a combination of the linear sigmoid activation function and the activated linear unit (ReLU) function.

The purpose of this model is to analyze the results of a hepatitis diagnosis to find a pattern for patient survival. The forward-fed neural network was created with an input layer (19 features) and one output layer (1 feature) and interspersed with two hidden layers (16 neurons for the first hidden layer and 8 neurons for the second hidden layer).

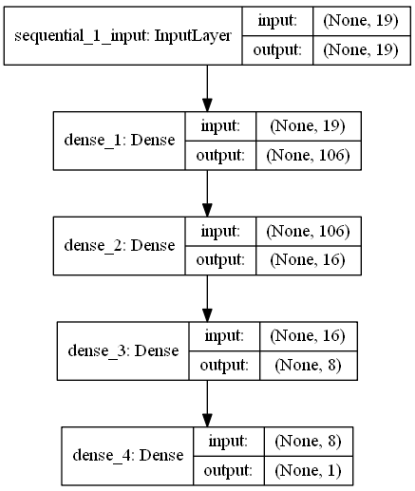

Figure 1 Final Architecture

In this experiment, data from 142 patient records obtained from Kaggle were analyzed. Data were distributed to be about 75% (106 records) as a

training group and about 25% (36 records) used for investigation.

The neural network is compiling to be forward-fed so that the computations travel in one direction from the input layer to the output layer through the hidden layers. Moreover, good results were obtained during training, as shown in the figure below.

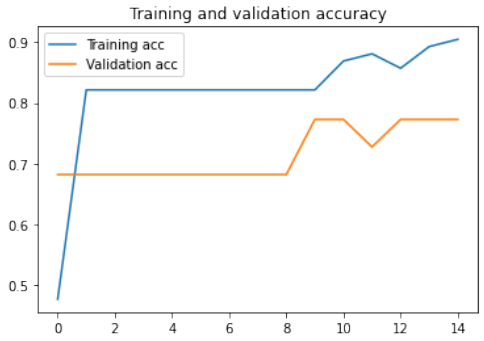

Figure 2 Training and validation accuracy

The network was tested after completing its training using a test dataset, and the network was able to correctly predict 34 out of 36 patients with hepatitis used to test the network structure. The network gave excellent results, as the accuracy of the model reached 94.44%, while the rate of error in the classification reached 5.56%. Moreover, the model incorrectly predicts a 100% yes, when in reality, it does not. Next, the neural network gives precision at 94.11% as the model correctly predicts yes results. Finally, the network specificity was 50% as the model correctly predicts no as outcomes and the network sensitivity and sensitivity has reached 100% as how many times does the model expect "yes" when in fact it is "yes".

Sensitivity	100.000000
Specificity	50.000000
Precision	94.117647
False_Positive_Rate	100.000000
Misclassification_Rate	5.555556
Accuracy	94.444444

Table 4 Testing accuracy

XIII. Conclusion

Accuracy is one of the concerns in the research on how to develop disease diagnosis. This research reviewed the efficacy of deep learning in predicting hepatitis using different criteria. Accordingly, it has suggested that an artificial neural network used with several hidden layers. This study demonstrated the ability of an artificial neural network to predict patient survival of hepatitis by analyzing hepatitis diagnostic results. Through this experience, it appears that deep learning can provide significant help in the field of medicine and other fields.

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