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A Theoretic Utility of Augmenting Generalized Regression Neural network with Expert System for Hepatitis B Diagnosis

Ojie D. V. [1], Ogala Onyarin Justin[2], & Okpako Abugor Ejaita[3]
[1,] Department of Software Engineering, Faculty of Computing, University of Delta, Agbor, Nigeria,
[2,3]Department of Cyber Security, Faculty of Computing, University of Delta, Agbor, Nigeria
Deborah.ojie@unidel.edu.ng[1], Justin.ogala@unidel.edu.ng[2], ejaita.okpako@unidel.edu.ng[3]

Corresponding Author's Email: deborah.ojie@unidel.edu.ng

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ABSTRACT

The inclusion of computing devices in the diagnostic phase in medical care has received a disturbing publicity owing to its inherent benefits: practicality, reproducibility, efficiency, and immunity to disturbance variables unique to humans (fatigue, stress, diminished attention). Technology does not replace human professionals in this area of medical support; instead, it aims to aid them by developing systems that can pick up or create appropriate data. In medicine, diagnosis is defined as "the detection of a disease or condition based on its outward signs and symptoms" or "the investigation of the underlying physiological, biochemical cause." Hepatitis B, which includes chronic liver disease, is quite widespread worldwide and can harm hepatocytes. Cirrhosis can range in severity from healthy carriers to decompensated cirrhosis. We have developed an intelligent framework for identifying hepatitis B viral illness in this research. Hepatitis is a dangerous disease that requires expensive treatment and severe side effects. The generalized regression neural network is a suitable and promising approach to detection and prediction of severity of Hepatitis B in patients.

1.0 INTRODUCTION

According to contemporary medical practice, patients must now contact experts for additional diagnosis and therapy. According to [7], "diagnosis of disease must be done with care since it is the first stage of therapeutic actions toward eventual management of the disease; a mistake at this stage is disastrous, and such, adequate care must be ensured". General practitioners or doctors may lack the necessary skills or experience to handle certain high-risk conditions. However, treatment waiting times can range from days to weeks or even months. The disease may have already spread by the patients who see a specialist. Because most high-risk conditions may only be healed early while some patients may have to live with them for the rest of their lives; innovative techniques for disease diagnosis with the use of computer technology are critical. Risk stratification, or the classification of patients based on the severity of their condition, is an essential aspect of medical diagnosis. This is critical since it may assist cut down cases of admissions, equipment use, and other medical services. If the clinical condition is outside the scope of the physician's expertise, the best course of action is to contact a specialist; unfortunately, expert advice is frequently unavailable or not available promptly. They must tackle the challenge of determining the cause of particular diseases and make appropriate medical recommendations for eventual treatment. Continuous training, practice, and learning on the job encourage physicians to keep more relevant information in their heads at all times.

However, due to the inherent limitations of human memory, combined with the humongous amount of knowledge, ability to understand what is previously known becomes limited. A good physician uses his knowledge, experience, and talent to diagnose an illness during a medical diagnostic procedure. The diagnosis is then made after considering the state of all accessible patients. The proper therapy is provided on the diagnosis, and the entire process may be iterated. The diagnosis may be reworked, refined, or rejected in each iteration. According to contemporary medical practice, patients must now contact experts for additional diagnosis and therapy. Other doctors may lack the necessary skills or experience to handle certain high-risk conditions. However, treatment wait times might range from days to weeks or even months. The sickness may have already spread by the time the patients see a specialist. Because most high-risk diseases may only be treated early in their progression, individuals may be forced to live with them for the remainder of their lives, so innovative techniques for disease detection using computer technology are needed [1]. The mortality rate and the time it takes to visit an expert might be decreased by using computing technology, such as a computer program or software that simulates human intelligence and assists clinicians in making judgments without consulting specialists directly. Patients with high-risk characteristics or symptoms, or those expected to be severely affected by specific diseases or illnesses, might be sent to a specialist for additional treatment.

Neural networks are seemingly becoming a widely accepted method in solving some complex problems and have thus been successfully implemented in medical industry. Its overly wide acceptance of neural netwo*rks is due to the fact that it* can effectively identify patterns or trends in data as well as excellent predicting or forecasting capability. Hepatitis B, which includes chronic liver disease, is quite widespread worldwide and can harm hepatocytes. From healthy carrier to decompensate cirrhosis, the severity can vary. The goal is to incorporate an intelligent system for diagnosing Hepatitis B viral sickness, as it is a serious disease that have high financial burden and can cause severe side effects.

2.0 LITERATURE REVIEW OF HEPATITIS B

The word 'Hepatitis' means 'liver inflammation. Either a virus or a toxin can cause inflammation of the liver as Hepatitis B . The hepatitis A and C viruses are two more viruses that can cause damage to liver cells. These different diseases of the liver caused by different viruses differ in their structure, propagation, severity, treatment options and disease progression. The hepatitis B virus causes a hepatitis B. (HBV) liver infection. When a person contracts hepatitis B for the first time, it is an '"acute' infection". The majority of people can get rid of the virus and will no be longer infected. Some infections of hepatitis B persists and develop a 'chronic' hepatitis B infection that lasts for the rest of their lives. Hepatitis B is a deoxyribonucleic acid virus, which means its genetic material comprises deoxyribonucleic acids. It is a member of the Hepadnaviridae virus family. The virus is most commonly present in the liver, although it could be found in the blood and other bodily fluids [2][6].

A core particle (center section) and an envelope surround the hepatitis B virus (outer coat). DNA makes up the core, as does the core antigen (HBcAg). The surface antigen is included in the envelope (HBsAg). These antigens are indicators found in the blood and are used to diagnose and assess individuals with suspected viral Hepatitis. Although the Hepatitis B virus replicates in liver cells, it is not a direct cause of liver disease. Instead, the presence of the virus activates the body's immune system, which attempts to fight the virus and recover from the infection. This immune system reacts to these antigens and creates inflammation, which can harm the liver cells severely.

2.1 Hepatitis B Diagnosis

The medical history, symptoms, tests and physical examination indicate risk factors for Hepatitis B. However, abnormal liver tests can be caused by various liver disorders. Hepatitis B can only be diagnosed with precise hepatitis B viral blood testing. Hepatitis 'markers' or 'serology' are the terms for these tests. Blood markers can confirm hepatitis B infection and distinguish between acute and chronic illnesses. The indicators are the indicators of antigens generated by the hepatitis B virus and antibodies produced by the immune system to combat the infection. The surface antigen (HBsAg), the core antigen (HBcAg), and the e antigen are the three antigens for which there are routinely used tests for the Hepatitis B virus (HBeAg).

2.1.2 HBsAg and Anti-HBs

Hepatitis B surface antigen (HBsAg) in the blood is good indicators of the disease. Anti-HBs give total protection against hepatitis B virus infection in the future. Anti-HBs are produced in the blood by those effectively vaccinated against hepatitis B. Chronic hepatitis B develops in patients who do not eliminate the virus during an acute episode. When HBsAg is detected in the blood for at least six months, chronic hepatitis B is diagnosed. Anti-HBs do not present in severe hepatitis B. However, "HBsAg "can be detectable for years.

2.1.3 Anti-HBC

A distinct class of early antibodies (IgM) emerges in acute Hepatitis and is directed against the anti-HBc IgM. Anti-HBc IgG antibodies form later and last for the rest of the person's life, irrespective if the person heals or develops a chronic infection. Anti-HBc IgM is the only test that is used to detect an acute hepatitis B infection.

Table I: The Markers for Hepatitis Diagnosis

Marker	Value
AgHBs	Positive
AgHBs	Negative
AgHBe	Positive
AgHBe	Negative
anti – VHD	Positive
anti – VHD	Negative
anti – VHC	Positive

Rule:
IF (AgHBs=Positive) AND (AgHBe= positive) AND (anti-VHD= Negative) THEN Hepatitis B.

2.1.4 HBeAg, Anti-HBE, and Pre-Core Mutations

When the hepatitis B virus is actively increasing, the e antigen (HBeAg) is present. Still, the creation of anti-HBe indicates a paasive state of the virus and a decreased probability of transmission. The genetic material for the hepatitis B virus has undergone a structural alteration in some people who have been infected. This is known as a pre-core mutation. The hepatitis B virus cannot create HBeAg due to this mutation, even if it is actively replicating. This implies that, even if no HBeAg is present in the blood of people who have the transformation, the hepatitis B virus is still active in their bodies, and they can be infectous.

2.1.5 Interpreting Hepatitis B Blood tests

The tables below show how to interpret various serological test results.

2.2 Intelligence in Medical Diagnosis

Using an expert system is one of the most well-known methods of complementing physical diagnosis. These systems employ human thinking and use a set of decision criteria that evaluate symptoms and lab tests before recommending a diagnosis. It is frequently challenging to describe the system's regulations. The loss and distortion of information content would result from translating implicit

TABLE II: MARKERS FOR HEPATITIS B DIAGNOSIS

Most Likely Status	Tests	Results
Susceptible, not infected, not Immune	HBsAg	Negative
	anti-HBc	Negative
	anti-HBs	Negative
Immune due to natural Infection	HBsAg	Negative
	anti-HBc	Positive
	anti-HBs	positive
Immunes due to hepatitis B Vaccination	HBsAg	Negative
	anti-HBc	Negative
	anti-HBS	positive
Acutely infected	HBsAg	Positive
	anti-HBc	Positive
	IgM anti-HBc	Positive
	anti-HBs	negative
Chronically infected	HBsAg	Positive
	anti-HBc	Positive
	IgM anti-HBc	Negative
	anti-HBs	negative

knowledge into explicit norms. In addition to these challenges, there is no gainsaying that developing such an expert system involves getting a sound software engineer who is familiar with the medical domain in which the expert system is designed. However, when more layers of information are added, the tree structure of rule-based interactions becomes too complex. Artificial neural networks might be utilized in any circumstance where there is a link between certain variables that are inputs and other variables that can be anticipated [3]. The most significant benefit of neural networks is that they can tackle issues that are too difficult for traditional technologies to handle, or are too hard to employ. These traits have frequently been seen in the medical field. Diagnostic systems, biological analysis, picture analysis, and drug discovery are areas where artificial neural networks have been effectively employed. It is possible to monitor various health indicators or anticipates the patient's medication response using artificial neural networks. The field of medical imaging is critical as it provides a wealth of diagnostic information and treatment [4], [5].

2.3 Diagnosing "Hepatitis B" Using Neural Networks

The following Neural Networks [8] can diagnose hepatitis B.

- ✓ BPNN: Back Propagation N/N
- ✓ RBFNN: Radial Basis Function N/N
- ✓ PNN: Probabilistic N/N
- ✓ GRNN: Generalized Regression N/N

Table III: Comparison Of Different Neural Networks

Neural N/W Criteria	BPNN (Multilayer feed-forward n/w)	RBFNN	PNN	GRNN
No. of layers	Any	Two layers	Three layers	Four layers
Output	Fuzzy or non-numeric	Linear	Probabilistic	Single
Task	Relating large input and output data	Model complex mappings.	Classification tasks.	Regression on tasks.
Speed	Time consuming	Extrapolate.	Slow to execute.	Trains instantly

It can be deduced from the above table that GRNN (Generalized regression N/N) will be the best Neural Network for detecting Hepatitis B. The paradigms of the radial basis function (RBF) networks that will be employed for the diagnosis of Hepatitis B are the Generalized Regression Neural Networks (GRNNs) [5]. To satisfy the logical inference rule, the markers of the Hepatitis B diagnosis will be employed as inputs to the network. Depending on the direction, the outcome will be positive or negative.

3.0 STRUCTURE OF GENERALIZED REGRESSION NEURAL NETWORK

One of the so-called Bayesian networks, the Generalized Regression Neural Network (GRNN), is a neural network that does regression using kernel-based approximation. GRNNs offer several benefits and drawbacks that are comparable to those of PNNs. PNNs can only be used for classification problems, whereas GRNNs can only be used for regression issues. It can train fairly instantly, although it's usually big and sluggish (although, unlike PNNs, it is unnecessary to have one radial unit for each training case, the number still needs to be significant). A GRNN, like an RBF network, doesn't extrapolate [8][10].

Generalized regression neural networks (GRNNs) are radial basis function (RBF) networks commonly used to approximate functions. The learning process is analogous to determining which surface in a multidimensional space best fits the training data, with the "best fit" criterion being quantified statistically. The generalization is the same as interpolating the test data with this multidimensional surface. Donald F. Specht proposed the GRNN in [Specht 91], which belongs to probabilistic neural networks [10, 11]. Like other probability-based neural networks, this neural network requires a small fraction of the training data needed for a backpropagation neural network. For a backpropagation neural network, the data available from operating system metrics is rarely enough. Because of its capacity to converge to the underlying function of the data with only a few training samples, the usage of a probabilistic

neural network is advantageous. The additional information required to achieve a comfortable fit is small, and it may be accomplished without the user's participation. As a result, GRNN is an excellent tool for making predictions and comparing system performance in practice.

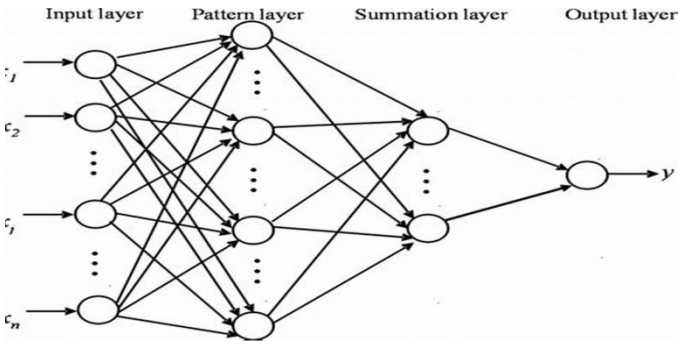

Fig. 1. Generalized Regression Neural Network

- ✓ Input Layer – The inputs are applied in the input layer.
- ✓ A hidden layer is created when data is transformed from the input space to the confidential space via a nonlinear transformation, e.g., by a Fourier Transform or Gaussian Data Transfer Model (GFT).
- ✓ Linear output layer – The outputs are created in the linear output layer.
- ✓

3.1 An Expert System Augmented with Generalized Regression Neural Network For Diagnosis of Hepatitis B

Artificial Intelligence in Medicine (AIM) is specifically designed for medical purposes. Several researchers have shown interest in the potential of AI in medicine and have characterized the potential of AI approaches for treatment as:

- ✓ Produces a lab for medical knowledge assessment, organization, depiction, and categorization.
- ✓ Produces innovative tools to aid medical decision-making, training, research, and other fields of study.
- ✓ Provides a rich content for future medical consultations. The system shown here combines the two main branches of artificial intelligence: the conventional branch, which is represented by expert systems, and the connectionist branch, characterized by artificial neural networks.

The system's purpose is to make predictions regarding people who have been infected with the hepatitis virus. Correct diagnosis and timely treatment can help lower the risk of progressing into cancer. If created for mutually exclusive illnesses and different symptoms, such an expert system may be helpful. However, there are occasions when these limits are impossible to enforce since specific symptoms have the same source (are linked), and a patient may be suffering from many diseases. The Bayes theorem is not always a solution because of these issues. As a result, there are many situations in which expert systems cannot replace human intellect. These are based on the assumption that systems with similar designs are required [10],[12]. The program has a complicated configuration, assessing data related to the indication of hepatitis infection, its progression, antecedents, symptoms, laboratory test results, and the development of some particular biological markers during therapy. It can create a versatile database and construct an expert system that can identify various forms of Hepatitis and make predictions about the patient's progression and response to therapy. The method may operate on the multipurpose database using two primary components (an inference machine and neural network architecture). It can be multidisciplinary and meet the needs of a medical diagnosis and prediction system.

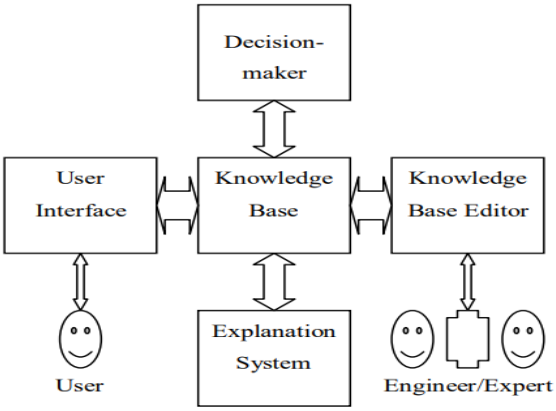

Figure 2: The Configuration of the Expert System

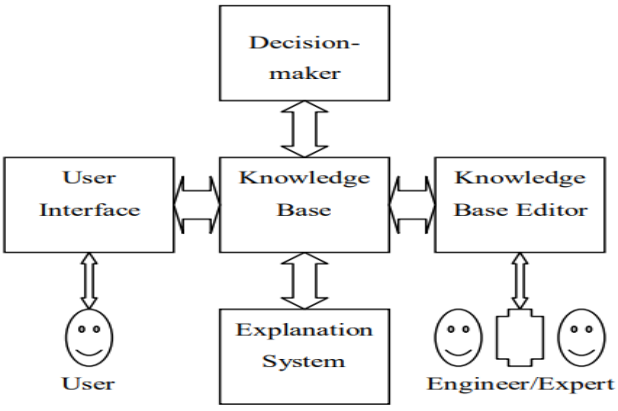

Figure 3: Architecture of the Proposed System

Expert systems give pre-selected rules in decision making in specialized realms of expertise. Still, they are constrained by predetermined options and the date of the specialist opinion encoded in the decision rules. A medical expert system has been designed to give physicians structured questions and replies within medical fields of specialized knowledge or expertise. The proposed framework is based on therapeutic recommendations of one or more medical experts, who also articulated the best questions and conclusions to sieve from the answers the general practitioner picks. The system can explore and manage the multipurpose database with the help of two key components (an inference machine and a neural network). A trained GRNN is utilized to predict the aetiology of the disease. The

expert system can specify the progression of the sickness over time after the patients' data is supplied, together with the results test results performed at the start of therapy. Specification of the characteristics that distinguish distinct types of Hepatitis becomes an unavoidable first step in diagnosing hepatitis B. The next step is to create an expert system. After a thorough investigation of a set of indicators that must be evaluated, hepatitis B can be detected in the patient.

4.0 CONCLUSION

Computer and information communication have been successfully applied in medical practices to a more significant level. In this research work, analysis of expert system was carried out in respect of diagnosis of hepatitis B and some limitations were highlighted for consideration. The potential benefit of integrating Generalized Regression Neural Network (GRNN) with the conventional inference rule based system was elucidated. The proposed architecture provides a user interface taking in the symptoms and test results as inputs into the system while the interaction between the inference engine and generalized regression neural network form the decision making module and together with the knowledge base, will make therapeutic recommendation. This paper concluded that the best Neural Network for Hepatitis B diagnosis will be GRNN (Generalized regression N/N), which will decrease unnecessary time spent in therapy. Even if there are several missing factors in a blood test, artificial intelligence will diagnose the problem using extended regression neural networks. Future work will delve into the implementation of the framework for the diagnosis of Hepatitis B and the result of its evaluation will be provided.

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