Artificial Intelligence Based Expert System For Hepatitis B Diagnosis

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Abstract—**The health of population, which is based primarily on the result of medical research, has a strong impact upon all human activities. Among the most important medical aspects are considered the good interpretation of data and setting the diagnosis. But medical decision making becomes a very hard activity because the human experts, who have to make decisions, can hardly process the huge amounts of data. So they need a tool that should be able to help them to make a good decision. There are a lot of tools which try to reduce the risk of error apparition in medical life. Diagnosis has a very important role here. It is the first step from a set of therapeutic actions; an error at this level can have dramatic consequences. The presence of technology in diagnosis phase is welcome because of its advantages: pragmatism, repeatability, efficiency, immunity toward perturbation factors that are specific to human beings (fatigue, stress, diminished attention). The technology doesn't replace human experts in this point of medical assistance; it only tries to help them, implementing systems that are able to select or to generate data which are relevant. In medicine, diagnosis is "the recognition of a disease or stipulation by its apparent signs and symptoms" or "the analysis of underlying physiological, Biochemical cause(s) ". Hepatitis B including chronic liver disease is quite common in the world, which may cause damage to hepatocytes. The severity may range from healthy carrier to decompensated cirrhosis. In this paper we have described an intelligent system for the diagnosis of the Hepatitis B virus disease, as Hepatitis is one of the serious diseases which demands expensive treatment and severe side effects can appear very often. The intelligent system consists of the generalized regression neural network which gives the result for whether the patient is Hepatitis B positive or not and the severity of the patient.**

Index Terms—**Medical Diagnosis; artificial intelligence, neural networks; hepatitis b; generalized regression neural network; hepatitis b virus (HBV); hepatitis b DNA.**

I. Introduction

Recent practice for medical treatment make it mandatory that patients consult specialists for further diagnosis and treatment. Other medical practitioners may not have adequate expertise or experience in handling certain high-risk diseases. Nonetheless, typical waiting time for treatments may be few days, weeks or even months. Possibly, by the time the patients consult the specialists the diseases may have already spread out. Since the majority of the high-risk disease could only be cured at the early stage, the patients may have to endure for the rest of their life, due to which new approaches with the support of computer technology for the diagnosis of diseases is essential.An important issue in medical diagnosis is the risk stratification, which refers to the sorting of patients based on the severity of disease. This is vital owing to the reason that it can help in reducing the usage of beds, equipment, and other medical resources. In case the clinical problem lies beyond the physician's competence, the solution is to consult a specialist, however in common, expert opinion is either unavailable or not available in a timely fashion. The problem of deducing certain diseases or formulating a treatment has to be solved by them on the basis of more or less specified observations and knowledge. In order to keep more of the relevant information constantly in mind the physicians are encouraged by continued training and recertification procedures. However, it is assured that most of what is known cannot be known by most individuals due to the fundamental limitations of human memory and recall coupled with the growth of knowledge. A good physician employs his knowledge, experience, and talent during a medical diagnosis procedure to diagnose a disease. The diagnosis is then determined by taking the total available patients' status into account. The appropriate treatment is prescribed depending on the diagnosis and the entire process might be iterated. The diagnosis might be reconfigured, refined, or even rejected in every iteration. Recent practice for medical treatment make it mandatory that patients consult specialists for further diagnosis and treatment. Other medical practitioners may not have adequate expertise or experience in handling certain high-risk diseases. Nonetheless, typical waiting time for treatments may be few days, weeks or even months. Possibly, by the time the patients consult the specialists the diseases may have already spread out. Since the majority of the high-risk disease could only be cured at the early stage, the patients may have to endure for the rest of their life, due to which new approaches with the support of computer technology for the diagnosis of diseases is essential[1]. The mortality rate and the waiting time to see the specialist could be reduced by employing the computer technology or computer program or software developed by emulating human intelligence which supports the doctors in making decisions without the direct consultation with the specialists. It is possible to shortlist the patients with high-risk factors or symptoms or predicted to be highly effected with certain diseases or illness to see the specialist for further treatment. Neural networks are extensively applicable to real world problems and thus have already been employed successfully in numerous industries. Neural networks are appropriate for prediction or forecasting requirements like sales forecasting, industrial process control, customer research, data validation, risk management, target marketing and the like since they are capable of efficiently recognizing patterns or trends in data. Besides fields such as identification of speakers in communications; diagnosis of disease; recovery of telecommunications from faulty software; elucidation of multimeaning Chinese words; undersea mine detection; texture analysis; three-dimensional object recognition;

handwritten word recognition; and facial recognition extensively-make-use-of-Artificial-neural.

Artificial Neural Networks (ANN) is presently a 'hot' research area in medicine and it is believed that they will receive extensive application to biomedical systems in the next few years. Hepatitis B including chronic liver disease is quite common in the world, which may cause damage to hepatocytes. The severity may range from healthy carrier to decompensate cirrhosis. The aim is to embed an intelligent system for the diagnosis of the Hepatitis B virus disease, as Hepatitis is one of the serious diseases which demands expensive treatment and severe side effects can appear very often.

II. Overview of Hepatitis B

The term 'hepatitis' simply means inflammation of the liver. Hepatitis may be caused by a virus or a toxin such as alcohol. Other viruses that can cause injury to liver cells include the hepatitis A and hepatitis C viruses. These viruses are not related to each other or to hepatitis B virus and differ in their structure, the ways they are spread among individuals, the severity of symptoms they can cause, the way they are treated, and the outcome of the infection. Hepatitis B is an infection of the liver caused by the hepatitis B virus (HBV).The major modes of transmission of hepatitis B (sexual transmission, illicit drug use, exposure to infected blood) and the effect of universal vaccination of infants. When a person first gets hepatitis B, they are said to have an 'acute' infection. Most people are able to eliminate the virus and are cured of the infection. Some are not able to clear the virus and have 'chronic' infection with hepatitis B that is usually life-long. The hepatitis B virus is a DNA virus, meaning that its genetic material is made up of deoxyribonucleic acids. It belongs to a family of viruses known as Hepadnaviridae. The virus is primarily found in the liver but is also present in the blood and certain body fluids [2][6].

Hepatitis B virus consists of a core particle (central portion) and a surrounding envelope (outer coat). The core is made up of DNA and the core antigen (HBcAg). The envelope contains the surface antigen (HBsAg). These antigens are present in the blood and are markers that are used in the diagnosis and evaluation of patients with suspected viral hepatitis.The hepatitis B virus reproduces in liver cells, but the virus itself is not the direct cause of damage to the liver. Rather, the presence of the virus triggers an immune response from the body as the body tries to eliminate the virus and recover from the infection. This immune response causes inflammation and may seriously injure liver calls. Therefore, there is a balance between the protective and destructive effects of the immune response to the hepatitis B virus.

III. Diagnosis of Hepatitis B

Infection with hepatitis B is suspected when the medical history and the physical examination reveal risk factors for the infection or symptoms and signs that are suggestive of hepatitis B. Abnormalities in the liver tests (blood tests) also can raise suspicion; however, abnormal liver tests can result from many conditions that affect the liver. The diagnosis of hepatitis B can be made only with specific hepatitis B virus blood tests. These tests are known as hepatitis 'markers' or 'serology.' Markers found in the blood can confirm hepatitis B infection and differentiate acute from chronic infection. These markers are substances produced by the hepatitis B virus (antigens) and antibodies produced by the immune system to fight the virus. Hepatitis B virus has three antigens for which there are commonly-used tests - the surface antigen (HBsAg), the core antigen (HBcAg) and the e antigen (HBeAg).

A. HBSAG and Anti-HBs

The presence of hepatitis B surface antigen (HBsAg) in the blood indicates that the patient is currently infected with the virus. Anti-HBs provide complete immunity to subsequent hepatitis B viral infection. Similarly, individuals who are successfully vaccinated against hepatitis B produce anti-HBs in the blood. Patients who fail to clear the virus during an acute episode develop chronic hepatitis B. The diagnosis of chronic hepatitis B is made when the HBsAg is present in the blood for at least six months. In chronic hepatitis B, HBsAg can be detected for many years, and anti-HBs does not appear.

B. Anti-HBc

In acute hepatitis, a specific class of early antibodies (IgM) appears that is directed against the hepatitis B core antigen (anti-HBc IgM). Later, another class of antibody, anti-HBc IgG, develops and persists for life, regardless of whether the individual recovers or develops chronic infection. Only anti-HBc IgM can be used to diagnose 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.

C. HBEAG, Anti-HBE, and Pre-Core Mutations

Hepatitis B e antigen (HBeAg) is present when the hepatitis B virus is actively multiplying, whereas the production of the antibody, anti-HBe, (also called HBeAg seroconversion) signifies a more inactive state of the virus and a lower risk of transmission. In some individuals infected with hepatitis B virus, the genetic material for the virus has undergone a structural change, called a pre-core mutation. This mutation results in an inability of the hepatitis B virus to produce HBeAg, even though the virus is actively reproducing. This means that even though no HBeAg is detected in the blood of people with the mutation, the hepatitis B virus is still active in these persons and they can infect others.

D. Interpretation of Hepatitis B Blood tests

The following tables give the usual interpretation for sets of results from hepatitis B blood (serological) tests.

TABLE II: MARKERS FOR HEPATITIS B DIAGNOSIS

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

IV. ARTIFICIAL INTELLIGENCE IN MEDICAL DIAGNOSIS

One of the most known modalities of setting the diagnosis consists in using an expert system. These kinds of systems implement human reasoning and they use a set of decision rules, which test physical symptoms and laboratory analyses, making a suggestion for diagnosis. Frequently is hard to express the rules for the system. The translation of implicit knowledge into explicit rules would lead to loss and distortion of information content. In addition to these difficulties it can be said that to make such an expert system need a good engineer who must understand the medical domain in which expert system is made. On the other hand, the tree structure of rule-based relationships becomes too complex if new levels of knowledge are added. Artificial neural networks could be used in every situation in which exists a relationship between some variables that can be considered inputs and other variables that can be predicted (outputs)[3]. The most important an advantage using artificial neural networks is that this kind of system solves problems that are too complex for conventional technologies, do not have an algorithmic solution or the solution is too complex to be used. These characteristics have often appeared in medicine. Artificial neural networks have been successfully applied on various areas of medicine, such as: diagnostic systems, biomedical analysis, image analysis, drug development. Using artificial neural networks, it can be monitored a lot of health indices (respiration rate, blood pressure, glucose level) or can be predicted the patient response to a therapy. Artificial neural networks have a very important role in image analysis, too, being used together with processing of digital image in recognition and classification. They are used in pattern recognition because of their capacity to learn and to store knowledge. The medical image field is very important because it offers a lot of useful information for diagnosis and therapy [4], [5].

V. NEURAL NETWORKS FOR HEPATITIS B DIAGNOSIS

Hepatitis B diagnosis is possible using following Neural Networks [7]

- 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
Working method	Generalization of delta rule. (Back propagation learning rule)	Employed for function approximation in time series modeling and pattern classification	Kernel based approximation to form an estimate of pdf's of classes in classification problem. (Bayesian network)	Similar to PNN,
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 tasks.
Speed	Time consuming	Extrapolate.	Slow to execute.	Trains instantly

From the above table, we can conclude that GRNN (Generalized regression N/N) will be the best suitable Neural Network for Hepatitis B diagnosis. The Generalized Regression Neural Networks (GRNNs) are the paradigms of the radial basis function (RBF) networks which will be used for the diagnosis of Hepatitis B [5]. The Markers of the Hepatitis B diagnosis will be used as the inputs to the network in order to fulfill the logical inference rule. The output will be either positive or negative based on the rule.

VI. STRUCTURE OF GENERALIZED REGRESSION NEURAL NETWORK

Generalized Regression Neural Network (GRNN) is a type of neural network using kernel-based approximation to perform regression and is one of the so-called Bayesian networks. GRNNs have some advantages and disadvantages which are broadly similar to PNNs. GRNNs can only be used for regression problems,whereas PNNs are used for classification problems. It trains almost instantly, but tends to be large and slow (although, unlike PNNs, it is not necessary to have one radial unit for each training case, the number still needs to be large).Like an RBF network, a GRNN does not extrapolate[8][10]. Generalized regression neural networks (are paradigms of radial basis function (RBF) networks, often used for function approximations. The learning process is that equivalent to finding a surface in a multidimensional space provides a best fit to the training data, with the criterion for the "best fit" being

measured in some statistical sense. The generalization is equivalent to the use of this multidimensional surface to interpolate the test data. GRNN, as proposed by Donald F. Specht in [Specht 91] falls into the category of probabilistic neural networks[9,10]. This neural network like other probabilistic neural networks needs only a fraction of the training samples a back propagation neural network would need. The data available from measurements of an operating system is generally never enough for a back propagation neural network. Therefore the use of a probabilistic neural network is especially advantageous due to its ability to converge to the underlying function of the data with only few training samples available. The additional knowledge needed to get the fit in a satisfying way is relatively small and can be done without additional input by the user. This makes GRNN a very useful tool to perform predictions and comparisons of system performance in practice.

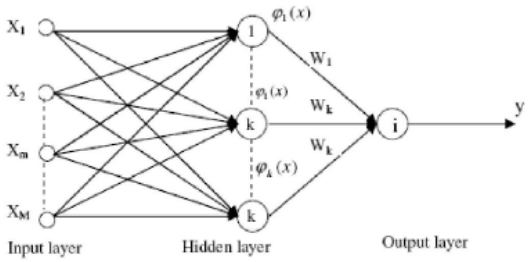

Fig. 1. Generalized Regression Neural Network

- Input Layer – where the inputs are applied.
- Hidden layer – where a nonlinear transformation is applied on the data from the input space to the hidden space; in most applications the hidden space is of high dimensionality.
- Linear output layer – where the outputs are produced.

VII. An Expert System for Diagnosis of Hepatitis B

Artificial Intelligence (AI) is the studies of ideas, which enable computers to do the things that make people seem intelligent. AI in Medicine (AIM) is AI specialized to medical applications. The potential of AI in medicine has been expressed by a number of researchers and summarized the potential of AI techniques in medicine as follows:

• Provides a laboratory for the examination, organization, representation and cataloguing of medical knowledge. Produces new tools to support medical decisionmaking, training and research and other sciences.

• Offers a content-rich discipline for future scientific medical specialty The system presented here is made using the main two branches of artificial intelligence:— the traditional one, represented by expert systems;— the connexionist one, where the most common forms used are artificial neural networks. The goal of the system is to offer predictions about patients infected with hepatitis virus. Hepatitis is one of the principal causes for liver cancer. A correct diagnosis and an adequate treatment could reduce the risks of liver cancer apparition. Such an expert system could be successfully used if it is developed for mutual exclusive diseases and independent symptoms. But sometimes these restrictions cannot be accomplished because there are situations when some symptoms have the same cause (being connected) and a patient can suffer of more than one disease. Because of these problems, Bayes theorem is not always a solution. Therefore, there are a lot of cases when is not possible to implement the human intelligence with expert systems. This is the reason because artificial neural networks (a new branch of artificial intelligence) have been developed. These start with the idea that in order to reproduce intelligence, it would be necessary to build systems with a similar architecture[9],[11].The application has a complex structure, analyzing information connected to the apparition of the hepatitis infection, its evolution, the antecedents, the symptoms, the results of the laboratory tests, and the evolution of some specific biological indicators during the treatment. It can develop a multifunctional database and can implement an expert system to be used in order to diagnose different types of hepatitis and to realize some predictions regarding the evolution of the patient and the response to the treatment. The system can use two major components (an inference machine and architecture of neural networks) that can operate on the multifunctional database. It can have an interdisciplinary character and fulfil the requirements of a system used in medical diagnosis and prediction.

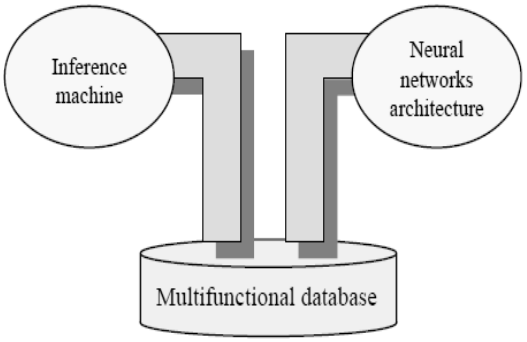

Fig. 2. The configuration of the expert system

Expert system provides pre-selected rules for decision making within the specialized domains of knowledge, but are limited by the fixed choices and by the date of the expert opinion embodied in the decision rules. In order to provide physicians with structured questions and structured responses within medical domains of specialized knowledge or experience, medical expert system has been developed. The advice of one or more medical experts, who also suggest the optimal questions to be considered and provide the most accurate conclusions to be drawn from the answers the physician chooses, is used to embody the structure in the program. The two vital components (an inference machine and neural network) aid the system to explore and manipulate the multifunctional database. A trained artificial neural network is used to assume the evolution of biological indicators. Once the patients' personal data is presented along with the results of the tests taken at the onset of the treatment and postulated code of reaction, the evolution in time of the illness can be specified by the expert system. In case of diagnosis of hepatitis B the specification of the factors that define various kinds of hepatitis becomes an ineviatable first step. This is followed by the design of an expert system. Hepatitis B can be found in patient organism after a thorough analysis of a set of markers that have to be analyzed in order to decide.

VIII. Conclusion

Medical diagnosis has become highly attributed with the development of technology lately. Furthermore the computer and communication tools have improved the medical practice implementation to a greater extent. Artificial neural network ensemble is a powerful learning technique that could significantly improve the generalization ability of neural learning systems, but its comprehensibility is even worse than that of a single artificial neural network, which may hinder the wide acceptance of this technique in medicine. The hepatitis B virus is a DNA virus belonging to the Hepadnaviridae family of viruses. Hepatitis B infection is transmitted through sexual contact, contact with contaminated blood , and from mother to child. Hepatitis B is not spread through food, water, or casual contact. Serologic (blood) markers specifically for hepatitis B virus are used to diagnose hepatitis B viral infection. The blood tests can also identify people who are at highest risk for complications.Injury to the liver by hepatitis B virus is caused by the body's immune response as the body attempts to eliminate the virus. Progression of chronic hepatitis B viral infection occurs insidiously (subtly and gradually), usually over several decades. The course is determined primarily by the age at which the hepatitis B viral infection is acquired and the interaction between the virus and the body's immune system. GRNN (Generalized regression N/N) will be the best suitable Neural Network for Hepatitis B diagnosis which will help in reducing extra time consumption in treatment. Even if there is any number of missing parameters in blood test, the diagnosis will be done by artificial intelligence using generalized regression neural networks.

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