IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 3, Ver. 1 (May – Jun. 2015), PP 50-53
www.iosrjournals.org

Application of Support Vector Machine and Fuzzy Logic for Detecting and Identifying Liver Disorder in Patients

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Abstract: *The liver is the largest organ in the body, and plays a major role in food digestion and process in the body. Based on the role it plays, it has a higher chance of coming in contact with harmful product that goes into the body.This system first screens the patients then identifies if any, the particular liver disorder suffered by the patient. The diagnosis of liver disorder has been subjective at best, based on subjective approaches. This research paper has proposed a hybrid system utilizing fuzzy logic for approximation and handling of noisy or incomplete while appropriate classification was handled utilizing Support Vector Machine (SVM)*
Keywords: *Liver Disorder, Fuzzy logic, SVM, Dataset*

I. Introduction

No single organ in the body can be said to be the most important, but it is arguable that the liver plays more and holds the most important role in digestion process (Mycoclinic, 2014. The liver is a vital organ of the digestive system present in vertebrates and some other animals. It has a wide range of functions, including detoxification, protein synthesis, and production of bio chemical's necessary for digestion (Healthlin, 2014 and medicineNet, 2014). The liver is necessary for survival; there is currently no way to compensate for the absence of liver function in the long term, although new liver dialysis techniques can be used in the short term (Healthlin, 2014 and medicineNet, 2014).This gland plays a major role in metabolism and has a number of functions in the body, including glycogen storage, decomposition of red blood cells, plasma protein synthesis, hormone production, and detoxification. It lies below the diaphragm in the abdominal-pelvic region of the abdomen. It produces bile, an alkaline compound which aids in digestion via the emulsification of lipids. The liver's highly specialized tissues regulate a wide variety of high-volume biochemical reactions, including the synthesis and breakdown of small and complex molecules, many of which are necessary for normal vital functions (Healthline, 2014)

The liver is a reddish brown organ with four lobes of unequal size and shape. A human liver normally weighs 1.44–1.66 kg (3.2–3.7 lb), and is a soft, pinkish-brown, triangular organ. It is both the largest internal organ and the largest gland in the human body. It is located in the right upper quadrant of the abdominal cavity, resting just below the diaphragm. The liver lies to the right of the stomach and overlies the gallbladder. It is connected to two large blood vessels, one called the hepatic artery and the other called the portal vein (RighDiagnosis, 2014).

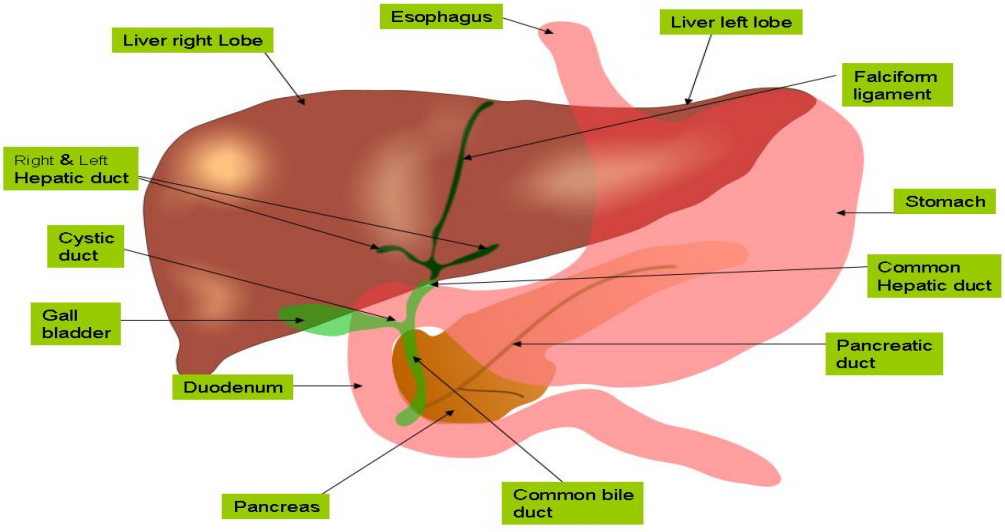

Figure 1.0: The Human Liver (MedicineNet, 2013)

There are various liver disorders based on environmental and human degredation, but the very basic and most common type that would be identified by this system is:

a. Hepatitis: Hepatitis is swelling and inflammation of the liver Hepatitis is most commonly caused by a viral infection. There are, however, other causes of hepatitis. These include autoimmune hepatitis (a disease occurring when the body makes antibodies against the liver tissue) and hepatitis that occurs as a secondary result of medications, drugs, toxins and alcohol. Hepatitis can be acute (inflammation of the liver that lasts less than six months) or chronic (inflammation of the liver that lasts more than six months). Viral hepatitis is common. Thousands of cases are reported each year, but this is not the true value as most people with hepatitis are not diagnosed. Many people mistake their symptoms as the flu instead of hepatitis. There are different types of hepatitis, they are, Hepatitis A, Hepatitis B, Hepatitis C and Hepatitis D

b. Cirrhosis: Cirrhosis is a slowly progressing disease in which healthy liver tissue is replaced with scar tissue, eventually preventing the liver from functioning properly. The scar tissue blocks the flow of blood through the liver and slows the processing of nutrients, hormones, drugs, and naturally produced toxins. It also slows the production of proteins and other substances made by the liver.

II. Material And Methodology

The theory of fuzzy logic provides a mathematical strength to capture the uncertainties associated with human cognitive processes, such as thinking and reasoning. In standard set theory, an object does or does not belong to a set. There is no middle ground. In such bivalent systems, an object cannot belong to both its set and its compliment set or to neither of them. This principle preserves the structure of the logic and avoids the contradiction of object that both is and is not a thing at the same time (Zadeh, 1965). However, fuzzy logic is highly abstract and employs heuristic (experiment) requiring human experts to discover rules about data relationship (Angel and Rocio, 2011).

Fuzzy classification assumes the boundary between two neighboring classes as a continuous, overlapping area within which an object has partial membership in each class (Kuang and Ting-Cheng, 2011). Fuzzy logic highlights the significant of most applications in which categories have fuzzy boundaries, but also provides a simple representation of the potentially complex partition of the feature space. (Sun and Jang**,** 1993 and Ahmad, 2011) Conventional approaches of pattern classification involve clustering training samples and associating clusters to given categories. The complexity and limitations of previous mechanisms are largely due to the lack of an effective way of defining the boundaries among clusters. This problem becomes more intractable when the number of features used for classification increases (Christos and Dimitros, 2008).

2.1 Methodology

The system is divided into two parts as it makes use of two different systems for the analysis and identification of the liver disorder if any. They are:

a. The fuzzy logic classification stage, and
b. The SVM identification stage.

The Fuzzy Logic Classification: Here the patient is asked a series of question and the response could be classified into 3 groups:

a. High => a positive response with high certainty
b. Average =>a response with certain level of uncertainty
c. Low =>a negative response with high certainty
   The response isdivided into 3 groups instead of 2, so as to accommodate answers from patient with uncertainty. Each response has a value attach to it
d. High >5
e. Average > 3≤ 5
f. Low > 1 ≤ 3

All response from the users are summed after each entry, and at the enda total sum is gotten, which can then be used to determine if a patient has a liver disorder or not.

Algorithm:

```
int Response /*total score of patient response*/
If (Response > 25){
        Patient has liver disorder
}else{
        Patient is healthy.
}
```

Figure 2: Hybrid SVM-FUZZY Algorithm

The SVM Identification Stage: After the patient has been diagnosed from the "fuzzy classification stage" to have a liver disorder, here the particular liver disorder being suffered by the patient is being identified.Support vector machine are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. Support vector machine success is based on building nonlinear classifiers.Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other, making it a non-probabilistic binary linear classifier. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall on.

Here the two categories of the training data used for training the SVM machine are:

a. Hepatitis
b. Cirrhosis

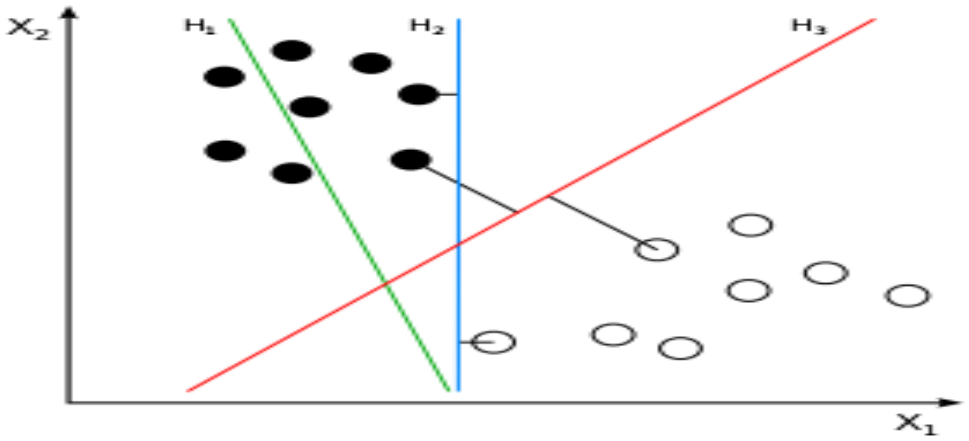

Figure 3:SVM Binary Classification

After the Support Vector Machine has been trained with data from both categories, it can now be used to classify the type of liver disorder the patient might have after receiving the patient blood attributes as parameter.

III. Dataset Elicitation

The dataset used for training are attributes gotten from the blood samples of patients suffering from "Hepatitis" and "Cirrhosis. Each individual instance of the data set has been scaled to fall between -1 and 1.

Attribute information of the data set:

1. Mcv ➔ mean corpuscular volume
2. Alkphos ➔ alkaline phosphotase
3. Sgpt ➔ alamine aminotransferase
4. Sgot ➔ aspartate aminotransferase
5. Gammagt ➔ gamma-glutamyltranspeptidase
6. Drinks ➔ number of half-pint equivalents of alcoholic beveragesdrunk per day

IV. Results

The fuzzy logic system and the Support Vector Machine combination is a perfect way of identifying a patient with liver disorder and classifying the particular liver disorder being suffered.

V. Conclusion

A hybrid system has been proposed and designed for the diagnosis of liver disorder. The system can obtain binary classification based on the available trained dataset. The system can be improved by making the SVM multiclass through the introduction of kernel. The support vector machine classifier can be extended to handle multi-classification for identifying more liver disorder diseases thus improving the system. The multi-classification must be accommodated with relevant trade-off to ensure efficiency.

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