Adaptive Splitting and Selection Method for Noninvasive Recognition of Liver Fibrosis Stage

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Abstract. Therapy of patients suffer form liver diseases strongly depends on the liver fibrosis progression. Unfortunately, to assess it the liver biopsy has been usually used which is an invasive and raging medical procedure which could lead to serious health complications. Additionally even when experienced medical experts perform liver biopsy and read the findings, up to a 20% error rate in liver fibrosis staging has been reported. Nowadays a few noninvasive commercial tests based on the blood examinations are available for the mentioned above problem. Unfortunately they are quite expensive and usually they are not refundable by the health insurance in Poland. Thus, the cross-disciplinary team, which includes researchers from the Polish medical and technical universities has started work on new noninvasive method of liver fibrosis stage classification. This paper presents a starting point of the project where several traditional classification methods are compared with the originally developed classifier ensembles based on local specialization of the classifiers in given feature space partitions. The experiment was carried out on the basis of originally acquired database about patients with the different stages of liver fibrosis. The preliminary results are very promising, because they confirmed the possibility of outperforming the noninvasive commercial tests.

Keywords: machine learning, multiple classifier system, clustering and selection, evolutionary algorithm, feature selection, medical informatics, liver fibrosis.

1 Introduction

Medical diagnosis is important area of computer aided diagnosis. Liebowitz [16] reports that 11% of expert systems are dedicated to the medical aided diagnosis and 21% of articles devoted intelligent method applications are connected with the medical cases. Such software is widely used especially when we do not
have enough accurate diagnostic tools to make a reliable diagnosis. Our research is focusing on evaluating liver fibrosis stage. Diseases causing liver damages are serious thread for patient life as they may progress without any significant symptoms until the very final stage. Such a disease may be caused by the liver hepatitis virus which may lead to liver fibrosis and, in the terminal stage, to liver cirrhosis and death. Early detection of liver fibrosis is very important because, despite there is no cure for the virus itself, there is a therapy which slows down or even stops the progression of fibrosis. Unfortunately, in most cases the condition stays in so called compensated state, so no visible changes nor dysfunctions might be observed. Although most medical examination results are within their normal results, some slight discrepancies may be observed and used to evaluate the liver fibrosis stage [10]. We propose to use easy accessible noninvasive biomedical examinations as a blood test gathered from patients infected with (liver hepatitis type B virus and type C respectively). Our aim is to create an accurate medical decision support tool that will allow for an automatic classification of patients under the observation. For the problem under consideration we use the modified Adaptive Splitting and Selection method (AdaSS), previously developed by our team [9] and it is compared with several machine learning methods. This work is a starting point of the interdisciplinary research which the main objective is to design the reliable decision support system which could outperform the expensive commercial tools for the task of liver fibrosis stage.

The outline of the work is as follows. Firstly the medical background is presented, then the propose algorithm and its method of training are described. Next section focuses on the experimental evaluation of the pool of available classification methods which results are compared with proposed approach. The last part of the paper includes some conclusions and future research directions.

2 Medical and Clinical Aspects

As mentioned neither the chronic liver hepatitis nor the early stages of liver fibrosis give noticeable symptoms. During this early stage the remaining healthy regions of liver compensate the dysfunction of degraded ones. As the condensation of scare tissue within the liver may vary in different regions of the organ the only method of liver fibrosis stage recognition which gives the confidence is an autopsy and histopathological examination of the liver tissues. For the same reason the most common examination method - liver biopsy does not guarantee the correct diagnosis. This method is unfortunately not only inaccurate, but also may lead to serious health complications including risk of patient’s death. Despite of that it is still a so called ”gold standard” in the liver examination and is used as a reference method of alternate diagnostic methods.

There are three common description methods for liver biopsy samples. One used in the article is METAVIR [2] (4 stages of fibrosis) and the other are Histological Activity Index (HAI Score) also known as Knodell Score [11] (3 stages of fibrosis) and it’s modified version called Ishak Score [7] (6 stages of fibrosis). METAVIR has been specifically designed and validated for patients with