# Chapter 5.11
# Diagnostic Support Systems and Computational Intelligence:
## Differential Diagnosis of Hepatic Lesions from Computed Tomography Images

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## ABSTRACT

Recent advances in computer science provide the intelligent computation tools needed to design and develop Diagnostic Support Systems (DSSs) that promise to increase the efficiency of physicians during their clinical practice. This chapter provides a brief overview of the use of computational intelligence methods in the design and development of DSSs aimed at the differential diagnosis of hepatic lesions from Computed Tomography (CT) images. Furthermore, examples of DSSs developed by our research team for supporting the diagnosis of focal liver lesions from non-enhanced CT images are presented.

## INTRODUCTION

Hepatic diseases, including disorders that cause the liver to function improperly or cease its function (e.g. hepatitis and cirrhosis), are one of the most

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common diseases all over the world. According to the National Center for Health Statistics, the American Liver Foundation, and the United Network for Organ Sharing over 26.000 people in the United States die each year from chronic liver disease and cirrhosis, while according to the Office for National Statistics in the United Kingdom, liver disease is now the fifth most common cause of death after heart disease, stroke, chest disease and cancer. Hepatic cancer is one of the fastest growing cancers in the United States, while the number of Hepatocellular Carcinomas (HCC), type of primary liver cancer and one of the top eight most common cancers in the world, is rising worldwide. HCC is much more common outside the United States, representing 10% to 50% of malignancies in Africa and parts of Asia. Advances in imaging technologies permit the non-invasive detection and diagnosis of liver of both diffuse hepatic disease, like hepatitis and cirrhosis, and focal liver lesions like cysts, hemangiomas and HCC. The diagnosis can be performed through a wide array of medical imaging techniques including Ultrasonography (US), Magnetic Resonance (MR) imaging, and Computed Tomography (CT) with or without contrast agents. The choice of imaging test depends on the clinical question, availability of the test, patient's condition and clinician's familiarity with the test. US imaging is inexpensive, widely available, can easily detect cysts, but its diagnostic accuracy depends strongly on the operator and his/her experience. CT and MR imaging are more sensitive in detecting focal liver lesions. MR imaging although accurate in detecting and differentiating liver lesions, is very expensive and therefore not very popular. The most commonly used image-based detection method of liver lesions is CT due to its short acquisition time, wide imaging range, high spatial resolution, and relatively low cost. Although the quality of liver images has lately improved, it is difficult even for an experienced clinician to discriminate various types of hepatic lesions with high accuracy and without the need for diagnosis confirmation by means of contrast agents (related with renal toxicity or allergic reactions).

Rapid development of computer science permitted the design and development of computerized systems able to assist radiologists in the interpretation, early detection and diagnosis of abnormalities from hundreds of medical images every day. These systems are known as Diagnostic Support Systems (DSSs). Recent advances in DSSs demonstrated that the application of digital image processing techniques along with advanced Computational Intelligence (CI) methods increase the efficiency, diagnostic confidence and productivity of radiologists, acting as a "second" opinion to the clinician.

The main areas of computerized analysis of liver images are: i) general image preprocessing in order to improve the quality of hepatic images; ii) registration of images in case of multi data sets; iii) manually, semi- or fully-automatic segmentation of Regions of Interest (ROIs) corresponding to anatomical structures and/or liver lesion; iv) visualization into two- and/or three-dimensional (2D and/or 3D) space of liver lesions for diagnosis, surgery, radiation therapy planning, quantitative studies and final presentation purposes; v) image analysis for the detection of an abnormality and its classification into one out of several types of liver tissues. Generally, a DSS includes tools based on image processing techniques in order to support all the above mentioned techniques of computerized analysis, while the intelligence is provided through the usage of CI based algorithms embedded into the DSS. CI algorithms belong to Artificial Intelligence (AI) methods and are able to handle complex data characterized by non-linearities.

It is worth mentioning that a DSS can be combined with computer based medical image archiving and management systems following certain information protocols, e.g. DICOM and HL7. Furthermore, a DSS can support telematic technologies, in order to permit the remote diagnosis and tele-consultation between health care