# Chapter 2.23
# Image Mining for the Construction of Semantic-Inference Rules and for the Development of Automatic Image Diagnosis Systems

**Petra Perner**
*Institute of Computer Vision and Applied Computer Sciences (IBal), Germany*

## ABSTRACT

This chapter introduces image mining as a method to discover implicit, previously unknown and potentially useful information from digital image and video repositories. It argues that image mining is a special discipline because of the special type of data and therefore, image-mining methods that consider the special data representation and the different aspects of image mining have to be developed. Furthermore, a bridge has to be established between image mining and image processing, feature extraction and image understanding since the later topics are concerned with the development of methods for the automatic extraction of higher-level image representations. We introduce our methodology, the developed methods and the system for image mining which we successfully applied to several medical image-diagnostic tasks.

## INTRODUCTION

The increasing number of digital-image and video repositories have made image mining an important task. Image mining means a process of nontrivial extraction of implicit, previously unknown and potentially useful information from image databases. The application of image mining will help to get some additional knowledge about specific features of different classes and

the way in which they are expressed in the image. This method can elicit nonformalized expert knowledge; it can automatically create effective models for decision-making, and can help to find some inherent non-evident links between classes and their imaging in the picture. It can help to get some nontrivial conclusions and predictions on the basis of image analysis. The new knowledge obtained as a result of data analysis in the database can enhance the professional knowledge of the expert or the user of the image-database. This knowledge can also be used for teaching novices or can support image analysis and diagnosis by the expert. It can be used for semantic annotation of digital visual content to enable sophisticated semantic querying of the media in terms familiar to the user's domain, whilst also ensuring that the information and knowledge have a much greater chance of being discovered and exploited by services, agents and applications on the Web.

An additional advantage of image-mining application in decision-making of medical or other tasks is on the long-run the opportunity of creating fully automatic image-diagnosis systems that could be very important and useful in the case of lacking knowledge for decision-making.

In this chapter we present our methods and methodology for performing image mining. We describe the recent state of the art in image mining, the questions that can be answered by applying image-mining methods to image databases, and the problems concerned with image mining. A design of image-mining tools is considered followed by a presentation of our methods and the developed tool for image mining. A methodology for image mining that was created and tested in the task of Hep-2 cell analysis is described. Finally, we summarize our experience in applications of image-mining methodology in different medical tasks, such as pre-clinical diagnosis of peripheral lung cancer on the basis of lung tomograms, lymph-node diagnosis and investigation of breast diseases in MRI and the inspection of microscopic images of cell-based assays. Conclusions and plans for future work are given at the end of this chapter.

## BACKGROUND

As in data mining, we can classify image mining into two main problem types: prediction and knowledge discovery. While prediction is the strongest goal, knowledge discovery is the weaker approach and usually occurs prior to prediction. In prediction we want to discover a model that allows us, based on the model, to predict new data in the respective classes. In knowledge discovery we want to discover similar groups of database entries, frequent patterns, and deviations from a normal status or just relations among the database entries.

Image mining differs from data mining in respect of the data and the nature of the data. The raw image is of 2-dimensional or 3-dimensional numerical data type. Videos are temporal sequences of numerous 2-d images. The image information can be represented by the 2-d or 3-d image matrix itself, by low-level features such as edges, blobs and regions, or by high-level features that allow a human to semantically understand the image content. The different data types in which an image or an image sequence can be represented and the resulting need for special methods and techniques offer a data-type dimension to data mining and make image mining a specific field.

Consequently, image mining can be applied to all the different data representations of an image. Which of the data representations is used, usually depends on the question under study. If we mine our images for knowledge that can be used to construct a fully automatic image-interpretation system, we have different questions to answer: We have to mine the images for regions-of-interest and separate them from the background of the image. Once we have found these regions we need to mine them for distinguishing features and later on we are interested in discovering rules that