

Chapter 3

Image Classification Techniques

Eugenio Vocaturo

 <https://orcid.org/0000-0001-7457-7118>

Università della Calabria, Italy

ABSTRACT

The image processing task, aimed at interpreting and classifying the contents of the images, has attracted the attention of researchers since the early days of computers. With the advancement of computing system technology, image categorization has found increasingly broader applications, covering new generation disciplines such as image analysis, object recognition, and computer vision, with applications quite general both in scientific and humanistic fields. The automatic recognition, description, and classification of the structures contained in the images are of fundamental importance in a vast set of scientific and engineering fields that require the acquisition, processing, and transmission of information in visual form. Classification tasks also include those related to the categorization of images, such as the construction of a recognition system, the representation of patterns, the selection and extraction of features, and the definition of automatic recognition methods. Image analysis is of collective interest and it is a hot topics of current research.

INTRODUCTION

The image processing task, aimed at interpreting and classifying the contents of the images, has attracted the attention of researchers since the early days of computers. With the advancement of computing system technology, image categorization has found increasingly broader applications, covering new generation disciplines such as image and scene analysis, image understanding, object recognition and Computer Vision, with applications quite general both in scientific and humanistic fields.

The objective of this chapter is to provide an overview of some of the main techniques used for image classifications by introducing the general issue of interest for this research topic.

BACKGROUND

Discussions on computers, machine learning and artificial intelligence seem, nowadays, entirely smooth. However the road that has taken us here has been very complex and difficult due to the skepticism surrounding such field of research.

MACHINE LEARNING

The term “Machine Learning (ML)” refers to techniques and approaches used for automatic detection of relevant patterns from data collections. The growing availability of digital data makes the ML approaches widely used for information extraction. We are surrounded by machine learning based technology: search engines learn how to deliver results in the most efficient way, anti-spam software learns to filter our email messages, and credit card transactions are secured by software solutions that learn how to detect frauds. Smartphones are now equipped with advanced digital cameras through which they are able to detect faces interacting with voice commands. In sectors such as bioinformatics and medicine, ML approaches are increasingly adopted to address specific challenges.

The growing digitalization of our world and the following proliferation of data allow the proposal of algorithms for large-scale machine learning (Big Data), giving rise to a wide spectrum of different learning techniques. Machine Learning aims at teaching computers and robots to perform actions and activities in a natural way like humans: learning from experience.

Summing up, machine learning algorithms exploit mathematical - computational methods to obtain learning information directly from data. Machine Learning algorithms may improve their performance in an “adaptive” way, as the examples with which they work increase without having been explicitly programmed.

Machine Learning allows computers to learn from experience; there exists “learning” whenever the performance of the program improves after the performance of a task or the completion of a possibly wrong action. Instead of writing the programming code through which, step by step, the machine is “told” what to do, the computer is only provided with data sets inserted in a generic algorithm that develops its own logic to perform the function, the activity, the task required. The evolution of the concept of “intelligence” in “artificial intelligence” follows (Russell, S. J., & Norvig, P., 2016).

How Machine Learning Works

In principle, machine learning works on the basis of two distinct approaches, which were originally identified by Arthur Samuel at the end of the 1950s. These approaches make possible to differentiate machine learning in two general sub-categories depending on whether the computer is given examples on how to perform the required task (supervised learning) or let the software work without any “help” (unsupervised learning).

Indeed, a more rich taxonomy is available which allows us to make a further and even more detailed classification of the Machine Learning techniques based on its modus operandi (Figure 1). All these techniques are used to classify data.

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