

# Preface

The use of cameras to obtain images or videos from the environment has been extended in the last years. Now these sensors are present in our lives, from cell phones to industrial, surveillance and medical applications. The tendency is to have automatic applications that can analyze the images obtained with the cameras. Such applications involve the use of image processing algorithms.

Image processing is a field in which the environment is analyzed using samples taken with a camera. The idea is to extract features that permit the identification of the objects contained in the image. To achieve this goal is necessary applying different operators that allow a correct analysis of a scene. Most of these operations are computationally expensive. On the other hand, optimization approaches are extensively used in different areas of engineering. They are used to explore complex search spaces and obtain the most appropriate solutions using an objective function. This book presents a study the uses of optimization algorithms in complex problems of image processing. The selected problems explore areas from the theory of image segmentation to the detection of complex objects in medical images. The concepts of machine learning and optimization are analyzed to provide an overview of the application of these tools in image processing.

The aim of this book is to present a study of the use of new tendencies to solve image processing problems. When we start working on those topics almost ten years ago, the related information was sparse. Now we realize that the researchers were divided and closed in their fields. On the other hand, the use of cameras was not popular then. This book presents in a practical way the task to adapt the traditional methods of a specific field to be solved using modern optimization algorithms. Moreover, in our study we notice that optimization algorithm could also be modified and hybridized with machine learning techniques. Such modifications are also included in some chapters. The reader could see that our goal is to show that exist a natural link between the image processing and optimization. To achieve this objective, the first three chapters introduce the concepts of machine learning, optimization and the optimization technique used to solve the problems. The structure of the rest of the sections is to first present an introduction to the problem to be solved and explain the basic ideas and concepts about the implementations.

The book was planned considering that, the readers could be students, researchers expert in the field and practitioners that are not completely involved with the topics.

This book has been structured so that each chapter can be read independently from the others. Chapter 1 describes the machine learning (ML). This chapter concentrates on elementary concepts of machine learning. Chapter 2 explains the theory related with global optimization (GO). Readers that are familiar with those topics may wish to skip these chapters.

In Chap. 3 the electromagnetism-like optimization (EMO) algorithm is introduced as a tool to solve complex optimization problems. The theory of physics behind the EMO operators is explained. Moreover, their pros and cons are widely analyzed, including some of the most significant modifications.

Chapter 4 presents three alternative methodologies for image segmentation considering different objective functions. The EMO algorithm is used to find the best thresholds that can segment the histogram of a digital image.

In Chap. 5 the problem template matching is introduced that consists in the detection of objects in an image using a template. Here the EMO algorithm optimizes an objective function. Moreover, improvements to reduce the number of evaluations and the convergence velocity are also explained.

Continuing with the object detection, Chap. 6 shows how EMO algorithm can be applied to detect circular shapes embedded in digital images. Meanwhile, in Chap. 7 a modified objective function is used to identify white blood cells in medical images using EMO.

Chapter 8 shows how a machine learning technique could improve the performance of an optimization algorithm without affecting its main features such as accuracy or convergence.

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Finally, it is necessary to mention that this book is a small piece in the puzzles of image processing and optimization. We would like to encourage the reader to explore and expand the knowledge in order create their own implementations according their own necessities.

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