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# INTRODUCTION

Image Segmentation aims to subdivide an image into its constituent regions or objects (Gonzales et al., 2008). It is one of the most important phases in the digital image processing field and its accuracy determines the eventual success or failure of the following phases such as recognition and/or classification. Many segmentation algorithms have been proposed in the last decades (Vantaram et al., 2012), which evidence the importance and efforts toward their improvement.

While the quantity of segmentation algorithms has been increasing, a natural question came up: Which algorithm is the best? This question requires a thorough quality assessment of the results provided by each segmentation algorithm as well as the segmentation algorithm itself. It could be done in two different ways: qualitative and quantitative. The first one is done by a visual analysis of the results. It is subjective and strongly depends on the experience of the specialist. The second one is a more objective way; it quantitatively assesses the segmentation results and makes possible to directly compare different segmentation approaches. Many metrics have been proposed for this purpose during the last years (Zhang et al., 1994; Zhang, 1996; Hoover et al., 1996; Zhang, 2001; Neubert et al., 2003; Jiang et al., 2006; Pont-Tuset et al., 2013). Some of them compare segmentation algorithms based on one single metric, what may lead to biased conclusions. Therefore, many metrics were selected for this study.

For a correct and fair comparison between segmentation algorithms, it is desirable to know the values of their input parameters that best fit a given reference. There are two ways to achieve it, *manually* or *automatically*. The first one is called *manually* because it is done through a troublesome and time consuming trial and error process. It could be improved with the help of the owners of the algorithm. However, it does not happen frequently. Thus, this method will produce results that will depend on the knowledge, skill and effort of the experimenter. Furthermore, if the algorithm developer and a new user spend equal time manually tuning the algorithm parameters, their results are likely to be

different. Hence, an automated parameter tuning is preferred rather than the manual one.

The second approach, the automated parameter tuning, becomes an optimization problem whose objective function is given by a metric for segmentation assessment. Each configuration of parameters values yields a quality score determined by this metric. Hence, the objective will be to find those parameters values that will produce the minimum or the maximum value for that metric.

The study performed in this work comprehends the evaluation and comparison of four algorithms that represent the current state-of-the-art in terms of segmentation. Three remote sensing images from different parts of Brazil were taken for the experiments. The parameter tuning for each segmentation algorithm was done in an automatic way using the Nelder-Mead algorithm.



## 1.1. Objectives of the dissertation

The general objective of this dissertation is to evaluate and compare four different segmentation algorithms for remote sensing. These algorithms were chosen with the intention of covering a vast range of approaches.

A secondary objective of this work is to analyze the behavior and understand the different approaches available for image segmentation. It is really interesting and fascinating the variability and diversity of existing approaches for this task. Some of them model the image as a whole; others do it individually, pixel by pixel, or divide it into patches or regions. Also, there are mathematical models that fit perfectly and enclose the whole concept behind an image and its attributes.

As further result of this work, a tool for automated parameter tuning has been developed. This tool finds the best configuration of parameter values for a specific segmentation algorithm. A friendly user interface allows the user to select a segmentation algorithm, a metric and an optimization algorithm to iteratively find the best parameters values.

In summary, the main contributions of this dissertation are:

- Evaluation and comparison between segmentation algorithms for remote sensing images.
- A tool for automated parameter tuning.

## 1.2. Organization of the remainder parts

The next chapter describes the state of the art in the areas of image segmentation and segmentation assessment. A brief survey of different approaches in each area will be presented.

Chapter 3 describes the segmentation algorithms to be evaluated and the implementations considered in the experiments.

Chapter 4 explains the optimization algorithm responsible for iteratively execute the segmentation algorithm and find the parameters that provide the best results based on the metrics.

Chapter 5 describes the set of metrics considered.

Chapter 6 presents the dataset used in the experiments as well as the results obtained in this study.

Chapter 7 presents the final conclusions and directions for further development of what is presented in this dissertation.