Image segmentation by clustering

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1. Introduction

The segmentation process tries to differentiate different objects in a given image. There are different approaches, in first place, it can be taken as a classification problem, for this case, an value is assigned to every pixel, to get the predictions is necessary to produce the information by the annotation, therefore is necessary to have an annotated data set, these are no always available so the process can be realized by non-supervised methods, in these case clustering methods are implemented, such as kmeans, KMM, watersheds and hierarchical models. For K means and GMM the data is adjusted to a circular or a gaussian distribution respectively which present a limitation for both methods [1] [2] . For watersheds the predictions are taken as the behavior of a particle in the respective position to in the image [3]. Finally for the hierarchical the methods are assigned by groping them either from pixels until the image is completed or vice versa[4].
In this case, the images were not modified to prevent the loss of resolution which can affect the performance of the methods, others aspects relevant to the algorithm are the dataset and the validation metric, for the dataset a section of the BSDS500 dataset is used, this consist a group of professional pictures with annotations made by 5 different persons, an example of the images and the respective annotation can be seen in image 1 and 2. Given the methods used does not require a prior training and are in state crated for each image and parameter in particular, there is no necessity to divide the data set into different categories for train and validation.

Figure 1. original image form the data base

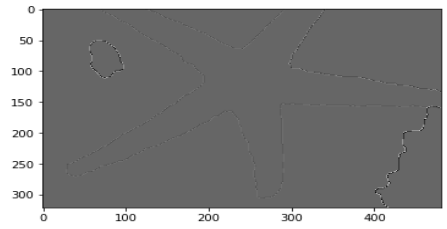

Figure 2. Anotation provided by one of the individuals

Finally, the validation metric will be the precision and recall by comparing all the annotations given with the predictions with the different methods, in order to realize this, is necessary to create a new annotation which consider all the annotations available, this result can be seen in image 3. In this case, only the edges will be evaluated in state of the different regions.

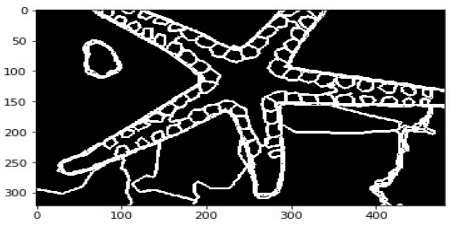

Figure 3. produced anotation

2. Methods

In order to achieve the desired outcome different procedures are required, including conversion to a different color space, the clustering itself, the validation and testing for different values.

2.1. Conversion to a different color space

In this case, five different color spaces are considered, RGB, HSV, Lab, RGB+xy and HSV + xy. For the RGB space there is no need to transform the image since the dataset consist of rgb images, in HSV and Lab spaces is necessary to use an external function to change the color

space, which can be obtained from the OpenCV library, in case xy axes are needs is necessary to generate a matrix with the corresponding values, for this is necessary to take the height and width of the image in order to create and replicate vectors of this size to match the original image, once this matrix are obtained they are concatenated to the image in the final color space. To validate whether or not these dimensions are required the method was to split the string contain the desired color space bi the + if the number of elements is two it is assumed the xy dimensions are wanted.

2.2. clustering method

In first place it is necessary to create the representation matrix in order to generate the clusters, this procedure is required for k means, GMM and hierarchical since these methods could depend in the adjacent information in order to perform adequately.
To implement the different clustering methods the an if sentence was used to determine the different possible method, for k means,GMM, and hierarchical the function implemented in the sklearn library and reshaping the labels to match the original dimensions, by reshaping the prediction, it makes able to compare them to the annotation by reconstructing the spacial information.

2.3. validation

As mentioned before, only the edges will be compared making necessary to create a new annotation form the existing ones, in fist place, the Laplacian is calculating to acquire the edges in each annotation and adding the result, the output of this contains information apart of the edges therefore the Laplacian is calculated again so the only data remining are the edges marked by any human. For the prediction is necessary to take the Laplacian since the edges will be the only thig evaluated , now the precision and recall are calculated, for the precision the point in the annotations that belong to the annotations and the recall the number of point in the annotations present in the prediction, this method allow to compare how good are the edges of the image although is sensible to the thick line generated as result in the annotation.

3. Results

once the methods wew implemented we proced to analize images in order to compare the different methos as well values of k, as can be seen in the next images. For image 4 there is the segmentation using the HSV color space addig the x and y axix for position.

As it can be seen in the image, the obtainded clusters not nesesarily have clear borders therefore difficulting the aplication of the validation algorithm since it is based on edges, althoug it can be apresiated some of the structures

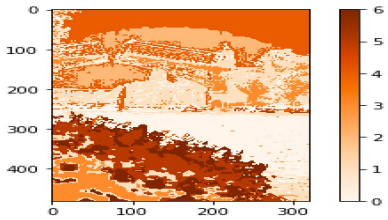

Figure 4. Segmentation produced by using HSV + xy with 7 clusters and kmeans

present.
By chanding the method it can be seen how some structures chages as can be seen in image 5 wich only vaiation is the clustering method.

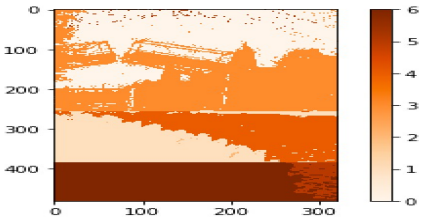

Figure 5. Segmentation produced by using HSV + xy with 7 clusters and GMM

the effect of changing the color space can be seen in figures 6 and 7,wich have the same k and the respective method but it is using RGB + xy

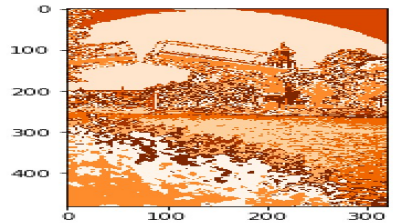

Figure 6. Segmentation produced by using RGB + xy with 7 clusters and kmeans

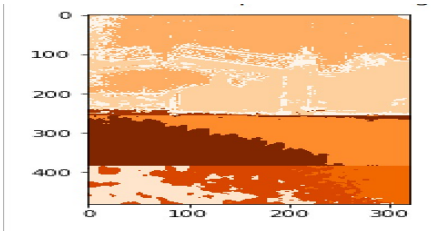

Figure 7. Segmentation produced by using RGB + xy with 7 clusters and GMM

Finaly it is necesary to observe the original image and the respective anotation wich can be seen in images 8 and 9

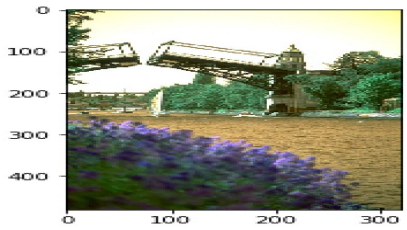

Figure 8. Original Image

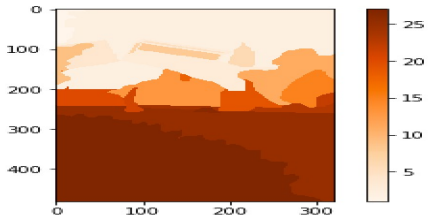

Figure 9. Original Image

as can be seen by comparing the anotations insome cases such as HSV + XY using 7 cluster there are more elements present than in the segmetnation but again it depends on the purpuse of the segmentation, and incases such as RGB clustesr seem to be separated keeping only the bigger structures when using either method.

4. Colcusions

In conclusion, to aboard the segmentation problem have different probles such as the anotation it sef even if they are similar among humans there still diferences that can alter the result of the algorith, there fore it is not posible to stablish a clear metric for every problem and needs to be adjusted acording to the situation.

References

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