Study on Various Methods for Image Segmentation - A Review

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Abstract**—**Image Segmentation is able to identify the most effective features from an image as well as group the similar features. Once the features are collected, the selection of the most appropriate features can be done to take the decision for the problem. In each prediction and classification algorithm, there is the requirement of some segmentation method to identify the effective features. The segmentation methods are able to reduce the processing information set and to improve the reliability in decision making. In this paper, a study on the common segmentation methods is provided. The KMeans, CMeans and other segmentation methods are discussed in this paper.

Keywords**—***Image Segmentation; CMeans; KMeans; Dataset; Feature;*

I. INTRODUCTION

Image Segmentation is the process of grouping feature vectors into classes in the self-organizing mode. Choosing segment centers is crucial to the Image Segmentation. Image Segmentation is a well-known problem in classification and prediction methods. Image Segmentation is an important area of application for a variety of fields including Image mining, statistical Image analysis and vector quantization. The problem has been formulated in various ways in the machine learning, pattern recognition optimization and statistics literature. The fundamental Image Segmentation problem is that of grouping together the Image items that are similar to each other. The most general approach to Image Segmentation is to view it as a density estimation problem. Because of its wide application, several algorithms have been devised to solve the problem. Notable among these are the EM algorithm, neural nets, SVM and k-means. Image Segmentation the Image acts as a way to parameterize the Image so that one does not have to deal with the entire Image in later analysis, but only with these parameters that describe the Image. Sometimes Image Segmentation is also used to reduce the dimensionality of the Image so as to make the analysis of the Image simpler.

In one of its forms, Image Segmentation problems can be defined as: given a dataset of N records, each having dimensionality d, to partition the Image into subsets such that a specific criterion is optimized. The most widely used criterion for optimization is the distortion criterion. Each record is assigned to a single segment and distortion is the average squared Euclidean distance between a record and the corresponding segment center. Thus this criterion minimizes the sum of the squared distances of each record from its corresponding center. K-means Image Segmentation is used to minimize the above-mentioned term by partitioning the Image into k non-overlapping regions identified by their centers. Also k-means is defined only over numeric or continuous Image since it requires the ability to compute Euclidean distances as well as the mean of a set of records.

Image Segmentation is useful in several exploratory pattern-analysis, grouping, decision-making, and machine-learning situations, including Image mining, document retrieval, image segmentation, and pattern classification. However, in many such problems, there is little prior information (e.g., statistical models) available about the Image, and the decision maker must make as few assumptions about the Image as possible. It is under these restrictions that Image Segmentation methodology is particularly appropriate for the exploration of interrelationships among the Image points to make an assessment (perhaps preliminary) of their structure.

A. Issues Of Image Segmentation

The main requirements that a Image Segmentation algorithm should satisfy are the following Dealing with different types of attributes:

There are various attributes of Image that any Image Segmentation algorithm need to satisfy, the most general taxonomy being in common use distinguishes among numeric (continuous), ordinal, and nominal variables. A numeric variable can assume any value in R. An ordinal variable assumes a small number of discrete states, and these states can be compared.

1) Scalability to large datasets:

The Image sets could be in any possible range, varying between large extremes and they need to be normalized by the Image Segmentation algorithm.

2) Ability to work with high dimensional Image :

The Image could be multidimensional varying from 1, 2……n.; depending on the application Image on which Image Segmentation is being applied Development of a medical inferencing system using Image Image Segmentation The Image could be multidimensional varying from 1, 2……n.; depending on the application Image on which Image Segmentation is being applied.

3) Ability to find segments of irregular or arbitrary shape:
The shape of segments could be any arbitrary shapes. We prefer using Euclidean distance to get a circular shape of the segments, but still shape of segments can not be accurately defined

4) Handling outliers:
The Image points on the boundary of segments need to be handled; this is done in hierarchical methods by associating the boundary points to one of the segments. While in fuzzy Image Segmentation, we associate membership functions to the points lying on the boundary of segments.

5) Time complexity :
Complexity of the Image points in terms of time has to be taken care of while Image Segmentation.

6) Image order dependency:
Dependency of Image points on other variable can affect the Image Segmentation of Image and there by the segment centers too, so it has to be taken care before hand.

B. Components Of Image Segmentation

Typical pattern Image Segmentation activity involves the following steps

(1) Pattern representation (optionally including feature extraction and/or selection),

(2) Definition of a pattern proximity measure appropriate to the Image domain,

(3) Image Segmentation or grouping,

(4) Image abstraction (if needed), and

(5) Assessment of output (if needed).

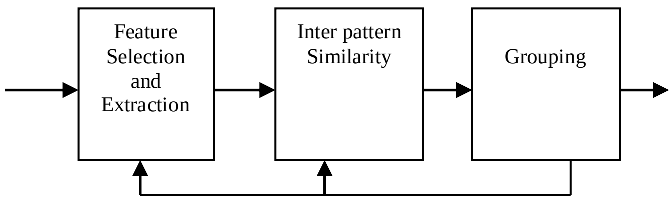

Figure 1 : Image Segmentation Process

Figure 1 here shows the basic Image Segmentation process. Where some dataset is passed as input and on it feature selection and extraction is performed. Now on the basis of features the pattern analysis is performed. Finally on the basis of pattern analysis the grouping is performed

Segment validity refers to the problem whether a given fuzzy partition fits to the Image at all. The Image Segmentation algorithm always tries to find the best fit for a fixed number of segments and the parameterized segment shapes. However this does not mean that even the best fit is meaningful at all. Either the number of segments might be wrong or the segment shapes might not correspond to the groups in the Image, if the Image can be grouped in a meaningful way at all. Two main approaches to determining the appropriate number of segments in Image can be distinguished:

- Starting with a sufficiently large number of segments, and successively reducing this number by merging segments that are similar (compatible) with respect to some predefined criteria. This approach is called compatible segment merging.
- Image Segmentation Image for different values of c, and using validity measures to assess the goodness of the obtained partitions.
- This can be done in two ways
- The first approach is to define a validity function which evaluates a complete partition. An upper bound for the number of segments must be estimated (cmax), and the algorithms have to be run with each c □{2; 3; : : : ;cmax}. For each partition, the validity function provides a value such that the results of the analysis can be compared indirectly.
- The second approach consists of the definition of a validity function that evaluates individual segments of a segment partition. Again, cmax has to be estimated and the segment analyses have to be carried out for cmax. The resulting segments are compared to each other on the basis of the validity function. Similar segments are collected in one segment; very bad segments are eliminated, so the number of segments is reduced. The procedure can be repeated until there are bad segments.

II. LITERATURE SURVEY

Our process-Image modeling technique uses fuzzy logic and statistical Image Segmentation. Patterns of system calls must be represented as a model of normal behavior. This model should extract the essence of correctness, or normalness, of a process. Image Segmentation methods group Image by centers. Image Segmentation techniques partition Image into several segments such that similar objects belong to the same segment. The segment centers represent the most normal of sequences, and deviations from the centers indicate behavior that is more abnormal. A good review of different Image Segmentation techniques and categories of Image Segmentation techniques is giving in Jain et. al's survey paper "Image Image Segmentation: A Review." [13]

Fuzzy Image Segmentation involves fuzzy logic. Fuzzy logic defines what degree of normalcy a classifier should give to new process-Image compared against the database. Fuzzy logic can better help represent the uncertainty that lies in the Image. Hence, we look at fuzzy Image Segmentation techniques that can determine the true nature of the underlying Image to help predict whether new sequences are abnormal or not, and to what degree.

In fuzzy Image Segmentation, each Image element belongs to several partitions to certain degrees. Non-fuzzy Image Segmentation techniques generate different partitions to which Image elements belong. These partitions are disjoint. In fuzzy Image Segmentation, the partitions are not disjoint.

Several previous attempts have tried to create a good fuzzy Image Segmentation algorithm. A general high level partitioning fuzzy Image Segmentation algorithm called Fuzzy Image Segmentation Algorithm (FCM) is presented by Jain, et al. Additionally, a generalization of the FCM algorithm was presented by Bezdek [5], while an adaptive variant for detecting circular and elliptical boundaries was presented by Dave. [6] These algorithms have failed when trying to work with large Image sets.

In addition these algorithms focus on quantitative Image. Our Image consists of nominal qualitative Image, Image that is categorical such as the groups of colors, red, blue, black or types of cars, Ford, GM, Honda, Ferrari. System calls are numbered, for example, open is one, write is two, and read is three, etc., however, the numbers do not indicate ordering. The 6th system call is not twice as far as the third system call. Hence, the underlying Image distribution is on a different dimension. We will be focusing on qualitative Image, particularly *fuzzy* qualitative Image.

In order to handle categorical or qualitative Image, Ralambondrainy [7] represented multiple categorical attributes using binary attributes to indicate the presence or absence of a category. The binary values were then used in the well-known c-means algorithm. The number of binary values becomes very large when each attribute has many categories.

The complexity of the binary feature vector technique was reduced in the k-modes algorithm, introduced by Zhexue Huang in "Extensions to the k-means algorithm for Image Segmentation large Image sets with categorical values." It reduces the complexity by using a simple matching dissimilarity measure. The algorithm is very sensitivity to initialization.

The fuzzy version of the k-modes algorithm was first proposed by Zhexue Huang and Michael K. Ng in their paper "A Fuzzy k-Modes Algorithm for Image Segmentation Categorical Image" as an extension for the fuzzy c-means algorithm. The fuzzy c-means algorithm is the most prominent fuzzy Image Segmentation algorithm [4] The fuzzy k-modes algorithm was developed to segment large categorical Image sets in Image mining. They added the element of fuzzy logic to represent better the uncertainty found in the Image set.

III. IMAGE SEGMENTATION APPROACHES

The Image Segmentation groups a sample set of feature vectors into K segments via an appropriate similarity (or dissimilarity) criterion (such as distance from the center of the segment).

A. K-MEANS

The k-means algorithm assigns feature vectors to segments by the minimum distance assignment principle [5], which assigns a new feature vector $\mathbf{x}^{(q)}$ to the segment $\mathbf{c}^{(k)}$ such that the distance from $\mathbf{x}^{(q)}$ to the center of $\mathbf{c}^{(k)}$ is the minimum over all K segments. The basic k-means algorithm is as follows:

- Put the first K feature vectors as initial centers
- Assign each sample vector to the segment with minimum distance assignment principle.
- Compute new average as new center for each segment
- If any center has changed, then go to step 2, else terminate.

The advantages of the method are its simplicity, efficiency, and self-organization. It is used as initial process in many other algorithms. The disadvantages are: 1) K must be provided; 2) it is a linearly separating algorithm.

B. ISODATA

This algorithm is based on the k-means algorithm, and employs processes of eliminating, splitting, and Image Segmentation. The algorithm is described as following [8].

- Start with K_{init} (initial number of segments) which is user-given. Assign the first K_{init} samples as segment centers.
- Assign all samples to the segments by minimum distance principle.
- Eliminate segments that contain less than n_{min} feature vectors and reassign those vectors to other segments to yield K segments.
- Compute a new segment center as the average of all feature vectors in each segment.
- For each kth segment, compute the mean-squared error $\sigma_n^2(k)$ of each nth component x_n over that segment and find the maximum $\sigma_{n*}^2(k)$ component mean-squared error over within segment k for over n = 1, …, N, where the index n* is for the maximum component.
- If there are not enough segments ($K_{init} < K/2$) and this is not the last iteration, then if $\sigma_{max}(k) > \sigma_{split}$ for any segment k, split that segment into two.
- If this is an even iteration and $K_{init} > 2K$, then compute all distances between segment centers. Merge the segments that are close than a given value.

The advantages of the ISODATA are its self-organizing capability, its flexibility in eliminating segments that are too small, its ability to divide segments that are too dissimilar, and its ability to merge segments that are sufficiently similar. Some disadvantages are: 1) multiple parameters must be given by the user, although they are not known a priori; 2) a considerable amount of experimentation may be required to get reasonable values; 3) the segments are ball shaped as determined by the distance function; 4) the value determined for K depends on the parameters given by the user and is not necessarily the best value; and 5) a segment average is often not the best prototype for a segment [9].

C. FUZZY CMEANS

Fuzzy Image Segmentation plays an important role in solving problems in the areas of pattern recognition and fuzzy model identification. A variety of fuzzy Image Segmentation methods have been proposed and most of them are based upon distance criteria [6]. One widely used algorithm is the fuzzy c-means (FCM) algorithm. It uses reciprocal distance to compute fuzzy weights. A more efficient algorithm is the new FCFM. It computes the segment center using Gaussian weights, uses large initial prototypes, and adds processes of eliminating, Image Segmentation and merging. In the following sections we discuss and compare the FCM algorithm and FCFM algorithm.

Algorithm:

1. Fix the number of segment.
2. Randomly assign all training input vector to a segment this creates partition.
3. Calculate the segment center as the mean of each vector component of all vectors assigned to that segment. Repeat for all segment
4. Compute all Euclidean distances between each segment center and each input vector.
5. Update partitioned by assigning each input vector to its nearest segment minimum Euclidean distance.
6. Stop if the center do not move any more otherwise loop to step, where is the calculation of a segment center.

IV. CONCLUSION

The paper has provided a brief overview of different image segmentation methods. The paper has discussed the KMeans, CMeans and other segmentation methods for images for extracting and groups the effective features. The paper also explore the requirement and significance of Clustering methods.

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