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Image Segmentation using Biogeography based Optimization and its Comparison with K Means Clustering

Babita Chauhan[1], Preeti Sondhi[2]

[1]M. Tech Scholar, Universal Group of Institutions, Lalru, Punjab, India
babitapundir[at]gmail.com

[2]Assistant Professor, Universal Group of Institutions, Lalru, Punjab, India
preetisondhi4[at]gmail.com

Abstract: ***Image segmentation plays vital role to understand an image. Only proper understanding of an image tells that what it represents and various objects present in the image. In this project we are using new approach Biogeography Based Optimization for the segmentation of Medical images and its comparison with K means Clustering on the basis of elapsed time in sec. Image segmentation are done with many techniques like PSO, ACO etc. BBO is a Biogeography technique used for image segmentation which provided more accurate segmented images as compared to other optimization method. So BBO can be used in MRI image segmentation to detect any disease. BBO is a population based optimization algorithm and it does not involve reproduction or the generation.***

Keywords: Image segmentation, edge detection, fuzzy clustering, thresh-holding, biogeography-based optimization

1. Introduction

Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subfield of digital signal processing, digital image processing has many advantages over analog image processing; it allows a much wider range of algorithms to be applied to input data, and can avoid problems such as the build - up of noise and signal distortion during processing. Image segmentation refers to the process of partitioning a digital image into multiple regions (set of pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in an image.

Image segmentation is an important image processing, and it seems everywhere if we want to analyze what inside the image. For example, if we seek to find if there is a chair or person inside an indoor image, we may need image segmentation to separate objects and analyze each object individually to check what it is. Image segmentation usually serves as the pre - processing before image pattern recognition, image feature extraction and image compression. Researches of it started around 1970, while there is still no robust solution, so we want to find the reason and see what we can do to improve it.

Optimization Techniques for Image Segmentation
Optimization is an act, process or methodology for making something fully functional or as effective as possible. There are three different types of optimization methods which are classified as follows: -

Direct search method: - This method is used for solving optimization problems that do not require any information about the gradient of the objective function. The advantage of this method is that it is applicable to problems which are not even continuous. This method searches for a set of points around the current point looking for one where the value of function is lower than the value of current point.

Gradient method: - This method is used for solving the problems in which derivative is to be taken. Gradient methods use information from the derivatives of the optimization function to more effectively guide the search and find optimum solutions quicker. The disadvantage of this method is that it is applicable to problems which are continuous.

Nature inspired method: - To overcome problems of finding local maxima or minima that is to overcome problem of finding optimal solution we use nature inspired methods. This method is applicable to both continuous and discontinuous functions. This method is an attractive alternative for solving complex problems which cannot be solved by the usual techniques like the concept of evolution and behavioral pattern of different species. Some of the nature inspired methods are as follows:

- ACO (Ant Colony Optimization)
- PSO (Particle Swarm Optimization)
- GA (Genetic Algorithm)
- ES (Evolutionary Strategies)
- DE (Differential Evolution)
- SGA (Stud Genetic Algorithm)
- PBIL (Population Based Incremental Learning)
- BBO (Biogeography Based Optimization)

2. Biogeography based Optimization

Biogeography based optimization a type of evolutionary algorithm. As its name implies, BBO is based on mathematical study of biogeography. Biogeography is the study of the distribution study of animals and plants over time and space.

BBO is an evolutionary process that achieves information sharing by species migration. It is modeled after the emigration and immigration of species between habitats to achieve information sharing. BBO operates by migrating information between individuals, thus resulting in a modification of existing individual. Individual do not die at the end of generation one characteristic of BBO is that the original population is not discarded after each generation; rather it is modified by migration. BBO is a population based optimization algorithm it does not involve reproduction or the generation of "children". In 1960, the first mathematical equations were discovered and developed that govern the distribution of organisms. Therefore, mathematical model of biogeography describe how species migrate from one island to another, how species arises, and how species become extinct. Biogeography technique is based basically on two criteria - HSI and LSI. Geographical area that are well suited and more compatible residence for biological species are said to have highly suitability index (HSI). Features that correlate with HSI include factors such as rainfall, diversity of vegetation, diversity of topographic features, land area and temperature. The variables that are characterized habitability are called suitability index variables (SIV). Habitats with HSI tend to have large number of species, while those with LSI have a small number of species. HSI are more static than LSI. LSI has a high species immigration rate because of their sparse population.

In this approach, immigration and emigration of species is done to calculate the best fit value also known as fitness. Population size refers to the number of species present in particular area or habitat. Before optimizing, each individual of population is evaluated and then follows migration and mutation step.

BBO basically depends upon following theory:

- Migration: - The BBO migration strategy in which many parents can contribute to a single offspring, but it differ in at least one important aspect. BBO migration is used to change existing habitat. Migration in BBO is adaptive process; it is used to modify existing islands. Migration stage arises when LSI occurs. When species are less compatible with their habitat then they migrate.
- Mutation: - In BBO, the mutation is used to increase the diversity of the population to get good solution.

Fuzzy K - Means Clustering

Clustering is an unsupervised classification that the classes have not been predefined. In this process, the samples are divided into categories in which the members are alike and are called cluster. In classic clustering, each input sample belongs to one cluster and cannot be a member of several clusters, so if a sample is like more than one clusters, it will be difficult for us to recognize that the sample belongs to which cluster, and this is the main difference between classic and fuzzy clustering. It shows that in fuzzy clustering a sample can belong to more than one cluster, and in fuzzy logic, belonging function of clusters doesn't have two values and can have any value between 0 and 1.

Cluster analysis is also recognized as an important technique for classifying data, finding clusters of a dataset based on similarities in the same cluster and dissimilarities in the different clusters. Clustering is basically considered as classification of similar objects or in other words, it is precisely partitioning of datasets into clusters so that data in each cluster shares some common trait or attribute.

Fuzzy k - means clustering is basically a partitioning method applied to analyze data and treats observations of the data as objects based on locations and distance between various input data points. Partitioning the objects into mutually exclusive clusters (K) is done by it in such a fashion that objects within each cluster remain as close as possible to each other but as far as possible from objects in other clusters. Each cluster is characterized by its centre point i. e. centroid. The distances used in clustering in most of the times do not actually represent the spatial distance. In a dataset, a desired number of clusters K and set of K initial starting points, the K - means clustering algorithm find the desired no of distinct clusters are their centroid. A centroid is a point whose co - ordinates are obtained by means of computing the average of each of the co - ordinates of the points of samples assigned to the clusters. The fuzzy K - means clustering algorithm is a special case of the generalized fuzzy K - means clustering algorithm scheme, where point representatives are adopted and the Euclidean distance is used to measure the dissimilarity between a vector X and its cluster representative.

Implementation steps

- Understanding of BBO (biogeography based optimization and image segmentation, & neural network.
- select population size, fitness element and lambda in BBO
- select size of area in BBO
- selection of lambda using BBO in segmentation
- Calculation for contour point and fitness value in segmentation
- Calculate elapsed time by using BBO technique.
- Calculate elapsed time by using fuzzy k means technique.
- Results shows BBO gives better results as compare to fuzzy k means.

3. Results

In this project work we compare two image segmentation techniques (BBO, K MEANS CLUSTERING) and find out which one provides better results on the basis of elapsed time.

(1) Image (2. jpg) segmentation using k means clustering

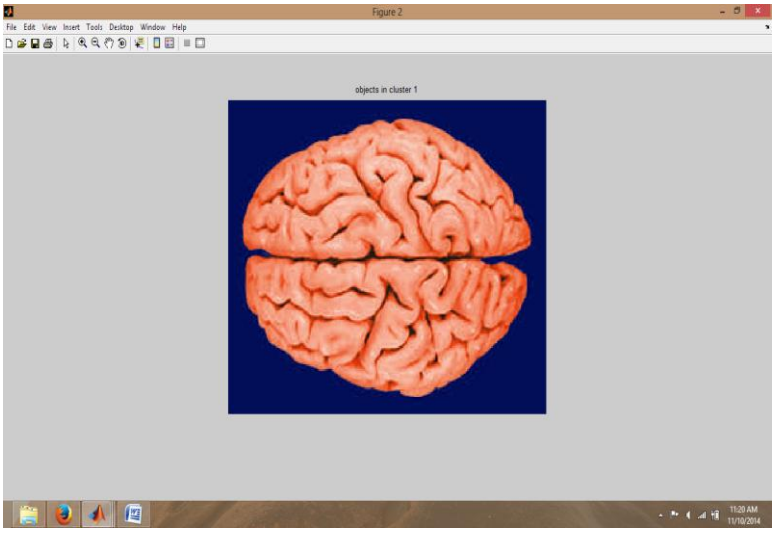


Figure 1: Objects in Cluster 1

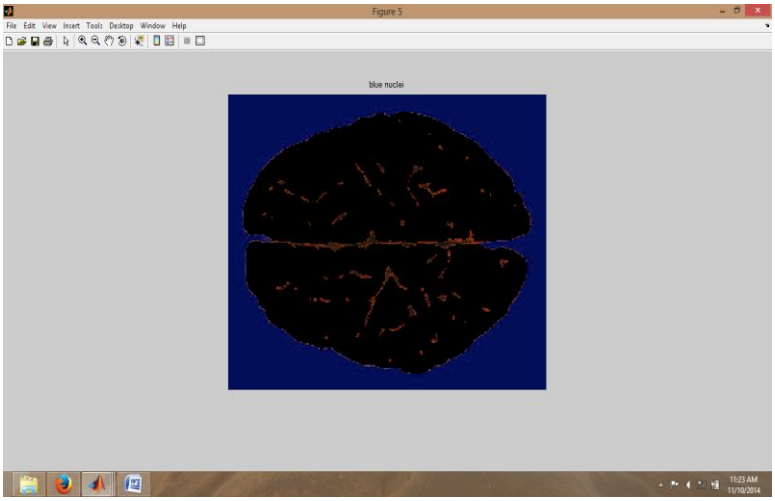


Figure 2: Blue Nuclei

Elapsed time for K means Clustering: 4.20

(2) Image (2. jpg) segmentation using BBO

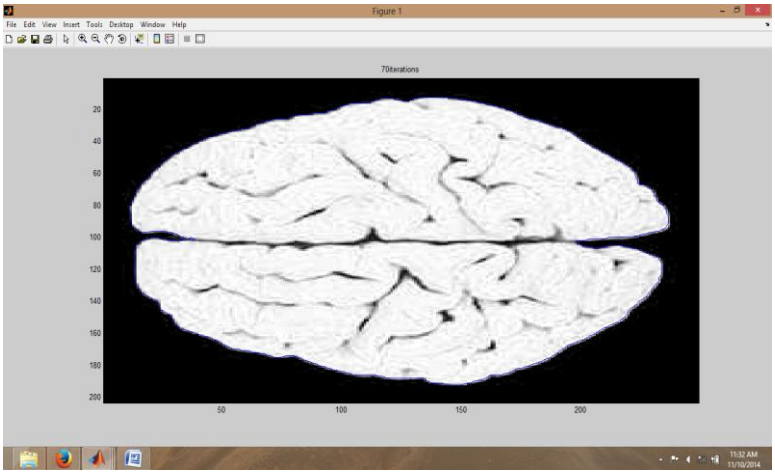
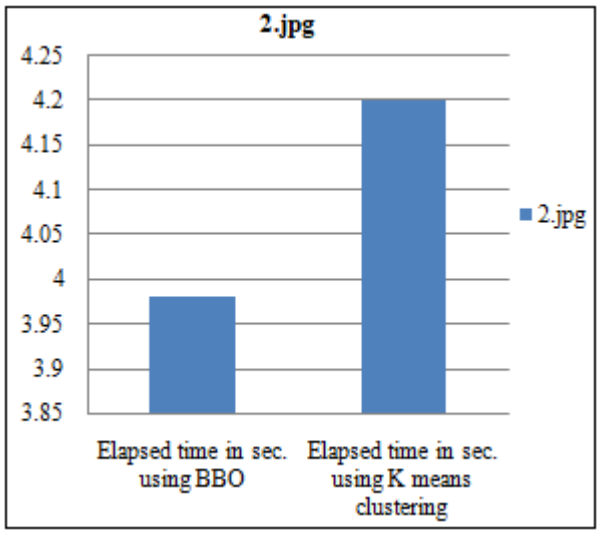


Figure 3: BBO segmentation for 70 iterations

Elapsed time for BBO: 3.98

Table 1: Comparison of BBO and K means clustering on the basis of elapsed time

image	Elapsed time in sec. using BBO	Elapsed time in sec. using K means clustering
2. jpg	3.98	4.20



4. Conclusion

BBO differs from other optimizations in that the BBO solution is altered directly from another solution. BBO solutions exchange their attributes with other solutions directly. However, this does not happen in other optimization methods; hence BBO is better at detecting aberrant tissue growth than other optimization methods. BBO is a population - based optimization approach that does not use generations or reproduction. In comparison to other methods, BBO takes less time.

5. Future Work

The term "segmentation" refers to a set of techniques for interpreting nearby sections of an image as objects. BBO is a biogeography methodology for image segmentation that, when compared to other optimization methods, produces more accurate segmented medical images. In the future, we will apply BBO in medical picture segmentation to detect objects.

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