The Unavoidable and Unfixable Biases Within Machine Learning Algorithms

Christopher Linscott
clinscott@oxy.edu
Occidental College

1 Abstract

The following report dives into an approach to clustering images together: based on purely pixels. After performing both Fuzzy C-Means and K-Means on select color images, it was found that these methods were not useful in creating meaningful clusters, given only pixels as data points.

2 Methods

2.1 Approach/Framework

The general approach to grouping images is the idea of clustering, where the main goal is "to cluster pixels into different image regions, which are regions corresponding to individual objects, surfaces or natural parts of the objects" (Roy). As image pixels are generally unlabeled, the common approach is utilizing a clustering algorithm to group them together. In the context of my COMPS project, being able to separate images means being able to separate them apart based on their differences in objects, shapes, or environment. The main goal is not to recognize the objects, but to recognize meaningful differences or similarities between two images based on their visual similarity. While this is an unsupervised version of machine learning (allowing for mainly testing), there is no response "class", or that the human needs to associate meaning with each cluster it generates.

The two clustering algorithms employed are Fuzzy C-Means and K-Means. With the help of tutorials, I implemented them from scratch and from a library, and tested them in clustering an image where the objects were distinct in color versus where the objects were more similar. To allow the images to be clustered, they were loaded using OpenCV's image read function, creating arrays of data points of size three to represent each value for each channel (red, green, blue). After clustering upon these images using either algorithm, the following images were plotted using matplotlib, coloring pixels of the same cluster with the same color to show the results of the computation.

2.2 Datasets

2.3 Algorithms

A very well-known, partition-type clustering algorithm is K-Means. Partition-based clustering refers to a harder (meaning more strict) form of partitioning where every datapoint can only be in one cluster. The main goal of this algorithm is to create partitions of data points, by creating points of relevance called clusters, which minimize the distance from any given data point to any given cluster. The distance metric utilized by K-Means is Euclidean distance where the distance from a datapoint i to a cluster j with given dimensions (x, y, z) d: $D_{i,j} = \sum_{l=1}^{d} \sqrt{|x_{il}^2 - x_{jl}^2|}$. In my own implementation (for learning, understanding, and documentation), I utilized Euclidean distance for only 2 dimensions via: $D_{i,j} = \sqrt{|x_j - x_i|^2 + |y_j - y_i|^2}$.
In combination with my own implementation, I utilized Lloyd's algorithm to compute and converge on centers of clusters, which is the same as for the library utilized in the tutorial, sklearn.

2.3.1 Pseudocode

Algorithm 1 K-Means: Lloyd's Algorithm

```
Initialize k clusters to be at initial positions of (0, ..., 0).
Select k number of initial centers (centroids) from datapoints (at random)
while Centroid positions don't change do
    for n datapoints do
        for k clusters do
Calculate distance from data point n to cluster k

        end for
Store closest cluster for each data point n
    end for
New centroid position = mean of all subsequent data point positions
end while
```

The soft (fuzzy) counterpart to the K-Means algorithm is the Fuzzy C-Means (FCM) algorithm. The FCM algorithm is "softer" or "fuzzier" as unlike K-Means, it allows for a datapoint to coexist in several different clusters with different values of membership (i.e. how much it relates to that given cluster).

In comparison to the K-Means, the FCM algorithm is more popular for image segmentation because ...

3 Evaluation

4 Discussion