Clustering Optimization using k-means

Preface In this paper, we shall demonstrate two approaches for the optimizing the k-means algorithm for clustering.

There are two kinds of clustering that we would like to consider, which may affect the algorithm that we run,

1. Clustering of scattered details
In this kind of clustering, we try to identify clusters from details that are scattered along the image. This can have various applications, such as
Military Intelligence (clusters of troops, aircraft, armored vehicles),
Nature Science (clustered structures of birds, insects, fish) and many more.

2. Identification of natural clusters
In this kind of clustering, we try to identify large objects, from samples found in the imagery. A major example for this kind of clustering would be face recognition, where we have many features in some photo, and we try to isolate and identify the face of a person, or of several people.

The basic k-means algorithm One of the classic algorithms for clustering is the k-means algorithm. This algorithm is based on a very simple concept of acquiring initial data, then adjusting this data until the algorithm stables.
This algorithm is called k-means, because we are trying to find $k \in \mathbb{N}$ clusters, which are supposed to give the optimal clustering, because each cluster has a center point, which is the mean of all the points that are grouped together in this cluster. We call this cluster, or the center point of this cluster, a **centroid**.

The basic description of this algorithm, for a given k, is,

Algorithm 1 Calculate k-means

Require:
Ensure:
  $L \leftarrow size(samples)$
  $i \leftarrow 1$
  while $i \neq L$ **do**
    $s \leftarrow samples[i]$
    $j \leftarrow 1$
    while $j \neq k$ **do**
      $c \leftarrow centroids[j]$
      $dx \leftarrow s.x - c.x$
      $dy \leftarrow s.y - c.y$
      $d2 \leftarrow dx^2 + dy^2$
    end while
  end while
  if $n < 0$ **then**
    $X \leftarrow 1/x$
    $N \leftarrow -n$
  else
    $X \leftarrow x$
    $N \leftarrow n$
  end if
  while $N \neq 0$ **do**
    if N is even **then**
      $X \leftarrow X \times X$
      $N \leftarrow N/2$
    else {N is odd}
      $y \leftarrow y \times X$
      $N \leftarrow N - 1$
    end if
  end while