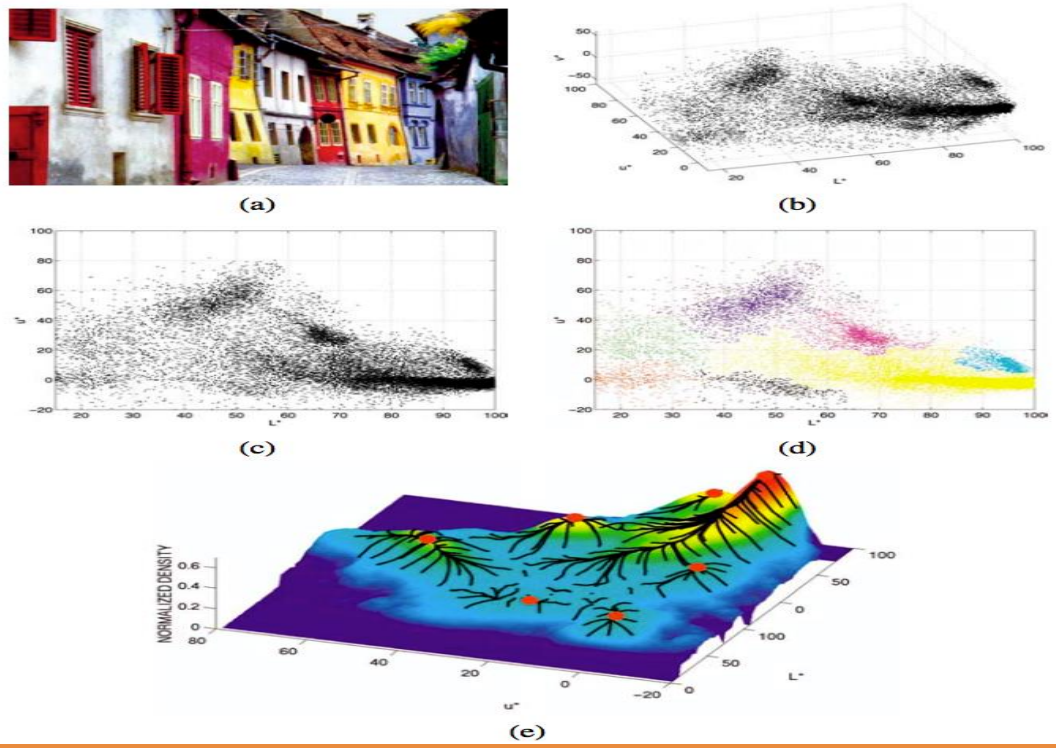
Segmentation - Split and Merge

Objectives

- Learn about K-means and mixtures of Gaussians.
- Learn the principles of Mean shift segmentation.
- Their applications in image processing.

Color Image Segmentation

- How to segment this image based on color alone?
- How to finding these clusters?
- How many obvious clusters do you see?

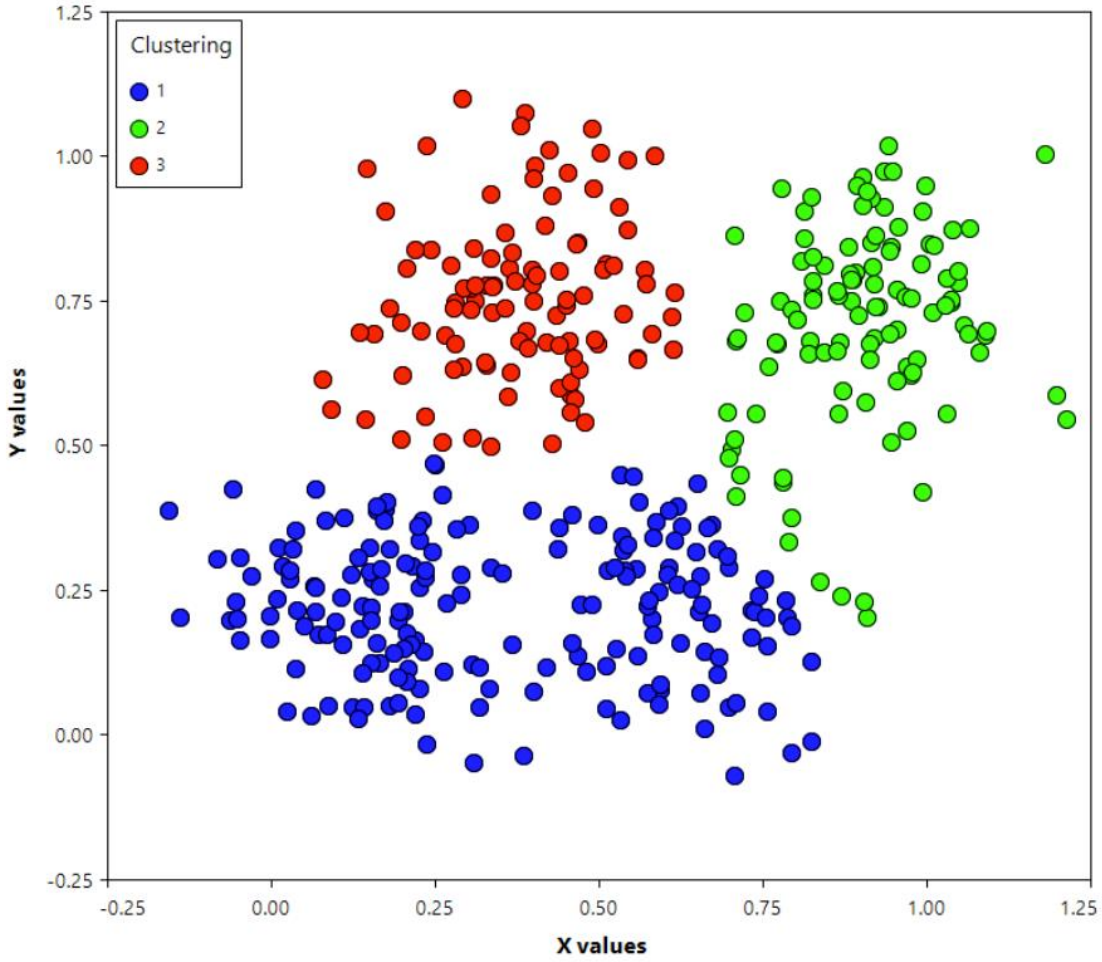


K-means for Segmentation

FPT Education
FPT UNIVERSITY

- K Means is a clustering algorithm.
- It is used to identify different classes or clusters in the given data based on how similar the data is.
- Data points in the same group are more similar to other data points in that same group than those in other groups.
- K represents the number of clusters.
- The main idea of performing the following process is to find those areas of pixels that share the same color hue parameter value.

K-means for Segmentation

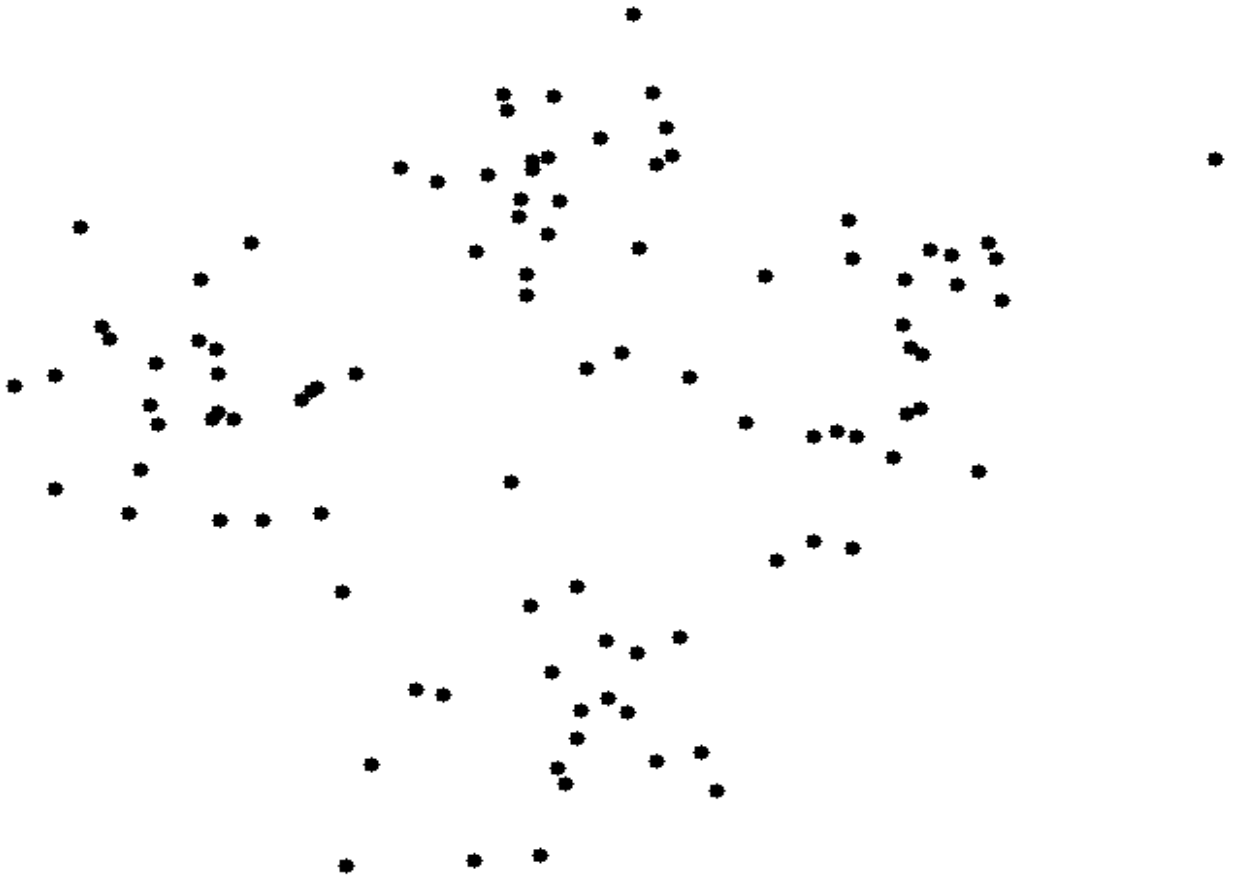


K-means for Segmentation

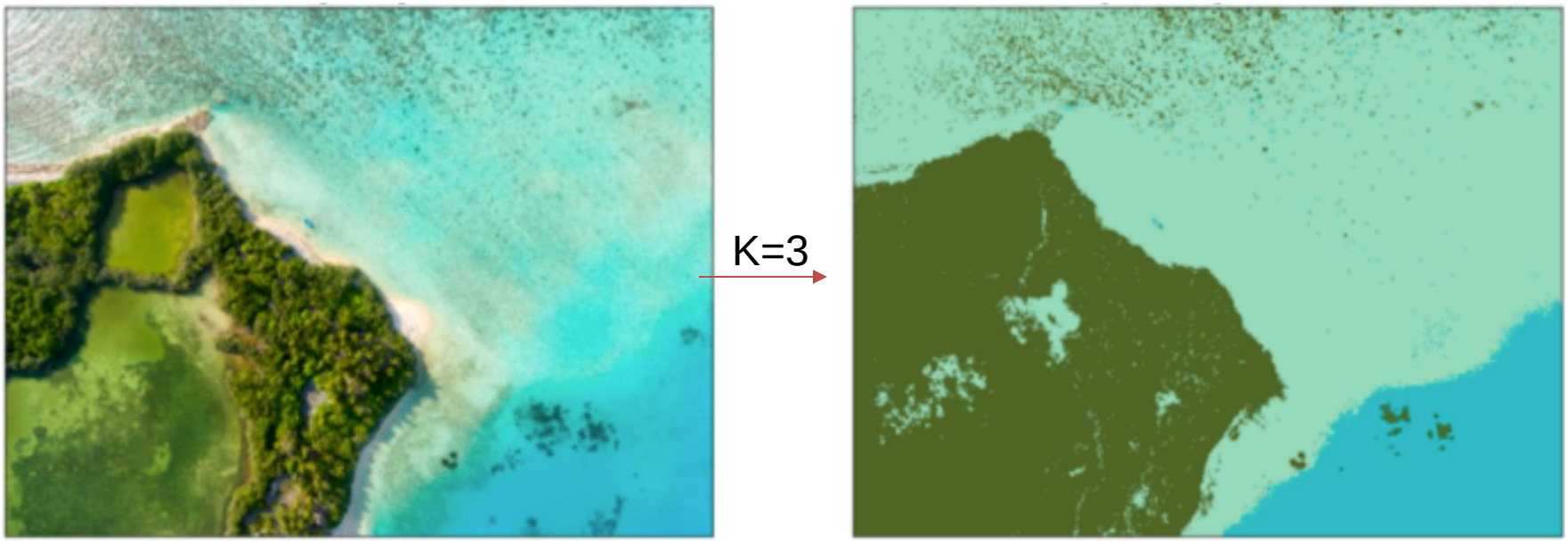
- Guess K centroids positions, a centroid for each results cluster
- Assign each observation to the group that has the closest centroid
- When all observations have been assigned, recalculate the positions of the K centroids
- Repeat Steps 2 and 3 until either the centroid position or the observation assignments no longer move.
- → the magnitude of similarity value between two 3D-vectors of colors (R; G; B):

$$S = \sqrt{(r_1 - r_2)^2 + (g_1 - g_2)^2 + (b_1 - b_2)^2}$$

K-means for Segmentation



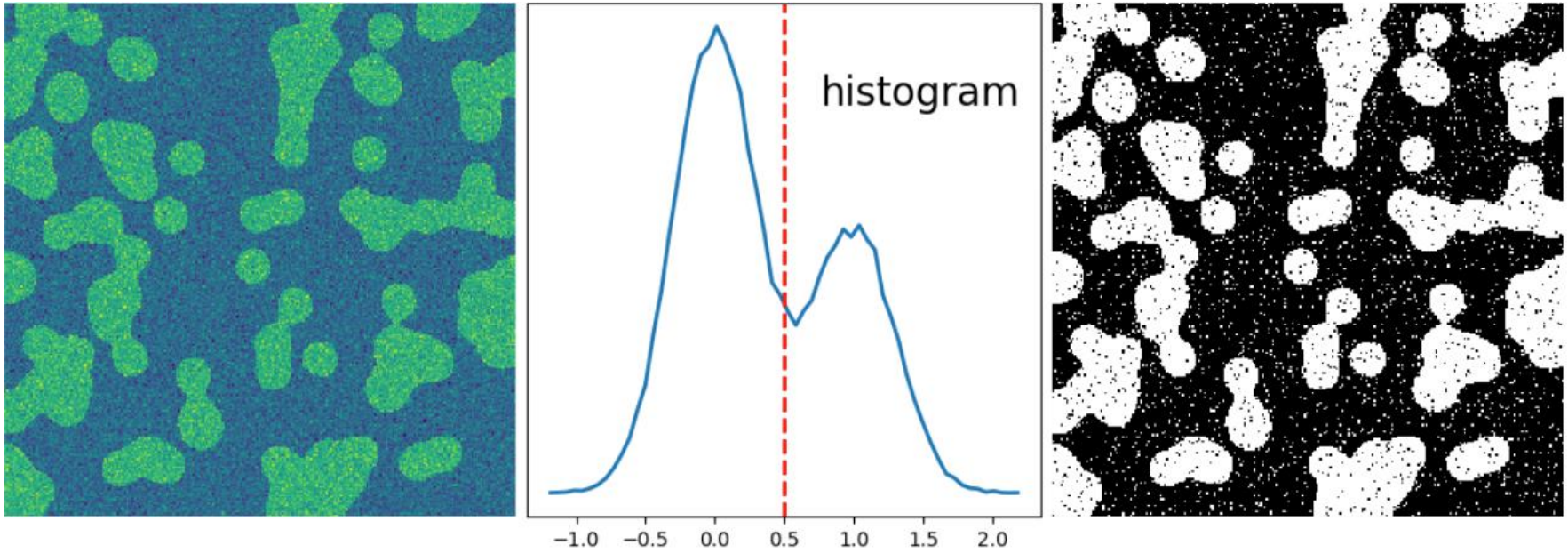
K-means for Segmentation



Gaussian Mixture Model

- Gaussian Mixture Models (GMMs) assume that there are a certain number of Gaussian distributions, and each of these distributions represents a cluster. Hence, a Gaussian Mixture Model tends to group the data points belonging to a single distribution together.
- "Gaussian Mixture Model" models each cluster to a Gaussian distribution with a specific mean and variance.
- Gaussian Mixture Models are probabilistic models and use the soft clustering approach for distributing the points in different clusters.

Gaussian Mixture Model



Mean shift

- Mean shift implicitly models this distribution using a smooth continuous non-parametric model.
- The key to mean shift is a technique for efficiently finding peaks in this high-dimensional data distribution without ever computing the complete function explicitly
- The idea is replaces each pixel with the mean of the pixels in a range neighborhood and whose value is within a distance d.

Mean shift Algorithm

- Choose kernel and bandwidth
- For each point:
  - a: Center a window on that point
  - b: Compute the mean of the data in the search window
  - c: Center the search window at the new mean location
  - d: Repeat (b,c) until convergence
- Assign points that lead to nearby modes to the same cluster

Mean shift Segmentation

- Compute features for each pixel(color, gradients, texture, etc.)
- Set kernel size for features Kf and position Ks
- Initialize windows at individual pixel locations
- Perform mean shift for each window until convergence
- Merge windows that are within the width of Kf and Ks

Mean shift Segmentation

FPT Education
FPT UNIVERSITY

- Advantage
  - Good general-practice segmentation
  - Flexible in number and shape of regions
  - Robust to outliers
- Disadvantage
  - Have to choose kernel size in advance
  - Not well suited for high-dimensional features

Mean shift Segmentation

Summary

- Learn about K-means and mixtures of Gaussians.
- Learn the principles of Mean shift segmentation.
- Their applications in image processing.