

# Report on Content-Based Image Retrieval with and without K-means

## Objective of the Project

The goal of this project is to develop a Content-Based Image Retrieval (CBIR) system using visual features (color and shape) to compare and retrieve similar images from a database. Two methods were implemented and compared:

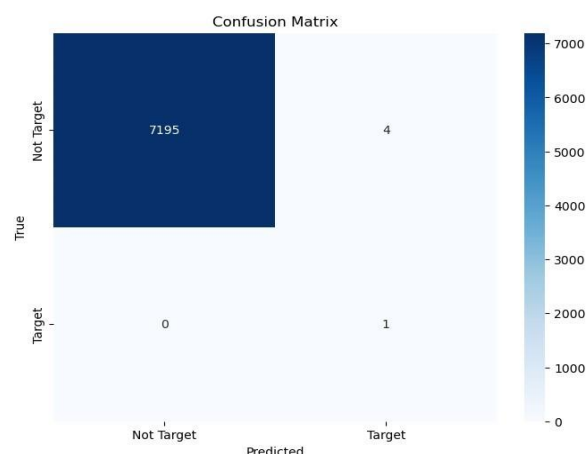
1. A direct method without clustering.
2. A method using the K-means clustering algorithm.

## A- Direct Method

### Steps

1. **Feature Extraction:**
  - **Color Histograms:** Images are converted to the HSV color space, and histograms are calculated for the H, S, and V channels. These histograms are normalized and concatenated into a single feature vector.
  - **Hu Moments:** Images are converted to grayscale, and Hu moments are calculated to represent the shapes within the images.
2. **Distance Calculation:**
  - **Chi-2 Distance** for color histograms.
  - **Euclidean Distance** for Hu moments.
  - **Total Distance:** A weighted combination of color and shape distances.
3. **Retrieving Similar Images:**
  - Distances between the query image and all images in the database are calculated.
  - Images are sorted by ascending distance, and the top N closest images are returned.

## Evaluation and Display of Confusion Matrix



The confusion matrix obtained for the evaluation of the method without K-means is as follows:

	Prédit : Not Target	Prédit : Target
True : Not Target	7195	4
True : Target	0	1

#### **True Positives (TP): 1**

- Number of target images correctly identified as targets.
- This indicates that only one image among the target images was correctly identified as belonging to the target category.

#### **True Negatives (TN): 7195**

- Number of non-target images correctly identified as non-targets.
- The majority of non-target images were correctly identified, demonstrating that the model is highly effective at recognizing images outside the target category.

#### **False Positives (FP): 4**

- Number of non-target images incorrectly identified as targets.
- A small number of non-target images were misclassified as targets.

#### **False Negatives (FN): 0**

- Number of target images incorrectly identified as non-targets.
- No target images were missed, meaning that all target images were at least partially detected.

### **B- Method with K-means**

#### **Steps**

- 1. Feature Extraction:**
  - Same as in the direct method.
- 2. Clustering with K-means:**
  - Image features are grouped into clusters using the K-means algorithm. Each image is assigned to a cluster based on its visual characteristics.
- 3. Retrieving Similar Images:**
  - **Assigning the query image to a cluster:** The query image is assigned to a cluster using the trained K-means model.
  - **Distance Calculation within the Same Cluster:** Distances are calculated only between the query image and images in the same cluster.
  - **Sorting Images by Ascending Distance:** The images in the same cluster are sorted by ascending distance relative to the query image, and the top N closest images are returned.

## Detailed Steps in Similar Image Retrieval:

- **Query Image Assignment to a Cluster:** After training the K-means model on the database image features, each image is assigned to a cluster. Each cluster represents a group of visually similar images.
  - When a new query image is introduced, the trained K-means model is used to determine the appropriate cluster for this image.
2. **Distance Calculation within the Assigned Cluster:**
    - Once the query image is assigned to a cluster, it is compared only to the images within that cluster rather than the entire database.
    - This reduces the number of necessary comparisons, focusing only on a subset of similar images.
  3. **Sorting Images by Ascending Distance:**
    - For each image in the query image's cluster, the distance between the query image's features and those of other cluster images is calculated.
    - Distances are computed as in the direct method, using measures such as Chi-2 distance for color histograms and Euclidean distance for Hu moments.
    - Images are then sorted by ascending distance from the query image, with the N images having the smallest distances considered the most similar to the query image.

## Evaluation and Display of Confusion Matrix



	Prédit : Not Target	Prédit : Target
True : Not Target	7195	6
True : Target	11	4

## Interpretation of Results

1. **True Positives (TP): 4**
  - Number of target images correctly identified as targets.
  - This means that four images among the target images were correctly identified as belonging to the target category.
2. **True Negatives (TN): 7179**

- Number of non-target images correctly identified as non-targets.
  - The majority of non-target images were correctly identified, indicating that the model is very effective at recognizing images outside the target category.
3. **False Positives (FP): 6**
- Number of non-target images incorrectly identified as targets.
  - A small number of non-target images were misclassified as targets.
4. **False Negatives (FN): 11**
- Number of target images incorrectly identified as non-targets.
  - Some target images were not identified, meaning a few target images were missed.

## **Conclusion**

The method using K-means improves precision but reduces recall. A hybrid approach or parameter optimization could provide a better balance between precision and recall.