🧩 WEEKLY CHALLENGE : Segment Objects Using K-Means (Image Segmentation)

Segmenting Objects in Images Using K-Means Clustering (Unsupervised Image Segmentation)

🎞️ Challenge Overview

In this weekly challenge, you will implement unsupervised image segmentation using the K-Means clustering algorithm. The final goal is to separate different regions or objects within an image based on color information (and optionally pixel positions).

Unlike supervised deep learning segmentation, this challenge uses no training labels and no model training.
The algorithm simply groups pixels into clusters that share similar characteristics.

You will work with a set of 15 images that contain different kinds of objects, backgrounds, lighting conditions, and complexity, to evaluate how well K-Means performs on diverse scenes.

This challenge helps you understand:

- Unsupervised learning
- Clustering algorithms
- Image as a feature matrix (pixels × features)
- Feature engineering (RGB, HSV, RGB + positions)
- Visualization and reconstruction of segmented images
- Basic evaluation metrics for segmentation without supervision

🧠 Challenge Objectives (What You Must Do)

1. **Load and prepare the images**
    - Load images
    - Reshape images into format for clustering.
2. **Extract pixel features**
   You can choose one of the following:
    - **Option A:** RGB values (3 features per pixel)
    - **Option B:** HSV color space (3 features per pixel)
    - **Option C (advanced):** RGB + pixel coordinates (x, y) (5 features per pixel)

Note: Using positions helps separate spatially distant objects that share color but may add complexity. For beginners, **color-only segmentation is recommended**.

3. **Run K-Means clustering**
    - Test for **K = 2, 3, 4, 5** clusters.
    - Reconstruct segmented images by assigning each cluster a distinct color.
4. **Compare results**
    - Visualize segmented images for all tested K values.
    - Optional advanced tasks:
        - Apply **Gaussian blur** to smooth images before clustering.
        - Use **morphological operations** (OpenCV) to clean the segmentation.
        - Try **Elbow Method** to determine the optimal K.

Deliverables

Each participant must submit:

1. **Notebook (.ipynb)** containing:
    - Full code
    - Feature extraction
    - Segmentation results for **K = 2, 3, 4, 5**
    - Comparison plots
    - Short explanation (max 10 lines) per experiment
2. **Images folder (Output Folder)** containing:
    - segmented_K2.png
    - segmented_K3.png
    - segmented_K4.png
    - segmented_K5.png

      ...

      (repeat for all 15 images)
3. **Short report (Max 2 pages)** including :
    - Which feature representation worked best
    - Impact of different K values
    - Limitations of K-Means for segmentation

Evaluation Criteria (How You Will Be Scored)

Since this is **unsupervised segmentation**, there is **no train/validation/test split**.
We evaluate your results using a combination of **objective metrics** and **visual quality**.

COMPONENT	WEIGHT
SILHOUETTE SCORE (OBJECTIVE)	**40%**
VISUAL QUALITY OF SEGMENTATION	**30%**
NOTEBOOK COMPLETENESS & STRUCTURE	**20%**
REPORT (CLARITY & INSIGHTS)	**10%**

🙌 Final Notes for Participants

- This is **not** a deep learning challenge no model training, no labels.
- Everything is based on **unsupervised clustering**.
- Spend time on **feature engineering**, **visualization**, and **analysis**.
- Creativity in improving segmentation is encouraged!