

**Exercise 04 for MA-INF 2201 Computer Vision WS24/25**  
**06.11.2024**  
**Submission on 17.11.2024**

Please submit your solution in jupyter notebook(.ipynb) format, make one notebook for each task: `TextureClassification.ipynb`, `SuperPixels.ipynb` and `Snakes.ipynb`.

1. **Texture classification:** Implement the complete pipeline to perform texture classification on the KTH\_TIPS dataset (already split in train and test).
  - (a) Feature extraction: extract Local Binary Patterns (LBP) features using the function `skimage.feature.local_binary_pattern` and compute the histogram of features for each image.
  - (b) Use k-means (k=50) to create a visual vocabulary and convert image's features into a Bag-of-Words representation.
  - (c) Implement classifiers using k-NN (k=5).
  - (d) Make a proper classification report, do some data exploration and visualize some classified examples from the test set.

*(7 Points)*

2. **Super Pixels:** You are required to perform image segmentation using the Normalized Cuts approach on the given image `superpixels.png`.
  - (a) Construct the similarity graph and compute the weights  $w(i, j)$  between each pair of pixels  $i, j$  based on color and spatial distance.

$$w(i, j) = \exp\left(-\frac{\text{dist}_{\text{color}}^2}{2\sigma_{\text{color}}^2}\right) \cdot \exp\left(-\frac{\text{dist}_{\text{space}}^2}{2\sigma_{\text{space}}^2}\right)$$

Use a radius parameter to limit the distance between connected pixels.

- (b) Compute the normalized cut: calculate the matrix  $D$ , then the Laplacian matrix  $L$  and obtain the eigenvectors needed for clustering.
  - (c) Use k-means to cluster the eigenvectors into the desired number of segments.
  - (d) Find the right combination of hyper parameters to obtain a correct segmentation of the 4 shapes plus the background.

*(8 Points)*

3. **Snakes:** Read the images `ball.png` and `coffee.png` and segment the object in both images using snakes. Initialize the snake by a circle around the object and optimize it using dynamic programming. The elastic term should be used as pairwise cost, penalizing deviation from the average distance between pairs of nodes. Visualize for both images how the snake converges to the boundary of the object.

*(5 Points)*