UNIVERSITÉ DE GENÈVE
CENTRE UNIVERSITAIRE D'INFORMATIQUE

Université de Genève

Départment d'informatique

Advanced Image Processing

Lossy image compression

TP Class N° 3

April , 2019

Notes: The details of the analytical calculations must be included in the report. If you do not use an Equation Editor (for Word, Latex or similar) you can easily scan a handwritten page (readable!) and put it in the report.

Theoretical basis

Exercise 1.

(a) Derive the entropy for the i.i.d. Laplacian and Gaussian distributions with the same variance.

(b) Derive the Shannon lower bound for both distributions for ℓ_2-norm. Plot on the same figure. Make the conclusions which distribution is better compressible with the smaller distortion.

(c) Derive the rate-distortion curve for the Laplacian distribution for ℓ_1-norm. Compare the obtained result with the above Shannon lower bound (obtained for ℓ_2-norm). Plot both results on the same figure. Make the conclusions.

K-means

Exercise 2.

(a) Given training data $\{x_i\}_{i=1}^N$ generated from Gaussian distribution $p(x) \sim \mathcal{N}(\mu, \sigma^2)$ in two dimensional space.

(b) Implement and investigate:

- K-means clustering algorithm producing $\{\hat{x}_k\}_{k=1}^K$.
- Investigate the impact of initialization of clusters on the converge.
- Investigate overfitting by playing with different N and K.
- Conclude how many training samples are needed for the given number of clusters.
- Investigate the impact of the number of clusters on the approximation accuracy.

(c) Investigate k-means clustering on the mixture of Gaussians consisting of C clusters with different means and covariance matrices in two dimensional space. Visualize the intermediate steps of clustering. Select the number of cluster smaller, equal and larger than the amount of mixture components C.

Product Quantization

Exercise 3.

(a) Given a dataset of images *EXT_YALE_B_Normal.mat*. Each image has a size 192×168. Randomly split this dataset into the training (2/3) and test (1/3) su-bsets.

(b) Implement and investigate:

- Product Quantization (PQ) of the training sub-set into two ways:
  - by splitting the images into non-overlapping blocks of size $b \times b$;
  - by splitting the images into overlapping blocks of size $b \times b$ with stride $b/2$;
- Compress the images from the test sub-set.
- Investigate the impact of
  - the block size b;
  - the number of centroids;

  on the approximation accuracy by measuaring the *MSE* between the original and compressed images.

Submission

Please archive your report and codes in "Name_Surname.zip" (replace "Name" and "Surname" with your real name), and upload to "`Assignments/TP3: Lossy Image Compression`" on `https://chamilo.unige.ch` before Wednesday, April 17 2019, 23:59 PM. Note, **the assessment is mainly based on your report, which should include your answers to all questions and the experimental results**.