

**Exercise 02 for MA-INF 2201 Computer Vision WS18/19**  
**20.10.2018**  
**Submission on 27.10.2018**

1. **Fourier Transform** In this task, we will show that the convolution in spatial domain can be achieved by the multiplication in the frequency domain. Read the image *einstein.jpeg*, and get a 7x7 Gaussian kernel with sigma=1 (you can use `cv2.getGaussianKernel`).

- Blur the image using `cv2.filter2D` with the Gaussian kernel.
- Blur the image using Fourier Transform, you can use `numpy.fft`. Print the mean absolute difference of both versions.

(2 Points)

2. **Template Matching** In this task, we will implement template matching using normalized cross-correlation as similarity measures. Read the image *lena.png* and the template *eye.png*

- Implement normalized cross-correlation.
- Implement template matching using your implementation of normalized cross-correlation.
- Draw rectangles where *similarity*  $\geq 0.7$ , you can use `np.where`.

(2 Points)

3. **Gaussian Pyramid** In this task, we will build the Gaussian pyramid and make template matching faster by utilizing pyramid. Read image *traffic.jpg* and the template *traffic-template.png*

- Build a 4 level Gaussian pyramid.
- Build a 4 level Gaussian pyramid using `cv2.pyrDown`. Compare it with your implementation by printing the mean absolute difference at each level.
- Do the template matching by using your implementation of normalized cross-correlation, print the time taken by this routine.
- Use pyramids to make template matching faster. Follow the procedure described in the lecture *03pyramids* slides (82 to 88). Print the time taken by this routine.

(8 Points)

4. **Edges** In this task, we will detect edges in the image using derivative of a Gaussian kernel. Read the image *einstein.jpeg*.

- Compute weights of derivative (in x) of a 5x5 Gaussian kernel with sigma=0.6.
- Compute weights of derivative (in y) of a 5x5 Gaussian kernel with sigma=0.6.
- To get edges, convolve the image with the kernels computed in previous steps. You can use `cv2.filter2D`.
- Compute edge magnitude and edge direction (you can use `numpy.arctan2`). Display magnitude and edge direction.

(3 Points)

5. **Distance Transform** In this task, we will compute precise Euclidean distance transform.

- Read the image *traffic.jpg*, convert it to gray image, extract the edges using `cv2.Canny`. Display the result.
- Compute precise Euclidean distance transform of the image by using [1].
- Compute precise Euclidean distance transform of the image by using `cv2.distanceTransform`, compare it with your implementation by printing the mean absolute difference.

(5 Points)

[1] Pedro Felzenszwalb and Daniel Huttenlocher. Distance transforms of sampled functions. Technical report, Cornell University, 2004