LUNDS TEKNISKA HÖGSKOLA
MATEMATIK

TENTAMENSSKRIVNING
Image Analysis
2022 HOME EXAM

Home Exam

You may use any books and computer programs (e.g. Matlab and Maple), but it is not permitted to get help from other persons. It is ok to use existing implementations of known methods, but the methods used should be explained in detail. The exam should be uploaded via the Canvas homepage, at the latest
72 hours after pick up.

1. In the provided files `beach1.jpg` - `beach6.jpg`, six images of beach scenes are given (also shown to the right). Use a clustering approach based on all these images to cluster the colors into *ten* unique colors,

i) in the original colorspace (RGB),

ii) in the CIE L*a*b* colorspace.

Use these two versions to map the colors in the image to the lower right, `newbeach.jpg` (using a nearest neighbour approach). Compare and discuss the two approaches.

2. Assume that we are given the task of training a classification method using a CNN. The input is 32×32 grayscale images, and we want to classify them into 5 classes. We have a CNN-model with the following layers: Convolution layer with 3×3 kernel and 16 output channels (stride 1 and padding 1), A RelU layer, a 4×4 Max pooling layer with stride 4, a Convolution layer with $3 \times 3 \times 16$ kernel and 32 output channels (with stride 1 and padding 1), A RelU layer, a 2×2 Max pooling layer with stride 2, a fully connected layer from $4 \times 4 \times 32$ input nodes to 5 output nodes, and finally a Softmax layer.

a) Calculate how many parameters we need to find and store for this model.

b) The receptive field of a feature in a specific layer is defined as the size of the region in the input image that affects the feature. What is the receptive field of the features in the final max pooling layer? Here you don't have to consider edge effects at the image border (note also that all the kernels are symmetric in size in the $x-$ and y-direction, so you only need to reason in one dimension).

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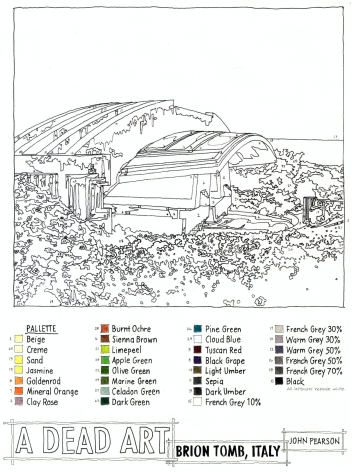
3. In this task we have an image `butterfly_color.jpg` that has wrong colors. We assume that the image has RGB-values between zero and one, and that it can be transformed to correct colors by applying a gray-value transformation on each color channel individually. We further assume that this transformation is on the form $T(r) = b_i r + (1 - b_i)r^2$, with some unknown parameters $b_i, i = 1, 2, 3$ corresponding to the R,G and B-channels respectively. We also have an image with correct colors given in `butterfly_blobs.jpg`. Unfortunately this image has been corrupted by noise and some random blobs.

a) Find the least-square estimate of the transformations, i.e. estimate $b_i, i = 1, 2, 3$ in a least square sense. Transform the image `butterfly_color.jpg` using the estimated transformation.

b) Estimate $b_i, i = 1, 2, 3$ using a method that is robust to outliers. Transform the image `butterfly_color.jpg` using the estimated transformation.

4. This task relates to the problem of so-called inpainting. In the file `sunset.jpg` an image is given with some annoying text superimposed. Design an algorithm that automatically removes the text, and fills in an appropriate background.

5. An image, `color_tomb.png`, is given in the supplied data (also shown here to the right). Color the image using the color translation table given under the image. Make your method as automatic as possible.



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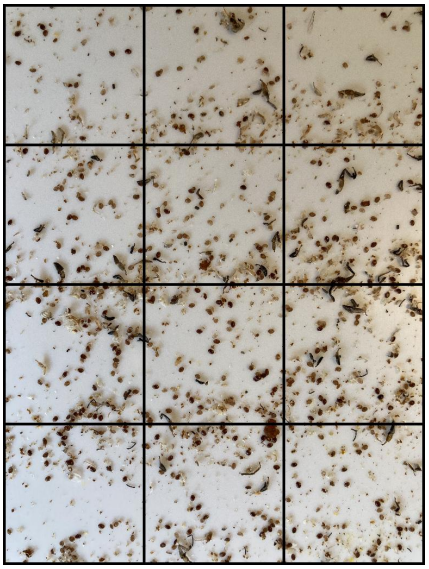
6. In the provided files `mite_1.jpg` - `mite_12.jpg`, 12 images of a collection board for Varroa mites are given. In the file `mite_gt.mat` the ground truth positions (x- and y-coordinates) of mites are given in the variable `X` for the first six images. Construct an algorithm that finds the mites in the six unlabeled images.



Good Luck!