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Webpage for the lecture: `https://mathopt.de/TEACHING/2020OMML/`

Optimization Methods for Machine Learning

WS 2020 – 5. exercise sheet

Exercise 5.1 (kernel trick: `tanh`
Goals: *See that the `tanh` kernel is not positive semidefintie.)*

1. Get the exercise template `ex05_temp.py` from our webpage `https://mathopt.de/TEACHING/2020OMML/` and go through the provided lines.
2. The `tanh` kernel is NOT positive semidefinite. Show this!
3. The function `computeGram` computes the Gram matrix K of your kernel k, that is

$$K = (k(x_i, x_j))_{i,j=1}^m,$$

   for a given set $\mathcal{X} = \{x_1, \ldots, x_m\} \subset \mathbb{R}^d$ of data points. Use the provided function `min_ev_gramian` and check whether Gram matrix for different kernel functions (`linear`, `rbf`, `tanh`) and different sklearn datasets (`iris`, `wine`, subset of `20newsgroups`) is psd.
4. Why is positve semidefiniteness of the kernel important? What does this mean for the SVM?

Exercise 5.2 (image classification)
Goals: *Use a Neural Network in sklearn to classify images of numbers.*

1. Write a function, similar to our SVM classifier function from exercise two, that trains a neural network from given image data using the `MLPClassifier` from `neural_network`.
2. Optional parameters you should have a look at are:
   - the `hidden_layer_sizes` of your neural network,
   - the `activation`-function that links the layers,
   - the `solver` of the NLP.
3. Analyze the image data with your function and have a look at different optional parameter settings.
4. Visualize the weight matrices in your neural network.