Machine Learning Worksheet 07

Constrained Optimization and SVM

1 Constrained Optimization

Problem 1: Solve the following constrained optimization problem using the recipe described in the lecture (slide 31).

$$\begin{aligned} \text{minimize} \quad & f_0(\boldsymbol{x}) = -(x_1 + x_2) \\ \text{subject to} \quad & f_1(\boldsymbol{x}) = x_1^2 + x_2^2 - 1 \leq 0 \end{aligned}$$

2 SVM

Problem 2: Explain the similarities and differences between the SVM and perceptron algorithms.

Problem 3: Show that the duality gap is zero for SVM.

Problem 4: Recall, that the dual function for SVM (slide 37) can be written as

$$g(\boldsymbol{\alpha}) = \frac{1}{2}\boldsymbol{\alpha}^T \boldsymbol{Q} \boldsymbol{\alpha} + \boldsymbol{\alpha}^T \mathbf{1}_N$$

(a) Show how the matrix $\boldsymbol{Q}$ can be computed. *(Hint: You might want to use Hadamard product, denoted as $\odot$).*

(b) Prove that the matrix $\boldsymbol{Q}$ is negative (semi-)definite.

(c) Explain, what the negative (semi-)definiteness means for our optimization problem. Why is this property important?

Problem 5: Load the notebook `07_homework_svm.ipynb` from Piazza. Fill in the missing code and run the notebook. Convert the evaluated notebook to pdf and add it to the printout of your homework.

Note: We suggest that you use Anaconda for installing Python and Jupyter, as well as for managing packages. We recommend that you use Python 3.

For more information on Jupyter notebooks and how to convert them to other formats, consult the Jupyter documentation and nbconvert documentation.