

## Exercise sheet 5

Submission deadline: 10:00, December 11, 2020

### Task 1: Lagrange multipliers (10 points)

Consider the optimization problem

$$\text{maximize } f(x_1, x_2) \text{ subject to } g(x_1, x_2) = 0$$

with

$$f(x_1, x_2) = x_1^2 + x_2^2 + 1 \text{ and } g(x_1, x_2) = x_1 + x_2 + 2 \cdot \sqrt{2}.$$

- Write a MATLAB script which plots in one figure
  - the level contours of  $f(x_1, x_2)$  for  $c \in \{1, 2, \dots, 10\}$  and
  - the function  $g(x_1, x_2)$for  $(x_1, x_2) \in [-3, 3] \times [-3, 3]$ . Zip your implementation and the plot and upload your archive to the Moodle course. (5 points)
- Just from the plot, what can you say about the solution? (1 point)
- Give the Lagrangian of the optimization problem and find the optimum of  $f(x_1, x_2)$  under the given constraint. (4 points)

### Task 2: Separating planes is still not about air traffic control (10 points)

Download the given MATLAB code snippets from the Moodle course.

- maxMarg05.m

```
function [exitflag, w, d, margin, dists, alphas, sv] = maxMarg05( X, y )
```

For a given data point matrix  $\mathbf{X}$  and a given vector of class labels  $\mathbf{y}$  with  $y_i \in \{-1, +1\}$ , this function uses Quadratic Programming for finding the maximum margin separating plane between the linearly separable data points of the two classes **by incorporating the dual optimization problem** and returns the exitflag of MATLABs quadprog function, the weight vector  $\mathbf{w}$ , the bias of the separating plane  $d$ , the margin, the distances from each data point to the separating plane, a vector of the Lagrange multipliers  $\alpha_i$ , and the indices of the support vectors. Implement the needed functionality.

- maxMargTest05.m

This script tests your implementation. There are three test instances. The script generates three figures and some text output which will automatically be saved as PDF and TXT files. Do not edit this script.

Implement the missing functionality in maxMarg05.m. Zip your implementation and the generated PDF and TXT files from the maxMargTest05.m script together with the stuff from task 1 and upload your archive to the Moodle course. Briefly discuss your results. (10 points)