Technische Universität Chemnitz Chemnitz, 24th October 2017
Prof. Dr. R. Herzog, T. Etling, S. Richter, Dr. D. Shklyarov, A. Stötzner

Optimization for Non-Mathematicians
Sheet 2

Exercise 3: Insulation in Home Construction

We consider example 2.1 from the lecture about heat insulation:

Minimization of the objective

$$K(d_1, d_2) = c_0 \left(\frac{1}{d_1} + \frac{1}{d_2}\right) + c_1\, d_1 + c_2\, d_2$$

with constants

$$c_0 = 20\ 000\,[€cm], \qquad c_1 = 300\,[€/cm], \qquad c_2 = 400\,[€/cm].$$

(a) Determine the optimal wall thicknesses d_1 and d_2 analytically by using the necessary and sufficient optimality conditions, see the lecture.

(b) Use the MATLAB optimization toolbox to solve the problem numerically. Write an `.m`-file with a function that evaluates the objective and another `.m`-file (MATLAB script) for the optimization routine. The constants c_0, c_1, c_2 may be hard coded in the objective.

Hints for the usage of MATLAB:

- use `fminunc` as solver (for unconstrained optimization problems), call `doc fminunc` in MATLAB and try to understand the basic functionality
- use `optimoptions` to create custom optimization options for `fminunc` (see `doc optimoptions` for more information)
- set `Quasi Newton` as `algorithm`
- use reasonable values for wall thicknesses (d_1, d_2) as starting point
- the solution of the optimization is the first returned argument of `fminunc`
- for a detailed display of the iteration you can set the option `Display` to `iter`

Exercise 4: Site Optimization

The location of a rescue station with a helicopter should be planned. The station is supposed to service m towns. A measure for the goodness of the rescue station's location is the weighted sum of the distances between the site and the towns (the smaller the distance, the better). The weights of the towns are proportional to the number of their inhabitants.

(a) Model a suitable optimization problem.

(b) Program the corresponding objective and determine the optimal location of the rescue station using the MATLAB function `fminunc`. The following 5 towns are given in the x-y coordinate system:

position	(1,1)	(2,7)	(4,5)	(6,8)	(9,7)
inhabitants	5000	3000	1000	4000	2000

(c) Is the optimization problem truly realistic? Which phenomena are not being considered? How could a more realistic problem setting (possibly including constraints) look?