

Fachbereich Mathematik und Informatik  
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## Nonlinear Optimization

<http://www.zib.de/weiser/NichtlineareOptimierung/>  
Homework 2

**Due: Thursday, May 7, 2020**

(Fewer assignments due to the public holidays on Friday, May 1 and May 8.)

**Assignment 1** (2 points):

Show the following: For  $c_1 \geq \frac{1}{3}$ , the gradient method for minimizing  $f(x) = x^3$  converges to  $x = 0$ . Use  $x_0 = 1$  as initial guess.

**Assignment 2** (6 points, programming exercise):

Given the Rosenbrock function  $f : \mathbb{R}^2 \rightarrow \mathbb{R}$ ,

$$f(x) = 100(x_2 - x_1^2)^2 + (1 - x_1)^2.$$

Define the gradient  $\nabla f(x)$  of  $f$  at  $x$  as

$$\nabla f(x) := f'(x)^T.$$

Show that  $-\nabla f(x)$  is a descent direction for  $f$ . Use this to implement the descent method to minimize the Rosenbrock function. Use  $x_0 = (-1.9, 2)^T$  as initial guess. Implement both Armijo and Wolfe line search. For both methods, plot the course of iterates. How many steps are required to achieve a tolerance of  $\|\nabla f(x)\| \leq 10^{-5}$ ?

**This assignment is due on Friday, May 15.**

**Remarks on the programming exercises:**

Programming tasks have to be implemented in Matlab/Octave. Please send your source code and results to [weiser@zib.de](mailto:weiser@zib.de) **and** [danecker@zib.de](mailto:danecker@zib.de). Please state in your email which program belongs to which assignment, and how to use the programs. Your source code has to be well documented. Please aim at understandable code, e.g., split it up into functions, use expressive names for functions and variables, and refrain from excessive optimization (execution speed is not that important).