SoSe 2020 | Kiel University
Dr. Joscha Reimer | Department of Computer Science

Optimization and Data Science
10. Homework exercises

Programming exercise 1:
Implement the stochastic gradient method and the minibatch gradient method with

a) 2^{-k}

b) k^{-1}

c) 1

as step size at the k-th iteration.

Programming exercise 2:
We would like to determine the amplitude and the period length of a sine oscillation. The oscillation with the parameters s, where s_1 is the amplitude and s_2 is the period length, at a time point x is given by

$$F(s,x) := s_1 \sin\left(\frac{2\pi x}{s_2}\right).$$

For three different oscillations these values were measured at several time points (including some measurement noise). They are available in the sine1.txt, sine2.txt and sine3.txt files where the first column contains the time points x and the second column contains the corresponding values $F(s,x)$. Determine the parameters s with the stochastic gradient method and the loss function

$$L(y,z) := \tfrac{1}{2}\|y-z\|_2^2.$$

Start always with an initial guess $s_1 = 2$ and $s_2 = 2$. Try to minimize the total computational effort of evaluating $F(s,x)$ and $\nabla_s F(s,x)$ using minibatches of an appropriate size.

Programming exercise 3:
Implements the $(\mu + \lambda)$-ES with Mutation Strategy Parameter Control (MSC).

Programming exercise 4:
Minimize the Roosenbrock function using

a) the $(\mu + \lambda)$-ES with MSC implemented in the previous exercise and different values for μ and λ and different initial mutabilities.

b) the CMA-ES implementation provided by the Python package pycma (`https://pypi.org/project/cma` and `https://github.com/CMA-ES/pycma`).

Compare the total effort of these minimizations with the effort of your minimizations of the Roosenbrock function with previous optimization algorithms.

Programming exercise 5:
Visualize the two dimensional Griewank function

$$f : \mathbb{R}^2 \to \mathbb{R}, x \mapsto \sum_{i=1}^{n} \frac{x_i^2}{4000} - \prod_{i=1}^{n} \cos\left(\frac{x_i}{\sqrt{i}}\right) + 1$$

and minimize this function using your implemented

a) *$(\mu + \lambda)$-ES with MSC.*

b) *BFGS-method.*

Compare the obtained results. Which of these algorithms is better suited for this minimization?

Hint: 0 is the minimizer of the Griewank function.

The solutions of the theoretical exercises will be discussed on 15. June 2020.