# Computer lab 3: Monte Carlo optimization

## Learning objectives

The main objective of this computer lab is to make the student familiar with basic numerical and Monte Carlo techniques for optimization problems.

After completing the lab the student shall be able to:

1. Implement and evaluate some of the most important deterministic and Monte Carlo optimization algorithms in R.
2. Perform stochastic optimization using simulated annealing and genetic algorithms.

## Recommended reading

Chapter 5 in Robert and Casella (2009)

Chapter 2-3 in Givens and Hoeting (2013)

## Assignment 1: Multi-dimensional optimization

a). The purpose of this assignment is to compare some common methods for multi-dimensional optimization. The methods will be evaluated on Himmelblau’s function which has one global maximum and four local minimum (https://en.wikipedia.org/wiki/Himmelblau%27s\_function). First, use the Newton method in the nlm() function with two different starting values[(0,-2); (1,1)] to perform function minimization. The next step is to analyse the same function with three methods (Conjugate-Gradient and L-BFGS-B) available in the optim() function in R. Use the two different sets of starting values as earlier for each method. Make sure that you read the documentation of this function so you can verify that convergence has been reached, it may be necessary to alter the parameters of the control option. Present three function plots (one for each method), trajectories and the final estimates.

b). The next step is to analyse the same function with stochastic gradient descent. Use the two different sets of starting values as in a). for the SGD implementation following the lecture notes. Present a new plot. Compare and discuss the results from b). with these from a).

## Assignment 2: Simulated Annealing and Genetic Algorithms

a). The data set housing.txt contains data on 13 socio-economic variables that are

assumed to influence the median housing price (MEDV) in a region in USA. The first task is to implement R code for variable selection in a linear model using simulated annealing. The BIC criterion should be used as test statistic. A reasonable temperature schedule should be chosen. Provide a plot of the BIC statistic over iterations

and the selected variables in the final model.

b). Secondly, perform variable selection using the genetic algorithm in library GA. The binary type should be chosen. Other parameters should be set in order to find an appropriate genetic algorithm. Provide a plot of the fitness function over iterations (generations) and the selected variables in the final model. Compare with the results obtained in a).

## To hand in

A written report (Word, pdf, html) where you summarize your main findings in the assignments. Submit your report via Moodle before the deadline.