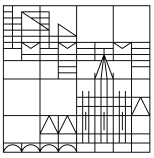
# Task Sheet 6

Universität Konstanz



## Optimal classification with evolutionary algorithms

### Deadline 01:00pm June 12th, 2024

### Review June 12th, 2024

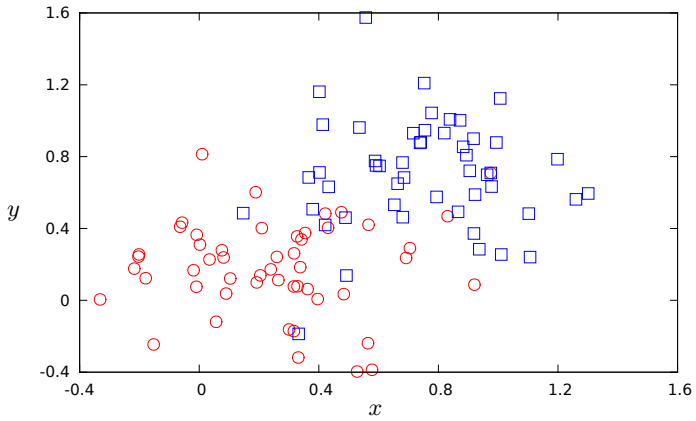
Lecture: *Evolutionary Robotics*, Summer Term 2024

Lecturer: Prof. Dr.-Ing. Heiko Hamann

Tutor: Eduard Buss, Pranav Kedia

Objectives:

- implement a complete evolutionary algorithm and a simple ANN.
- investigation of effects concerning selection, mutation rate, population size etc.




Statistical classification is a classical problem of machine learning. It is an example for supervised learning (a set of already classified examples is provided) and hence in difference to typical situations in evolutionary robotics (classifying sensor input with appropriate actuator outputs is exactly what we do not want to do by hand). In the following, the task is to evolve a classifier for a simple problem with two-dimensional features. For this purpose, we evolve a small ANN without a hidden layer.

1. Download the training set (file 'data', see plot above). It has four columns: number of example, class it belongs to (either 0 or 1), feature $x$, and feature $y$. Write some code that imports the data.

2. Extend your code from task 1: implement a simple ANN that has two inputs, one output neuron, and a bias neuron (as on ANN slide 20) but no hidden layer. This ANN is fully described by just three weights. As activation function we use

$$\varphi(x) = 2/(1 + \exp(-2x)) - 1. \tag{1}$$

   We say that the ANN classifies an input as 'class 0' if it outputs $\varphi < 0$ and as 'class 1' if it outputs $\varphi > 0$. To calculate the fitness, you have to successively evaluate an ANN's output for all entries of the data set and account for how many have been classified correctly.

3. Evolve an ANN that solves the problem satisfyingly. Output the three weights of the best evolved ANN and plot the dividing line that is implemented by the ANN:

$$y = \frac{w_0}{w_2} - \frac{w_1}{w_2}x, \tag{2}$$

(again, see ANN slide 20).

*Optional*:
Download the training set file 'data2' and try to evolve an ANN that satisfyingly classifies it. However, you will need to add a hidden layer to your ANN. Furthermore, bias neurons seem beneficial, too.

Your submission:

- please zip your submission in a single file named: 'evoRobo_sheet1_YOURLASTNAME1_YOURLASTNAME2.zip'
- a readme file with the full names of all group members, a list of the tasks and subtasks you have completed and/or a list of tasks/subtasks you have not completed
- accepted file formats for plots: png and jpg
- all your code
- a plot of best fitness and population average fitness over generations
- the best three weights that you found
- a plot of the data and the separating line as defined by your weights