Autonomous Intelligent Systems,
Institute for Computer Science VI, University of Bonn

Dr. N. Goerke
Friedrich-Hirzebruch-Allee 8, 53115 Bonn, Tel: (0228) 73-4167
E-Mail: goerke@ais.uni-bonn.de
www.ais.uni-bonn.de

Exercises for Artificial Life (MA-INF 4201), SS24

Exercises sheet 8, till: Mon 2. June, 2025

26.5.2025

Assignment 50 (2 Points)

Explain how a hypercube and a binary genome of an Evolutionary Algorithm are related to each other. Draw a sketch, visualizing this for a binary genome that has more than two bits.

Assignment 51 (3 Points)

Imagine an Evolutionary Algorithms shall optimize the recipe for a chocolate bar. The fitness function would be a group of volunteering students tasting and judging the creation. The gneome would then represent the recipe and consists of:
a real value for the amount of sugar, a real value for the amount of cacoa butter, a real value for the amount of cacoa, a real value for the amount of milk, and 38 binary values telling if a special flavor (like vanilla, orange, etc.) is included or not.
How large is the genome, and what is the dimension d of the resulting search space?

Assignment 52 (2 Points)

Draw a typical development of the best fitness within the population (performance graph) during an evolutionary algorithm working with a deterministic rank based, elitism, $(\mu + \lambda)$ strategy with no mutation for the parents.

Assignment 53 (2 Points)

Explain the term *Hamming-Cliffs* with respect to Evolutionary Algorithms.
Discuss the negative and positive aspects of this phenomenon in the context of EAs.

You are explicilty encouraged to seek the literature about Evolutionary Algorithms to complete the task, provided you give a correct reference (citation).

Assignment 54 (2 Points)

Depict the fitness sorted distribution of fitness values within a population of an Evolutionary Algorithm before and after applying the 3 EA steps (4 diagrams):
1. External selection $(\mu + \lambda)$ with rank based elitism, 2. Inheritance step, 3. Mutation step.

Assignment 55 (2 Points)

Name, and describe at least three aspects, why evolutionary algorithms are so popular.

Assignment 56 (2 Points)

Describe two operators for an evolutionary algorithm: one that is implementing a pure *exploration* strategy, and a second one implementing a pure *exploitation* strategy.

Programming Assignment: E (10 Points, due date **Mon 23.6.2025**)

Write a Python Programm, that implements an evolutionary algorithm to **maximize the length** of a route going **twice** through a given set of N points (cities) in 2-dimensions. Starting, and ending point are open to be determined by the algorithm; each point (city) must be visited **exactly twice**.

It is completely your choice, which variant of evolutionary algorithm to take. The parameters P, μ and λ, are to be set by the user at runtime, the N points $\mathbf{X}_n = (x_1, x_2)_n$ shall be read in from the text-file `Positions_PA-E.txt`. Allow a maximum of up to $N = 150$ points.

The program has to output the fitness of the best individual, the mean fitness and the least fitness of the parents in every generation in a text based format. Depict and draw the development of these three values into a graph. Hand it in together with the other solutions. When your algorithm has finished (implement a reasonable criterion for that), print the resulting length of the path found and the resulting sequence of coordinates (one position with two coordinates per line).

Extend your program to the possibility to find the **shortest cyclic route** going twice through all cities, with the extra constraint to visit at least one other city between visiting one city twice.