Exercise 3: Real-World Applications

Summer Term 2024

In the previous exercises, you have reviewed some basic skills on optimization. Now, this exercise is devoted to the understanding of how to deal with *real-world* applications. A key point is that often, the fitness $f(x_1, \ldots, x_n)$ is not directly a function of its parameters x_i, but rather in some indirect way. This fact often requires some *indirect thinking* of how to formalize a proper fitness function, and in turn, requires *practice*.

Review: Again, review the requirements/skill that are essential for almost any optimization task.

To Do: In the following applications, the focus is on the identification of the parameters x_i to be optimized, the identification of the optimization goal, the definition of a proper fitness function, and an experimental setup for the actual fitness evaluation. Please note that this exercise does not ask for the actual optimization process or choosing a particular algorithm.

Applications: Please consider the following applications:

1. A color sample is given (you can look at it) for which you do not know the red, green, and blue values. Some sort of machinery allows you to generate arbitrary colors, which you can compare with the sample. How can you determine the color components?

2. You should design the *shape* of a water pipe, which deviates the water flow by 90°. The pipe's cross-section is of circular shape with a fixed diameter. The pipe's friction should be minimal.

3. The famous Formula-1 racer Sterling Moos wanted to win the Monte Carlo race, and asked his mechanic to prepare the six gears, with each having two cogwheels, of his gearbox. How would you proceed?

4. In an experimental laboratory test, the following measurements have been obtained:

x	-2.0	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0
y	12.1	4.9	0.2	-3.0	-4.1	-3.2	0.1	5.1	11.9

   For further processing, the laboratory staff wants to have a quadratic function $f(x) = ax^2 + bx + c$ that describes the data as best as possible.

5. A new synthetic material has been developed, which requires a production time of 30 minutes at varying temperatures. It is known that the material's performance significantly depends on the particular temperature schedule within those 30 minutes, and thus the production line allows for resetting the temperature minute after minute.

Have fun, Theo and Ralf.