

AI505/AI801, Optimization – Exercise Sheet 03

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Exercise 1 *

Implement the extended Rosenbrock function

$$f(x) = \sum_{i=1}^{n/2} [a(x_{2i} - x_{2i-1}^2)^2 + (1 - x_{2i-1})^2]$$

where a is a parameter that you can vary (for example, 1 or 100). The minimum is $\mathbf{x}^* = [1, 1, \dots, 1]$, $f(\mathbf{x}^*) = 0$. Consider as starting point $[-1, -1, \dots, -1]$.

Solve the minimization problem with [scipy.optimize](#) using all methods seen in class that are suitable for this task. Observe the behavior of the calls for various values of parameters.

Use the [COCO test suite](#) (see [article](#)) to carry out this exercise. The advantages of the platform is that it provides:

- a set of problem instances to use, about 1000 to 5000 problems (number of functions \times number of dimensions \times number of instances)
- a collection of results from the literature
- tools to launch and analyze the experiments

The COCO framework considers functions divided in suites. Functions, f_i , within suites are distinguished by their identifier $i = 1, 2, \dots$. They are further parametrized by the (input) dimension, n , and the instance number, j . We can think of j as an index to a continuous parameter vector setting. It parametrizes, among other things, search space translations and rotations. In practice, the integer j identifies a single instantiation of these parameters. We then have:

$$f_i^j \equiv f[n, i, j] : \mathbb{R}^n \rightarrow \mathbb{R} \quad \mathbf{x} \mapsto f_i^j(\mathbf{x}) = f[n, i, j](\mathbf{x}).$$

Varying n or j leads to a variation of the same function i of a given suite. Fixing n and j of function f_i defines an optimization problem instance $(n, i, j) \equiv (f_i, n, j)$ that can be presented to the solver. Each problem receives again an index within the suite, mapping the triple (n, i, j) to a single number.

Varying the instance parameter j represents a natural randomization for experiments in order to:

- generate repetitions on a single function for deterministic solvers, making deterministic and non-deterministic solvers directly comparable (both are benchmarked with the same experimental setup)
- average away irrelevant aspects of the function definition,
- alleviate the problem of overfitting, and
- prevent exploitation of artificial function properties