Mathematics for Intelligent Systems
Lecture 11 Homework
(Optimization)

Marc Toussaint, Andrea Baisero

1 Problem Formulation

Solving real-world problems involves 2 subproblems:

1) formulating the problem as an optimization problem (conform to a standard optimization problem category) ($\rightarrow$ human)

2) the actual optimization problem ($\rightarrow$ algorithm)

A Linear Program

$$\min_x c^\top x \quad \text{s.t.} \quad Gx \leq h, Ax = b \tag{1}$$

is one such type of standard problem form for which specialized optimization algorithms exists. In the LP case, objective and constraint functions are all linear. These exercises are on the issue of problem formulation. Exercises from Boyd et al `http://www.stanford.edu/~boyd/cvxbook/bv_cvxbook.pdf`:

a) (**5 points; 1 for each subproblem**) Conversion of l_1 and l_∞ norms. Solve Exercise 4.11 (pdf page 207) from Boyd & Vandenberghe, *Convex Optimization.*

b) Network flow problem. Solve Exercise 4.12 (pdf page 207) from Boyd & Vandenberghe, *Convex Optimization.*

c) Minimum fuel optimal control. Solve Exercise 4.16 (pdf page 208) from Boyd & Vandenberghe, *Convex Optimization.*

2 Global Optimization via UCB

The 2-dimensional Rosenbrock function is defined as

$$f(x, y) = (a - x)^2 + b(y - x^2)^2 \tag{2}$$

Find an implementation of Gaussian Processes for your language of choice (e.g. python: scikit-learn, or Sheffield/Gpy; octave/matlab: gpml) and implement UCB. Test your implementation with different hyperparameters (Find the best combination of kernel and its parameters in the GP) on the rosenbrock function with parameters $a = 1$ and $b = 10$.

3 Brainstorm (no points): Constrained Global Bayes Optimization?

How would you modify a standard blackbox global optimization method (e.g. UCB) to include an (unknown) constraint functions?