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Nonlinear Optimization

http://www.zib.de/weiser/NichtlineareOptimierung/

Homework 9

Due: Friday, July 03, 2020

Assignment 1 (6 points, programming exercise)**:**
Revisit example (III.2.5),

$$\begin{aligned} &\min_{x\in\mathbb{R}^2} \frac{1}{2}x^T x \\ &\text{s.t.} \quad x_1 + x_2 = 1 \ . \end{aligned}$$

Implement the penalty method to solve this problem with $x_0 = (2, 3)$.
Hint: A template for this exercise can be found on the web page.

a) Implement the objective function in `objFun()`.

b) Implement the constraints in `constrFun()`.

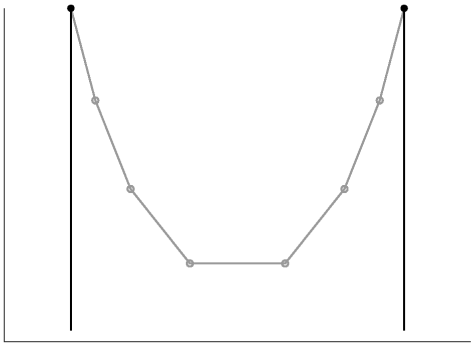
c) Implement the penalty function in `penaltyFun()`.

d) Plot the penalty function for various values of μ, e.g. for $\mu = \{100, 10, 1, 0.1\}$.

e) Implement a variation of Newton's method as solver for unconstrained problems in `newtonOpt()`.

f) Implement the function `penaltyOpt()`, that uses your solver to find the minimum of the penalty function for a declining sequence of μ-values. E.g. start with $\mu = 1$ and decrease by a factor of 10 for 6 steps. Check if the solutions converge to the expected solution.

Assignment 2 (6 points, programming exercise)**:**
Imagine a chain of length L and n segments. Both ends are attached to fixed points such that the chain itself is sagging in between. Use what you have learned so far to calculate the stable position of the chain.



Hint: A template for this exercise based on the Newton-KKT method can be found on the web page.

a) What is the objective here? What should be minimized? Implement `objFun()`.

b) Assume that the chain segments are perfectly rigid. How can this be used to transform the physics of the chain into equality-constraints? Implement `constrFun()`.

c) Use these functions to set up the KKT-system. Implement `KKT()`.

d) Implement a variation of Newton's method as solver for unconstrained problems in `newtonOpt()`.

e) Solve the problem using your solver for n=7, x_0=$(0,0)$, x_n=$(1,0)$, L=2.

f) Play around with the parameters and see if your code still works. Can you move the end-point up? Can you calculate the position of a chain with 10 segments?