Technische Universität Chemnitz Chemnitz, 13th November 2017
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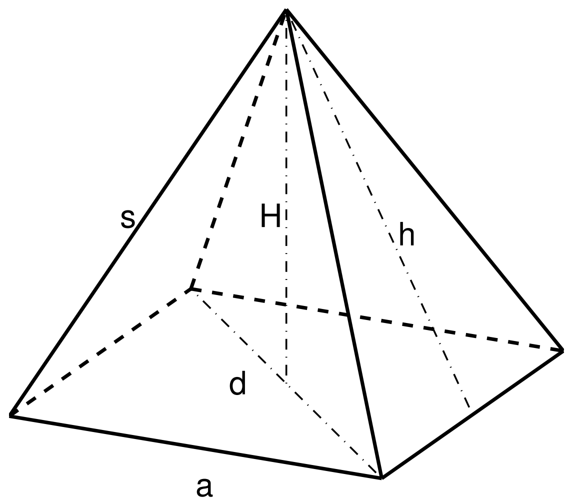
Optimization for Non-Mathematicians
Sheet 6

Exercise 13: Edges of a pyramid



For a square-based pyramid, the side length x_1 of the base and the height x_2 are to be determined. To improve the accuracy of the result, more than these two lengths are measured (data in cm):

$$a = 2.8, \quad d = 4.0, \quad H = 4.5, \quad s = 5.0, \quad h = 4.7.$$

(a) Set up five model functions which describe the dependencies of a, d, H, s and h on the model parameters (x_1, x_2).

(b) Determine the parameters (x_1, x_2) such that the model fits the five measured lengths as well as possible (in the least squares sense). What is the difference to the previous scheme for least-squares problems?

(c) Solve the problem using `lsqcurvefit` (or `lsqnonlin`) with the Levenberg-Marquardt algorithm.

Exercise 14: Parameter identification: material constants II

We recall the paramater identification problem of material constants from Sheet 5, Exercise 12. This time, the so-called Johnson-Cook model (without temperature dependence) is used:

name	Johnson-Cook		
indep. variable	$\xi = (\varepsilon, \dot{\varepsilon})$	dep. variable	$\eta = \sigma$
model equation	$\sigma = (A + B\,\varepsilon^n)\big(1 + C\,\ln\frac{\dot{\varepsilon}}{\dot{\varepsilon}_0}\big)$		
parameter	$x = (A, B, n, C, \dot{\varepsilon}_0) \in \mathbb{R}^5$		

Find material constants such that the model will fit the measurements as well as possible (in the least squares sense).

(a) What does the corresponding least-squares problem look like?

(b) Solve the problem using `lsqcurvefit` with the Levenberg-Marquardt algorithm. You will find the measurement file `al2030_jc.txt` on our homepage.

In this problem the sucess of the optimization method highly depends on the starting point. If no good initial estimate is available, there is a way out in reduction/simplification of the model. This means, at first only a part of the parameters is determined, which will then enter into a (hopefully better) starting point for the original problem.

- How can the model be reduced/simplified?
- Implement this ansatz and use it to solve the original problem.
- Extra: Some of the model parameters are not used in the reduced model function and the Levenberg-Marquardt algorithm will not change these parameters during the optimization. Convince yourself of that fact using equation (8.9) from the lecture notes.