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Optimization for Non-Mathematicians

Sheet 5

Exercise 11: Parameter identification: braking distance

For the braking distance s of a car, depending on its velocity v, we have the following measurements:

velocity v $[km/h]$	10	20	25	30	40	50
braking distance s $[m]$	4	10	14	20	30	42

The goal is to find a quadratic dependency of the form

$$s(v) = a\,v^2 + b\,v$$

with unknown model parameters $(a, b) \in \mathbb{R}^2$. Find parameters 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.

(c) Generate a plot showing the measurements and the model curve $s(v)$ with optimally fitted parameters (a, b).

(d) What is the physical meaning of the model parameters a and b?

Hints:

- In the documentation for `plot` you can read how to draw single points or lines.

Exercise 12: Parameter identification: material constants

Material laws are the basis for almost every technical computation in engineering. These are normally functional dependencies containing unknown and material dependent factors (parameters or material constants). For example, one can find in the literature the empirical Hollmon material law (model) stated below, which models the stress response of a raw material (the dependent variable) under a uniaxial load as a function of the strain ε (the independent variable).

name	Hollmon		
independent variable	ε	dependent variable	σ
model equation	$\sigma = K\,\varepsilon^n$		
parameter	$x = (K, n) \in \mathbb{R}^2$		

Find material constants such that the model will fit the measurements as good as possible (in the least-squares sense). A file `al2030.txt` with measurement data is provided on our homepage.

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

(b) Solve the problem using `lsqcurvefit` with the Levenberg-Marquardt algorithm.

(c) Generate a plot showing the measurements and the model curve.

Hint: The file `al2030.txt` can be imported via `temp = importdata('al2030.txt');`. The matrix containing the measurements can then be addressed as `temp.data`.