Series 2: Parametric models

1 Sensitivity of the Young modulus

Objective

The objective of this exercise is to train the computing of the different elements necessary to perform a least square fit estimate for a linear model. It will also train the reporting on statistical analysis and the preparation of recommendations for further measurements.

A the level of Matlab the following specific functions are potentially of interest: *x2fx(), corrcov(), diag(), rescale(), imagesc(), plot3(), syms, fsurf(), fcontout(), subs(), meshgrid(), reshape(), boxplot(), repmat(), errorbar(), fitlm(), plotadded(), anova(), array2table(), tinv()* .

Table 1 reproduces the data relative to a set of experiments on steal samples with different concentration in carbon and sulfure, tested at different temperatures in order to determine the elastic behavior of the material[1].The content of the table corresponds then to the experimental conditions as well as the Young modulus following the Hooke phenomenological relation:

$$\epsilon = \frac{\sigma}{E}$$

with ϵ the strain, σ the longitudinale stress and E the Young modulus.

a) Load the data from the data file in a table.

b) Analyse with a critical mind the design of experiment for a linear model and for a model with interactions between C and S. For each of those models determine :

- the model matrix
- the dispersion matrix
- the correlation matrix
- the variance inflation factors
- the variance of the model (the problem can be solved easily with the symbolic calculation using; It is also possible to solve it numerically using, among other things, the functions).

Arrange these elements and prepare the recommendation for the experimenters as if the experiments was not yet .

c) (We now place ourselves after that the measurements have been done) Infer the main effects and the interaction between the concentration of carbon and the one of sulfur on the Young modulus of the material in the standardized metric.Transform the coefficients in the original metric.

d) Compute the 95% confidence intervals of these coefficients.

[1]The data can also be downloaded from the Excel file available in Moodle

e) Prepare elements of the conclusion of a report about the experiment considering the thematic of the quality of the measurements.

f) Prepare recommendations for a second campaign that should allows to evaluate the interactions with the temperature.

Table 1 – Data relative to experiments on steal samples replicated three times

Run	C [%]	S [%]	T [°C]	E [kPa]		
1	0.04	0.4	-20	207.15	206.74	208.36
2	0.04	0.4	0	206.45	204.71	206.83
3	0.04	0.4	20	206.03	203.22	206.34
4	0.04	0.8	0	194.51	192.89	195.03
5	0.05	0.6	0	209.13	209.09	210.38
6	0.06	0.4	0	222.86	221.29	222.08
7	0.06	0.8	-20	214.56	212.06	211.84
8	0.06	0.8	0	209.52	209.86	211.35
9	0.06	0.8	20	211.89	210.2	209.24