Bayesian inference for material parameter identification in elastoplasticity

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Material parameter identification based on error minimisation (e.g. least squares) is frequently used in the field of mechanics. These conventional error minimisation methods do not explicitly account for the statistical noise of the experimental devices [1]. An alternative identification method is the Bayesian approach which explicitly accounts for the experimental noise and consequently gives a probabilistic estimation of the material parameters. It can therefore not only characterise the most probable parameter values, but also the uncertainty of these values.

The use of Bayesian inference results in a probability density function (PDF), a so-called posterior distribution, as a function of the material parameters of interest. The statistical properties of the PDF, e.g. the mean values of material parameters, the material properties at which the PDF is maximum and the standard deviation, can be obtained by analysing the posterior distribution [2, 3].

Based on literature, Bayesian inference for parameter identification of elastoplastic models is a nontrivial task, if one is only familiar with identification procedures based on error minimisation. Furthermore, no studies have focused on the incorporation of statistical errors in the stress as well as in the strain. Depending on the experimental equipment however, both the measured stresses and the measured strains may be polluted by statistical errors.

This presentation aims to present formulations of the Bayesian approach to identify elastoplastic material parameters based on numerically generated 'experimental data'. To make the presentation as approachable as possible, all examples deal with one dimensional tensile tests. Special attention is paid to a formulation that incorporates uncertainties in stress, as well as in strains. Furthermore, a number of misconceptions about Bayesian inference will be highlighted, that may not be straightforward for researchers only familiar with error minimisation based identification.

References

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