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GOAL-ORIENTED STRATEGY FOR THE UPDATING OF MECHANICAL MODELS

Ludovic Chamoin*[1], Pierre Ladevèze[1] and Julien Waeytens[2]

[1] LMT-Cachan, 61 Avenue du Président Wilson 94235 Cachan, France
{chamoin,ladeveze}@lmt.ens-cachan.fr, www.lmt.ens-cachan.fr
[2] Ifsttar, 14-20 Boulevard Newton, 77447 Marne-la-Vallée, France
julien.waeytens@ifsttar.fr, www.ifsttar.fr

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A major concern with mathematical models is their capability of these models to represent a faithful abstraction of the real world. To address this issue and control the error between physical and mathematical models, model validation methods have been used for a long time. In such methods, model parameters are identified or updated in order to minimize the discrepancy between numerical predictions and experimental measurements. The process leads to inverse problems [1] which are usually ill-posed and require special care and specific techniques, such as regularization techniques, in order to ensure solvability.

We focus on Computational Mechanics models, in which a major component is the constitutive equation that describes the local behavior of the material. It is characterized by a set of material parameters whose values may highly influence results given by numerical simulations, and thus need to be calibrated using experimental data [2]. The model calibration method we consider uses the concept of Constitutive Relation Error (CRE), introduced in [3] for dynamics models and latter successfully used in many calibration applications [4, 5, 6]. The use of the CRE presents interesting advantages; it has excellent capacities to localize structural defects spatially, it is very robust with respect to noisy measurements, and it has good convexity properties. Furthermore, the hierarchic updating in the CRE methid (only most erroneous zones are corrected) is a strategy that directly leads to a regularization process.

Here, we consider that the prediction target is only the value of a given output of the model, denoted quantity of interest, that implicitly depends on model parameters. Therefore, if the quantity of interest is not very sensitive with respect to some parameters, there is probably no need to estimate these parameters with high accuracy. The objective is thus to define a goal-oriented version of updating methods performed using the CRE

[7]. On the one hand, we define new dedicated cost functions that lead to a convenient goal-oriented updating process, selecting automatically the relevant model parameters that need to be updated for the prediction of the quantity of interest. This leads to a partial model calibration that enables to obtain an approximate value of the quantity of interest with sufficient accuracy and minimal model identification effort. The updating method uses the constitutive relation error framework as well as duality and adjoint techniques.On the other hand, we define quantitative sensitivity tools that enable to set up optimal experiments and measurements (sensor location, type of measure) with respect to the output of interest to predict. We present the new method and associated tools and performances in the framework of linear elasticity as well as time-dependent models (an example is given in Fig. 1).

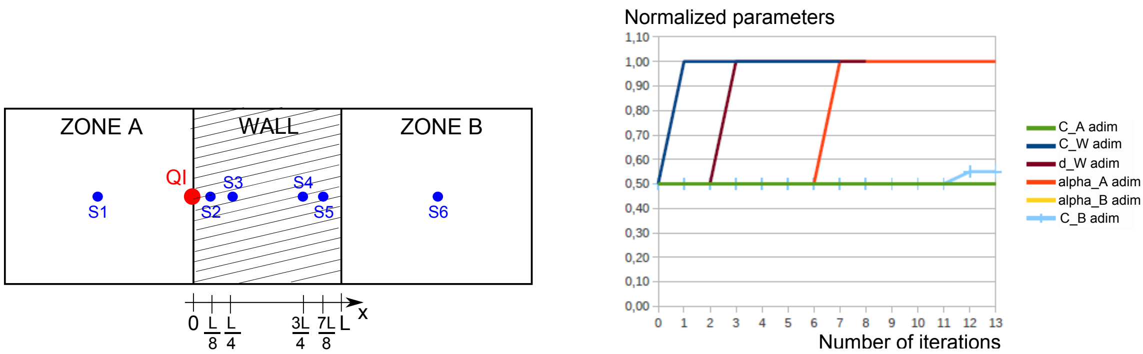

Figure 1: Unsteady thermal problem with two zones separated with a wall (left), and updated parameter values with the goal-oriented calibration technique (right)

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