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The Role of Optimization in the Validation Verification Verification, Calibration Validation Processes

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A comprehensive study of many of the complex systems in science and engineering may demand physical experimentation. However, in many cases, physical experiments can be prohibitively expensive or even impossible to perform. Fortunately, the behavior of many of these systems can be imitated by computer models, and thus, computer simulation may be a viable alternative or augmentation.

The inclusion of computer simulations does introduce many new challenges. For example, code verification should be used to confirm that the underlying equations are being solved correctly. Calibration or parameter estimation must be incorporated to update the computational model in response to experimental data. In addition, validation is an important process that can answer questions of correctness of the equations and models for the physics being modeled and the application being studied. Moreover, validation metrics must be carefully chosen in order to explicitly compare experimental and computational results and quantify the uncertainties in these comparisons. Overall, the validation and verification verification, calibration, and validation processes for computational experimentation can provide the best estimates of what can happen and the likelihood of it happening when uncertainties are taken into account.

In this talk, we will focus on the validation calibration under uncertainty process. In particular, we will focus on the problem of electrical simulations and elucidate the role of optimization in the parameter extraction problem. We will describe the process, an example problem and our results, and how the inclusion of sensitivity analysis can improve the optimization procedure.