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Automatic and High Precise Modeling for System Optimization

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Abstract : To describe and propagate the behavior of a system mathematical models are formulated. Parameter identification is used to adapt the coefficients of the underlying laws of science. For complex systems this approach can be incomplete and hence imprecise and moreover too slow to be computed efficiently. Therefore, these models might be not applicable for the numerical optimization of real systems, since these techniques require numerous evaluations of the models. Moreover not all quantities necessary for the identification might be available and hence the system must be adapted manually. Therefore, an approach is described that generates models that overcome the before mentioned limitations by not focusing on physical laws, but on measured (sensor) data of real systems. The approach is more general since it generates models for every system detached from the scientific background. Additionally, this approach can be used in a more general sense, since it is able to automatically identify correlations in the data. The method can be classified as a multivariate data regression analysis. In contrast to many other data regression methods this variant is also able to identify correlations of products of variables and not only of single variables. This enables a far more precise and better representation of causal correlations. The basis and the explanation of this method come from an analytical background: the series expansion. Another advantage of this technique is the possibility of real-time adaptation of the generated models during operation. Herewith system changes due to aging, wear or perturbations from the environment can be taken into account, which is indispensable for realistic scenarios. Since these data driven models can be evaluated very efficiently and with high precision, they can be used in mathematical optimization algorithms that minimize a cost function, e.g. time, energy consumption, operational costs or a mixture of them, subject to additional constraints. The proposed method has successfully been tested in several complex applications and with strong industrial requirements. The generated models were able to simulate the given systems with an error in precision less than one percent. Moreover the automatic identification of the correlations was able to discover so far unknown relationships. To summarize the above mentioned approach is able to efficiently compute high precise and real-time-adaptive data-based models in different fields of industry. Combined with an effective mathematical optimization algorithm like WORHP (We Optimize Really Huge Problems) several complex systems can now be represented by a high precision model to be optimized within the user wishes. The proposed methods will be illustrated with different examples.

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