GMDH: building self-organizing feedforward perceptron-like polynomial models for real-time applications

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Abstract

Approximation of a complex multidimensional system by a self-organizing Multi-Layer Perceptron (MLP), known as Group Method of Data Handling (GMDH), was introduced by A.G. Ivakhnenko. The GMDH models are constructed by combining the low-order polynomials into the MLP-like structures. The corresponding learning data set is used for polynomial regression and the test data set for its verification. The least-square-error measure is generally used for the polynomial regression and verification. When modeling the complex multidimensional system by using the GMDH, the total number of possible models may increase extremely by increasing the number of layers and the complete search may become unfeasible. Therefore, the proper selection of the candidate models plays an important role in building the satisfactory GMDH surrogate.

Modeling the complex calculation procedures by the MLP-like polynomials, with respect to the accuracy and the execution time, opens the possibilities of their efficient adaptation for real-time systems. The proposed compound squared relative error measure of the accuracy and the complexity (execution time) can be efficiently used for the verification and selection of the candidate model. The complexity of the surrogate model can be decreased extremely as well as the execution time but the accuracy of the substitute is somewhat degraded when compared to the referent physical model. This algorithmic trade-off between the accuracy and the complexity of the surrogate prove to be a favorable approach for low-computing power systems since the referent physical models are sometimes too complex to be executed in real-time. The compound squared relative error measure of model efficiency meets the peculiarities of real-time embedded systems and generally discovers more favorable surrogate model with respect to the execution time and the accuracy then the least-square-error criterion.

It will be demonstrated how the polynomial model of the natural gas properties and measurement procedures could efficiently compensate for the adiabatic expansion effects in the flow-rate measurements.