Validation of a structure of a multiscale model with OWL and metaprogramming

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ABSTRACT

Modern numerical models of engineering material are usually complex ones. They integrate several sub-models, describing particular processes. Each of the sub-models could be also a complex numerical model itself. There are several difficulties present during developing and managing complex numerical models. One of them is integration of various, independently developed sub-models into a consistent solution. The other problem to be solved is reusability of already designed sub-models. The paper describes the Agile Multiscale Modelling Methodology Framework (AM3), which has been developed for dealing with these issues.

The basis of AM3 is a concept of modularization of numerical models. A model of a material treatment process is not designed as a single, indivisible model but is composed of smaller modules, describing particular phenomena, significant or potentially significant for the model. The modularization brings an ‘interface problems’ – necessity of enforcing of compatibility between sub-models. In this work, several issues referring to this problem are discussed. It includes securing compatibility on the levels of problem design (with application of an object-oriented analysis [1] and a semantic description) and model implementation (with application of metaprogramming in C++ language).

The object-oriented analysis of the model has been applied to split the model into a set of sub-models, each responsible for computing a single variable or a set of coupled variables. In addition, possibility of providing of variables by several, alternative sub-models is investigated. The semantic description, based on the Web Ontology Language (OWL) has been used to support a researcher in proper configuring of the model, especially to verify, which inputs for sub-models are provided by other sub-models and which ones must be provided as boundary conditions or fixed values. The metaprogramming partially duplicates object-oriented analysis and semantic description, but additionally enforces fulfilment of the design assumptions with strong, compile-time mechanisms.

The workflow, from the strongly coupled model to the verified structure of the sub-models is described with examples [2].

REFERENCES

[1] P. Macioł, R. Bureau and Ch. Sommitsch, “An Object-Oriented Analysis of Complex Numerical Models”, *Key Engineering Materials*, **611-612** , 1356–1363 (2014)

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