The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

CoSTA: Improving Physics-Based Models Using Deep Learning

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Keywords: *Hybrid Analysis and Modelling, Deep Neural Networks, Applied Machine Learning, Predictive Modelling*

Predictive modelling has traditionally been dominated by two modelling paradigms: Physics-based modelling (PBM) and data-driven modelling (DDM). These two paradigms possess complementary characteristics – PBM offers trustworthy and generalizable models, while DDM yields models which are computationally efficient and self-adapting but lacking in trustworthiness and generalizability. The emerging hybrid analysis and modelling (HAM) paradigm aims to combine PBM and DDM such as to utilize the strengths of both traditional paradigms [1].

The Corrective Source Term Approach (CoSTA) is a recently introduced approach to HAM [2]. The basic concept of the approach is to augment the governing equation of a PBM with a corrective source term generated by a deep neural network (DNN). A general supervised learning problem can be formulated for the DNN such that CoSTA can be used to correct both modelling error and discretization error.

In terms of accuracy, CoSTA has been found to outperform pure PBM and DDM by more than one order of magnitude in numerical experiments on 1D heat diffusion [2]. At ECCOMAS, we would like to present additional results from numerical experiments demonstrating the superior accuracy achieved with CoSTA. We would also like to discuss how CoSTA's modular structure facilitates in-built DNN sanity checks.

REFERENCES

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