Data-model-coupling computing for composite materials and structures

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ABSTRACT

Multiscale simulation methods for composite materials and structures have been intensively developed during the past decades. The balance between the computational efficiency and accuracy remains one of the main issues. Recently, the Data-Driven Computational Mechanics (DDCM) opens a new route to achieve this balance. By directly embedding the constitutive data into mechanical simulations, it bypasses the empirical material constitutive modelling, thus reduces the related cost and modelling error. Obviously, the development of DDCM could be accelerated based on the fruitful achievements of Model-Driven Computational Mechanics (MDCM, which refers to the standard constitutive model-based simulations), such as model reduction techniques, homogenization methods, domain decomposition techniques, etc. In this work, we will discuss two potential combinations between DDCM and MDCM: (1) the data-driven computational homogenization method, where the multilevel finite element technique (FE^2) is applied to construct accurate constitutive database, and the distance-minimizing data-driven approach is employed to reduce the online computing time; and (2) a domain decomposition coupling technique between DDCM and MDCM, where DDCM is employed for the local region to avoid material modelling errors and uncertainties, whilst MDCM is applied to the remaining regions to benefit from its computational efficiency.