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Bayesian inference of multiscale model parameters with artificial neural networks as surrogate

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In the context of multiscale models, it is not always possible to identify the constituents properties and inverse analysis is a way to identify them from experimental data conducted at the higher scale.

For example, non-aligned Short Fibers Reinforced Polymer (SFRP) responses can be modelled by Mean-Field Homogenization (MFH) but some geometrical parameters, such as the effective aspect ratio, and some phase material parameters, such as the matrix model parameters, should be inferred from composite experimental responses in order to avoid extensive measurement campaigns at the micro-scale.

In practice, because of the increase in the number of parameters in the non-linear models, this identification requires several loading conditions, and a unique set of parameters cannot reproduce all the experimental tests because, on the one hand, of the model limitations and, on the other hand, of the experimental errors [1]. Bayesian Inference (BI) allows circumventing these difficulties, but requires a large amount of the model evaluations during the sampling process. Although MFH is computationally efficient, when considering non-aligned inclusions, the evaluation cost of a non-linear response for a given set of model and material parameters remains too prohibitive.

In this work, a Neural-Network (NNW) is first trained using the MFH model, and is then used as a surrogate model during the BI process which is conducted using experimental composite coupon tests as observation data [2].

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