

Proposal for Mechanistic Data Science Final Project

Title: Use of data-driven approach for the homogenization of composite mechanical properties

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Proposal:

Composite materials, due to their advantages, are widely used today in various applications. But before they can be used in any application, knowing their properties is essential. To characterize the composites, various approaches such as experiments, analytical modeling, and numerical modeling have been used in the past. Experiments are an expensive way to characterize any materials in terms of cost as well as time. Hence, experiments cannot always be performed. To reduce the number of experiments carried out, analytical and numerical models were developed. Analytical models are pure mathematical models with closed-form solutions. But, usually, mathematical models do not capture the effect of fiber's shape, position, and orientation effectively. Therefore, numerical models (finite elements models) were developed to capture the effect of the above parameters.

But, carrying out numerical analysis is also a time-consuming process and for the optimization process, it needs to be executed in a loop. Therefore, the aim of this project is to use a data-driven approach to homogenize the material properties of composites. The first step in this direction will be to collect the data from the past finite element analysis carried out for the homogenization of various composites. Then, from the collected data, features such as the stiffness matrix, shape, orientation, position and volume fraction of the fiber will also be extracted. Then the effect of various extracted features on the homogenized properties will be studied using a regression technique for dimensional reduction. In the penultimate stage of the project, with the help of extracted and prepared data, a machine learning model will be trained to predict the homogenized properties of any composites. During the last phase of the project, the drawbacks of the model will be studied and steps for further improvements will be proposed.