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Feature Extraction and Impact Analysis for Solid Mechanics Using Supervised Finite Element Analysis

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Abstract : We present a generalized feature extraction approach for supporting Machine Learning (ML) algorithms which perform tasks similar to Finite-Element Analysis (FEA). We report results for estimating the Head Injury Categorization (HIC) of vehicle engine compartments across various impact scenarios. Our experiments demonstrate that models learned using features derived with a simple discretization approach provide a reasonable approximation of a full simulation. We observe that Decision Trees could be as effective as Neural Networks for the HIC task. The simplicity and performance of the learned Decision Trees could offer a trade-off of a multiple order of magnitude increase in speed and cost improvement over full simulation for a reasonable approximation. When used as a complement to full simulation, the approach enables rapid approximate feedback to engineering teams before submission for full analysis. The approach produces mesh independent features and is further agnostic of the assembly structure.

Keywords : mechanical design validation, FEA, supervised decision tree, convolutional neural network.
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