Supervised Learning for Computer-Aided Design (CAD): Towards Clean-up and Defeaturing

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1 Abstract

Computer-Aided Design (CAD) models are a core component of the industrial design process; however, they often require significant modifications to facilitate computational simulations that accurately reflect the target physics. This *defeaturing* process involves carefully modifying the geometry to meet meshing, physics, and computational requirements to enable efficient and accurate simulations. Defeaturing is essential for preparing CAD models for simulation, but it demands substantial user expertise and is often time-consuming, creating a bottleneck in the design-to-simulation workflow. To address this, we propose a machine learning approach aimed at automating the defeaturing process while keeping expert input in the loop. Our approach uses mesh quality metrics as proxies for simulation suitability, leveraging machine learning to predict the necessary CAD operations based on anticipated mesh outcomes. We develop new machine learning features for predicting meshing outcomes, extending the feature sets developed in previous work [2, 4, 3]. Using models from the open-source ABC repository [1], we compile an extensive training dataset to address issues with variability in meshing outcomes and improve the generalization capabilities of the models. We train and evaluate a collection of random forest and neural network models to predict mesh quality based on the geometric features extracted from the CAD models. Initial results show the potential for high-accuracy mesh quality predictions to be made prior to meshing, enabling analysts to automatically identify problematic regions. In future research, we plan to extend this procedure to perform engineering-specific and physics-based defeaturing; we also plan to explore applications of reinforcement learning to create an end-to-end workflow for processing CAD geometries into simulation-ready models.

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