

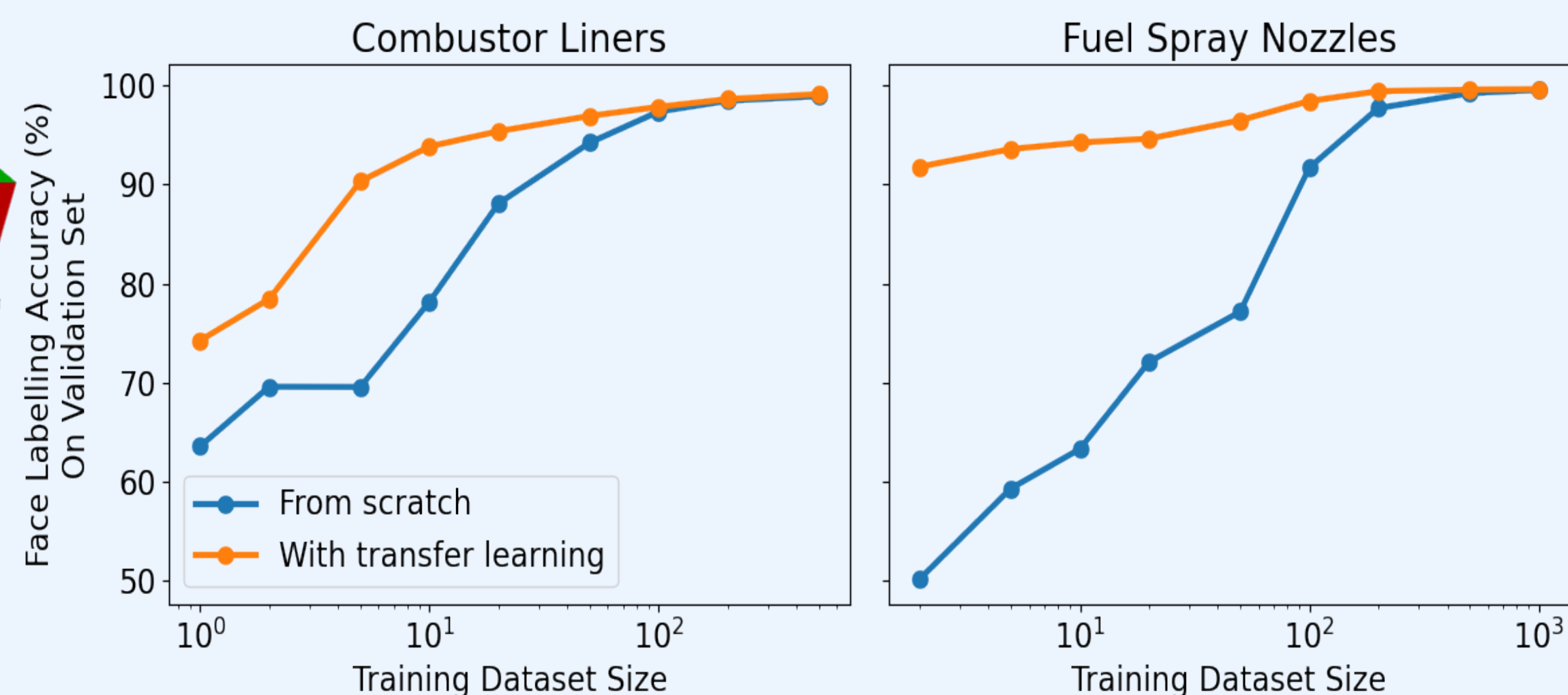
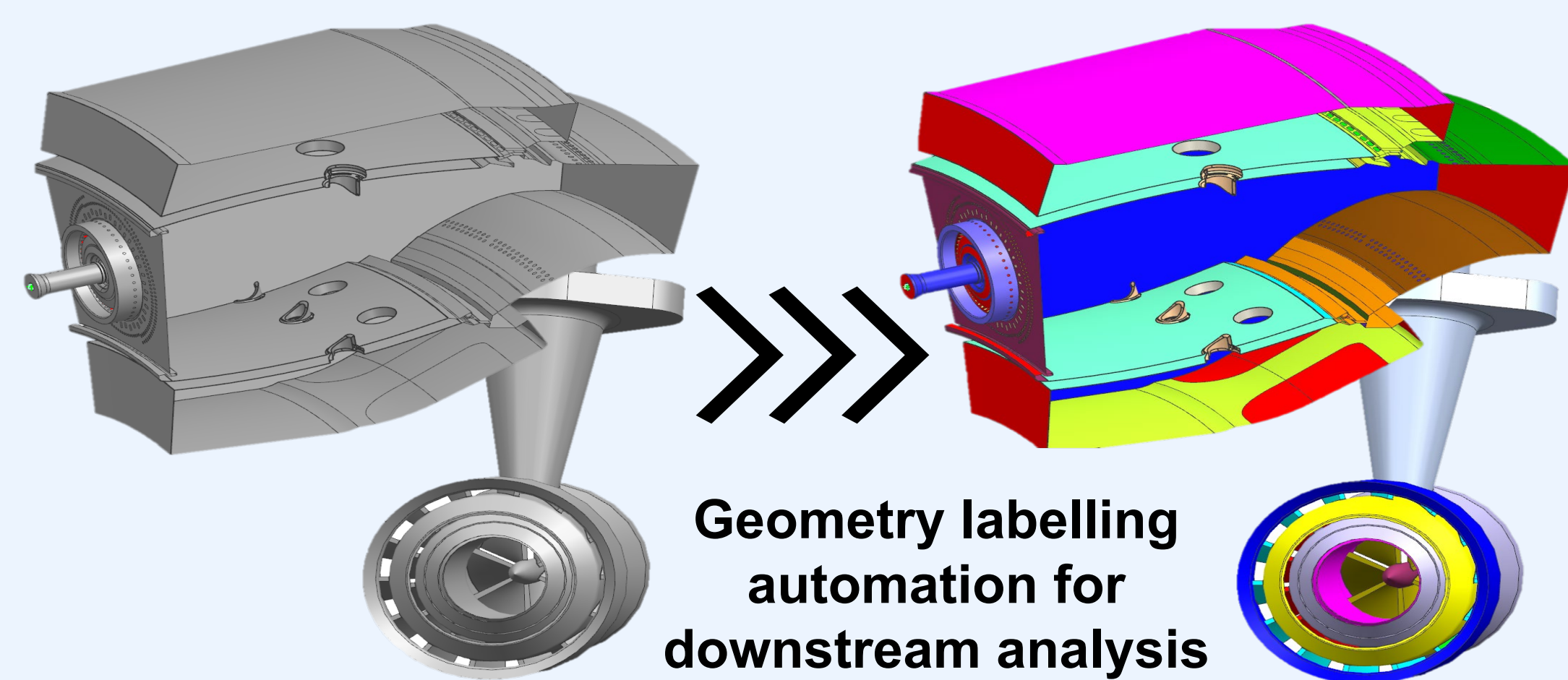


# Enhancing Human-Machine Collaboration in CAD: Replicating user input to accelerate feature recognition

## UTC for Computational Engineering

*Gerico Vidanes, David Toal, Xu Zhang, Andy Keane, Faculty of Engineering and the Environment  
Jon Gregory Marco Nunez, Fred Witham, Rolls-Royce plc.*

Computer-aided design (CAD) forms a cornerstone of the modern engineering workflow. Recently, deep learning (DL) has been applied to automate CAD tasks and accelerate the design process. These rely on large annotated datasets and deployment is limited to similar cases; arguably not suitable for engineering design's ever-changing landscape. We present work towards an adaptive system that alleviates these drawbacks, focusing on geometric feature recognition as a case study.

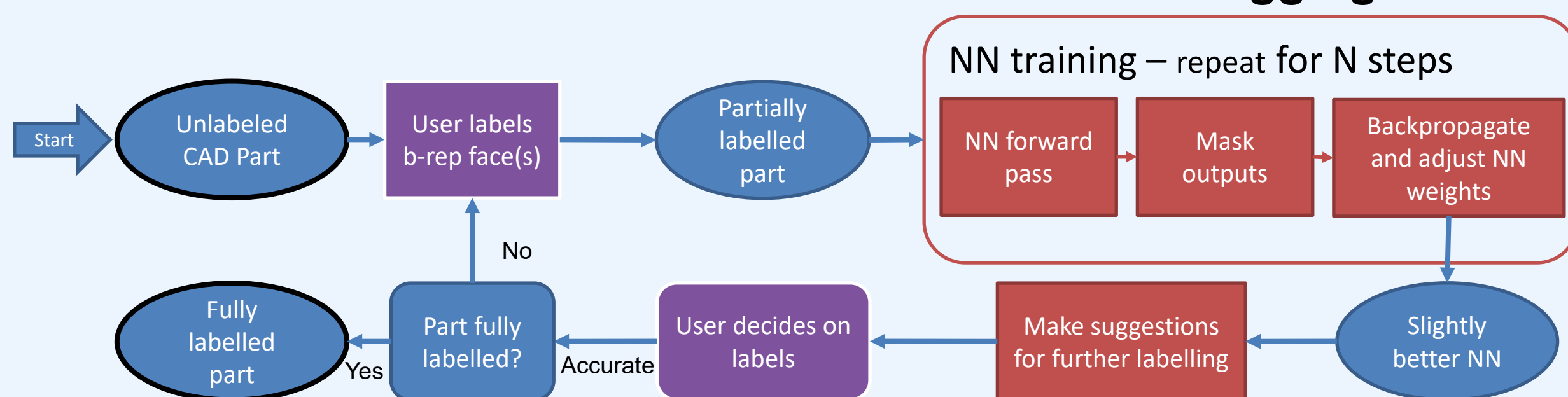


Pre-training on large public datasets and transfer learning to the target geometries can alleviate the degradation of accuracy with decreasing training data. There is potential for **learning a new task from a small number of labelled examples** for application to new designs of features. In addition, **inference is fast even on CPU** - <8s to label a FSN model with >400 b-rep faces in NX using the trained GNN.

## Incremental Learning from User Inputs to Accelerate Manual Tagging

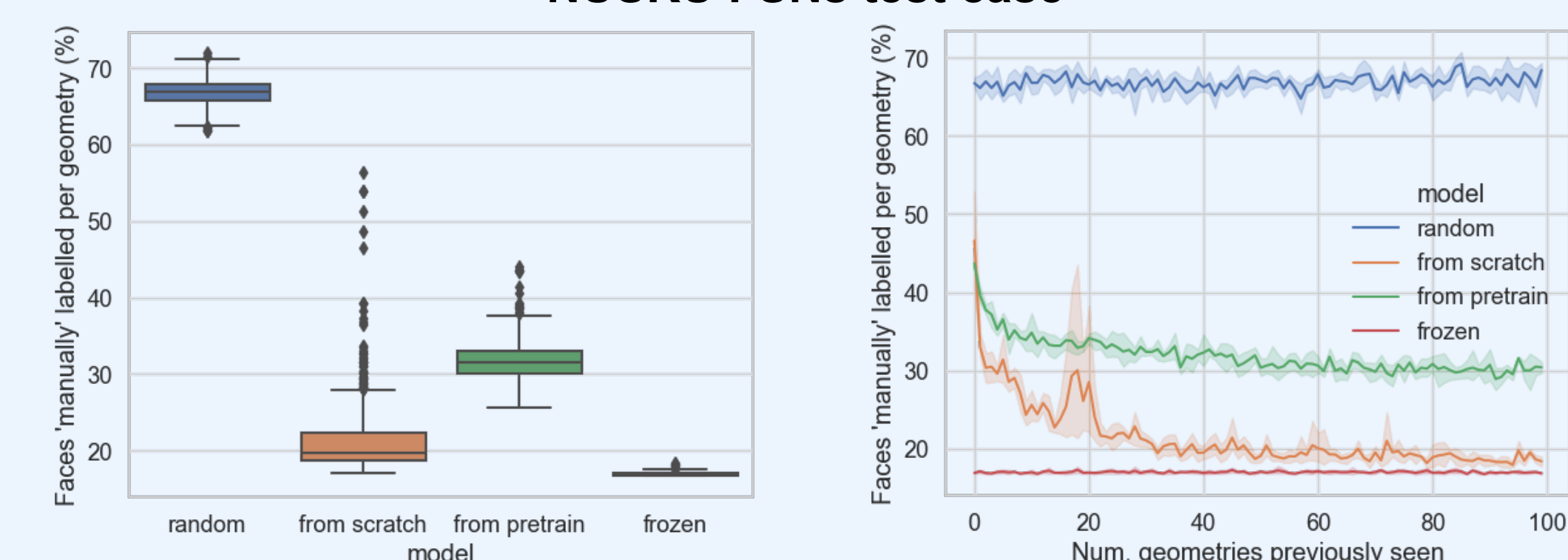
Both new geometric features and different contexts for the same geometry (CFD vs FEA) would require retraining GNN outputs. Because of data-efficiency and fast training (one training step takes 0.4s on mid-range desktop GPU, NVIDIA GTX1080Ti), we are attempting to train the GNN live as a user labels a CAD model. GNN outputs are used to suggest tags for other b-rep faces.

### Iterative workflow for DL accelerated tagging

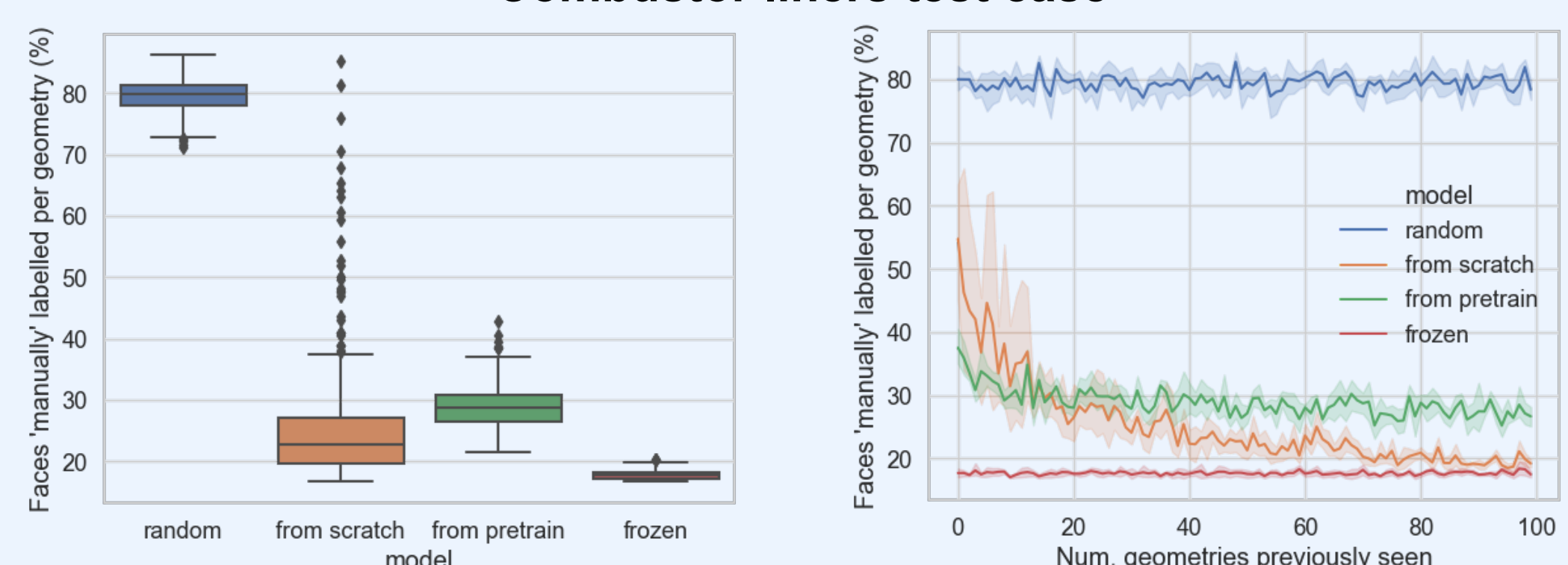


- Preliminary results show that the model can help accelerate manual tagging as it learns compared to a random baseline.
- Improvements are compounded as more geometries of the same type are tagged.
- **Future:** Instead of curating labelled datasets to train DL models, the system observes user inputs to CAD and progressively learns to replicate them.

### NUSKU FSNs test case



### Combustor liners test case



Orange and green are learning the labels live.  
'Frozen' (red) was trained on a full labelled dataset of the target geometry and task.

**"CAD Autocomplete" - Less time clicking, more time designing!**

