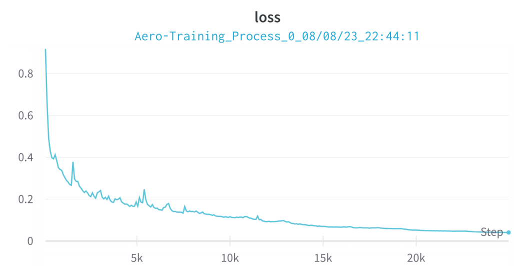
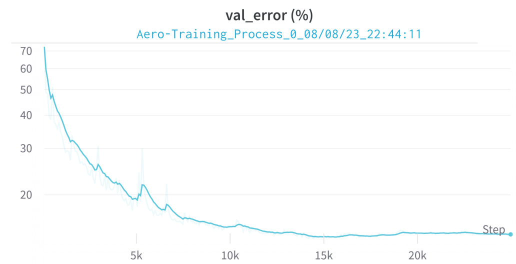
Supplemental Figures for Geometry-Informed Neural Operator

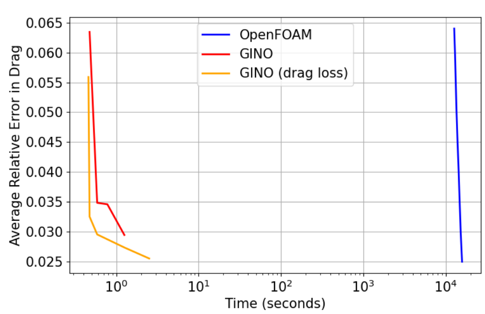
1. Comparison against graph neural networks

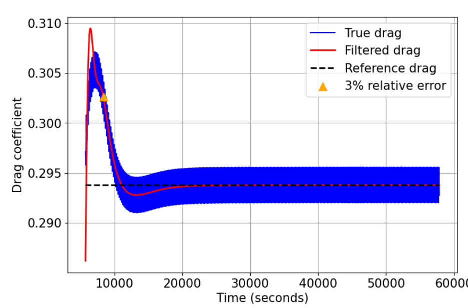




We did a new experiment to compare GINO's performance with GNN. We used the MeshGraphNet, as suggested by Reviewer 4. This model is a common GNN method for physical simulations. The training curves are presented in the figures above. The validation error for the pressure field is **13.88%**. The training curve is shown below. The error of the GNN model is much higher than the GINO model of 8.31%. The GNNs model is good at learning the local interaction with flexible meshes. However it has the challenge of learning the long-range global interactions. On the other hand, the GINO model has the advantages of both the graph and Fourier method. It has the flexibility of graphs as well as the efficiency of Fourier methods.

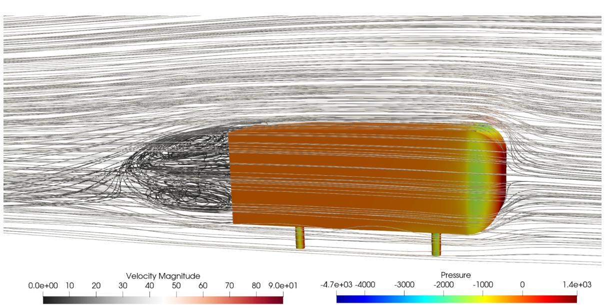
2. Comparison against solver on drag coefficients

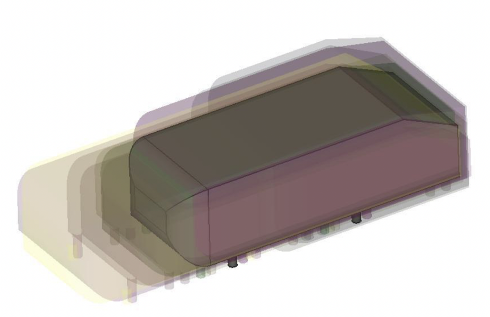




To compare the performance of our model against the industry-standard OpenFOAM solver, we perform a full cost-accuracy trade-off analysis. Figure (left) shows the cost-accuracy curve, measured in terms of inference time needed for a relative error in the drag coefficient for GINO and OpenFOAM. The solver is run on two NVIDIA V100 GPUs in parallel. Its convergence is shown in Figure (right). We observe a four to five order of magnitude speed-up when using GINO. At a 3% relative error, we find the speed-up from our model which includes drag in the loss to be 26,000 times.

3. Further illustrations of the Ahmed-body datasets.





We further add the illustrations of the Ahmed-body dataset. The figure on the left shows the velocity field and the pressure field. The velocity field, represented with 7 million nodes, has complex vortexes at the rear of the body. The pressure field, represented with 100 thousand nodes, is steep at the front and also the legs. Such aerodynamic simulations are extremely expensive. Each simulation takes 7-19 hours on 2 Nvidia v100 GPUs with 16 CPU cores. It is extremely costly to generate a 3D dataset with multiple shapes. We continue to generate simulations on new shapes and increase the instances from 500 to 800.