

Solving Complex Engineering Problems: Deep Learning (DL) for Computational Fluid Dynamics (CFD)

SIM

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It all started with ...



Figure: (Image by Kiu Trung from Pixabay)

■ Visual Cortex (Hubel and Wiesel, 1959)

... and dogs



Figure: *(Image by Free-Photos from Pixabay)*

- AlexNet & ImageNet (Krizhevsky, Sutskever, and Hinton, 2012)
- CNN for object classification: cats vs. dogs

Training Data: Initial & Boundary Conditions

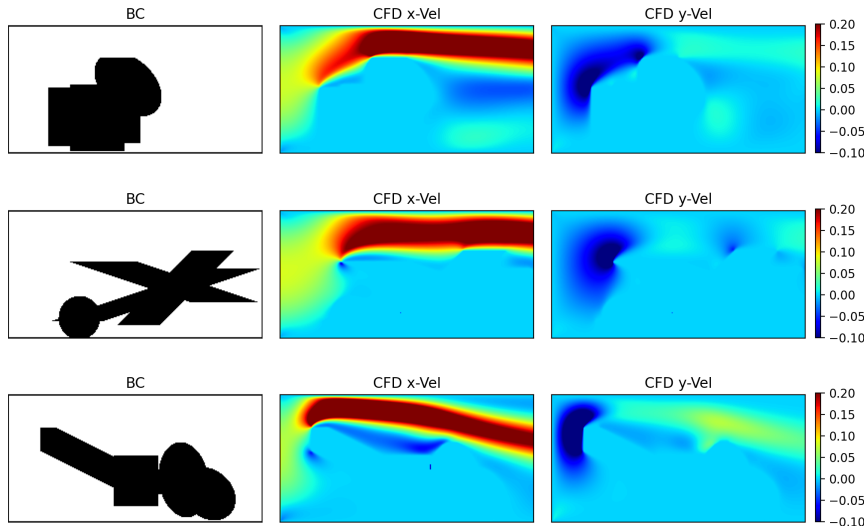


Figure: Computational Domain: input BCs, CFD results

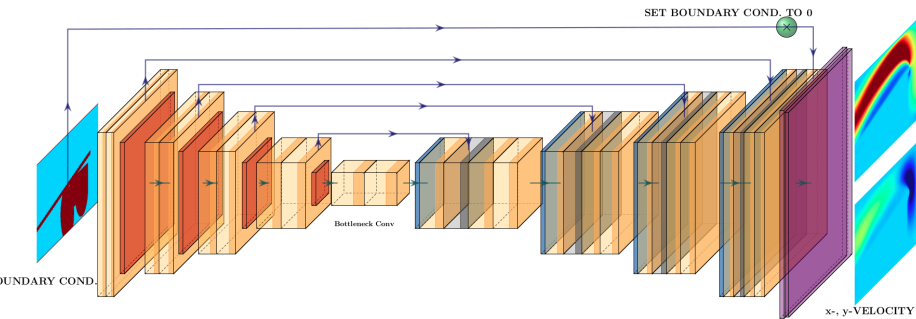
CFD costs $\uparrow\uparrow$

- Base Costs \Rightarrow 3,000 calculations: 24h
- Unseen Data Costs \Rightarrow 9,000 calculations: 3x24h

DL costs \Downarrow 80%

- Base Costs \Rightarrow 3,000 calculations: 24h
- Unseen Data Costs \Rightarrow 9,000 calculations: 3x1h

Our Architecture: CNN + U-Net + ResNet



Validation Data: predictions on unseen data

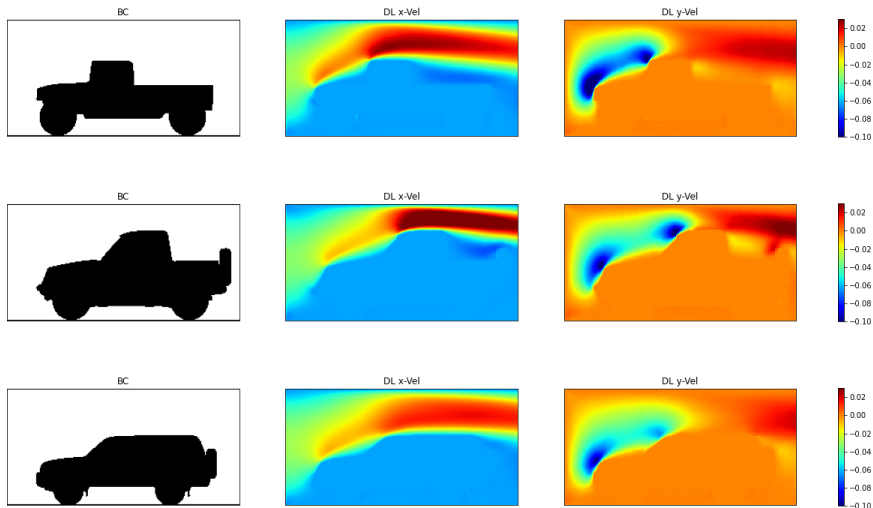


Figure: BCs & DL predictions

Validation Data: comparison

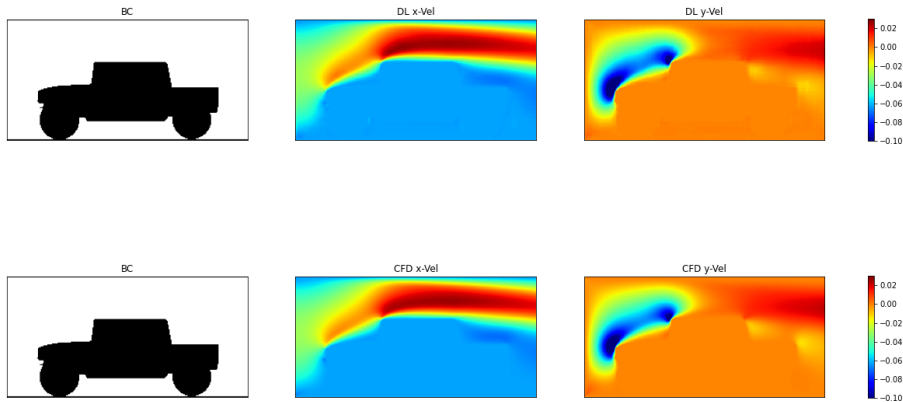


Figure: BCs & DL vs. CFD

- DL Costs: \Downarrow 80%