Prediction of Airfoil Performance Parameters Using CNN
Project Proposal

Conventional CFD softwares take large amount of time to solve for the flow around an airfoil. For reducing the time taken to calculate the lift coefficient, we intend to employ a Convolutional Neural Network that would decrease the computation time drastically. CFD solvers have high-dimensional nonlinearity, therefore if our CNN can learn those nonlinearities, that would be really useful and computationally efficient.

Recently, similar work has been done in this area by a team at Georgia Institute of Technology where CNNs have been employed to calculate the performance parameters of an airfoil. Their work can be found at: Application of Convolutional Neural Network to Predict Airfoil Lift Coefficient.

We will gather data for the airfoil shapes using UIUC Airfoil Coordinates Database having about 133 NACA airfoil data and analyse the airfoils using JavaFoil to evaluate the performance parameters(lift and drag coefficient). JavaFoil is an application which is used to predict the performance parameters of an airfoil on the basis of airfoil geometry, angle of attack and Reynold's number. Training a Convolutional Neural Network needs a large dataset to train, therefore we will run the JavaFoil applet for computing the performance parameters for a range of angles of attack and a range of Reynolds numbers. Therefore generating a dataset of about 80,000 training examples.

Our goal is to implement a CNN which takes in the airfoil geometry, Reynold's number and angle of attack as it's input and gives the performance parameters of the airfoil (lift coefficient, drag coefficient) as it's output. We intend to improve upon the previous work by implementing the following:

1. We would like the CNN to be able to predict the performance for other shapes as well. These shapes can be sphere, cuboid etc. This would increase the scope of application of the CNN. This is especially useful because predicting flows by performing CFD simulations for geometries which have a higher degree of flow separation is very difficult.
2. For now, we are using the performance parameters given by a simulation program to train the network. If we are able to train the network using experimental data, then we can improve the accuracy of our results.

We will split our dataset in 70%(training) and 30%(testing), then compare the performance parameters(lift coefficient) from the CNN with JavaFoil results.

We are a team of 3 members:

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Our TA advisor is Krishna Toshniwal. We will divide tasks according to data generation and algorithm implementation.