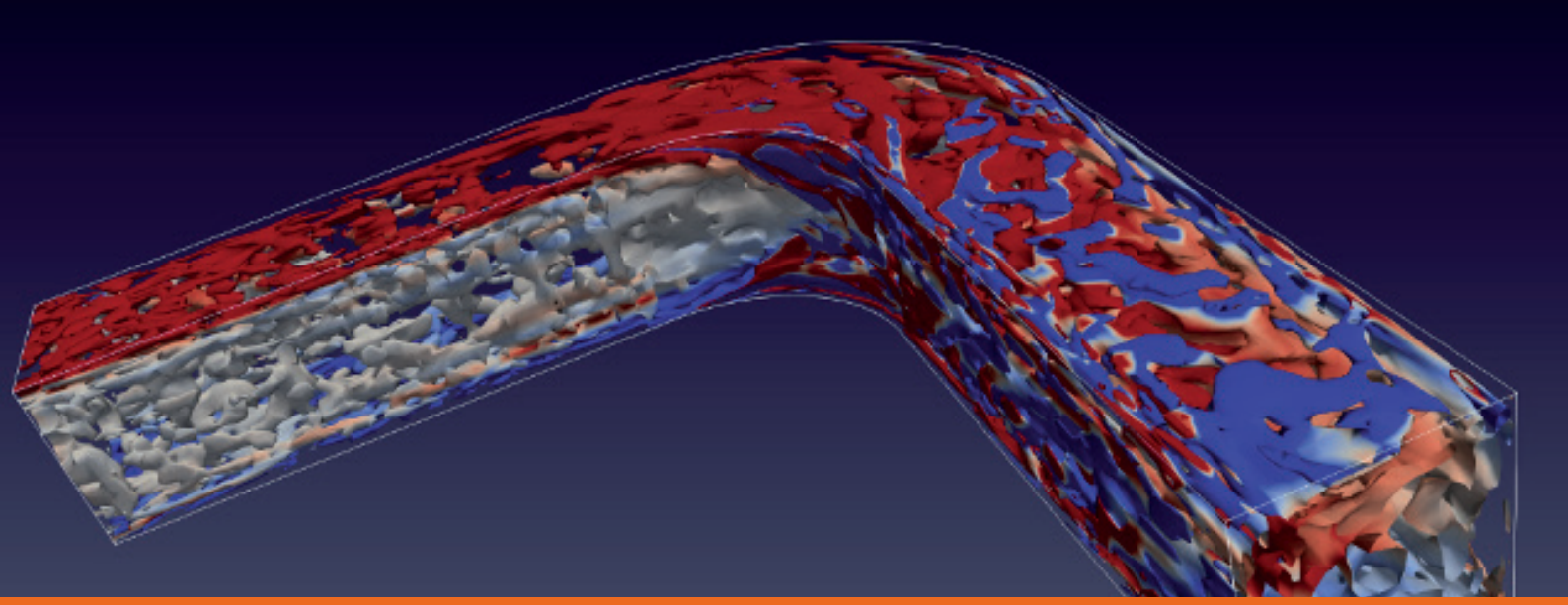

MACHINE LEARNING FOR TURBULENT FLOWS

Assignment

Computational Fluid Dynamics (CFD) simulations can be very challenging, especially when the flow becomes turbulent. Standard turbulence models used in commercial CFD packages are known to be inaccurate in many complex real-world applications. In this project, we explore the possibilities to improve turbulence models using machine learning techniques. The main question is if machine learning provides more accurate results than a state-of-the-art CFD model. For this purpose, we implement a turbulence model in a machine learning framework and use data from high-fidelity simulations (e.g. Large-Eddy Simulations, LES) as ground truth and for quantitative comparison. Specifically, we investigate the ability of the model to qualitatively capture complex flow features in various geometries. Furthermore, a practical (robust and fast) implementation in a CFD code should be developed.

Activities

- Generate training data by setting up and running LES in OpenFOAM for various geometries
- Obtain a turbulence model by training a neural network (or equivalent machine-learning algorithm
- Implement the new model in OpenFOAM
- Extend the turbulence model by adding features (geometry dependence, pressure gradient, heat transport)

Internship overview

- Master Student
- Graduation Assignment
- Mathware
- Location: Eindhoven

Technologies

- Computational Fluid Dynamics
- Machine learning
- Large-Eddy Simulations
- Data Analysis

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Context

For many high-tech companies, computational physics simulations are a useful tool for product design and prototyping. At Sioux Mathware we often work with commercial packages like Comsol to perform such simulations for clients. These simulations can be very challenging, especially when fluid flow is involved. For high Reynolds numbers, such flows can become turbulent and difficult to model. Despite being a very old research topic, the “perfect” turbulence model has never been found, and the standard models used in commercial CFD packages are known to be inaccurate.

However, since a few years turbulence research has turned towards machine learning to improve existing turbulence models. The general idea is that a machine-learning algorithm (e.g. neural networks, random forests) can be trained on data from high-resolution simulations and experiments to “learn” a more advanced functional relationship between the turbulence and the mean-flow quantities.

At Sioux Mathware we have explored this topic in previous research/student projects and wish to bring this to the next level. The goal is a practical implementation that can be used in commercial projects. Crucial open questions that remain:

1) on how many different geometries do we need to train to capture complex flow features?
2) which features / physics can be included in the model to further improve it?

Why choose Sioux?

- Working on innovative technology
- Challenging, dynamic and varied work
- A comfortable and personal work environment
- Plenty of opportunities for personal development
- Great carreer opportunities
- Contributing to a safe, healthy and sustainable society

Get in touch!
Would you like to know more about this student assignment?

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