Lehrstuhl für
Aerodynamik und
Strömungsmechanik

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Transformers for Aerodynamics

Traditional aerodynamic design studies have used CFD simulations, but neural networks have shown promise in approximating complex physical phenomena. The Transformer architecture, known for its success in natural language processing and computer vision, remains relatively unexplored in aerodynamics and flow analysis.

Project Description:

This master's thesis aims to explore the potential of using Transformer architecture in aerodynamics and fluid dynamics. The research will focus on determining if Transformers can effectively capture complex flow patterns and enhance prediction accuracy compared to conventional neural networks. By leveraging an established dataset, enough data to train and fine-tune the model is available.

Tasks and Responsibilities:

- Review prior work in the area to establish a foundation for the research.
- Study relevant literature on neural networks in fluid dynamics and aerodynamics.
- Familiarize with the Transformer architecture and its adaptations for different domains.
- Work with the existing large dataset of 2D airfoil simulations and its preprocessing pipeline.
- Propose enhancements or modifications to the Transformer architecture for improved performance in aerodynamic simulations.
- Implement and fine-tune the improved model for flow prediction.
- Analyze the findings and compare them with previous research and conventional neural network approaches to understand the model's capabilities and limitations for different geometries and flow conditions.
- Document the research, methodologies, results, and conclusions in a well-structured thesis.

Requirements:

- Motivated, independent, and proactive approach to research.
- Familiarity with fluid dynamics and aerodynamics principles.
- Strong background in machine learning, deep learning, and neural networks.
- Proficiency in programming languages such as Python, and experience with deep learning frameworks like TensorFlow, Jax, or Flax.
- Strong written and verbal communication skills in English and/or German.

Application Process:

Interested candidates should submit their applications, including a CV, academic transcripts, and a brief statement of interest. Please highlight any relevant experience.

For any questions about the project or application process, please do not hesitate to reach out. We look forward to receiving your application and collaborating on this exciting research endeavor!

Optional: Students may begin with a semester project to familiarize themselves with the topic before tackling the master's thesis.

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