Chair of Aerodynamics and Fluid Mechanics
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Development of a CI/CD pipeline for the Fully-differentiable JAX-Fluids CFD Code

Interdisciplinary Project (IDP)

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JAX-Fluids is a computational fluid dynamics (CFD) solver for compressible single- and multiphase flows. Built on the JAX library, the entire code base is inherently differentiable, making it ideal for gradient-based optimization tasks. JAX-Fluids utilizes JAX-based parallelization primitives to enable distributed computations across multiple XLA devices, including the computation of automatic differentiation gradients across XLA devices. The solver has demonstrated excellent scaling on up to 512 NVIDIA A100 GPUs and up to 1024 TPU cores.

To enhance the reliability, scalability, and maintainability of JAX-Fluids, this project will build upon the existing CI/CD pipeline, which currently covers only basic functionalities. The aim is to develop an advanced and robust CI/CD pipeline that automates essential workflows, including comprehensive testing, automated documentation generation, and validation of critical features such as parallelization and automatic differentiation. The workflow of this project includes the following steps:

1. **Automated Documentation Generation**: Create comprehensive and dynamically generated documentation using tools like Sphinx or MkDocs. Ensure that the documentation includes API references, usage examples, and tutorials (including Jupyter Notebooks).
2. **Unit Testing Framework**: Implement a suite of unit tests for core functions using Pytest.
3. **Physics-Based Tests**: Include existing physics-based tests into a comprehensive test suite.
4. **Parallelization Testing and Differentiation Testing**
5. **Continuous Integration/Continuous Development**: Set up automated testing workflows triggered by code commits and pull requests using GitLab CI. Automate the deployment of documentation and tagged releases to GitLab.

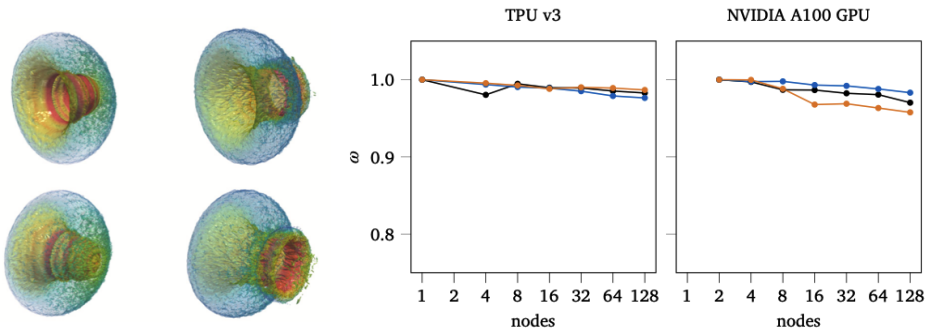

Figure 1: Left: Simulation result of a shock-bubble interaction. Right: Weak scaling efficiency of JAX-Fluids. Pictures taken from Bezgin et al. 2025.

Requirements

- Programming experience in Python.
- Experience with CI/CD tools.
- Interest in HPC, numerical solution of partial differential equations, and CFD.

Application

Please send an up-to-date transcript of records to deniz.bezgin@tum.de