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A collaborative framework for generating and visualizing parametric results of CFD simulations

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Recent technological developments have made it possible to accelerate computational fluid dynamics (CFD) modeling through physics-based or data-driven surrogate modeling. This acceleration is key for enabling the integration of such solutions with real-life systems for dynamically controlling complex processes, and also allows an interactive analysis of the parametric space of CFD simulations. We present an open-source framework for generating and visualizing parametric results of CFD simulations using surrogate models. The framework consists of two main components: a JavaScript module (rom.js) and a React JS web app (cfd.xyz) accessible at https://cfd.xyz. Working together, these tools create a shared space where canonical and industrial CFD problems can be visualized and analyzed on the web without carrying out a simulation. It can also be executed outside a web browser within a backend JavaScript runtime environment. The models and workflows for generating the surrogate models are shared in a reproducible way, and new cases can be easily integrated on the web thanks to React reusable components. The current version is based on OpenFOAM as the CFD tool and ITHACA-FV as the reduced-order modeling (ROM) one. Further implementations will be considered for including other ROM or machine learning packages, as well as other CFD tools.

The rom.js module is only 5 MB and applied to the pitzDaily OpenFOAM tutorial takes around 0.06 s. for calculating and reconstructing new fields for a given set of parameters. This allows a smooth interaction through the different parameters. The framework provides a proof of technology for OpenFOAM tutorials, showing the whole process from the generation of the surrogate model to the web browser. It also includes two standalone web tools for visualizing users' data by directly dragging and dropping ROM's data or VTK unstructured grids. Beyond the current proof of technology, this enables a collaborative effort for the implementation of OpenFOAM surrogate models in applications demanding real-time solutions such as digital twins and other digital transformation technologies.