Predictive Analysis for Large Unstationary CFD Simulations in Automotive Applications

Overview

In partnership with a leading car OEMI, we developed a machine learning-based predictor to assess the runtime of extensive non stationary CFD simulations. The predictor aids in determining whether these simulations, which run for several days on thousands of cores, can be terminated early without sacrificing essential data or if they need to continue for an extended period to capture vital dynamics.

Keywords

computational fluid dynamics (CFD)
machine learning
predictive analysis
car OEMI
non stationary simulations
termination prediction
HPC

Situation

The car OEM conducts long, nonstationary CFD simulations, each spanning several days and utilizing thousands of cores. Due to the inherent complexities and the nonstationary nature of these simulations, conventional stationarity tests were ineffective. There was a pressing need to identify whether these simulations could be terminated early without compromising on the quality of results or if they had to be run longer to ensure all critical dynamics were captured.

Requirements

Collaborate with the car OEM to understand the intricacies of their CFD simulations and the challenges faced due to their non stationary nature.

Develop a machine learning predictor capable of reliably determining the potential runtime of the simulations.

Ensure that the predictor can make accurate determinations on whether the simulation can be terminated early without losing essential information.

Integrate the predictor into the OEM's existing simulation workflow for seamless operation.

Solution

Working alongside the car OEM, a machine learning-based predictor was designed specifically for their extensive non stationary CFD simulations. This predictor, trained on past simulation data and refined for accuracy, could reliably determine if a simulation could be terminated early without compromising the integrity of the results. By doing so, it ensured optimal utilization of computational resources and reduced unnecessary runtime.

Benefits and Results

- Enabled the car OEM to make informed decisions about the runtime of their CFD simulations, ensuring efficient use of computational resources.
- The machine learning predictor provided a solution to the challenge of unreliable stationarity tests, offering a reliable alternative for assessing simulation termination.
- By potentially reducing the runtime of certain simulations without compromising on data quality, significant time and computational savings were achieved.
- The project showcased the potential of machine learning in enhancing traditional simulation processes, opening doors for further innovations in the field.
- The success of the predictor paves the way for its adaptation and application in other industries facing similar challenges with non stationary simulations.