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Towards Trustworthy Neural Networks for Certification by Analysis – Fuel Tank Flammability Reduction System

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Abstract

Analytical models of aircraft systems have been used to supplement aircraft certification by demonstrating analysis-based compliance. These models have deterministic behaviors that can be empirically validated. However, these accurate simulations are computationally expensive, raising concerns about computing resources.

Data-driven surrogate models are increasingly used in aerospace to reduce computational time, improve efficiency, and enable extensive design exploration. These models utilize simulation, test, and operational data for training, validation, and calibration. While surrogate modeling shows promise in augmenting traditional certification, their data-driven nature hinders immediate use in certification and airworthiness assessment. The lack of Uncertainty Quantification (UQ) further raises concerns about model trustworthiness.

We explore the use of data-driven surrogate models for certifying the fuel tank Flammability Reduction System (FRS). FRS certification involves multiple physics-based analysis models run via Monte-Carlo analysis, incorporating statistical distribution of environmental and airplane-specific parameters. This unique case presents an opportunity to develop trustworthy surrogate models, leveraging UQ. Such models can e.g. expedite certification of new minor models and enhance in-service system safety assessments.

This presentation highlights the value of surrogate models for the FRS use case and discusses approaches to improve model trustworthiness.