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### Title

Formal Analysis and Redesign of a Neural Network-Based Aircraft Taxiing System with VerifAI

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## Formal Analysis and Redesign of a Neural Network-Based Aircraft Taxiing System with VerifAI

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### Abstract

We demonstrate a unified approach to rigorous design of safety-critical autonomous systems using the VerifAI toolkit for formal analysis of AI-based systems. VerifAI provides an integrated toolchain for tasks spanning the design process, including modeling, falsification, debugging, and ML component retraining. We evaluate all of these applications in an industrial case study on an experimental autonomous aircraft taxiing system developed by Boeing, which uses a neural network to track the centerline of a runway. We define runway scenarios using the Scenic probabilistic programming language, and use them to drive tests in the X-Plane flight simulator. We first perform falsification, automatically finding environment conditions causing the system to violate its specification by deviating significantly from the centerline (or even leaving the runway entirely). Next, we use counterexample analysis to identify distinct failure cases, and confirm their root causes with specialized testing. Finally, we use the results of falsification and debugging to retrain the network, eliminating several failure cases and improving the overall performance of the closed-loop system.

### BibTeX

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