Adaptive Stress Testing of Trajectory Predictions in Flight Management Systems

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A primary component of flight management systems is to provide guidance in the form of navigational waypoints between source and destination airports. A trajectory predictor is the subsystem that provides this guidance directly to the pilots or autopilot. Failures within the trajectory prediction system can occur if the provided waypoints are infeasible to fly given the physical limitations of the aircraft. Adaptive stress testing is a method which uses reinforcement learning to search for rare failure events in sequential decision-making systems. This work applies adaptive stress testing of trajectory prediction systems to systematically find failure events and their likelihoods. The trajectory prediction system is treated as a black-box simulator and the adaptive stress testing approach controls the seed for the random number generator that affects the sampling of assembled waypoints and other environmental input parameters. Monte Carlo tree search with action progressive widening is used to explore the possible trajectories and a notion of "miss distance" to a failure event is used to help guide the search. Transition probabilities between states are used to find the most likely failures. Experiments will be run to generate likely failure events that are provided to the developers of the trajectory predictor to analyze and resolve potential shortcomings of the system.