Abstract: With the increasing popularity of deep learning, there have been several efforts to use neural network based controllers in cyber-physical system applications. However, neural networks are equally well-known for their lack of interpretability, explainability and verifiability. This is especially an issue for safety-critical cyber-physical systems such as unmanned aerial vehicles or autonomous ground vehicles. How can we verify that a neural network based controller will always keep the system safe? We look at a new verification approach based on automatically synthesizing a barrier certificate for the system to prove that: starting from a given set of initial conditions, the system behavior can never reach an unsafe state. Barrier Certificates are essentially a generalization of inductive invariants for continuous dynamical systems, and we will show how we can use nonlinear SMT solvers to establish the barrier certificate conditions. A more intriguing challenge is whether we can actually train neural networks to obey safety constraints. We will look at a new way of reward shaping in reinforcement learning that could help achieve this goal.

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