CAREER: Verified AI in Cyber-Physical Systems through Input Quantization

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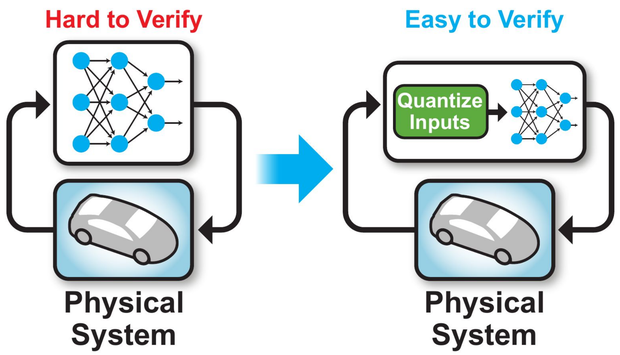
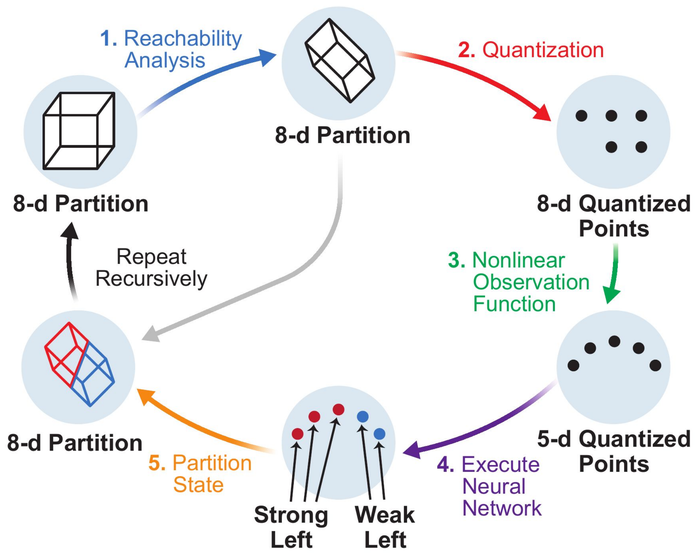
Goal: Practical formal verification for neural network control systems with small numbers of inputs

How: Approximate NN by quantizing (rounding) inputs. Then use batch execution rather than NN verification.

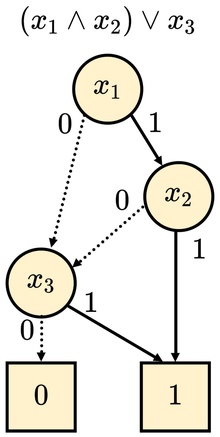


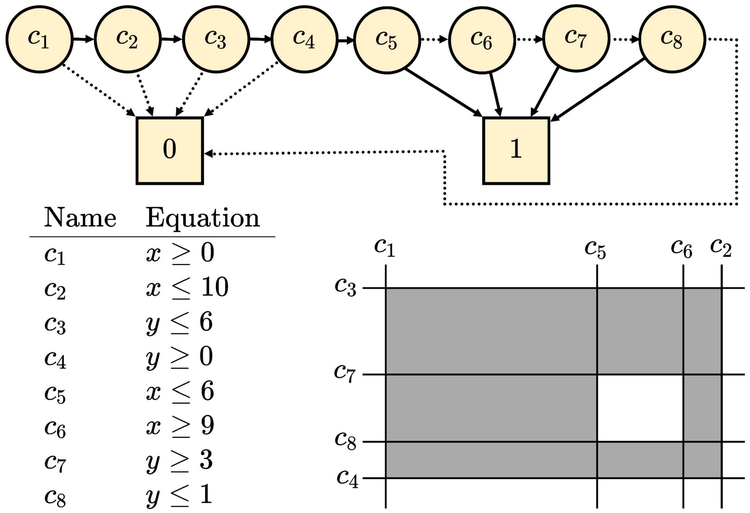


Closed-loop verification combines batch execution with reachability analysis.

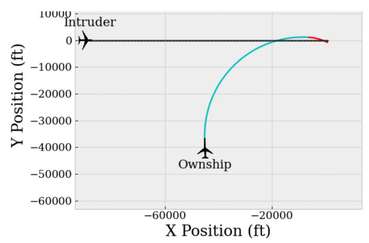
We also plan to investigate non-convex set representations based on binary decision diagrams (**BDDs**) called linear constraint decision diagrams (**LCDDs**).

Key question: How can we do reduction?

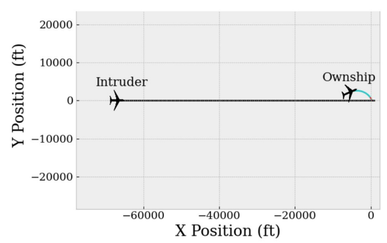




Name	Equation
c_1	$x \geq 0$
c_2	$x \leq 10$
c_3	$y \leq 6$
c_4	$y \geq 0$
c_5	$x \leq 6$
c_6	$x \geq 9$
c_7	$y \geq 3$
c_8	$y \leq 1$



(a) Fast Ownship Keeps Turning.

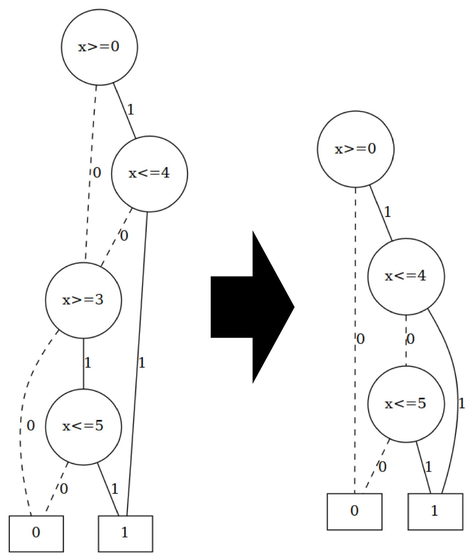


(b) Safety System Causes Crash.

Two examples closed-loop trajectories from ACAS Xu neural network compression which were found to be unsafe.

On the right, LCDDs from the union operation: [0, 4] U [3, 5]

We can represent it with two constraints, but reduction from root gives 3.



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