Validating System Safety with Level Sets (and vice-versa)

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Many safety requirements for systems modeled by differential equations or hybrid automata can be formulated as optimal control or differential game problems. We describe this formulation, and how such problems can be turned into Hamilton-Jacobi partial differential equations for which level set algorithms can compute numerical solutions.

We then discuss a particular three dimensional example with complex continuous dynamics for which we can analytically determine the boundary of the set of safe states. Consequently, this solution can be used to numerically validate the accuracy of three dimensional level set solvers. We illustrate this backward validation on our own level set code, and then the forward safety validation process using that code on a hybrid system model of aircraft landing.