Model Generation for Hybrid Systems Verification in HYST
Stanley Bak¹, Sergiy Bogomolov², Taylor T. Johnson³

¹Air Force Research Laboratory (AFRL), USA, ²Institute of Science and Technology (IST) Austria, ³University of Texas at Arlington (UTA), TX USA

Overview

HYST: a source-to-source translation tool for hybrid automaton models [4]. Three main functions:

- Model translation
- Model transformation
- New: Model Generation

Model transformations ease modeling and improve reachability analysis:

- Model Optimization
- Hierarchy Flattening
- Look-up Table Conversion
- Model-Order Reduction
- Automated Pseudo-Invariants [1]
- Continuation of Real-Time Controllers [5]
- Simulation-Guided Hybridization [3]

References

HYST is open source: https://github.com/verivital/hyst


Model Generation

Navigation Benchmark [6] (others: Chains of Integrators Benchmark [2])

Dynamics: Velocities are steered towards target velocities:

\[ \dot{y} = A \cdot (\dot{y} - y) \]

\[ A = \begin{pmatrix} -1.2 & 0.1 \\ 0.2 & -1.2 \end{pmatrix} \]

Vanderpol Dynamics

Multiple Iterations may be Necessary

- Simulations are used to determine the placement of auxiliary hyperplanes, improving accuracy.

Model Transformation

Transformation: Static Simulation-Guided Hybridization [3]

\[ x' = y \]

\[ y' = (1 - x^2) \cdot y - x \]

Transformation: Continuation of Real-Time Controllers [5]

- Real-time scheduling guarantees periodic actuation for low-level controllers.
- Continuation enables analysis of such systems using continuous dynamics approximations with additional bounded noise.

SpaceEx

HyCreate

dReach

SpaceEx

(others)

Model of a Real-Time Low-Level Controller