Task 2: Convex polytopes

Optimization

In this task you will improve your current implementation of convex polytopes with respect to reachability analysis of hybrid systems.

Due date: Friday, 12^{th} February 2016.

Present your implementation in a short presentation ($\sim$ 20 minutes).

Tasks

To optimize your implementation there are several ways. We provide some ideas on which you can choose at least one:

1. Consider other already given implementations of state set representations (boxes, support functions) and provide conversion functions from your implementation to those representations and back. Provide additional convenience-constructors for your implementation to ease the conversion from those state set representations to your implementation.
   Note: You might want to provide exact as well as over-approximating conversions.

2. Implement reduction techniques which allow to reduce the representation regarding its complexity (i.e. overapproximate a polytope by a less complex polytope. Think of different ways to reduce your representation (i.e. drop single or multiple planes, unite planes, ...). Furthermore, implement the reduction of a sequence (a part of a given flowpipe) of sets to a single set during flowpipe construction. Develop heuristics on the choice and size of those sets of segments for a given flowpipe, which minimizes the introduced over-approximation.

3. Implement more sophisticated datastructures and algorithms: By analyzing runtime of your implementation find bottlenecks and fix those by implementing more sophisticated algorithms for operations such as Minkowski sum or convex hull or tune your datastructures to achieve a reduced runtime.
   Note: The sophisticated reduction of rational number representation can significantly reduce running times but requires to ensure outward rounding.

If you have own ideas on optimization, please feel free to discuss them with us such that we can decide if it makes sense to further develop those ideas instead of one of the previously mentioned tasks.