



Modeling and Analysis of Hybrid Systems

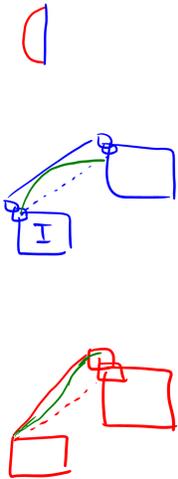
Series 7

Exercise 1

Which operations on state set representations are required for the computation of the reachable states of a linear hybrid automaton, and what are they used for?

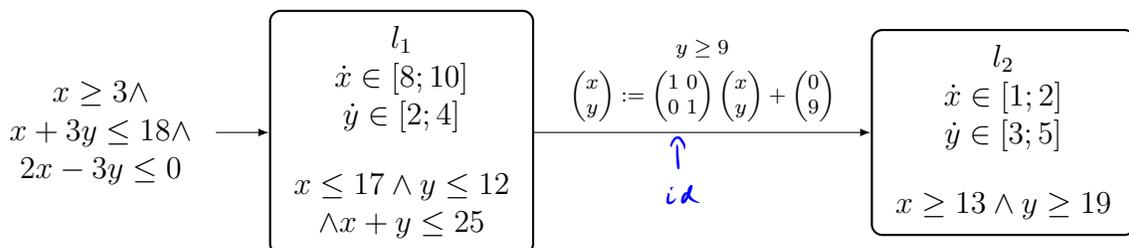
Solution:

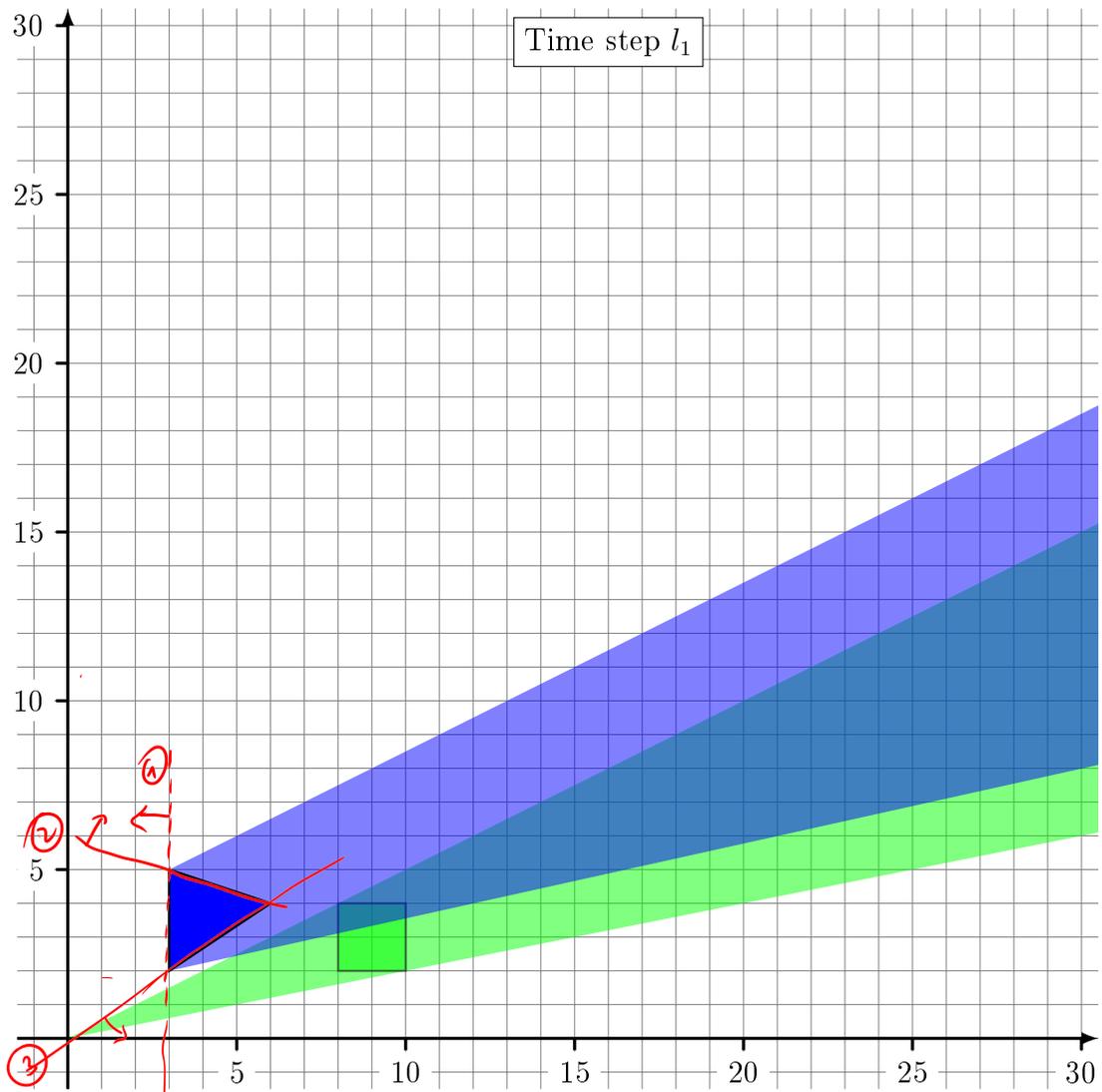
- Convex hull of the union: Used in the computation of the first flowpipe segment (applied to the initial state sets and its bloated linear transformation).
- Intersection: Used to compute which part of a set satisfies guards and invariants.
- Linear transformation: Used to compute the first flowpipe segment and successors of flowpipe segments.
- Minkowski sum: Used for bloating in the flowpipe computation to assure safe over-approximation.



Exercise 2

Given the linear hybrid automaton \mathcal{A} (see below), please sketch the set of reachable states as computed by a reachability analysis algorithm as presented in the lecture. Please use a new plot for every operation including *time step*, *discrete step*, *invariant intersection*, *guard intersection* as already prepared.





① $x \geq 3$
 ② $x + 3y \leq 18$
 ③ $2x - 3y \leq 0$

$x \in [8, 10]$
 $y \in [2, 4]$

JW : $x \leq 17$
 $y \leq 12$
 $x + y \leq 25$

Invariant intersection

