Optimization with Expensive Cost Functions for Safe Maneuver Automata

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Safe trajectory planning is a hard task . . .

...but it can be simplified using maneuver automaton (see previous presentation)
Optimal controllers and reachable set are computed for short trajectories, so-called motion primitives, e.g., drive straight for a short time, turn left, turn right, etc.

All motion primitives are stored as states in a maneuver automaton.

If the final reachable set of one motion primitive is completely inside the initial set of another motion primitive, they can safely be concatenated.
Motion primitives can be combined if the final reachable set of one motion primitive is completely inside the initial set of another motion primitive.

For best planning, we want to be able to connect as many motion primitives with each other as possible.

⇒ The reachable sets of the motion primitives should be as small as possible.

→ This can be done by using a novel optimal control algorithm.
The optimal control algorithm for computing the motion primitives requires solving an optimization problem with an expensive cost function.

In classical optimization, the evaluation of the cost function is cheap and can be performed many thousand times in a short amount of time.

In our case, each evaluation of the cost function requires computing the reachable set of a system, which takes some time.

⇒ Optimization algorithms are needed which choose the cost function evaluations in a smart way.
Several optimization algorithms for expensive cost function have been developed.

**Goal:** Find the best optimization algorithm for the computation of motion primitives and use it to compute a maneuver automaton.

**Tasks:**
- Review literature for existing optimization algorithms for expensive cost function.
- Implement the optimization algorithms in Matlab.
- Apply them for our problem and compare their performance and computation times.
Questions?

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