Motion Planning — Exercise 13

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1. Consider the task of generating a motion for a kinodynamic car with the same properties (dynamics, limits) as in the programming assignment. Specifically, we would like to compute a motion primitive in free space for a left turn ($\mathbf{q}_{start} = (0, 0, 0)$, $\mathbf{q}_{goal} = (8, 8, \pi/2)$, time horizon 8 s, time step 0.1 s, straight line initial guess).
   (a) Use sequential convex programming (SCP). Write down the mathematical definition of the convex program that SCP has to solve in each iteration. Be as specific as possible for the given example and indicate the number of decision variables.
   (b) Write down the mathematical definition when solving the problem with KOMO. Be as specific as possible for the given example and indicate the number of decision variables.
   (c) What are advantages and disadvantages of the two formulations above?

2. Define a motion planning problem that is easy to solve with optimization but very difficult to solve with sampling. Explain where the difficulty for the sampling-based approach comes from.

3. Imagine the following (fictional) hybrid motion planner: We use an A*-like informed search. For the node expansion, we randomly sample 10 configurations near the current node and use an optimizer to try to connect the current node with the sampled configurations, ignoring obstacles (i.e., for each expansion, we solve 10 optimization problems). If the optimization succeeds, we check for any collisions and add all collision-free configurations to OPEN.
   (a) Is this variant complete or asymptotically optimal? Explain.
   (b) Consider the kinodynamic planning case. List one advantage and one disadvantage compared to PRM*, where the TVBP is solved using optimization.