Motion Planning — Exercise 10

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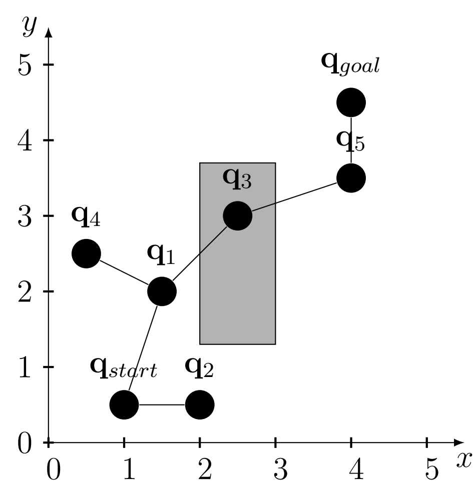
Non-Programming

1. Consider a variant of kinodynamic RRT, where we use a deterministic steering function rather than Guided Monte Carlo as node propagation.
   (a) Is this algorithm probabilistically complete (proof or counterexample)?
   (b) Is this algorithm asymptotically optimal (informal argument)?
   (c) What changes with respect to completeness/optimality if we use a deterministic *optimal* steering function, i.e., a function that computes actions such that the robot moves towards $\mathbf{q}_{rand}$ with the lowest possible cost?

2. Consider the following variant of Expansive Space Trees (see lecture 7, slide 2). Rather than sampling the configuration $\mathbf{q}$ (line 4, slide 2, lecture 7), we pick $\mathbf{q}$ deterministically to be the vertex that had the fewest *attempted* expansions. Here, we count an attempt if line 4 was executed, independent of the condition in line 6.
   (a) Is this algorithm probabilistically complete (proof or counterexample)?
   (b) Is this algorithm asymptotically optimal (informal argument)?
   (c) What changes with respect to the algorithmic properties if we pick the vertex that had the fewest *successful* expansions (i.e., the lowest number of child nodes).

3. The lecture covered LazyPRM, but not LazyRRT. Consider the following (geometric) RRT that was constructed, but did not perform any collision checks, yet.



(a) Describe the order in which vertices and edges are checked. After how many collision checks is the first collision detected?

(b) Describe how the algorithm (and especially the "node enhancement" step) may identify a collision-free path.

(c) What major challenge arises when trying to apply LazyRRT to the kinodynamic setting?