COMP550 Project4 Report

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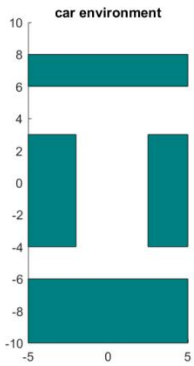
1.

For this project, I am trying to do motion planning for pendulum and car with three kinds of planners: RRT, KPIECE and RGRRT.

2.

For pendulum problem, there are no obstacles in the environment. Start-goal query: $(\theta_s, \omega_s) = \left(-\frac{\pi}{2}, 0\right) \rightarrow (\theta_g, \omega_g) = \left(\frac{\pi}{2}, 0\right)$, the radius of goal region is 0.05

For car problem, there are four rectangular obstacles in the environment. Start-goal query: $(x_s, y_s, \theta_s, v_s) = (-4, -5, 0, 0) \rightarrow (x_g, y_g, \theta_g, v_g) = (3.5, 4.5, 0, 0)$,the radius of goal region is 0.5.

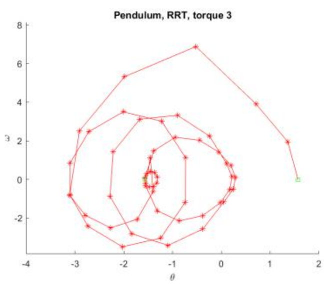


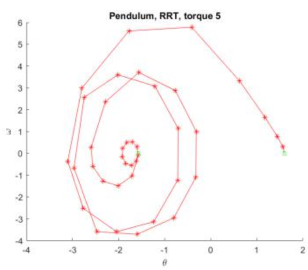
3.

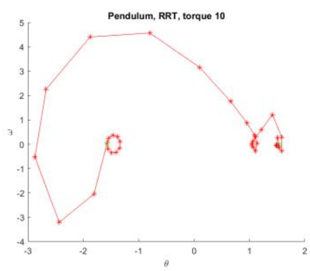
For pendulum problem, robot is a point and its geometry state can be determined by angle θ and rotational velocity ω, its configuration is R×SO2,

For car problem, I also assume robot is a point, its geometry state can be determined by coordinate (x, y), angle θ and rotational velocity ω, its configuration space is R^3×SO2, the radius of goal region is 0.5.

4.



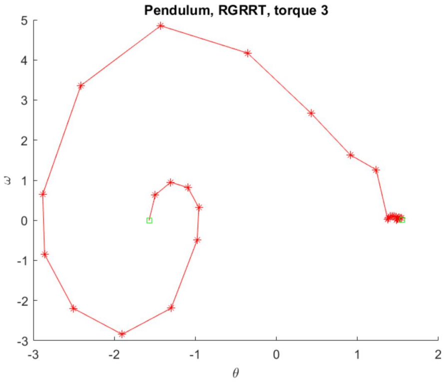


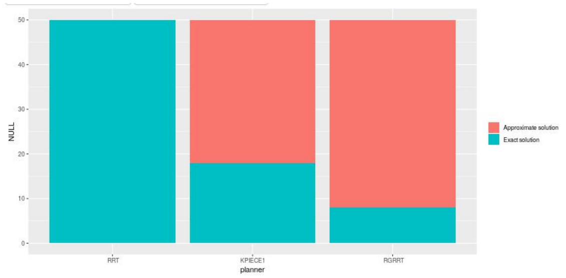


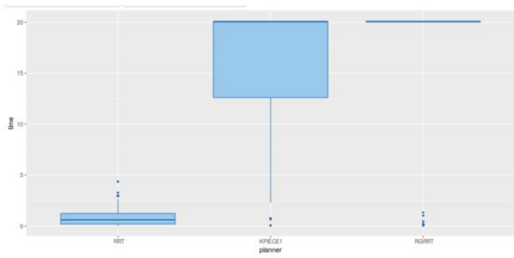
With the increase of torque limit from 3 to 10, the number of states in the path is decreasing, which means it is getting easier to find the solution with bigger torque limit.

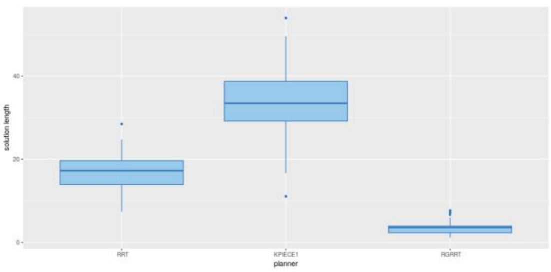
5.

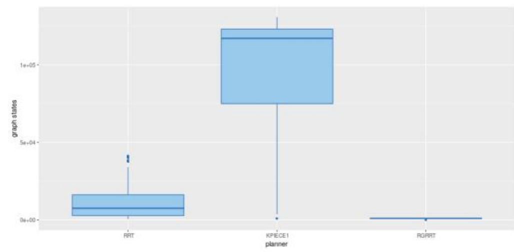
For pendulum problem:



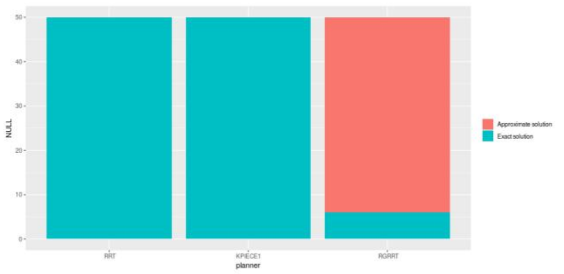


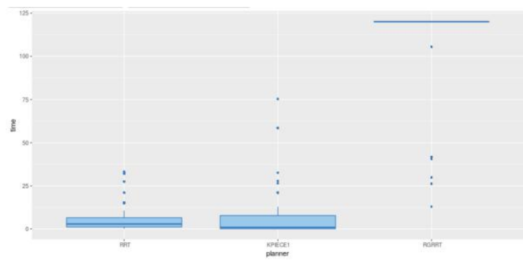


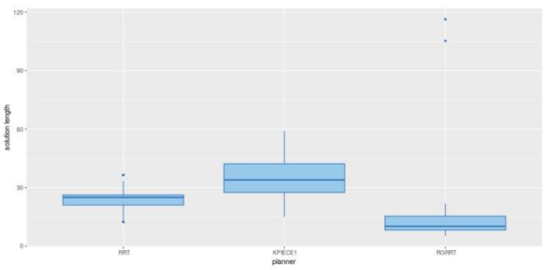


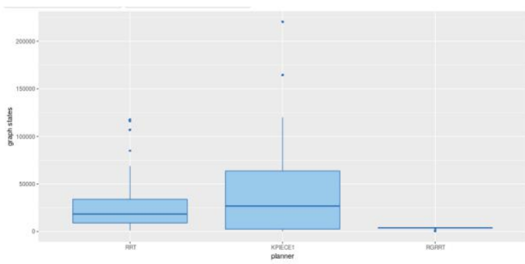


For car problem:









From the benchmark plots of pendulum and car problem, the success rate of RGRRT is worse than RRT and KPIECE since I am using discretization of control space to approximate reachability set. However, the solution length of RGRRT is shorter than the other two planners and its has much fewer states to explore, which matches the description in the paper of RGRRT.

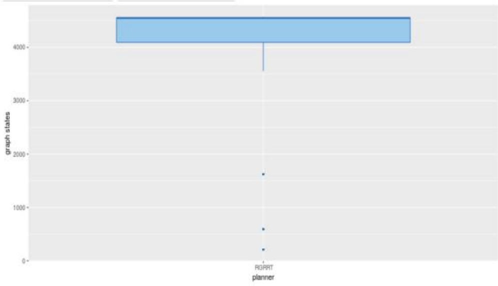
6.

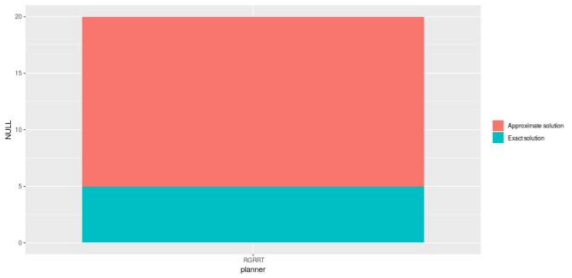
Comparison of RRT and RGRRT:

From the benchmark plots of previous question, we can see that the success rate of RRT is higher than RGRRT but RRT explores much more states in the space than RGRRT, which makes RRT less efficient than RGRRT.

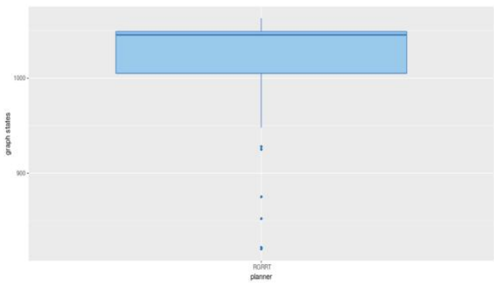
Trade-offs of length of time period and number of controls in RGRRT:

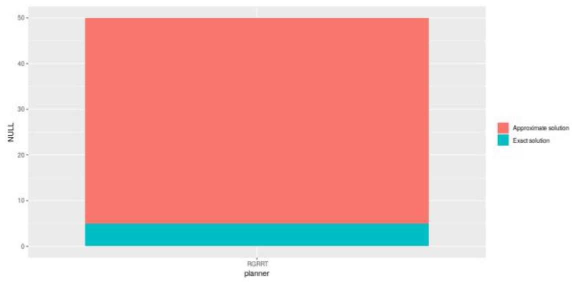
Case 1: length of time period = 0.267, number of controls = 11





Case2:length of time period = 0.5, number of controls = 41





If we increase the length of time period, we can apply control on a state for a longer time and reach a further position in state space, which can make state space exploration more efficient but explored states are more sparse. Hence, to get a good approximation of reachability set we also need to use finer controls, i.e., increase the number of controls.