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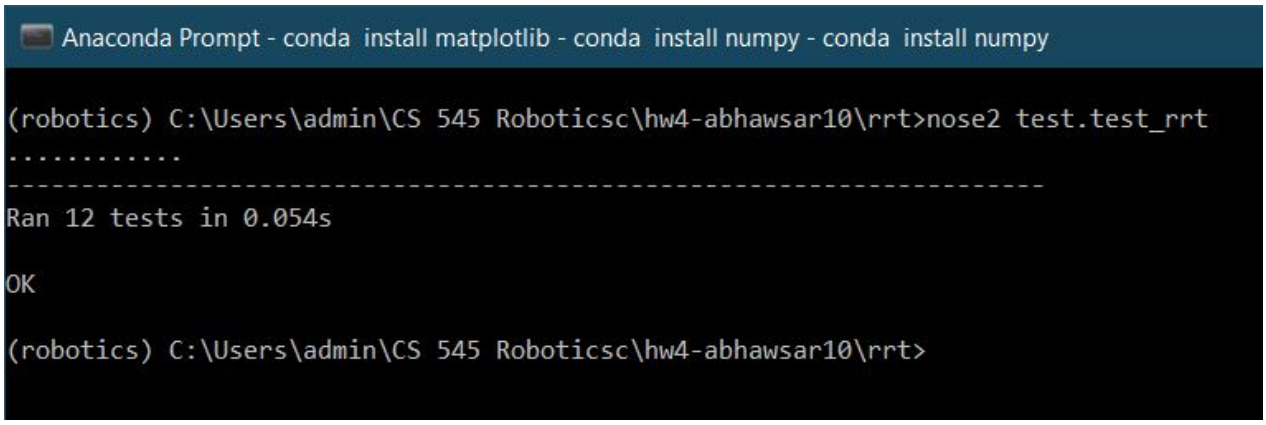
HW4
CSCI 545: Robotics

2021-11-07

1 Testing RRT:

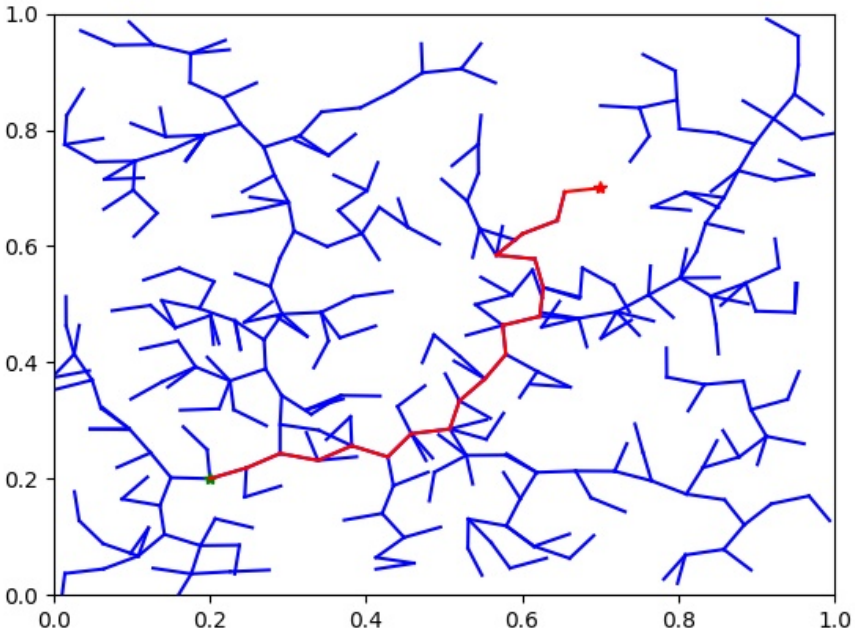
Following are the results after implementing all the functions of the RRT class:
Test Results:



All tests passed

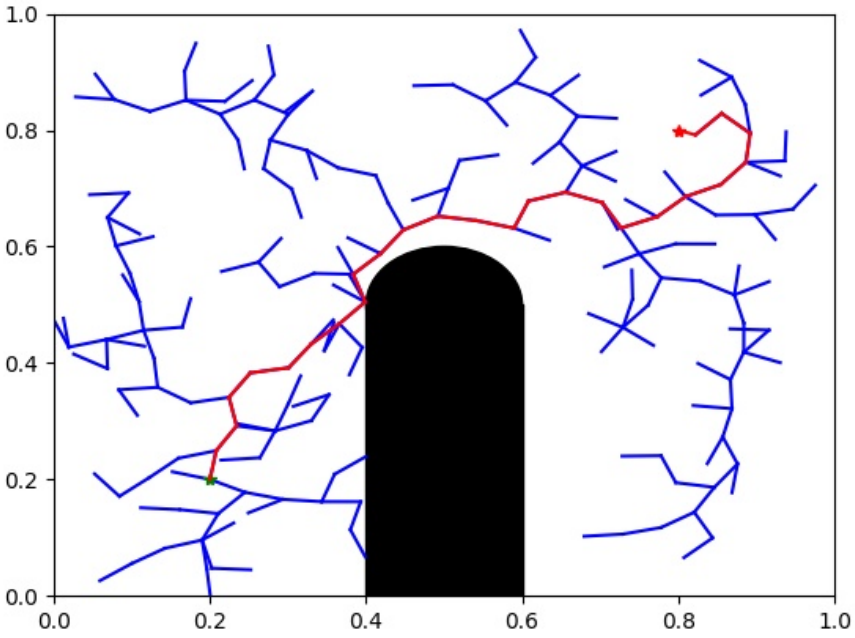
2 Visualizing RRT:

2.1 RRT with No Obstacle



Feasible Path shown in Red

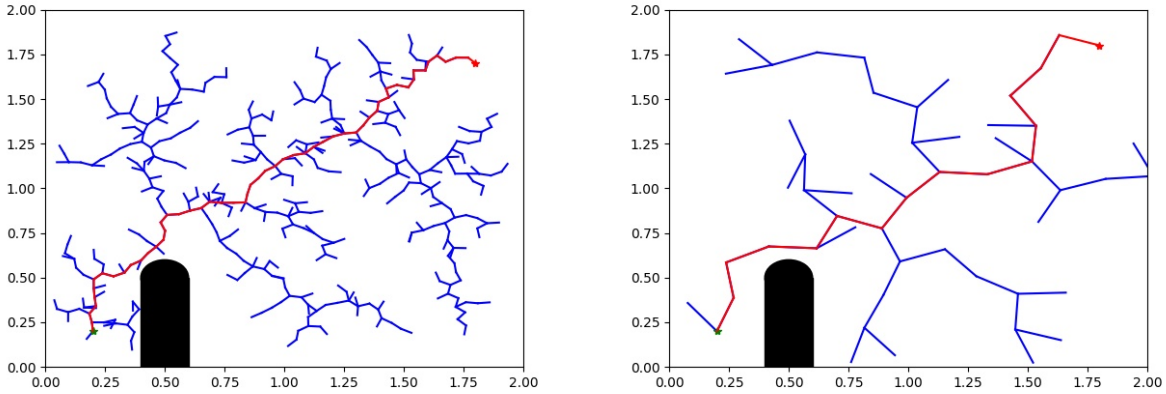
2.2 RRT with Default Obstacle



Feasible Path shown in Red

2.3 RRT with Larger Region

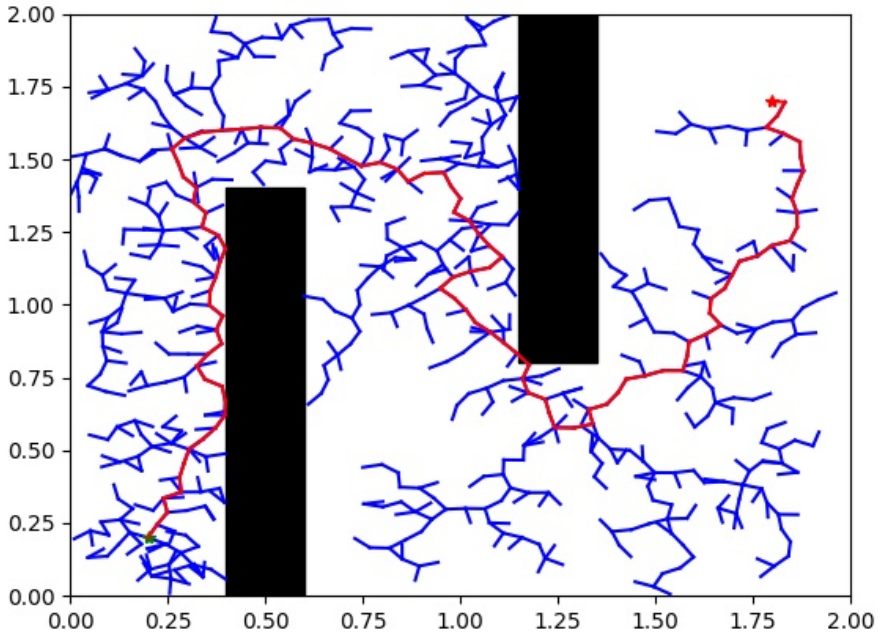
Larger region calls for a greater step size, otherwise we will be wasting resources in continuously sampling points.



Small Step size vs Large Step Size

2.4 RRT with Complex Obstacle

When dealing with complex obstacles in a large region, we must increase the max_iterations, otherwise the algorithm fails to find the goal in given steps.



Max iterations increased to 2000

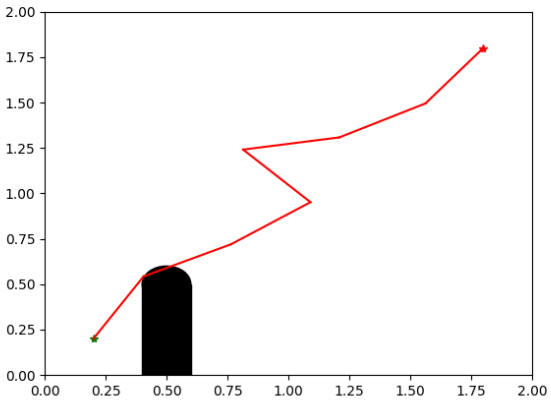
3 Questions:

3.1

The path returned by RRT is not guaranteed to be optimal path because of the fact that we use random sampling to add points in the tree. While expanding the size of the tree, we randomly sample points in all directions in the hope of getting close to the goal, but there is no guarantee that the points sampled are in the direction of the goal.
As such, points that are in the general direction of the goal help us to navigate toward the goal state, but form in no way, the shortest navigable path.

3.2

Increasing δ will generally make finding a feasible path faster in a given region, but it will also mean that the path found to the goal will be far from optimal. After a certain point, an increase in δ will also cause problems in RRT, such as not being able to add points to the tree because of collisions, and the path going through obstacles.



Path appearing to go through an obstacle because of large step size

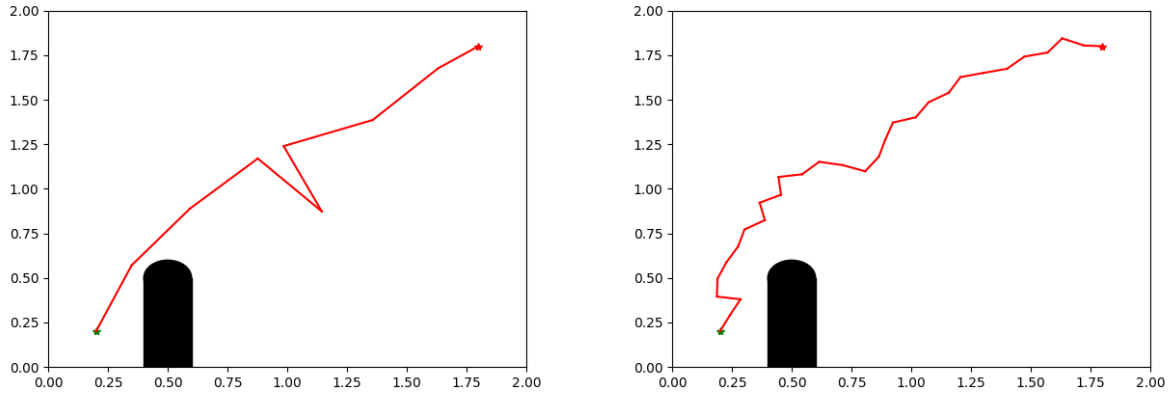
3.3

As seen from the figure above, increasing the bounds of the search space would mean randomly sampling a larger space, which takes more time and resources. A fitting solution would be to increase the step size so that the time required to build a tree and find the goal state decreases.

Increasing the dimensions of the search space also has the same effect. It drastically increases the space to be sampled and hence increases the time and resources required to find a feasible path.

3.4

It can be observed that RRT with a large δ is more likely to find the goal, whereas a RRT with a relatively smaller δ is prone to finding an optimal path.
A smaller step size means the path found to the goal state varies very little from the shortest path possible from the start to goal, but it also means it takes longer to find such a path.
Example:



Path found with step size 0.4 vs 0.05

The figure on the right with a smaller δ, is much closer to the optimal path one would take from start to the goal.
Whereas the path found using a large δ is very far from the optimal path.