Problem 1

Bi-directional RRT* grows two trees. One is from Start point, the other originates from Goal point. As each sample is drawn, a connection is attempted between it and the nearest state in the tree. If the connection is feasible, this results a new state to the tree. The parent node of new state is chosen according to the cost of neighbor nodes. After each point sampled, we check if the cost of other nodes in the tree is less through new node as compared to their older costs, then we change its parent to the new node. The search stops when two tree reach each other within a certain distance.

Algorithm 1 Bi-directional RRT* Algorithm

1: *Initialize N, $l \leftarrow 0$ and distance*
2: **for** $i = 0, 1, 2... \ to \ N - 1$ **do**
3:      Add Node to Tree($tree_l$) (Algorithm 2)
4:      Get latest node $node_0$ from $tree_0$
5:      **for** $node_1$ in $tree_1$ **do**
6:          **if** $Distance(node_0, node_1) < distance$ **then**
7:              $FinalTree \leftarrow$ Link $node_0$ and $node_1$
8:              **return** $FinalTree$
9: Get latest node $node_0$ from $tree_0$ and Get latest node $node_1$ from $tree_1$
10: $FinalTree \leftarrow$ Link $node_0$ and $node_1$
11: **return** $FinalTree$

Algorithm 2 Add Node to Tree

1:   $x_{new_node},$ $\leftarrow$ get sampling point
2:   $x_{near_node} \leftarrow$ find the nearest node in $tree$
3: **if** $ObstacleFree(x_{rand}, x_{near})$ **then**
4:      $x_{parent_node} \leftarrow$ *find a parent node with minimum cost*
5: *rewire the tree*
6: **return** *tree*

For implementation, we set up environment with several square obstacles. Final path is found as figure shows.

Reference:

[1]Sertac Karaman, Emilio Frazzoli. Incremental Sampling-based Algorithms for Optimal Motion Planning[C]// Robotics: Science and Systems 2010. 2010.

[2]Zaid T , Qureshi A H , Yasar A , et al. Potentially guided bidirectionalized RRT* for fast optimal path planning in cluttered environments[J]. Robotics and Autonomous Systems, 2018, 108:13-27.
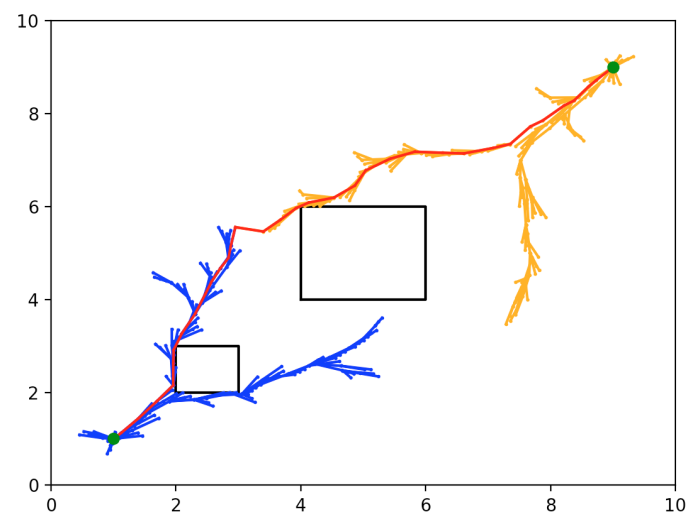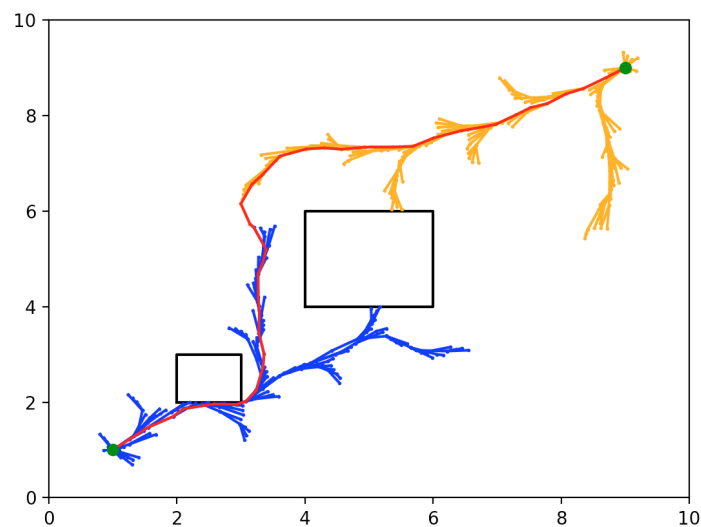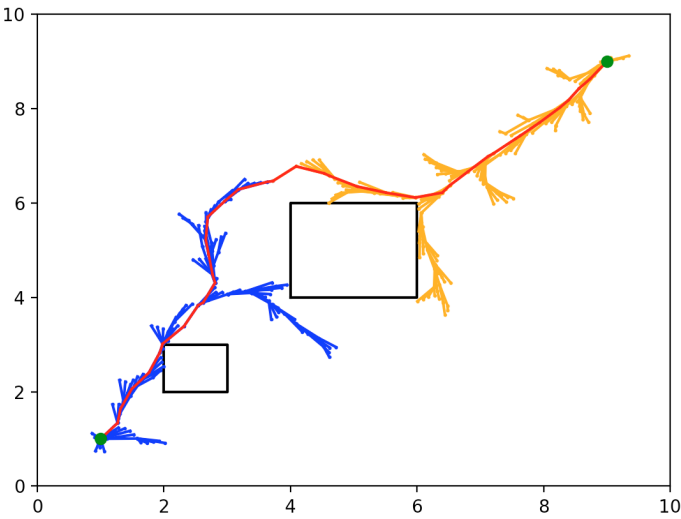
Figure 1: Result 1

Figure 2: Result 2

Figure 3: Result 3