AUTOMATIC PLANNING - REPORT - LAB 5
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Lab 5.1. Theory: Spaces and Robots

Question 1)

Work space - It describes the physical space in which we work. i.e It describe the space within which the object we are considering is operating. For example in the case of UAV the UAV the work space would be 3 dimensional in which object would have x, y, and z coordinates to describe the position and way in which the object can move in the environment.

Configuration Space - It describe various possible attributes(configuration) of the object in consideration. The configuration of an object can be thought of as describing the current state of the object in the environment. e.g Location (x, y coordinates) and angle can be though of as the configuration of a car in a 2D work space that can specify how the car looks in the workspace. The coordinate space can be thought of as the collection of all possible configurations of the object in consideration in the workspace.

Question 2)

Searches are done in the configuration space. This is because we only want to search though the possible configurations that the object can have in space instead of searching through the all the points which would have a lot of impossible scenarios.

Question 3)

A robot is said to be holonomic if the total degrees of freedom of the robot is equal to the controllable degrees of freedom. i.e. The robot can move in any possible direction that is possible in a given system.

## Lab 5.2. Comparing Planners

The Maze_planer_env Environment

The same problem was run on the two planner RRTStar and PRMStar and results are given below,

1) RRTStar Planner
   • Plan Quality(Plan length) - 58 states
   • Number of states generated - 912
   • Time used by planner - 4.3 seconds
   • Distance Moved - 86.33942824571281
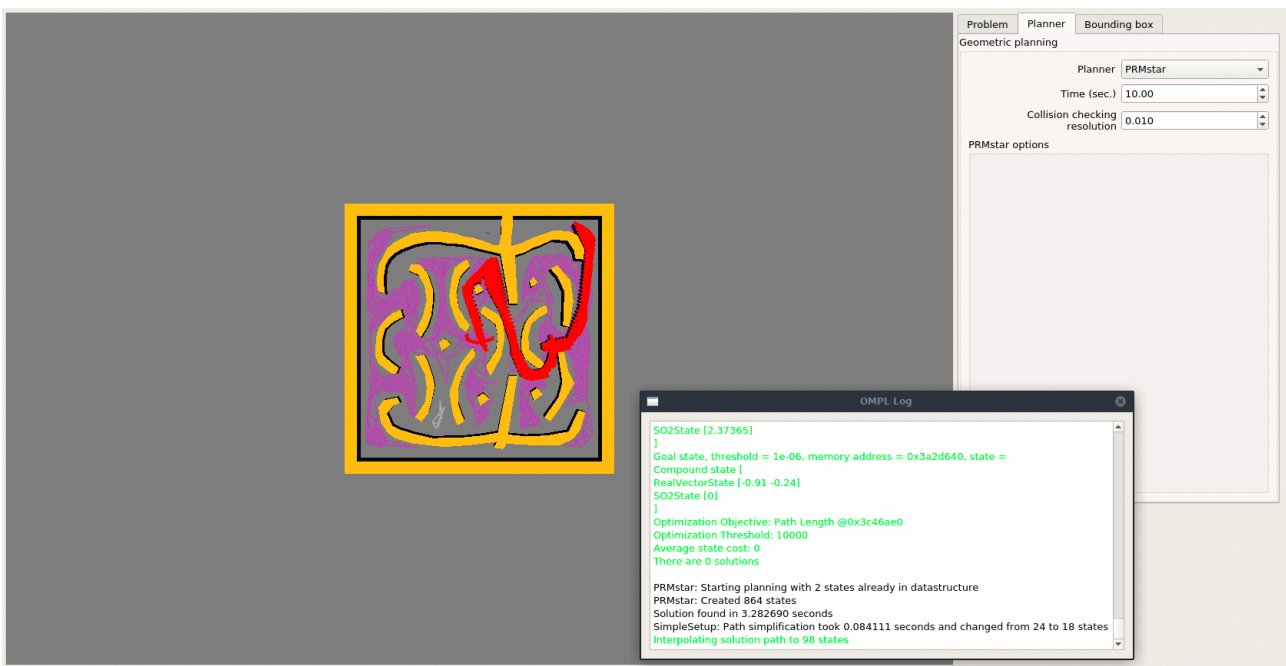   • Rotations Done - 11.357733068340169

The screenshot of the plan generated is given below,
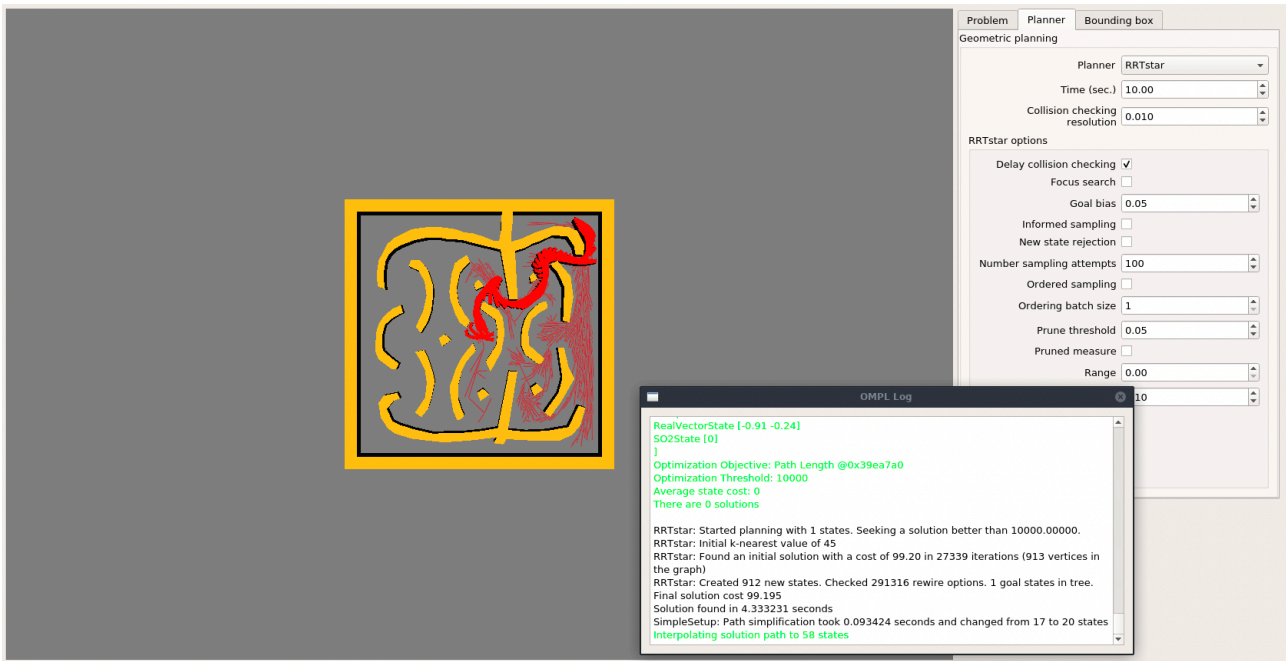
2) PRMStar Planner
   - Plan Quality(Plan length) - 98 states
   - Number of states generated - 864
   - Time used by planner - 3.28 seconds
   - Distance Moved - 149.27861375421335
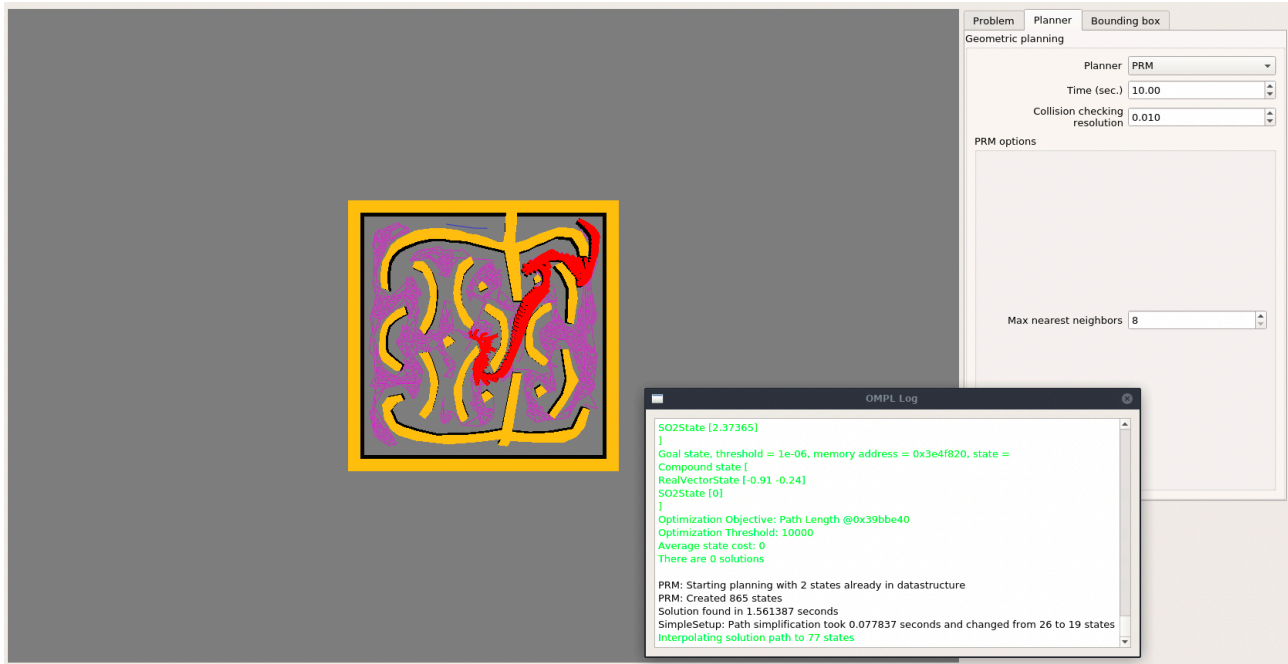   - Rotations Done - 11.349988333818763

The screenshot of the plan generated is given below,

3) PRM Planner
  • Plan Quality(Plan length) - 77 states
  • Number of states generated - 865
  • Time used by planner - 1.56 seconds
  • Distance Moved - 114.79829621739458
  • Rotations Done - 13.338840101283667

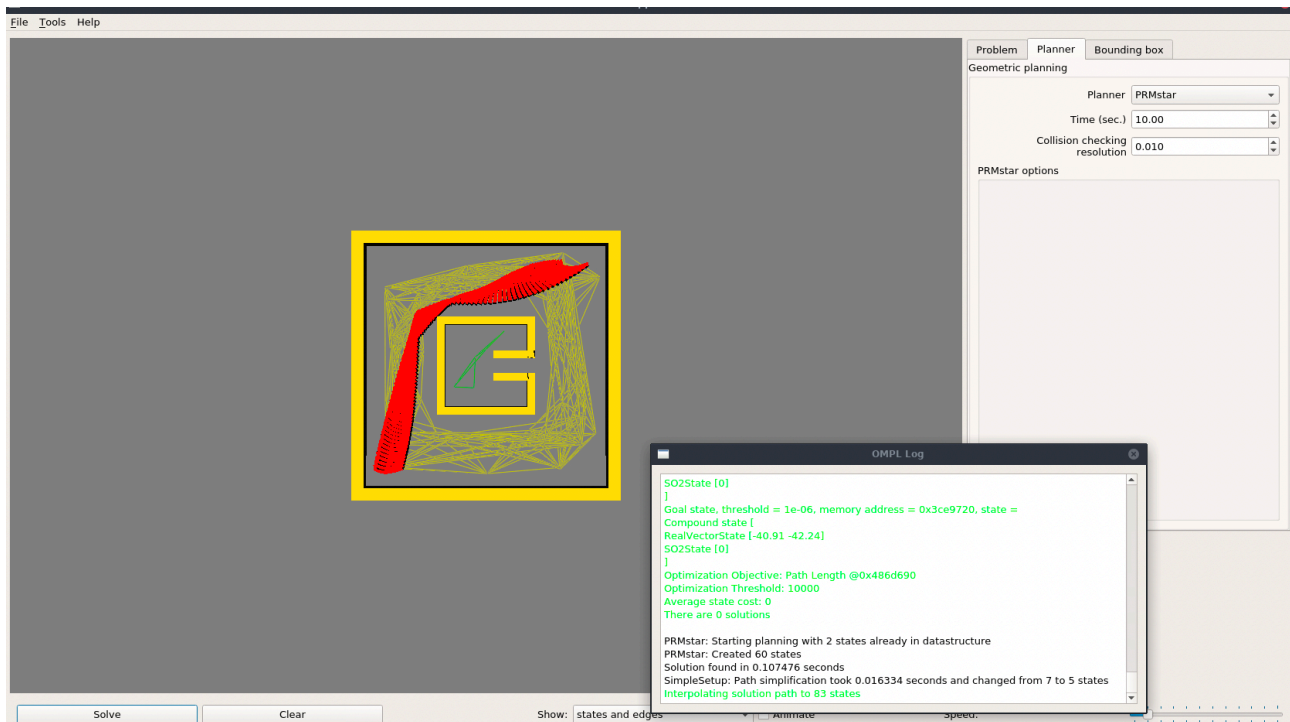The screenshot of the plan generated is given below,

The BugTrap_planer_env Environment

The Bug trap environment was selected as the second environment to test out the planners. The same problem setup was run on three planners RRTStar, PRMStar and KPIECE Planner. The results are given below,

1) RRTStar Planner
  • Plan Quality(Plan length) - 84 states
  • Number of states generated - 10
  • Time used by planner - 0.02 seconds
  • Distance Moved - 130.36310423459636
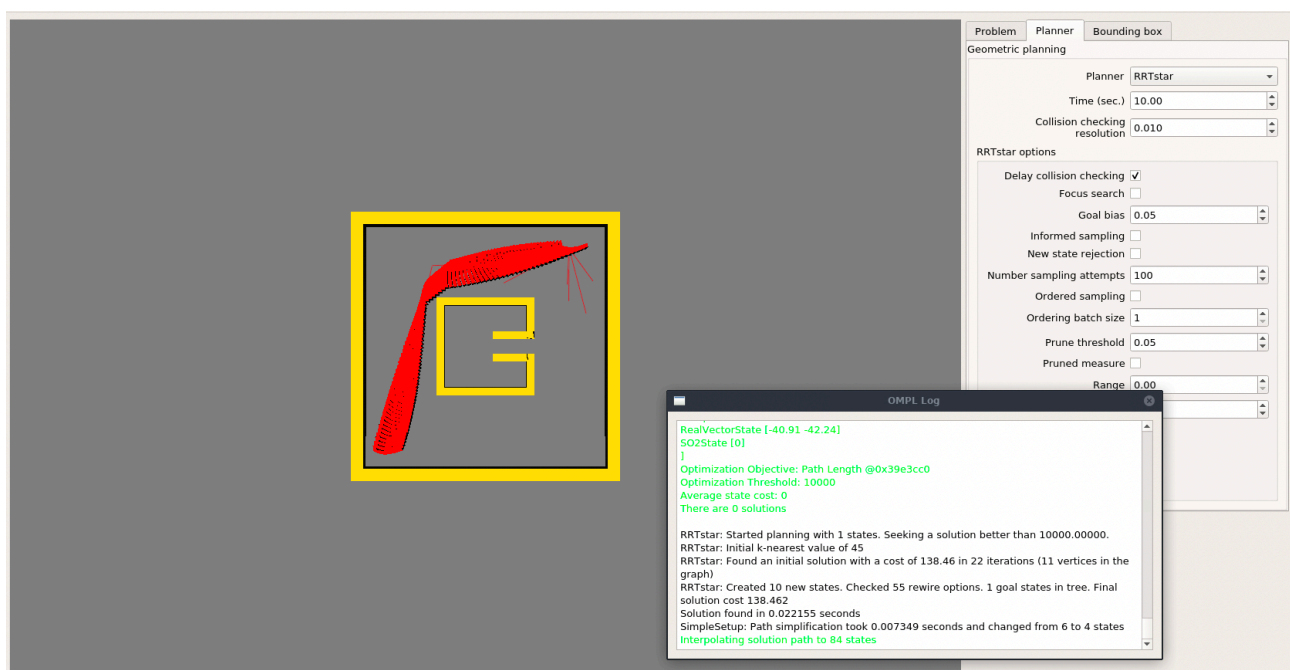 • Rotations Done - 3.777661097322018

The screenshot of the plan generated is given below,

2) PRMStar Planner

- Plan Quality(Plan length) - 83 states
- Number of states generated - 60
- Time used by planner - 0.1 seconds
- Distance Moved - 128.8829567673561
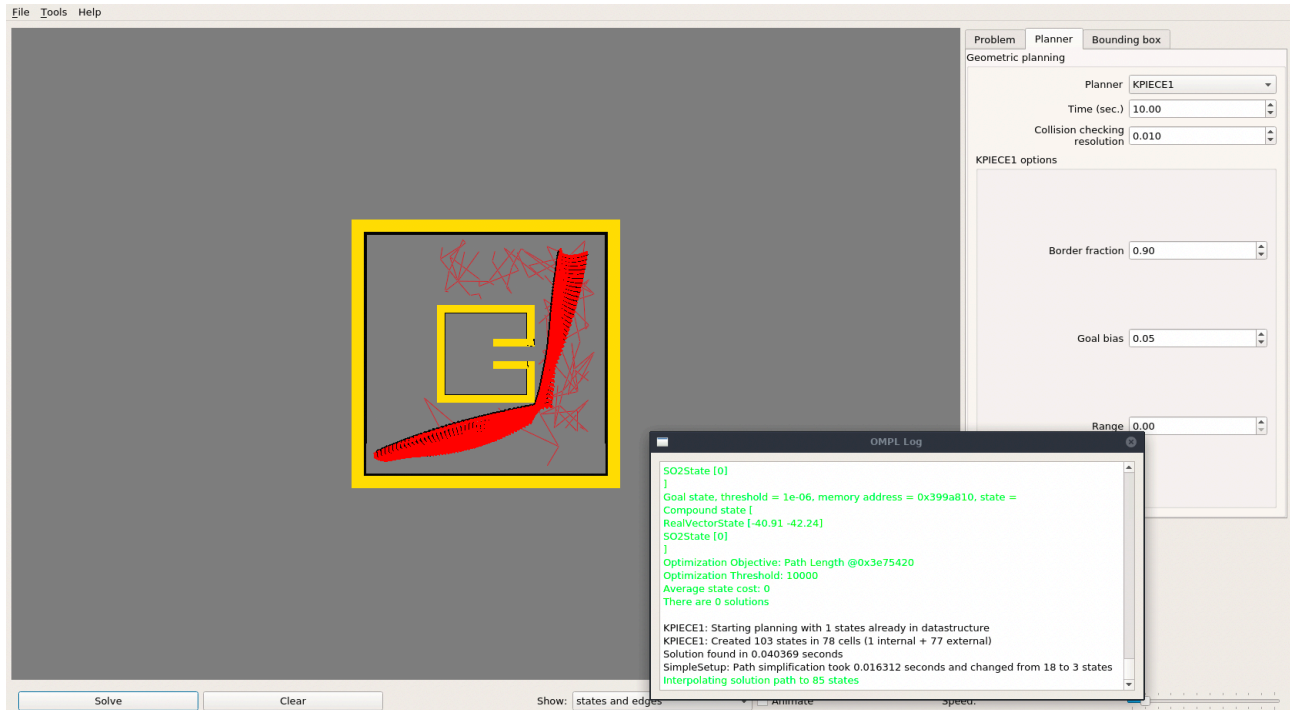- Rotations Done - 5.957822208612317

The screenshot of the plan generated is given below,

3) KPIECE Planner
   - Plan Quality(Plan length) - 85 states
   - Number of states generated - 103
   - Time used by planner - 0.04 seconds
   - Distance Moved - 131.7813059487769
   - Rotations Done - 4.753838502950526

The screenshot of the plan generated is given below,

PRM Planners Working

During the pre-processing part of planner PRM planners try finding configurations such that their domain covers the entire configuration spaces and also see that the configurations can be connected. During the construction phase the planners randomly generate a configuration from the free configuration space and try to connect the configurations if possible. And during the query phase (actual planning phase) the PRM planners connect the start and the goal configurations to the configurations in the roadmaps created so as to get a graph of possible connections which can solved using graph search algorithms like A*

Planners workings

1. *RRTStar Planner* - It is an optimal RRT(Rapidly exploring random tree) planner. It is granted to converge to an optimal solution with the running time as a constant factor of the RRT algorithm. RRT works by randomly sampling a state and then finding a state among the previously explored states that is closest to the randomly sampled one. Then it tries to expand from the previously seen state to the randomly sampled state.
2. *KPIECE Planner* - Tree based planner that works by discretisation of the continuous state space. It works by imposing a grid on the projection of the state space and exploring the space by giving preferences to boundaries of the grid.