16-662 Robot Autonomy
Homework 3 Write-up
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Q1.

2D Configuration space – Simple Robot

No. of Iteration	Resolution	Path Length	Plan Time	No. of Nodes
Breadth-First Search				
1	0.05	5.733	616.566	24910
2	0.1	5.691	152.618	6406
3	0.25	5.596	25.329	1138
Depth-First Search				
1	0.05	5.073	2.373	265
2	0.1	5.014	1.183	134
3	0.25	5.121	0.482	60
A-Star Planner				
1	0.05	4.779	30.630	1229
2	0.1	4.779	7.737	310
3	0.25	4.975	1.819	72

Video of A-Star run with resolution 0.1 is attached : “astar_simple_q1”. BFS, DFS and A star with Resolution 0.1 is shown in Figure 1, Figure 2 and Figure 3.

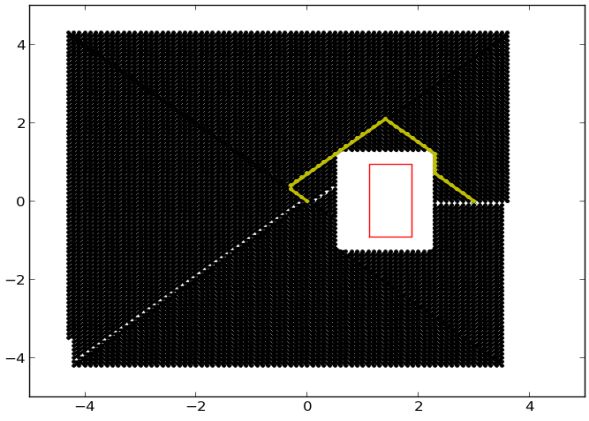

Figure 1 : Plot for Breadth-First Search for Resolution = 0.1 in Simple Robot

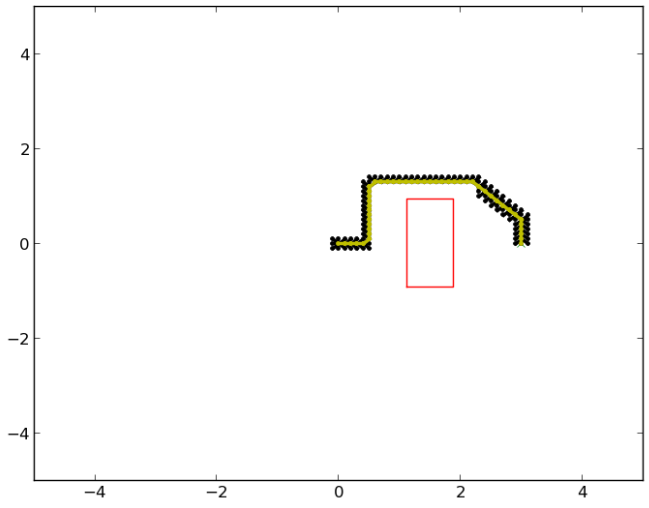

Figure 2 : Plot for Depth-First Search for Resolution = 0.1 in Simple Robot

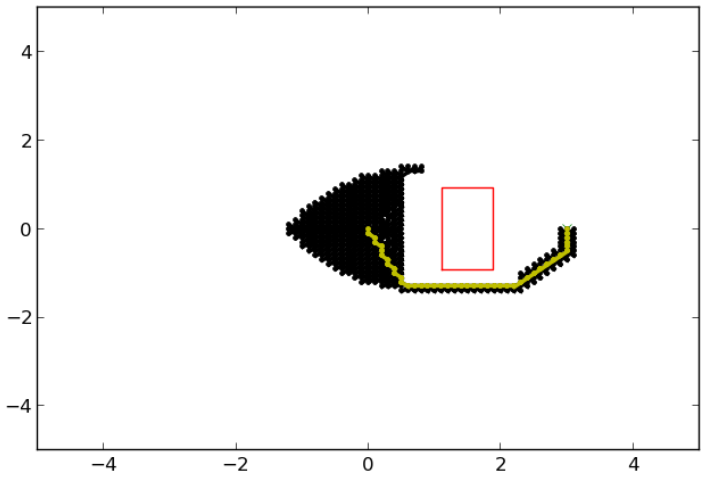

Figure 3 : Plot for A-Star Planner for Resolution = 0.1 in Simple Robot

Q2.

7D Configuration space – WAM Arm of Herb Robot

A-Star Planner			
Resolution	Path Length	Plan Time	No. of Nodes
0.1	2.019	143.918	3931

Video of A-Star run with resolution 0.1 : "astar_herb_q2" [NOTE : In this video, there is a delay in between time-frames 2min 32secs and 3min 56secs because I forgot to press 'ENTER' for execution of trajectory. Please fast-forward that time-frame. Sorry for the inconvenience.]

Q3.

Comparison of RRT Algorithm with Path Shortening and A-Star Planner

RRT with Path Shortening for Simple Robot and WAM Arm of Herb Robot

	Simple Robot			**WAM Arm**		
No. of iteration	Path Length	Plan Time	No. of Nodes	Path Length	Plan Time	No. of Nodes
1	6.334	0.056	4	12.97	15.293	5
2	6.519	0.015	4	16.885	15.51	5
3	6.378	0.071	4	9.751	20.5	7
4	7.727	0.027	3	18.313	22.36	5
5	7.108	0.017	4	16.451	17.13	5

Comparison of A-Star with RRT with Path Shortening :

As the resolution increases, A-Star planner reaches the goal much quicker by visiting less number of nodes.

For both 2D simple robot and 7D WAM arm of herb robot, path length is shorter, plan time is larger and number of nodes evaluated is much greater in the case of A-Star as compared to RRT with Path Shortening.

A-STAR

Strengths :

1. A-Star is discrete based search which is able to find an optimal path.

Weaknesses :

1. A-Star takes more planning time because it is traversing more number of nodes as compared to HRRT.
2. A-Star is computationally more expensive.

RRT with Path Shortening

Strengths:

1. RRT with Path Shortening is faster that is, it takes less time as compared to A-Star search.

Weaknesses:

1. RRT with Path Shortening takes the first path which it founds. Therefore it is not optimal.
2. Also, RRT is random, therefore the time taken to find the path can vary a lot for different iterations.

Q4. Extra Credit

Heuristic RRT Planner for Simple Robot and WAM Arm of Herb Robot

No. of Iteration	**Simple Robot**		**WAM Arm**	
	Path Length	Plan Time	Path Length	Plan Time
1	2.801	0.669	13.007	9.459
2	13.272	0.181	17.129	6.266
3	2.725	1.394	20.451	23.784
4	5.222	0.688	9.327	5.216
5	3.969	0.132	13.978	2.071

Compared with A-Star, HRRT has a longer path length on an average. But since it traverses less number of nodes the plan time is much less for HRRT.