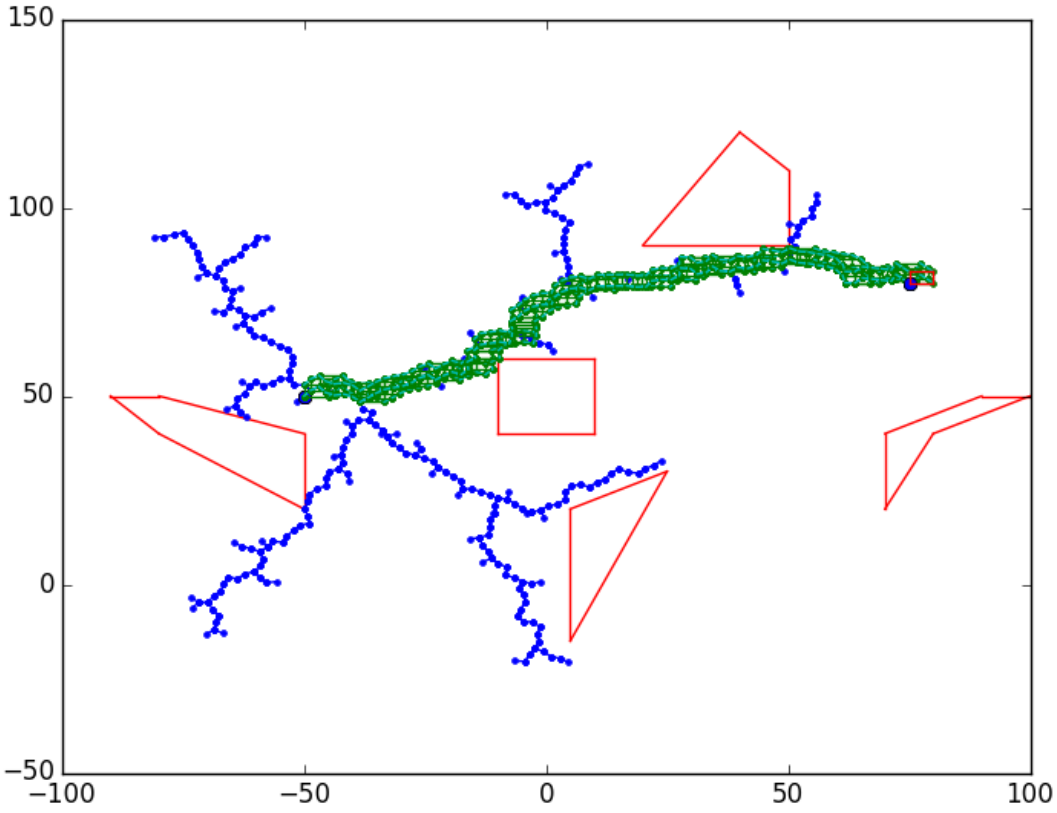
Project 2 : Sample Based Planning **Clinton Fernandes**

ME EN 6250 Motion Planning u1016390

Q 1.1_____

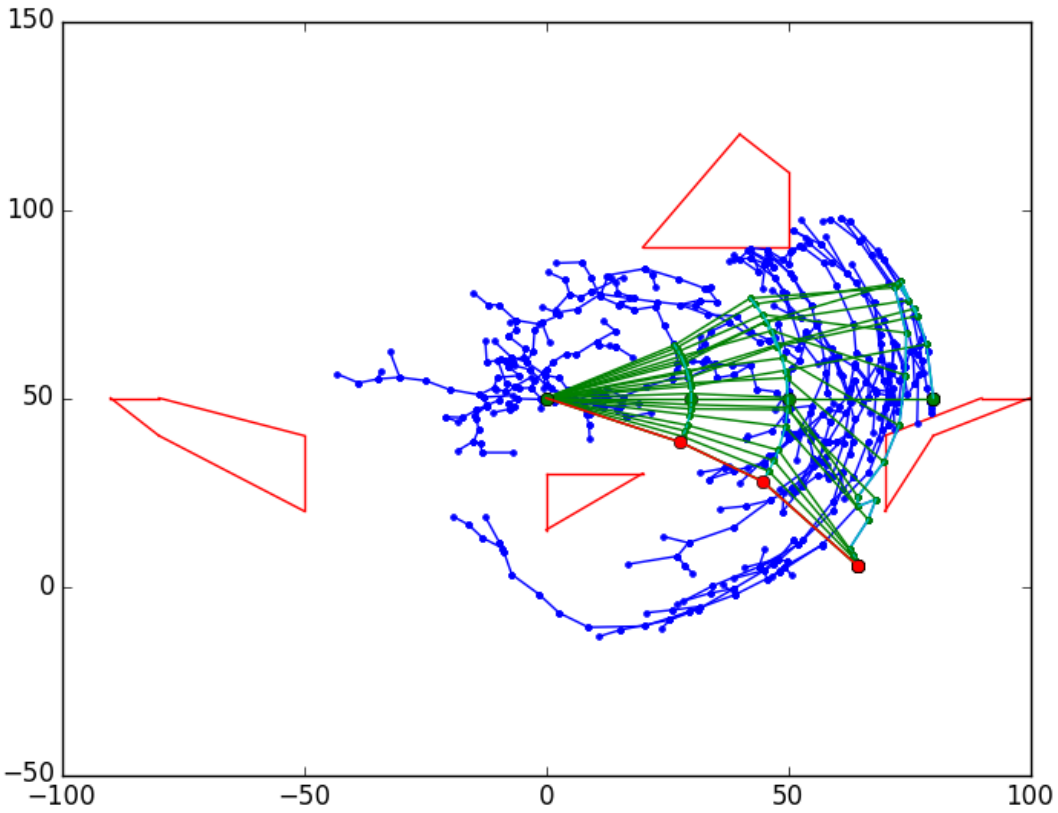
Start: -50 50

Goal: 75 80



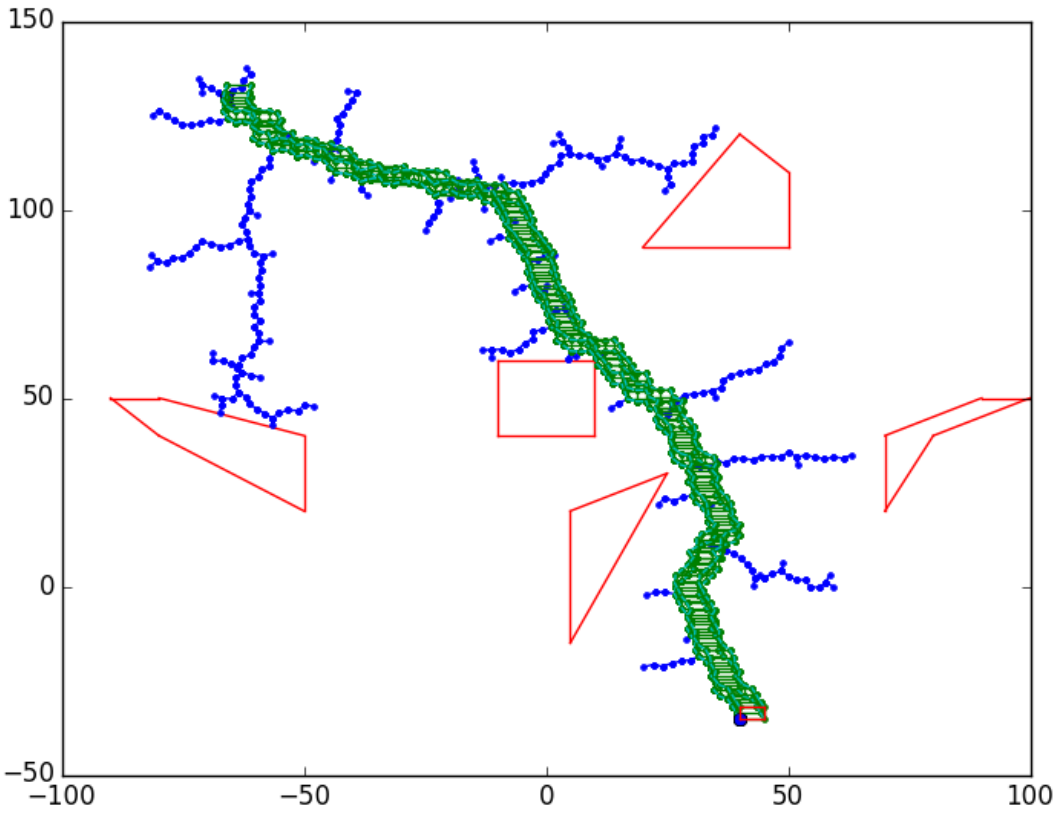
Start: 0 0 0

Goal: -0.4 -0.15 -0.3



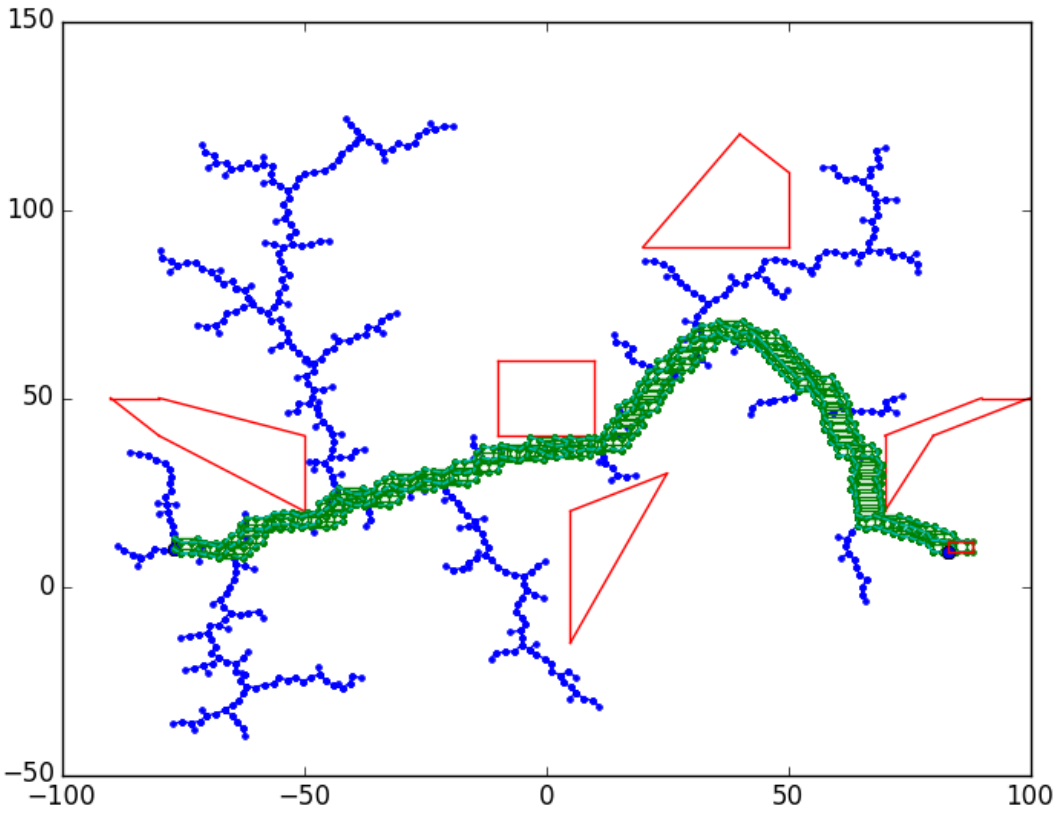
Start: -66 130

Goal: 40 -35



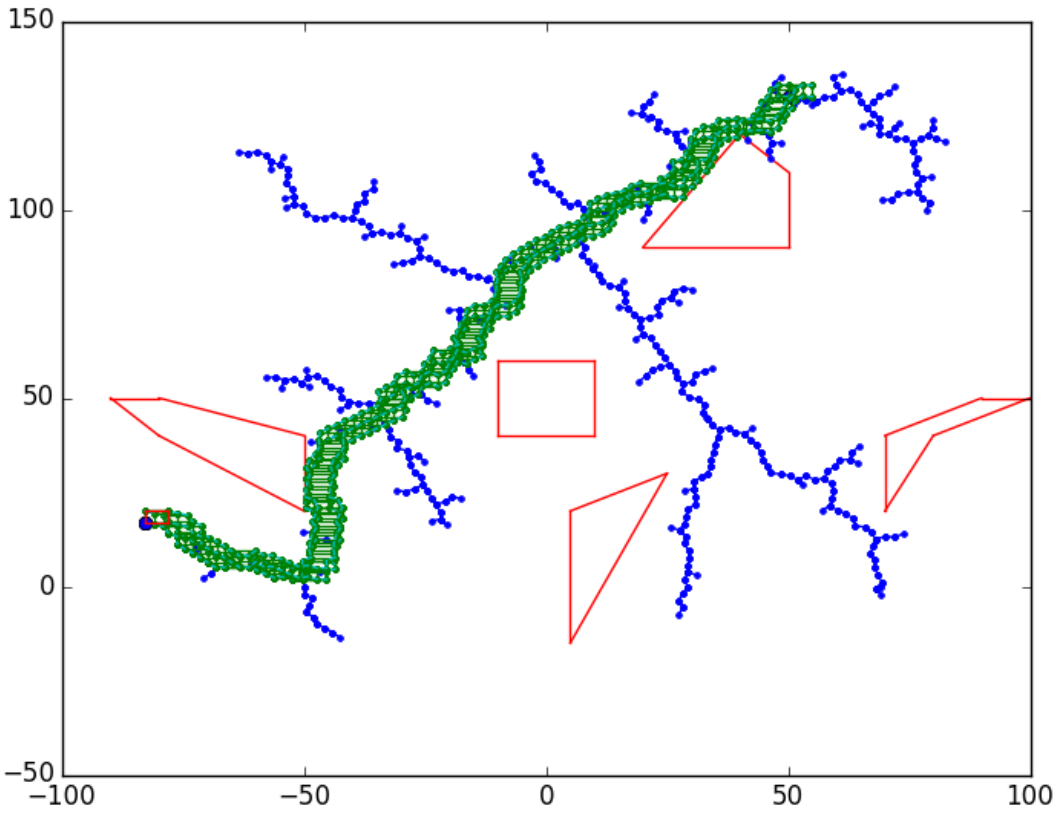
Start: -77 10

Goal: 83 9



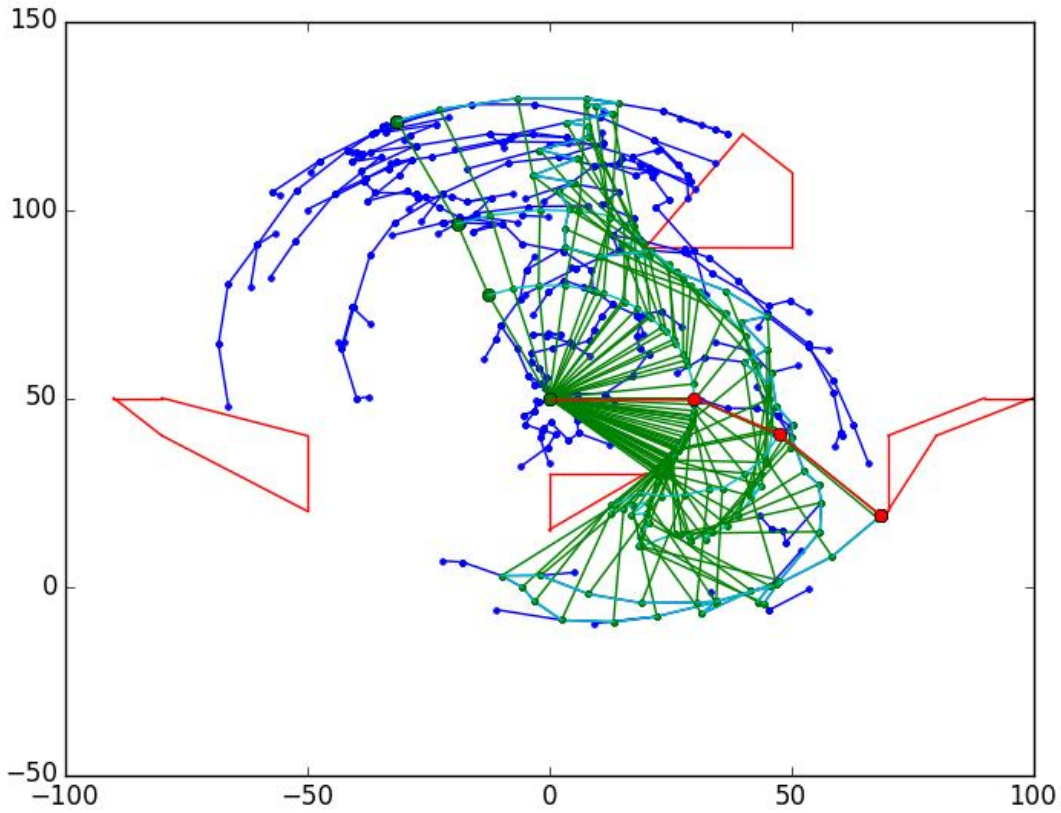
Start: 50 130

Goal: -83 17



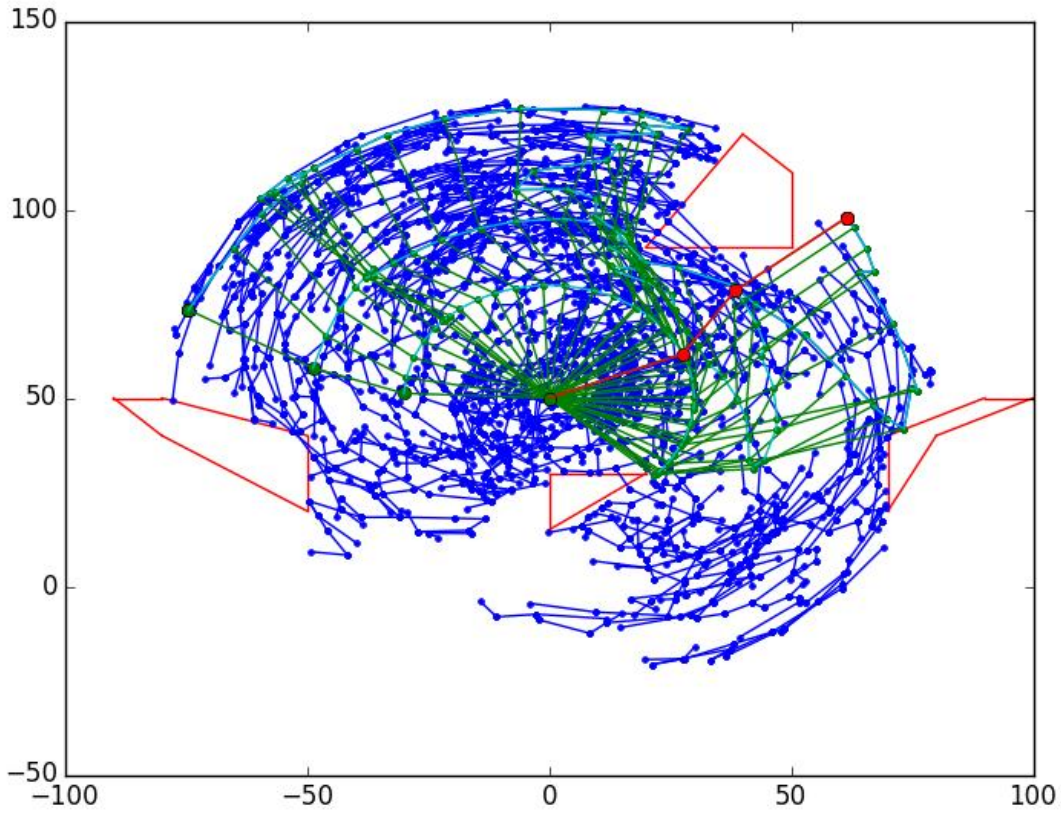
goal [0. -0.5 -0.3]

start [2. -0.1 0.1]



goal [0.4 0.6 -0.3]

start [3.1 -0.3 -0.2]



Q 1.2_____

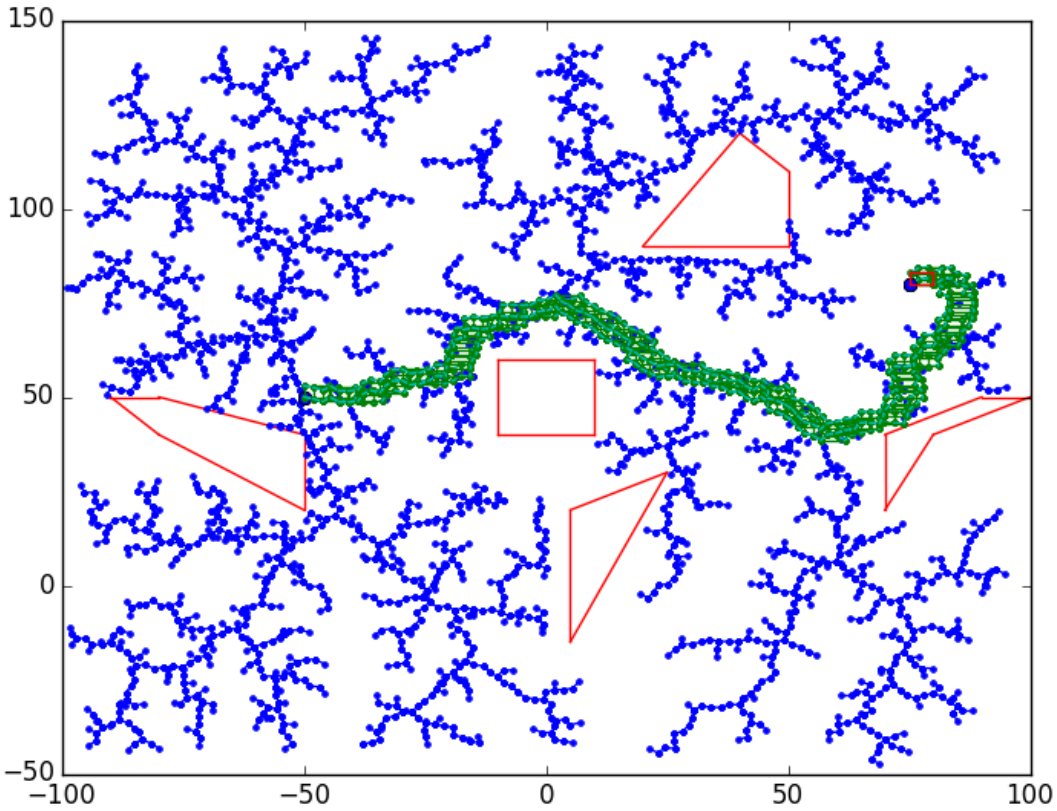
We see that, as the probability of sampling towards the goal increases, the time taken to find the goal reduces.

Also, it was found that for a given number of samples, K= 500, the planner with probability of sampling at 0% was not able to find the goal, hence the number of samples had to be increased. Even though there was increase in number of samples, the tree expanded to a larger area of the map and took a lot more time compared to other cases.

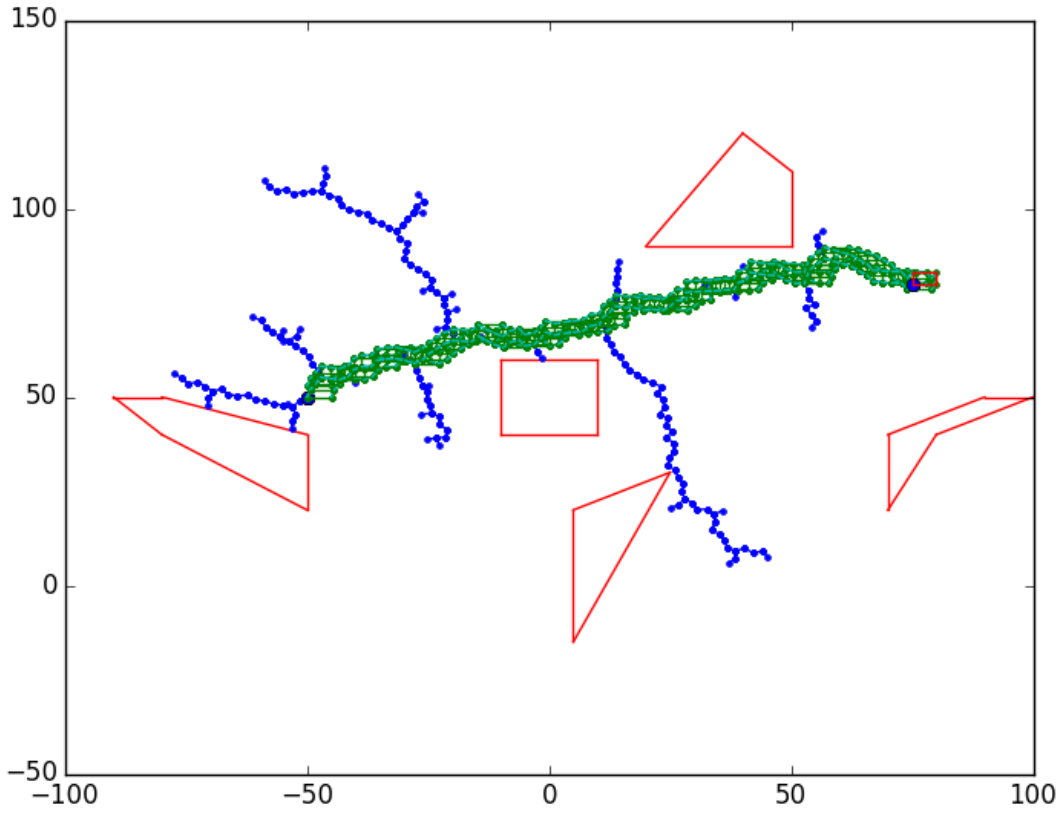
The one with 50% probaility had its sampled points almost along a straight line towards the goal and hence the plan was having the shortest path compared to other cases.

Probability	Samples	Time
0	2806	38.93
5	292	1.261
10	237	0.675
50	97	0.342

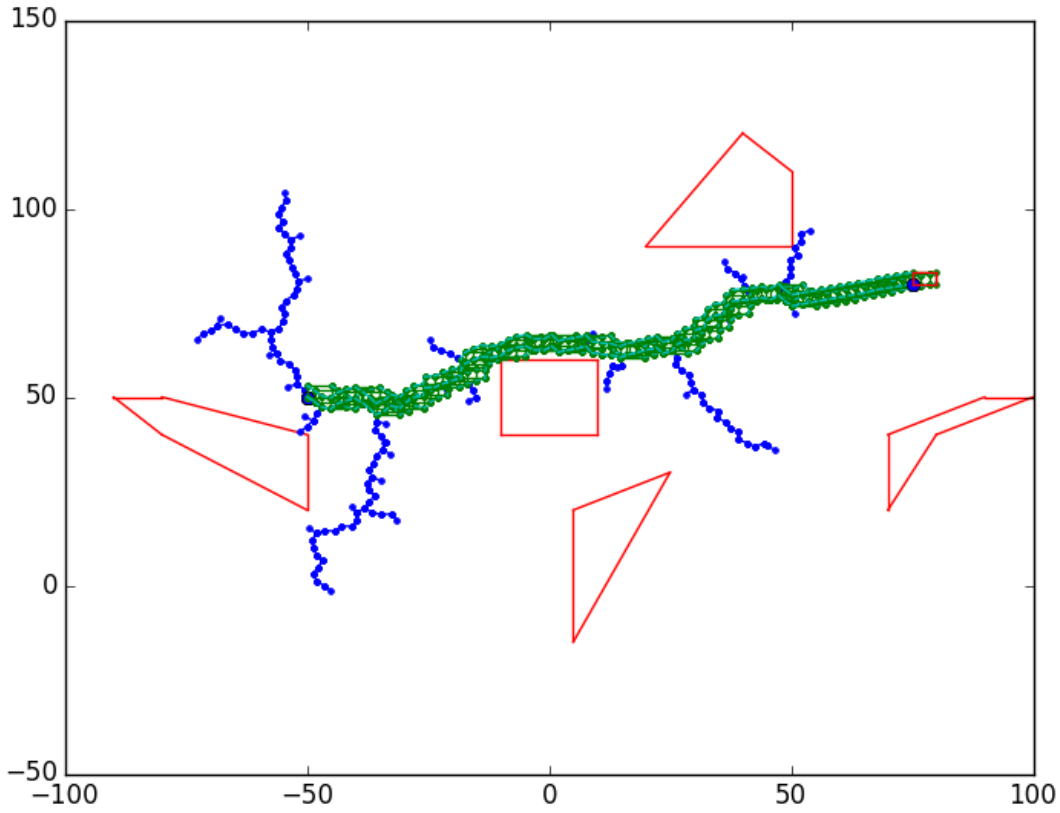
0% probability:



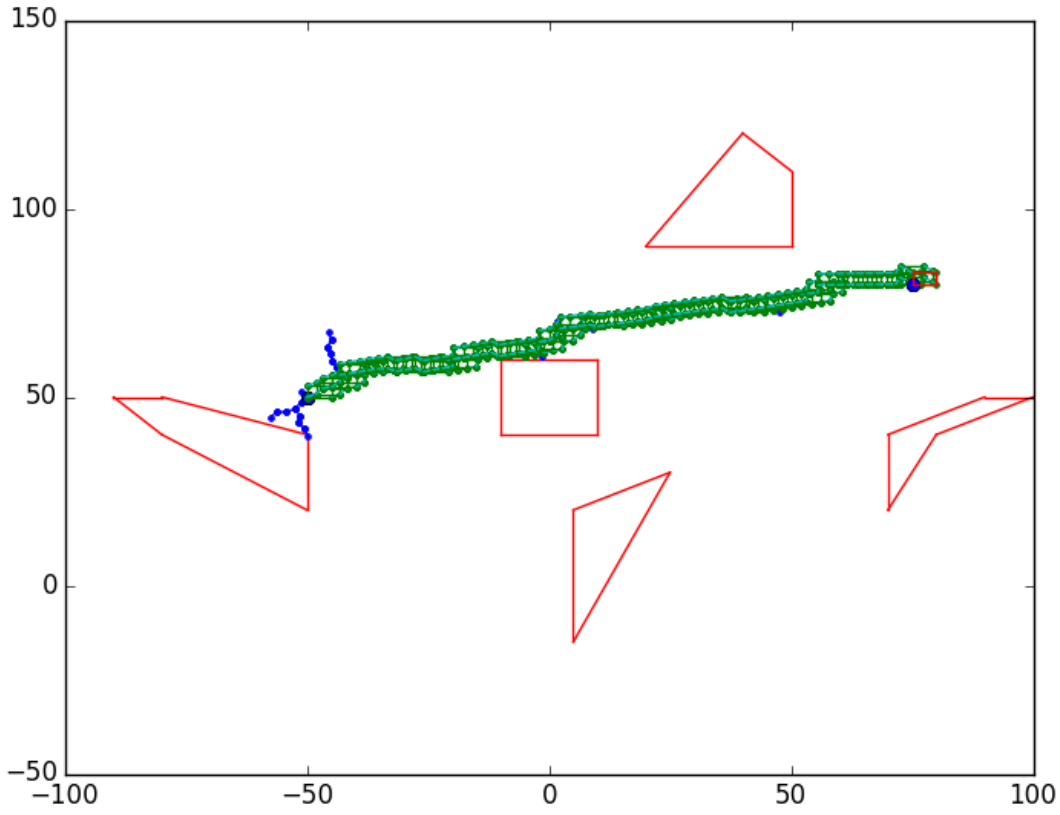
5% probability:



10% probability:

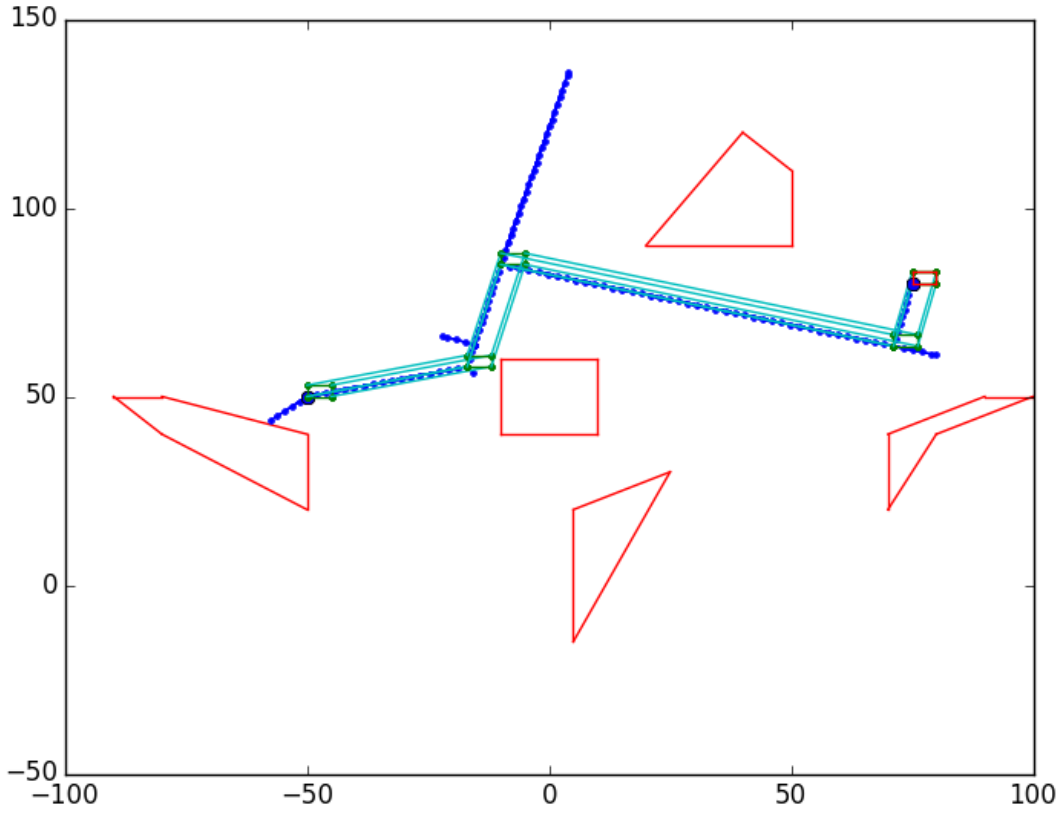


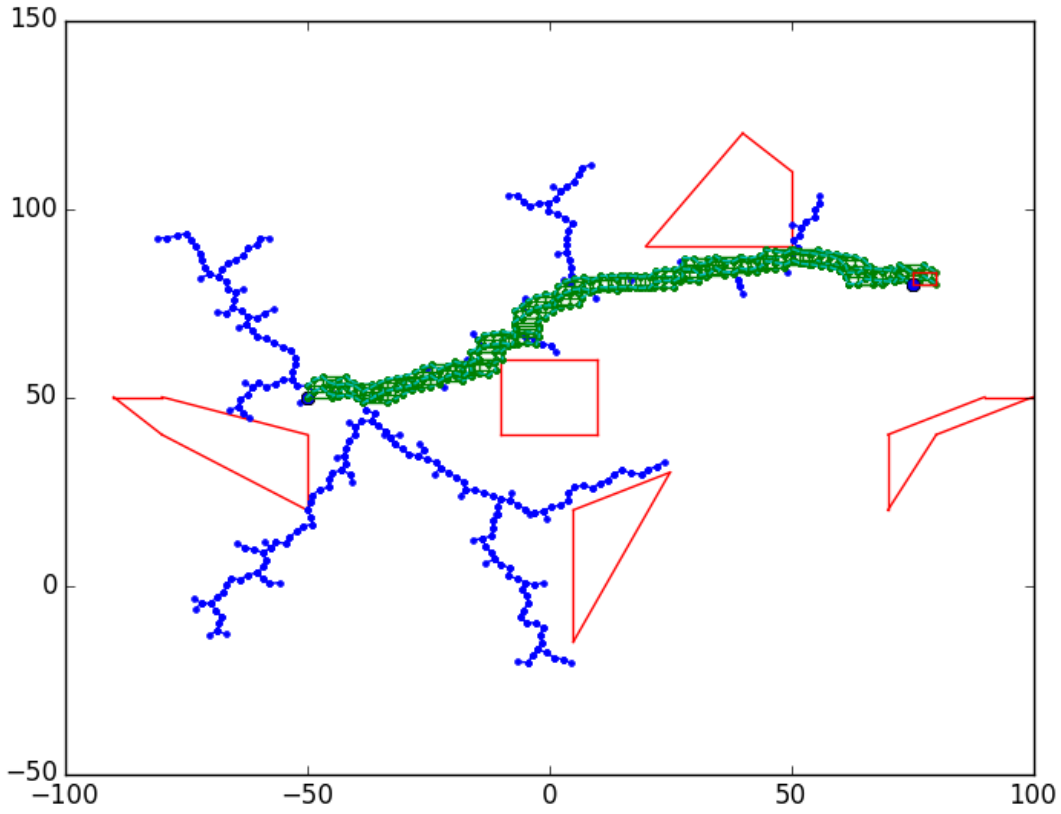
50% probability:



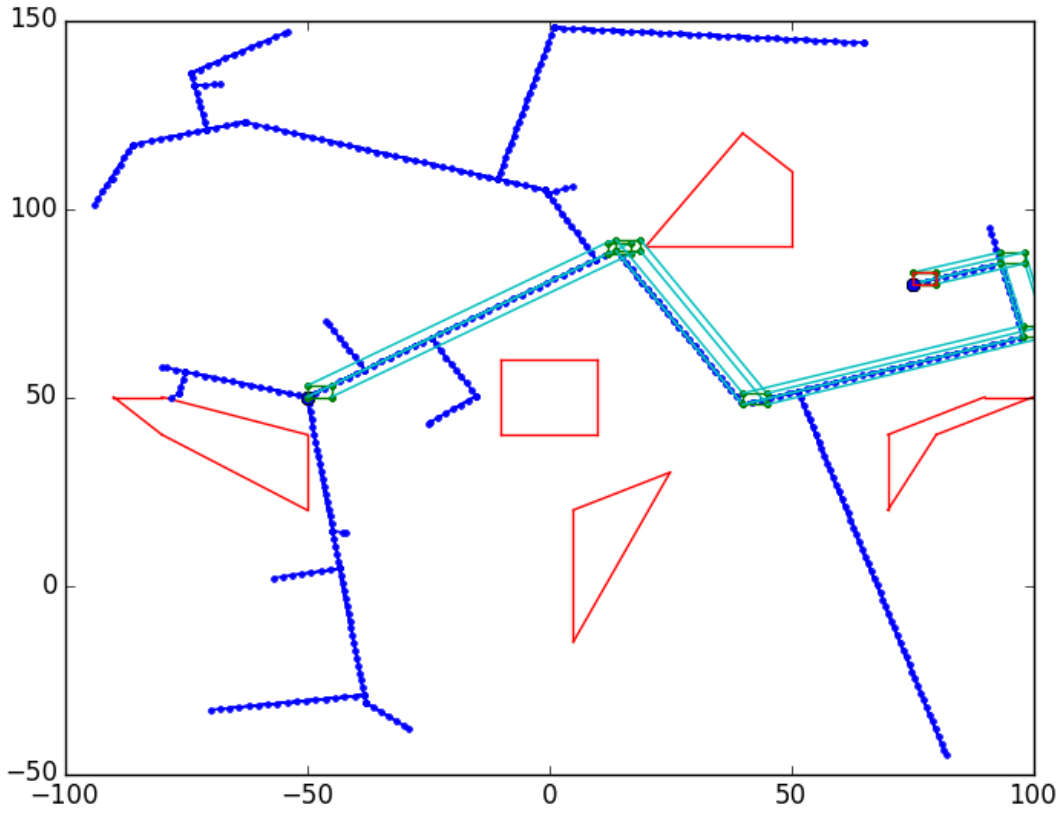
Q 1.3_____

I had run the RRT connect two times and have found that in one case the planner could find the goal in a very small time compared to the simple RRT.



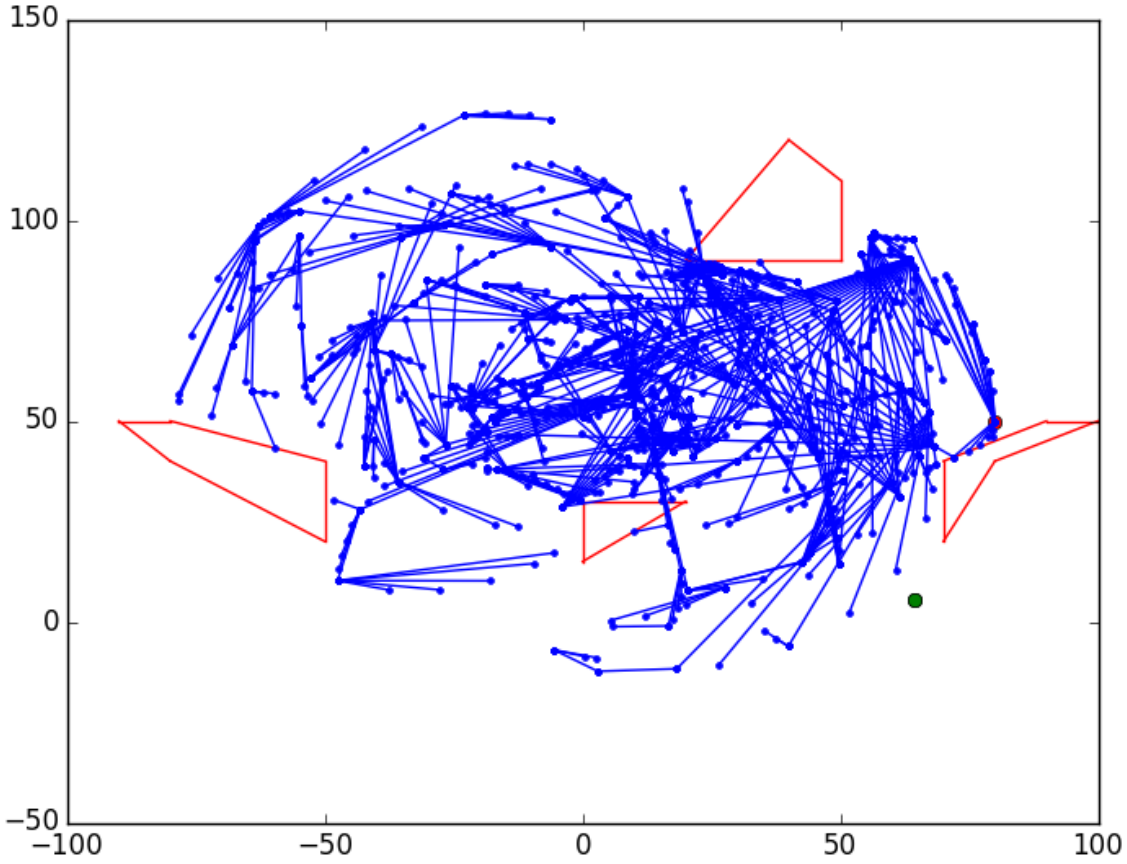


However, in another case, I found out that the if the sample was not directed towards the goal (with the help of sampling probability) then the RRT connect would take samples in any region of the map and would extend the tree towards the random sample. From the below figure, it can be seen that RRT connect has expanded trees in regions towards the boundaries. In this case RRT connect took much longer time to find the goal as compared to the simple RRT.



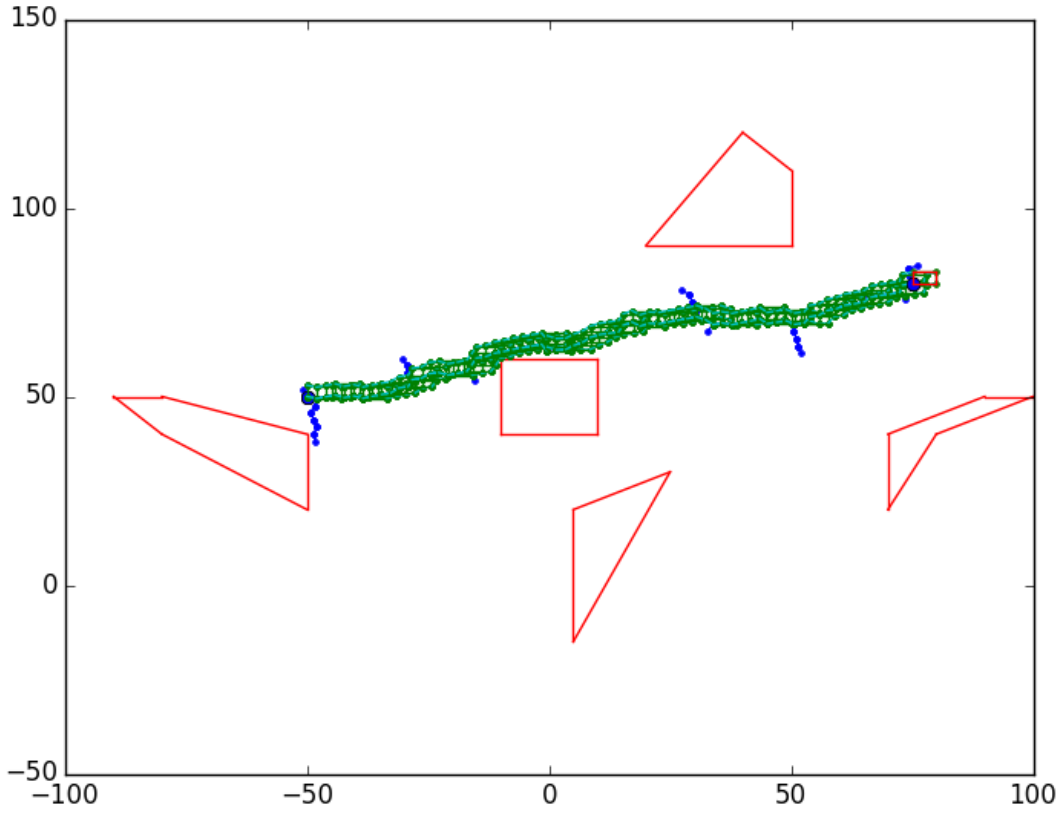
For the env1.txt

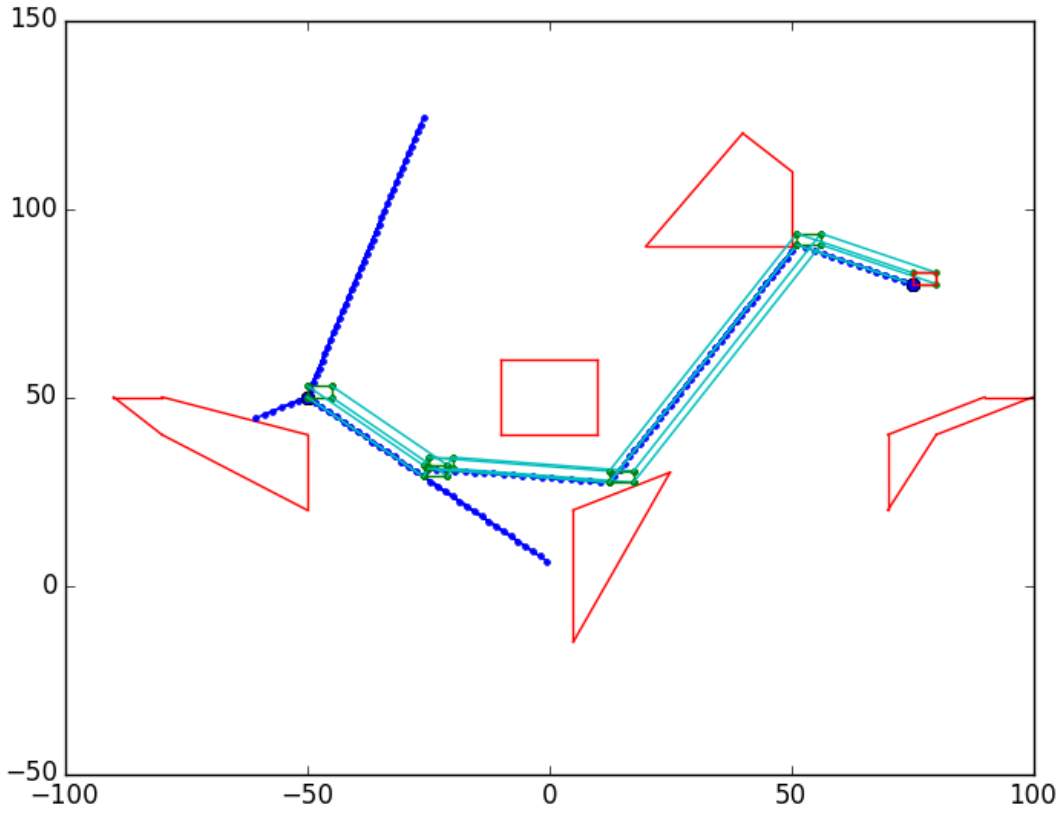
I found that RRT conect would find the goal in 2677 samples and with a runtime of 44 seconds compared to the simple RRT which took 4281 samples and a runtime of 57 seconds for the sample step size. The results were almost the same when both the planners were run for a second time. At some times, RRT connect would require about 8000 samples to get to the goal.



Note: the plan is not displayed as it long time to complete the figure, however, I had got the plan before

Q 1.4_____

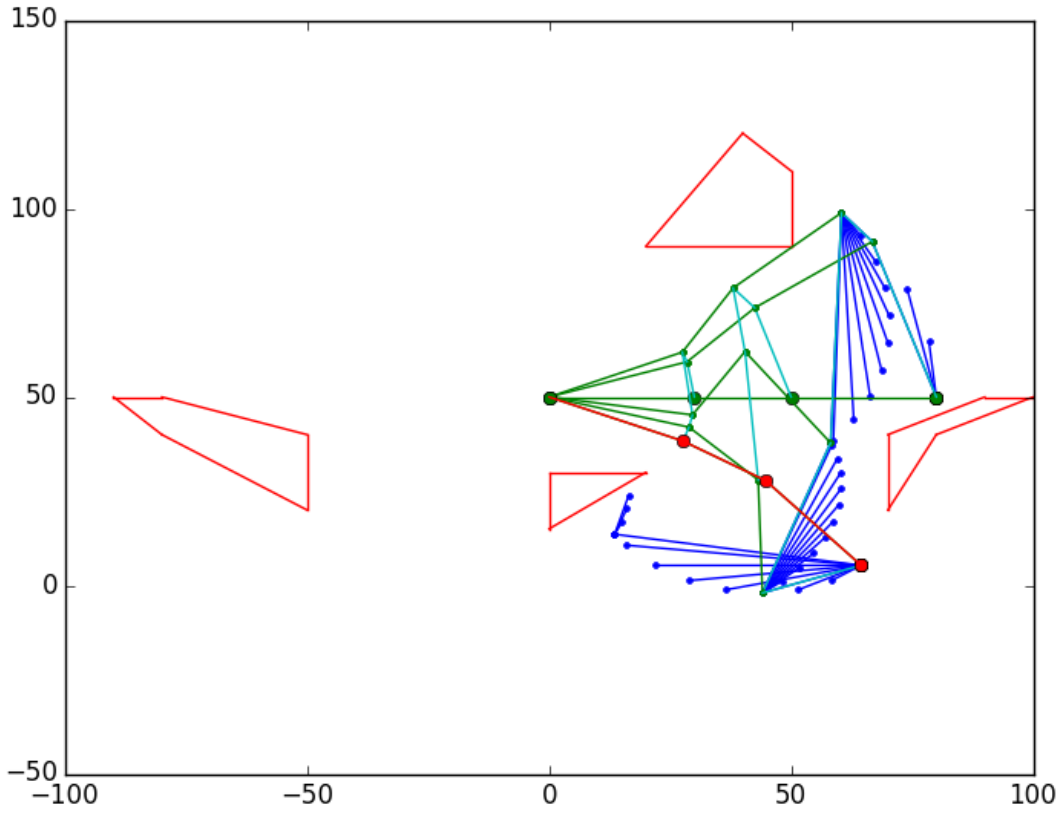




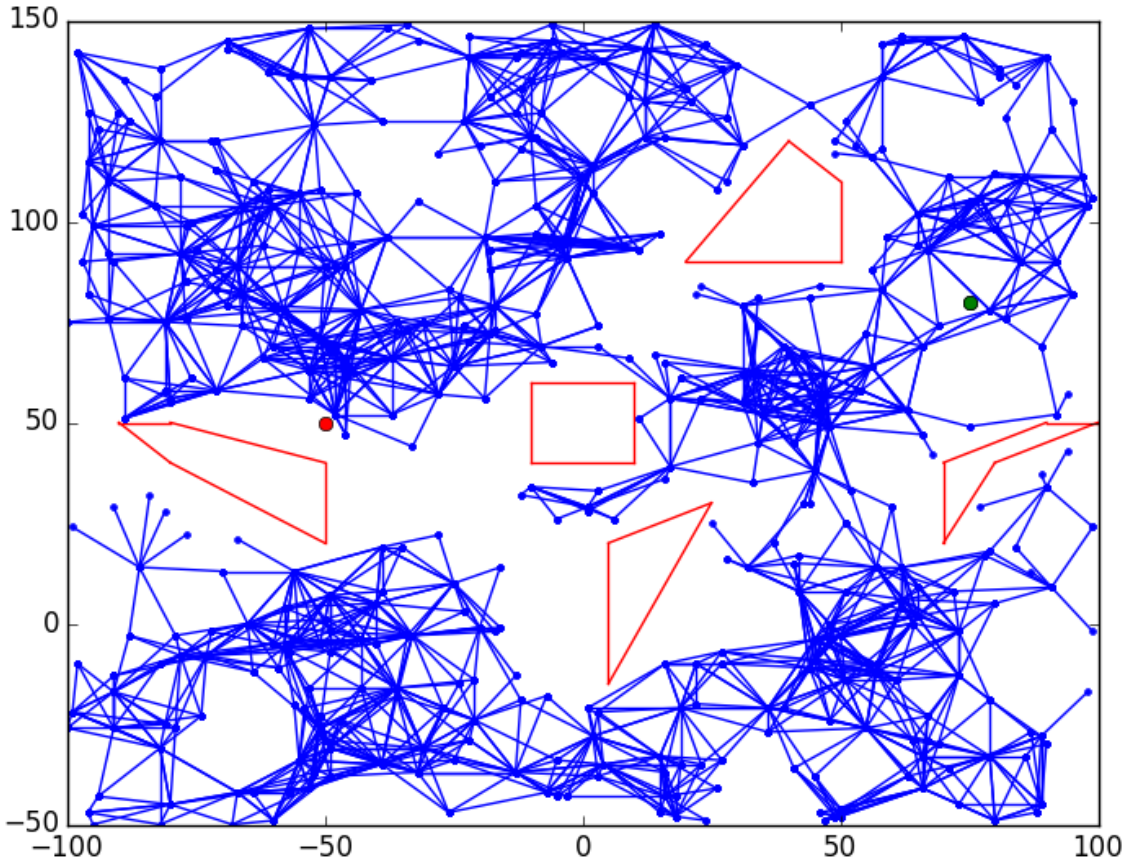
After running the bi directional RRT , it was found that the runtime was less as compared to the simple RRT or even the RRT connect version.

However, as I had used bidirectional search with simple RRT and RRT connect, I found that RRT connect does not always ensure a shorter path as compared to the simple RRT version.

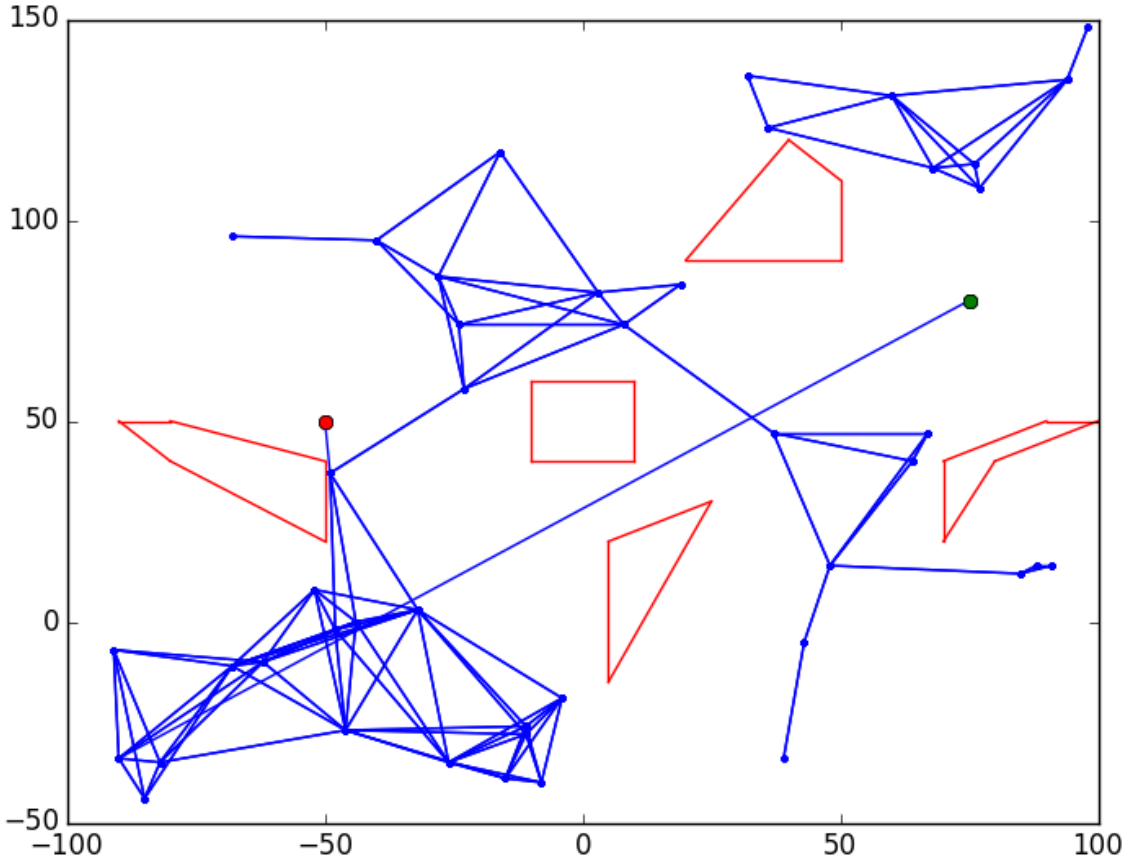
But, for the arm robot in env1.txt, it showed remarkable performance as compared to the other versions. The connection from the start to the goal was found in a very less time and with less number of samples, as compared to the previous versions.


150
100
50
0
−50
−100
−50
0
50
100

Q 2.1_____



Note: I was unable to get the plan. I tried to use the sampled nodes and the linked nearest neighbors with A*search method. However was unable to get a good result.



As the number of samples is increased, the probability that the algorithm will not find a plan from the start to goal reduces to zero. With increase in samples, we get a path of lesser distance to traverse.

Increasing the number of nearest neighbors helps to get more paths and to prevent a gap between two searched regions

Q 2.3_____

Increasing the number of samples helps to improve the connection in the roadmap as it introduces more paths

Q 3_____

3.1

The hardest part of this assignment was to find a plan using the sampled nodes that I found out the PRM problem. I tried to find the plan via A*search, however I was not able make a relation between the sampled nodes (and nearest neighbours stored) in PRM and the A*search algorithm.

3.2

I did not find any thing easy in the assignment yet

3.3

Solving the RRT problems and getting the solutions helped me understand the algorithm better. Getting the results boosted my confidence.

3.4

Linking the PRM and the graph search methods, this was difficult for me to understand

3.5

Overall, I have enjoyed solving this assignment. However, it would have been better if I could have got good results for the PRM problems.