CS 830 Intro to AI, Spring 2025

Written Assignments, Sushma Akoju

Assignment 3

1. Describe any implementation choices you made that you felt were important. Clearly explain any aspects of your program that aren't working. Mention anything else that we should know when evaluating your work.

   I chose nodes with x, y, dx, dy and theta, s and parent values.
   I chose to keep the implementation simple but still the problem was not simple. Here are the reasons for exploring various aspects and impacts on choices of the problem as I came across:

   Distance metric : I chose a naive 3D distance metric that includes angle as a third dimension.But I also tested my code with 2D and 3D distance metrics, but because this seems like a dynamic time warping algorithm, it was taking longer. So I had to rewrite distance calculation with just 2D and 3D.

   Secondly, for checking goal distance, I attempted by sampling 120, 270 or 360 numbers of angles to check for 0.1 radius of unit vector from the goal. But it takes longer as it depends on the number of iterations. So I just went with 2D distance for checking the distance from the goal.

   Thirdly, my code checks for transforming the theta to be within (0, 2π) after arctan2.

   Fourthly, for initializing dx, dy for random 10 controls - I used following in the steer function (get_trajectories)

   ```
   dx = random_node.x - nearest_node.x
   dy = random_node.dy - nearest_node.y
   ```

   Seed value:

Reference output using a reference solution with seed value same as the one I use, gives different outputs. Seed value significantly changes the outputs generated by the program and validator. But the seed value used by the validator, if I may assume, seems like 8. That is what gives me an output that has the same number of state, control pairs. The validator is sensitive to the seed - it took me 1 hour to intuitively debug this.

Goal bias: I think for getting random nodes with bias, initially I sampled with 0.05, 0.95 likelihood to “choose” from goal node and random node. But it did not seem correct, so I changed it to iterations%0.05 == 0. (I also thought of hard coding this, for every 100 iterations, randomly select 5 iteration indices and simply make those 5 times, random_node = goal_node. It is faster but it gives a lesser number of edges when backtracking the path from goal for space-0.sw.
I just chose to go with iterations%0.05 == 0.

Collision checks: for collision checks, I used distance from obstacles, but I used point distances. I did implement the unit vector distance with some random radius i.e. 0.05 - but it would not necessarily detect obstacles or it was taking longer. This is because obstacles did not have any angle, orientation. But for calculating if a node was colliding with obstacles, I attempted using the angle, magnitude of this_node to calculate 20 slices for each one of the obstacles and then calculate 2D distance from the 20th slice from this_node.

Slices and states/edges: The most difficult part (because it was time consuming): we needed to use 20 time slices, in that case, there were several questions:

1. Do we use the last slice as the node to connect an edge?
2. Do we extend the tree with 20 slices for each nearest node and state control that worked?

I did implement both directions. But taking the node that represented x, y, dx, dy, theta, and magnitude seemed sufficient to add for count purposes and for mapping purposes I thought I should extend the motion tree with all the slices for the “nicer” looking map of the trajectory, which seems to be the expectation from assignment instructions. However it disagreed with the validator, would the validator not allow all slices? But if I used last slice (20th slice of each node), then it didn’t really match validator’s expected output:

```
bash-5.2$ ./rrt-validator -grad -o grad-1-space-0-1.pdf -- ./run.sh < ./examples/space-
0.sw
Error parsing planner output!
Exception: End_of_file
Not bothering to draw or validate.
```

I wasn't saving the length of the list when discarding the tree that ended up with collision and restarting the tree, but in Space-0.sw output, I saw that first it gives 22 state control pairs, then 257 state control pairs in the reference output. I used seed and it always gave me a different number of edges i.e. 280 (even without goal state) which is one edge more than the expected output. I found out pretty late that we needed to add the lengths when starting a new tree, it was too late to modify the code.

This assignment seems smaller unlike what was told in the recitation, but is actually not small. I really wish the recitations were a bit earlier. Recitations are helpful, thanks to Steve!

My script can be run:
./run.sh < ./examples/space-0.sw > space-0-output.txt
Given the aforementioned error, this is what I have got with evidence.

2. What suggestions do you have for improving this assignment in the future?
   For this assignment, it is time consuming - as we have to make several informed-choices. How to process the slices - is another time consuming puzzle, any more tips, suggestions is helpful (like DTW algorithm or unit vector distances). It would be good if you make it explicit in the assignment to set seed value to avoid varying answers. It would help if some clues are given why the output of the reference solution gives two sets of edges. It is unclear if we need to treat all nodes including obstacles as nodes with 20 slices.

   Here is my sample output for space-0.sw:
   280
   0.1 1.54 0.0 0.0 0.8033411368895311 0.16106539660208968
   0.1 1.54 1.739265 1.294481 6.211535 0.365579
   1.739265 1.294481 0.382513 1.501818 1.123163 0.251039
   0.382513 1.501818 3.511572 1.429521 2.905094 0.416775
   3.511572 1.429521 2.14828 1.269178 2.309514 0.23285
   2.14828 1.269178 2.861796 0.198302 3.341563 0.122552

2.861796 0.198302 0.068828 0.738839 4.870199 0.187024
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2.008735 0.564877 1.594274 1.53172 2.244427 0.170041
1.594274 1.53172 1.394962 0.66802 0.98589 0.35376
1.394962 0.66802 2.754023 0.839146 2.933798 0.173735
2.754023 0.839146 3.888716 0.993493 2.766357 0.317088
3.888716 0.993493 3.357675 0.831933 6.038987 0.378256
3.357675 0.831933 0.57058 0.358691 2.076104 0.056168
0.57058 0.358691 1.90872 0.84725 5.901832 0.262469
1.90872 0.84725 1.477422 0.698482 2.461769 0.009445
1.477422 0.698482 2.577593 1.339829 0.635341 0.393833
2.577593 1.339829 1.184392 1.378005 1.096717 0.015916
1.184392 1.378005 1.660289 1.045159 0.728345 0.458874
1.660289 1.045159 1.36397 1.984621 5.243203 0.029512
1.36397 1.984621 3.296797 0.955439 3.257195 0.140025
3.296797 0.955439 1.468648 0.959775 3.436647 0.035938
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1.060069 0.215541 3.499516 0.960155 3.257952 0.247636
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Assignment 4

Assignment 5

Assignment 6