CS 747 : Assignment 3

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1 Task 1

- I first converted the heading angle of the car to a value between $0°$ and $360°$. This angle is measured w.r.t the positive X axis and in a clockwise manner.
- For this task, whenever the initial angle is greater than $90°$ and less than $270°$, I made it rotate so that the heading angle is either less than $90°$ or greater than $270°$.
- To be specific, if the angle is between $90°$ and $180°$, I made the steering angle equal to $-3°$. Otherwise, I made the steering angle equal to $3°$. All this was done keeping the acceleration 0. This is done until we get a heading angle in the range $0°$ to $90°$ or $270°$ to $360°$.
- From there, I calculated the intercept the car would make on the line from where the road starts if it travelled in a straight line starting from the current position.
- If the intercept is found to be between -75 and 75, the car starts with an acceleration of 5 units with steer angle set to $0°$. The car takes the same action subsequently until it reaches the road.
- Instead, if the initial intercept is found to be greater than 75, i.e, if the car would go below the road if it starts in a straight line from the current position, the car is steered by $-3°$ until the intercept falls in the range -75 to 75.
- Alternately, if the initial intercept is found to be less than -75, the car is steered by $3°$, until the intercept falls in the range -75 to 75.
- After confirming that the intercept indeed lies in the range -75 to 75, we start the car with an acceleration of 5 units with steer angle set to $0°$. We take the same step subsequently until we reach the road.

2 Task 2

- I basically divided the entire screen into four quadrants. The division of quadrants is quite natural, i.e., based on the signs of x and y. Lets follow the general naming system for quadrants : Q_1 for $x > 0, y > 0$, Q_2 for $x < 0, y > 0$, Q_3 for $x < 0, y < 0$, Q_4 for $x > 0, y < 0$.
- Let the four pits be named P_1, P_2, P_3, P_4 based on the quadrant they are present in. Let C_{ix}, C_{iy} denote the x, y coordinates of the center of P_i.
- I considered many cases to manoeuvre the obstacles. I used a function called decision which takes in the current x, y coordinates and the heading angle of the car along with a variable called type to give a decision when we're sure that we can reach the road without hitting any obstacles.
- The type variable is set to 1 for Q_1 and Q_2 and to 2 for Q_3 and Q_4. This function does stuff similar to what we have done in task 1. If type is 1, we first calculate intercept until it falls between 60 and 75, and steer the car until then. Else, we steer the car until the intercept falls between -60 and -75. Also, as the car might be moving with some velocity before steering, the car's acceleration is set to -3.95 units while steering, to preserve the whole purpose of steering. Once we are finished steering, we start the car with an acceleration of 5 units and with steer angle set to 0.
- As mentioned above, the target intercept range is set to $[60, 75]$ for Q_3, Q_4 (the upper parts of the screen), and to $[-75, -60]$ for Q_1, Q_2 for lower parts of the screen. This has been done to ensure that the car doesn't run into any new obstacles while accelerating to the road.

- For Q_1, if the y coordinate of the car is less than $C_{1y} - 50$, or if the x coordinate of the car is greater than $C_{1x} + 50$ i.e, if it is above the pit or beyond the pit in the figure respectively, we assume that we can find a path free of obstacles to the road and hence call the decision function. If the x coordinate of the car is less than $C_{1x} - 50$, i.e if the car is before the pit in the figure, we steer the car until it becomes vertical and keep moving up until the y coordinate of the car becomes less than $C_{1y} - 50$, i.e, until the car is above the pit in the figure. From there, we eventually reach the road as described above. Else, if the y coordinate of the car is greater than $C_{1y} + 50$, we steer the car until it becomes horizontal and move until the x coordinate of the car becomes greater than $C_{1x} + 50$ i.e, until the car moves beyond the pit. From there, we accelerate to the road as described above.
- For Q_2, if the y coordinate of the car is less than $C_{2y} - 50$, i.e., if it is above the pit in the figure, we assume that we can find a path free of obstacles to the road and hence call the decision function. If the x coordinate of the car is less than $C_{2x} - 50$ or greater than $C_{2x} + 50$, i.e if the car is before the pit or beyond the pit in the figure, we steer the car until it becomes vertical and keep moving up until the y coordinate of the car becomes less than $C_{2y} - 50$, i.e, until the car is above the pit in the figure. From there, we eventually reach the road as described above. Else, if the y coordinate of the car is greater than $C_{2y} + 50$ and the x coordinate is between $C_{2x} - 50$ and $C_{2x} + 50$, i.e., if the car is below and within the boundaries of the pit in the figure, we steer the car until it becomes horizontal and move until the x coordinate of the car becomes greater than $C_{2x} + 50$ i.e, until the car moves beyond the pit. From there, we steer and move up until we go above the pit and then accelerate to the road as described above.
- For Q_3, if the y coordinate of the car is greater than $C_{3y} + 50$, i.e., if it is below the pit in the figure, we assume that we can find a path free of obstacles to the road and hence call the decision function. If the x coordinate of the car is less than $C_{3x} - 50$ or greater than $C_{3x} + 50$, i.e if the car is before the pit or beyond the pit in the figure, we steer the car until it becomes vertical and keep moving up until the y coordinate of the car becomes greater than $C_{3y} + 50$, i.e, until the car is below the pit in the figure. From there, we eventually reach the road as described above. Else, if the y coordinate of the car is less than $C_{3y} - 50$ and the x coordinate is between $C_{3x} - 50$ and $C_{3x} + 50$, i.e., if the car is above and within the boundaries of the pit in the figure, we steer the car until it becomes horizontal and move until the x coordinate of the car becomes greater than $C_{3x} + 50$ i.e, until the car moves beyond the pit. From there, we steer and move down until we go below the pit and then accelerate to the road as described above.
- For Q_4, if the y coordinate of the car is greater than $C_{4y} + 50$, or if the x coordinate of the car is greater than $C_{4x} + 50$ i.e, if it is below the pit or beyond the pit in the figure respectively, we assume that we can find a path free of obstacles to the road and hence call the decision function. If the x coordinate of the car is less than $C_{4x} - 50$, i.e if the car is before the pit in the figure, we steer the car until it becomes vertical and keep moving up until the y coordinate of the car becomes greater than $C_{4y} + 50$, i.e, until the car is below the pit in the figure. From there, we eventually reach the road as described above. Else, if the y coordinate of the car is lesser than $C_{4y} - 50$, i.e., if the car is above the pit in the figure, we steer the car until it becomes horizontal and move until the x coordinate of the car becomes greater than $C_{4x} + 50$ i.e, until the car moves beyond the pit. From there, we accelerate to the road as described above.
- I have added some other additional constraints like, if $C_{2x} + 50 < x$ and $x < C_{1x} - 50$ and $y > 0$, i.e., if the car is between the lower two obstacles, steer the car to make it vertical and move it up until the y coordinate of the car becomes less than 100. From there, just use the decision function and accelerate to the road. Alternately, if $C_{3x} + 50 < x$ and $x < C_{4x} - 50$ and $y < 0$,

i.e., if the car is between the upper two obstacles, steer the car to make it vertical and move it down until the y coordinate of the car becomes greater than -100. From there, just use the decision function and accelerate to the road.

3 Pictorial representation of the above ideas

3.1 Task 1

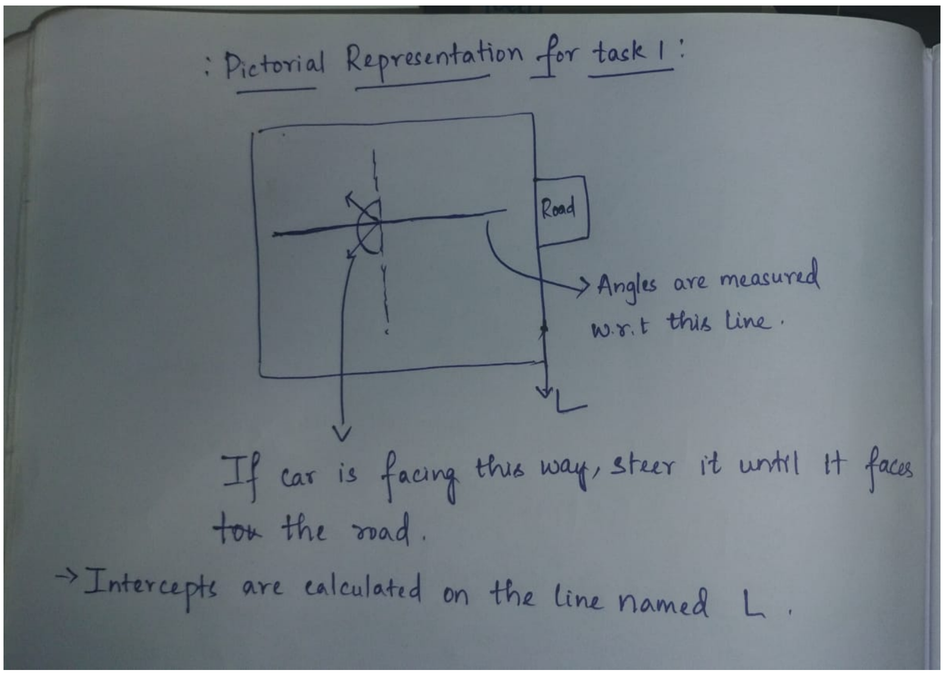

Figure 1: Task 1

3.2 Task 2

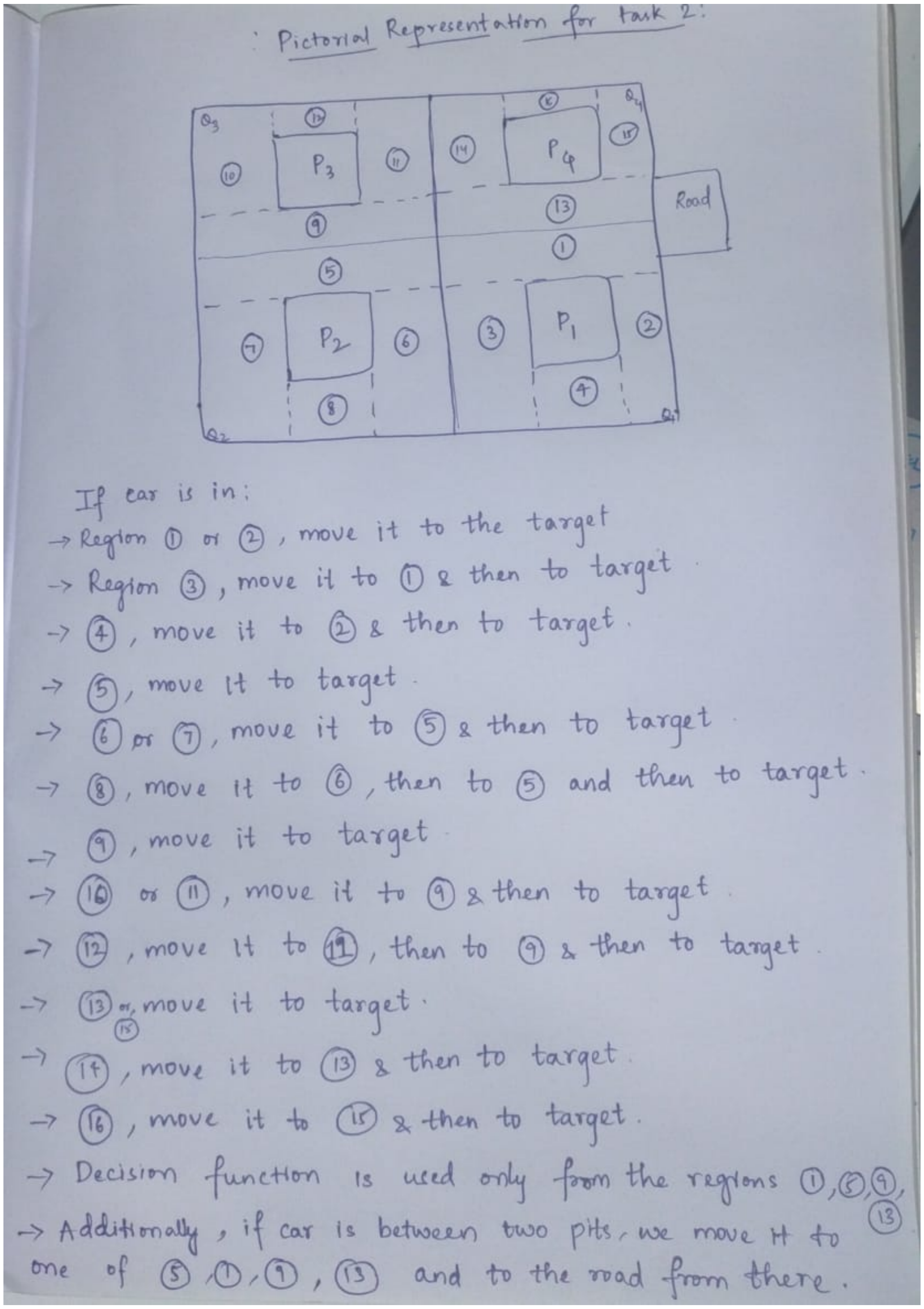

Figure 2: Task 2

4 Intermediate experiments and mistakes

For task 2, instead of making the car exactly vertical, I tried other angles to avoid obstacles, but I was getting some errors with that. For example, the reason to include the last case mentioned above(the case where the car is in between the two pits) is that, sometimes, the car might move from one quadrant to the other when it is close to the separating edge. To avoid that, we first check if it is in between the two pits and if the answer is yes, we move to a region from where it is convenient to reach the road.
I also used one more variable called dont_disturb to ignore movement from one quadrant to another after we have identified a straight line without any obstacles which leads us to the road. Otherwise, it took more time to account for the above movements and each time the car enetered a quadrant, it had to check the conditions corresponding to that quadrant.

5 References

- Lecture slides for understanding various RL algorithms.
- PyGame tutorials on the web