CS 3630 Project 4 Report

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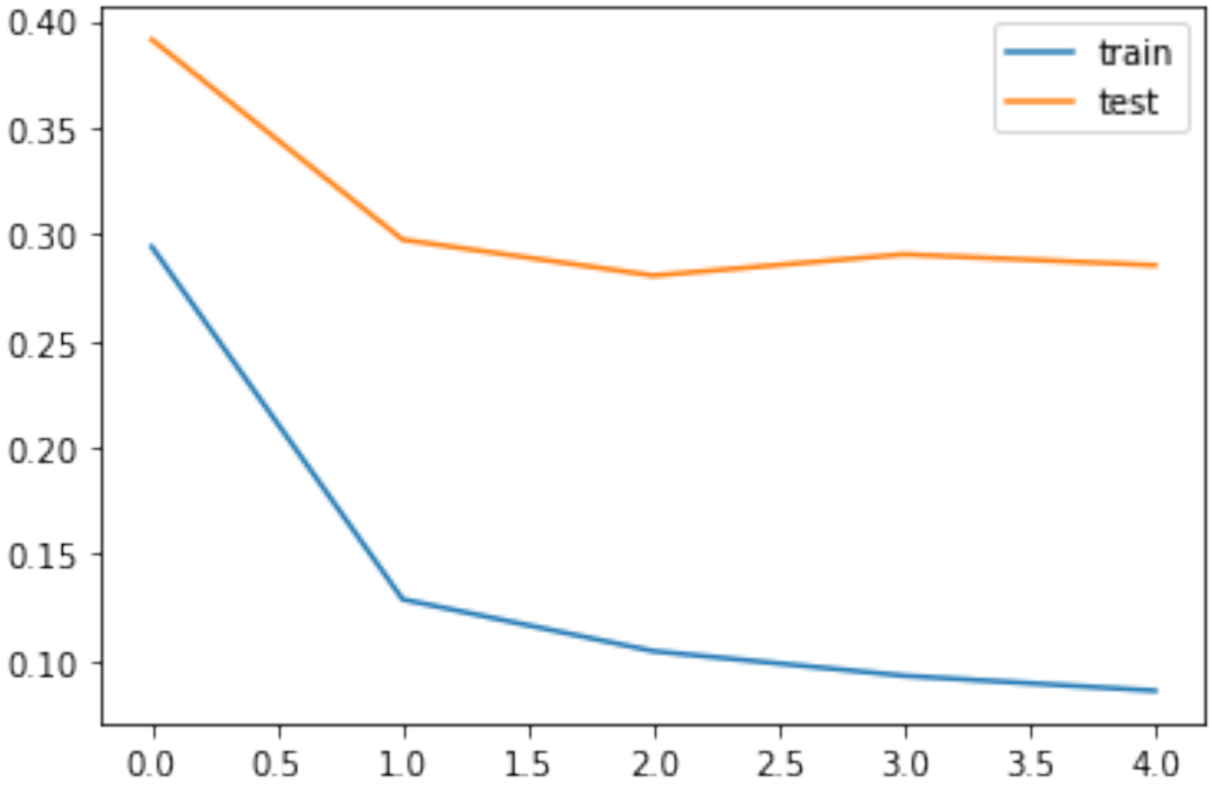
1.1) What is the shape of the feature map after an image from the kMNIST dataset is passed through the first convolution layer of SimpleNet?

$(5, 10, 10)$

1.2) Count the Number of Parameters:

- Relu Layer: 0
- AvgPool2D: 0
- The last Linear Layer (self.linear1): 490

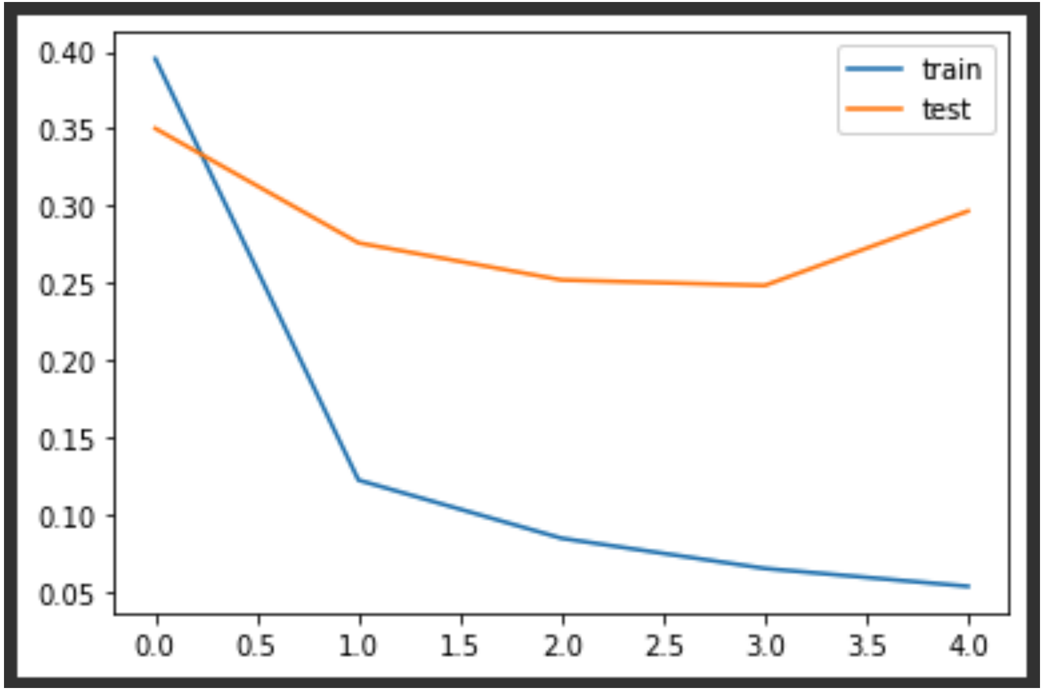
1.3) Paste a screenshot showing the loss vs epoch of your LeNet. (before tuning) State the train and test accuracies.



1.4) List the final set of hyperparameters you used to get the best test accuracy. Discuss your findings with other combinations that you tried.

What worked best for me was learning_rate = 0.005, num_epochs = 5, batch_size = 128. I found that the model is really sensitive to different parameters and that some seemingly small adjustment can have large differences in result. Through some theory-crafting and experimentation these values worked best for me.

1.5) Paste a screenshot showing the loss vs epoch of your LeNet. (after tuning) State the train and test accuracies.



1.6) The kMNIST data set is a high-contrast collection of Japanese characters. Let's say the museum owner wanted to run this bot in a section of the museum containing a more varied collection of artwork. What considerations might we want to make in approaching this problem? What hyper-parameters might we want to adjust?

The largest consideration is the variety would take more time for the model to recognize accurately. The hyper-parameter to adjust in that scenario would be the amount of epochs so the model could train more.

2.1) Read through the code in the Setup section. Answer the questions below.

1. How many obstacles are in the environment? Exclude the walls along the corners of the environment.

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1. What does the integer ‘0’ in the images_list (ex. Image([0,3], ‘e’, **0**) represent?

The last parameter in the Image constructor is the image label. In the code's documentation its specified to be between 0 and 9.

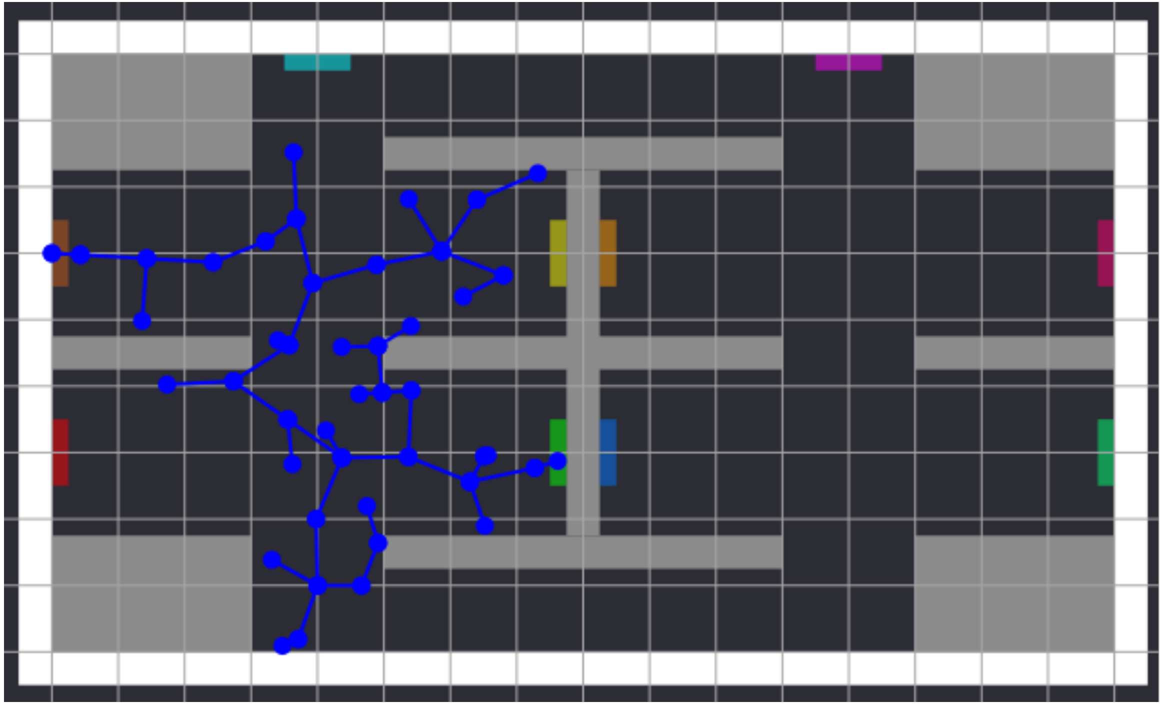
2.2) When randomly sampling points for RRT, what is the purpose of returning the goal position with some probability?

The purpose of having a probability that correlates to the goal position is to give the algorithm a bias towards the intended end point. This bias ends up with a tree disproportionally heavier in the direction of the goal point. This heaviness lets a smoothing algorithm have more routes to choose from which can lead to a more optimal route to the end goal. The bias also can lead to the the goal being found faster because the tree is pushed (to a degree) in that direction.

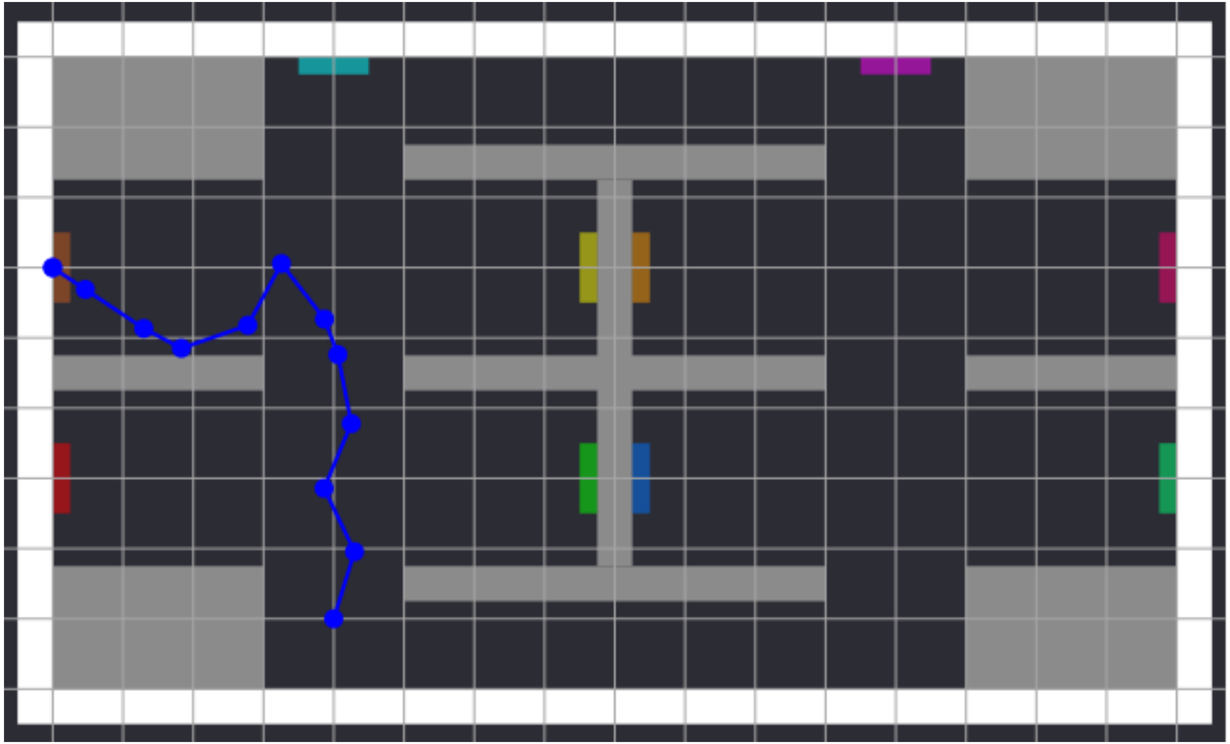
2.3) Write the high-level pseudocode for the RRT algorithm here. Add an explanation of each step beside the pseudocode.

```
Node start = [3,4] // Set the start node’s coordinates to the coordinates you want to start from
Node end // initialize end variable as null for later


LOOP: // this is the node creation loop
  rand = getRandomSample([9,9]) // generate a random point with some bias towards the end position
  step = getStep(rand) // return a node that is in the direction of rand but less than a perdetermined distance
  if no collision and not in an obstacle: // check if valid traversal
    set parent of step as nearest node // chain step to its nearest neighbor
    add step to tree // increase the size of the tree with a new ending point

  if step is the end: // Solution is found!
    end = step // store the goal node for later
    exit LOOP // no need to increase tree any further
START LOOP // no solution is found so keep on increasing the tree

path = list that stars with end // initiliaze an array with a single element of the end node
While(end.hasParent): // loop until the master ancestor is found
  end = end.parent // set end to its parent
  add end to path // add previous end's parent to the array

path = reversed path // reverse the path so it starts from the start node
```

2.4) Attach a screenshot of the rapidly-exploring random tree (RRT) generated to find the path from [4,1] to goal position [0,6].

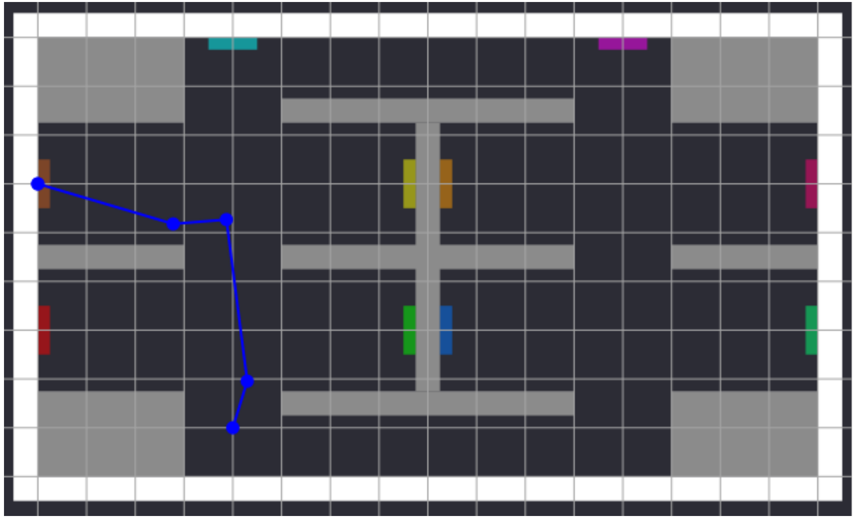


2.5) Attach a screenshot of the path found from the tree in 2.4 without path smoothing.

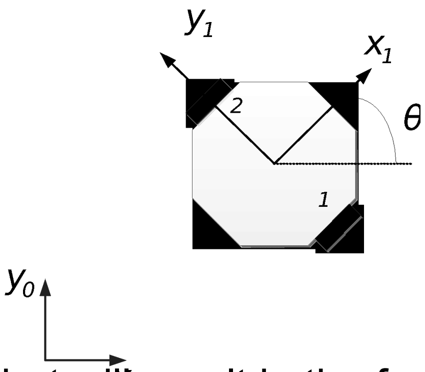


2.6) Attach a screenshot of the path found from the tree in 2.4 with path smoothing. Explain the differences with and without smoothing. If you haven't implemented smoothing, just explain the expected differences in the path when smoothing is applied.

The major difference is the amount of points between the two different paths. The smoother path has less points but is simply a subset of the points in the original path. This preserves the overall end product but does it with less distance traversal and rotations required to complete. This makes the smoother path more efficient and simpler to compute and store.



3.1) Consider the differential drive robot with the coordinate frame assignments as shown below. The robot has a wheelbase of 60 cm between the centers of the right and left wheels (labeled as 1 and 2). The wheels have a radius of 10 cm. The rotational speeds of right and left wheels are denoted by 1 and 2, respectively.

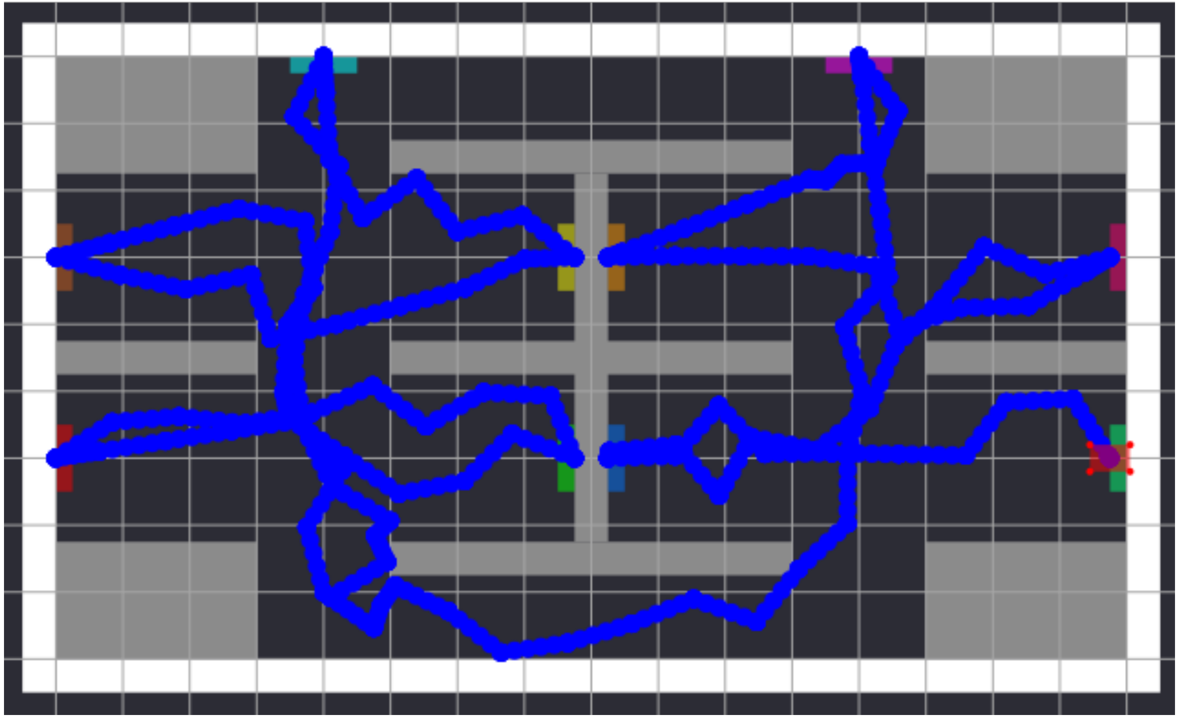


a) Calculate the wheel velocities that will result in the forward robot velocity v_x = 20 cm/s and turning radius of 1 m.

b) Given the above, what is the resulting angular velocity?

c) Given that the robot's orientation is θ=2, calculate the robot's velocity in the global coordinate frame. Show work.

3.2) Attach a screenshot of the paths generated by the robot to look at all ten images in the museum.



3.3) The RRT algorithm implemented in this lab plans paths composed of straight-line segments. How would you edit the differential drive section to plan smooth curved paths?

I would implement Dubin's pathing algorithm on the points of the path. This would be a combination of RSR, LSL, RSL, LSR, RLR, and LRL (where R is right, S is Straight, and L is Left) commands. This would find the most minimal arc needed to traverse the path smoothly along the points.

3. Feedback

Please provide feedback on the coding portion of the project. How did it help your understanding of the material? Is there anything that you think could have been made more clear?

<Put your answer in this textbox, replace this text>