W23 CMPUT 412/503 Final Project
Autonomous Driving with Duckietown

Project demonstration: April 13th
Written report due: April 16th

You must work in a group of 2 or 3 for this project. You cannot work individually.
[Please sign up your group members here](.).

Description

For the final project you will need to traverse the Duckietown from start to finish and collect points along the way. There are **three stages of the town**, each with different tasks to complete.

During the final project demo **your group will have 3 rounds to attempt the course** and collect as many points as you can (as laid out in the table at the end of this document). The round with the most collected points will be counted as your final demo mark. A round is composed of 3 stages; for each stage there are a potential 40 points to collect. To get 100% you need to collect 100 points out of 120 potential points. Partial points will not be assigned for each subtask (i.e., you will either get 5 points for each row in the table or 0 points).

Your round starts when your launch your program and finishes when either:
a) You reach the end of the course (park in the parking lot);
b) 10 minutes elapses;
c) Your program crashes or you manually stop your program.

This means that you are allowed to pick your robot up manually **if it drives off of the town or gets stuck** and place it back on the course. You must place your robot back on the course at the position it drove off of the town or right after the place where it got stuck (i.e., you **cannot** try the same subtask over again within the same round). You **cannot** move any other parts of the town (i.e., apriltags, peduckstrians or other duckiebots), you are only allowed to touch your own robot.

 If you want to skip a task you are allowed to pick your robot up and manually move it forward in the course. You **cannot** move it backwards in the course.

You **cannot** control the robot with manual keyboard control; it must navigate the town autonomously. As soon as you touch your laptop to send the robot commands the round is over.

Deliverables

Include in your 1-2 page written report:
- A short video of your Duckiebot completing all 3 stages of the course
- A discussion of your strategy and results for each stage of the course, including what worked well, what didn't work, and what you would do differently
- Which parts of the project each group member worked on

On eClass one member of your team will submit:
- A pdf printout of your published report
- A link to your team written report hosted on your website
- A link to your final project repository

Resources

You can use any material on the internet as long as you cite it properly. You are encouraged to collaborate with your labmates and if you develop a solution together please acknowledge who you worked with in your written report.
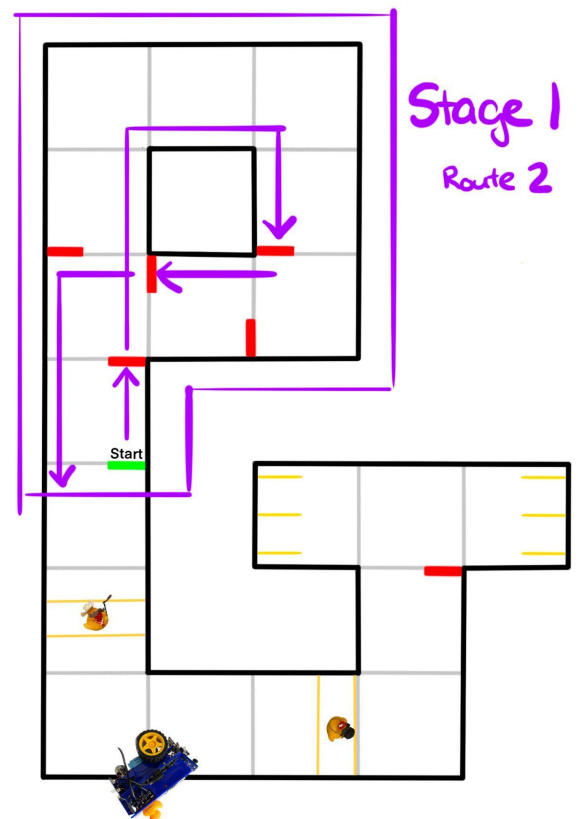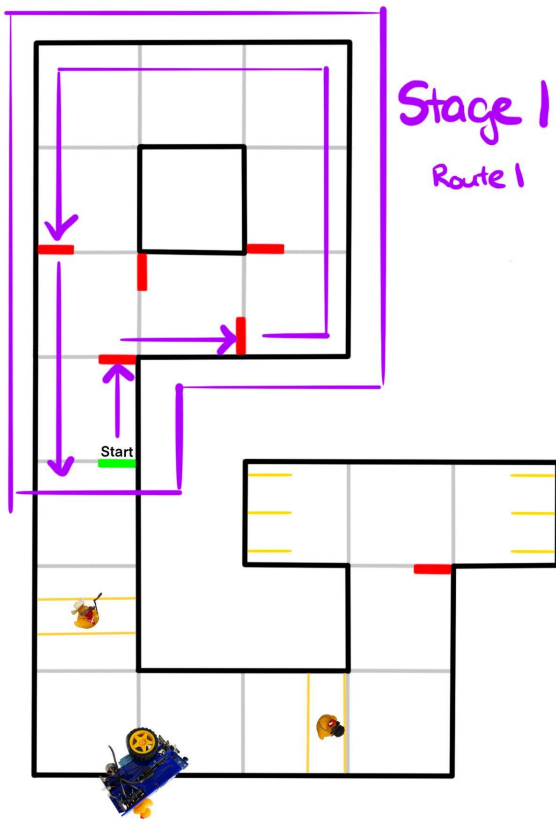
Stage 1: Apriltag Detection and Lane Following

In Stage 1 you are being tested on your ability to accurately detect apriltags and reliably drive within the proper lane.

At the first intersection you encounter you will find an **apriltag** that will tell you to either **turn right (Route 1) or drive straight (Route 2).**

You must **completely stop at every red line** that you encounter (there will also be an apriltag at each red line telling you which direction to turn).

You will have the opportunity to collect a maximum of 40 points during Stage 1 (outlined in the table at the end of this document).

Stage 2: Obstacle Avoidance

Why did the duck cross the road?

In Stage 2 you are being tested on your ability to **safely** navigate the road.
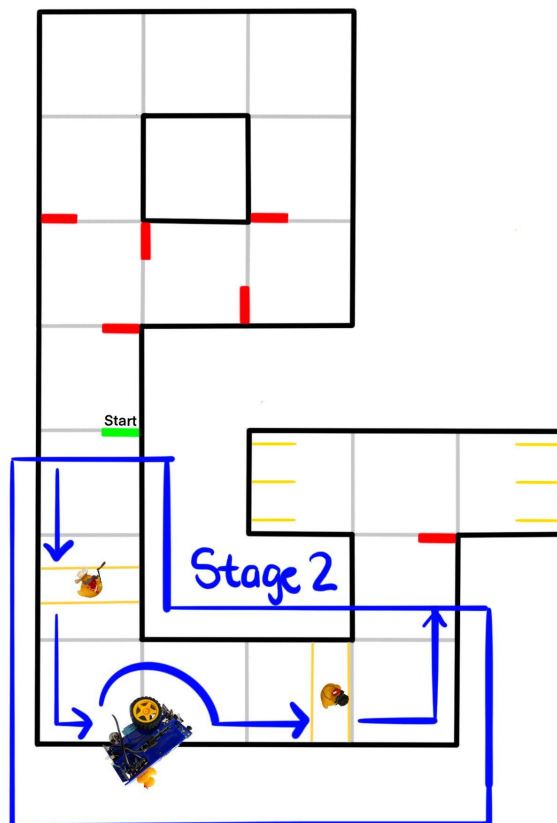
You will be required to detect and wait for peduckstrians to cross at the crosswalk as well as detect and maneuver around a duckiebot broken down on the side of the road.

The two duck crosswalks will be marked with an apriltag. **You must always stop at the crosswalk and check if there are any ducks crossing the road.** If there is a duck, you must wait for them to finish crossing the road before continuing to drive. If there is not a duck crossing, then you may continue driving right away. **Only one of the crosswalks will have a duck crossing the road**; the duck will be clearly visible in the middle of the lane that you are driving in. You must stay in your own lane when driving through the crosswalk.

When you detect the broken down duckiebot on the side of the road **you must stop** to inquire if they would like assistance (don't worry - they won't). After you have stopped you will need to **safely drive around the duckiebot** and continue along the road in the proper lane.

You will have the opportunity to collect a maximum of 40 points during Stage 2.

To prove he wasn't a chicken!
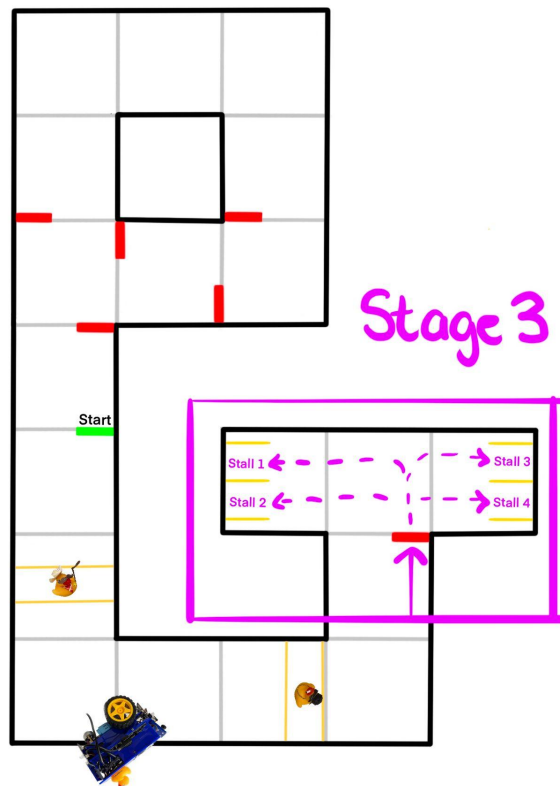
Stage 3: The Parking Lot

For Stage 3 you are being tested on your ability to find and park in the correct stall.

At the beginning of each round you will be told by the TA which stall you must park at in the parking lot (stall 1, stall 2, stall 3, or stall 4). You should pass this as input to your program at launch time.

Each stall will be marked with a **unique, static apriltag**.

At the end of the round your duckiebot must **drive to the correct stall, park, and turn itself off** (i.e., properly shut down the robot and the launched program).

You will have the opportunity to collect a maximum of 40 points during Stage 3.

Stage One	
Detect left turn apriltag at intersection and turn left	+5 points
Detect right turn apriltag at intersection and turn right	+5 points
Detect go straight apriltag at intersection and go straight	+5 points
Stay within the correct lane while turning left through the intersection	+5 points
Stay within the correct lane while turning right through the intersection	+5 points
Stay within the correct lane while going around the curved part of the road	+5 points
Stay within the correct lane while going straight through the intersection	+5 points
Complete stage one with autonomous navigation without running into an apriltag	+5 points
Stage Two	
Stop at the first duck crosswalk apriltag	+5 points
Stop at the second duck crosswalk apriltag	+5 points
Drive through the first duck crosswalk if there are no ducks on the road	+5 points
Drive through the second duck crosswalk if there are no ducks on the road	+5 points
Stop at the broken duckiebot to see if they require assistance	+5 points
Safely drive around the broken duckiebot without hitting it	+5 points
Continue proper lane following after passing the broken duckiebot	+5 points
Complete stage two with autonomous navigation without running into an apriltag or peduckstrian	+5 points
Stage Three	
Stop before entering the parking lot	+5 points
Drive to the correct side of the parking lot	+5 points
Park in the correct parking spot (most of robot in stall)	+5 points
Back into the correct parking spot	+5 points
Park properly within the stall (not touching the lines denoting the stall)	+5 points
Turn off Duckiebot and program after parked	+5 points
Complete stage three with autonomous navigation without running into an apriltag	+5 points
Made it through entire course without touching your duckiebot	+5 points

Stage One	Round 1	Round 2	Round 3
Detect left turn apriltag at intersection and turn left			
Detect right turn apriltag at intersection and turn right			
Detect go straight apriltag at intersection and go straight			
Stay within the correct lane while turning left through the intersection			
Stay within the correct lane while turning right through the intersection			
Stay within the correct lane while going around the curved part of the road			
Stay within the correct lane while going straight through the intersection			
Complete stage one with autonomous navigation without running into an apriltag			
Stage Two			
Stop at the first duck crosswalk apriltag			
Stop at the second duck crosswalk apriltag			
Drive through the first duck crosswalk if there are no ducks on the road			
Drive through the second duck crosswalk if there are no ducks on the road			
Stop at the broken duckiebot to see if they require assistance			
Safely drive around the broken duckiebot without hitting it			
Continue proper lane following after passing the broken duckiebot			
Complete stage two with autonomous navigation without running into an apriltag or peduckstrian			
Stage Three			
Stop before entering the parking lot			
Drive to the correct side of the parking lot			
Park in the correct parking spot (most of robot in stall)			
Back into the correct parking spot			
Park properly within the stall (not touching the lines denoting the stall)			
Turn off Duckiebot and program after parked			
Complete stage three with autonomous navigation without running into an apriltag			
Made it through entire course without touching your duckiebot			
TOTAL POINTS COLLECTED			