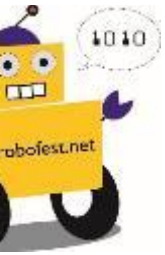

LAWRENCE TECHNOLOGICAL UNIVERSITY
ROBOFEST

2018 Workshops

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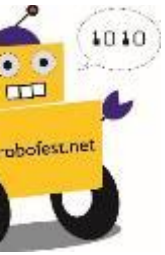
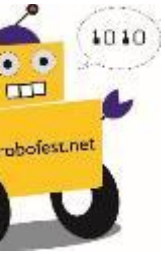


LAWRENCE TECHNOLOGICAL UNIVERSITY
ROBOFEST

Robot Mesh Software
Vex IQ Robot
Workshop

Instructor:
Assistants:

Lawrence Technological University
Computer Science



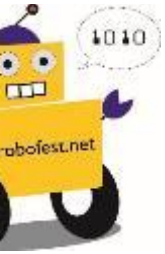
Course Overview

- 2018 Robofest competition AtBC
  - Autonomous tennis Ball Collector
- VexIQ robot introduction
- Using the Vex IQ robot to solve the AtBC challenge

2018 Robofest Competition

- Video overview

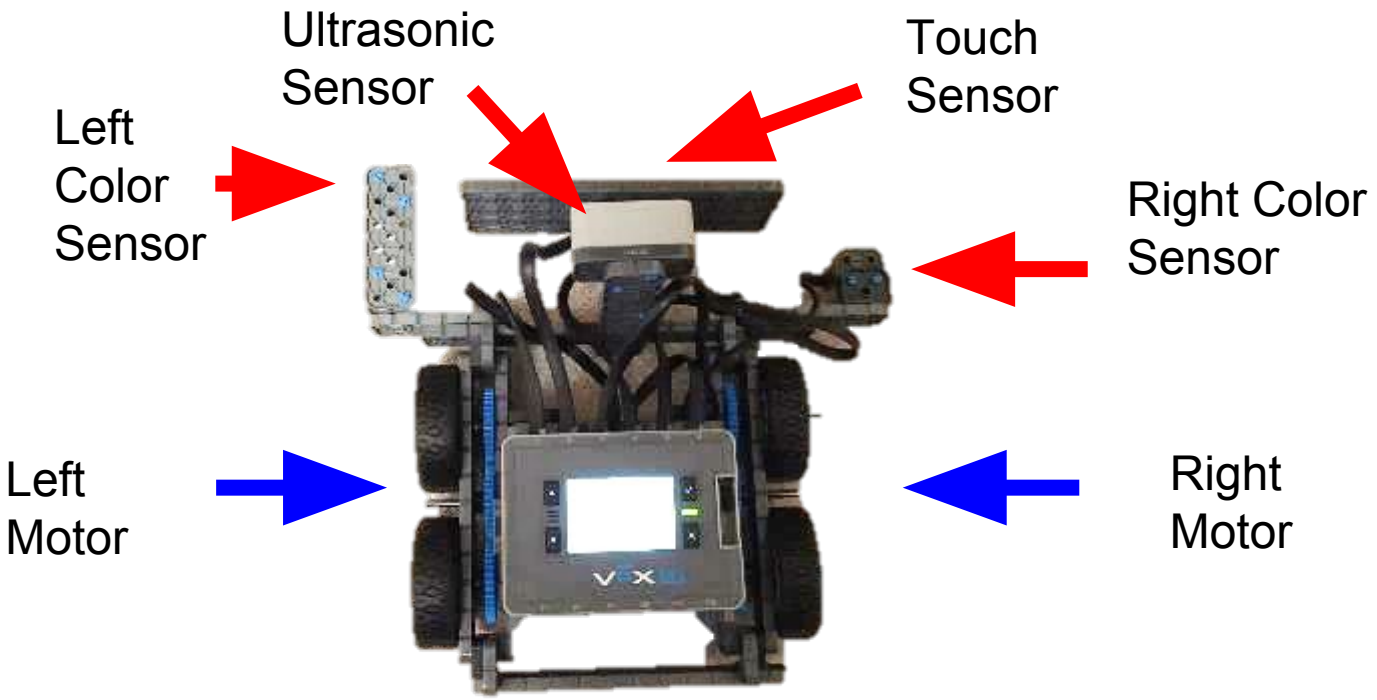
- Key tasks
  - Find the edge of the playing field
  - Follow the playing field edge until corner
  - Travel around the tennis court table
  - Find bottles (and gather)
  - Find the box fence edge
  - Find the center of the box fence edge

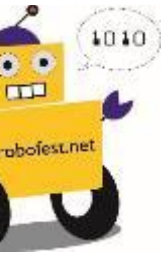


2018 Robofest Competition

- Please note that the actual collection and delivery of the tennis balls is beyond the scope of this workshop

Workshop Vex IQ Robot





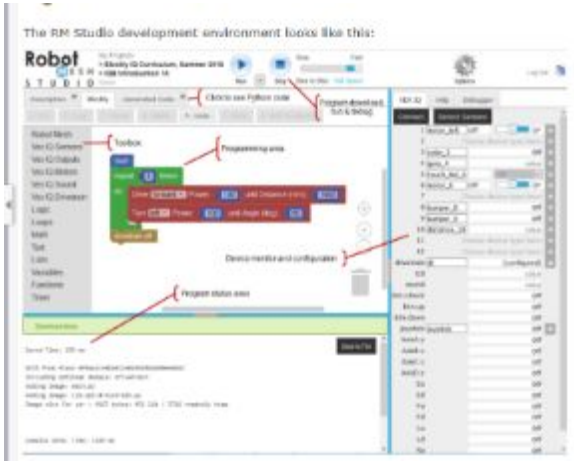
Robot Connections

- Left Motor connects to **1**
- Left Color Sensor connects to port no. **2**
- Touch sensor connects to port no. **3**
- Ultrasonic sensor connects to port no. **4**
- Right Color Sensor connects to port no. **5**
- Right Motor connects to **6**

What is Robot Mesh Studio?

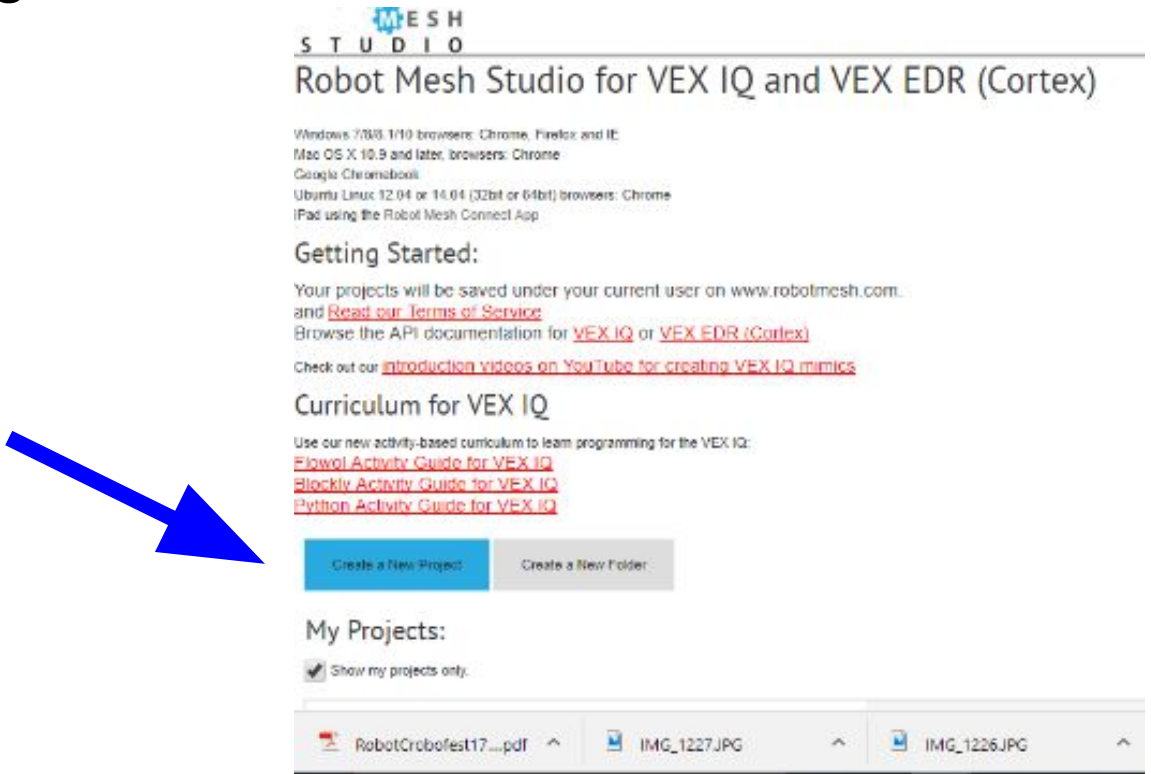
- Web-based programming software for VexIQ
- Uses a drag and drop interface
- Based on Python programming language

Robot MESH STUDIO
Education Edition



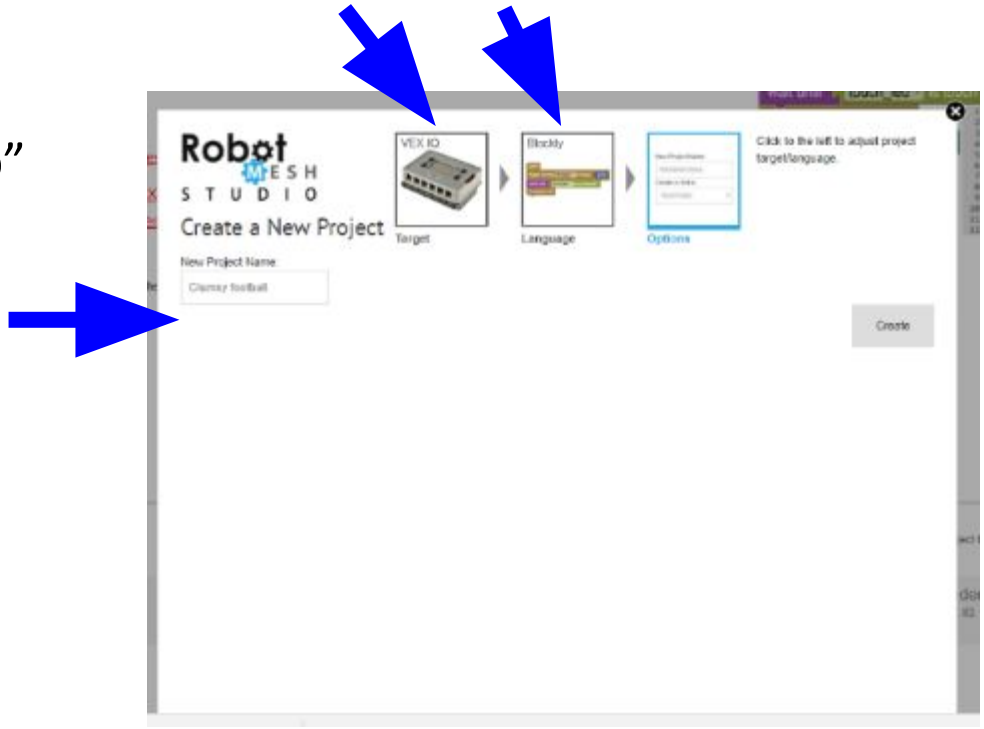
Getting Started

- Go to webpage: https://www.robotmesh.com/studio
- Create an account
- Configure browser/ Install plug-ins
- Create a new program



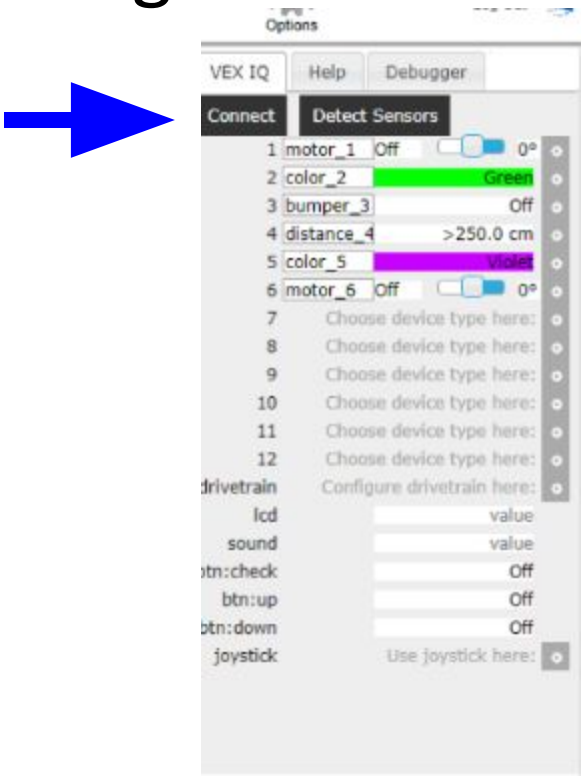
Create a New Program

- Make sure these are selected
  1. Target: “Vex IQ”
  2. Language: “Blocky”
- Name the program “Workshop”



Connect to Robot

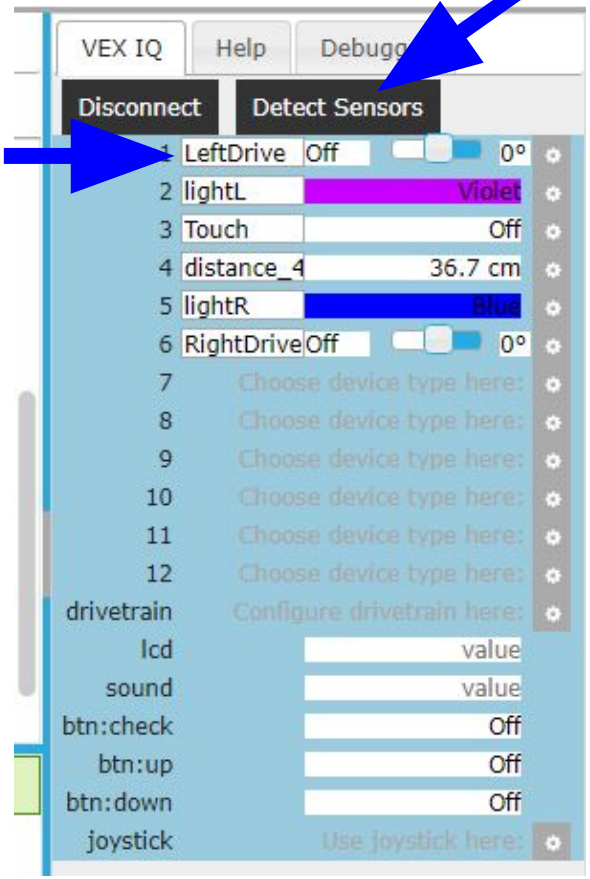
- Click on “Connect”
- If not connecting, try the following:
  - Check connection at computer
  - Check connection at robot
  - Restart robot
  - Restart browser



Motor and Sensor Setup

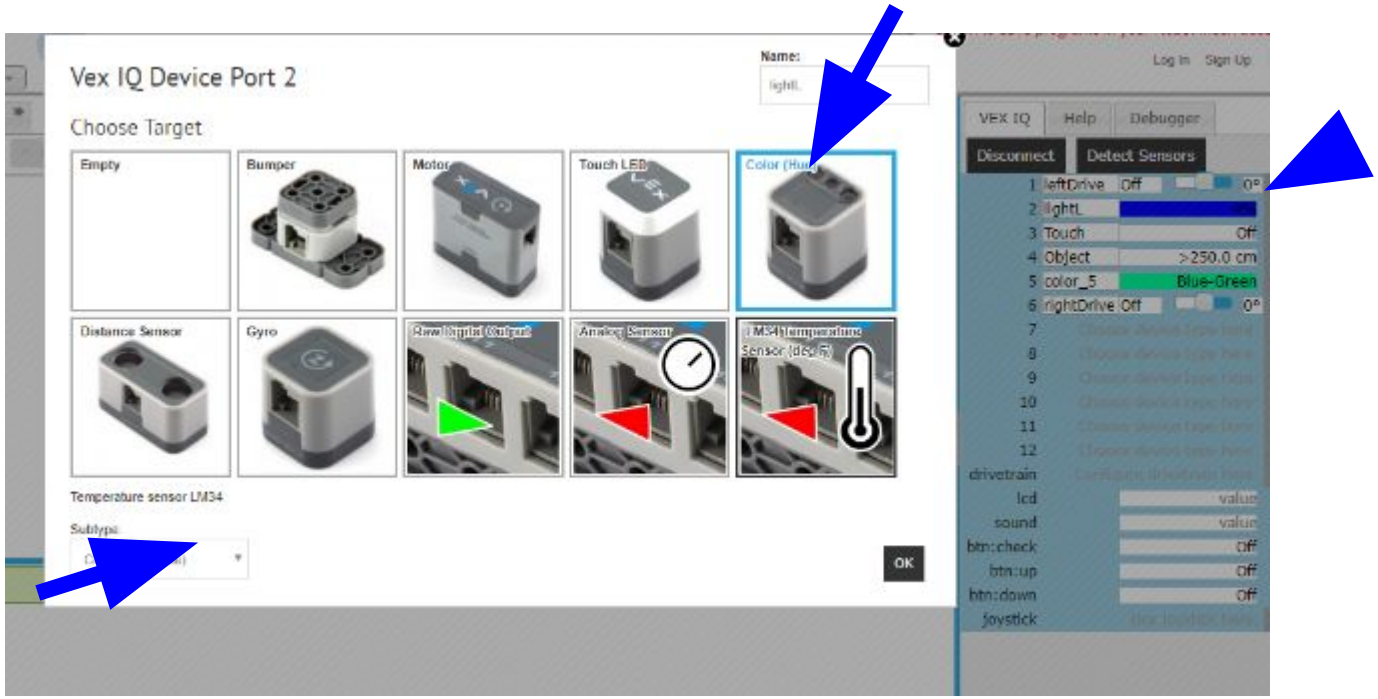
1. Click Here

2. Change to names that have meaning



Motor and Sensor Setup

Change Color Sensors to gray scale mode

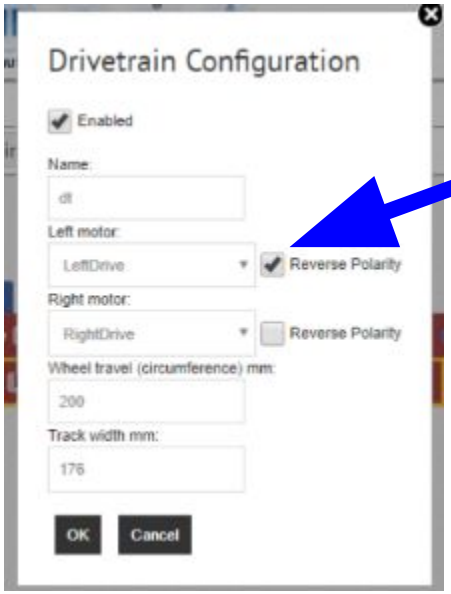


Drivetrain functions

- Robot Mesh has “Drivetrain” programming blocks
- Blocks enable shorter programs and faster coding
- You need to configure the drivetrain in the right side Interface Panel
- Click on the gear symbol

Drivetrain Configuration

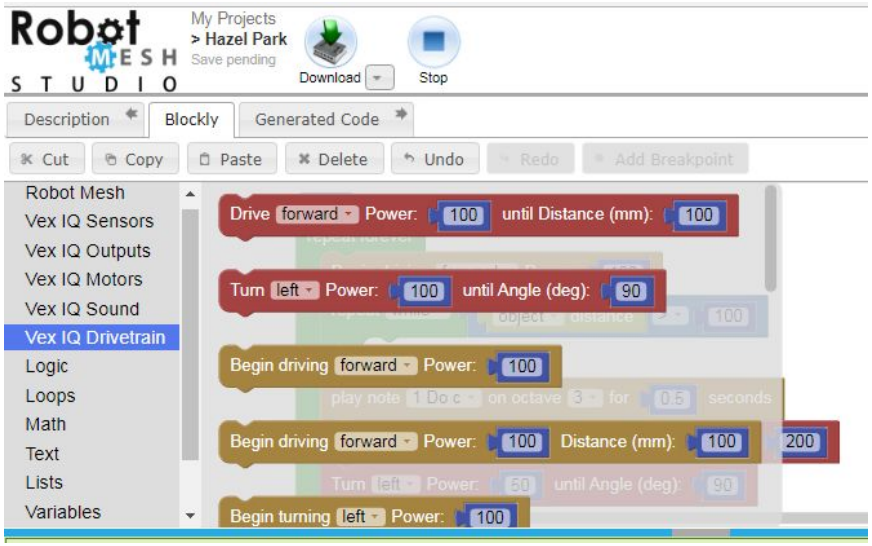
- Configuration dialogue window
- Configuration below should work
- Click “ok” when done

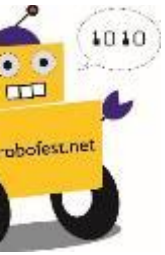


Make sure Left Motor is REVERSED and Right motor is NOT reversed

Drivetrain blocks

- Found on left menu in “Vex IQ Drivetrain”
- Enables you to program both drive motors with one block



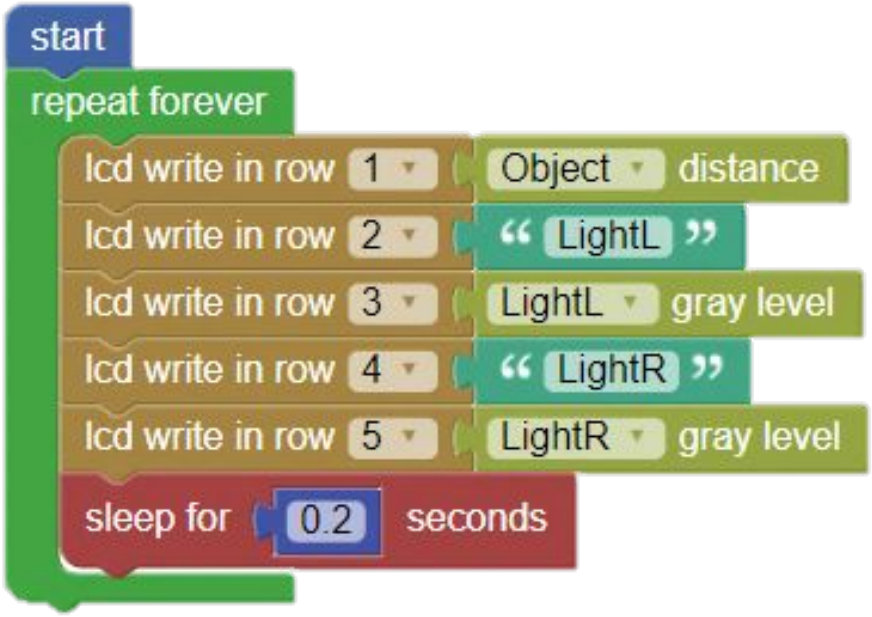


Task 0

Find the edge of the table

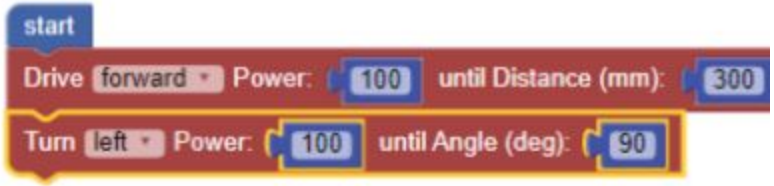
Display Sensor Values on LCD

Use the LCD Display to Display the Value of a Sensor

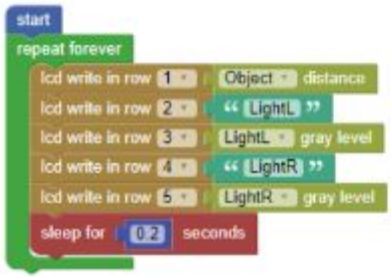


Drive Forward and Turn

- Add this code to our program
- Use a new start block

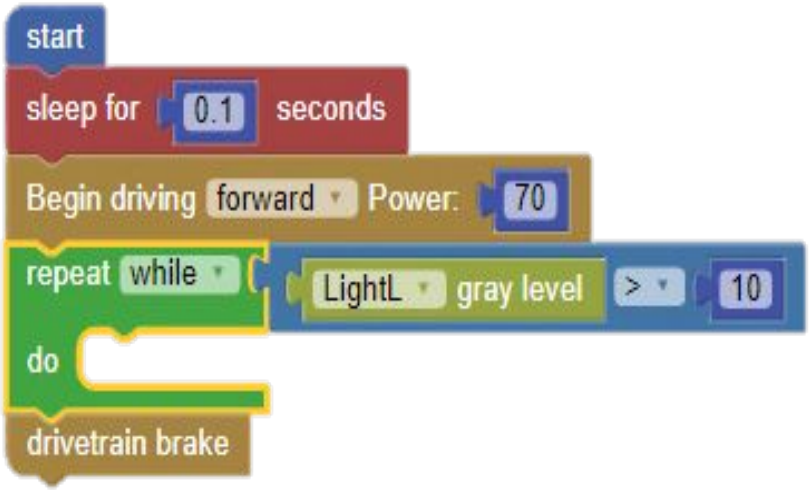


- Both the new code and the display code can be run at the same time



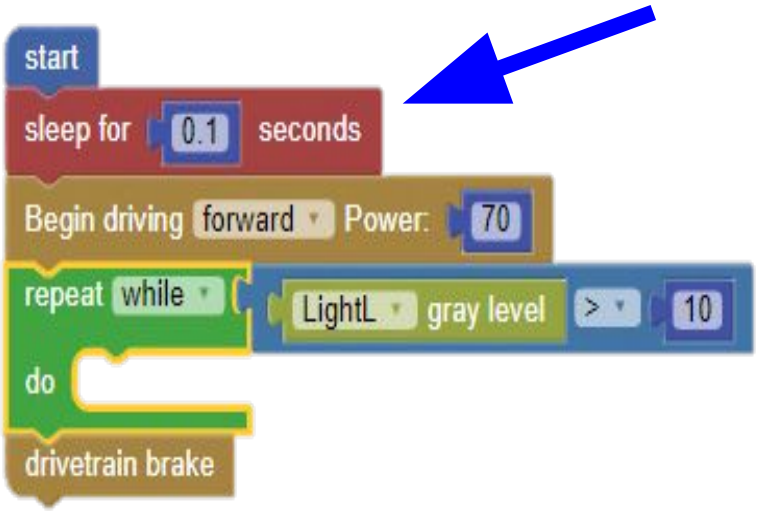
Find the edge of the playing field

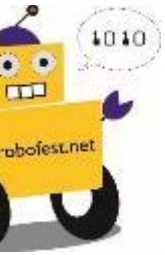
- Delete the “forward” and “turn” blocks and replace with the code below



TIP

- Put a small delay at the start of the program
- Allows for initialization of sensors
- Without delay, initial sensor readings may be incorrect





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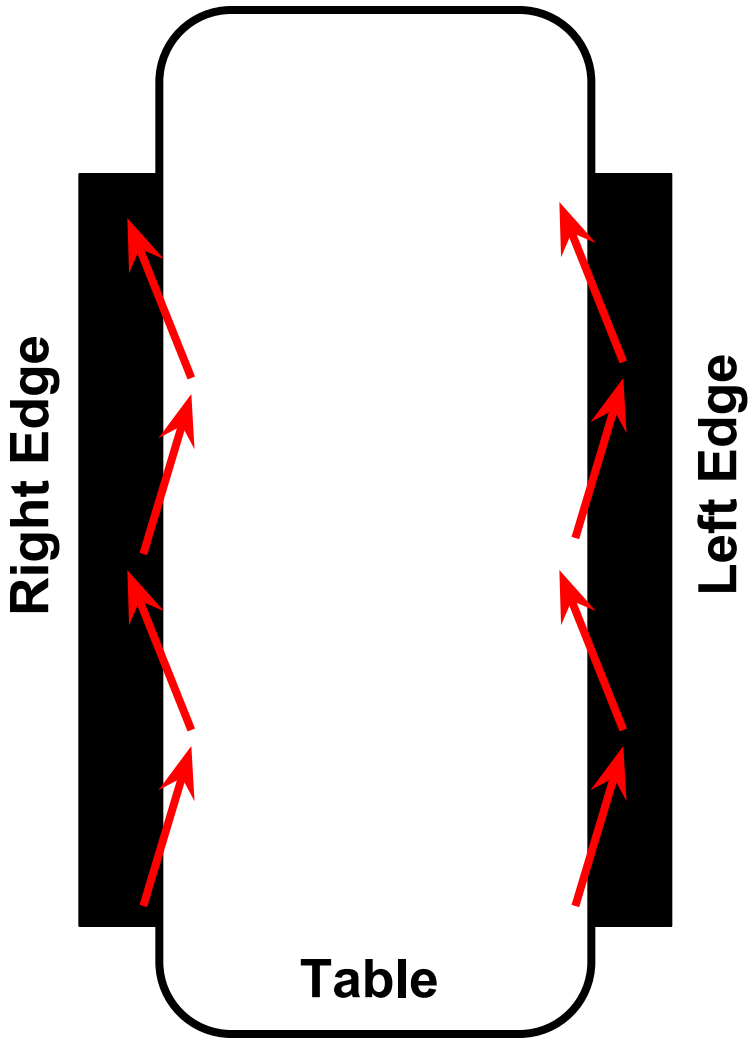
Task 1

Follow the edge of the table

Follow The Edge Of The Table

- Use the zig-zag method to follow the edge of the table
- Edge following is also referred to as line following
- We need to determine when the robot is on or off the table



Follow The Edge Of The Field

- Get color sensor values to determine when the robot is **on** or **off** the playing field.

- We will use the color sensor in Grayscale mode.
- Color Sensor 1 Color Sensor 2
- On field = _____ On field = _____
- Off field = _____ Off field = _____

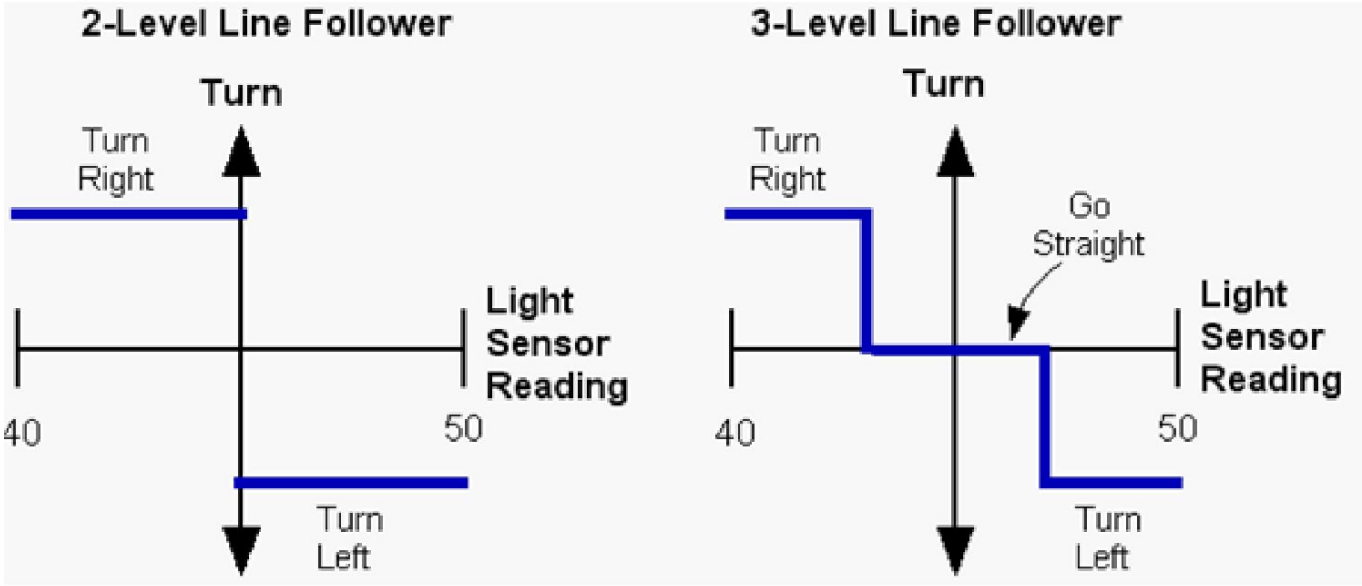
Follow The Edge Of The Table

- Light sensor settings example
  - Off table = 5
  - On table = 45
  - Median threshold = (5+45)/2 = 25
- Two cases
  - Light sensor reading > 25. On table.
  - Light sensor reading < 35. Off table.

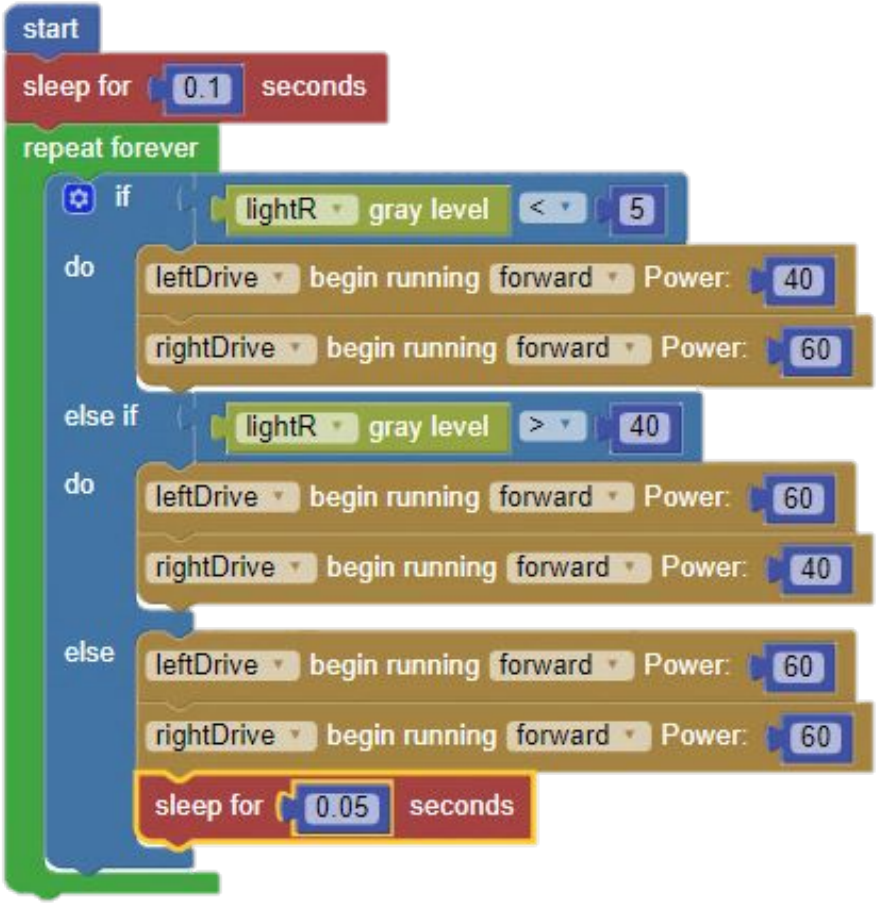
Simple Line Following Algorithm

How to improve our line following algorithm

- Zig-zag method can cause a bumpy response
- To improve the response, you can use a 3-level line follower (concept shown below)



How to improve our line following algorithm

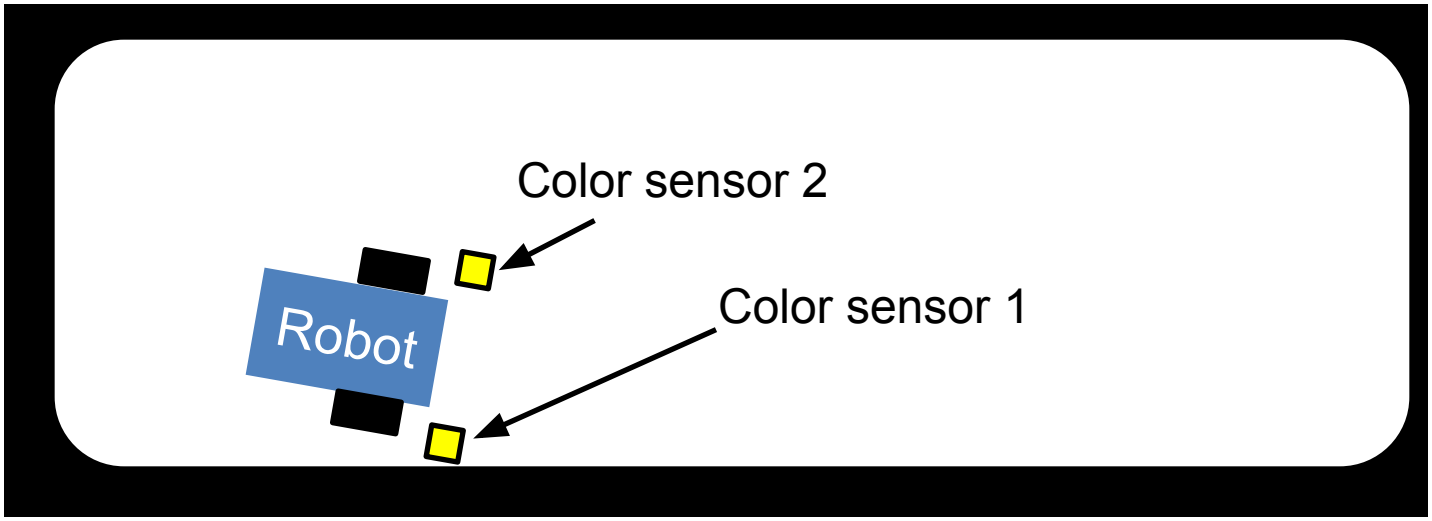


Task 2

Travel around the tennis court table

Travel around the tennis court table

- One method to travel around the tennis court table is to follow the edge of the table with one color sensor and detect the corners with a second color sensor
  - Sensor 1 used to follow the edge of the table
  - Sensor 2 used to locate the end of the table



Travel around the tennis court table

- Couple comments regarding moving around the table
  - It is possible to travel around the edge of the tennis court table only one color sensor, but it more difficult and potentially less reliable
  - Remember that there are no markers to identify the four corners of the tennis court table
    - Need to count the corners has your robot reaches them

Travel around the tennis court table

- Recall our line following program LineFollowZZ
  - Let's modify the program to stop when the robot reaches the end of an edge of the table

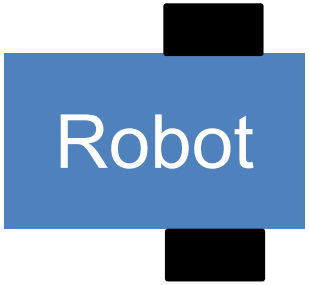
Using this program, the robot will line follow continuously. How can we make the robot stop when it reaches a corner?

Follow the playing field edge until corner

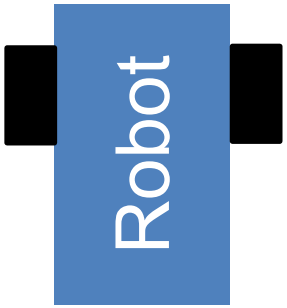
Spin 90 Degrees

- Let's have the robot spin 90 degrees CCW

Starting Position



Final Position



Spin 90 Degrees

- To spin 90 degrees CCW, we use the turn block from the “Drivetrain” menu

- Set “Turn” to “left” and “Angle” to “90”. This causes
  - Right wheel to rotate forward
  - Left wheel to rotate reward
  - Equal and opposite rotations

- Now, we need to determine the correct number of degrees

Spin 90 Degrees

- You can determine the proper number of rotations mathematically; however, the result typically needs some adjustment due to lash in the motors

- For today's class, we will use trail and error to find the number of degrees that cause the robot to turn 90 degrees

Spin 90 Degrees

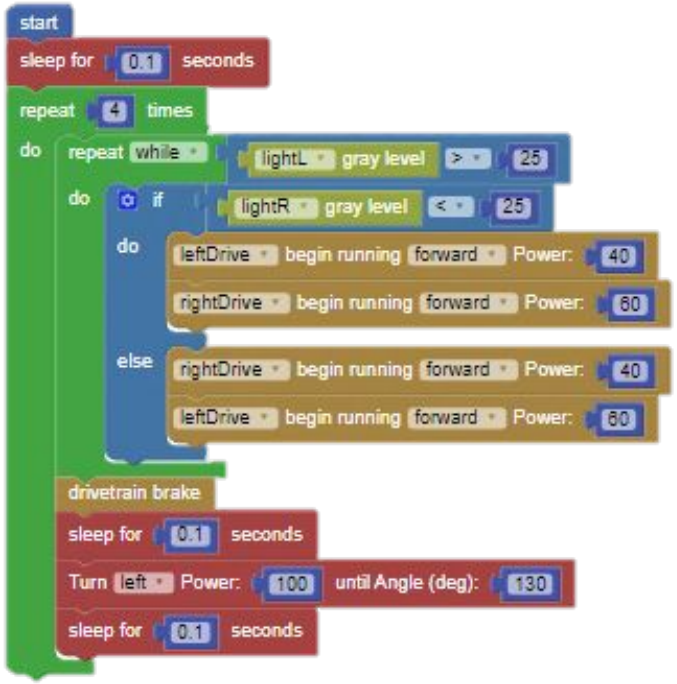
- We can use one block to spin the robot

- For our sample robot, it takes 130 degrees to spin the robot 90 degrees

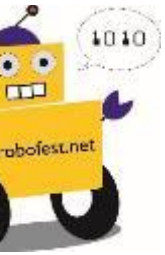
Spin90

Travel around the tennis court table

- Now we can combine line following to the edge and the 90 degree spin to travel around the table
- We added some delays at each corner to help the robot stabilize after the turns and stops



TravelTable



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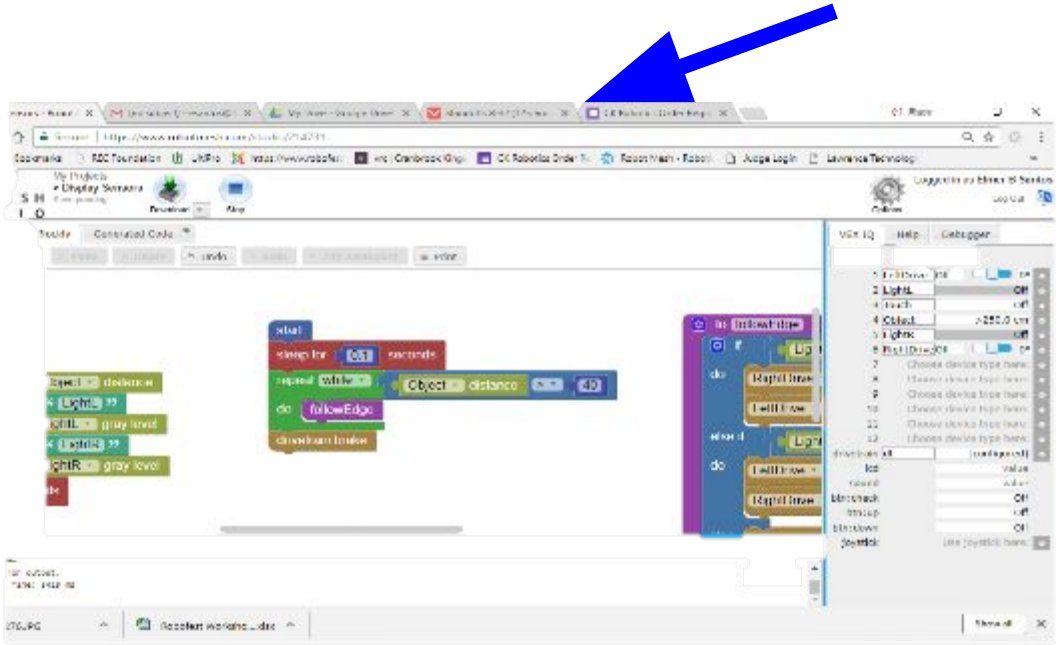
Task 3

Find bottles

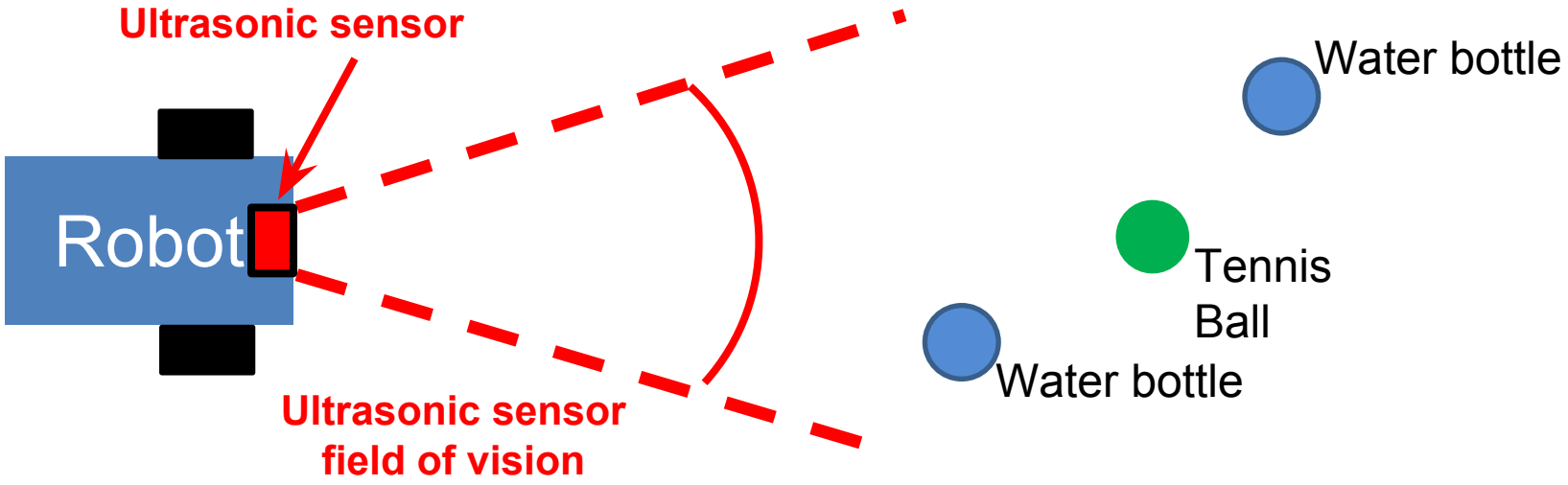
Find Object

- Try using the Ultrasonic Sensor or Touch Sensor



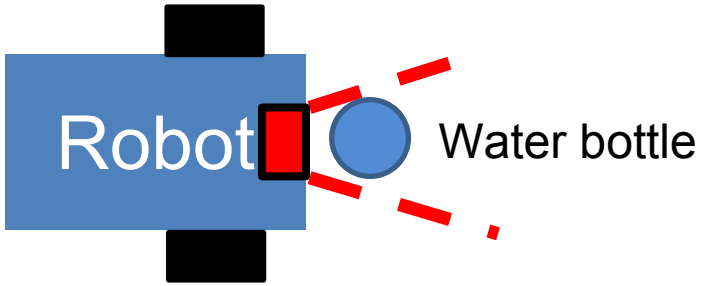
Find bottles

- We can use the ultrasonic sensor to determine if an object near the robot is a tennis ball or a water bottle
- As the robot gathers objects, the ultrasonic sensor can be positioned to help differentiate water bottles and tennis balls

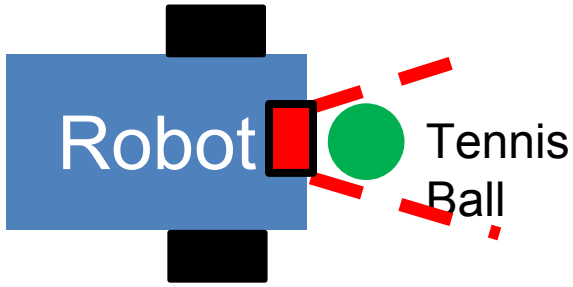


Find bottles

- Place the ultrasonic sensor to aim over the tennis balls is an enabler to differentiating water balls from tennis balls
- Due to the conical shape of the ultrasonic field of vison, it is best to determine the object when it is close



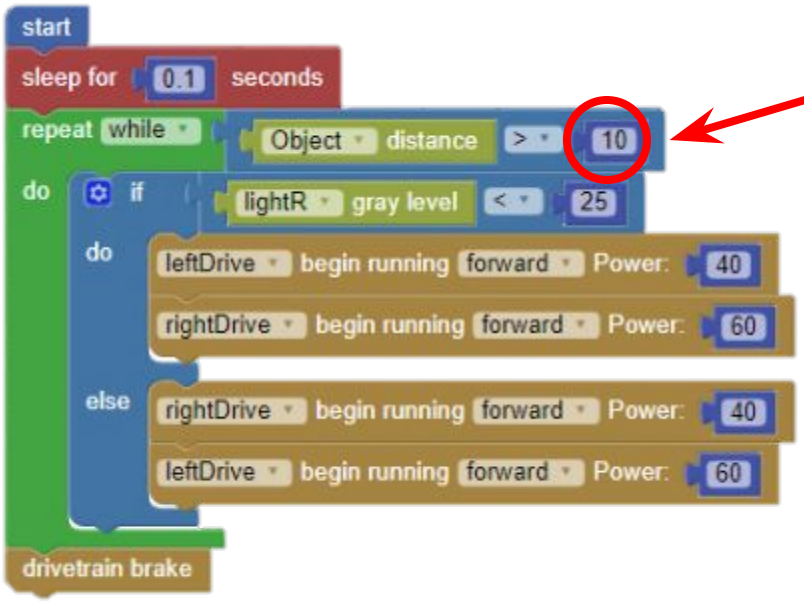
Ultrasonic sensor will read low values with water bottle in the field of vision



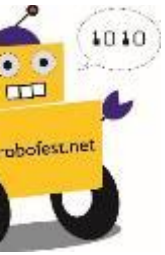
Ultrasonic sensor readings will not be effected by tennis ball

Find bottles

- Now, we travel along the edge of the table and stop if we find a trash object



We chose a low threshold. We can determine the appropriate value by testing the sensor readings with a water bottle near the front of the robot.



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Task 4

Find the box fence edge

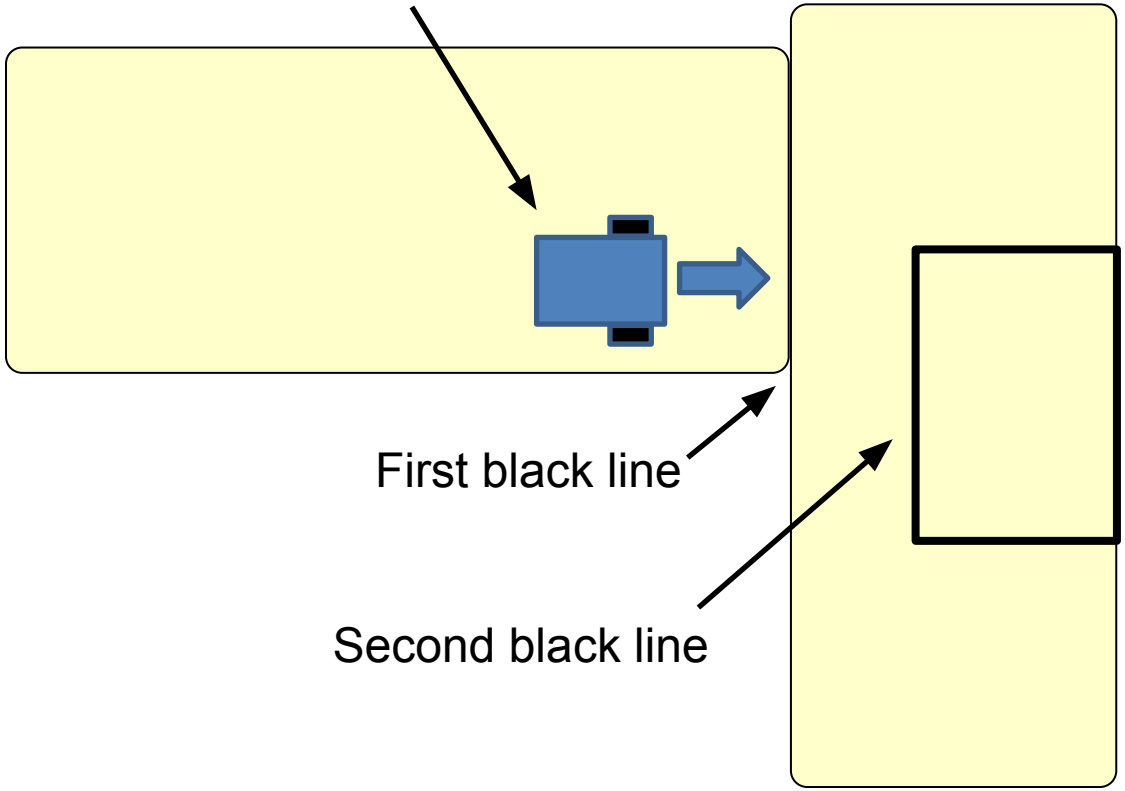
Find the box fence edge

- One method to find the box fence edge:
  - Start on the tennis ball table facing the ball box
  - Travel forward until two “black lines” are detected
    - First “black line” is the transition from the tennis ball table to the ball box table
    - Second “black line” is the actual box fence edge
  - Goals
    - Cross the first black line
    - Stop when the second black line is detected

Please note that based on the competition table layout, the robot may need to start near the northern or southern edge of the tennis ball table.

Find the center of the box fence edge

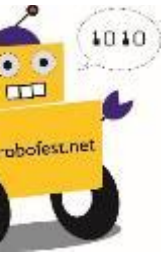
Robot positioned near southern edge



The robot must travel forward until both black lines are detected.

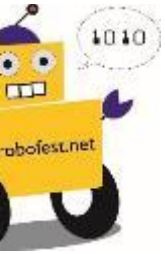
Find the center of the box fence edge

- Steps
  - Go forward until the edge of the table is detected
  - Drive the complete robot over the table transition
  - Go forward until the box fence edge is detected



Task 5

Find the center of the box fence edge

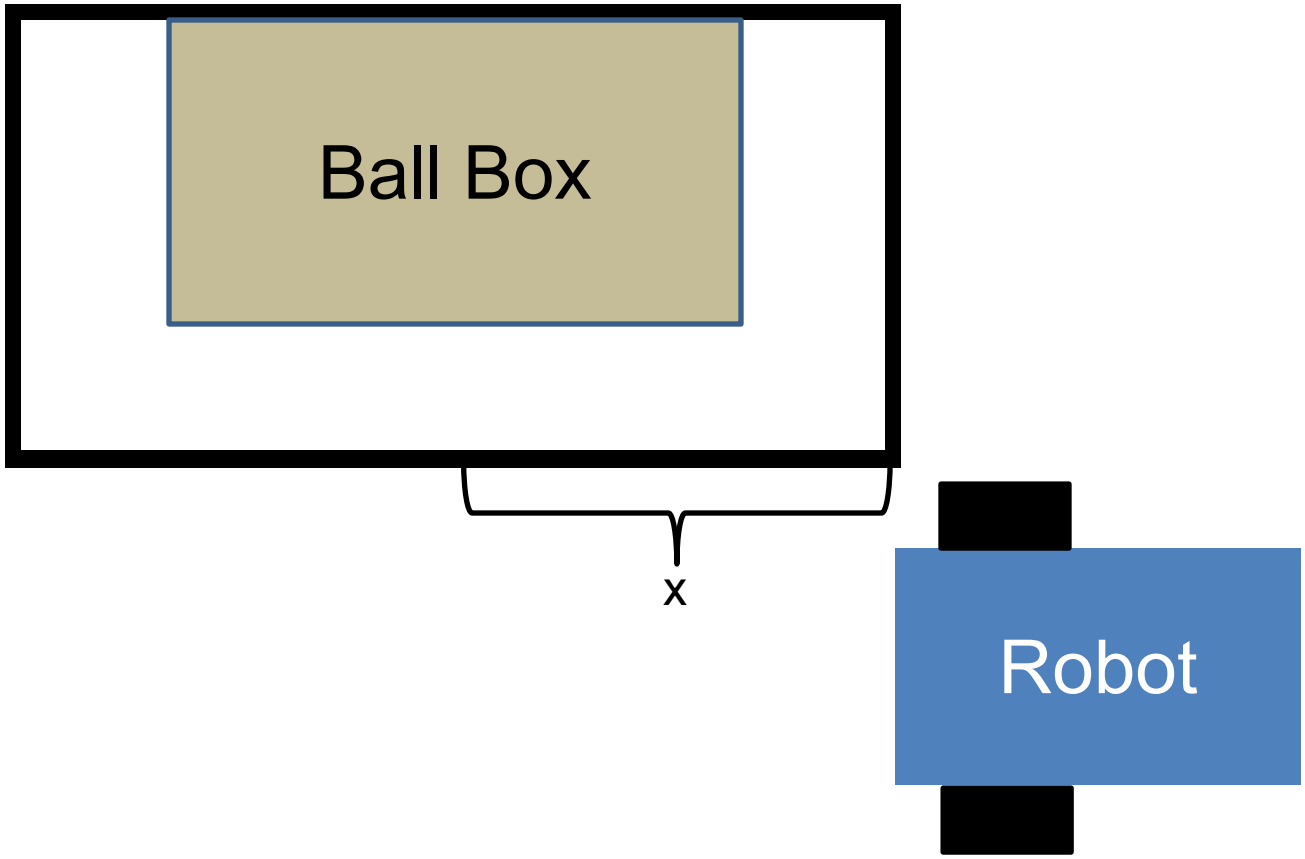


Find the center of the box fence edge

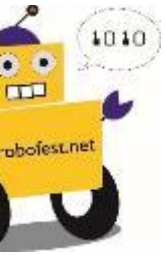
- General idea
  - Let's assume we located the robot at the corner of the box fence edge
  - How can we begin to position our robot at the center of the box fence edge

Find the center of the box fence edge

- Example starting position



The goal is to have the robot travel the distance x (cm)



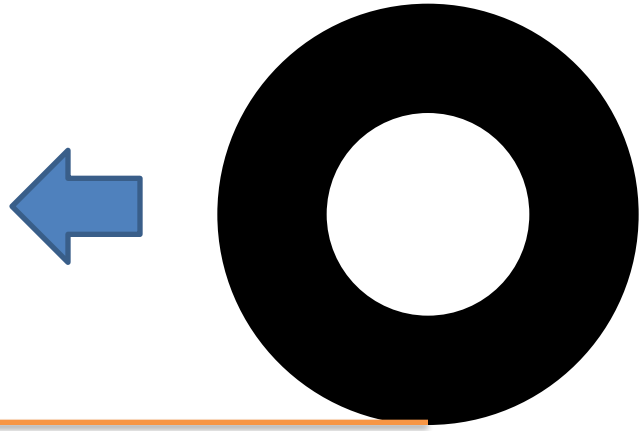
Find the center of the box fence edge

- One solution
  - Follow the edge of the box fence edge until we reach the center of the fence edge
- Approach
  - Let's modify LineFollowZZStop to stop at the center of the box fence
- Tools needed
  - Line following
  - Measure distance traveled

Measure Distances

- How do we measure distance traveled?
- Let's determine how far the robot travels moving forward for 2 seconds

Compute distance traveled by measuring the number of rotations of the wheel



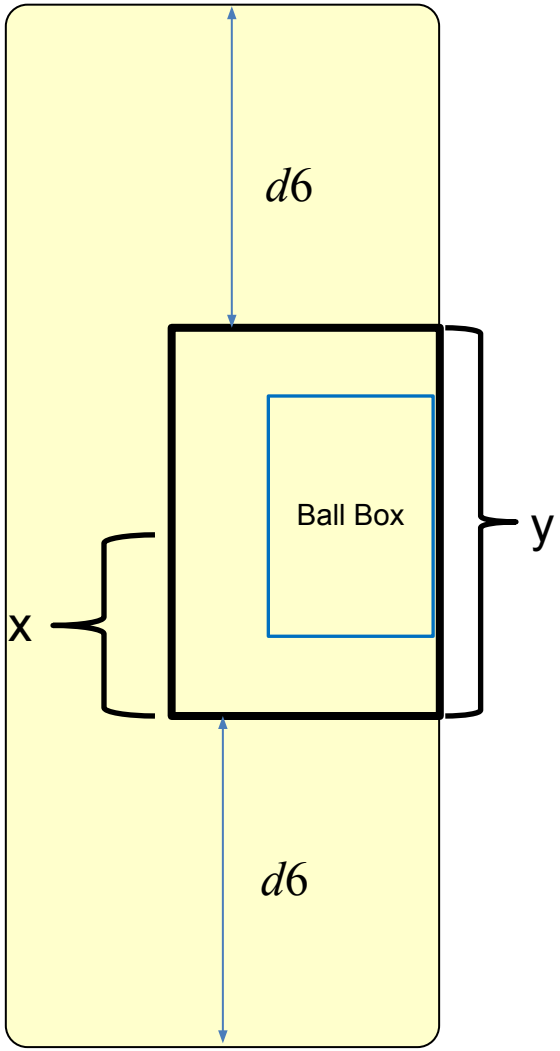
Distance

Find the center of the box fence edge

- How to find “x”
  - Known values
    - Table length = L = 182 cm
    - d6 = 55 cm
    - y = 72 cm

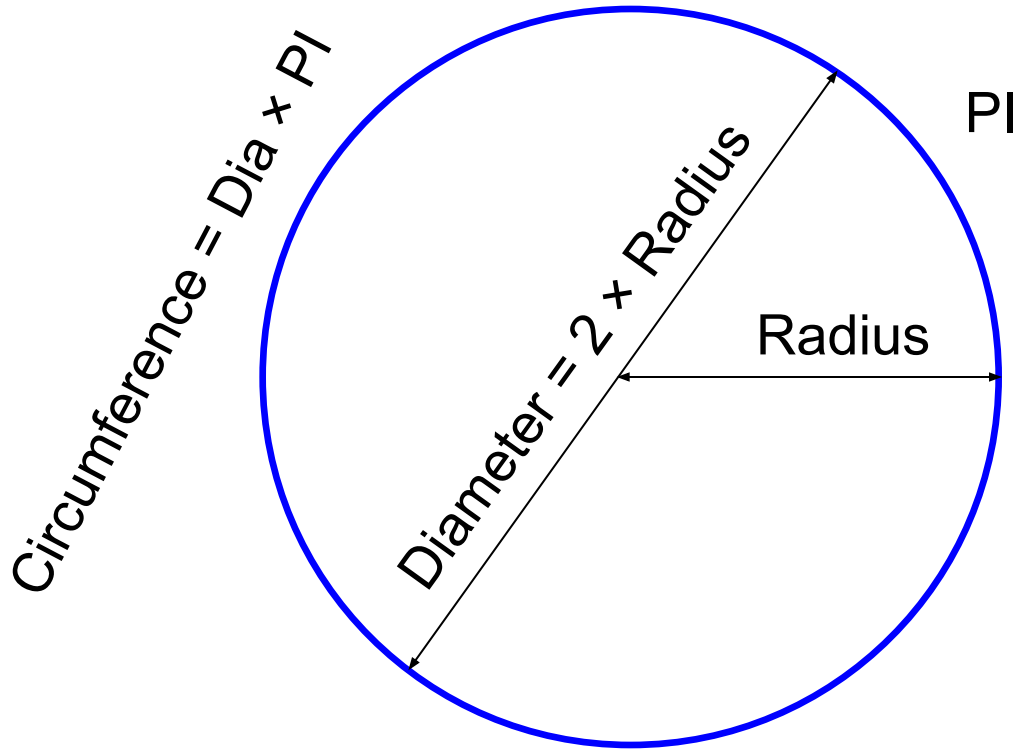
$$x = \frac{y}{2}$$

$$x = \frac{72\text{cm}}{2} = \boxed{36\ \text{cm}}$$



Measure Distances

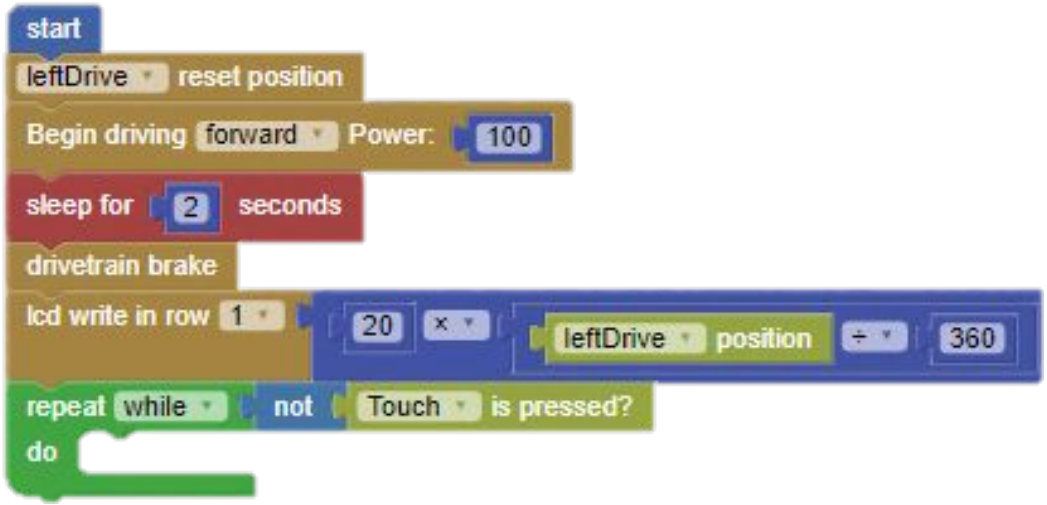
- Use the wheel geometry

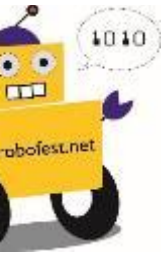


How can use this information?

Measure Distances

- For each rotation of the wheel, the robot will travel (Wheel Diameter) x (PI)
  - Distance = (Wheel Diameter) x (PI) x (# Rotations)
  - Distance = (63 mm) x (PI) x (# Rotations)
  - Distance = (20cm) x (# Rotations)





Find the center of the box fence edge

- Proposed method:
  - Compute the distance to travel along the box fence edge
  - Compute the number of rotations required to travel that distance
  - Position the robot at the corner of the box fence
  - Reset motor rotation sensor
  - Line follow the box fence edge
  - Stop the robot when the desired number of rotations is reached

Find the center of the box fence edge

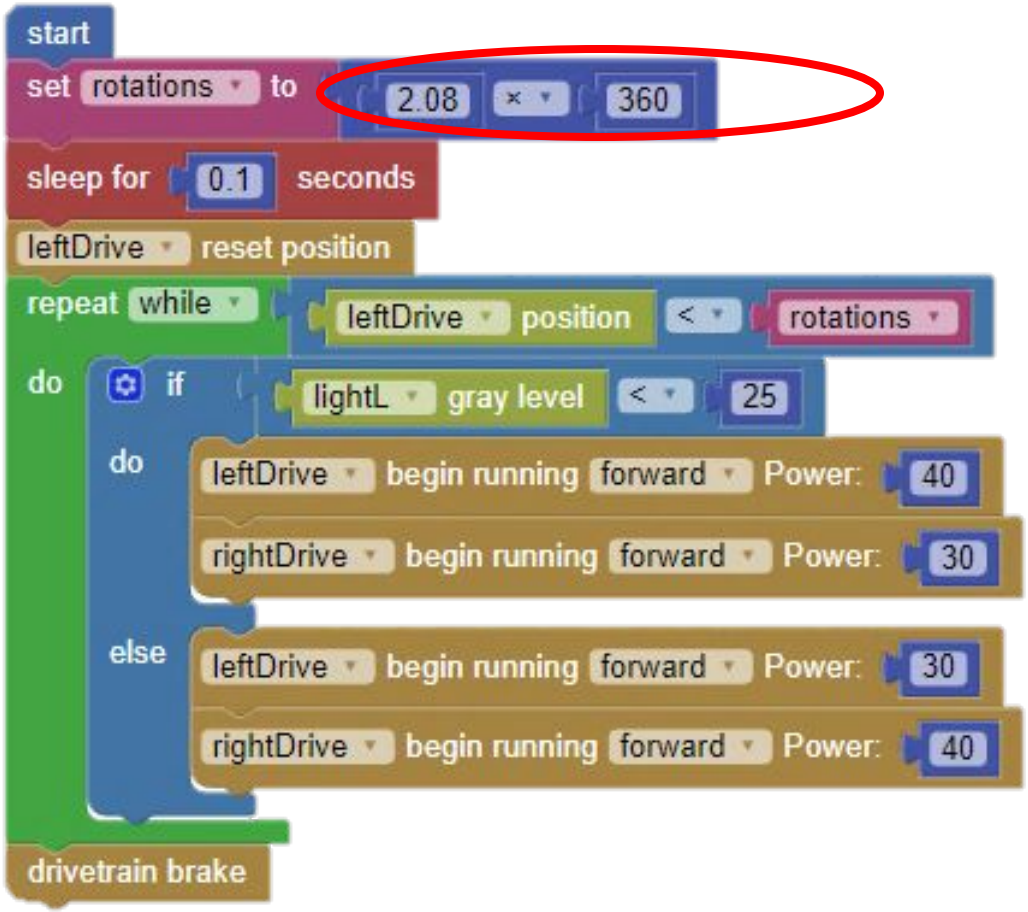
- Example
  - Box fence dimensions
    - X = 36 cm
  - Number of rotations
    - Distance = (Wheel Diameter) x (PI) x (# Rotations)
    - Solve for (# Rotations)

$$(\#\ \text{Rotations}) = \frac{\text{Distance}}{(\text{Wheel Diameter}) \times (\text{PI})}$$

$$(\#\ \text{Rotations}) = \frac{36\ \text{cm}}{(5.5\ \text{cm}) \times (\text{PI})} = 2.08\ \text{rotations}$$

Find the center of the box fence edge

- Line follow a desired distance



Functions

- Solving the Robofest Game challenge will typically require a fairly large program (around 100 blocks is not unreasonable)
- Very large programs can be difficult to understand, navigate and use
- To alleviate this issue, the Robot Mesh Studio software has “Functions” to create custom blocks that can replace sections of your program
- Variables can be used to make the function more flexible

Functions

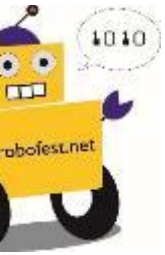
- For example, let's assume you have a section code that completes the following:
  - Move forward until the edge of the table is found with color Left Color Sensor, then stop
  - After stopping, rotate the robot 90 degrees
- The code may look like this

- My blocks will allow us to convert this to a single block

Create a Edge Following Function

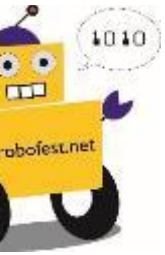
- Go to Functions Menu
- Get a “do something” block
- Name it “edgeFollow”
- Drag the edge following blocks into the function block

Use the Function in the Program



Putting It All Together

- In this course we learned how to
  - Find the edge of the playing field
  - Follow the playing field edge until corner
  - Travel around the tennis court table
  - Find bottles (and gather)
  - Find the box fence edge
  - Find the center of the box fence edge
  - Functions



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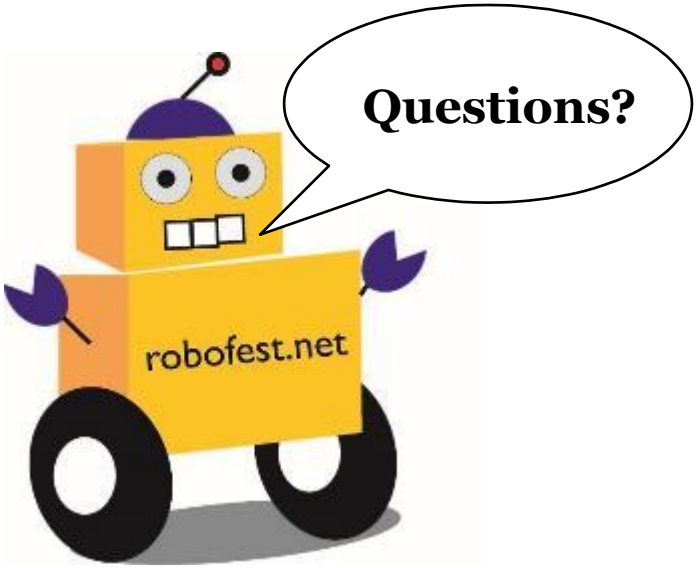

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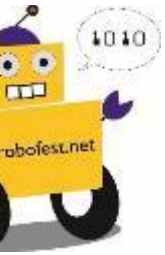
Additional Information

Web page
https://www.robotmesh.com/studio

Tutorial videos.
https://www.youtube.com/watch?v=L7iaKvTbEv0
https://www.youtube.com/watch?v=rSq_LijBb6Q&t=8

Curriculum Guide
https://www.robotmesh.com/docs/curriculum/Default.htm



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