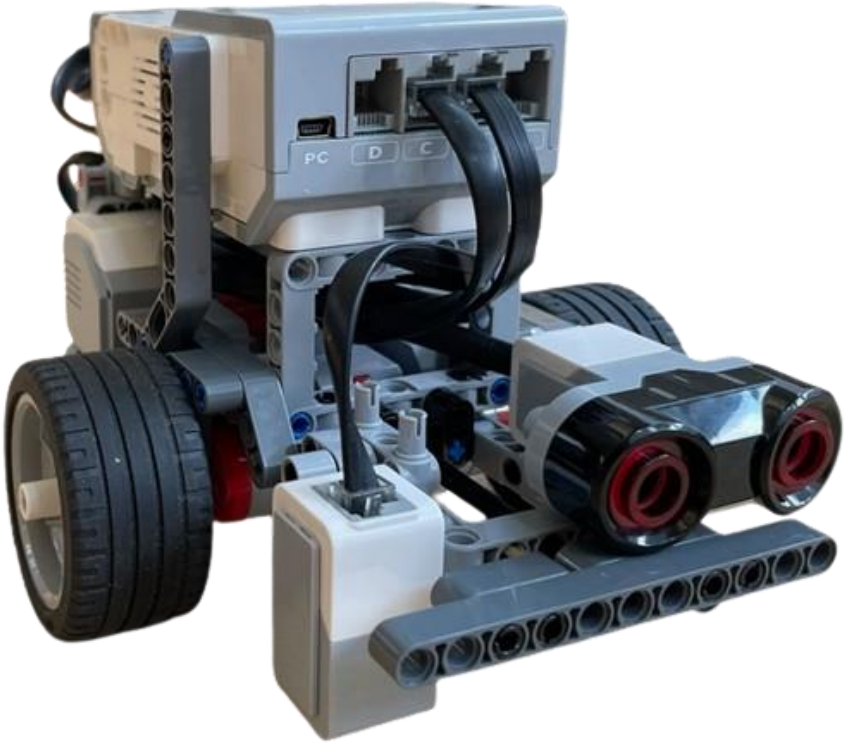
Colour Sensor



Colour Sensor

Learning Goals

- Build knowledge about coding and robotics by coding a sensor and making a robot move.
- Read, debug, and alter code featuring conditional statements to use sensor input to determine how a robot should move.
- Have FUN learning!

Colour Sensor

Do you need to review the Getting Started document?

Do you have the Robocar with the EV3 attached?
Is the EV3 turned on?

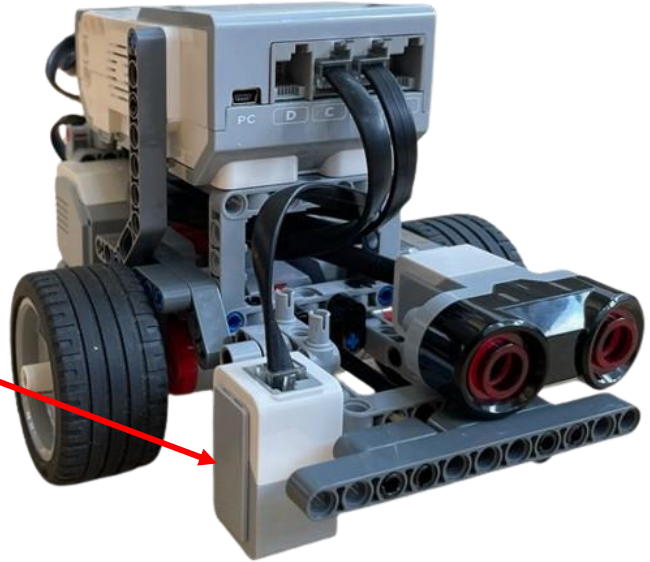
Is the LEGO EV3 Classroom app open and on screen?
Is the EV3 connected and ready to use?

Do you know how to download programs to the EV3 and select programs from the EV3?

Do you know how to move and steer the Robocar?

Colour Sensor

This is the LEGO EV3 colour sensor.



The colour sensor senses variances in light wavelengths to detect objects within the visible spectrum. As such it can be used to detect different colours.

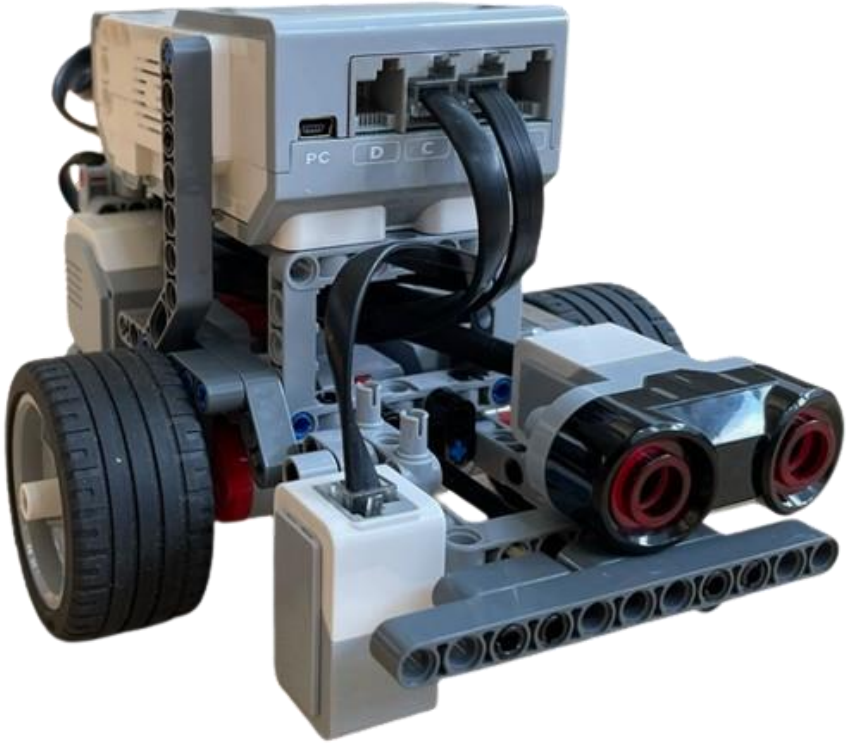
Colour Sensor

The Robocar motors are connected to ports B and C. The distance sensor is connected to port 4, the colour sensor is connected to port 3, and the touch sensor is connected to port 1.

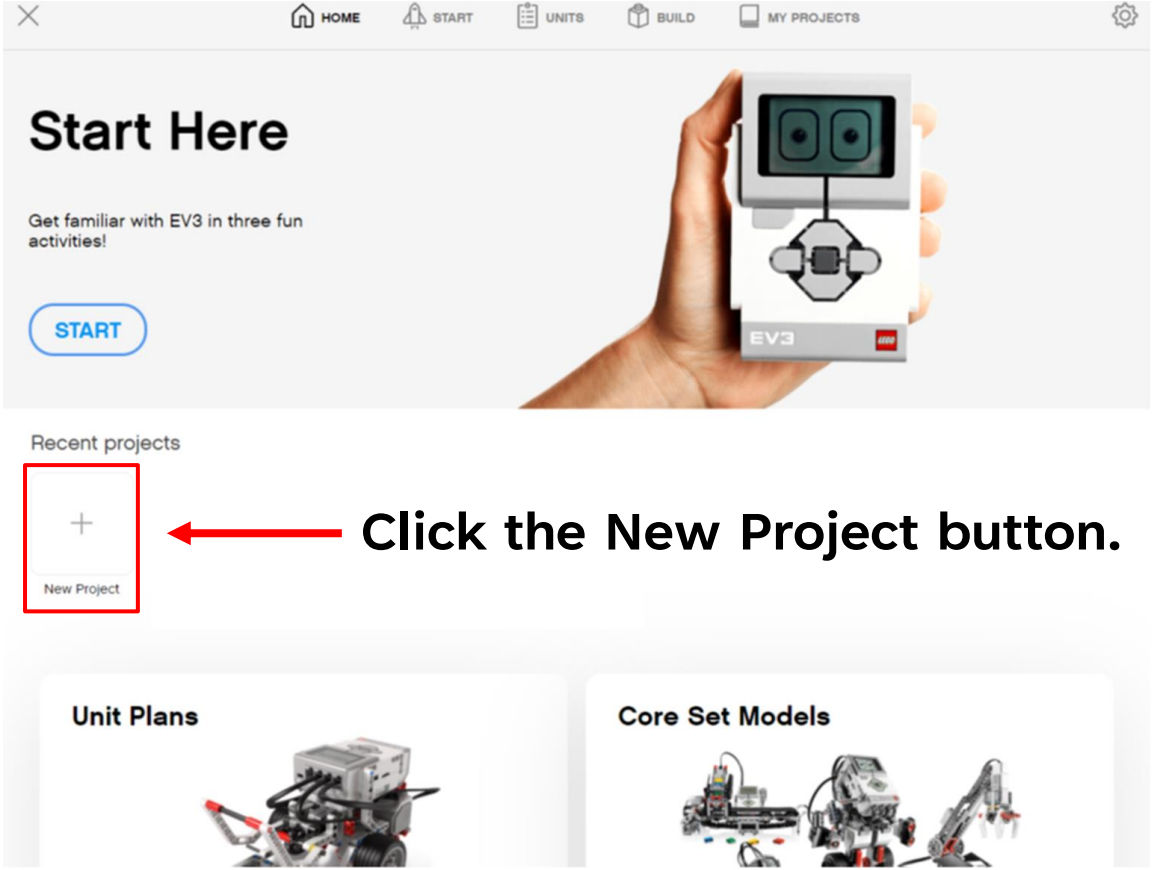
If for some reason any of these devices are not connected to the proper ports, please let Mr. Desmond know so that the proper adjustments can be made.

Colour Sensor

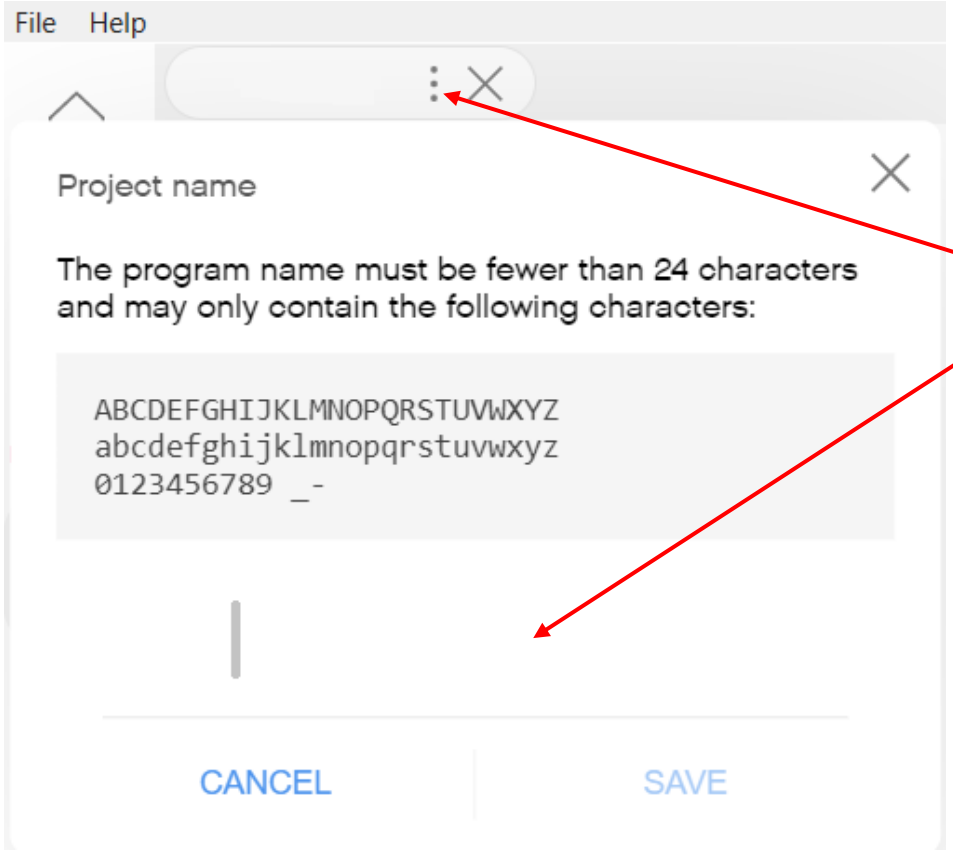
Exploration Activities



Colour Sensor



Colour Sensor



Name your program.

- Click the three dots.
- In the project name window type:
  Colour-_____
  (your names).

Colour Sensor

Colour Sensor - Exploration 1

Activity Goals

1) To explore how to use the colour sensor to allow the robot to independently respond to environmental situations using input information from the sensor to direct robot actions.
2) To demonstrate precision of movement of the robot while using the colour sensor.
3) To understand coding using conditional statements in combination with the colour sensor.

Colour Sensor

Colour Sensor - Exploration 1

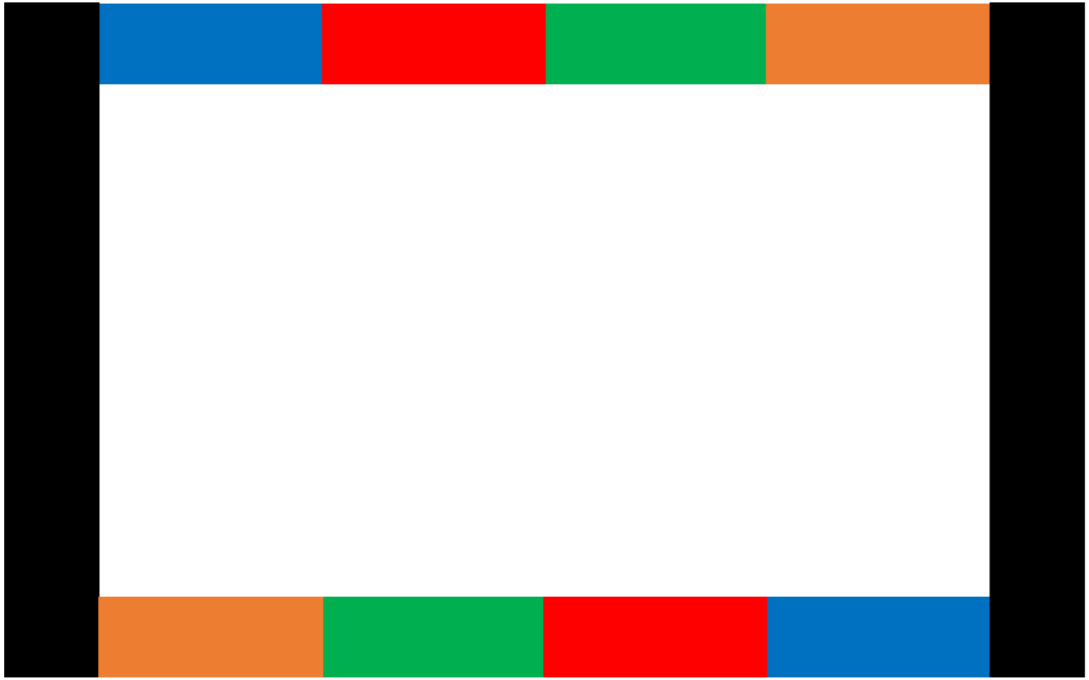
Activity Steps

1) Explore how to read colour sensor values. Reading Values
2) Create the Stop Black code sequence to move the Robocar and test how the colour sensor works. Stop On Black
3) Create the Stop Black Again code sequence to test how the colour sensor works. Stop On Black Again

Colour Sensor

Colour Sensor - Exploration 1

To complete the Exploration 1 activities you will need a colour mat.

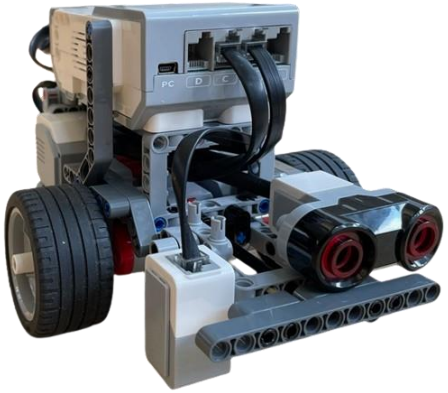


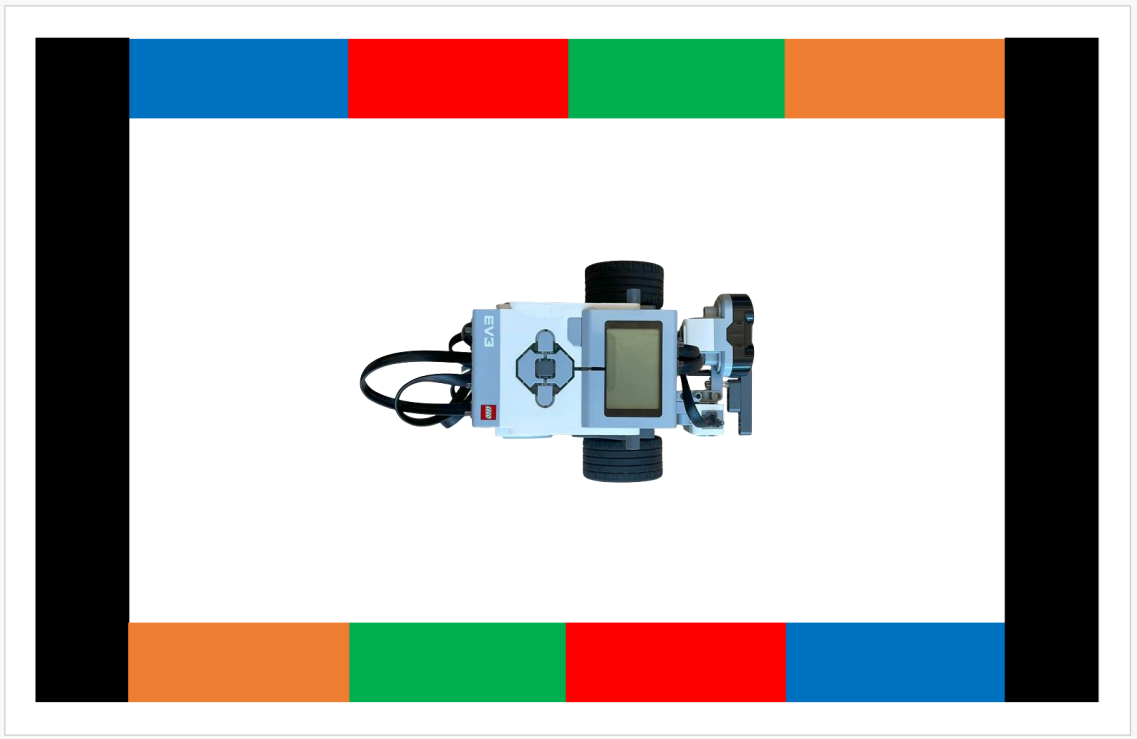
If you do not have one please ask Mr. Desmond.

Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Place the Robocar on the white area in the middle of the mat.

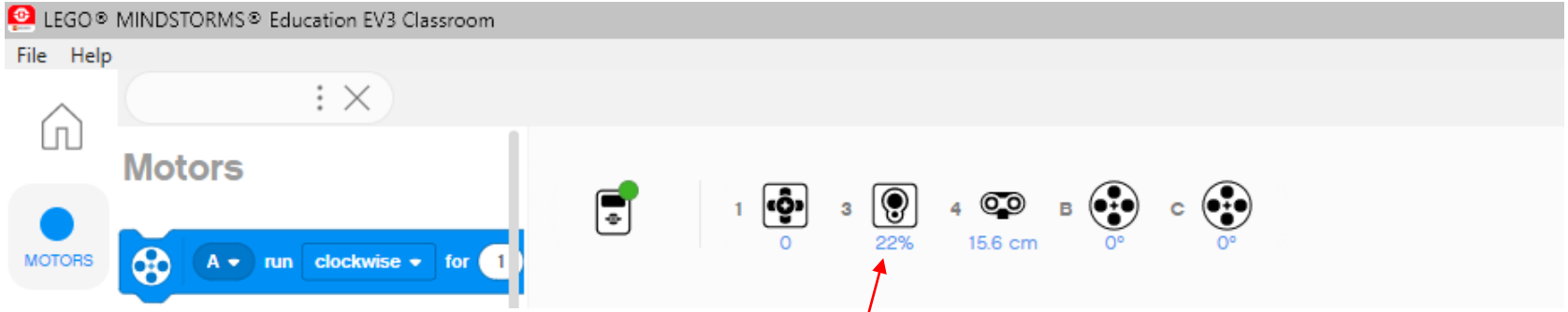




Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Notice that the percentage of reflected light the EV3 colour sensor is detecting is displayed in the on-screen EV3 information in the EV3 Classroom app.



Notice the readings for the colour sensor at port 3.

Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Another way to verify the percentage of reflected light the EV3 colour sensor is detecting is to use the display info on the EV3.

1

Select Port View

2

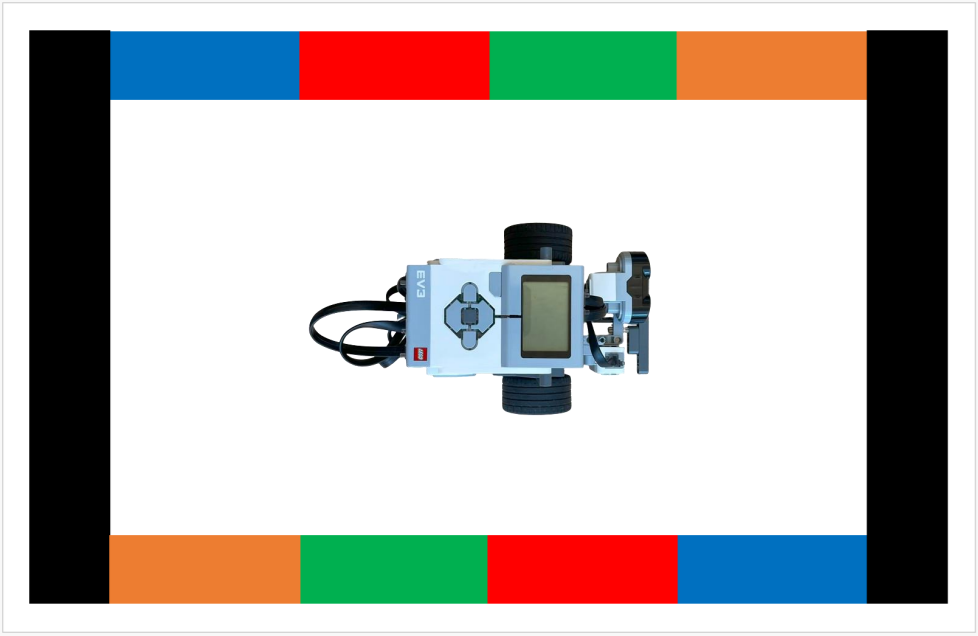
Select Port 3

Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Determine the reflected light intensity value of the white area.

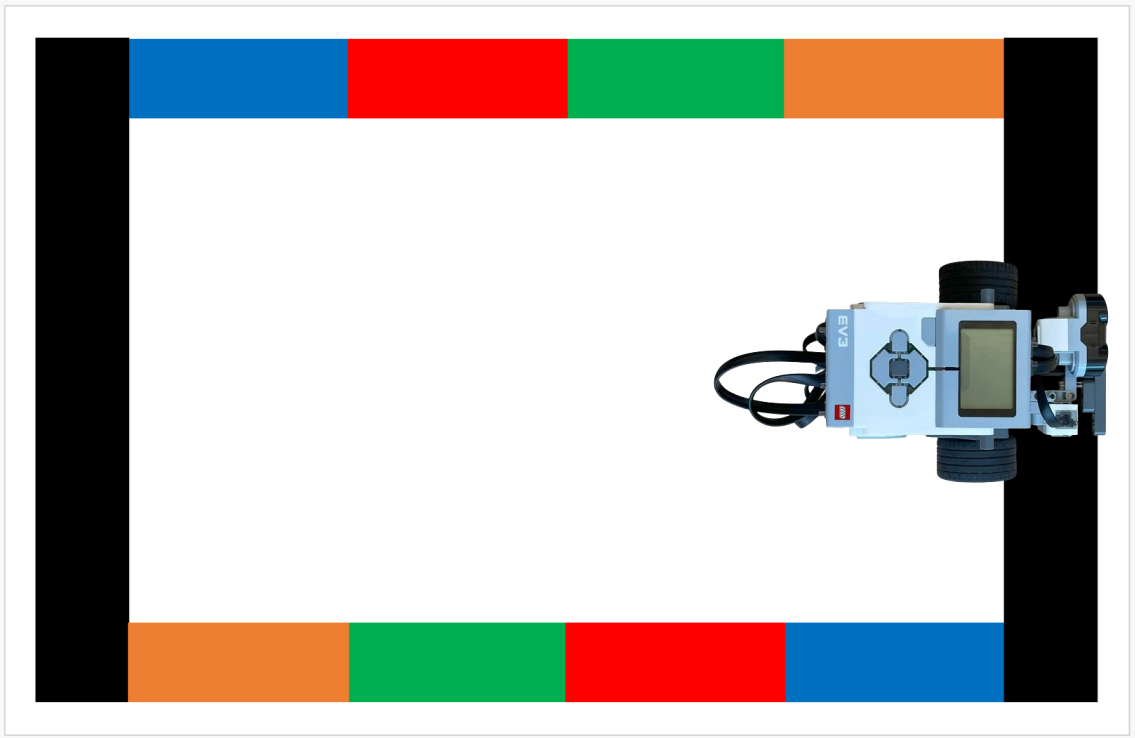
Read the colour sensor percentage value of the white of the mat that the colour sensor is detecting. Record this value on a piece of paper. White = __%



Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Position the Robocar so that the colour sensor is directly over the middle of the black area at the end of the mat.

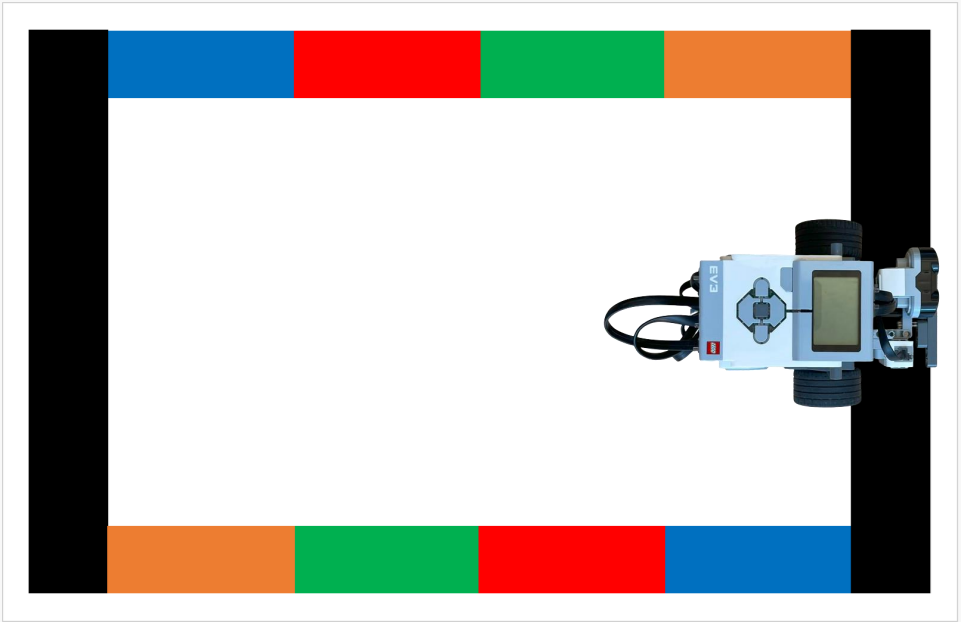


Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Determine the reflected light intensity value of the black area.

Read the colour sensor percentage value of the black of the mat that the colour sensor is detecting. Record this value on a piece of paper. Black = __%

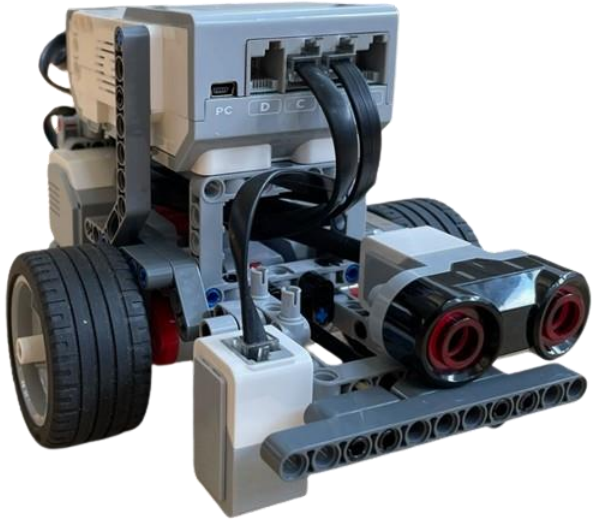


Colour Sensor

Colour Sensor - Exploration 1 - Reading Values

Show Mr. Desmond your readings for the reflected light intensity percentage values of the white and black areas of the mat.

Consider the percentage value of white compared to the percentage value of black. At less than (<) what percentage value will the colour sensor detect the difference between white and black ("not white")?



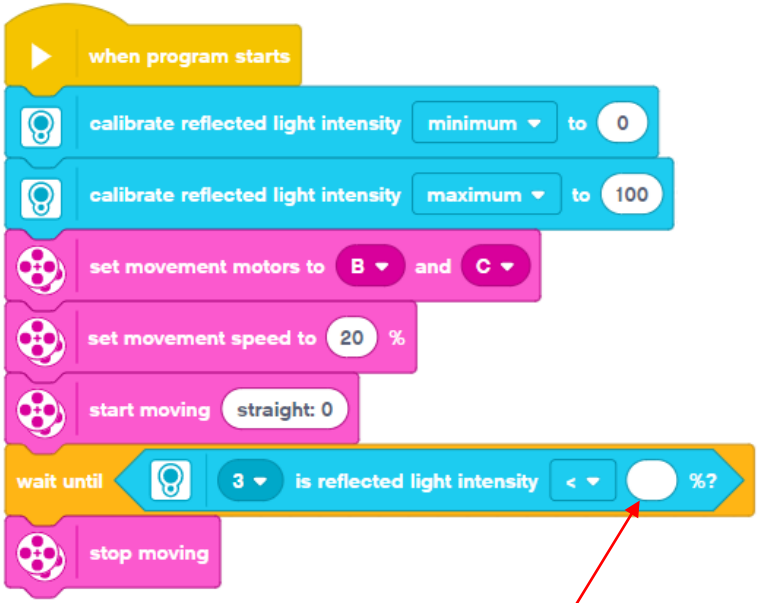
Colour Sensor

Colour Sensor - Exploration 1 - Stop On Black

Create this code sequence.

Use the colour sensor to detect the reflected light intensity of the white and black areas of the mat.

Use the reflected light intensity percentage values of the white and black of the mat to complete your coding so that the Robocar will move forward from the middle of the mat and then stop when it detects black.



You must determine what the reflected light intensity percentage (%) value should be.

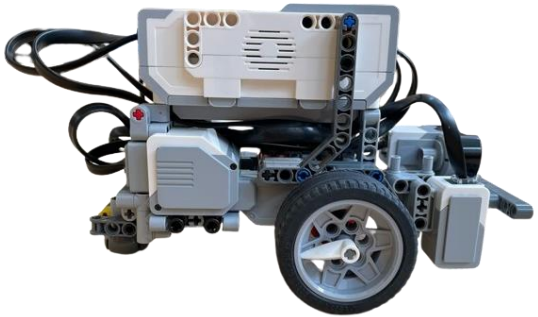
Colour Sensor

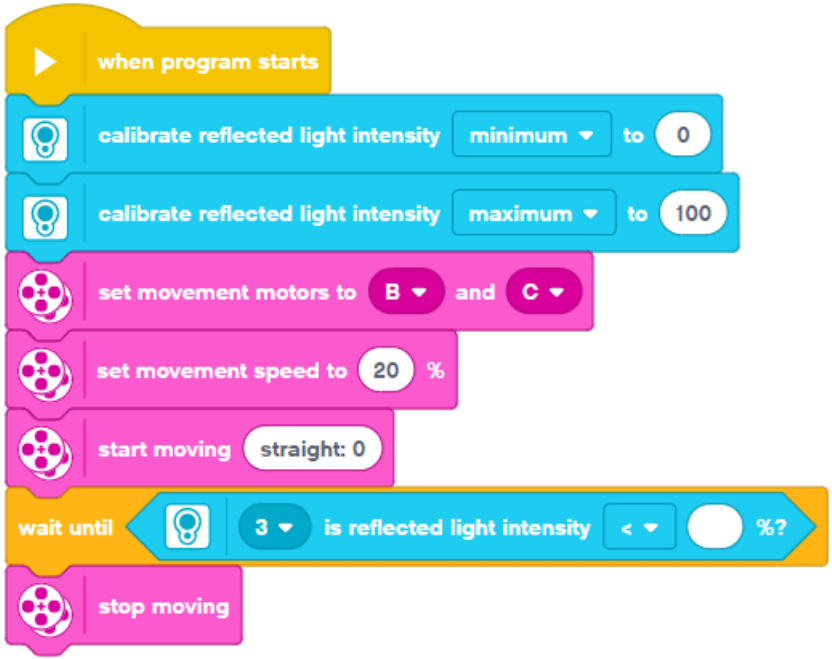
Colour Sensor - Exploration 1 - Stop On Black

Download the program to the EV3.

Run the program from the EV3.

Observe how the Robocar moves.



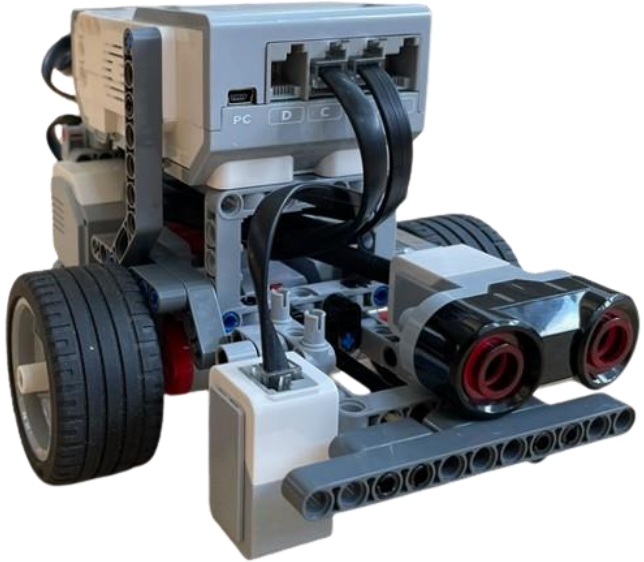


Are you able to get the Robocar to stop when the colour sensor detects black?

Colour Sensor

Colour Sensor - Exploration 1 - Stop On Black

Show Mr. Desmond how the Robocar travels forward from the middle of the mat and then stops when the colour sensor detects the thick black line.

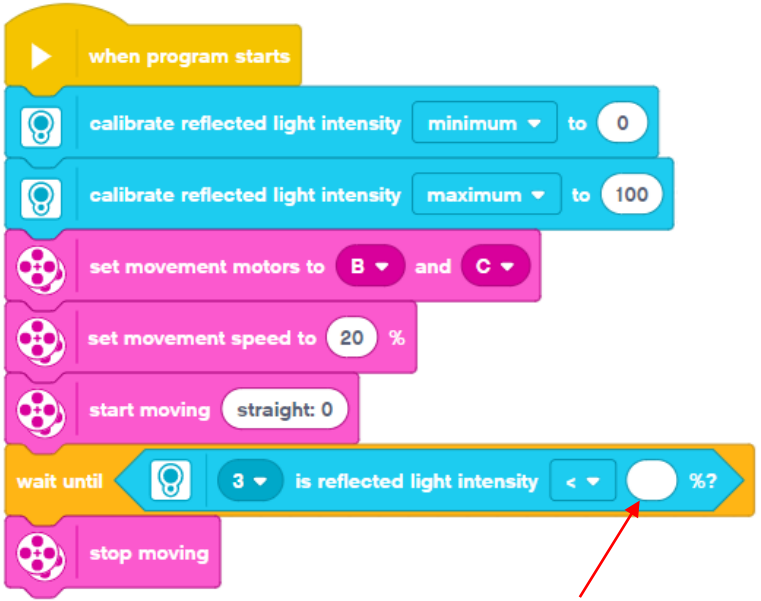


Colour Sensor

Colour Sensor - Exploration 1 - Stop On Black Again

Change the percentage (%) value that you used in your Stop On Black code by minus ten (-10).
Download and run the program.
Observe how the Robocar moves.

Repeat this process of making the percentage value number smaller by minus ten (-10) until the percentage value is lower than 5%.



Does the Robocar stop when the colour sensor detects the thick black line every time?

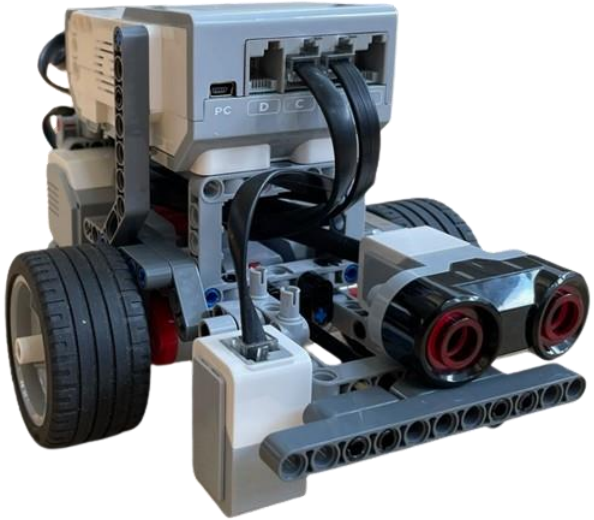
Colour Sensor

Colour Sensor - Exploration 1 - Stop On Black Again

Are you able to get the Robocar to stop when the colour sensor detects the thick black line?

Show Mr. Desmond how the Robocar travels forward and then stops when the colour sensor detects the thick black line.

Be prepared to discuss the effect of using different percentage values on the performance of the Robocar when using the colour sensor.



Colour Sensor

Colour Sensor - Exploration 2

Activity Goals

1) To explore how to use the colour sensor to allow the robot to independently respond to environmental situations using input information from the sensor to direct robot actions.
2) To demonstrate precision of movement of the robot while using the colour sensor.
3) To understand coding using conditional statements in combination with the colour sensor.

Colour Sensor

Colour Sensor - Exploration 2

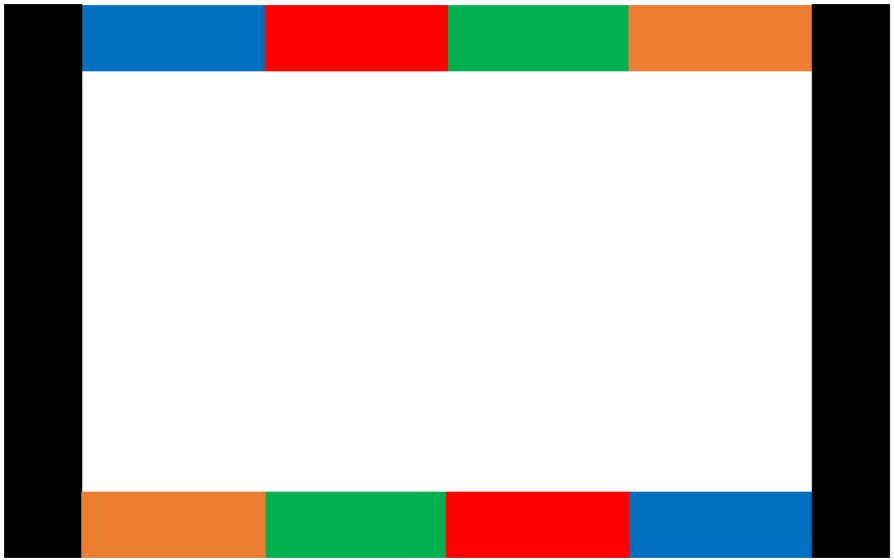
Activity Steps

1) Create the What Colour code sequence to test how the colour sensor works. What Colour?
2) Learn about the colour sensor. Colour Sensor
3) Create the What Colour Again code sequence. What Colour Again
4) Answer questions and explain your ideas. Explain

Colour Sensor

Colour Sensor - Exploration 2 - What Colour?

Determine the intensity of reflected light as a percentage value for the white, the black, the orange, the green, the blue, and the red areas of the mat.



Record your findings for the reflected light values.

White =

Black =

Orange =

Green =

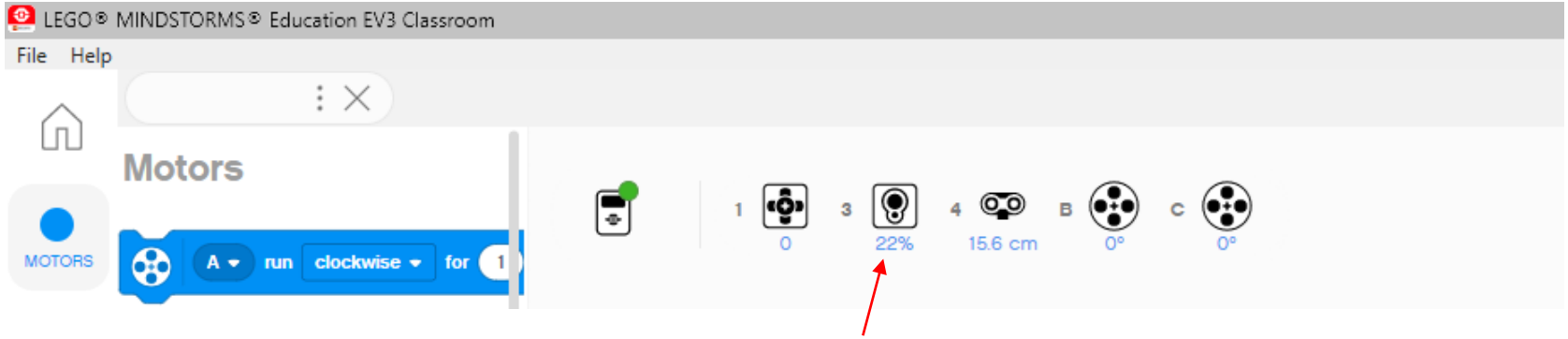
Red =

Blue =

Colour Sensor

Colour Sensor - Exploration 2 - What Colour?

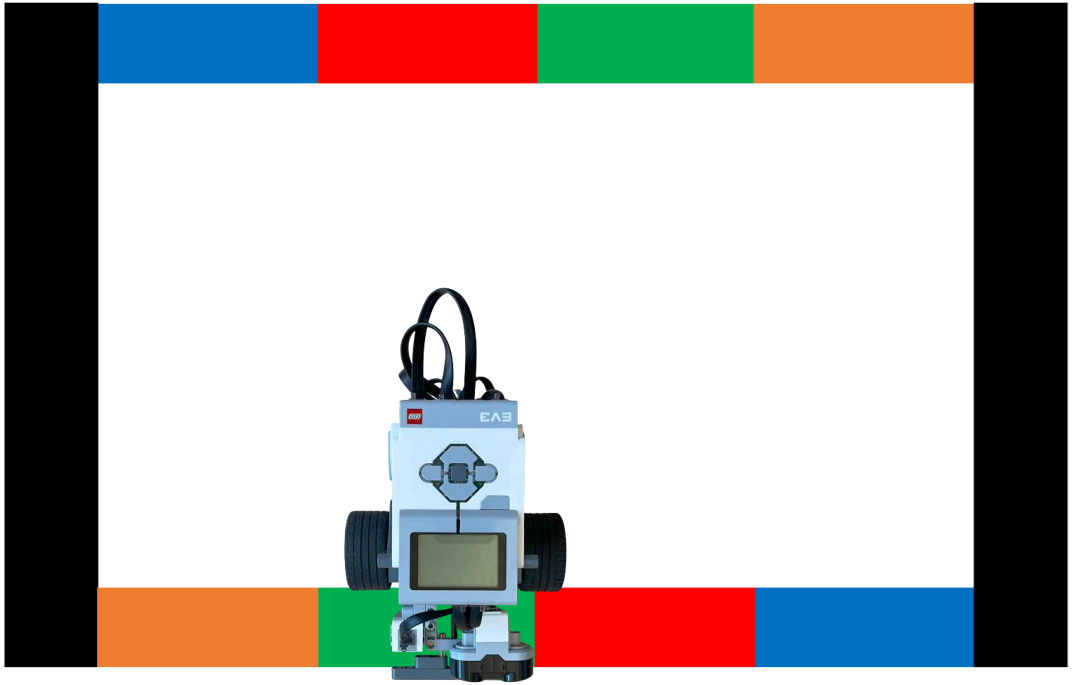
To verify the percentage of reflected light the EV3 colour sensor is reading you can use the on-screen information in the EV3 app.



Colour Sensor

Colour Sensor - Exploration 2 - What Colour?

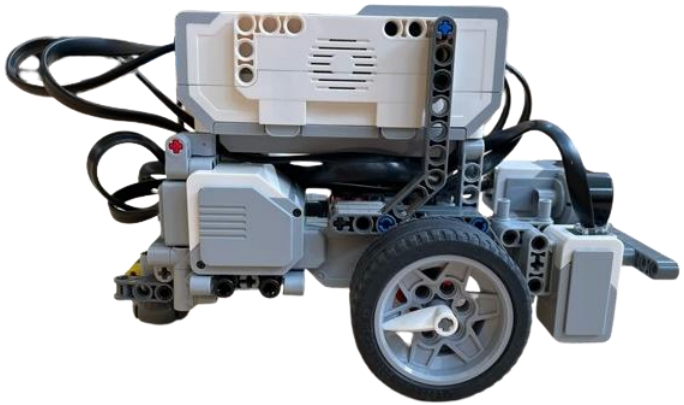
Position the Robocar on the mat so that the colour sensor is directly over the middle of the colour area that you are getting a reading for. Test each of the colours individually.

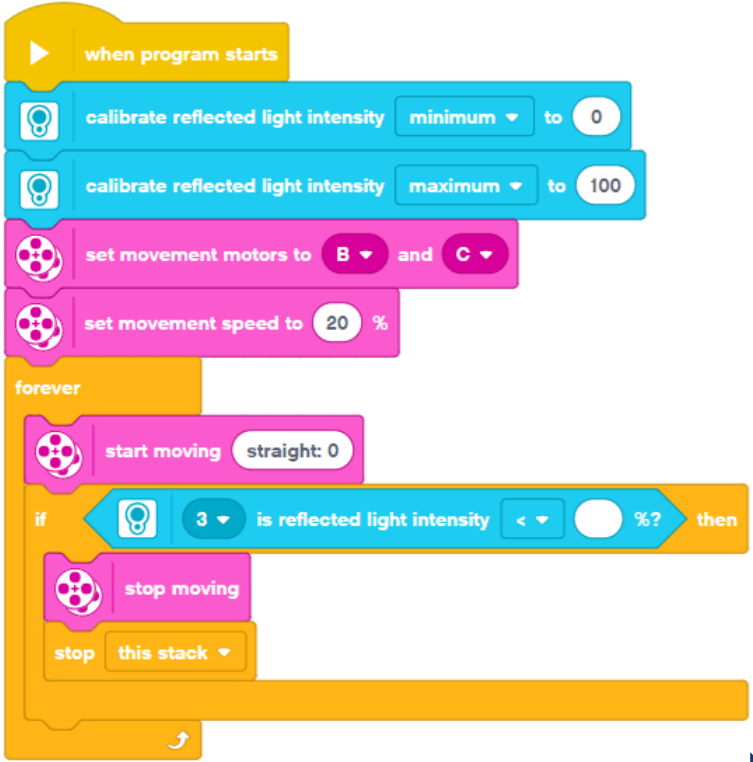


Colour Sensor

Colour Sensor - Exploration 2 - What Colour?

Create this code sequence to have the Robocar move forward and use the colour sensor to detect different colours on a mat.





Colour Sensor

Colour Sensor - Exploration 2 - What Colour?

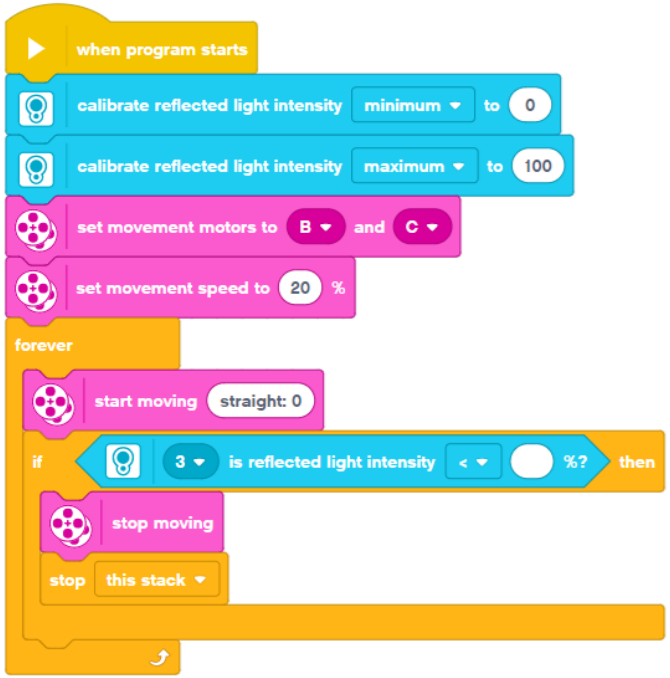
Use the values you recorded for each of the colours to complete your coding so that the Robocar will move forward and then stop when it detects the desired colour.

Individually test and detect the red, blue, orange, and green colours on the mat.

Download the program to the EV3.

Run the program from the EV3.

Observe how the Robocar moves.

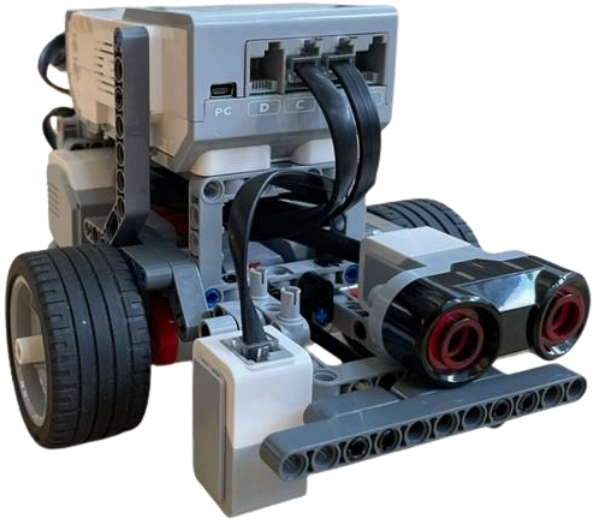


Colour Sensor

Colour Sensor - Exploration 2 - What Colour?

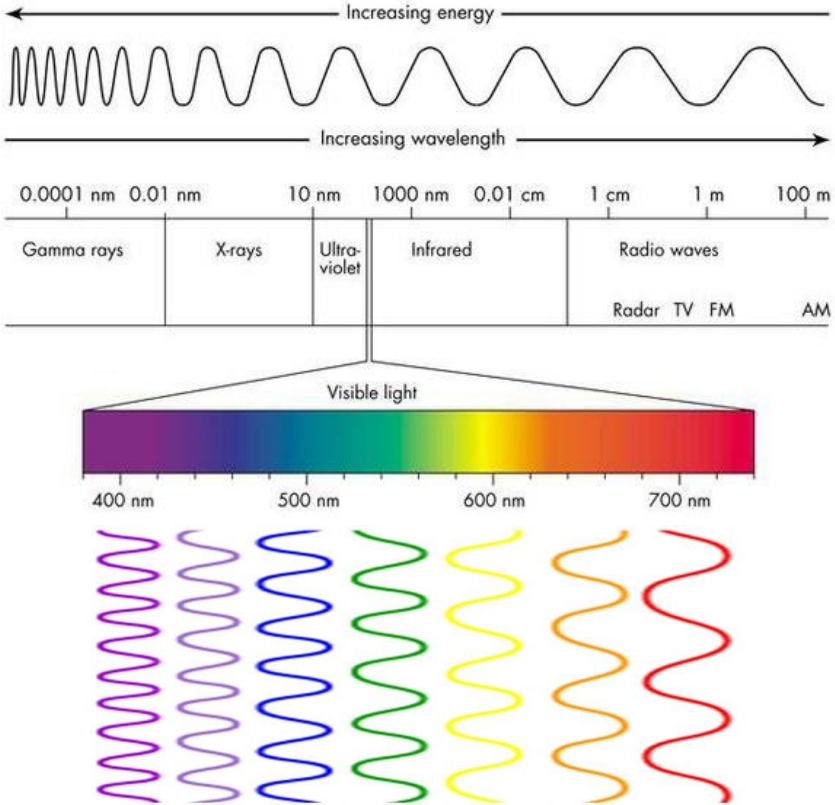
Are you able to get the Robocar to stop when the colour sensor detects each colour?

Show Mr. Desmond how the Robocar travels forward and then stops when the colour sensor detects each colour (orange, green, red, and blue).



Colour Sensor

Colour Sensor - Consider This



With your eyes and your sense of sight you can see light and different colours.

Like your eyes the colour sensor is able to sense different colours by detecting differences in the wavelengths of reflected light.

Check out this video for more information about light and colour.

https://www.youtube.com/watch?v=9Vsl0Iom3S0

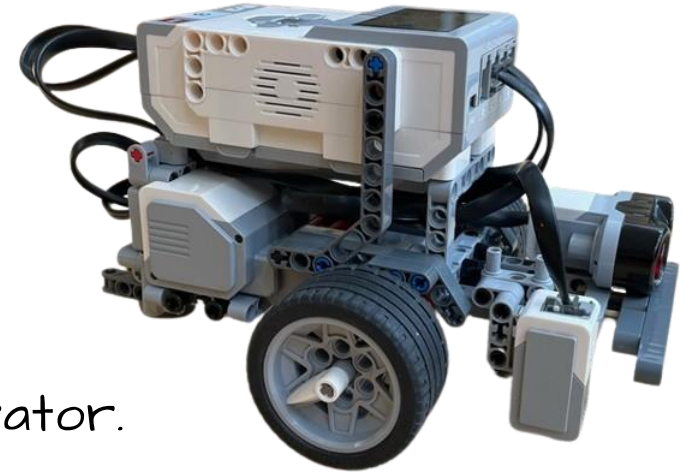
Colour Sensor

Colour Sensor - Exploration 2 - What Colour Again?

You have explored how to detect different colours using less than (<) as your operator.

1) Explore how to detect three different colours using equal to (=) as your operator.

2) Explore how to detect three different colours using greater than (>) as your operator.

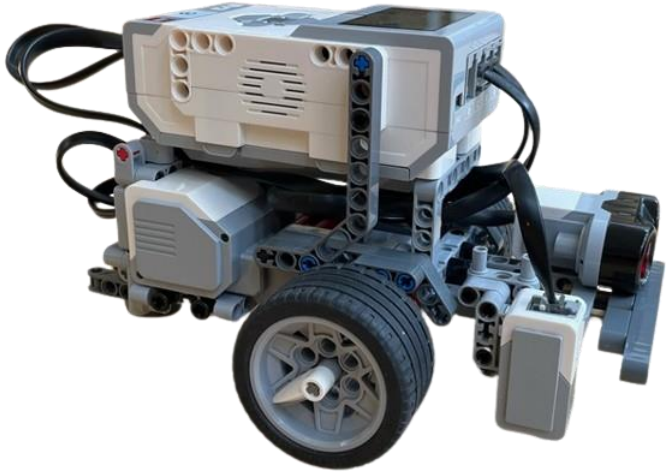


Colour Sensor

Colour Sensor - Exploration 2 - What Colour Again?

Demonstrate to Mr. Desmond three uses of equal to when detecting colours using the colour sensor and three uses of greater than when detecting colours using the colour sensor.

For each demonstration the Robocar will travel forward and then stop when the colour sensor detects the correct value.



Colour Sensor

Colour Sensor - Exploration 2

Think about it, discuss your ideas as a group, and then write down your answers on a sheet of paper.

1) Explain how the colour sensor detects variances in the visible spectrum.
2) Explain the differences in how the Robocar functions when using the colour sensor to detect variances in reflected light depending on whether you are using greater than, less than, or equal to in your conditional statements.

Show Mr. Desmond your answers and be prepared to explain your ideas about how the colour sensor works.

Colour Sensor

Colour Sensor - Exploration 3

Activity Goals

1) To explore how to use the colour sensor to allow the robot to independently respond to environmental situations using input information from the sensor to direct robot actions.
2) To demonstrate precision of movement of the robot while using the colour sensor.
3) To understand coding using conditional statements in combination with the colour sensor.

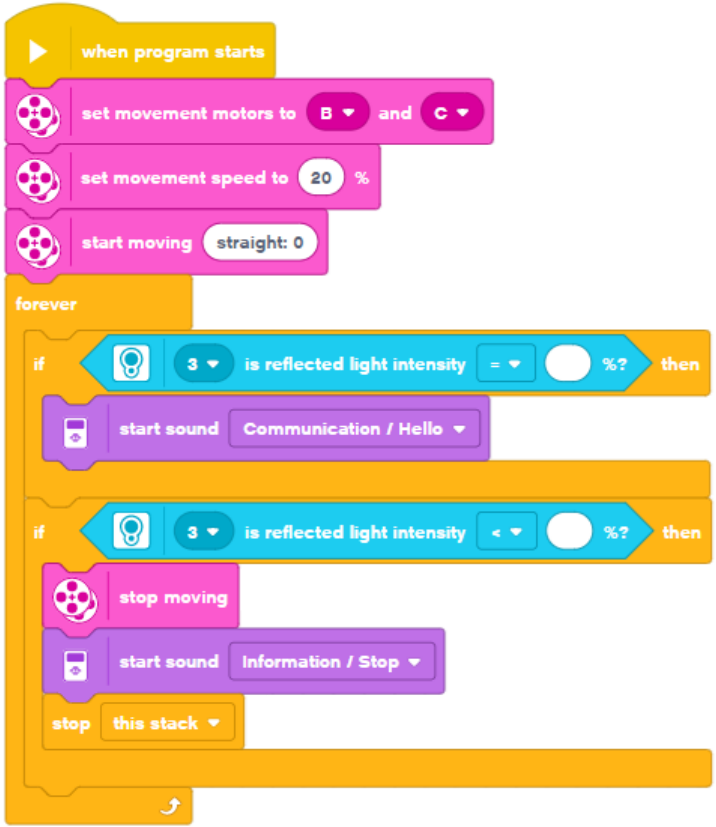
Colour Sensor - Exploration 3

Activity Steps

1) Create the Two Colours code sequence. Two Colours
2) Create the Rectangle Rover code sequence. Rectangle Rover
3) Answer questions and explain your ideas. Explain

Colour Sensor

Colour Sensor - Exploration 3 - Two Colours



Create this code sequence to have the Robocar move forward and use the colour sensor to detect different colours on a mat. Detect different colours using the intensity of reflected light.

You will choose the first colour the sensor detects. The Robocar will play a sound at the first colour, and then stop and play a sound when it detects the second colour.

Colour Sensor

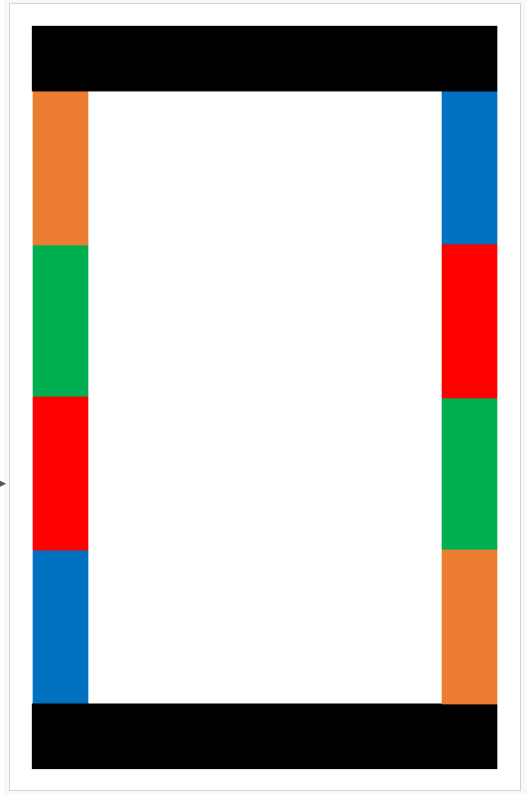
Colour Sensor - Exploration 3 - Two Colours

Download the program to the EV3.

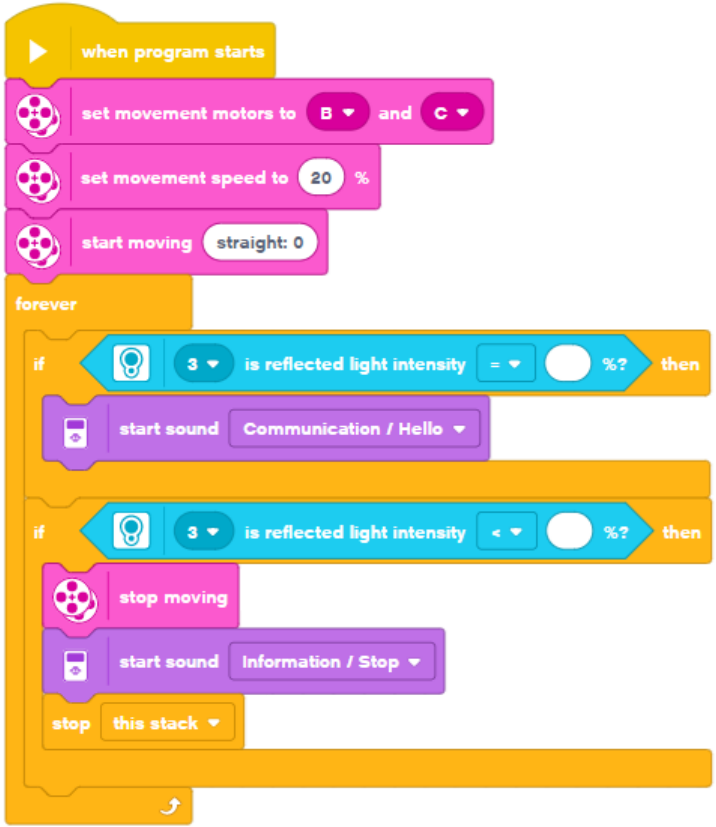
Start with the Robocar off the mat and about 10 cm from the mat.

Run the program from the EV3.

Observe how the Robocar moves.



Colour Sensor - Exploration 3 - Two Colours



Modify your code and repeat this exploration using different colours.

Download the program to the EV3.

Start with the Robocar off the mat and about 10 cm from the mat.

Run the program from the EV3.

Colour Sensor

Colour Sensor - Exploration 3 - Two Colours

Show Mr. Desmond your coding and the robot in action using the colour sensor to detect two different colours.

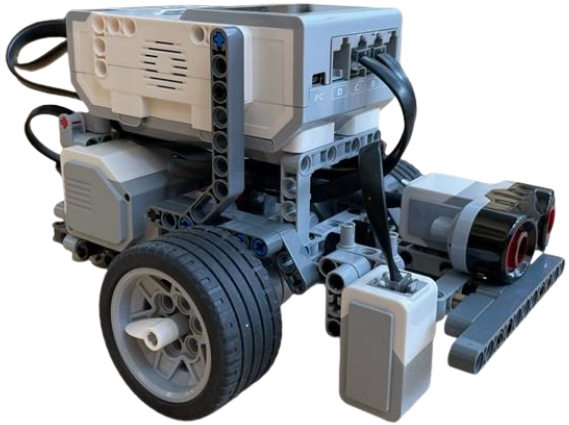
Be prepared to explain what is happening with the colour sensor and why.

Colour Sensor

Colour Sensor - Exploration 3 - Rectangle Rover

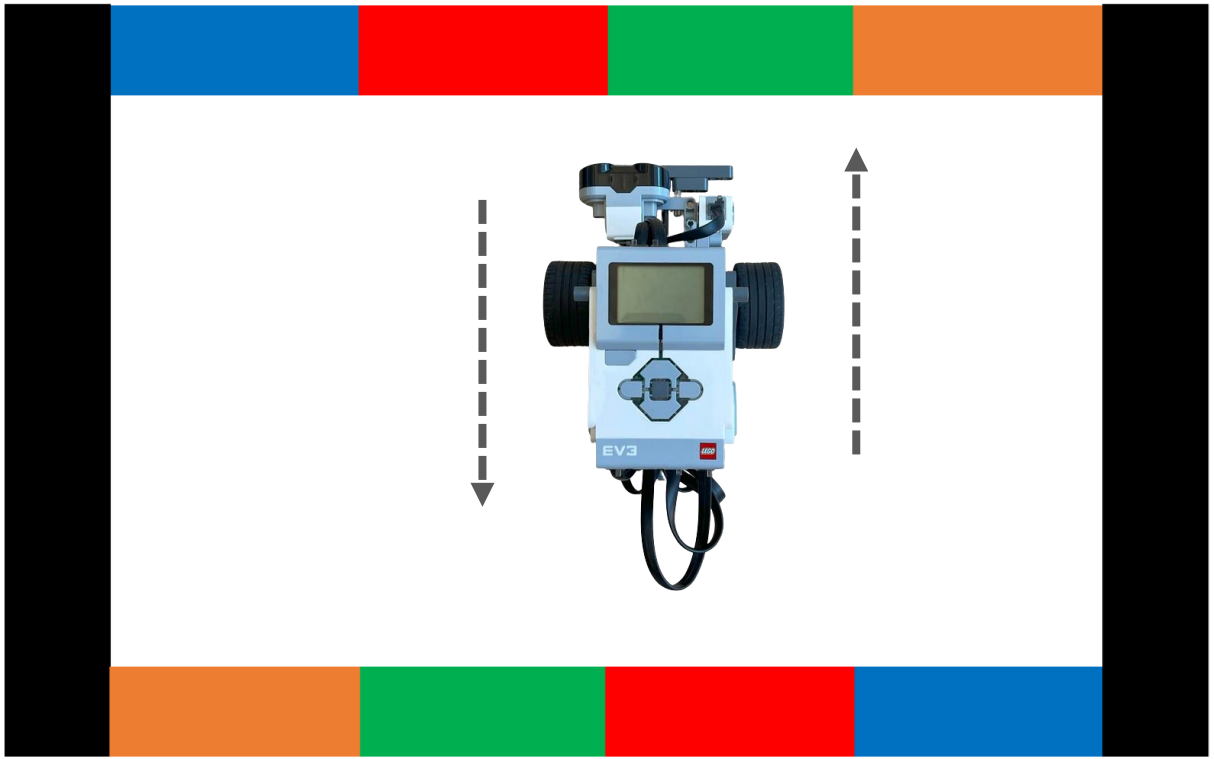
Create a code sequence to have the Robocar move over the surface of colour mat and use the colour sensor to detect the different colour rectangles.

Your challenge is to use the intensity of reflected light to make the Robocar independently move, turn, and navigate to opposite sides of the mat.
Complete the task by detecting all four of the coloured rectangles on the mat (orange, green, red, and blue) without any stops or resets in between.



Colour Sensor

Colour Sensor - Exploration 3 - Rectangle Rover



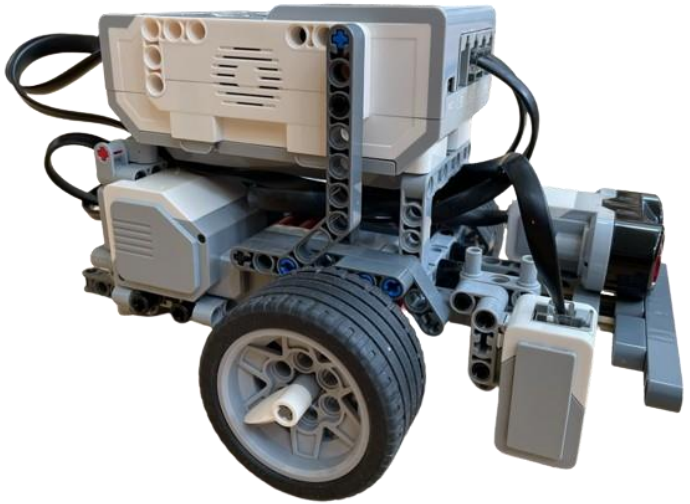
Colour Sensor

Colour Sensor - Exploration 3 - Rectangle Rover

Download the program to the EV3.

Run the program from the EV3.

Observe how the Robocar moves.



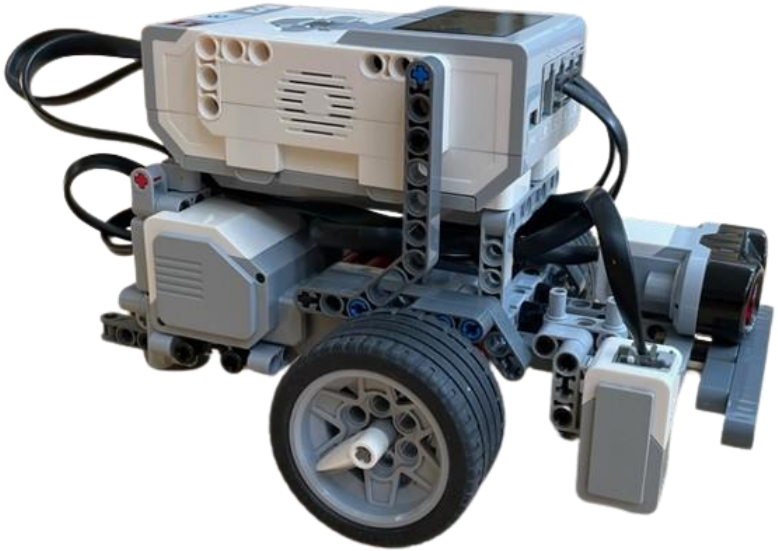
Make modifications as necessary to complete the task.

Colour Sensor

Colour Sensor - Exploration 3 - Rectangle Rover

Show Mr. Desmond your coding and the robot in action using the colour sensor to detect all four coloured rectangles.

Be prepared to explain what is happening with the colour sensor and why.



Colour Sensor

Colour Sensor - Exploration 3

Think about it, discuss your ideas as a group, and then write down your answers on a sheet of paper.

1) How does the colour sensor know how to "find" the coloured rectangles?
2) How does the colour sensor know which rectangle is which?
3) Explain how the colour sensor detects variances in reflected light.

Show Mr. Desmond your answers. Be prepared to explain your ideas about how the colour sensor works.

Colour Sensor

Colour Sensor - Exploration 4

Activity Goals

1) To explore how to use the colour sensor to allow the robot to independently respond to environmental situations using input information from the sensor to direct robot actions.
2) To explore how to use the colour sensor to allow the robot to detect a line and follow it.
3) To understand coding using conditional statements in combination with the colour sensor.

Colour Sensor - Exploration 4

Activity Steps

1) Create the Basic Line Tracker code sequence.

   Basic Line Tracker

2) Learn about the colour sensor. Colour Sensor

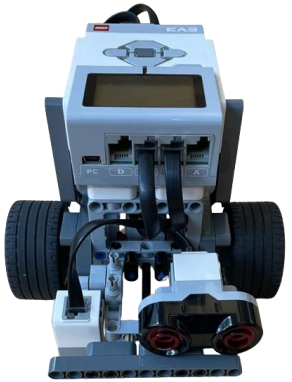
3) Answer questions and explain your ideas. Explain

Colour Sensor

Colour Sensor - Exploration 4

To complete this activity you will need a line mat.

If you do not have one please ask Mr. Desmond.



Colour Sensor

Colour Sensor - Exploration 4 - Basic Line Tracker

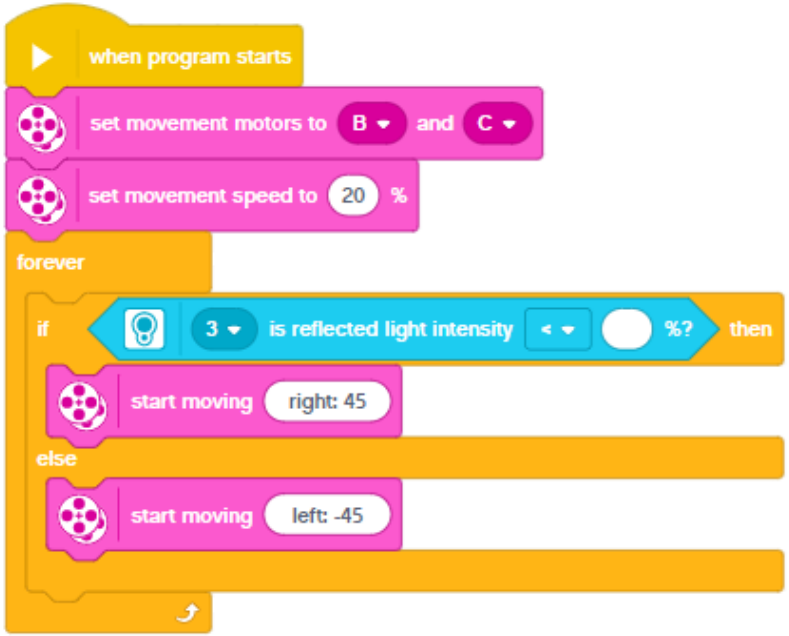
Detect different areas on a mat using reflected light intensity.

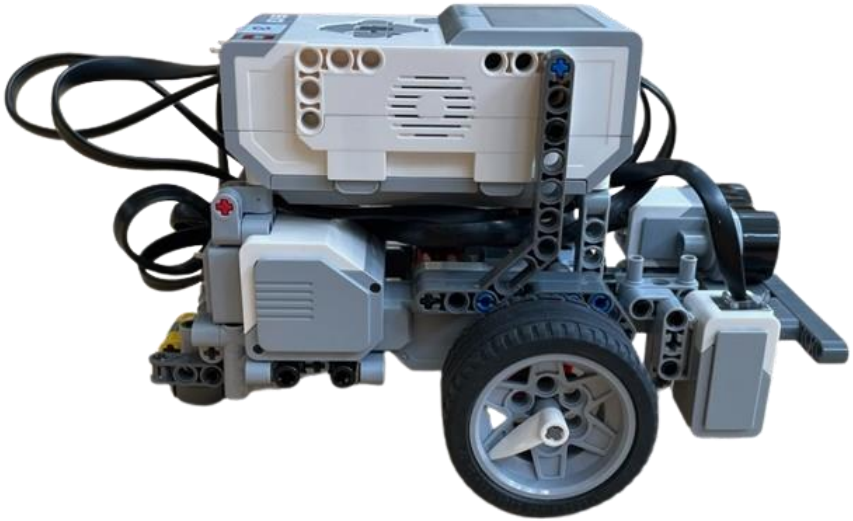
First use the sensor to detect the percentage value of the white of the mat. Record this value. White = ___%

Then use the sensor to detect the percentage value of the black of the mat. Record this value. Black = ___%

Colour Sensor - Exploration 4 - Basic Line Tracker

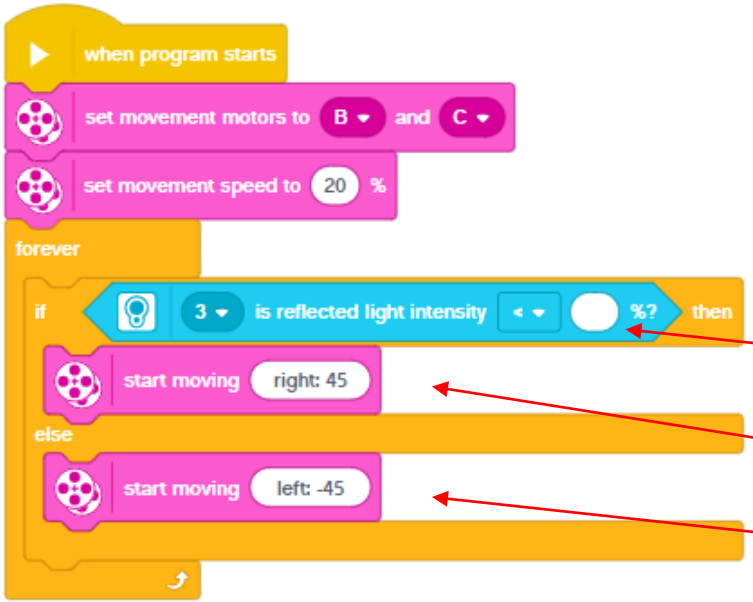
Create this code sequence to make the Robocar "find" and follow a line on the line mat provided.





Colour Sensor

Colour Sensor - Exploration 4 - Basic Line Tracker



Have the colour sensor detect if it is sensing "white" or "not white" using less than as the operator

Is the colour sensor detecting black? Type in the percentage value that represents "not white".

If the colour sensor detects black.

If the colour does not detect black.

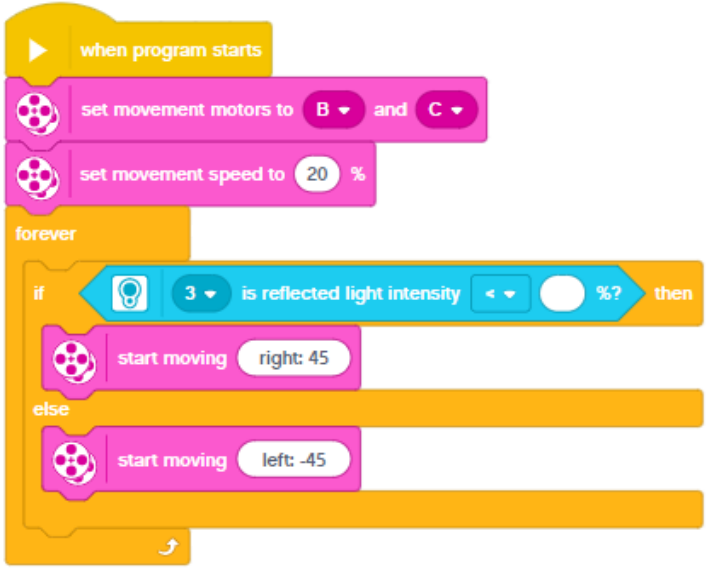
Colour Sensor

Colour Sensor - Exploration 4 - Basic Line Tracker

This coding sequence uses the "if then else" condition.

"If then else" is basically a "is it true" question in action.

If true then do, or else do the other. In this case if the robot sees black, it is too close to crossing the line, so it should turn right; or else, if robot sees white, it is too far from the line, so it should turn left.



Colour Sensor

Colour Sensor - Exploration 4 - Basic Line Tracker

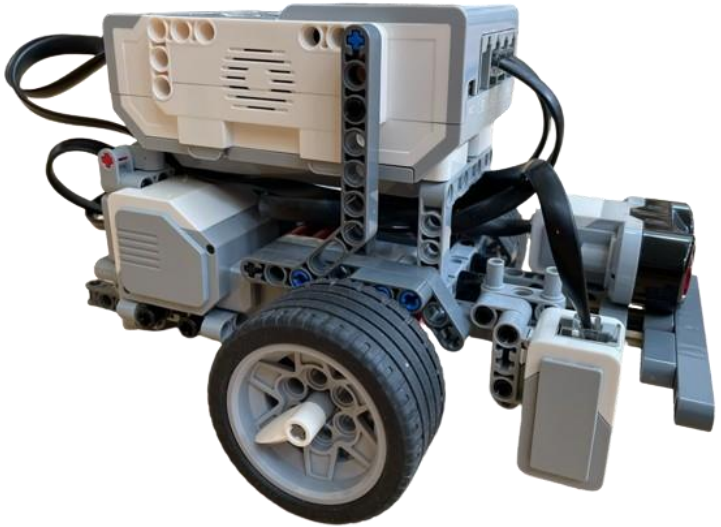
Download the program to the EV3.
Position the Robocar to the right side of the line on the mat.

Colour Sensor

Colour Sensor - Exploration 4 - Basic Line Tracker

Run the program from the EV3.

Observe how the Robocar moves and modify the program as needed.

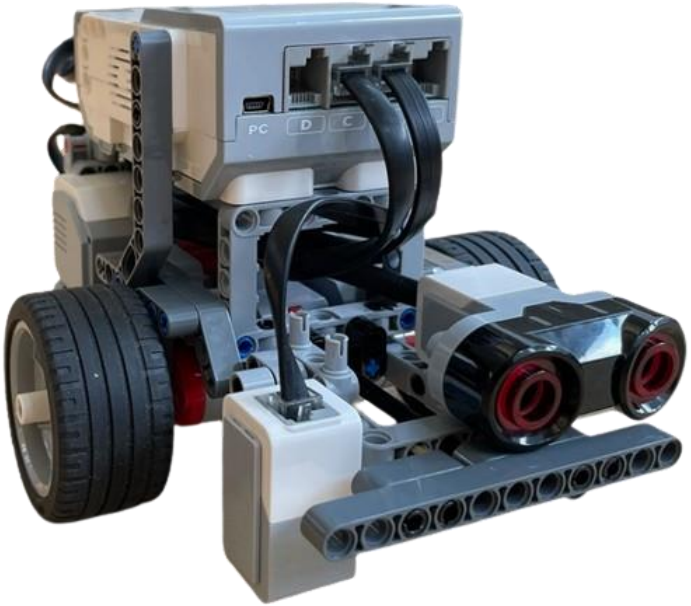


Colour Sensor

Colour Sensor - Exploration 4 - Basic Line Tracker

Show Mr. Desmond your "line tracker" coding and the robot in action using the colour sensor to detect a line on a mat and follow it.

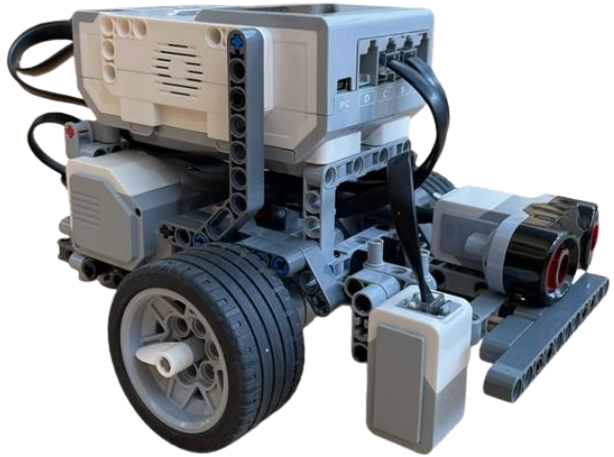
Be prepared to explain what is happening with the colour sensor and why.



Colour Sensor

Colour Sensor - Consider This

Unlike you, the robot cannot follow the center of the line. The colour sensor allows the robot to detect differences between the white (light) areas on the mat and the black (dark) areas on the mat. As such it follows along the edge of the line as the code instructs the robot to adjust its movement to the left or to the right according to the what values the colour sensor detects.

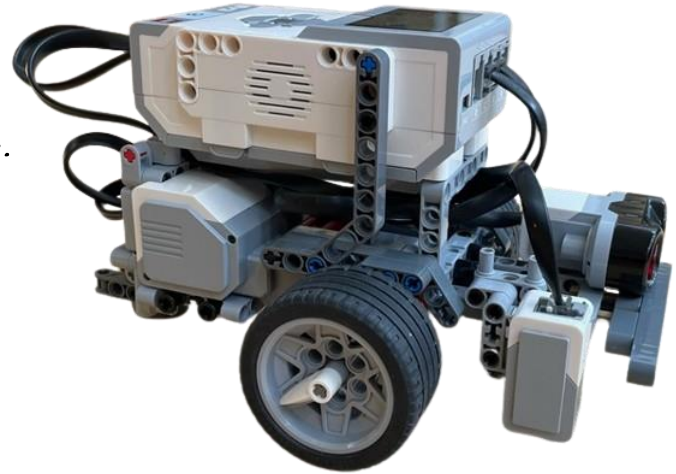


Colour Sensor

Colour Sensor - Exploration 4

Think about it, discuss your ideas as a group, and then write down your answers on a sheet of paper.

1) What does "if then" mean and "if then else" mean?
2) What is the purpose of putting the "if then else" blocks inside a forever loop?
3) The conditional statement in this exploration uses two states. What is meant by the term two states?



Colour Sensor

Colour Sensor - Exploration 4

Think about it, discuss your ideas as a group, and then write down your answers on a sheet of paper.

4) How does the colour sensor know how to "find" the line?
5) How does the colour sensor know how to follow the line?
6) Explain how the colour sensor detects variances in reflected light as it tracks the line?

Show Mr. Desmond your answers. Be prepared to explain your ideas about how the colour sensor works.

Colour Sensor - Exploration 5

Activity Goals

1) To explore how to use the colour sensor to allow the robot to independently respond to environmental situations using input information from the sensor to direct robot actions.
2) To explore how to use the colour sensor to allow the robot to detect a line and follow it.
3) To understand coding using conditional statements in combination with the colour sensor.

Colour Sensor - Exploration 5

Activity Steps

1) Create the Better Line Tracker code sequence.

   Better Line Tracker

2) Alter and explore changes to the Better Line Tracker code.

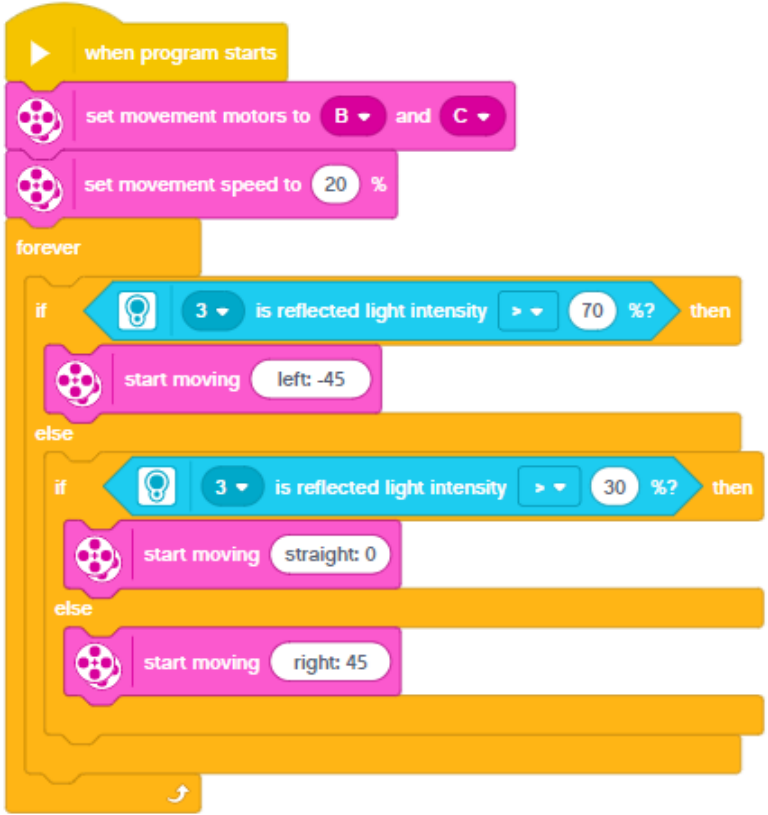
   Explore Code Changes

3) Answer questions and explain your ideas. Explain

Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker

Create this code sequence to make the Robocar "find" and follow a line on the line mat.

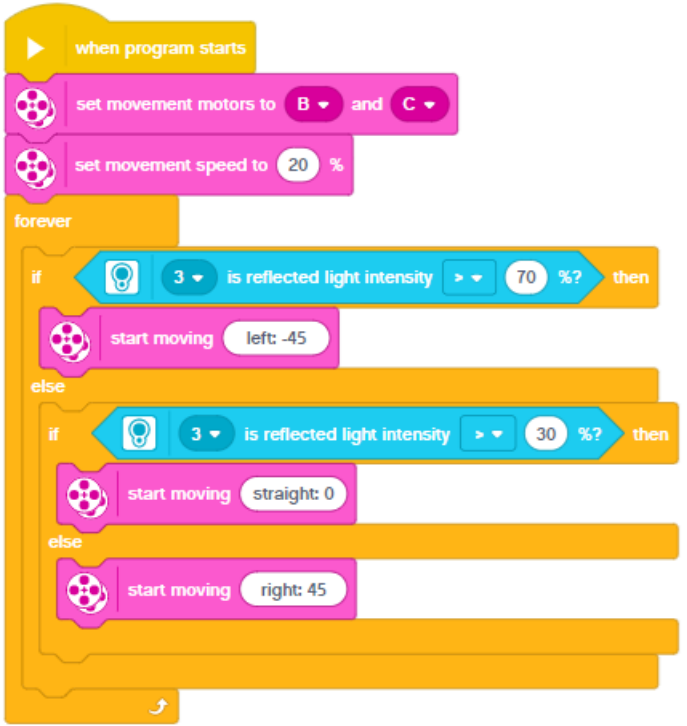


Colour Sensor - Exploration 5 - Better Line Tracker

This coding sequence has an "if then else" condition inside an "if then else" condition.

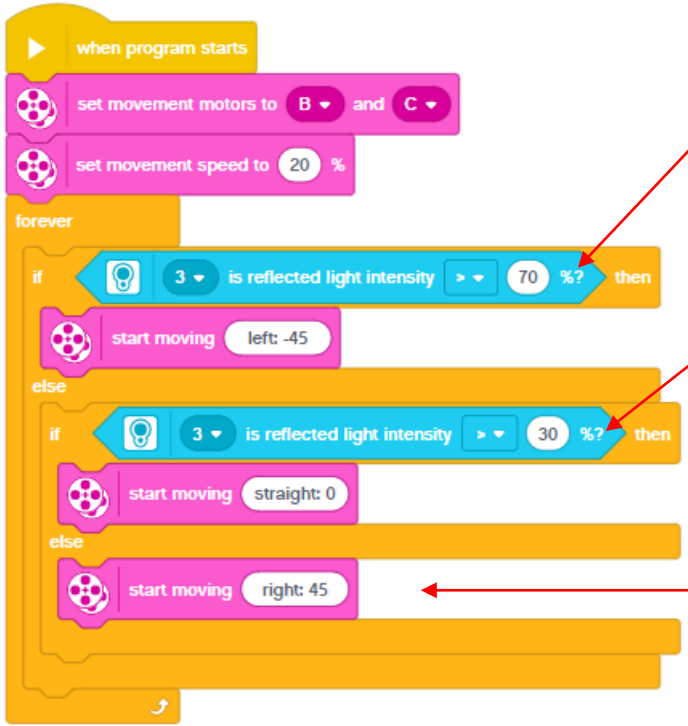
That means that there are multiple related "is it true" questions in action.

If you like vanilla ice cream [true] then you can ask for some or else [not true] if you like chocolate ice cream [true] then you can ask for some or else [not true] you can ask for something different.



Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker



Is the colour sensor detecting greater than 70%? ("white") If true, the robot should move left to find the black line.

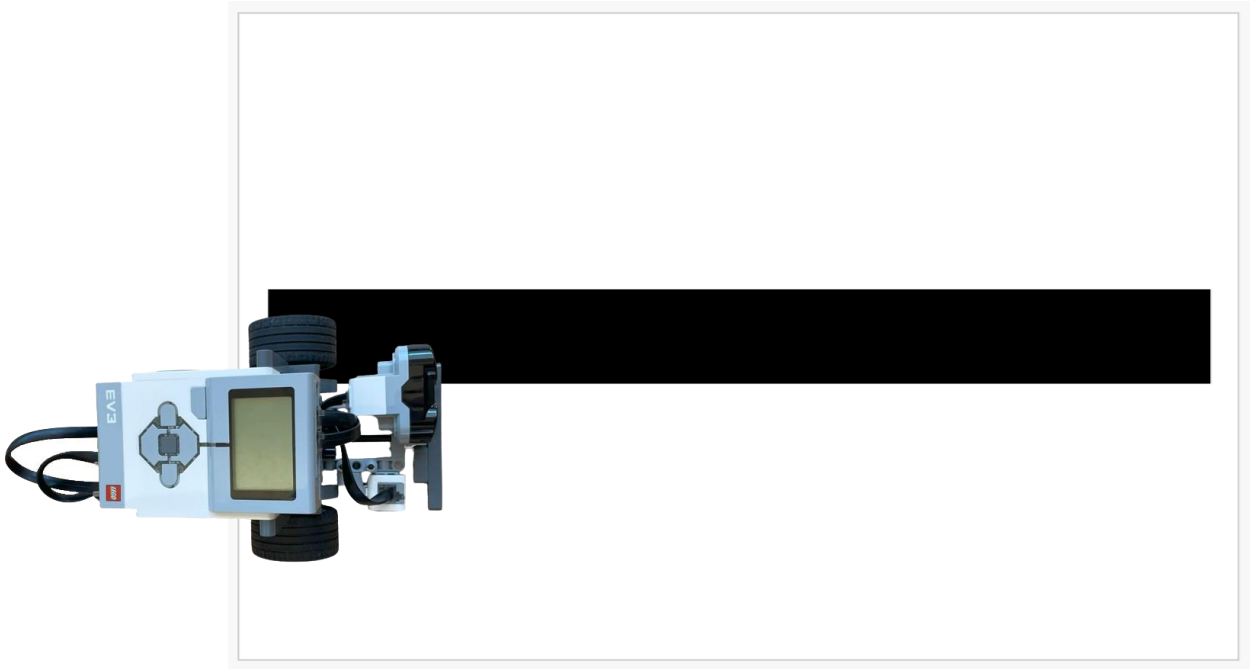
Or else if not greater than 70% is the colour sensor detecting greater than 30%? ("not black") If true, the robot should move straight.

Or else if not greater than 30% (meaning if the colour sensor does detect "black") move right to avoid crossing the black line.

Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker

Download the program to the EV3.
Position the Robocar to the right side of the line on the mat.

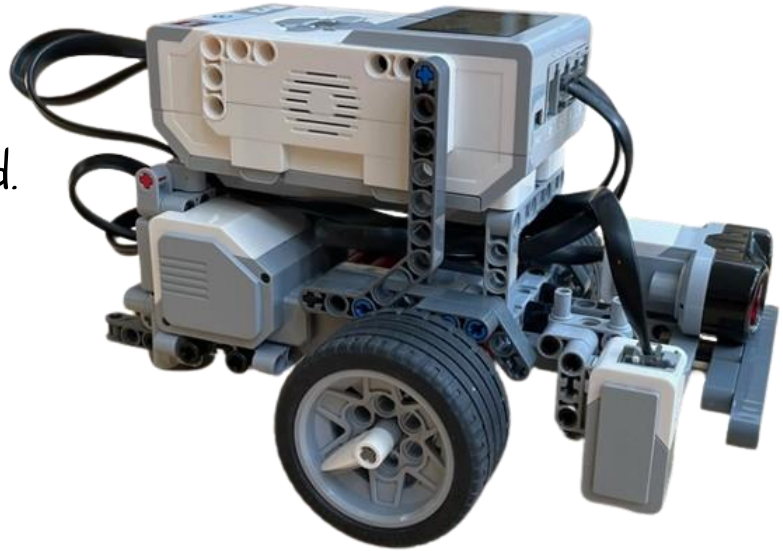


Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker

Run the program from the EV3.

Observe how the Robocar moves and modify the program as needed.

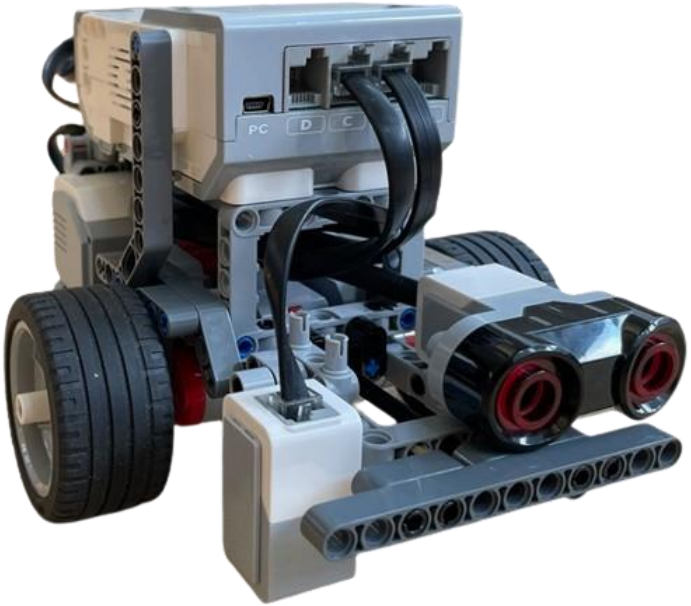


Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker

Show Mr. Desmond your "line tracker" coding and the robot in action using the colour sensor to detect a line on a mat and follow it.

Be prepared to explain what is happening with the colour sensor and why.



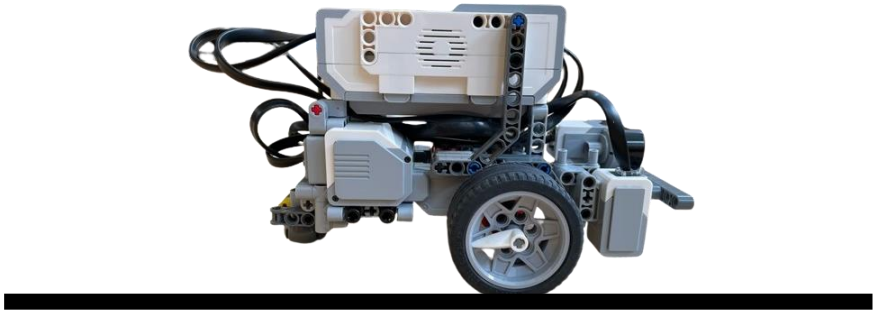
Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker

Explore the ideas below to examine the effectiveness of the Better Line Tracker three states code sequence.

1) Should the code be using less than values rather than greater than values? Change the code to explore this idea.

2) Are 70% and 30% the best number values for the colour sensor to detect? Change the code to explore this idea.



Colour Sensor

Colour Sensor - Exploration 5 - Better Line Tracker

Explore the ideas below to examine the effectiveness of the Better Line Tracker three states code sequence.

3) Should the turn dial arc be set to 45? Would a sharper turn with a value greater than 45 be better? Would a gentler turn with a value less than 45 be better?

Discuss these ideas with Mr. Desmond. Be prepared to explain your ideas about the effectiveness of the code.

Colour Sensor

Colour Sensor - Exploration 5

Think about it, discuss your ideas as a group, and then write down your answers on a sheet of paper.

1) How does the colour sensor know how to "find" the line?
2) How does the colour sensor know how to follow the line?
3) Explain how the colour sensor detects variances in reflected light as it tracks the line.
4) Explain what you have determined about the effectiveness of the Better Line Tracker three states code.

Show Mr. Desmond your answers and be prepared to explain how the colour sensor allows the Robocar to track a line.

Colour Sensor

Colour Sensor - Consider This

A sensor is designed to provide input information to the robotic system. As a form of artificial intelligence (AI) the robot will respond to the environmental circumstances noted by the sensor and take specific actions in response.

The coding provides the robotic system the ability to perform this feat of machine intelligence. Conditional statements are essentially true or false questions that provide the logic that allows the robot to read the sensor input and then make a decision based on what the information was.

Colour Sensor Challenges

Learning Goals

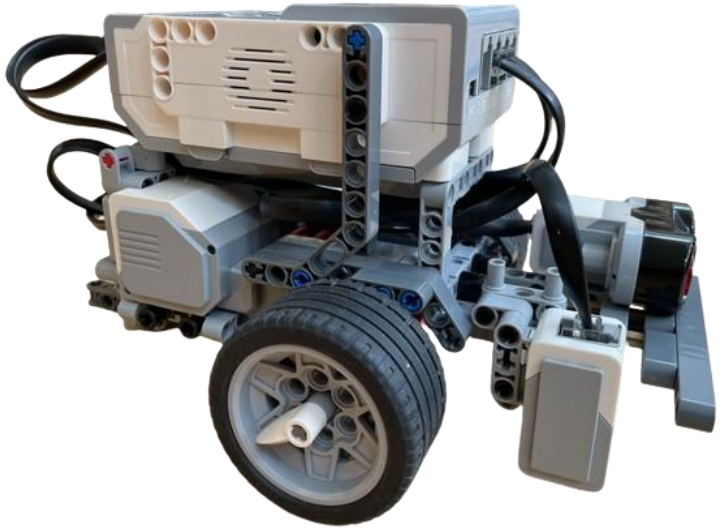
- Build knowledge about coding and robotics by coding a sensor and making a robot move.
- Independently create code featuring conditional statements to use sensor input to determine how a robot should move.
- Have FUN learning!

Colour Sensor Challenges

Challenge 1 - Line Tracking There and Back

Create a code sequence to have the Robocar track the path of a line from the beginning of the line to end of the line and then back to beginning.
(See image next page.)

Show Mr. Desmond your coding and the robot in action using the colour sensor to "find" and follow a line.



Colour Sensor Challenges

Colour Sensor Challenges

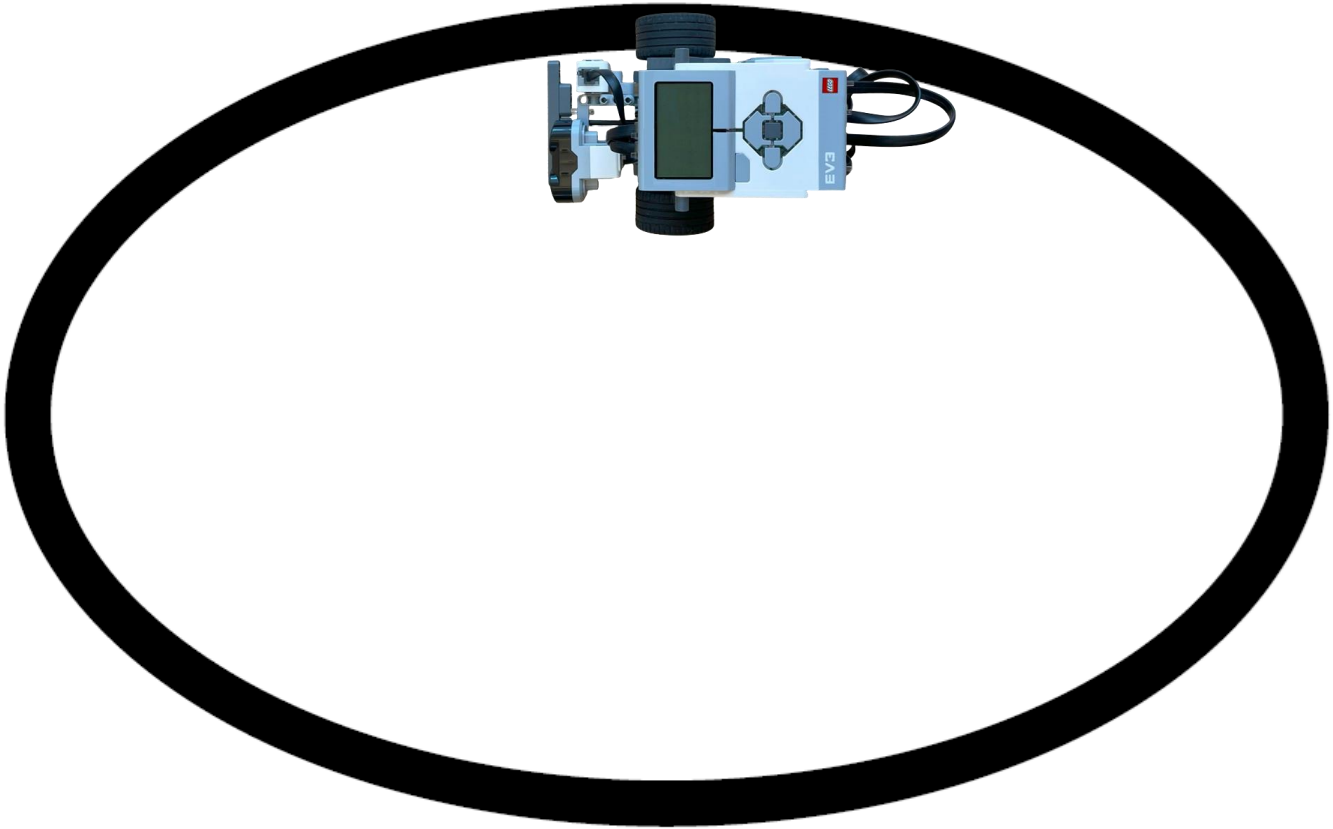
Challenge 2 - The Big O

Create a code sequence to have the Robocar complete the path of an oval or a large rectangular track.
(See images next two pages.)

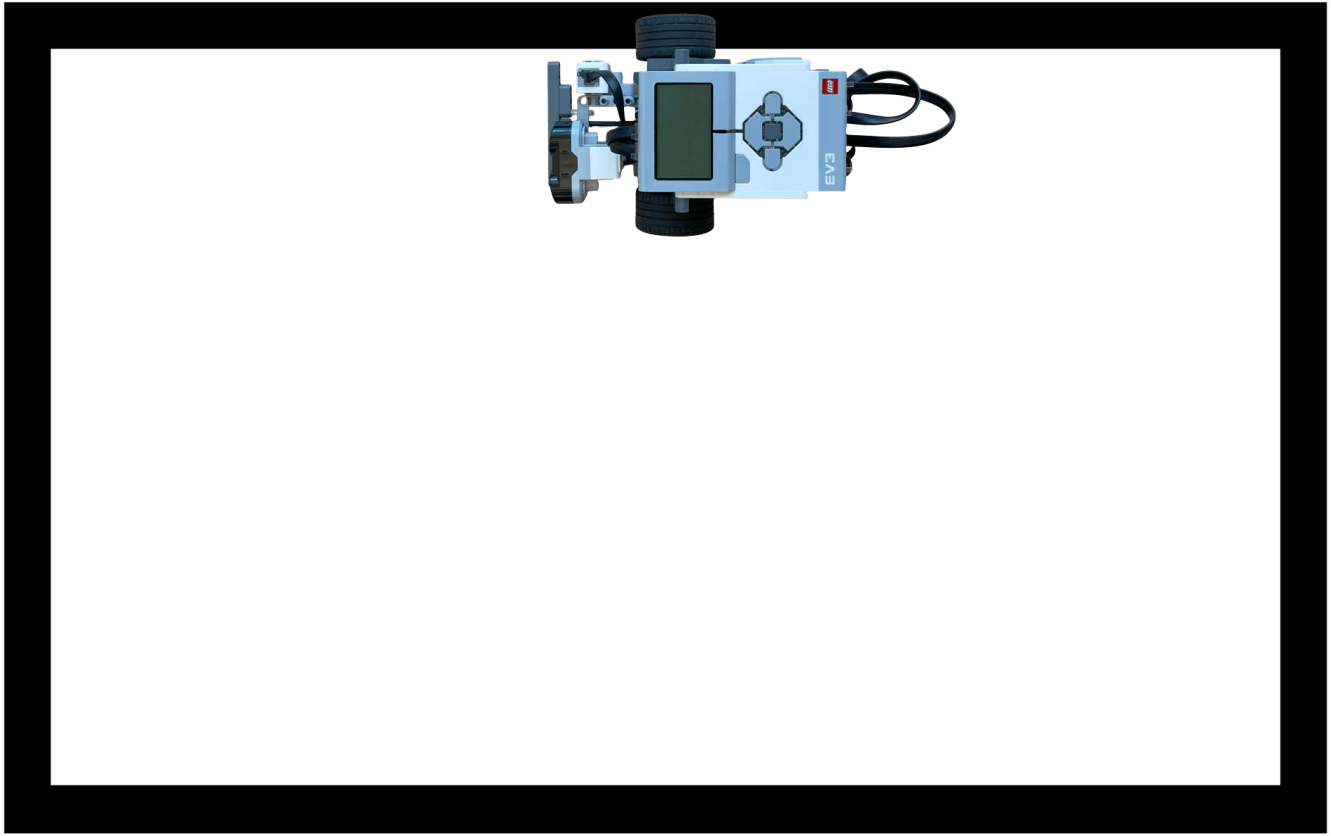
You are challenged to independently improve the efficiency of the line tracking by creating a more advanced code using five states (multiple greater than and less than values).
Explore how to refine the line tracking ability of the Robocar.
The goal is to create smoother movement of the Robocar as it tracks the line. Keep the Robocar on the line as much as possible.

Show Mr. Desmond your coding and the robot in action using the colour sensor to follow the lines of the big O.

Colour Sensor Challenges



Colour Sensor Challenges

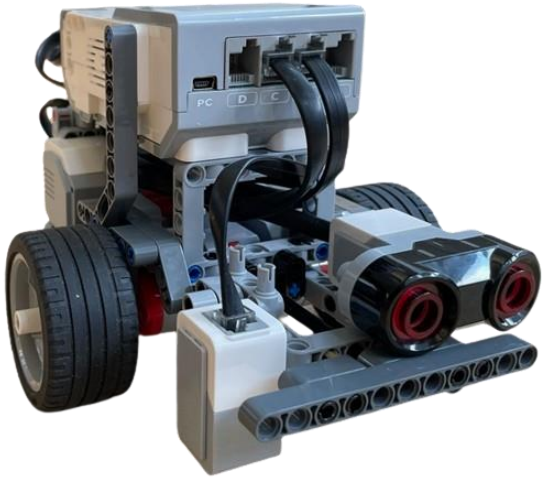


Colour Sensor Challenges

Challenge 3 - The AMAZing Challenge!

Create the code that will allow the Robocar to navigate a line maze independently using the colour sensor to detect and follow the black lines to complete the maze. (See image next page for a sample maze design.)

You are expected to demonstrate your success to Mr. Desmond. Be prepared to show both the Robocar in action and your code.



Colour Sensor Challenges