

```
numOfDataEntries = 100 # Total number of data entries to be recorded
data_buffer = 0 # Create buffer of data to write to SD card

# Setup CSV Header
data_buffer = "time,brightness,hue,color"
data_buffer += "\n"

# Check for SD card insertion and hold the program if absent
if not brain.sdcard.is_inserted():
    brain.screen.set_cursor(1,1)
    brain.screen.print("SD Card Missing")
    # Infinite loop to prevent program progress until an SD card is inserted
    while(True):
        wait(5, MSEC)

# Reset the brain timer before starting data collection
brain.timer.clear();

# Data collection loop: Generate and append data entries to the buffer
for i in range(numOfDataEntries):
    # Append the current timer value to the buffer
    data_buffer += "%1.3f" % brain.timer.value()
    data_buffer += ","

    # Append the brightness value from the optical sensor to the buffer
    data_buffer += "%.0f" % optical_2.brightness()
    data_buffer += ","

    # Append the hue value from the optical sensor to the buffer
    data_buffer += "%.0f" % optical_2.hue()
    data_buffer += ","

    # Use a conditional block to match the sensor's color output to a color
    if optical_2.color() == Color.BLACK:
        data_buffer += "Black"
    elif optical_2.color() == Color.WHITE:
```

Exploring Data Science Using Python with VEX EXP / V5

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Senior Education Developer, VEX Robotics

Workshop Goals

- **Collect Optical Sensor data using VEXcode V5 Python.**
- **Organize and graph data from a CSV file.**
- **Identify patterns in hue, brightness, and color readings.**
- **Compare data across different test conditions.**
- **Use data to make decisions about sensor use in robotics.**

The VEX Continuum



VEX 123
Coding Starts Early

Ages 4+



VEX GO
STEM Starts Early

Ages 8+



VEX AIM
Real World Coding

Ages 8+



VEX IQ
Applied STEM Learning

Ages 11+



VEX EXP
Real World STEM for Classrooms

Ages 14+



VEX VS
Real World STEM for Competition

Ages 14+



VEX CTE
Workforce Readiness

Ages 14+



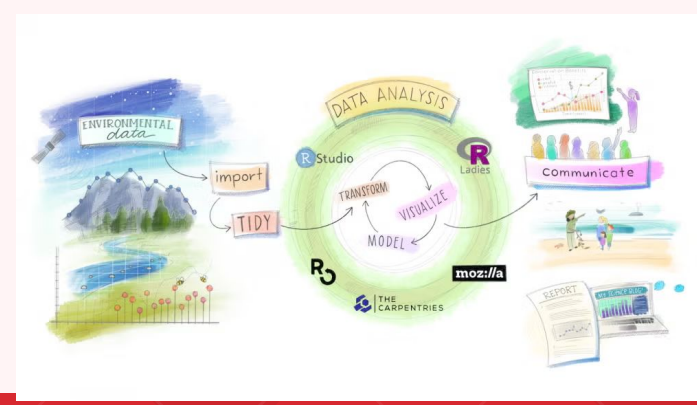
VEX AIR
STEM Skills Take Flight

Ages 14+



VEX CODE VR
Virtual Robot Coding

Ages 8+



Why Data Science?

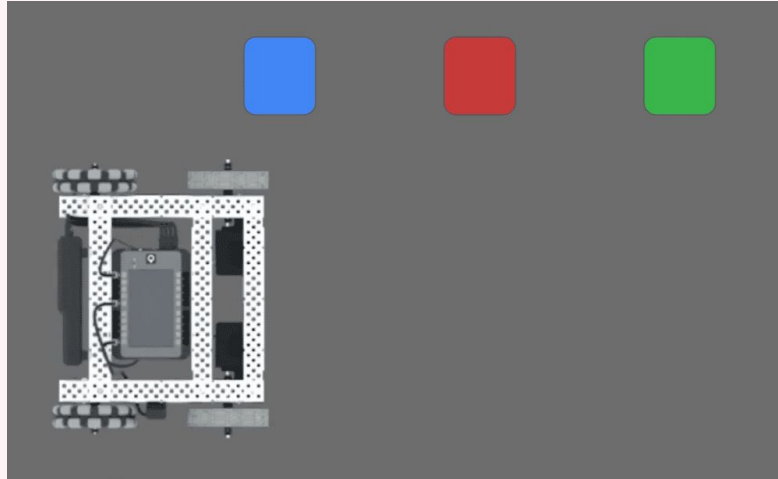
Data turns observations into actionable insights.



Collect → Graph → Interpret → Compare → Decide

Collect Data

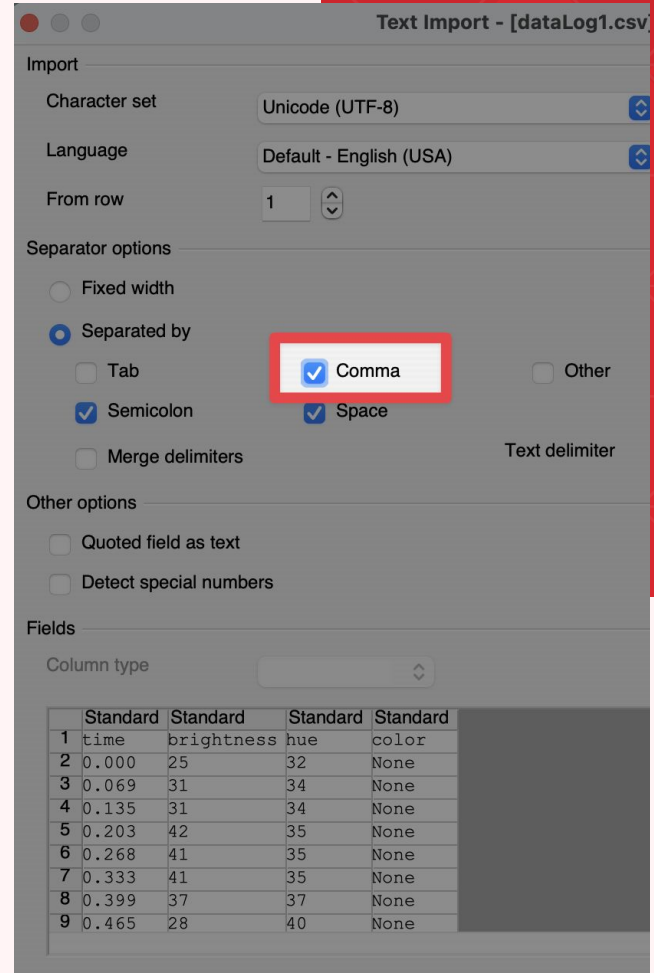
1. Insert microSD cards into the V5 Brain.
2. Set up 3 Cubes along the side of the robot.
3. Run the Data Visualization project on the Brain. The robot will drive forward for 600mm. Stop the project once the robot is done moving.

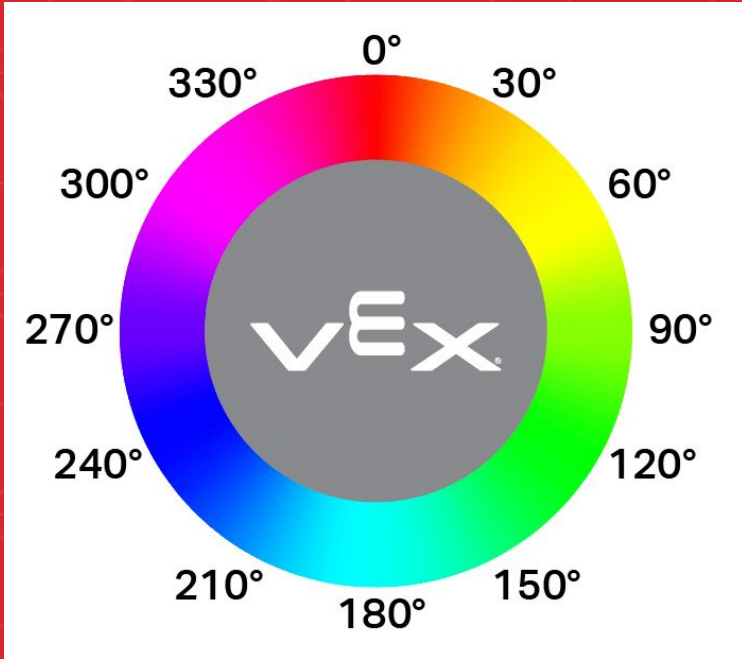


Visualize Data - 1

1. Remove the microSD cards from the Brain and insert into the reader
2. Launch Open Office Calc.
 - a. File → Open
3. Navigate to the **dataLog1.csv** file.
 - a. Make sure **Separated by: Comma** is checked
 - b. Preview should show 4 columns

If prompted, open a copy. You want to be able to edit the file!





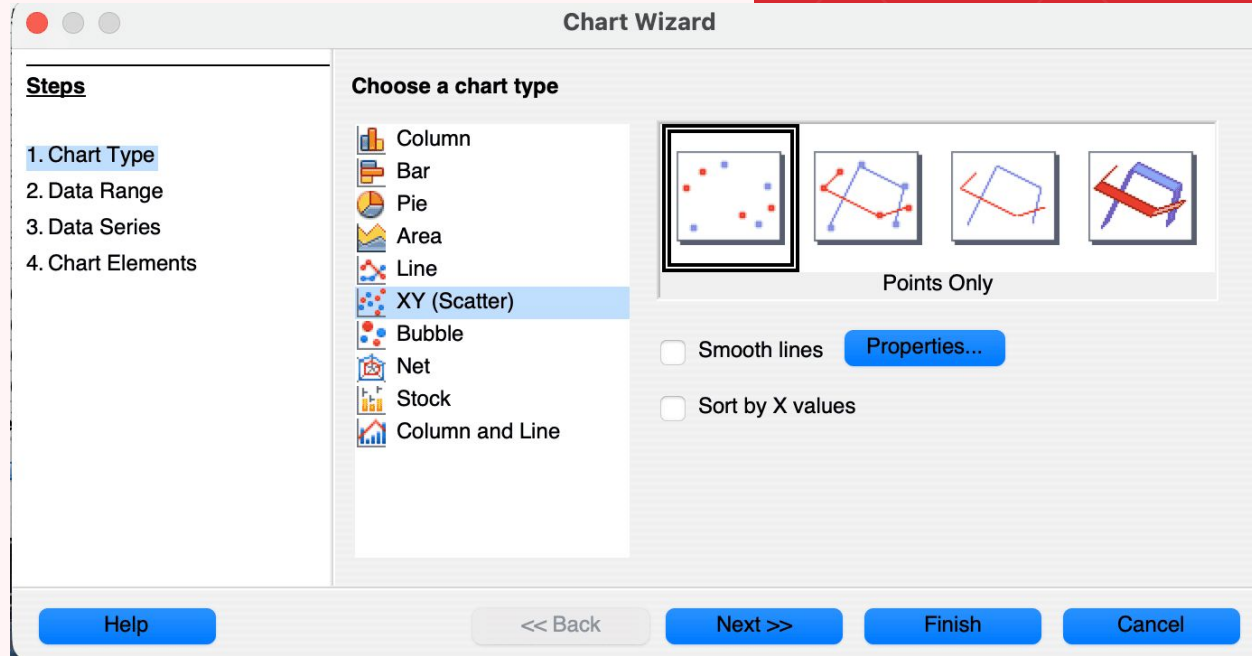
time	brightness	hue	color
0	25	32	None
0.069	31	34	None
0.135	31	34	None
0.203	42	35	None
0.268	41	35	None
0.333	41	35	None
0.399	37	37	None
0.465	28	40	None
0.531	28	40	None
0.594	23	45	Yellow
0.654	23	45	Yellow
0.715	21	49	Yellow
0.775	20	55	Yellow
0.835	20	55	Yellow
0.896	19	59	Yellow
0.956	19	59	Yellow
1.017	18	61	Yellow
1.079	18	61	Yellow
1.14	18	61	Yellow
1.202	19	61	Yellow
1.264	19	61	Yellow
1.326	19	61	Yellow
1.388	19	59	Yellow
1.452	19	59	Yellow
1.513	18	56	Yellow
1.575	18	56	Yellow
1.637	17	52	Yellow
1.698	14	47	Yellow
1.761	14	47	Yellow
1.824	12	32	None
1.887	12	32	None
1.949	11	17	Red
2.012	11	14	Red
2.074	11	14	Red
2.137	12	17	Red
2.199	12	17	Red
2.262	12	17	Red
2.324	12	18	Red
2.387	12	17	Red
2.450	12	18	Red
2.512	12	18	Red
2.575	12	17	Red
2.637	12	17	Red
2.700	11	18	Red
2.762	11	18	Red
2.825	12	17	Red
2.887	12	17	Red
2.950	12	17	Red
3.012	12	18	Red
3.075	12	18	Red
3.137	12	20	Red
3.200	12	20	Red
3.262	12	20	Red
3.325	12	20	Red
3.387	12	18	Red
3.450	12	24	None
3.512	12	24	None
3.575	13	38	None
3.637	13	38	Yellow
3.700	14	40	Yellow
3.762	15	54	Yellow
3.825	15	54	Yellow
3.887	17	58	Yellow
3.950	17	59	Yellow
4.012	19	59	Yellow
4.075	20	59	Yellow
4.137	20	59	Yellow
4.200	20	59	Yellow
4.262	20	59	Yellow
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4.387	19	61	Yellow
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4.637	21	56	Yellow
4.700	21	40	Yellow
4.762	23	49	Yellow
4.825	23	49	Yellow
4.887	28	45	Yellow
4.950	28	45	Yellow
5.012	28	45	Yellow
5.075	30	42	Yellow
5.137	30	42	Yellow
5.200	31	44	Yellow
5.262	31	44	Yellow
5.325	31	44	Yellow
5.387	32	44	Yellow
5.450	32	44	Yellow
5.512	35	42	Yellow
5.575	35	42	Yellow
5.637	38	42	Yellow
5.700	40	41	None
5.762	40	41	None
5.825	41	41	None
5.887	41	41	None
5.950	41	41	None
6.012	41	41	None
6.075	41	41	None
6.137	41	41	None
6.200	41	41	None

So many data points!

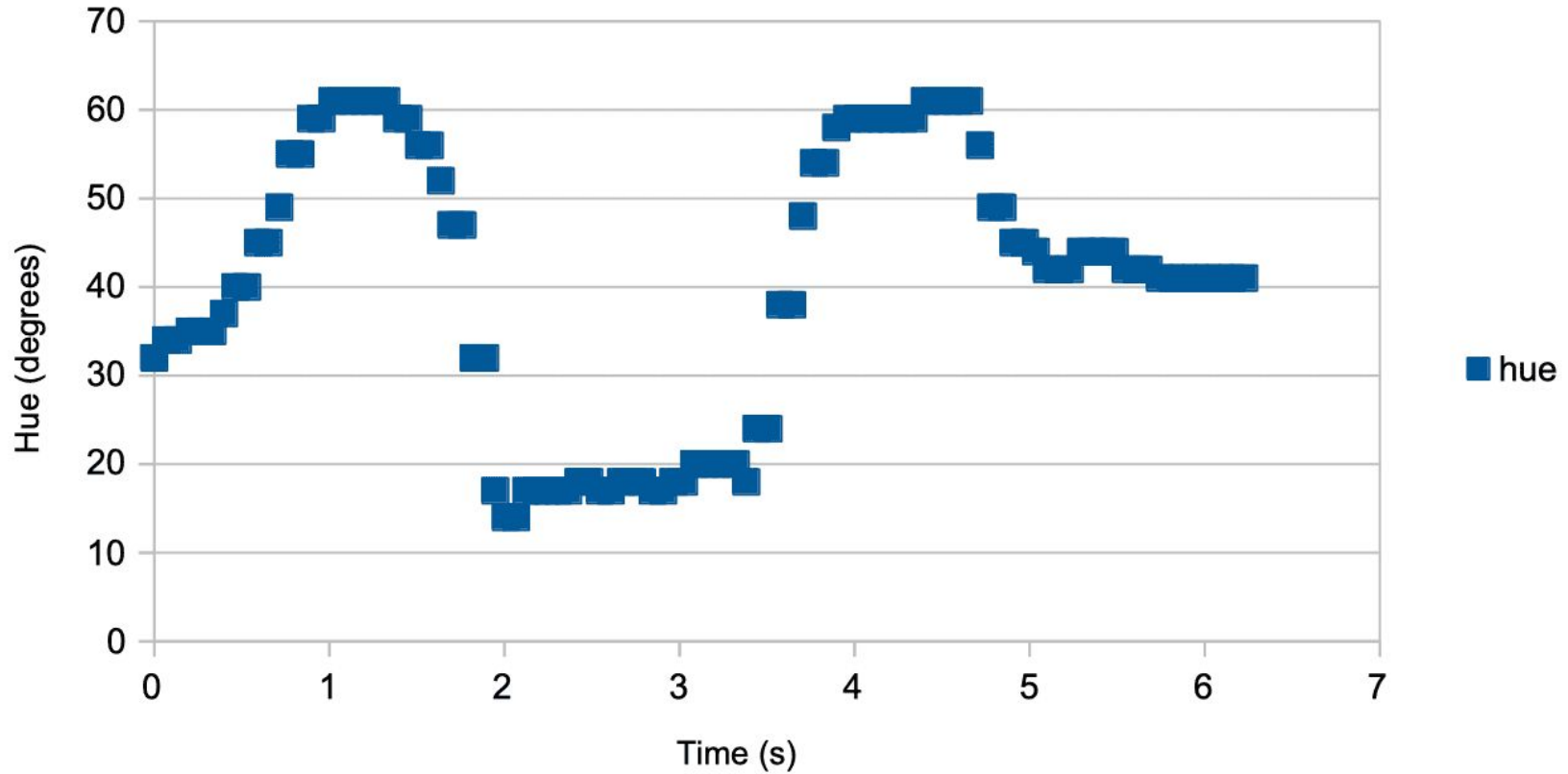
time	brightness	hue	color
0	25	32	None
0.069	31	34	None
0.135	31	34	None
0.203	42	35	None
0.268	41	35	None
0.333	41	35	None
0.399	37	37	None
0.465	28	40	None
0.531	28	40	None
0.594	23	45	Yellow
0.654	23	45	Yellow
0.715	21	49	Yellow
0.775	20	55	Yellow
0.835	20	55	Yellow
0.896	19	59	Yellow
0.956	19	59	Yellow
1.017	18	61	Yellow
1.079	18	61	Yellow
1.14	18	61	Yellow
1.202	19	61	Yellow
1.264	19	61	Yellow
1.326	19	61	Yellow
1.388	19	59	Yellow
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1.513	18	56	Yellow
1.575	18	56	Yellow
1.637	17	52	Yellow
1.698	14	47	Yellow
1.761	14	47	Yellow
1.824	12	32	None
1.887	12	32	None
1.949	11	17	Red
2.012	11	14	Red
2.074	11	14	Red
2.137	12	17	Red
2.199	12	17	Red
2.262	12	17	Red
2.324	12	18	Red
2.387	12	17	Red
2.450	12	18	Red
2.512	12	18	Red
2.575	12	17	Red
2.637	12	17	Red
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3.012	12	18	Red
3.075	12	18	Red
3.137	12	20	Red
3.200	12	20	Red
3.262	12	20	Red
3.325	12	20	Red
3.387	12	18	Red
3.450	12	24	None
3.512	12	24	None
3.575	13	38	None
3.637	13	38	Yellow
3.700	14	40	Yellow
3.762	15	54	Yellow
3.825	15	54	Yellow
3.887	17	58	Yellow
3.950	17	59	Yellow
4.012	19	59	Yellow
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4.387	19	61	Yellow
4.450	19	61	Yellow
4.512	20	61	Yellow
4.575	20	61	Yellow
4.637	21	56	Yellow
4.700	21	40	Yellow
4.762	23	49	Yellow
4.825	23	49	Yellow
4.887	28	45	Yellow
4.950	28	45	Yellow
5.012	28	45	Yellow
5.075	30	42	Yellow
5.137	30	42	Yellow
5.200	31	44	Yellow
5.262	31	44	Yellow
5.325	31	44	Yellow
5.387	32	44	Yellow
5.450	32	44	Yellow
5.512	35	42	Yellow
5.575	35	42	Yellow
5.637	38	42	Yellow
5.700	40	41	None
5.762	40	41	None
5.825	41	41	None
5.887	41	41	None
5.950	41	41	None
6.012	41	41	None
6.075	41	41	None
6.137	41	41	None
6.200	41	41	None

Visualize Data - 2

4. Highlight the time and hue value columns.
5. Select **Insert** → **Chart** → **XY (Scatter)**.
6. Can go to **Next** to add labels to the axes or choose **Finish** to see the chart.



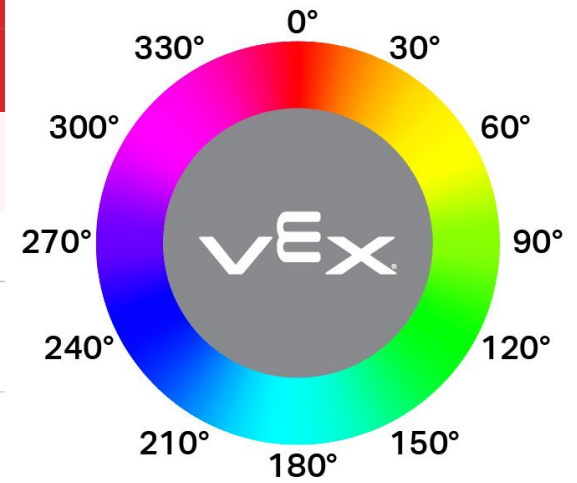
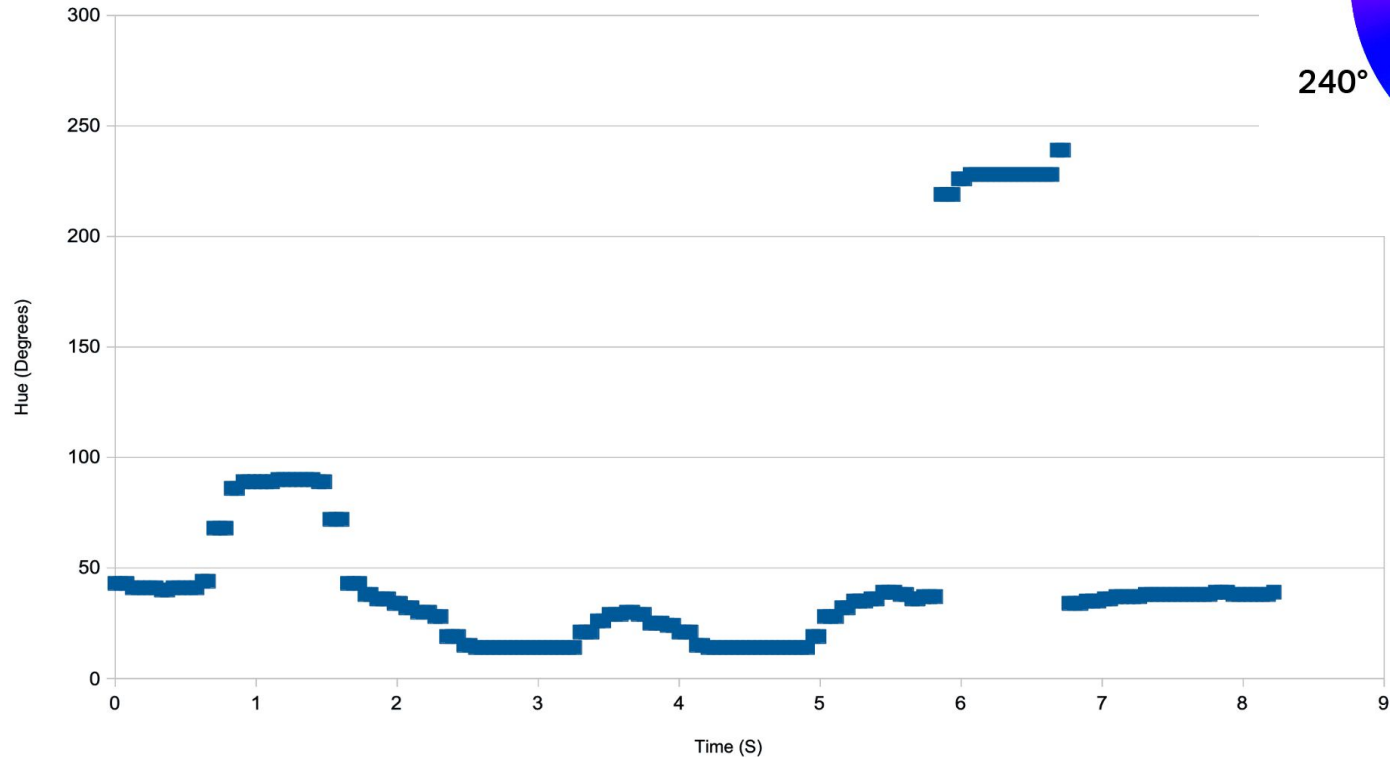
Hue Value Over Time



Let's take a look at the code ...

Interpret Data – Challenge

Using this chart, can you recreate the setup?

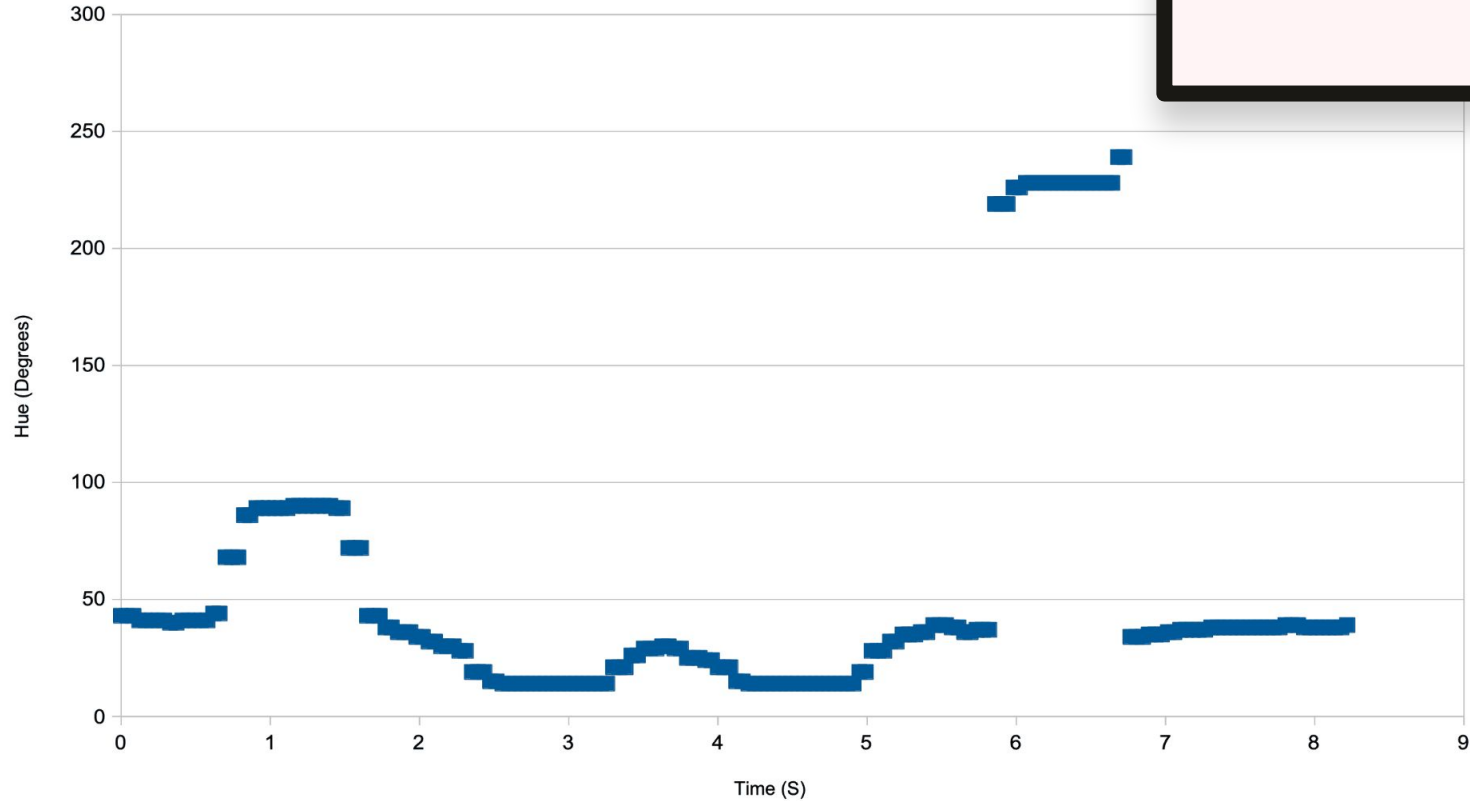


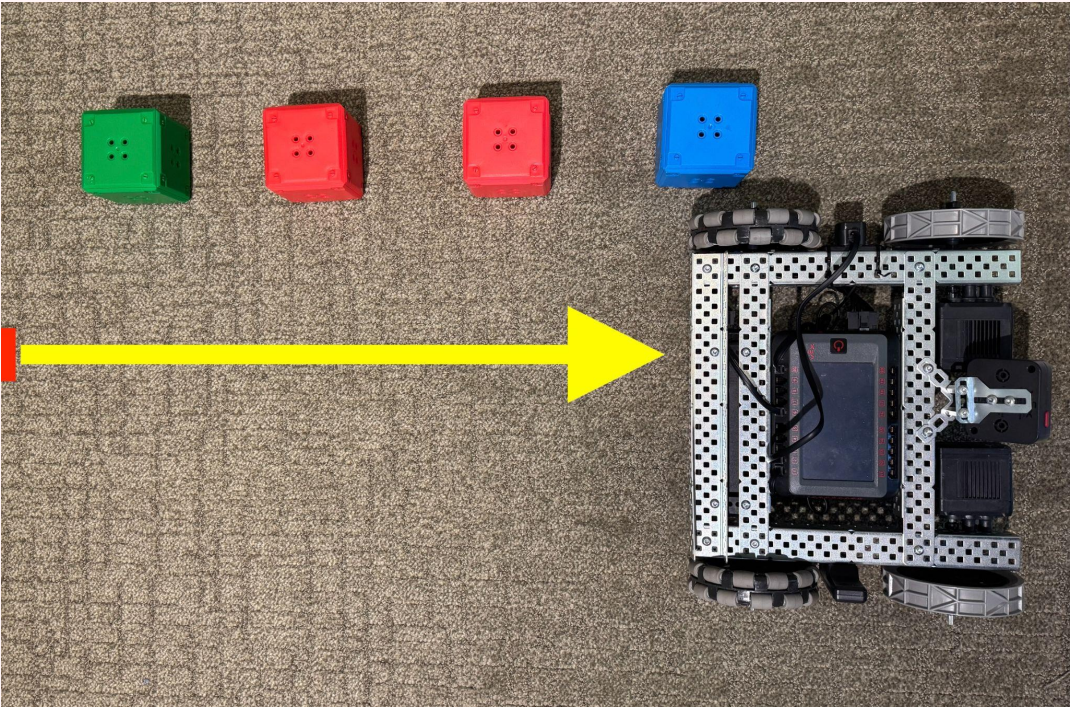
■ hue

Steps

1. Set up the objects in the test space. Be sure to leave space between!
2. Insert the microSD card into the Brain.
3. Run the V5 Optical Data Logging project.
4. Stop the project once “Data Written” appears on the Brain.
5. Remove the microSD card from the Brain and plug it back into your computer.
6. Open the file in Open Office - Calc.
7. Using the Time and Hue columns, insert a XY (Scatter) chart.


How does your chart compare?





Make a Decision

- Based on your data so far, what range of hue values would you use to reliably detect a specific color?
 - Would you use the specific ranges built into VEXcode or your own?
- What recommendations would you give to students when using the Optical Sensor?



Not sure if you
have enough
data yet?

Well do I have an
idea for you...

Test Other Conditions

- **Collect another data set in a changed environment and compare results!**

- **Possible changes:**
 - **Move to a darker area of the room**
 - **Use a phone flashlight to make the light brighter**
 - **Use colored films to change the light over the sensor**
 - **Move the objects further away from the robot.**



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