Evo Classroom Kit Demonstration + Activity

OZOBOT SELF-DRIVING

Evo

Summary

Discover how Evo turns into a self-driving car, with coding activities for each grade level.

Prerequisite

Complete the OzoBlockly Training Lesson.

Find it online at ozobot.com/lessons

Learning Outcomes

Discover Evo's sensors, and how to program them. Connect modern technology (self-driving cars) to understandable computer code and robots.

Grade Levels

ALL

See OVERVIEW for grade segmentation

Grouping & Materials

- Groups of 2-4 students
- 1 Self-Driving map, 1 Evo, 1 computer per group
- *Extra Challenge for 6+ grades: Intersection Map*

Academic Standards

ISTE 1.d, 4.b-d, 5.c-d, 6.b, 7.c

CSTA 1A-AP-10 to 15, 1B-AP-08 to 17, 1B-IC-20

OVERVIEW

How do self-driving cars know where to go and how to avoid danger? The answer is that they have sensors and cameras to see the world outside of them, and computers programmed to make decisions based on that data.

Evo, Ozobot's smart, tiny robot, also has sensors and a computer brain that can understand the outside world; you just need to code it to know what to look for and how to react.

Follow this lesson to show your students how to turn Evo into a self-driving vehicle that reacts to its environment. Start with the demo where Evo avoids obstacles on a 3D course and ends the program when it sees the blue finish line. Then, have your students explore and edit the program themselves. Programming Evo's brain is easy with OzoBlockly, Ozobot's free, online code editor.

The self-driving program is different for different skill levels. Use the chart below based on the grade or experience level of your class. If you're not sure, use Mode 2 for younger students and Mode 3 for older students. Then, follow the steps in SETUP, below, to set up your classroom for the activity.

OzoBlockly Level Coding Concepts	**Mode 1** **Pre-Reader** Picture blocks: movement, lights, sounds	**Mode 2** **Beginner** Movement, loops, lights, sounds	**Mode 3** **Intermediate** Mode 2 + logic, integers	**Mode 4** **Advanced** Mode 3 + functions, boolean operators
Ideal Grades	**Pre-Reader**	**2nd-3rd**	**4th-5th**	**6+**
Coding Experience	**Beginner**	**Beginner**	**Intermediate**	**Advanced**
Coding Activities	Modify Evo's lights and victory dance	Modify Evo's lights, speed, and victory dance	Mode 2 mods, plus turn angles and color reactions	Mode 3 mods, plus proximity sensor threshold
Program Links	ozo.bot/ Mode1SelfDriving	ozo.bot/ Mode2SelfDriving	ozo.bot/ Mode3SelfDriving	ozo.bot/ Mode4SelfDriving

***NOTE**: All programs, except for Mode 4, contain hidden code in the editor that create the self-driving ability with advanced Mode 4 blocks. Drag the editor's background to the left to see it. This code is not intended to be shown to or used by students in this lesson, but can be explored and edited if you would like to.*

At any time, your class can explore more OzoBlockly code examples. Check out the Examples tab in OzoBlockly; there are different examples for each Mode. Other examples are in Ozobot's Lesson Library as lessons or activities. Go to ozobot.com/lessons for code-able lessons in STEAM, history, literature, and more, for all grades.

PREPARATION

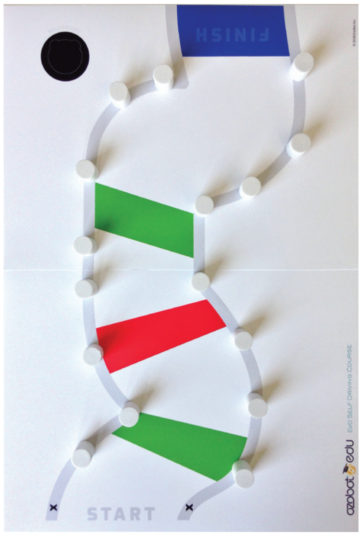
BEFORE CLASS

- **Test** your chosen program on Evo to see how it works using the HOW TO boxes below.
- **Set up** student laptops (1 per group) to the program link, and calibrate Evos to a bright screen.
- **Bring** the Evo Classroom Kit for the Evos, maps, and foam pillars you'll need.
- **Print** extra maps, if necessary, from ozo.bot/evo-self-driving-lesson.

HOW TO: SET UP SELF-DRIVING MAP

MATERIALS

- 1 Driving Course map from the Evo Classroom Kit
- 16 foam pillars from the Evo Classroom Kit
- Scissors and tape



STEPS

- Cut along the dotted line, then adhere the map together.
- Lay the map on a completely flat surface.
- Set the 16 foam pillars along the edge of the track on the Xs. You can move the pillars if Evo needs more obstacles to stay on the track.

TIPS

- Evo's proximity sensors see any object in front of it, and white is best. If you want more obstacles, use white paper to make paper craft 3D pillars or cubes.
- Evo will see bent paper in front of it as an obstacle. Make sure the paper is always flat.

HOW TO: LOAD PROGRAM ONTO EVO

1. Go to your chosen program's link, and follow the steps in OzoBlockly's Help tab to calibrate Evo, then flash load the program to your bot.
2. Calibrate Evo to a black circle on paper to make sure it can see all the printed colors.
3. With Evo on, double press the power button. This runs the program.
4. Place Evo immediately on the start line of your map. Avoid activating the front IR sensors. Watch Evo move forward, turn when it approaches the obstacles, and end the program on blue. In Modes 3 and 4, Evo reacts to the paper's colors.

If you need more help with loading and calibrating, go to the Help section in ozoblockly.com/editor

MODE 1

PRE-READERS

Link to Mode 1 Program: ozo.bot/Mode1SelfDriving

This demonstration gives you a chance to point out the cool, programmable parts of Evo. Students will discover "sequential" coding by deconstructing Evo's actions compared to its program. If you also do the activity, students will understand the code better by changing Evo's actions and lights before and after driving to create a personalized self-driving Evo.

Doing the activity with younger students may be easiest if you program as a class; let one student edit and test the program on a single computer at a time. This way, students will remember the OzoBlockly programming steps through repetition.

DEMONSTRATION STEPS

PART 1. DESCRIBE EVO'S PARTS

1. Hold an Evo without the silicon skin so all students can see it, and turn it on.
2. Point out the hardware on Evo. Start with underneath Evo:
    a. Point out the sensors in a row at the front of Evo - those are the "Line Sensors". They tell Evo if there is a line under it. Evo's computer tells the motors (or "wheels") how to move so the line is always under Evo.
    b. The "Color Sensor" is right in the middle of the bottom of Evo. It's clear and round. This sensor tells Evo if the paper or surface under it is red, green, blue, black or white.
    c. There are two wheels. Each wheel has a motor that can do different speeds.
3. Stand Evo up straight:
    a. Point out the 4 sensors around Evo's body that look like eyes. Those "eyes" are proximity sensors that can see if there is something in front of Evo if you program it to.
    b. Point out the 6 programmable LEDs - 1 on top and 5 across the front. Each light can be programmed to be any color, or turned off.
    c. The speaker is Evo's front, between the IR sensors and behind the horizontal lines. All sounds come from this speaker, like emotions or words.

PART 2. RUN THE SELF-DRIVING PROGRAM

1. Tell students what Evo will do: *Evo will drive forward and avoid the foam pillars by turning away. When Evo lands on the blue finish line it will do a victory dance then turn off.*
2. Run the program and set Evo on the starting line. Watch until Evo ends the program on blue. You can do this multiple times while doing the next step. (You might need to adjust the pillars.)

3. Ask students what actions Evo did, and in what order. *Answer: Evo lit up pink and white and laughed, started driving, turning when it saw foam, then spun and changed color on the blue finish line.*
4. Show the OzoBlockly Program. Point out that the blocks are in order, and that's why Evo did the actions in order. Feel free to run the program again so students can compare actions to code!
5. Ask students what the police light block means. *Answer: It's a "light animation", where there are many different lights flashing that look like something, like fireworks or a police car.*

ACTIVITY STEPS

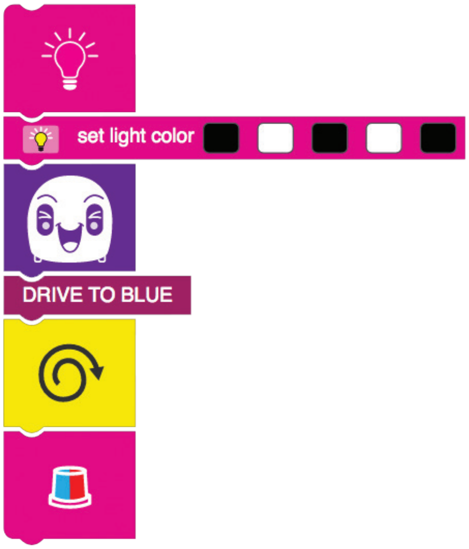
PERSONALIZE EVO'S LIGHTS AND VICTORY DANCE

1. Set up groups of 2-4 students with a computer, one Evo, a map and foam pieces, or, work as a class, sharing one computer, Evo, and map, and have students edit the code one at a time.
2. Students will only use Mode 1. They can change what Evo does before DRIVE TO BLUE, especially lights, and after, using code from the left side menu. Yellow is movement, Pink is light colors and animations, Blue is pause, Purple is sounds.
    a. *Keep the 'set light color' block (from Mode 3) to set the front lights, and edit them by clicking the colored boxes. Black turns the light off.*
3. Begin coding! Students edit or replace any code before and after DRIVE TO BLUE.
    a. *Note: light animations add a lot of time to the Flash Loading. We recommend using just one.*

TIPS

- If students accidentally delete anything, use the "Undo" arrow (on bottom right of editor). Reload the entire original program by revisiting the link to the original program.
- Recalibrate your robot to the screen if loading is not working well, and recalibrate to the map if colors are not read well.

HOW THE PROGRAM WORKS



Evo’s top light turns pink

Evo’s 5 front lights alternate off and white.
(Mode 3 block. Change colors by clicking the squares)

Evo makes a laughing sound.

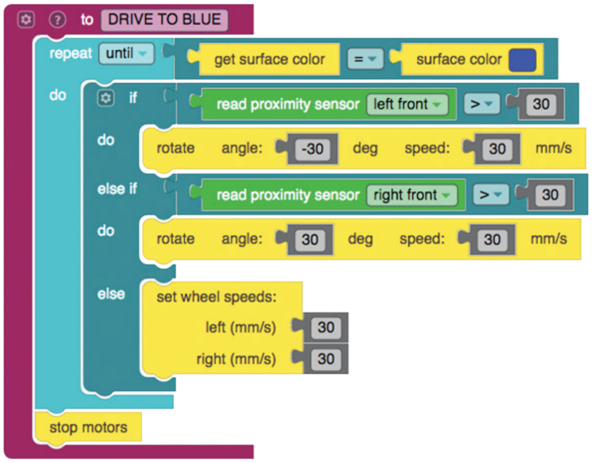
Evo self-drives until it sees blue underneath.
Learn about the DRIVE TO BLUE code below (optional).

Evo spins.

Evo plays Police Lights animation and program ends.

The Hidden Code

This code is not intended for students, and this info is FYI only. DRIVE TO BLUE uses Mode 4 code blocks to create the self-driving behavior. To find this code in the editor, drag the background to the left.



```
to DRIVE TO BLUE
  repeat until  get surface color = surface color
  do
    if  read proximity sensor left front > 30
    do  rotate angle: -30 deg speed: 30 mm/s
    else if  read proximity sensor right front > 30
    do  rotate angle: 30 deg speed: 30 mm/s
    else  set wheel speeds:
            left (mm/s) 30
            right (mm/s) 30
  stop motors
```

The magenta block creates ‘DRIVE TO BLUE’ block.

The turquoise loop repeats until Evo stands on blue.

If the left front IR sensor sees something, turn 30° to the right.

If the right front IR sensor sees something, turn 30° to the left.

Otherwise, just move forward at 30 mm/s.

After the turquoise loop, make sure the motors stop.

MODE 2

2ND - 3RD GRADE

Link to Mode 2 Program: ozo.bot/Mode2SelfDriving

This demonstration gives you a chance to point out the cool, programmable parts of Evo. Students will discover "sequential" coding by deconstructing Evo's actions compared to the program. If you also do the activity, students will change Evo's actions and lights before and after driving, and driving speed, to create a personalized self-driving Evo.

DEMONSTRATION STEPS

PART 1. DESCRIBE EVO'S PARTS

1. Hold an Evo without the silicon skin so all students can see it, and turn it on.
2. Point out the hardware on Evo. Start with underneath Evo:
    a. Point out the sensors in a row at the front of Evo - those are the "Line Sensors". They tell Evo if there is a line under it. Evo's computer tells the motors (or "wheels") how to move so the line is always under Evo.
    b. The "Color Sensor" is right in the middle of the bottom of Evo. It's clear and round. This sensor tells Evo if the paper or surface under it is red, green, blue, black or white.
    c. There are two wheels. Each wheel has a motor that can do different speeds, and go backwards.
3. Stand Evo up straight:
    a. Point out the 4 sensors around Evo's body that look like eyes. Those "eyes" are proximity sensors that can see if there is something in front of Evo. You can program how Evo will react!
    b. Point out the 6 programmable LEDs - 1 on top and 5 across the front. Each light can be programmed to be any color, or turned off.
    c. The speaker is Evo's front, between the IR sensors and behind the horizontal lines. All of Evo's programmable sounds come from this speaker.

PART 2. RUN SELF-DRIVING PROGRAM

1. Tell students what Evo will do: *Evo will drive forward and avoid the foam pillars by turning away. When Evo lands on blue finish line, it will do a victory dance, then turn off.*
2. Run the program and set Evo on the starting line. Watch until Evo ends the program on blue. You can do this multiple times while doing the next step. (You might need to adjust the pillars.)
3. Ask students what actions Evo did, and in what order. *Answer: Evo lit up pink and white and laughed, started driving, turning when it saw foam, then spun and changed color on the blue finish line.*

4. Show the OzoBlockly Program. Point out that the blocks are in order, and that's why Evo did the actions in order. Feel free to run the program again so students can compare actions to code!
5. Ask students what the police light block means. *Answer: It's a "light animation", where there are many different lights that look like something, like fireworks or a police car.*

ACTIVITY STEPS

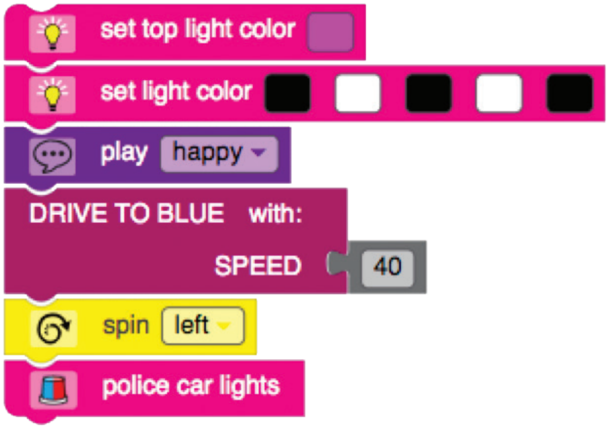
PERSONALIZE EVO'S SPEED, LIGHTS AND VICTORY DANCE

1. Set up groups of 2-4 with a computer, Evo and a map with foam, or work as a class and share a computer, Evo, and map, and have students code one at a time.
2. Instruct students to use Mode 2. They can change what Evo does before and after DRIVE TO BLUE, and the speed (by editing the number block).
    a. Keep the 'set light color' block (from Mode 3) to set the front lights, and edit them by clicking the colored boxes. Black turns the light off.
3. Begin coding!
    a. Note: light animations add a lot of time to the Flash Loading. We recommend using just one.

TIPS

- If students accidentally delete anything, use the "Undo" arrow. Reload the program by revisiting the link.
- Recalibrate Evo to the screen if it isn't Flash Loading well, and recalibrate to paper if colors aren't read well.

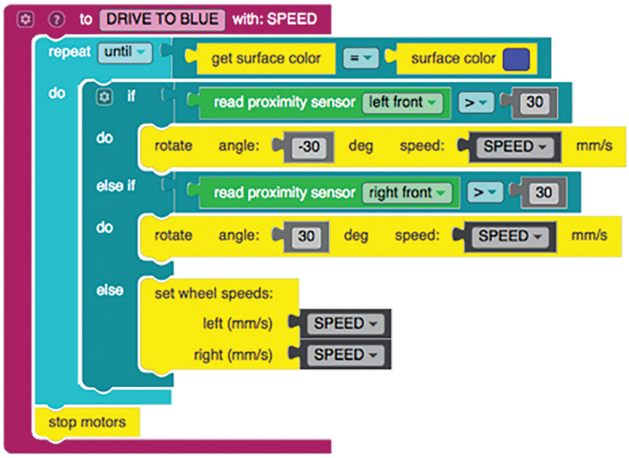
HOW THE PROGRAM WORKS



set top light color	Evo's top light turns pink.
set light color ■ □ ■ □ ■	Evo's 5 front lights alternate off and white. (Mode 3 block. Change colors by clicking squares)
play happy	Evo laughs.
DRIVE TO BLUE with: SPEED 40	Evo self-drives 40mm/s until it sees blue underneath. *Learn about DRIVE TO BLUE, below.*
spin left	Evo spins.
police car lights	Evo plays Police Lights animation and program ends.

The Hidden Code

This code is not intended for students, and this explanation is FYI only. DRIVE TO BLUE uses Mode 4 code blocks to create the self-driving behavior. To find this code in the editor, drag the background to the left.



```
to DRIVE TO BLUE with: SPEED
  repeat until  get surface color  =  surface color ■
  do
    if  read proximity sensor left front  >  30
    do
      rotate  angle: -30  deg  speed: SPEED  mm/s
    else if  read proximity sensor right front  >  30
    do
      rotate  angle: 30  deg  speed: SPEED  mm/s
    else
      set wheel speeds:
        left (mm/s) SPEED
        right (mm/s) SPEED
  stop motors
```

The magenta block creates the block 'DRIVE TO BLUE'.

The turquoise loop repeats until Evo lands on blue.

If the left front IR sensor sees something, turn 30° to the right.

If the right front IR sensor sees something, turn 30° to the left.

Otherwise, just move forward at SPEED mm/s.

After the turquoise loop, make sure the motors stop.

MODE 3

4TH - 5TH GRADE

Link to Mode 3 program: ozo.bot/Mode3SelfDriving

This demonstration gives you a chance to point out the cool, programmable hardware on Evo. Students will discover "sequential" coding by deconstructing Evo's actions compared to the program. If you also do the activity, students will change Evo's speed, actions and lights, and reactions to paper color and obstacles to create a personalized self-driving Evo.

DEMONSTRATION STEPS

PART 1. DESCRIBE EVO'S SENSORS

1. Hold an Evo without the silicon skin so all students can see it, and turn it on.
2. Point out the hardware on Evo. Start with underneath Evo:
    a. Point out the sensors in a row at the front of Evo - those are the "Line Sensors". They tell Evo if there is a line under Evo. Evo's computer tells the two motors what speed to rotate so the line is always under Evo.
    b. The "Color Sensor" is right in the middle of the bottom of Evo. It's clear and round. This sensor tells Evo if the paper or surface under it is red, green, blue, black or white.
    c. There are two wheels. Each wheel has a motor that can do different speeds, and go backwards.
3. Stand Evo up straight:
    a. Point out the 4 sensors around Evo's body that look like eyes. Those "eyes" are proximity (infrared) sensors that can see if there is something in front of, or behind, Evo. You can program how Evo will react to obstacles or hands!
    b. Point out the 6 programmable LEDs - 1 on top and 5 across the front. Each light can be programmed to be any color, or turned off.
    c. The speaker is in Evo's front, between the IR sensors and behind the horizontal lines.

PART 2. RUN THE SELF-DRIVING PROGRAM

1. Tell students what Evo will do: *Evo will drive forward and avoid the foam pillars by turning away. When Evo lands on blue finish line, it will do a victory dance, then turn off.*
2. Run the program and set Evo on the starting line. Watch until Evo ends the program on blue. You can do this multiple times while doing the next step. (You might need to adjust the pillars.)
3. Ask students what actions Evo did, and in what order. *Answer: Evo lit up pink and white and laughed, started driving (and turned when it saw foam), changed light color on green and red, then spun and*

changed color on the blue finish line.

4. Show the OzoBlockly Program. Point out that the blocks are in order, and that's why Evo did the actions in order. Feel free to run the program again so students can compare actions to code!
5. Ask students what the police light block means. *Answer: It's a "light animation", where there are many different lights that emulate something, like fireworks or a police car.*

ACTIVITY STEPS

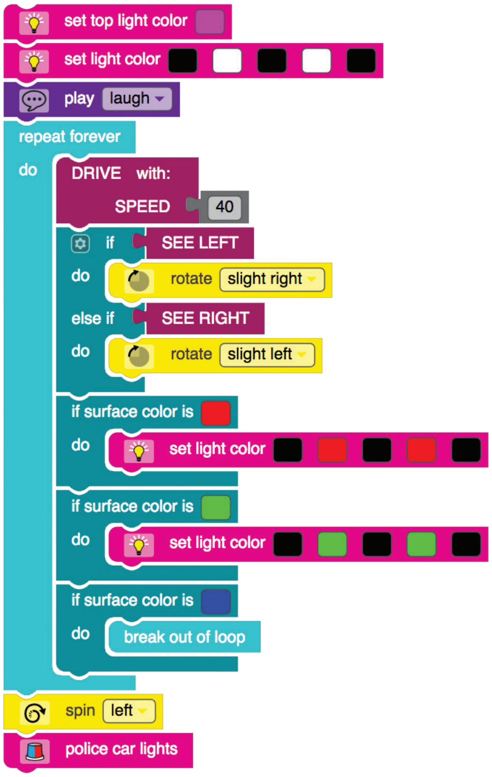
EDIT EVO'S LIGHTS, SPEED, ROTATIONS, COLOR REACTIONS AND VICTORY DANCE

1. Set up groups of 2-4 with a computer, Evo and a map with foam, or work as a class and share a computer, Evo, and one map, and have students code one at a time.
2. Students will use Mode 3. They can change Evo's rotation, LED colors, reactions to paper colors, speed and victory dance. To practice angles by degrees, go to Mode 4 and use rotate by degrees (yellow) block instead of the Mode 3 rotate block.
3. Begin coding! Students can modify Evo's lights, turns, speeds, color reactions and victory dance.
    a. *Note: light animations add a lot of time to the Flash Loading! We recommend just one.*

TIPS

- If students accidentally delete anything, just use the "Undo" arrow. Reload the original program by revisiting the link.
- Recalibrate your robot to the screen if loading is not working well, and recalibrate to the map if colors are not read well.

HOW THE PROGRAM WORKS



```
set top light color 🟪
set light color ⬛ ⬜ ⬛ ⬜ ⬛
play laugh
repeat forever
do  DRIVE with:
        SPEED 40
    if SEE LEFT
    do  rotate slight right
    else if SEE RIGHT
    do  rotate slight left
    if surface color is 🟥
    do  set light color ⬛ 🟥 ⬛ 🟥 ⬛
    if surface color is 🟩
    do  set light color ⬛ 🟩 ⬛ 🟩 ⬛
    if surface color is 🟦
    do  break out of loop
spin left
police car lights
```

Evo's top light turns pink

Evo's 5 front lights alternate off and white.

Evo laughs.

Begin to loop the inside code "forever".

Evo drives at 40mm/s. (Read about magenta blocks below)

If Evo's front left sensor sees an obstacle, turn slight right.

If Evo's front right sensor sees an obstacle, turn slight left.

If Evo is on red, light up red.

If Evo is on green, light up green.

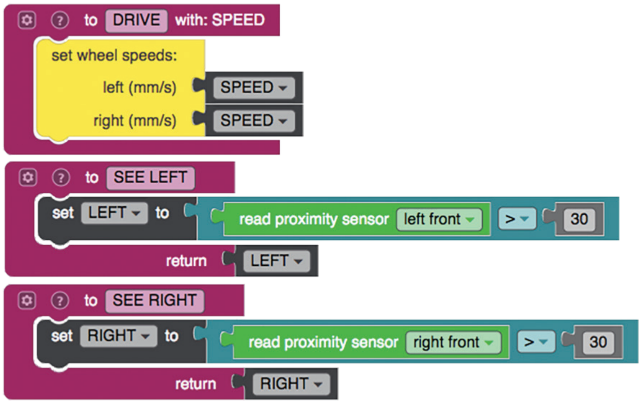
If Evo is on blue, end the loop.

Evo spins.

Evo plays Police Lights animation and program ends.

The Hidden Code

This code is not intended for students, and this explanation is FYI only. DRIVE, SEE LEFT and SEE RIGHT use Mode 4 blocks to allow the self-driving behavior. To find this code in the editor, drag the background to the left.



```
to DRIVE with: SPEED
    set wheel speeds:
        left (mm/s) SPEED
        right (mm/s) SPEED
to SEE LEFT
    set LEFT to read proximity sensor left front > 30
    return LEFT
to SEE RIGHT
    set RIGHT to read proximity sensor right front > 30
    return RIGHT
```

DRIVE sets the wheel speeds to the input number (SPEED).

SEE LEFT tests if the front left IR sensor sees an obstacle, and returns TRUE or FALSE.

SEE RIGHT tests if the front right IR sensor sees an obstacle, and returns TRUE or FALSE.

MODE 4

6TH GRADE AND UP

Mode 4 Program Link ozo.bot/Mode4SelfDriving

This program assumes students have enough coding experience to understand all the code used. If not, use the Mode 3 program. This demonstration gives you a chance to point out the cool, programmable hardware on Evo. Students will deconstruct Evo's actions compared to the program. The program gives students full control to change Evo's self-driving ability.

If your students are capable, follow up the activity with the challenge, where students edit the original program so that Evo can drive through the Intersection map safely, reacting to colors and obstacles to make turns.

DEMONSTRATION STEPS

PART 1. DESCRIBE EVO'S PARTS

1. Hold an Evo without the silicon skin so all students can see it, and turn it on.
2. Point out the hardware on Evo. Start with underneath Evo:
   a. The sensors in a row at the front of Evo are the "Line Sensors" that see light contrast (drawn line) so the computer tells the two motors what speeds to go to keep the line within the sensors' field of vision.
   b. The "Color Sensor" is right in the middle of the bottom of Evo. It's clear and round.
3. Stand Evo up straight:
   a. There are 4 infrared sensor arrays, two in front and two in the back.
   b. 6 programmable LEDs, 5 in front and 1 on top. Each can be any color and brightness, or off.
   c. The speaker is in Evo's front, between the IR sensors and behind the horizontal lines.

PART 2. RUN THE SELF-DRIVING PROGRAM

1. Tell students what Evo will do: *Evo will drive forward, and avoid the foam pillars by turning away. When Evo lands on blue finish line, it will do a victory dance, then turn off.*
2. Run the program and set Evo on the starting line. Watch until Evo ends the program on blue. You can do this multiple times while doing the next step. (You may need to adjust the pillars.)
3. Show the OzoBlockly Program to compare Evo's actions to the code, especially the proximity and color sensors.

ACTIVITY STEPS

EXPLORE AND EDIT ANY PART OF EVO'S SELF-DRIVING PROGRAM

1. Set up groups of 2-4 with a computer, Evo and a map with foam.
2. Students use Mode 4 to edit and explore the program and make their own self-driving Evo. Students can also create their own maps for their programs.

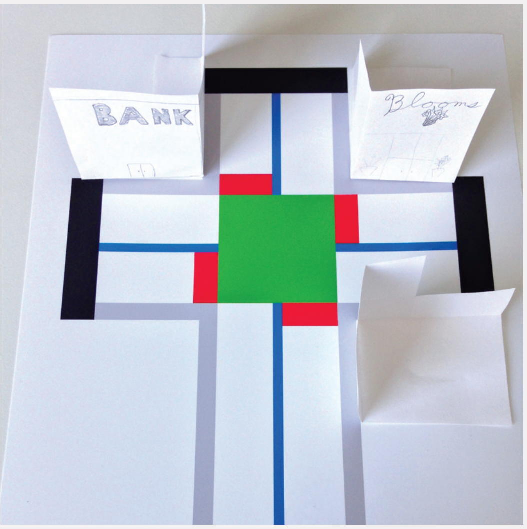
TIPS

- If students accidentally delete anything, just use the "Undo" arrow. Reload the original program by revisiting the link.
- Recalibrate your robot to the screen if loading is not working well, and recalibrate to the map if colors are not read well.

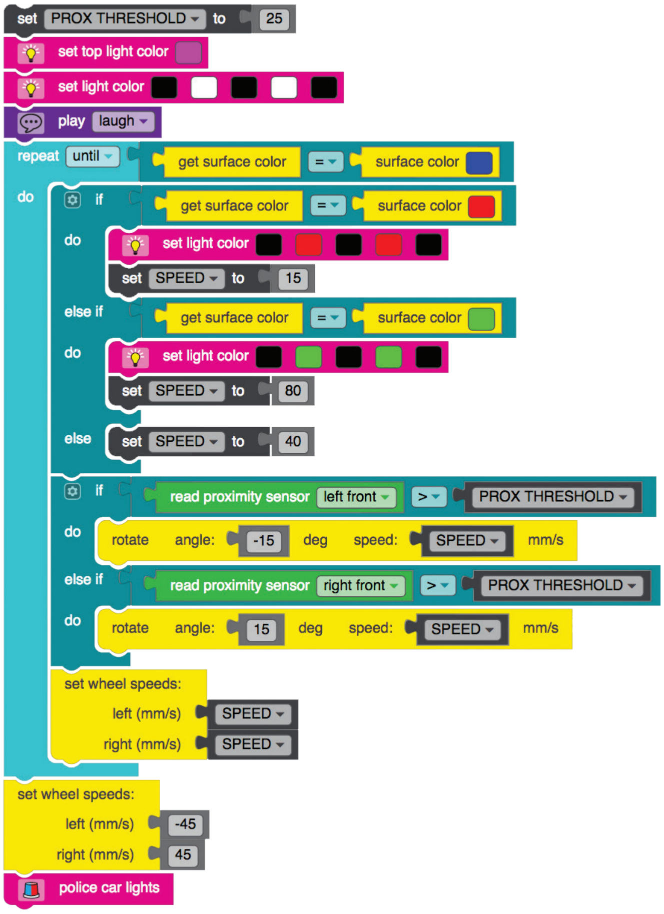
CHALLENGE STEPS

1. Hand out the Intersection map and point out the colors for the center median, stop signs, and intersection center, as well as the 'sidewalk' where they can place obstacles (see picture below).
2. Students create 3D papercraft 'shop fronts', as in the picture below, or simply white paper.
3. Challenge students to edit the given program to try the following (progressing in complexity):
    a. Make Evo drive on the right side of the road, stop on red, then continue straight to the black section.
    b. Make Evo drove to and stop on red, then make a right turn at the intersection.
    c. Like above, but make a left turn, staying on the right side of the road.

    See solution programs, below.



How The Program Works



```
set PROX THRESHOLD to 25
set top light color 🟪
set light color ⬛ ⬜ ⬛ ⬜ ⬛
play laugh
repeat until get surface color = surface color 🟦
do  if get surface color = surface color 🟥
    do  set light color ⬛ 🟥 ⬛ 🟥 ⬛
        set SPEED to 15
    else if get surface color = surface color 🟩
    do  set light color ⬛ 🟩 ⬛ 🟩 ⬛
        set SPEED to 80
    else  set SPEED to 40
    if read proximity sensor left front > PROX THRESHOLD
    do  rotate angle: -15 deg speed: SPEED mm/s
    else if read proximity sensor right front > PROX THRESHOLD
    do  rotate angle: 15 deg speed: SPEED mm/s
    set wheel speeds:
        left (mm/s) SPEED
        right (mm/s) SPEED
set wheel speeds:
    left (mm/s) -45
    right (mm/s) 45
police car lights
```

Set the distance for Evo's IR sensor threshold (1 is far, 127 is very close).

Set Evo's top light pink, alternate front light black and white.

Play laughing sound.

Repeat the following until color sensor sees blue:

While on red color, light up red and reduce speed to 15mm/s

While on red color, light up red and reduce speed to 80 mm/s

Otherwise (white), set speed 40 mm/s

If the left front sensor sees something, turn right about 15°

If the right front sensor sees something, turn left about 15°

Move at the speed set in above "if" statement

After loop, set wheels to spin in opposite directions while police light animation runs.

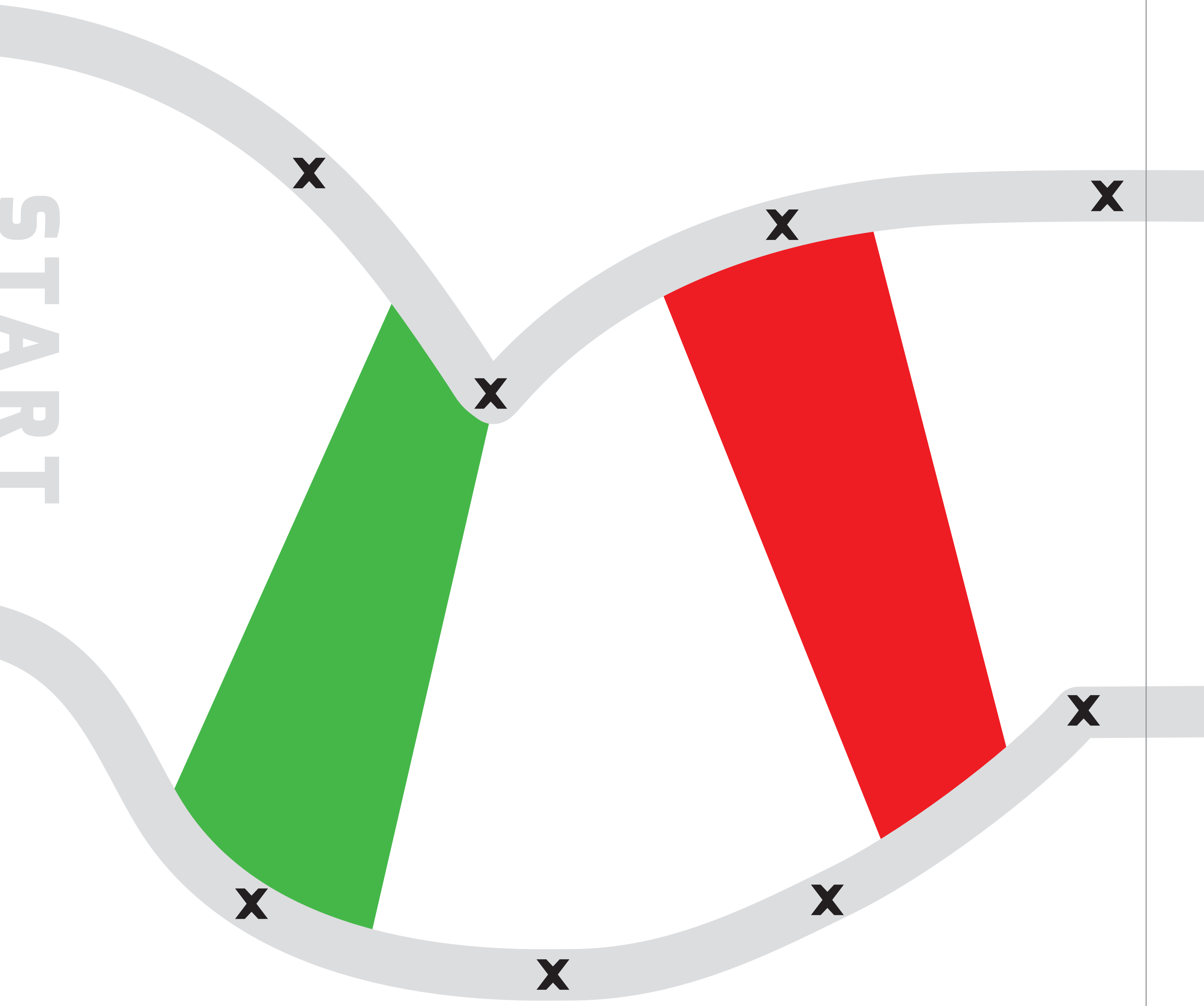
Evo turns off

Solutions to challenge (may require wheel speed and IR threshold tweaking to work on your Evo):

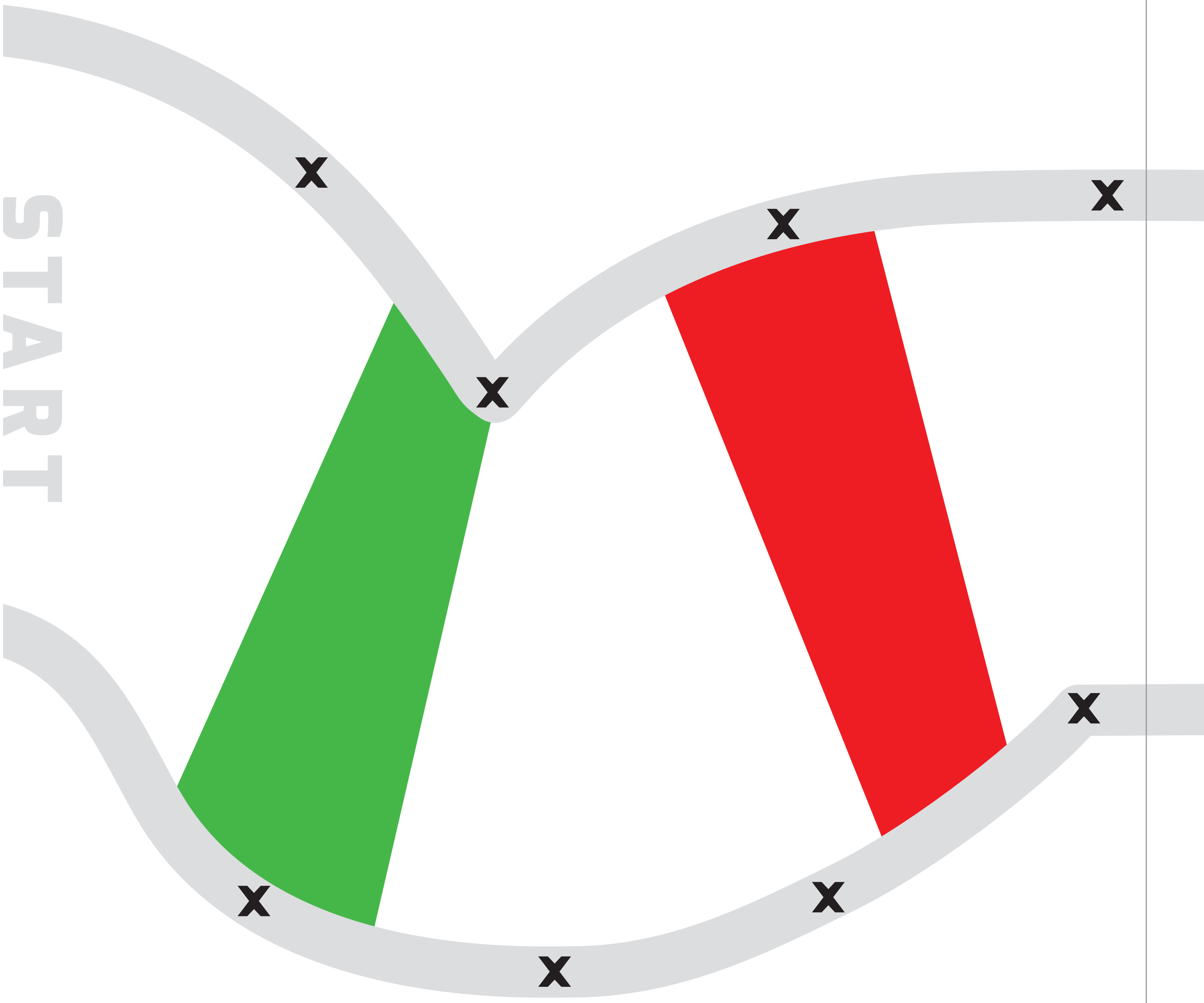
A. Straight: https://ozoblockly.com/editor?robot=evo&mode=5#pegi6t

B. Right turn: https://ozoblockly.com/editor?robot=evo&mode=5#2xrv8a

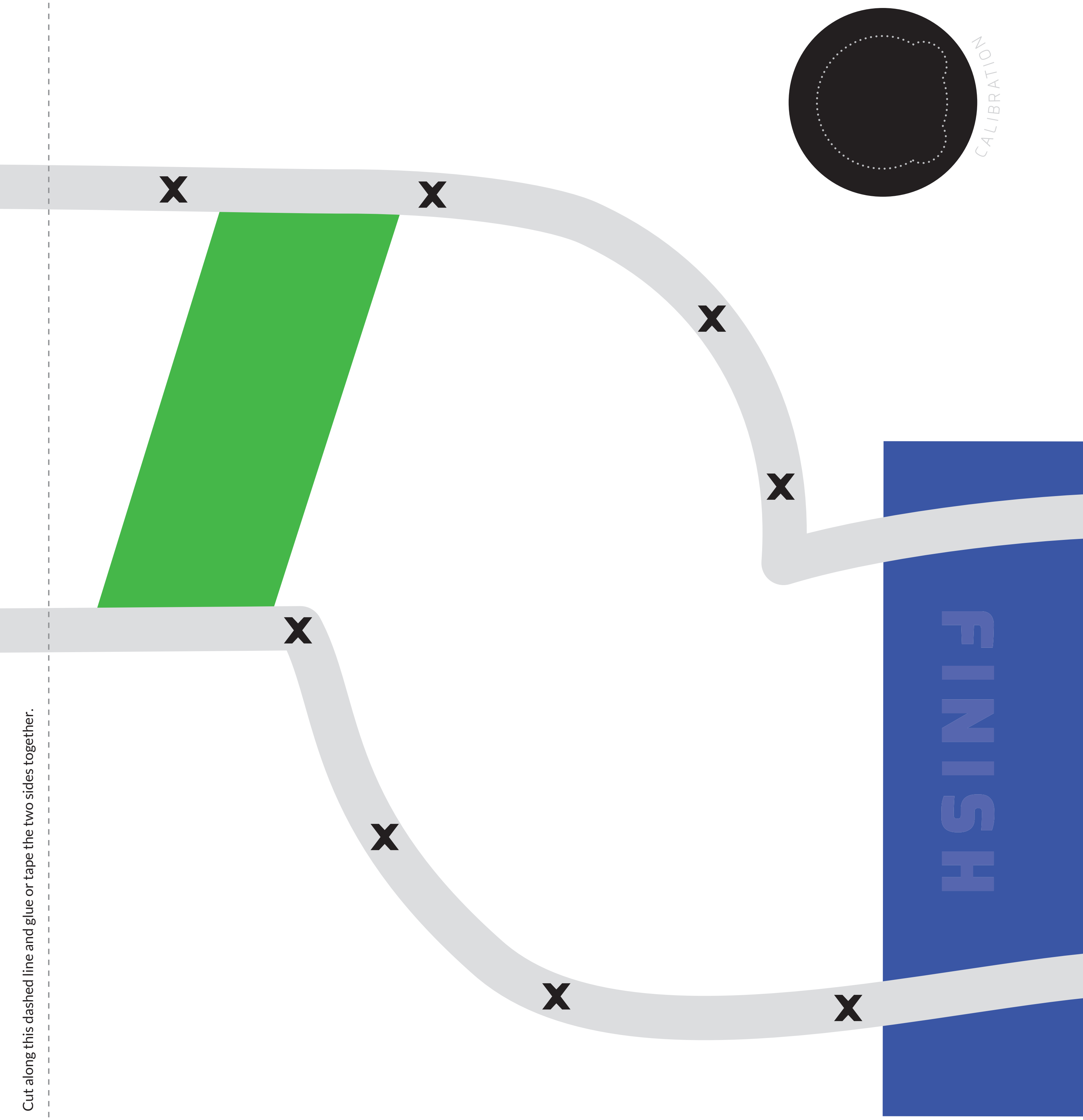
C. Left turn: https://ozoblockly.com/editor?robot=evo&mode=5#5rzhf6



TAPE OR GLUE

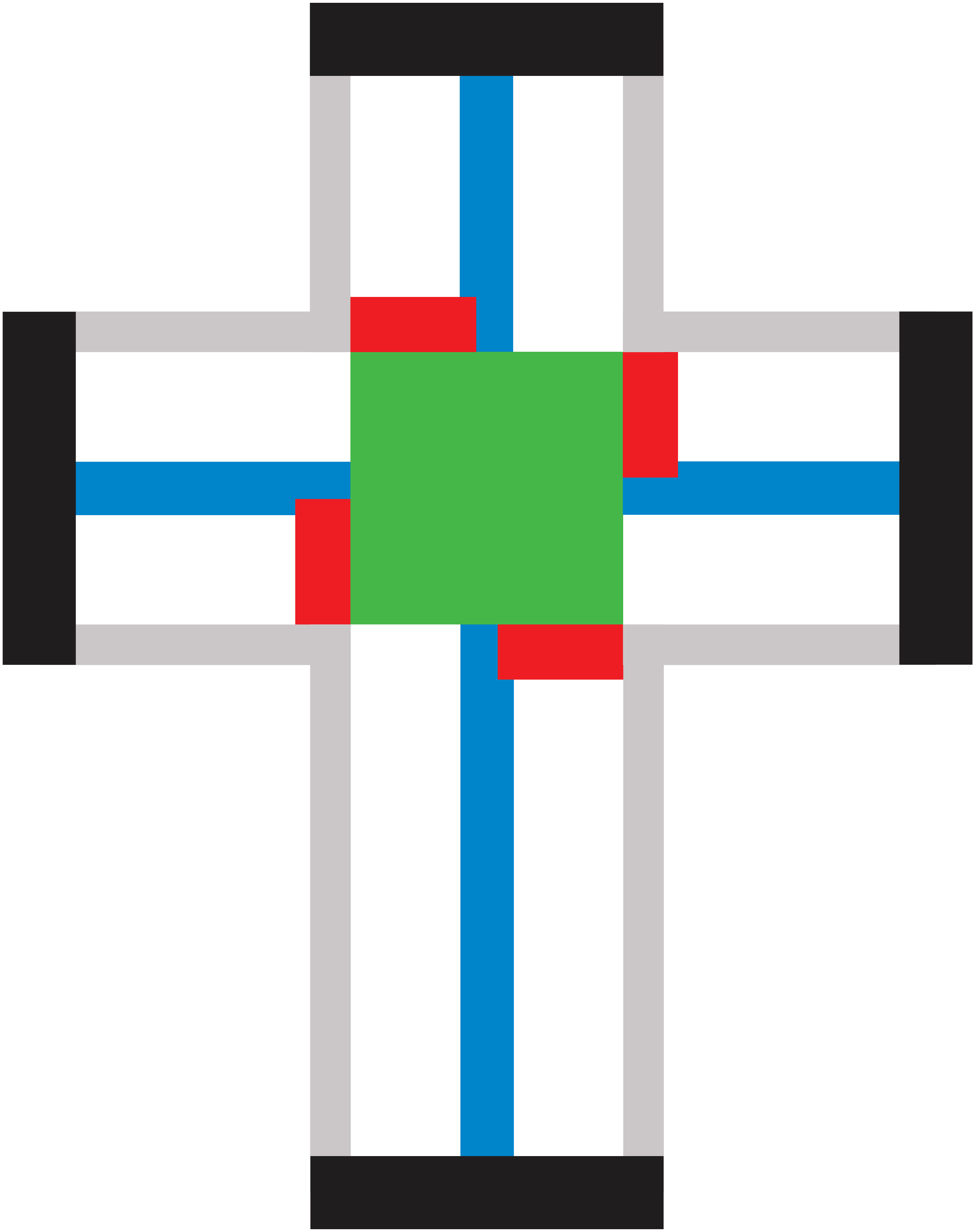


TAPE OR GLUE



CUT

Cut along this dashed line and glue or tape the two sides together.



EVO SELF DRIVING INTERSECTION