FOR THE WIN ROBOTICS

BRIDGE INSPECTION

LESSON PLAN | VERSION 2

LESSON OVERVIEW

Prerequisite Knowledge

- Build Essentials
- Fly Essentials
- Code Essentials
- Writing fractions

Materials Needed

- Hopper(s)
- safety glasses
- FTW CODE device(s) with Bluetooth capabilities (such as iPads or laptops)
- tape (for the floor)
- measuring tape (up to 20')
- landing pads
- towers
- writing utensils

Time Allotment

Lesson: 1 hour (or 1 – 2 class periods), Setup: 25 minutes

Documents

- Construction Slide Deck II
- Construction Student Workbook

Vocabulary

- Function – a written block of code that can be used multiple times in the code
- Inspection – an extensive examination of a structure to ensure safety, quality, and regulation compliance

In this Lesson...

Students learn about and discuss how drones are used in structure inspections. During the activity, they code Hopper to simulate inspecting a bridge after an earthquake so that they can identify any changes in the structure.

Learning Objectives

- Participate in a group discussion about the ways in which drones are used in structure inspections.
- Accurately code Hopper to inspect various viewpoints of a bridge in a simulation with the use of a function.
- Use the Engineering Design Process (EDP) and STEM practices to redesign Hopper's code as needed.

LESSON STRUCTURE

Read through the following table before starting the lesson. Approximate times have been given for each section to help with scheduling and time management.

Lesson Section	Description	Approximate Time
Direct Teaching	Open the slide deck titled Construction Slide Deck II and have the first slide up as the students walk in. Encourage students to think about the bell ringer question: "What types of structures need to be inspected regularly or after accidents?" Go through the rest of the slides of the slide deck with the students. Play any videos directly from the slides if possible (as opposed to going to the external website). Reference any presenter's notes as needed for each slide. The last slide presents the scenario of the Bridge Inspection activity to the students.	15 minutes
Discussion & Activity	Ensure the activity is set up prior to the beginning of the lesson. Allow for up to 25 minutes to set up. Separate students into small teams. Choose team sizes based on how many students there are and how many drones are available. Ideally, there would be no more than 3 – 4 students per team. Encourage the use of the steps of the Engineering Design Process, and computer programming terms such as algorithm, command, bug, and function as students write code. Implement the extension if time permits. Use the questions provided on page 7 to lead a group discussion with the students. Have them fill out a row in their flight log in their Construction Student Workbook. See pages 9 & 10 for examples of what students' codes could look like. See pages 11 & 12 for examples of what the student pages could look like filled in.	45 minutes

ACTIVITY SCENARIO

A newly built bridge is being inspected with Hopper's camera to make note of the normal appearance of the bridge. Then after an earthquake, Hopper needs to inspect the bridge again to check for any changes to ensure that the bridge is not damaged.

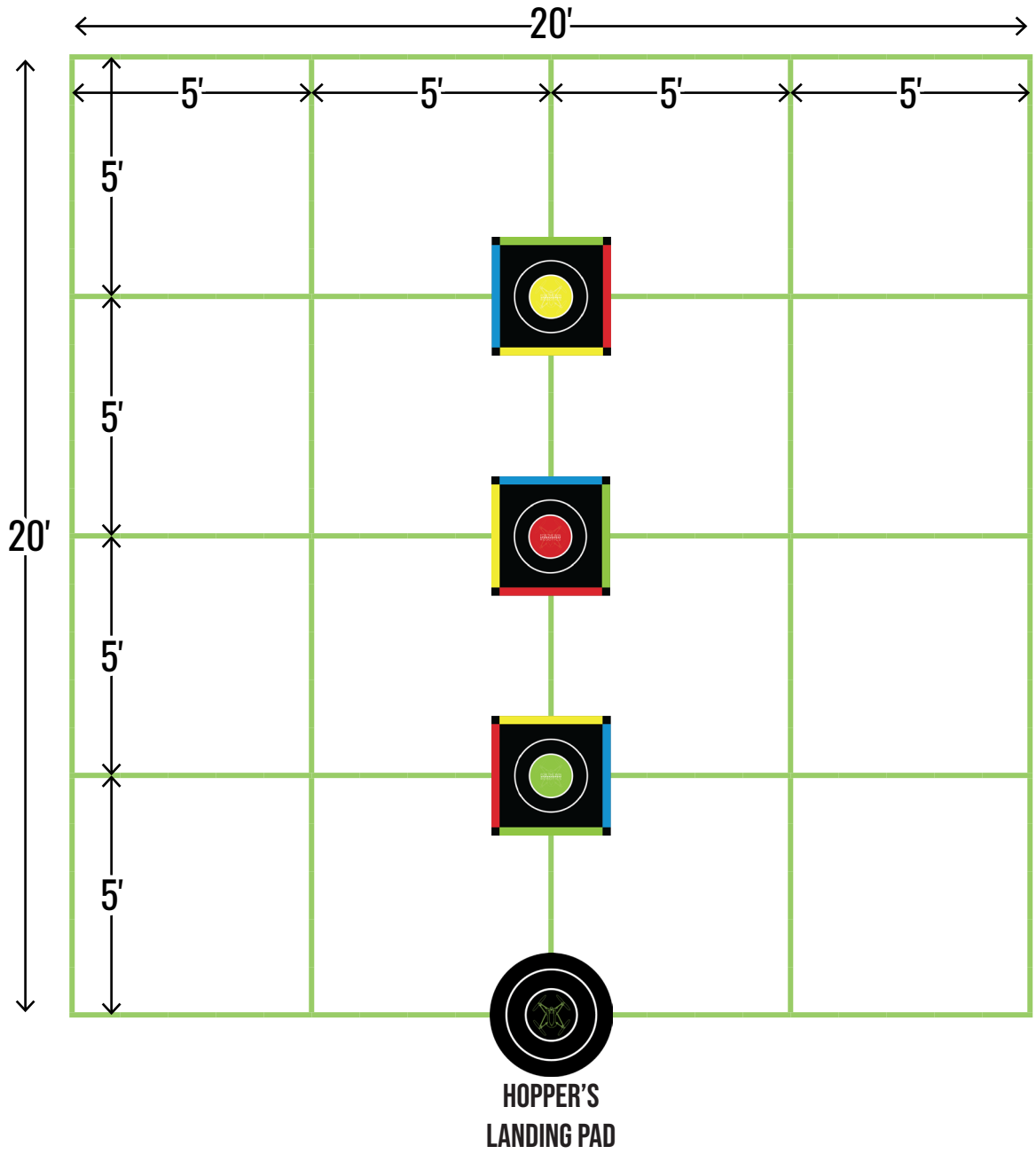
You will write a code to command Hopper to fly over and under the bridge to identify any changes in the bridge's structure. Hopper needs to stop and hover at three distinct points of the bridge to thoroughly inspect. You will use a function to simplify your code and stay organized.

ACTIVITY SETUP

Tape a 20' × 20' square on the ground which represents the fly zone. Tape a 5' × 5' grid in this square. Place Hopper's landing pad at one end facing the square, which will be north, in the center of the piece of tape. Place any three towers each 5 feet apart along the center of the square.

Then, place three landing pads of various colors and/or numbers ***under*** each activity tower (not shown in the diagram below).

An example of the setup is shown below. Activity towers are set at the 6' height setting.

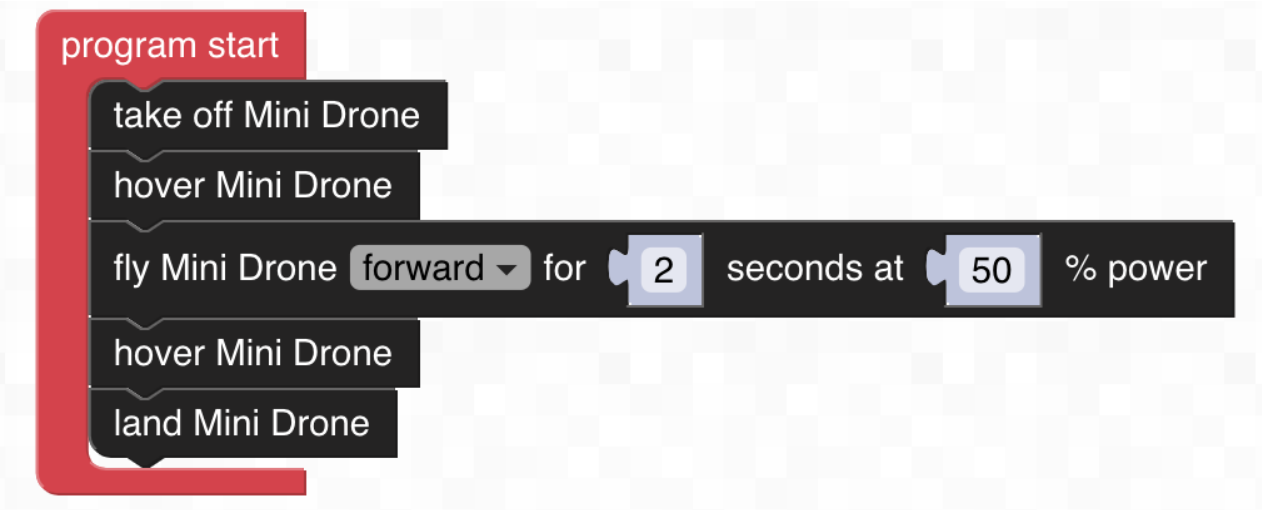


ACTIVITY IMPLEMENTATION

Have each team find Hopper's approximate speed when coded to fly at a certain power percentage and for a certain number of seconds. It is recommended to stay at 50% power or below.

A team's power percentage should stay *roughly* the same throughout this activity.

To stabilize Hopper after takeoff and before landing, it is recommended to command Hopper to hover. An example of a code students could write is shown below.



The takeoff and landing spots of Hopper should be measured.

Then, have each team use the formula rate = $\frac{\text{distance}}{\text{time}}$ to find the rate (speed) in feet per second of Hopper at the power percentage they chose.

Review with students that the formula for finding the rate is derived from the well-known formula:

$$\text{distance} = \text{rate} \times \text{time}$$

ACTIVITY IMPLEMENTATION

Activity Facilitation

Go through the following steps with the students to facilitate the activity.

1. Place Hopper on the landing pad facing toward the square (north).

2. Have each team write a code that commands Hopper to takeoff, then fly over and under the row of towers (in any order they choose), and then land. Hopper should fly directly above the towers and landing pads in order to identify the colors and/or numbers of each tower and landing pad. Hopper must also stop and hover above each tower and landing pad to inspect thoroughly through Hopper's camera.

   Encourage students to draw and label where they want Hopper to go, and to write down what they want Hopper to do in words before coding as needed. They can keep the answers to any calculations they do in exact form for coding. They can use the operation command in the Math tab for improper fractions, or they can convert to decimals.

   Students will use the Functions tab to name and write their function that commands Hopper to stop and hover three times, 5 feet apart. They can do this with or without a loop. They must call this function in their code to inspect the bridge.

3. Teams can test their code without the camera to check for accuracy. If a team was not successful in the accuracy of coding Hopper, have them adjust their code and try again. If Hopper ever flies outside of the 20' × 20' square, the student should click on the red Emergency Land button.

   If Hopper flies too close to the tops of the towers to where its sensors detect them, Hopper will automatically fly higher to avoid what its sensors perceive as being the ground.

4. Have either the facilitator or another team place the landing pads and towers while the team members' backs are turned to the fly zone. Then, have team connect Hopper's Wifi in the FTW Fly App before they run their code.

   While their code is running, each team member will make note of each landing pad and tower color or number in their Construction Student Workbook page.

5. After each team has made their initial inspection of the new bridge, an earthquake happens! Repeat the process laid out in Step 2. Not all landing pads and towers need to be changed or be rearranged.

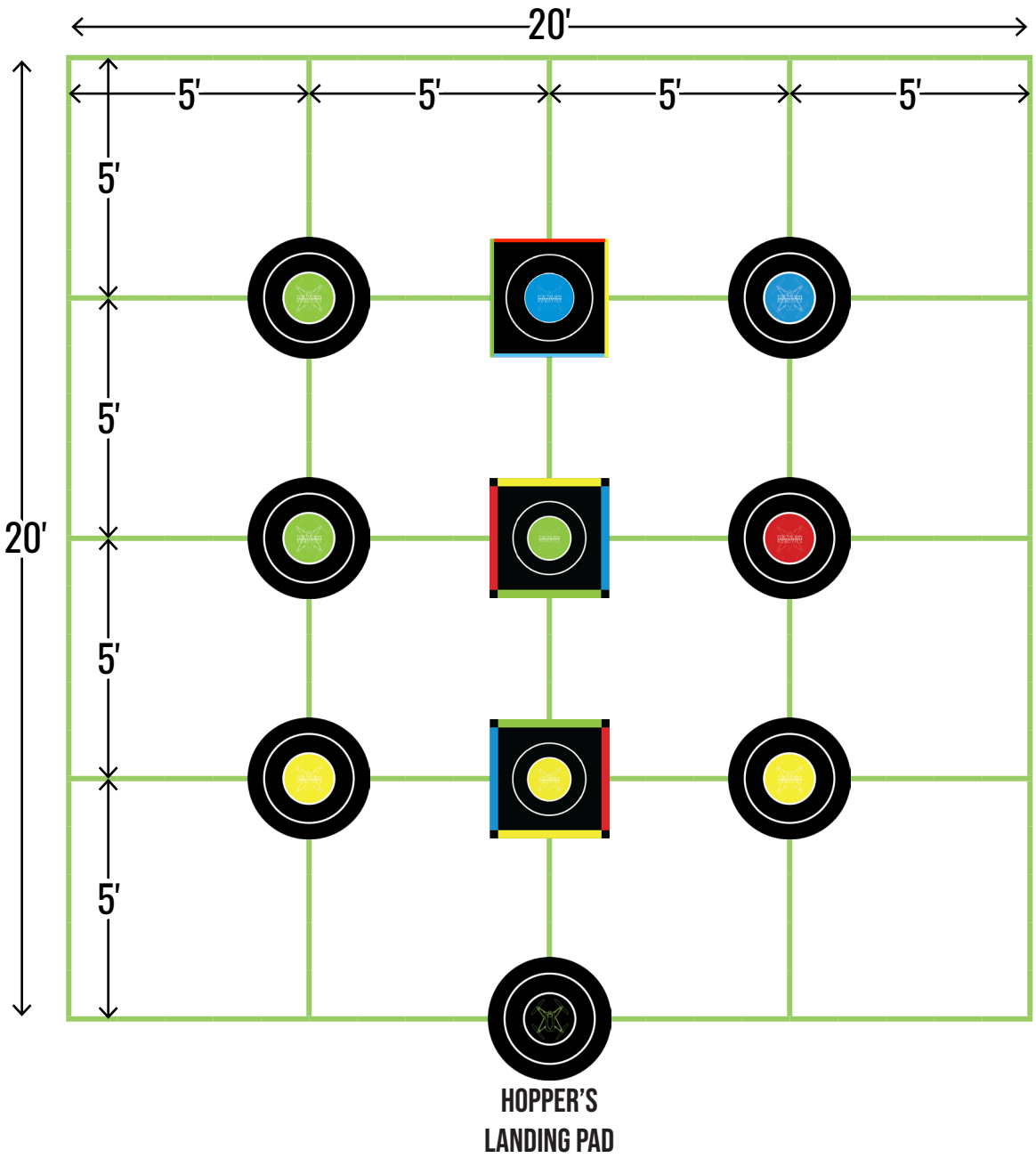
6. Have students fill out the chart in the Construction Student Workbook to make note of any in color and/or number changes. Then, have them complete the following exercises.

EXTENSION SETUP

From the original activity setup, change the colors of the existing towers, and change the colors and/or numbers of the landing pads ***under*** each tower (not shown in the diagram below)

Then, place three landing pads of various colors and/or numbers on each side of the towers (six total landing pads) on the taped 5' × 5' grid.

An example of the setup is shown below.



ACTIVITY IMPLEMENTATION

Extension

If time permits, challenge the students to additionally inspect both sides of the bridge as shown in the Extension Setup on page 7. Have each team write a code that commands Hopper to takeoff, then fly over, under, left, and right of the row of towers (in any order they choose), and then land. Educators are encouraged to use the 3D printed assets on the platform to attach to the sides of the towers in place of using landing pads.

Post-Activity Discussion Questions

Use the following questions to lead a group discussion after implementing the activity.

1. Did you keep your calculated values as simplified, improper fractions? Why or why not?
2. Did you write down or draw your code before creating it in FTW CODE? If so, what did you create and how was it helpful?
3. Compare the code from your group to the codes that other groups wrote. Are they different? If so, how? After comparing codes, would you make any changes to yours?
4. Was using a function helpful while completing this activity? Why or why not? How could using one or more functions be useful in longer or more complex code?
5. What was your answer to exercise #5 on the second Bridge Inspection page in the Construction Student Workbook?

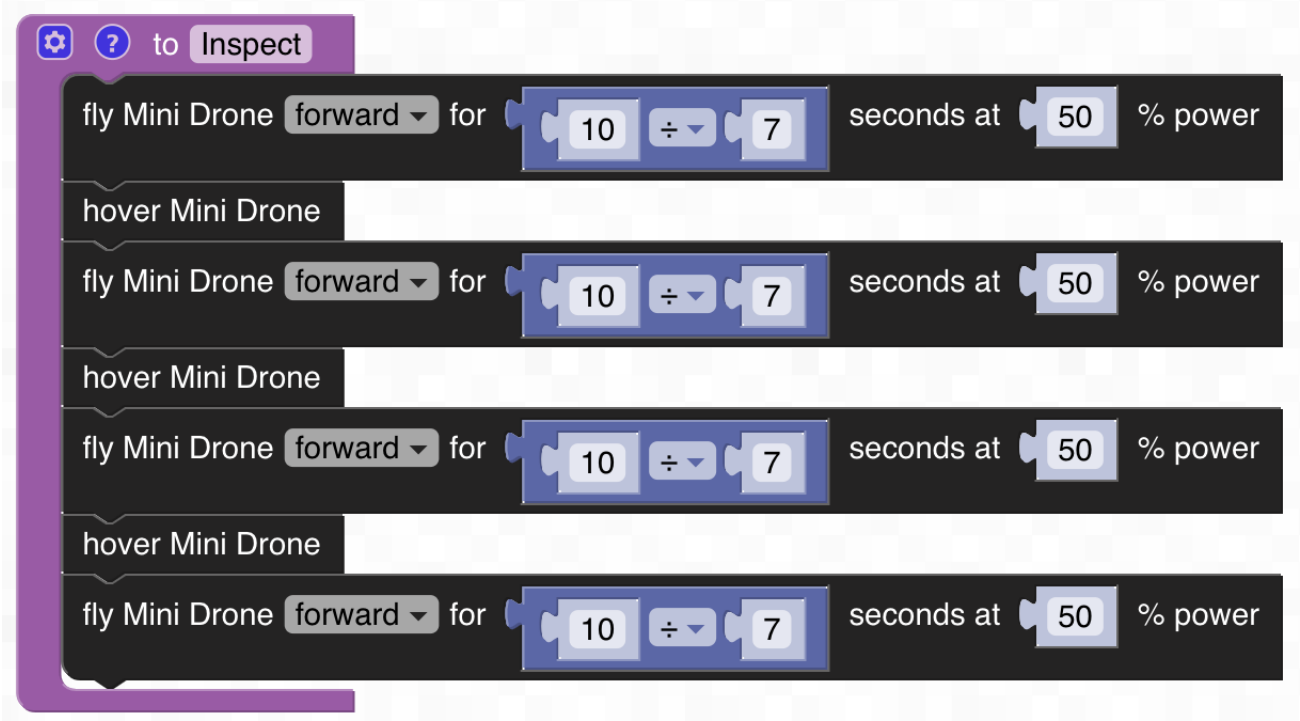
Flight Log

Have students fill out a row in their flight log in their Construction Student Workbook. An example of what it could look like is shown below.

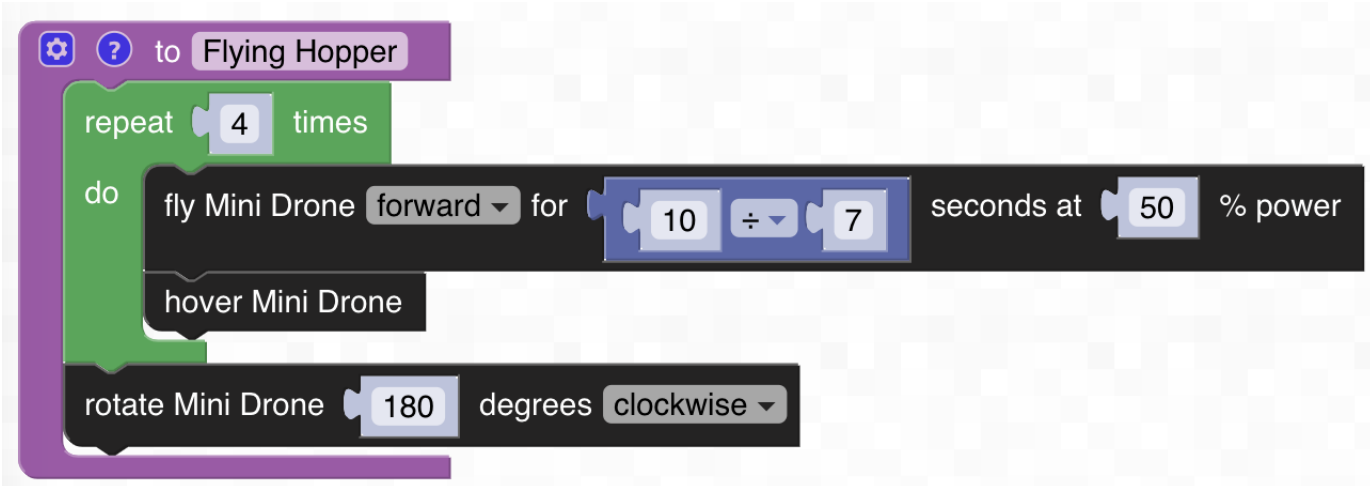
Date	Drone Model	Location	Flight Time	Notes
04/02/2025	Hopper	Calabasas High School Tennis Courts	15 minutes	My partner Connor and I used a function in our code that commands Hopper to inspect various viewpoints of a potentially damaged bridge. We made note in our workbooks of any changes before and after an earthquake.

CODING EXAMPLES

Sample Function 1

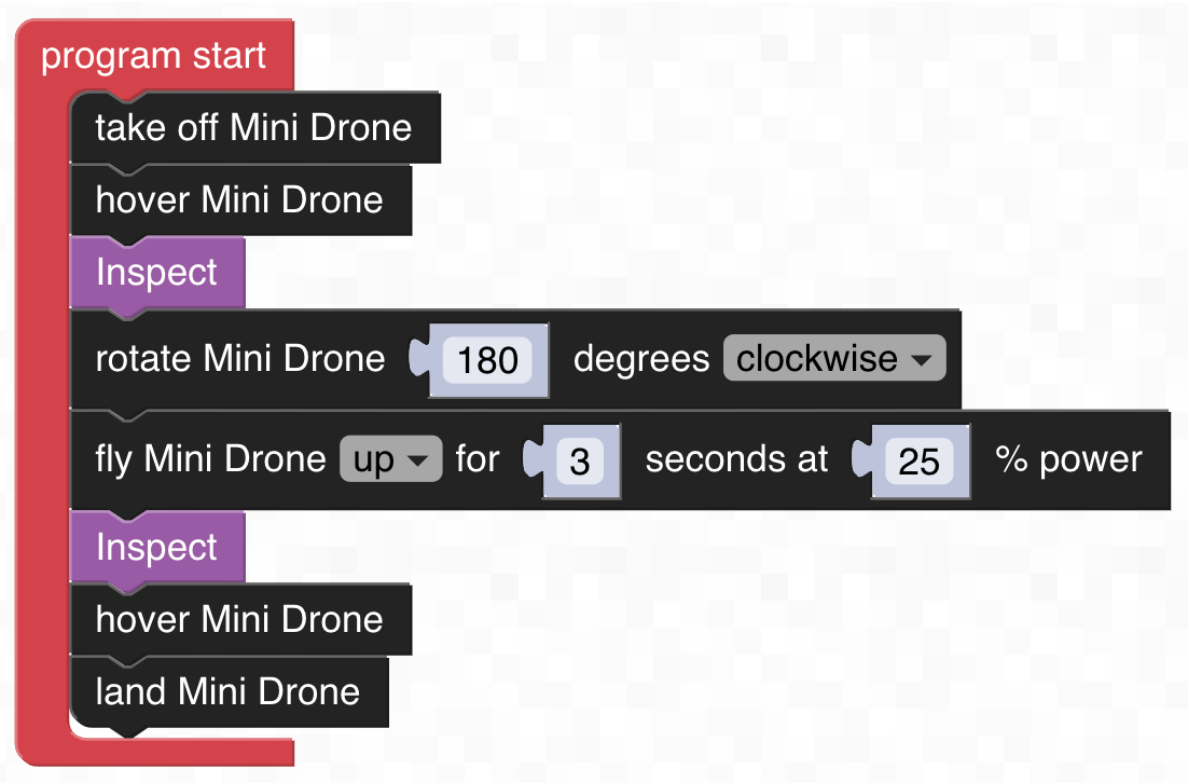


Sample Function 2

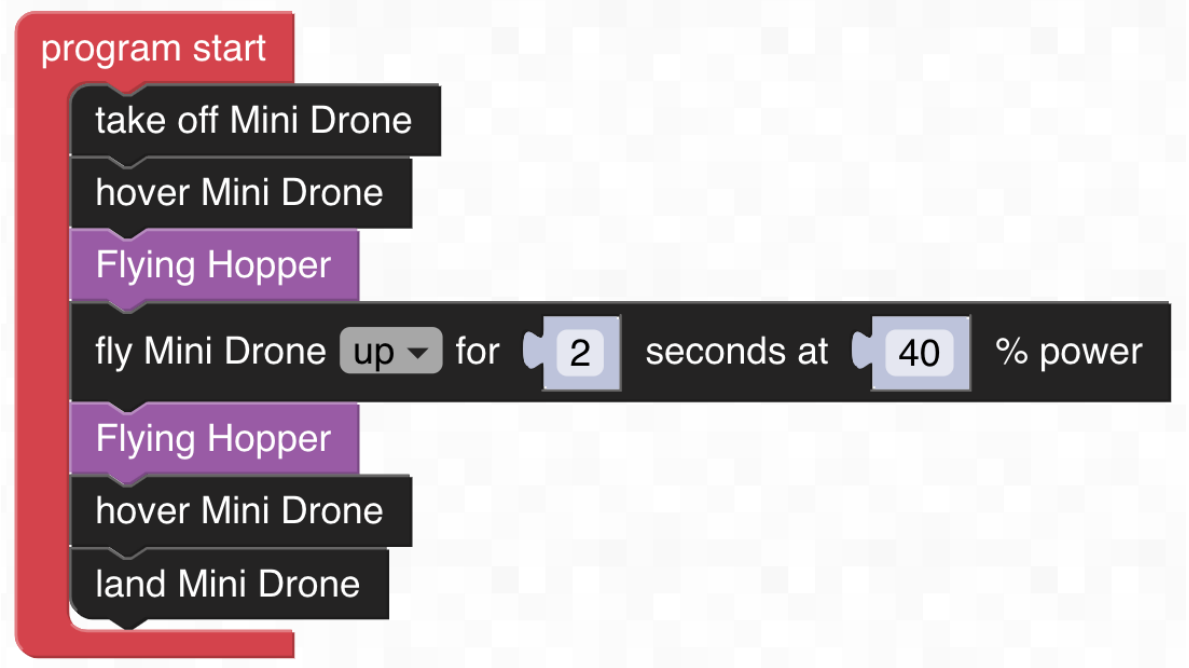


CODING EXAMPLES

Sample Code 1



Sample Code 2



STUDENT PAGE

1. Write the number or color of each viewpoint of the bridge you inspected ***before*** the earthquake.

NORTH ↑

OVER	UNDER
blue	blue
green	red
yellow	red

2. Write the number or color of each viewpoint of the bridge you inspected ***after*** the earthquake.

NORTH ↑

OVER	UNDER
green	red
yellow	green
yellow	red

STUDENT PAGE

1. Fill in the chart below with any changes you discovered while comparing the inspection before the earthquake to the inspection after the earthquake.

Bridge Viewpoint (over/under)	Before Earthquake	After Earthquake
over	green	yellow
over	blue	green
under	red	green
under	blue	red

2. At how many total points (landing pads) did you stop Hopper to inspect?

six

3. How many total points (landing pads) changed during the inspection after the earthquake?

four

4. As a fraction, write the number of changed points out of the total number of points inspected.

$\frac{4}{6}$ or $\frac{2}{3}$

5. In a real-life scenario, what could the fraction found in exercise #4 represent?

It could represent how much of the bridge has damage after the earthquake.