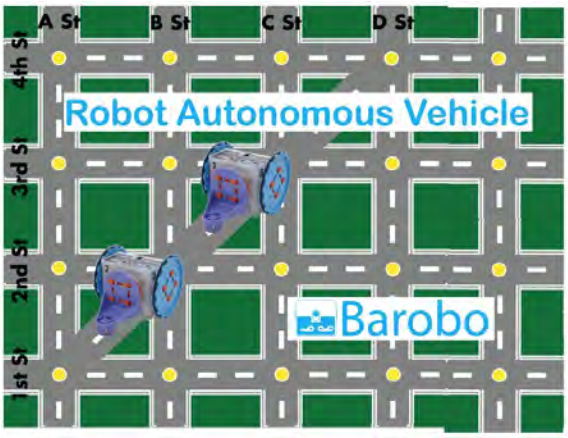
Barobo

Robot Autonomous Vehicle: An Introduction to Coding and Robotics

Lesson Plan and Teacher's Notes for an Hour of Code™ Activity



https://www.roboblockly.com/curriculum/hourofcode/
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Outline

A. Introduction

Guide Linkbot--modeling a robotic autonomous vehicle (RAV)--through a grid of streets! In this series of activities students will learn how to control a Linkbot robot and help it navigate successfully on a journey through a test track of criss-crossing streets. They will also learn about one of the most important concepts in computer programming--loops--and get a little practice using the Pythagorean theorem to traverse triangular paths. The activities are suitable for beginning students in grades 8 and above.

Students will use the drag-and-drop RoboBlockly interface at www.roboblockly.com (no registration required) to program the Linkbot to maneuver through the grid of streets. The Linkbot may be either an online virtual robot or an actual hardware robot, which provides more hands-on and engaging practice for students. After the Hour of Code™ students may continue to explore the many coding and math-related activities available at www.roboblockly.com.

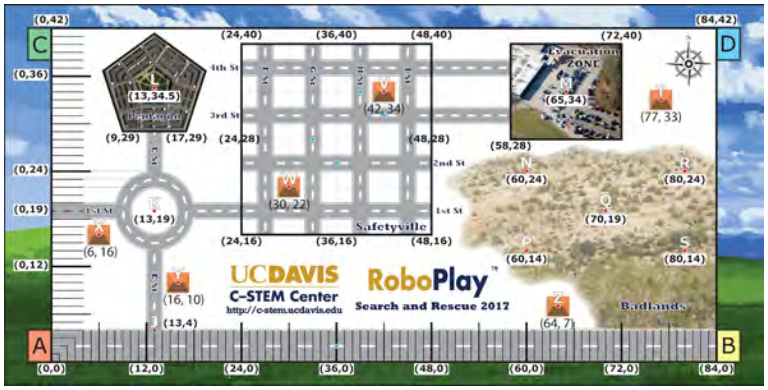
Learning Objectives:

1. Learn the basic terminology and concepts of computing and controlling robots, including the concepts of code blocks, commands, arguments (input values to commands), run/execute, bugs, debugging, and repeat loops.
2. Gain practice with the mathematical concepts of two-dimensional x-y grids, squares, triangles, and the Pythagorean theorem.

Equipment and Software Needed for Each Student or Pair of Students

1. Computer (PC, Mac, or Chromebook) with internet connection.
2. Web-based RoboBlockly interface at www.roboblockly.com to control the virtual (or hardware) Linkbot and run the activities (no registration needed).
3. Optional: Hardware Linkbot robot and either USB cable or wireless dongle, plus Linkbot Labs software to connect hardware Linkbots to the computer--free download from https://www.barobo.com/downloads. Hardware robots available at https://www.barobo.com/shop. Linkbot Super Kit recommended:

2017 RoboPlay Challenge Competition Mat (for street grid):



B. Overview of the Activities (details in Section G below)

1. RAV 1: Driving Forward
2. RAV 2: Turning and Debugging
3. RAV 3: Looping Around a Square
4. RAV 4: Traversing Multiple Squares
5. RAV 5: Traversing a Triangle
6. RAV 6: Explore!

C. How to Use Barobo's Hour of Code™ Activities in your Classroom

It will take students about an hour to get through each set of activities. However, we believe that students should be able to learn at their own pace, and so we encourage you to give students additional time if needed to complete the activities or make it clear that they don't need to finish the entire set of activities. The final activity has open-ended suggestions for further work if there are students who finish sooner. When using hardware Linkbots time should be budgeted for setting up and connecting the equipment (usually 3-5 minutes for an individual student or 5-10 minutes for a group).

D. Before Hour of Code™

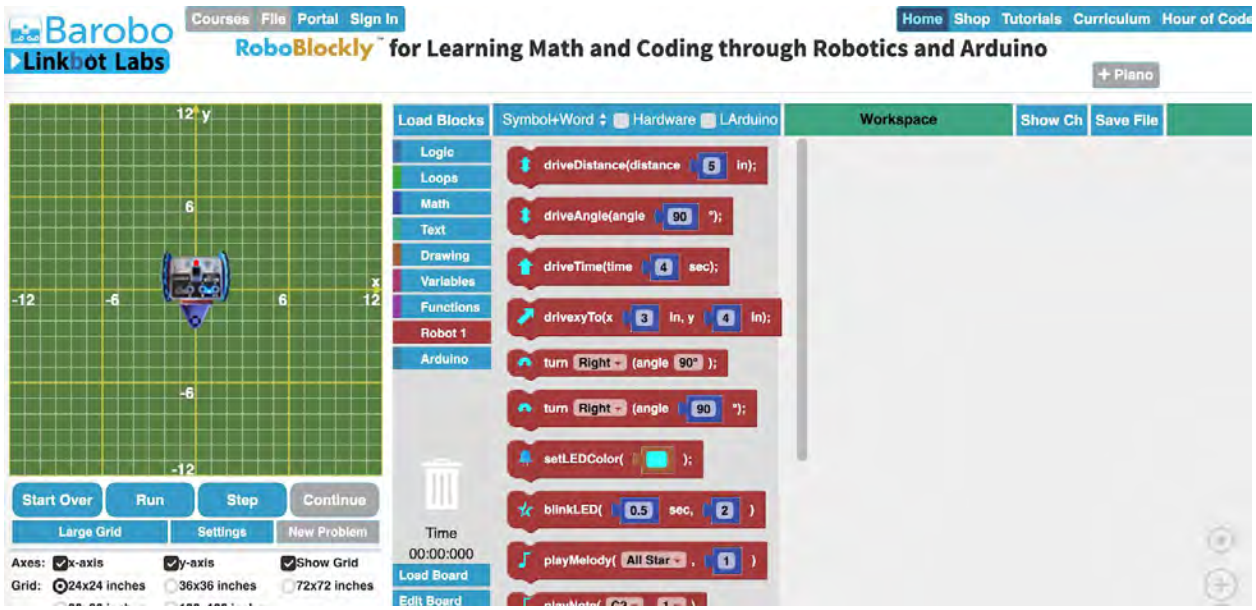
1. Prepare your classroom

- Make sure you have a computer (PC, Mac, or Chromebook) for each student or pair of students. (Tablets are suitable for doing the activities using virtual robots, but not for hardware robots.)
- Make sure you have good Internet access in the classroom, as you will need to access the RoboBlockly activities at www.roboblockly.com to control the virtual or hardware Linkbot and run the activities (no registration required).
- Make sure you have a modern browser installed on the computers or devices. Test RoboBlockly on students' computers.
- If you are using hardware Linkbots (available individually or in classroom bundles at https://www.barobo.com/linkbot-and-accessories), make sure to have enough for each student or pair of students, and connect them to the computer and test them beforehand using either USB cables or wireless dongles. (Instructions are listed in Section H below and also available here: https://www.barobo.com/faq-linkbot-labs-and-linkbots.)
- Hardware Linkbots require the use of Linkbot Labs software to connect them to the computer--free download is available for installation from https://www.barobo.com/downloads.
- If using hardware Linkbots, test each of them beforehand to ensure there are no connection issues (e.g., firmware update needed). Instructions here: https://www.barobo.com/faq-linkbot-labs-and-linkbots. For firmware issues: https://www.barobo.com/faq-troubleshooting.

- The activities do not use sound, but audio commands that enable a robot to beep or play music are available in RoboBlockly. So you may want to provide headphones or ask students to mute their speakers.

2. Prepare yourself
   - Go through the Hour of Code activities yourself so that you are familiar with what your students will be experiencing.
   - Each activity has an introduction that describes the activity and concepts involved, and a problem statement that instructs students on what they should do. (Full details in Section G below.) These are designed to be self-contained and self-explanatory, but some students may need clarifications or other assistance.

3. Prepare your students
   - When using RoboBlockly in class, first demonstrate to students how to navigate and use the RoboBlockly website, as shown below. (Your view of the website may be slightly different, depending on the activity loaded.) The basic idea is that users create programs to control the robot by dragging code blocks (commands) from the middle Blocks section to the Workspace on the right. Code blocks can be clicked together to form a sequence of commands. Clicking the Run button below the grid on the left will then run ("execute") the commands in sequence, with the virtual robot on the grid showing the results (as well as moving a hardware robot, if connected).



- Introduce dual programming for collaborative learning. This learning model is especially helpful for students who may need some extra assistance.

- Help students get excited about Hour of Code by inspiring students and discussing how computer science impacts every part of our lives. As a class, list things that use code in everyday life, or discuss different ways technology impacts our lives, etc.

E. Getting Started in Class (10 minutes for intro, 40-45 minutes for activities)

1. If using hardware robots, guide each student (or pair of students) in connecting the Linkbot to the computer via a direct USB connection or wireless dongle, and using the Linkbot Labs sidebar at www.roboblockly.com to enter the individual Linkbot's ID number and establish the connection (5-10 minutes).
2. Whether using hardware or virtual robots, going through the first activity as a group is a good way to start. The RoboBlockly website contains far more options than are used in the Hour of Code activities, so the most important features to cover are:
    a. Terminology: program, code, code blocks, commands, arguments (input values to commands), run/execute, debugging
    b. The basic layout: the grid, the middle code block section, the Workspace
    c. Important buttons: Run, Reset (label that appears on the Run button after Run is clicked), Step, Start Over, the Show Robot checkbox (in the "Robot 1" section at the lower left).
    d. Basic actions: running pre-placed code blocks, changing the argument values (input values) for commands, dragging and dropping code blocks from the center block section to the Workspace, unhooking code blocks from other blocks in the Workspace and dragging them back to the center block section to delete.
3. Point the students to the rest of the activities at https://roboblockly.com/curriculum/hourofcode/rav/ (40-45 minutes).
4. Circulate around to offer encouragement and give assistance as needed.

F. Wrapping Up in Class (5 minutes)

- If you and/or your students use social media, we encourage you to share your Hour of Code experience (as appropriate). For example, "I've controlled a robotic autonomous vehicle with @linkbots robots! Have you? #HourOfCode #robotics4mathlearning." Use the hashtag #HourOfCode (with capital letters H, O, C).
- After Hour of Code™, encourage your students to continue learning to program on RoboBlockly by exploring the Playground, Robotics, Computing, or grade-level Math activities.
- ***All student activities on RoboBlockly are free - students do not have to create accounts!***

G. Robotic Autonomous Vehicle Activities

This set of activities introduces students to the basics of computing and controlling robots, including the concepts of code blocks, commands, arguments (input values to commands), run/execute, bugs, debugging, and repeat loops. It also gives them practice with the

mathematical concepts of two-dimensional x-y grids, squares, triangles, and the Pythagorean theorem.

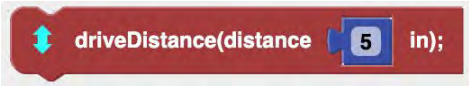
The following sections reproduce the online activity descriptions from www.roboblockly.com.

Activity 1. RAV 1: Driving Forward

Initial prompt: In this introductory lesson, you will learn how to move the Linkbot robot a specified distance by using the **driveDistance** code block.

Lesson description: In this series of Hour of Code activities, you will learn how to guide the Linkbot robot--modeling a robotic autonomous vehicle--through a test track of criss-crossing streets. You'll also learn about one of the most important concepts in computer programming--loops--and get a little practice using the Pythagorean theorem to traverse triangular paths.

You can control the robot's movements on the "Autonomous Vehicle Test Track" grid on the left side of the window by dragging and dropping various "**code blocks**," or "**commands**," from the middle "**Block**" section to the "**Workspace**" on the right and then clicking the "**Run**" button (located just below the grid). These commands are simply instructions that tell the robot what to do. Once the commands are in place, clicking the **Run** button will cause the computer to run or "**execute**" the commands in sequence, one after the other, thus activating and controlling the robot. We will get the hang of it by starting with just a single command that has already been placed in the Workspace for you--the **driveDistance** command:



To tell the robot how far to move, you enter a number into the blue box that is in the **driveDistance** command, then click **Run**. This number is called the "**argument**" for the command. To move the robot again, click "**Reset**" (which appears in place of the **Run** button after something is run), enter a different value for the argument, and then click **Run** again. (If you have a hardware Linkbot robot connected, the hardware robot will move in the same way as the virtual robot you see on the grid.)

Blocks used: driveDistance()

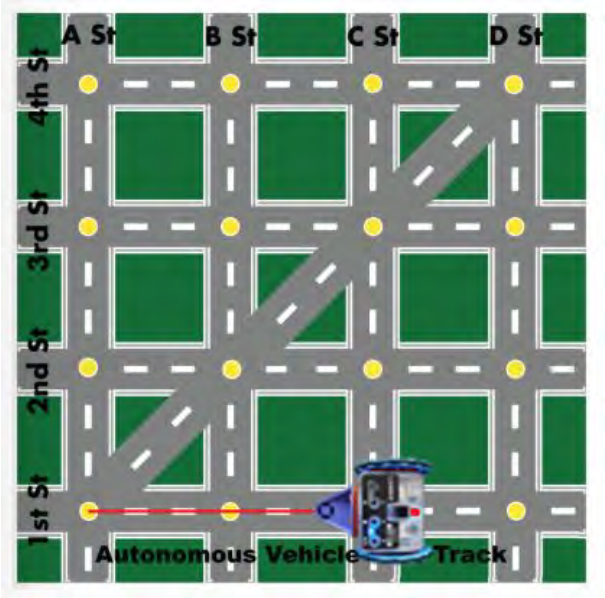
Pre-placed blocks:

Problem statement: Our robotic autonomus vehicle starts at point (3,3) on the grid, facing to the right. Change the argument value in the pre-placed code block so that it will move ahead two street blocks (12 units) to the right, at the point (15,3).

Hint: The pre-placed code block drives the Linkbot 7 units (inches) forward because the "argument" (the specified input value for the driveDistance command) is initially set at 7 inches. But the specified task is to move the Linkbot 12 inches, so change the value of the argument to 12.

Possible solution:

Solution image:



Activity 2. RAV 2: Turning and Debugging

Initial prompt: In this lesson you'll learn how to use the **turn** command and maneuver the RAV robot around a street square!

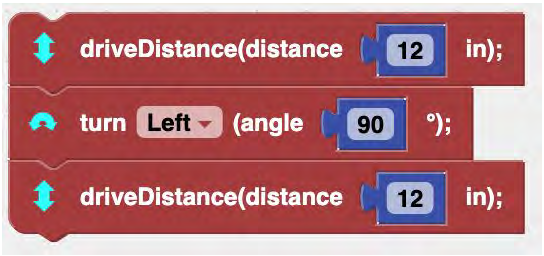
Lesson description: When we put together one or more commands to control the Linkbot robot, we are creating a "**program**." In other words, a computer program is like a recipe, a series of instructions to get something done. Often when we create a program we make mistakes, such as using the wrong command, or the right command at the wrong time, or the wrong numbers in the right command, or so on and so forth. These errors are called "**bugs**," and so we often need to "**debug**" the program in order to fix it and get it working properly. The **Step** button (just to the right of the **Run** button) is helpful in debugging, because it will step through a program's commands one at a time. At each step the command being executed is displayed in orange in the Workspace. This lesson gives you some practice in debugging, and also introduces the **turn** code block, which instructs the robot to turn left or right at a certain angle (90 degrees for a right angle turn):

To add a code block to the Workspace, drag and drop it from the Blocks section in the middle, positioning the block just above or below existing blocks in the Workspace, so that the new block clicks together with the existing ones. You can unhook blocks in the Workspace by dragging down on a block. Delete a block by dragging it back over to the Blocks section.

Tip: If you want to speed up the robot's journey, add a **setSpeed** block at the beginning. (You may have to scroll down in the list of code blocks to find it.)

Blocks used: driveDistance(), turn()

Pre-placed blocks:

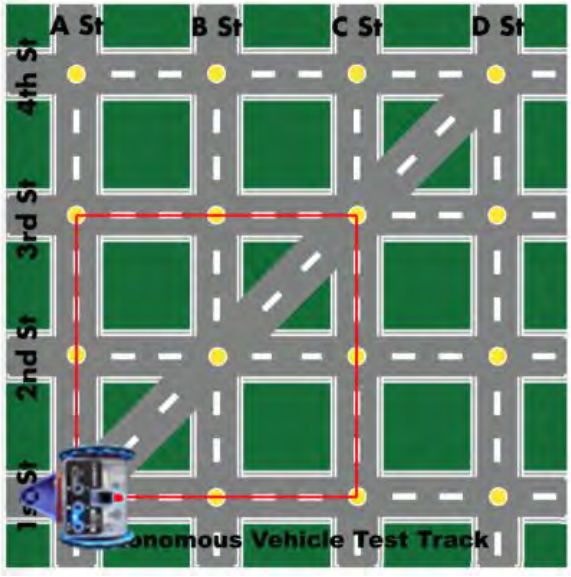


Problem statement: Use the **Step** button to step through the pre-placed blocks to see what they do, and then add more **turn** and **driveDistance** blocks to drive the RAV robot around the 2-block by 2-block street square, so that the RAV returns to its original position at the point (3,3), facing to the right.

Hint: Use the **Step** button to step through the commands one at a time.

Possible solution:

Solution image:



Activity 3. RAV 3: Looping Around a Square

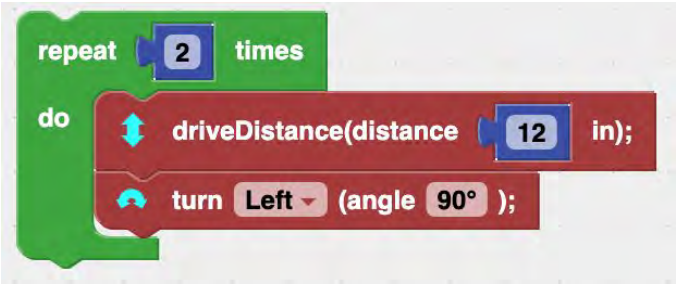
Initial prompt: This RAV activity will introduce you to loops, one of the most important and useful concepts in programming.

Lesson description: In the previous lesson we learned how to use the Linkbot to trace a square. To do so, we used the code blocks shown below.

Note that we used the same **driveDistance** and **turn** commands four times in a row. That is, we instructed the Linkbot to drive 12 units, then turn left 90 degrees, then drive 12 units, then turn left 90 degrees, and so on for the third and fourth sides. In programming we often encounter situations like this, where we need to repeat the same code several times in a row (or even hundreds or thousands of times in a row). Instead of writing (or copying and pasting) the same commands over and over, we can use what's known as a "**loop**." For a basic loop, we put the commands we want to have repeated inside a special loop code block, and then specify how many times we want the commands to be repeated. This is known as a "**repeat loop**." (As you continue to learn about programming, you will come across other types of loops as well.) In this lesson you will get to experiment with a repeat loop to have the RAV robot traverse the square.

Blocks used: turn(), driveDistance(), repeat()

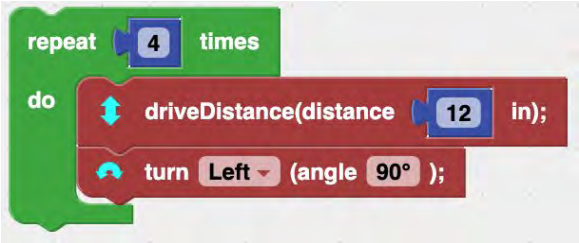
Pre-placed blocks:



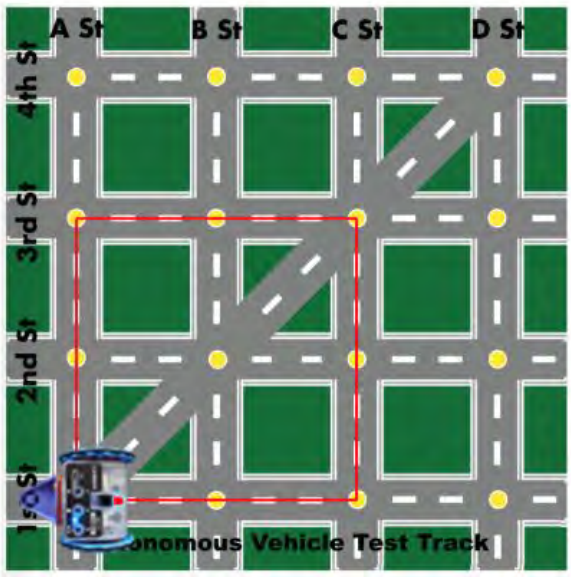
Problem statement: The pre-placed code blocks use a loop to draw two sides of a square. Use the **Step** button to step through the code piece by piece to see how it works. Then change the value of the argument in the loop so that the code has the robot draw a complete square with four sides. What happens if you have the loop repeat more than four times?

Hint: In order to trace out the four sides of a square, the argument value for the repeat loop should be 4.

Possible solution:



Solution image:



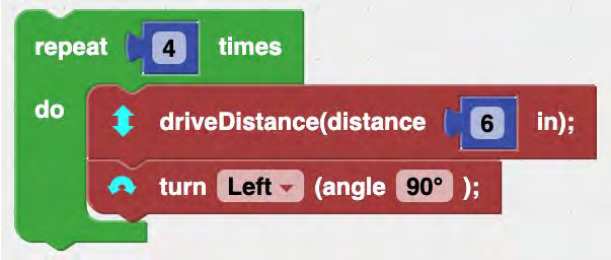
Activity 4. RAV 4: Traversing Multiple Squares

Initial prompt: The challenge in this activity is to program the RAV to traverse multiple squares, using loop code.

Lesson description: We would like to program our RAV to automatically traverse each block of streets in the grid. To do so, we have pre-placed the repeat loop code from the RAV 3 activity, but modified so that it traverses a one-block street square (6 units on a side). Your challenge is to add the code that will move the RAV one block over to the right and then traverse that square. So when you run the code, the RAV will traverse two squares, one at a time. The final code should have two repeat loops, one for each square. You can find the repeat loop code block by clicking the "Loops" button in the middle Blocks section. (Then click the "Robot 1" button to get back to the robot control blocks.)

Blocks used: driveDistance(), turn(), repeat()

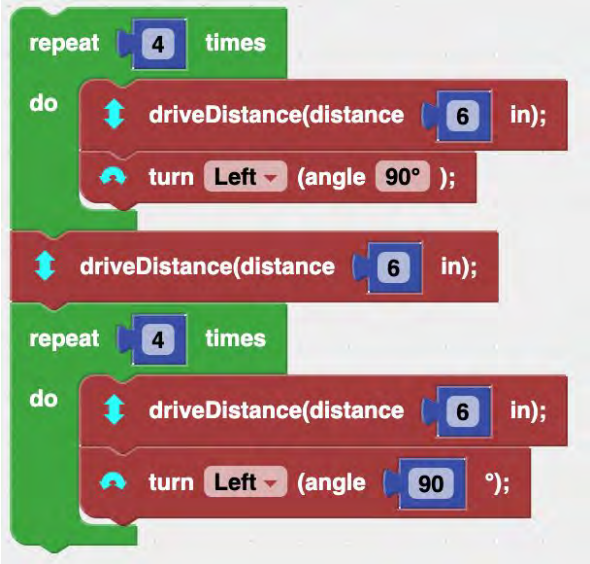
Pre-placed blocks:



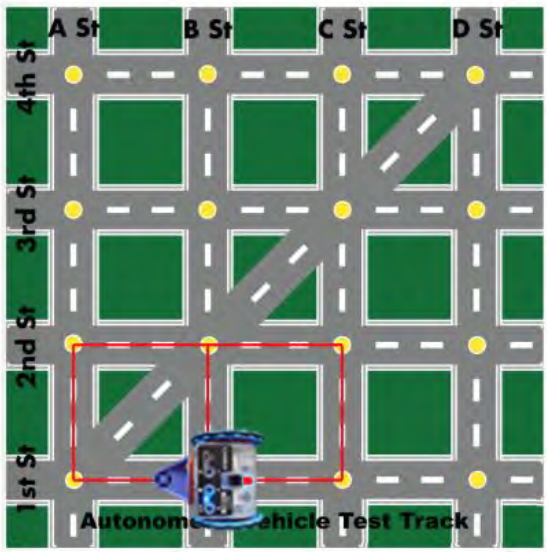
Problem statement: Add the code blocks so that the RAV will traverse two street squares (bottom left and bottom middle). Once you accomplish that, can you add code so that it traverses even more blocks?

Hint: Make sure that all the code blocks are clicked together both inside the repeat loops and outside, as appropriate.

Possible solution:



Solution image:



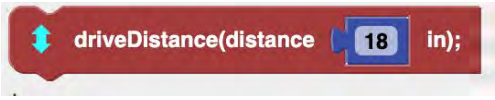
Activity 5. RAV 5: Traversing a Triangle

Initial prompt: In this activity we'll take on the challenge of creating the code that will program the RAV to traverse triangular paths.

Lesson description: The street grid on the Autonomous Vehicle Test Track has one diagonal street running from the bottom left corner to the top right. Your challenge in this activity is to create a program that will guide the RAV in a triangular path: first along the bottom of the street grid, from the left to the right (3 full street blocks), then up along the right side street (3 more street blocks), and then down the diagonal street back to its starting point. Note that the triangle that is traced out is a right triangle with two equal sides (each 18 units long). You will therefore need to use the Pythagorean theorem to calculate the length of the hypotenuse (the diagonal) that the RAV will need to travel. You can use the square root code block (click the "Math" button in the blocks section) to do the calculation.

Blocks used: driveDistance(), turn()

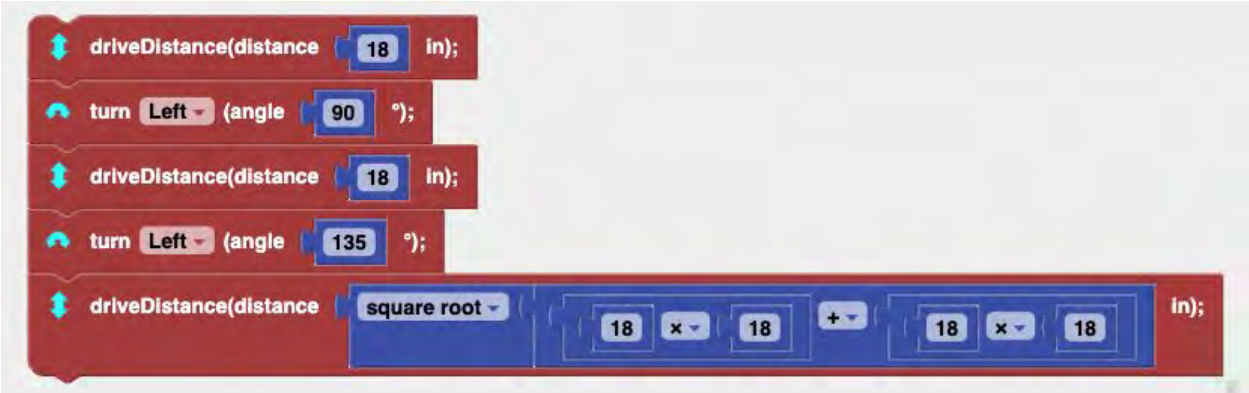
Pre-placed blocks:



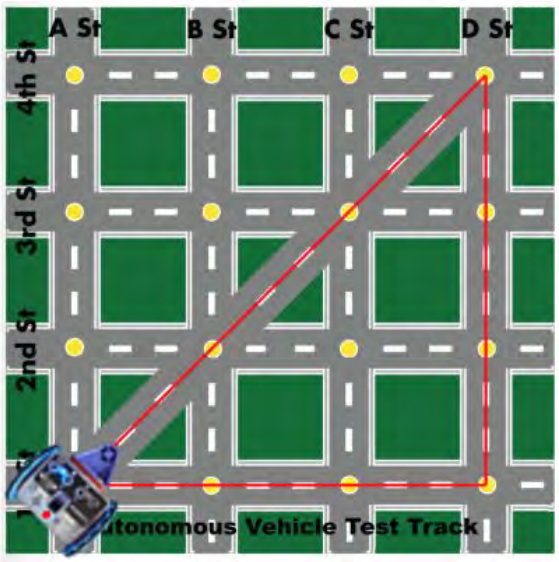
Problem statement: Add **driveDistance** and **turn** code blocks to enable the RAV to traverse a big triangle, as shown in red (three street blocks on the bottom, three street blocks on the right side, and then down the diagonal back to the starting position).

Hint: Don't forget that the turn angle at the top of the path will be more than 90 degrees!

Possible solution:



Solution image: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tonomous Vehicle Test Track

Activity 6. RAV 6: Explore!

Initial prompt: In this activity you'll get to experiment with paths of your own choosing for the RAV.

Lesson description: Now that you have learned how to instruct the RAV to traverse multiple street blocks and triangular paths, can you do other variations and patterns? More than two blocks? Multiple triangular paths? Use your imagination!

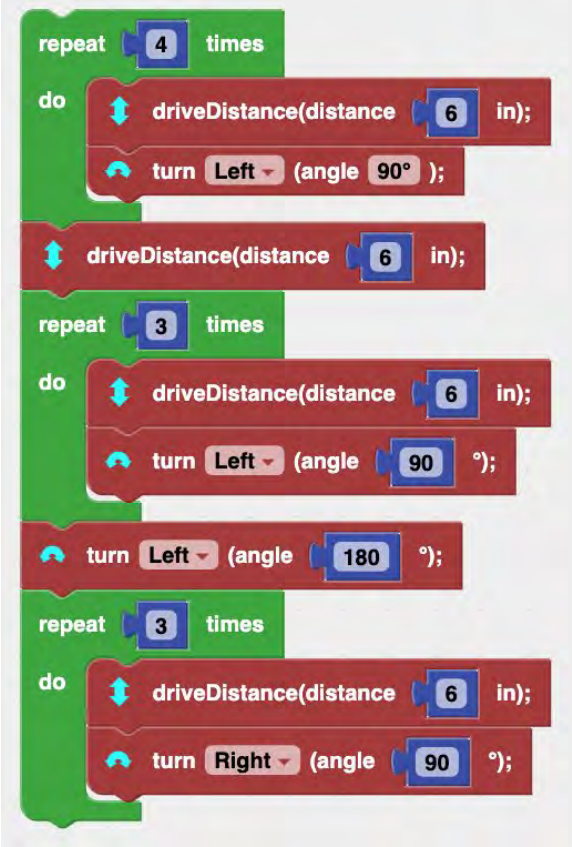
Blocks used: driveDistance(), turn(), repeat()

Pre-placed blocks: None

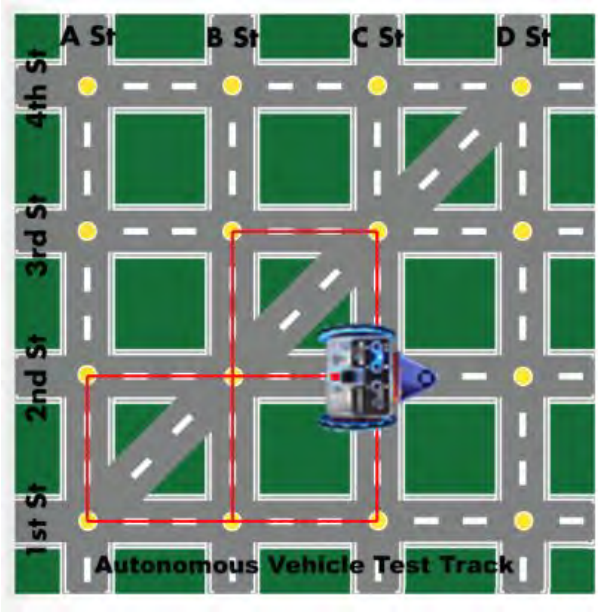
Problem statement: Experiment with creating the code that will instruct the RAV to traverse multiple blocks or triangular paths, or other patterns. Remember that each street block is 6 units square. Have fun!

Hint: Keep at it! Trial and error is often the best way to debug something!

Possible solution (sample: traverse three street blocks)



Solution image (sample):



H. Connecting Hardware Linkbots to the Computer and Initializing Them in RoboBlockly

To control hardware Linkbots you need to download and install Linkbot Labs software.

H.1. Instructions for Windows and Mac machines (instructions for Chromebooks follow; tablets are not supported)

(1) Download and install the latest version of Linkbot Labs from the Barobo Downloads page at https://www.barobo.com/downloads.

(2) Launch RoboBlockly at www.roboblockly.com using a regular browser (Chrome is recommended).

(3) Connect the hardware Linkbot to the computer using either a micro USB cable or a wireless dongle, and then add the Linkbot's ID (found on the Linkbot's label, e.g., "ZG81") using the Linkbot Labs sidebar on the left side at RoboBlockly, as shown in Figure 2 below. (Click on the "Linkbot Labs" arrow just below the RoboBlockly heading at the top left to open or close the sidebar, as circled in red in Figure 1.) Note that when first opening RoboBlockly it may take a few seconds for the Linkbot Labs arrow to appear.

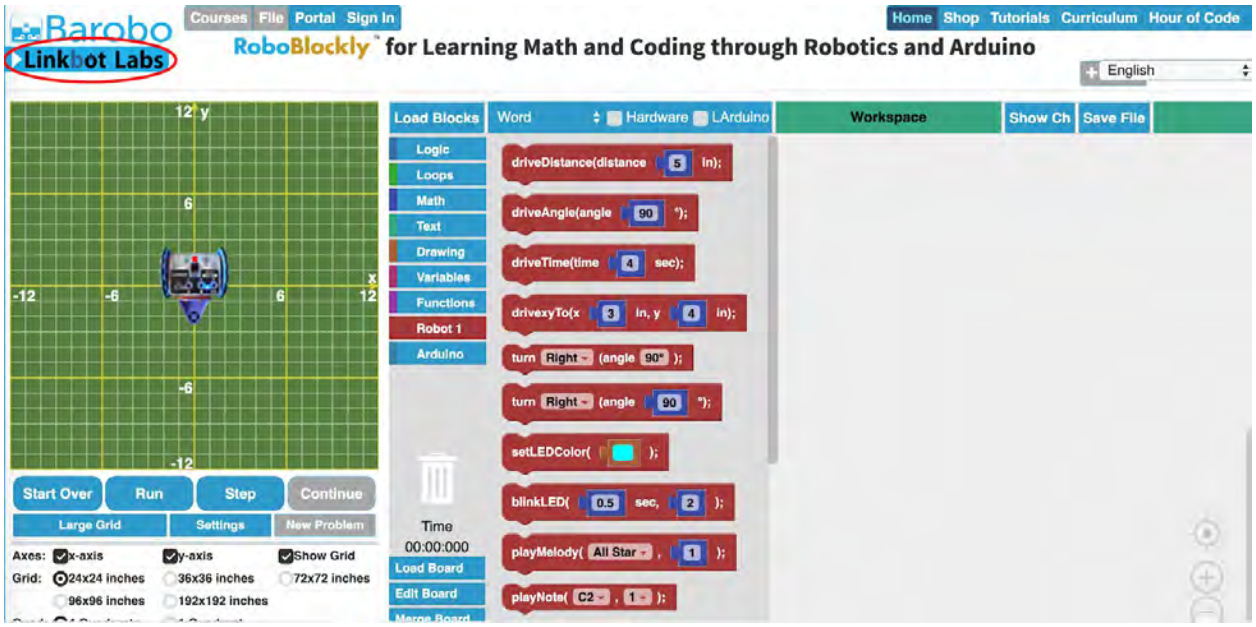


Figure 1: RoboBlockly user interface with the Linkbot Labs sidebar closed. Click on the "Linkbot Labs" arrow, as circled in red in the image, to open the sidebar (or close the sidebar, if open).

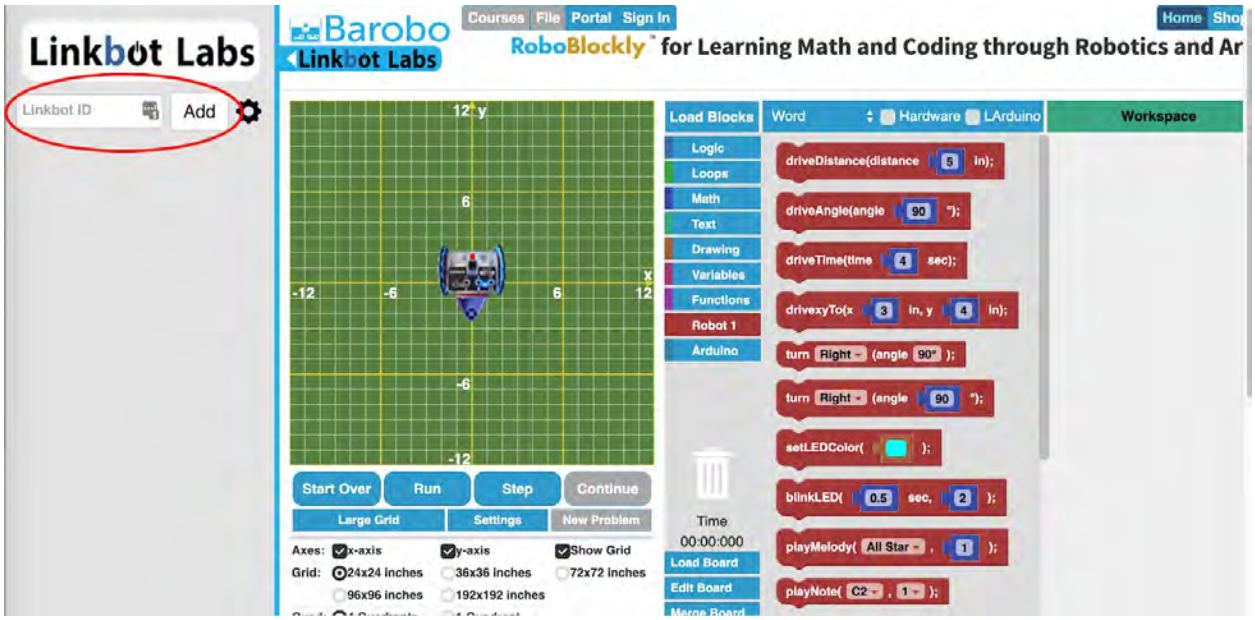


Figure 2: RoboBlockly user interface with the Linkbot Labs sidebar open. Enter the ID for a Linkbot in the box (circled in red) and click the “Add” button.

Instructions, continued:

(4) Drag a Linkbot instruction block such as driveDistance() to the Workspace area of RoboBlockly.

(5) Click “Run” or “Step” to move the virtual Linkbot on the grid and the hardware Linkbot at the same time.

(6) If the hardware Linkbot does not move, you may need to restart the Barobo Linkbot Service program by right-clicking on the “L” in the Windows task list at the bottom right of the screen (Figures 3 and 4 below) or clicking on the “L” in the Mac menu bar at the top of the screen (in the list of icons on the right side of the menu bar, Figure 5 below). Choose “Restart Linkbot Service” from the popup menu.

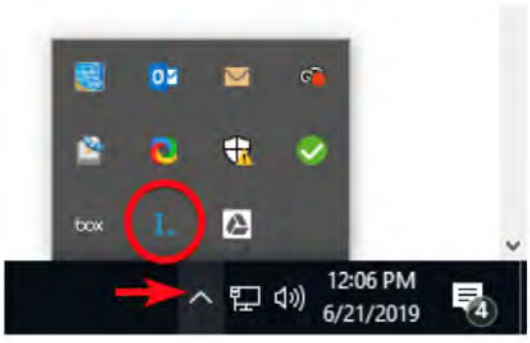


Figure 3: Accessing the Linkbot Service “L” in the Windows task list.

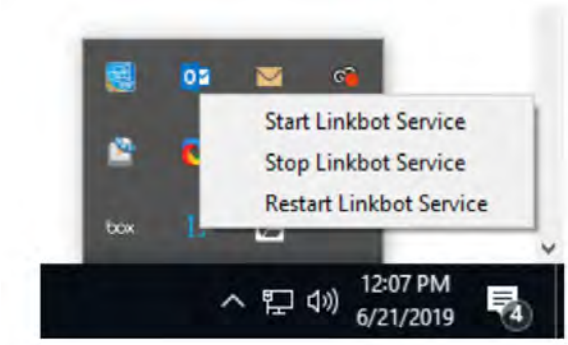


Figure 4: The popup menu with Linkbot Service options (Windows interface).

Figure 5: The Linkbot Service “L” in the Mac menu bar (your list of icons will be different). A similar popup window as for Windows will appear when you click the L.

Instructions, continued:

(7) If you receive messages about firmware needing updating, see https://www.barobo.com/faq-troubleshooting for guidance.

H.2. Instructions for Chromebooks

Download and install the Linkbot IDE (Integrated Development Environment) and Firmware Updater for Chromebooks, available via the Barobo Downloads page at https://www.barobo.com/downloads. Then open roboblockly.com in the browser and follow steps 2-5 in the instructions for Windows and Mac machines. If you receive messages about firmware needing updating, see https://www.barobo.com/faq-troubleshooting for guidance.