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Module: Robot Locomotion Mini Hackathon

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Learning Objectives:

Students will be able to:

- Describe the basics of Robots
- Describe basic hardware and software of the LEGO Robot
- Write sequential code for LEGO Robot to move

<p>INFORMATION <i>Assigned Readings</i></p>	<p>Text: "What is a Robot?": Reference: https://robots.ieee.org/learn/</p>
<p>DIALOGUE <i>Class Discussion</i></p>	<p>In Class Discussion (20 minutes):</p> <ul style="list-style-type: none"> ● Introduce robot hardware that includes the robot controllers, the robot sensors, and the motors. ● Why use robots? ● Where are robots used? ● Discuss the evolution of robotics and the current state of the art
<p>PRACTICE <i>Lab Exercises</i></p>	<p>In Class Lab Project Activity:</p> <ol style="list-style-type: none"> 1. Hands-on Lab Activity (30 Minutes): <ol style="list-style-type: none"> a. Introduce LEGO EV3 Robot Hardware and Software b. How to program the robot c. Introduce how to make the robot move in different ways 2. Challenge (40 Minutes): a mini hackathon challenge "L-O-V-E R-O-B-O-T-S" where they will apply the knowledge from the hands-on lab activity
<p>FEEDBACK <i>Lab</i></p>	<p>The feedback will be given during:</p> <ul style="list-style-type: none"> ● Demonstration of exercises in the hands-on lab activity. ● Demonstration of Mini Hackathon Challenge.
<p>EVIDENCE</p>	<ul style="list-style-type: none"> ● Completion of Lab and Mini Hackathon Challenge

Class Discussion	Lab Activity	Mini Hackathon Challenge
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Questions/comments? [Dr. Mohammad Q. Azhar](#)



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CLASS DISCUSSION:

Vocabulary/Terms

- Robot
- Mobile robot
- Locomotion
- Autonomous Robot

Introduction: What is a robot?

A **robot** is an **autonomous system** that can *sense* its environment (as well as its own internal state), *think* about the conditions of its environment, and *act* accordingly on its environment to achieve goals.

Why use robots?

- Dirty, dangerous, dull tasks
- Can go to extreme environments
- Used to perform repetitive jobs
- Can be faster and more efficient
- Can be more cost-effective than hiring people

Where are robots used?

- Home (Roomba, a home cleaning robot)
- Industry (manufacturing, packaging, etc)
- Medical (surgical robot)
- Military operations
- Space Exploration
- Entertainment (robot pets)

Robots are comprised of **hardware** and **software** working together to allow the robot to sense, think, and act.

Hardware

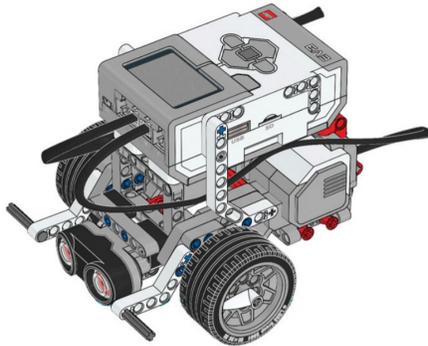
Hardware is the physical part of the system. In a desktop computer system, this can include the monitor, the tower, processor, hard drive, keyboard, mouse or printer. A robot has an embedded computer. A robot's hardware can include a display, motors, wheels, robot legs, sensors, etc.



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Some types of hardware are used to get **input** from an external source to the computer. Examples are web-cams, scanners, keyboards, microphones, etc. For a robot, the hardware components that allow it to get input are called **sensors**.

The computer can send **output** to other hardware components after processing. Examples are printers, monitors, speakers, etc. The embedded computer in a robot can send output to its motors, display screen, and speaker.



Introduction to LEGO Mindstorms EV3 Robot

- Robots can be stationary or mobile. A **mobile robot** is a robot capable of **locomotion**, the ability to move itself from one place to another.
- A mobile robot EV3 made by LEGO
 - Third in a line of LEGO robots after the RCX (1998) and NXT (2006)
 - EV3 Stands for “Evolution 3”(2013)

LEGO MINDSTORMS EV3 Robot Hardware:



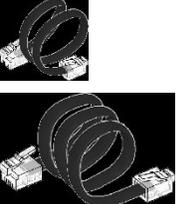
EV3 Brick:

Serves as the control center and power station for your robot. It has an embedded computer that includes a processor, memory, and input/output.

The brick has output ports A, B, C, D on one side and input ports 1, 2, 3, and 4 on the other.



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	<p>Large Motor: Makes the robot move. This motor is mainly for locomotion. The brick will output signals to the motor.</p>
	<p>Sensors detect or measure a property of the environment and sends the signal to the brick as input.</p> <p>(Pictured left: color sensor, infrared sensor)</p>
	<p>USB Cable: To send the program to the EV3 Brick</p>
	<p>EV3 Brick Input/Output Cables: Carry input to the EV3 Brick and output from sensors to EV3 Brick.</p>
	<p>EV3 Brick Input Ports: Input Ports 1, 2, 3, and 4 are used to connect sensors to the EV3 Brick.</p>
	<p>EV3 Brick Output Ports: Output Ports A, B, C, and D are used to connect motors to the EV3 Brick.</p>



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Software:

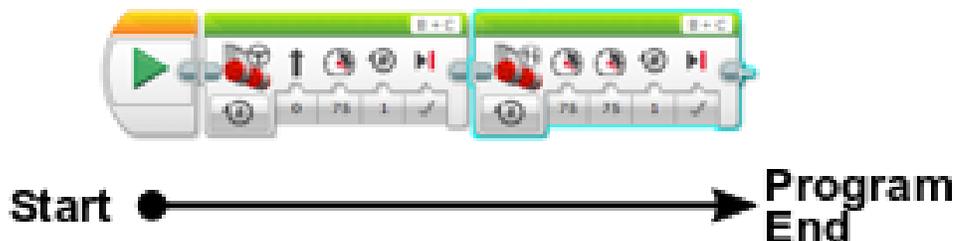
Software includes programs and data.

A Lego EV3 **program** is a set of instructions that tells the robot what to do. The programmer must use a language that the computer understands to write the program.

The EV3 robot can be programmed using a block-based, graphical programming language *The Lego Mindstorms EV3 Programming Language*.

The LEGO MINDSTORMS EV3 Software:

- Mindstorms is a programming interface for programmers to write programs for the EV3 robot using the graphical programming language
- Programs begin at a “Start” block and run from left to right



- Each programming block can represent an instruction for an action, a sensor input, control flow, data operation, or other behavior for the LEGO EV3 robot.



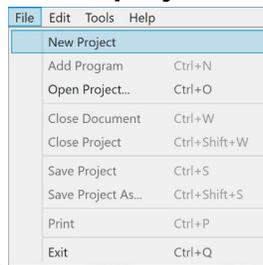
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LAB ACTIVITY

Writing a test program for LEGO Mindstorms EV3 Robot.

Step 1: On your computer, open the LEGO Mindstorms EV3 Programming Software.

Step 2: Create a new **project**



Step 3: Examine the parts of this screen:



- 1. Project and program tabs.** You can create new projects and programs here. You can change a program's name by double-clicking on its tab.
- 2. Programming Toolbar.** Tools to navigate the user interface and **create comments**.
- 3. Programming Canvas.** Lay out your programs here.
- 4. Programming Palettes.** Find blocks to build your program here.
- 5. Hardware Page.** Establish and manage communication with the EV3 brick here.

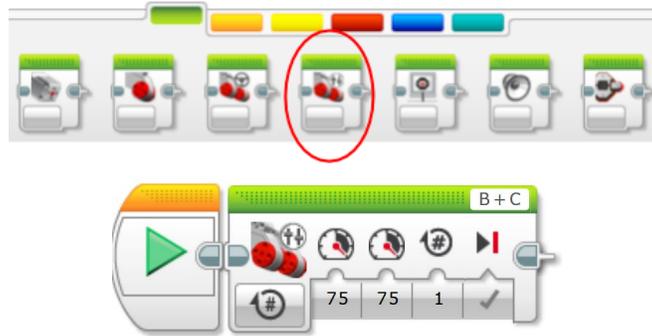
Step 4: Be sure to pay attention to the **Project name** as well as the **Program name**.

Step 5: From the programming Palette, drag and drop the following programming block onto the canvas and connect it to the 'Start' block.



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Step 6: When you finish writing your program, click Save Project as... and rename both the Project and Program to “minihackathon1_yourlastName”. Naming your Project and Program will help you locate your program on your computer as well as on the robot.

File	Edit	Tools	Help
New Project			
Add Program			Ctrl+N
Open Project...			Ctrl+O
Close Document			Ctrl+W
Close Project			Ctrl+Shift+W
Save Project			Ctrl+S
Save Project As...			Ctrl+Shift+S
Print			Ctrl+P
Exit			Ctrl+Q

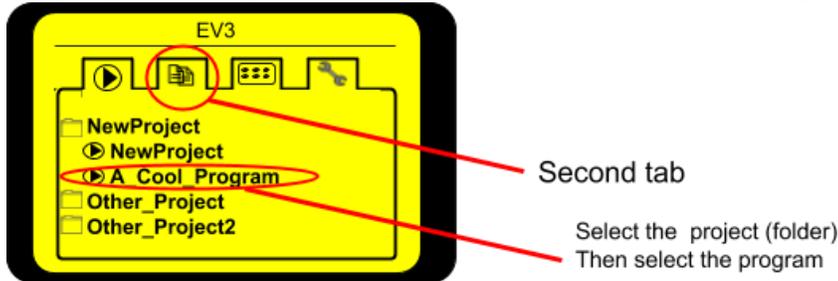
Downloading and Running A Program on the EV3 Robot

1. Connect the computer to the EV3 robot:
One of the ways to connect your computer to the EV3 is via USB cable: plug in the rectangular connector of the USB cable to the computer’s USB port and the smaller D-shaped connector to the EV3 brick.
2. Turn the robot on by pressing the Middle gray button on the brick.
3. Transfer the program from the computer to the EV3: On the bottom right corner of the Mindstorms program, click the download arrow to download the program to the robot. When the download is complete, the EV3 will play a tune.

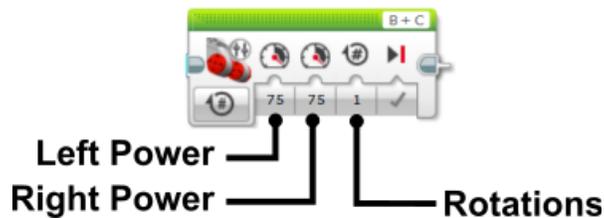


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- To select and run your program: On your brick, use the left and right arrow buttons to navigate to the second tab. You will see a list of Projects. Using the up and down arrows to navigate, select your Project by pressing the Middle Button to open it.
- Find your program and press the Middle Button to run your program.



- Let's take a closer look at the **Move Tank** block in your program:



The Move Tank block lets you move and steer your robot like a tank. It gives you control over how much power is sent to the motors that drive the robot's left and right wheels and the duration of the movement. The parameters of the block, labeled above, can be set to the desired value after clicking on them.

Let's experiment a bit. Each time you modify the program, download your project to the robot and run it again, making sure there is plenty of clear space around the robot.

Problem: Pick a number between 10 and 50 and set Left Power and Right Power. What do you expect your robot do? Did it do what you expected?



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IMPORTANT: BEFORE RUNNING ANY PROGRAM THAT MOVES YOUR ROBOT, UNPLUG THE USB CABLE AND PLACE YOUR ROBOT ON A FLAT SURFACE WITH CLEAR SPACE IN FRONT OF IT. THE BEST PLACE IS THE FLOOR.

Program: Left Turn

Create a new program and name it “Left Turn”. Make your robot turn 90° clockwise.

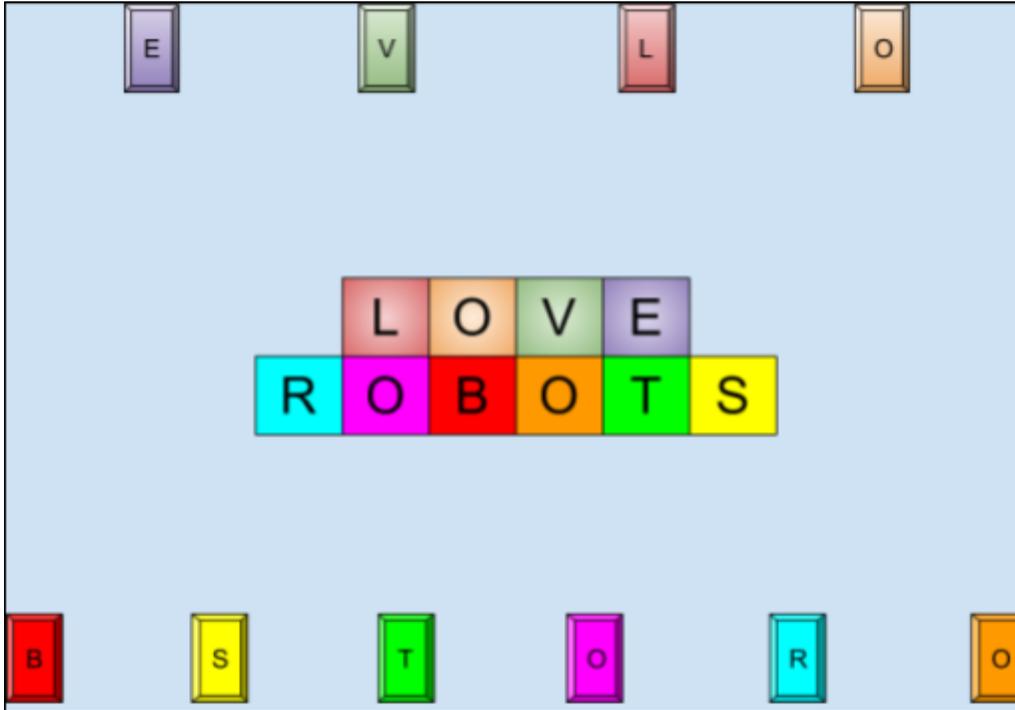
- Use a single **Move Tank** block
- The robot must turn **in place**; the axis of rotation should be in the center of the two wheels. This is sometimes called a “point turn”.
- The angle the robot turns should be as close to 90° as possible
- Explain what the relationship between Left Power and Right Power must be in order to give an instruction for the robot to turn **in place**. Write your answer below and also as a *comment* in your program. (Comments are written in a natural language like English for programmers to read and can be used as a reminder or can be read by other programmers to describe the program. The comment tool can be found on the Programming Toolbar in the upper right corner of the program window.)



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MINI HACKATHON CHALLENGE:

Objective: Using the Lego Mindstorms EV3 software, create a program that guides the robot from its starting point to its destination.



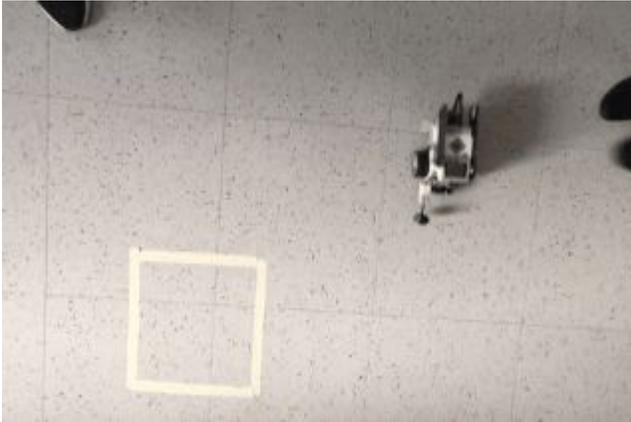
Example: Let's say you want to get Robot 'B' to its own square. To do so, we create a set of instructions - otherwise known as an **algorithm**. An **algorithm** is a step-by-step set of instructions for solving a problem.

Goal: Robot B needs to get to square B.

1. Robot moves forward.
2. Robot turns right.
3. Robot moves forward.
4. Robot turns left.
5. Robot moves forward.



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EV3 Robot in action travelling to its destination.

There are several paths for the Robot to travel from the starting point to square B.

Write an algorithm for another way for the Robot to travel from its starting point to square B



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Mini Hackathon Challenge: Each team will be given a random letter by the instructor.

Write an algorithm for your robot to travel from its starting point to your assigned destination letter

Write the program for your robot to travel from its starting point to your assigned destination letter



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Reflection: Write down the challenges that you experienced and how you solved them.

