



How to Use EV3Lessons

By Sanjay and Arvind Seshan

BEGINNER PROGRAMMING LESSON

SITE OVERVIEW




- **EV3Lessons.com provides the building blocks for successfully learning to program the LEGO MINDSTORMS EV3**
- **We also provide extensive resources for robotics teams such as planning tools, Quick Guides, Coach's Corner and Team Building Activities**
- **Anyone is welcome to use and modify these lessons for educational (non-profit) purposes**
 - However, you **must give credit to EV3Lessons** for the materials and **provide a link back to us** if you post materials online
 - If you use EV3Lessons materials in any robotics competition (e.g. FIRST, WRO), you **must cite your sources in your contest materials**.
 - If you make extensive use of our materials, **please consider making a donation to the site to support our work**

LESSON DESCRIPTION

<http://ev3lessons.com/lessons.html>

- **Beginner**: These lessons will teach you to move and turn the robot, use the sensors, and use loops and switches.
- **Intermediate**: These lessons introduce more advanced programming techniques such as My Blocks, variables, parallel beams, calibration and math/logic blocks.
- **Advanced**: These lessons assume that you are comfortable using all the blocks in the EV3 environment. The advanced lessons teach you to more sophisticated programs such as menu systems, proportional line followers, squaring on lines and stall detection techniques.
- **Beyond**: These lessons are for students who have completed all our other lessons and interested in learning about third-party sensors and using the EV3 with other platforms such as the Raspberry Pi.
- Beginner Lessons are designed to be done in order. Intermediate and Advanced Lessons may be done out of order. Lessons usually mention specific pre-requisites when needed.
- If you print the lessons out, make sure to return to the site often to check the date on the bottom of the page to make sure you have the latest version of the lesson.
- To be notified of updates, sign up for our mailing list on the Contacts page.

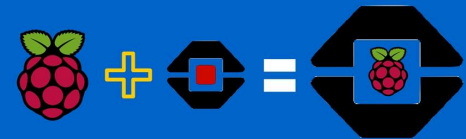
CORE PROGRAMMING LESSONS

| Beginner  | Intermediate  | Advanced  |
|--|--|---|
| <ul style="list-style-type: none">• How to Use the EV3Lessons• Build a Base Robot• Introduction to Brick/Software• Moving Straight• Port View• Pseudocode• Basic Turning• Displaying Text and Graphics• Custom Images & Sounds• Intro to Touch Sensor• Intro to Color Sensor• Loops• Switches• Importing Additional LEGO Blocks• Sound Block• Intro to Sound Sensor• Intro to Ultrasonic Sensor• Basic Line Follower• Moving an Object• Final Challenge | <ul style="list-style-type: none">• Basic Ultrasonic Wall Follower• Brick Buttons as Sensors• Data Wires• My Blocks with Inputs and Outputs• Moving with My Blocks• Turning with My Blocks• Color Line Follower with My Blocks• Infrared Sensor• Debugging Techniques• Move Blocks• Reliability Techniques• Color Sensor Calibration• Variables• Logic Operations and Decision Making• Intro to Parallel Beams | <ul style="list-style-type: none">• Parallel Beams Synchronization• Arrays• Intro to Proportional Control• Proportional Line Follower• Proportional 2 Color Line Follower• Proportional Ultrasonic Wall Follower• Proportional Control with the Sound Sensor• Ramping Up• Intro to Gyro Sensor• Gyro Sensor Turns• Gyro Move Straight and Wall Follow• Squaring on Lines• Stall Detection• Menu System• Data Logging• Bluetooth• Random Block |

BONUS LESSONS

Beyond

- Importing Third-Party Blocks
- PixyCam for MINDSTORMS: Introduction
- PixyCam for MINDSTORMS: Color Identifier
- PixyCam for MINDSTORMS: Using Color Codes
- Mindsensors PSP-Nx Controller: Introduction
- Mindsensors PSP-Nx Controller: Simon Game
- EV3 Raspberry Pi Communicator
- Controlling Lights with an EV3
- Introduction to ev3dev
- Raspberry Pi and ev3dev Communicator
- Controlling Lights using ev3dev and Raspberry Pi
- NXT Light Sensors in EV3



RPi & EV3

New Lesson Series



Linux & EV3

New Lesson Series



LESSON STRUCTURE


- 1. Each lesson starts with a list of objectives and ends with a challenge**
- 2. In most lessons, we provide hints in the form of Pseudocode. Students who need a hint should look at the Pseudocode.**
- 3. We provide a challenge solution as well, but want students to complete the challenge on their own before checking the solution**
- 4. A discussion guide is included after the challenge that will help understand the main objectives**
- 5. Some lessons have companion worksheets for students. More will be added over time.**

QUICK GUIDES

| Hardware | Programming | Documentation & Strategy |
|---|---|---|
| <ul style="list-style-type: none"> Cable Management 1 Cable Management 2 FLL Robot Build Guide Shielding Techniques Using Gears with the EV3 Passive Attachments Carabiner LEGO Digital Designer File One Way Gate LEGO Digital Designer File | <ul style="list-style-type: none"> One Minute Line Follower Using Sensors: Move Until Improving Robot Reliability Color Sensor: Shielding and Calibration My Blocks Myths & Truths About the Gyro Truth About Turns: Pivot Turns | <ul style="list-style-type: none"> Using Comments to Improve Code Engineering Notebook LEGO CAD & Robot Build Instructions Robot Game Strategy Mission Planning Worksheet Learning FLL Runs |

| EV3 Platform | Misc. |
|---|---|
| <ul style="list-style-type: none"> Edu vs. Home Edition Software EV3 and NXT Compatibility Updating Software/Firmware Home Edition Updating Software/Firmware Edu Edition | <ul style="list-style-type: none"> LEGO Organization Systems Roles and Responsibilities Tournament Checklist Ten Off-Season Ideas FLL: Getting Started Guide |

<http://ev3lessons.com/guides.html>




MYTHS & TRUTHS ABOUT THE GYRO

By Droids Robotics, 2015






"We used to fear the gyro but we did your BEV3Lessons today at practice and now we love it!" - FLL Team

There are numerous myths about the Gyro sensor that we would like to discuss. These myths make teams afraid of trying out the sensor.

The gyro sensor is an extremely useful sensor, but does take a bit of work to use correctly. That is why we have the Gyro lessons in **Advanced** on EV3Lessons.com.



| MYTH | TRUTH |
|--|---|
| The gyro is unreliable for turns. | The biggest problem with the gyro is drift and lag. Both can be fixed. |
| You cannot use software to correct for the gyro's drift. All you can do is unplug and replug the sensor. | There are software solutions you can try. There are several examples of solutions on EV3Lessons.com. |
| Placement matters: The gyro needs to be low to the ground and at the center of the robot. | See images below. Where it is on the robot and the height off the ground makes no difference in the readings for FLL. If the application is for a Gyro Boy or another type of robot that is balancing or has a twisting motion, other installs will work too. |
| Using two gyros will cancel out the drift. | Unfortunately, this does not work. |
| The gyro measures angles | The gyro measures angular velocity (rate) and computes angle from this. |
| The gyro cannot be used in FLL reliably | The gyro can be successfully used in FLL if you correct for lag and drift. |
| It takes 30secs or more to correct for drift | Gyro drift takes as little as 0.1 secs and at most 3 secs and is easily done during table set up time in FLL. |
| Gyro accuracy is an issue | While the gyro might be a couple of degrees off, other techniques (odometry) can produce similar or worse errors. Build a robot to tolerate these errors. |

Gyro Sensor mounting guide for an FLL robot

- 1: Angular install
- 2: Sideways install
- 3: Straight up or down
- 4: Parallel to ground
- 5: Upside down, but parallel to ground

SKILLS CHALLENGES

Challenges

FIX MY CODE Skills Challenge

By EV3Lessons



Fix my Code Series

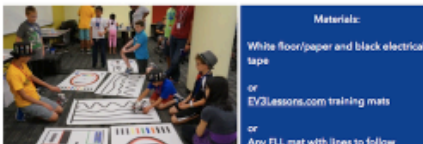
These challenges test a student's ability to read and understand code written by others. The goal is to identify errors and fix them. We will add challenges for each sensor

Challenge 4: Touch Sensor: Fix My Code

Challenge 2: Fix My Code

LINE FOLLOWING Skills Challenge

By EV3Lessons



Materials:

White floor/paper and black electrical tape
or
EV3Lessons.com training mats
or
Any FLL mat with lines to follow

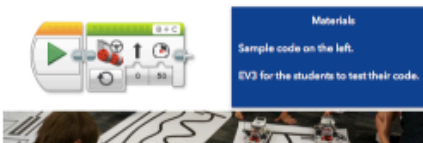
Line Following

These challenges are to practice writing line followers and find ways to improve them.

Challenge 1: Line Following

"ON" MODE Skills Challenge

By EV3Lessons



Other Skill Challenges

These are other challenges that we have not categorized yet.

Challenge 3: On Mode

<http://ev3lessons.com/challenges.html>


RESOURCES: COACH'S CORNER

EV3Lessons.com
Let's Learn Together

Coach's Corner

Maximize Learning, Minimize Cloning

By Asha Seshan
Not the Droids You Are Looking For
(Pennsylvania, USA)



In this article, I team: the good opinions are events, and Research is the first topic. It distributes people the In are a B E

EV3Lessons.com
Let's Learn Together

Coach's Corner

Motivating Your Team

By Asha Seshan
Not the Droids You Are Looking For
(Pennsylvania, USA)

I have coached a FIRST LEGO League team for six years - large teams and small teams. Each team and each student is motivated differently. For some, playing with LEGO is all they want or joined for. So how do you encourage the kids to learn all that FIRST LEGO League has to offer them?

When I had a large team with mixed interest levels, I used patches (spirit badge systems) as prizes for learning new skills. I used a large team on the side. I created little packets for them to place their patch in as they earned them. I included a photo of this chart in this article.

What skills do they learn? In the picture on the left, I have teamwork, Determination, Bright Idea, Oops, Early Bird, organized, and Note taking. Most of them speak for themselves, but they are worth talking about.

"Oops" patch was given when students made a mistake, but learn from the mistake. I wanted the kids on the team to learn as given as an encouragement to get their work done ahead of time. "Note taking" was given out to encourage the students to when we went on field trips or interviewed someone.


When they received an even large FIRST patch. When the electronic badge system. You could be as high-level or as taking, etc. But this system could work even for turning, gyro, etc.

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Coach's Corner

Coaching: What Can You Offer

By Carrie Koepke
The Final Elements and Fantastic
LEGO Ladies (Missouri, USA)



When a neighborhood FLL team formed in 2014, my daughter was excited to join. My son watched The Fantastic LEGO Ladies embrace their first season, tugging my sleeve about next year. In 2015, The Final Elements was formed. They followed in the Ladies' footsteps, able to attend the Razorback Invitational in their Rookie year. Both teams are excited to see what the Animal Allies season will bring. I coach The Final Elements and offer occasional support to The Fantastic LEGO Ladies.

It was intimidating to step into an FLL coach role. The closest I have come to an engineering degree was editing my friends' and husband's papers in college. My expertise is in English and Biology. Nonetheless, I am about to walk into year two of coaching my son's FLL team, The Final Elements. Last year was a bit of a shock to the system, but even more shocking was how many coaches I kept meeting who had zero experience. As we chatted about the perplexing oddity, it became clear that our background didn't matter. We arrived with the desire to help these kids reach their goals and our own unique abilities to nurture their dreams.

"We know our Coaches and Mentors don't have all the answers; we learn together." Thank goodness for this Core Value! Walking into our first meeting, the boys and the majority of the other parents (with a variety of engineering backgrounds) already knew more than me. I still have a lot to learn. I have discovered is that this allows the team to take ownership of their knowledge. They carefully explain their robot design and programming work to me, developing their understanding as they do so. They also take my inquiries well. When I ask why they do something, or if it can be done more efficiently, or if it should be done at all, they know I am asking because I don't know. It is an opportunity to take a step back and solidify their thoughts or take a new approach.

Know your strengths and weaknesses. I have coached before . . . in a completely different field. For years I coached children's gymnastics. Those years taught me to be aware of team dynamics, as well as how to focus on one individual while maintaining a connection with others.

"Coaching isn't about the coach. It is about the team."

RESOURCES: CORE VALUES ACTIVITIES

NEWSPAPER TOWER Core Values Activity

By Sanjay and Arvind Seshan



Objectives:

- Coming up with creative solutions to a problem (there are many ways to solve this challenge)

Before you begin:

- 2 full sheets of newspaper

HATS OFF! CORE VALUES ACTIVITY

By The Bayou Builders




Objectives:

- Exercise
- Work
- List

Notes for the Coach/Team

ACT IT OUT Core Values Activity

By Sanjay and Arvind Seshan



RECYCLED ART CORE VALUES ACTIVITY

By The Bayou Builders



Objectives:

- Working together to develop an action plan
- Choosing from a large set of items in a short amount of time
- Exercise creative thinking
- Explaining the decision making process utilized

Notes for the Coach/Team

recycled. Packaging works

RESOURCES: PLANNING & SCORING TOOLS

Resources for FLL

Wheel Converter: Automatic Distance to Degrees

This tool can be used to easily convert your wheel/tire size information into useful data to be used by your First Lego League team.

STEP 1: Enter Wheel Dimensions

Input your wheel diameter in millimeters *-OR-* You can click one of the tires commonly used by FLL teams below.

STEP 2: Enter Distance Robot Needs to Move

Input the distance you would like the robot to move in either inches or centimeters:

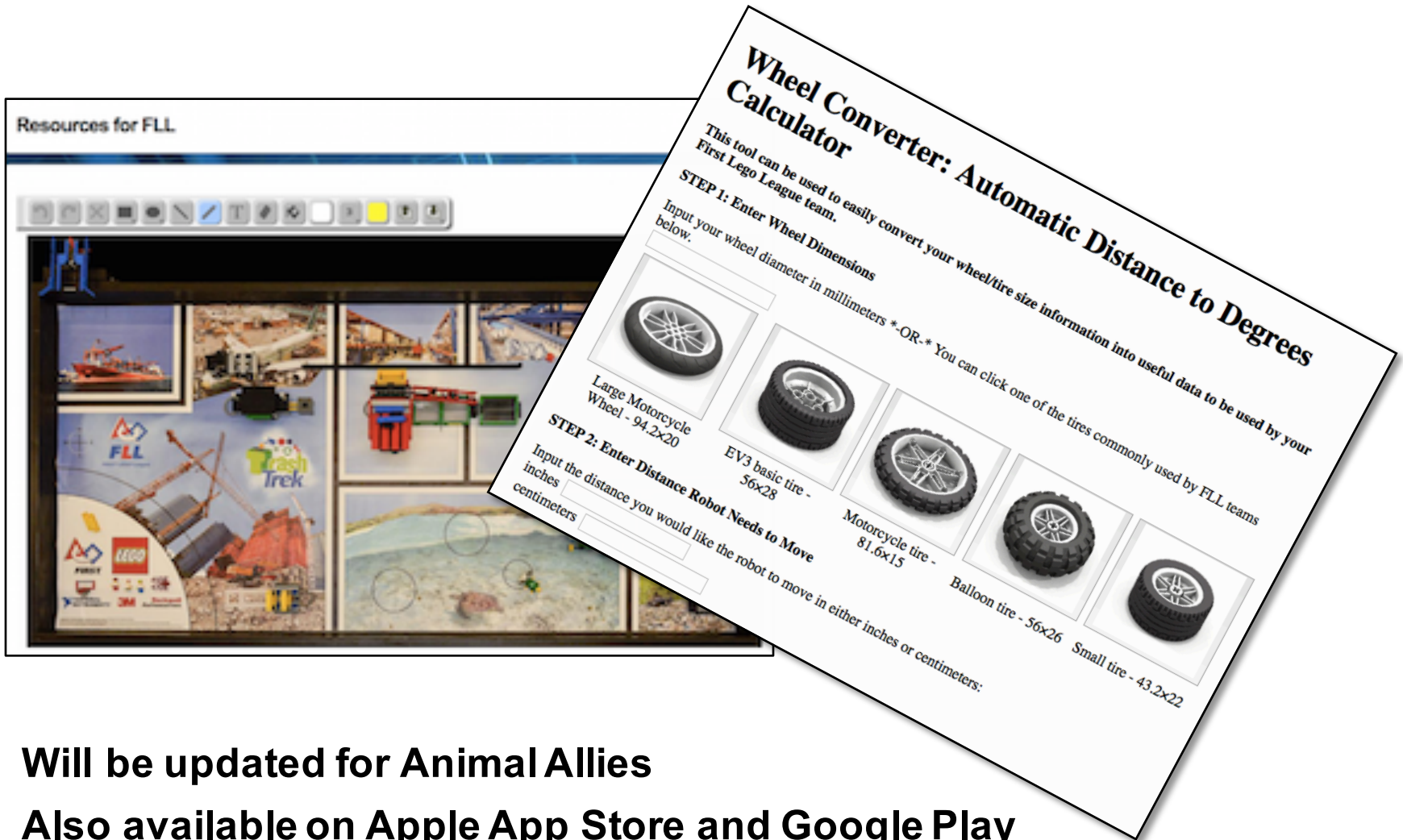
Large Motorcycle Wheel - 94.2x20

EV3 basic tire - 56x28

Motorcycle tire - 81.6x15

Balloon tire - 56x26

Small tire - 43.2x22



Will be updated for Animal Allies

Also available on Apple App Store and Google Play

CREDITS

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More lessons are available at www.ev3lessons.com



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