Fun with LEGO MindStorms Robot Inventor 51515 set for Absolute Beginners using LEGO Scratch

July 2022 Edition 2

DrGraeme

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Introduction and Overview

Do you have a LEGO Robot Inventor 51515 set, and you want to quickly learn how to teach your robot to obey your commands?

Perhaps we can help.

Included with LEGO's Robot Inventor 51515 set are instructions for building five huge, motorized robots. These are marvelous if you have the time to build them. However, we were contacted by some teachers who were considering buying these sets, but who wanted simpler robots that could be built and programmed using LEGO Scratch in less time than it takes to build these 5 wonderful, but slow-to-build robots.

Let us start. 😊

Can your computer use the LEGO Robot Inventor set App?

Before buying a set, you will want to know if this set work with your computer?

LEGO says that the LEGO Robot Inventor Set App. works with many (but not all) of the versions of computers, smartphones and tablets from Apple, Google, Amazon Fire and Windows.

To see if this set works with your computer, LEGO suggests that you see if you can download, install and successfully start up the Robot Inventor 51515 App. on your equipment.

If you can, this set is very likely to be suitable for your computer equipment.

We also need this App. later when setting up our Robot Inventor Set.

So, install it now by clicking on the image above, or by typing the link below into a browser!

https://youtu.be/Y-AtbxpUJrM

Unboxing the LEGO Robot Inventor 51515 set

In the video below we unbox our Robot Inventor kit.

LEGO does not provide compartments for storing the LEGO components in the Robot Inventor set. We demonstrate some boxes that we have found that are very convenient for sorting out and storing separately many of the small LEGO components. This will make finding components much easier when we are building new robots in the future.

Run the video by clicking on the image above, or by typing the link below into a browser!

https://youtu.be/gZ-cd2ph2fE

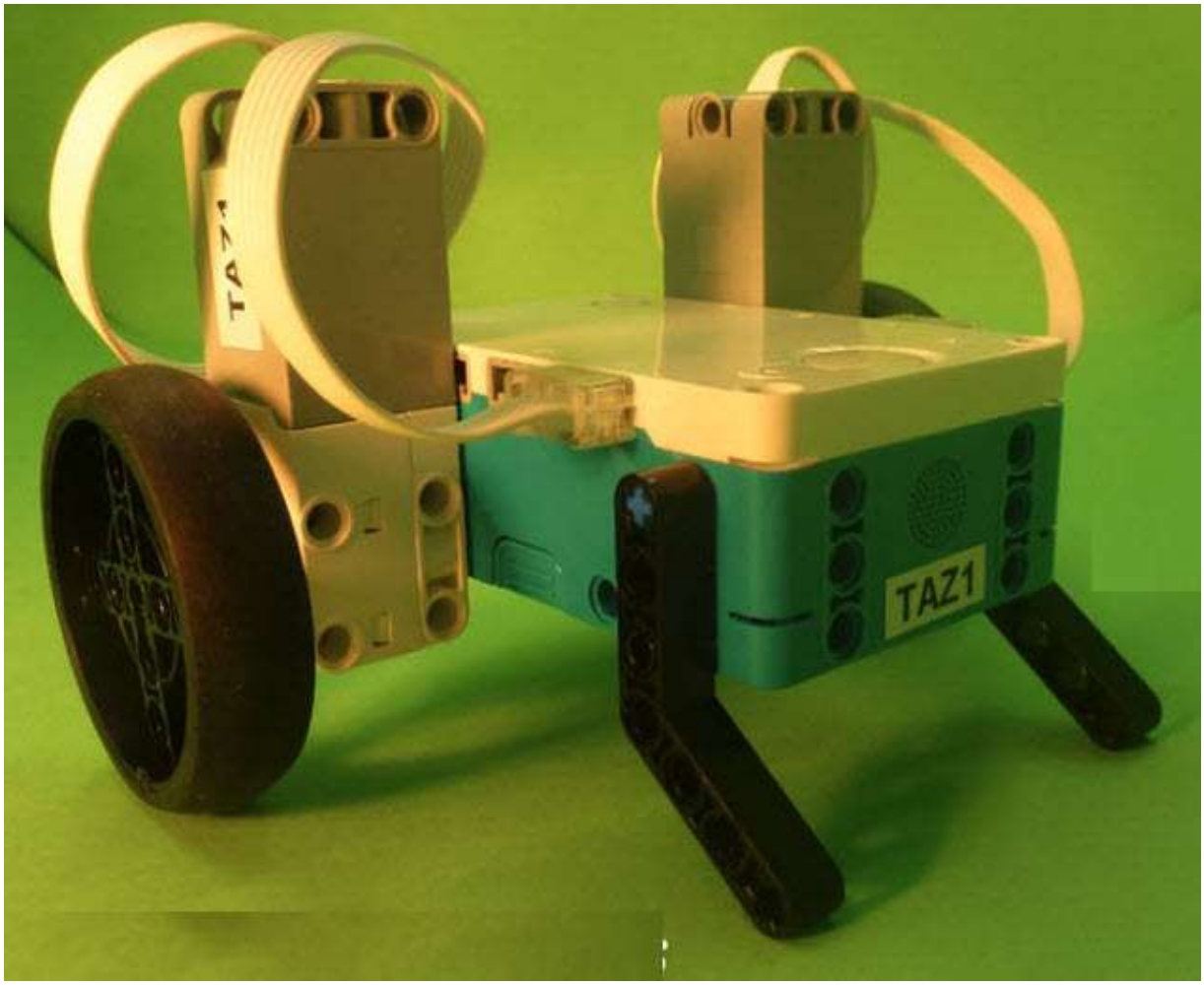
Updating the LEGO Robot Inventor 51515 set Hub and Motors for the first time.

Before the Robot Inventor 51515 set can be used for the first time, the Hub and four Motors should be all updated. They are updated by downloading software from the Internet. The video below aims to show Absolute Beginners how to go through this process for the very first time.

Run the video by clicking on the image above, or by typing the link below into a browser!

https://youtu.be/l7CchgtixXs

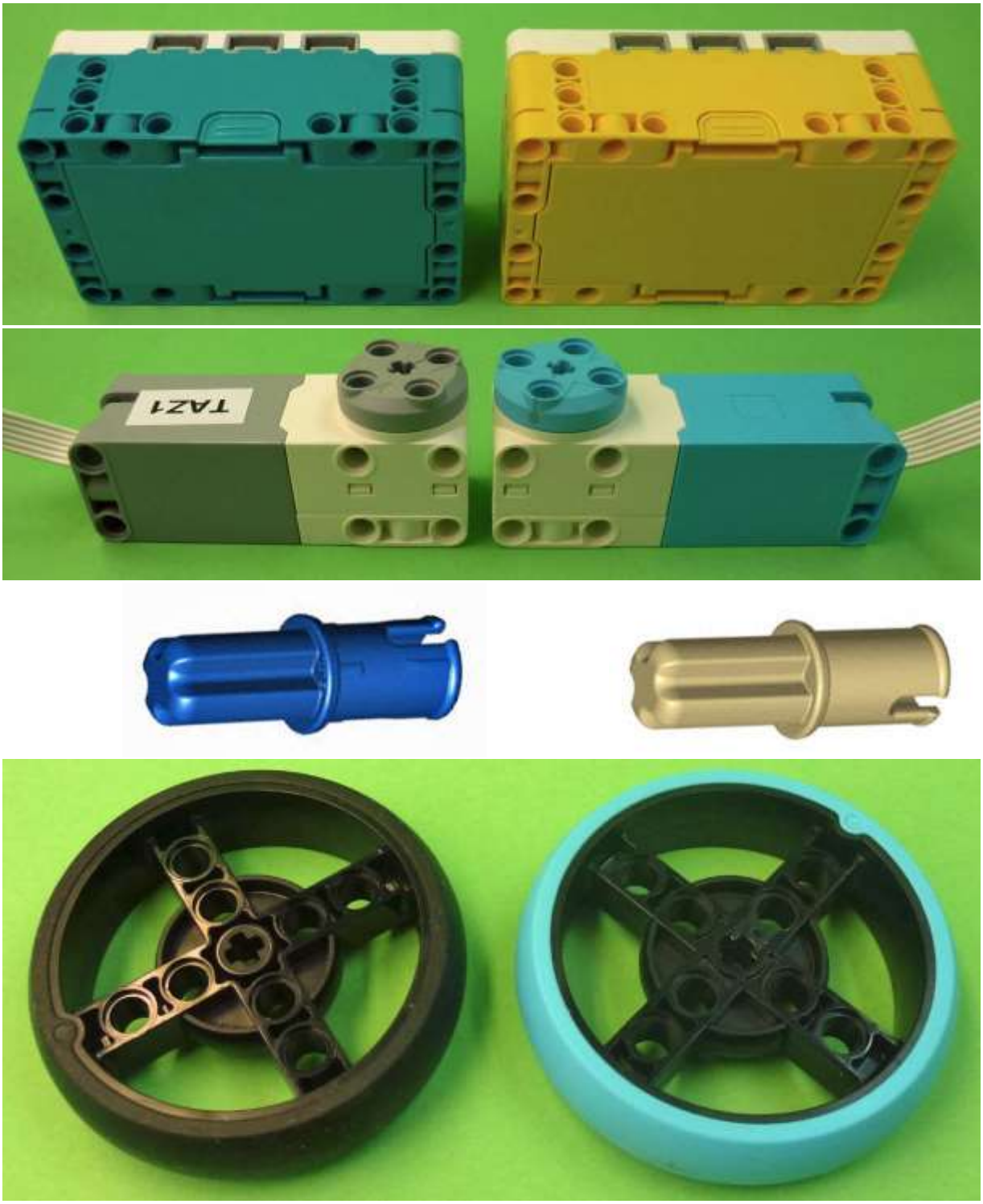
Your First Robot TAZ1.



This tutorial shows how to build a very small LEGO Robot that we can make quickly. A fast build means that we can have fun coding much sooner. Let's start!

In this build I use pieces from the LEGO Robot Inventor set. If you have a LEGO Spike set, you will have the same pieces, but they will have different colors, as shown on the next page. You can build the same robot from each set - it is just the colors that are different.

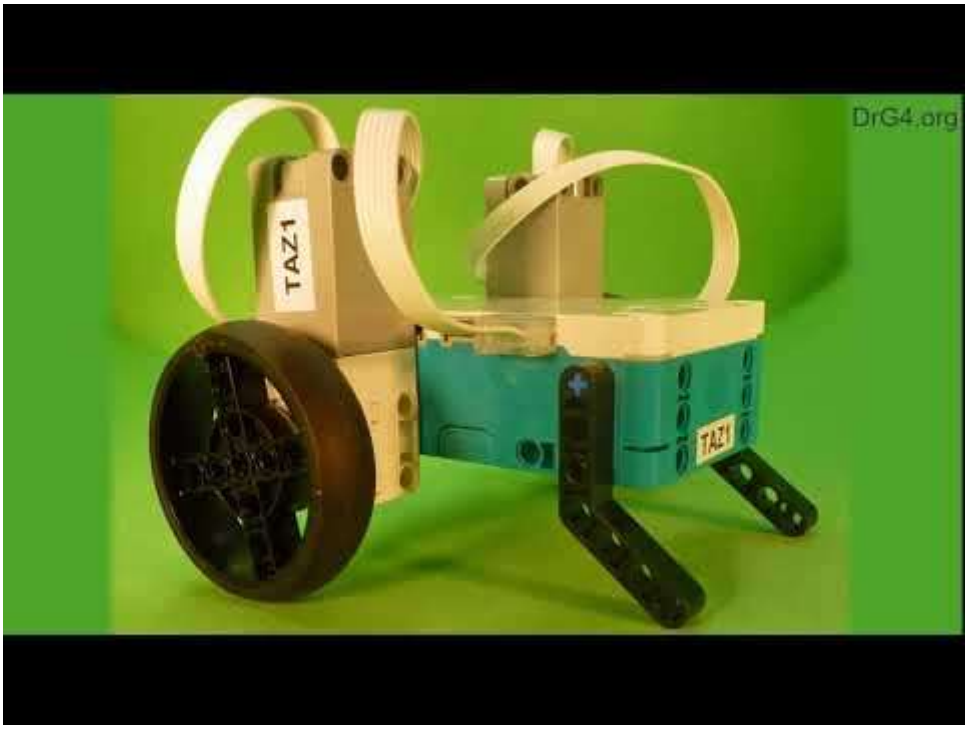
The "LEGO Robot Inventor 51515" pieces are on the left. The equivalent "LEGO Spike 45678" pieces are on the right.



Building your first Robot TAZ1 (Video)

The video below shows you how to build your first Robot.

If you prefer to build using images, more detailed build pictures are available starting on the next page.



Run the video by clicking on the image above, or by typing the link below into a browser!

https://youtu.be/yLIXOsQ8DZY

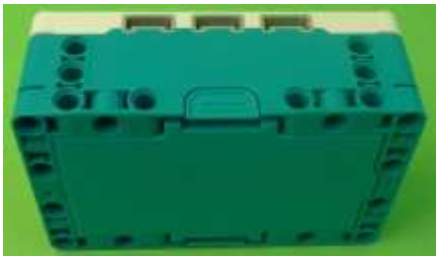
If you have built your robot using the video, go to page 18 to find out how to start running code on your robot.

Building your first Robot TAZ1 (Images)

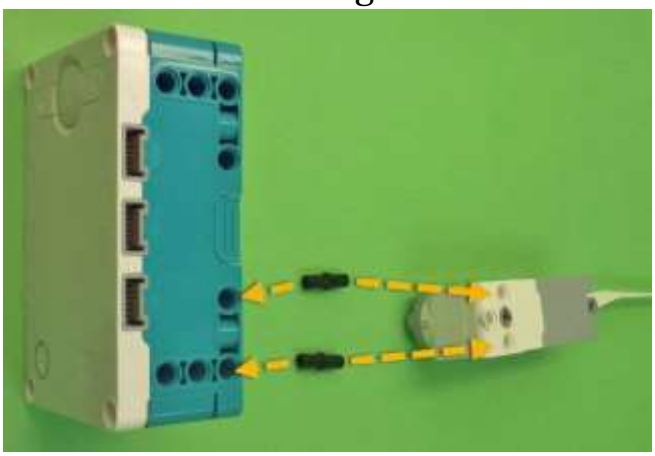
TAZ1 Build Step 1

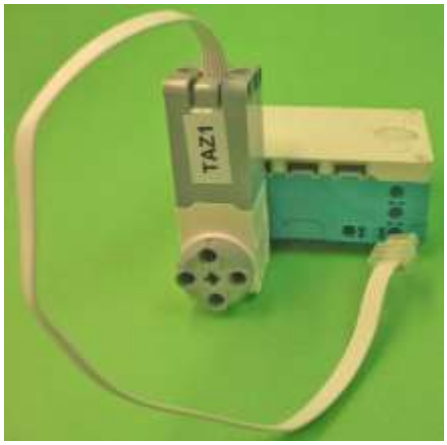
I have labeled my bigger LEGO pieces "TAZ1". Invent your own name! Names are a good idea because it saves confusion with other sets.

Next find these pieces:



Now connect them together:

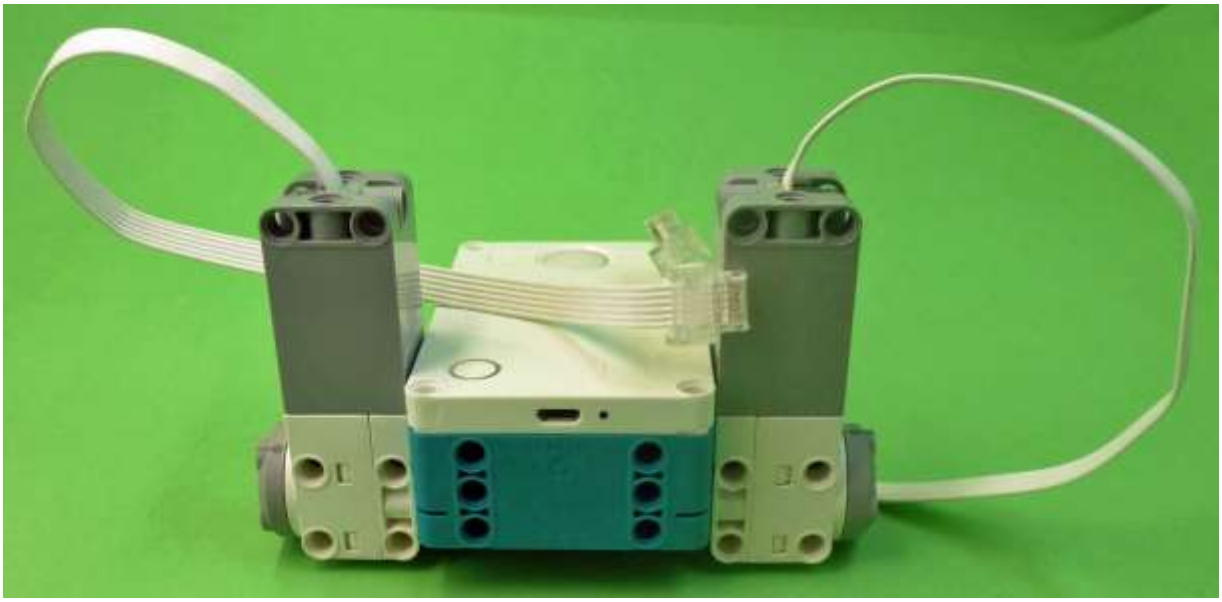




TAZ1 Build Step 2

Find these LEGO pieces.

Join them together.



TAZ1 Build Step 3

Find these LEGO pieces

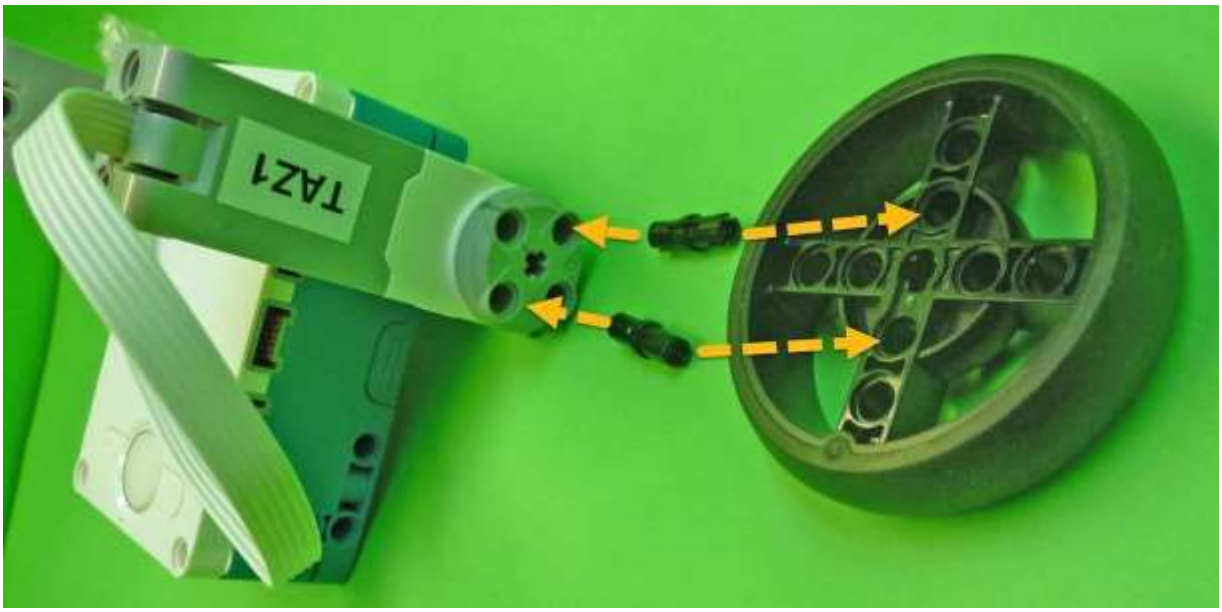
.

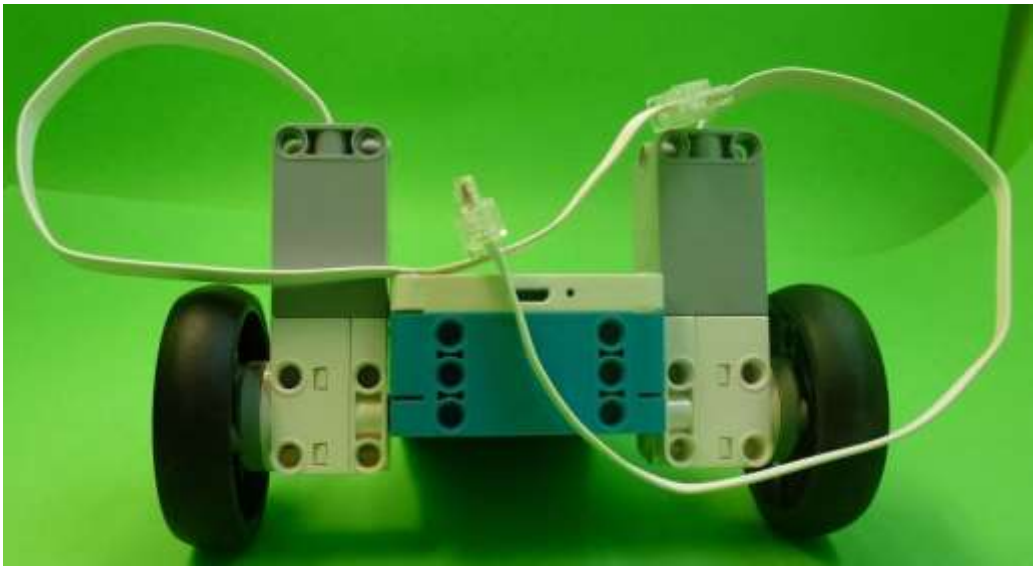
Join them together.

TAZ1 Build Step 4

Find these LEGO pieces.

Join them together.

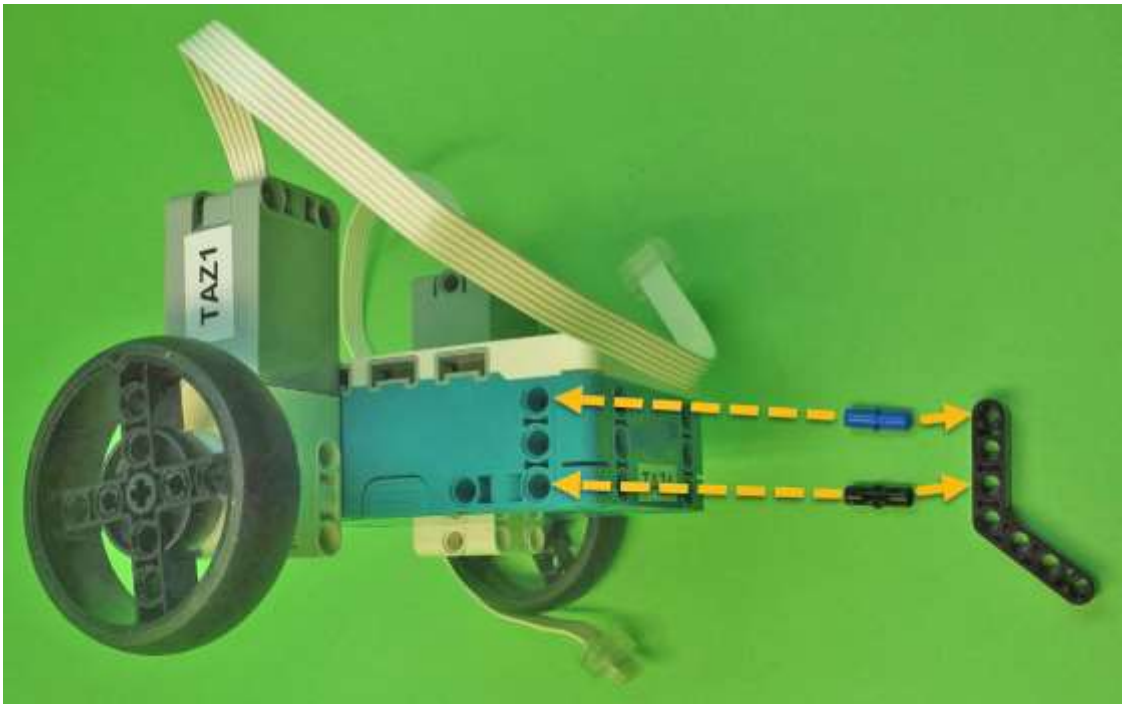


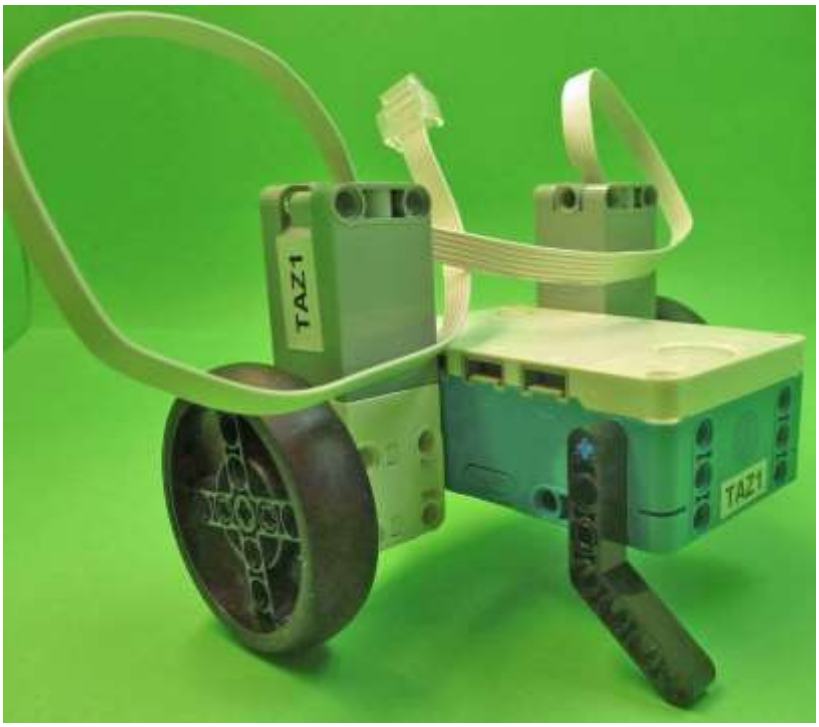


TAZ1 Build Step 5

Find these LEGO pieces.

Join them together.

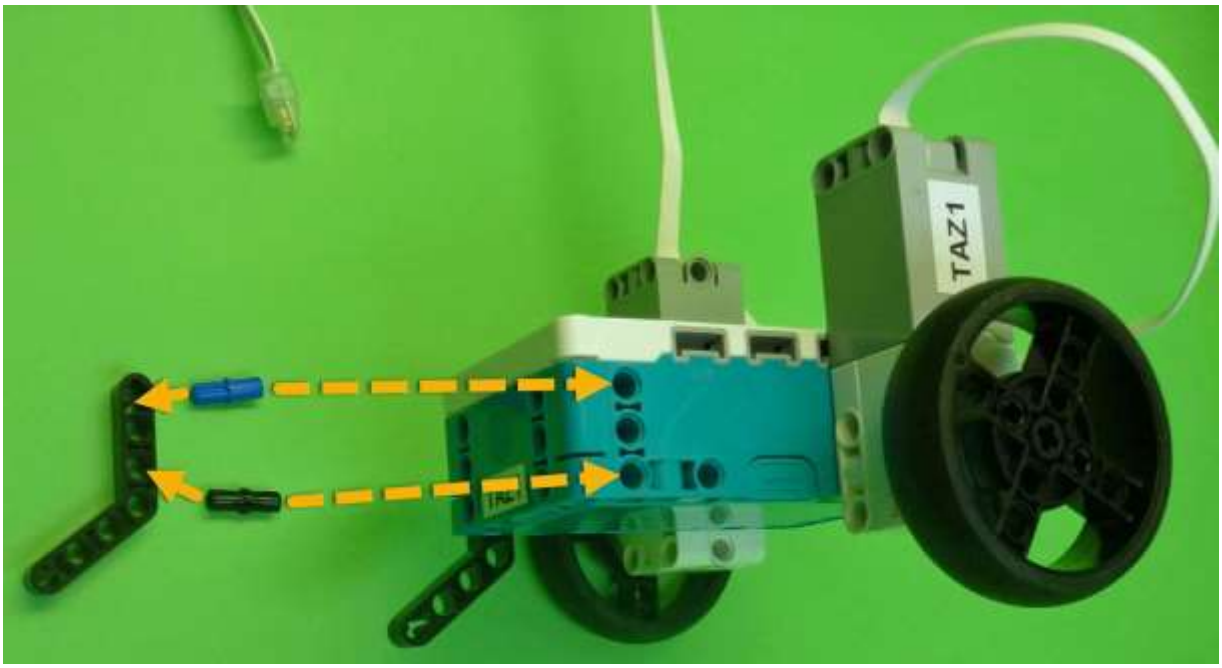


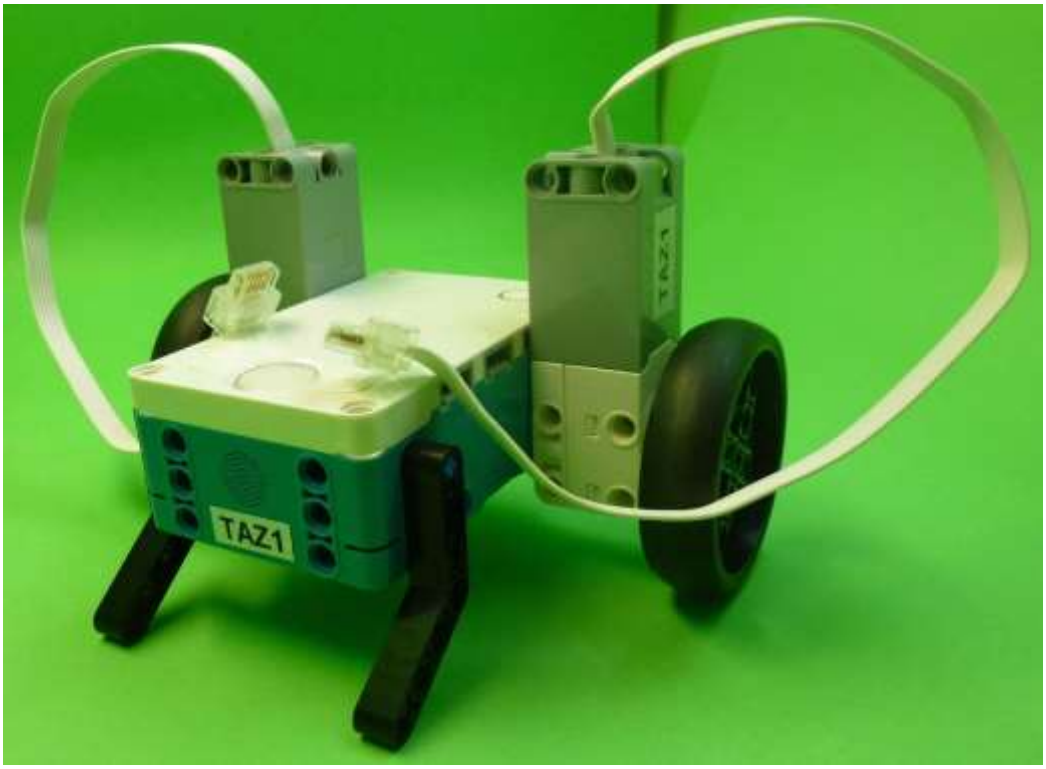


TAZ1 Build Step 6

Find these LEGO pieces.

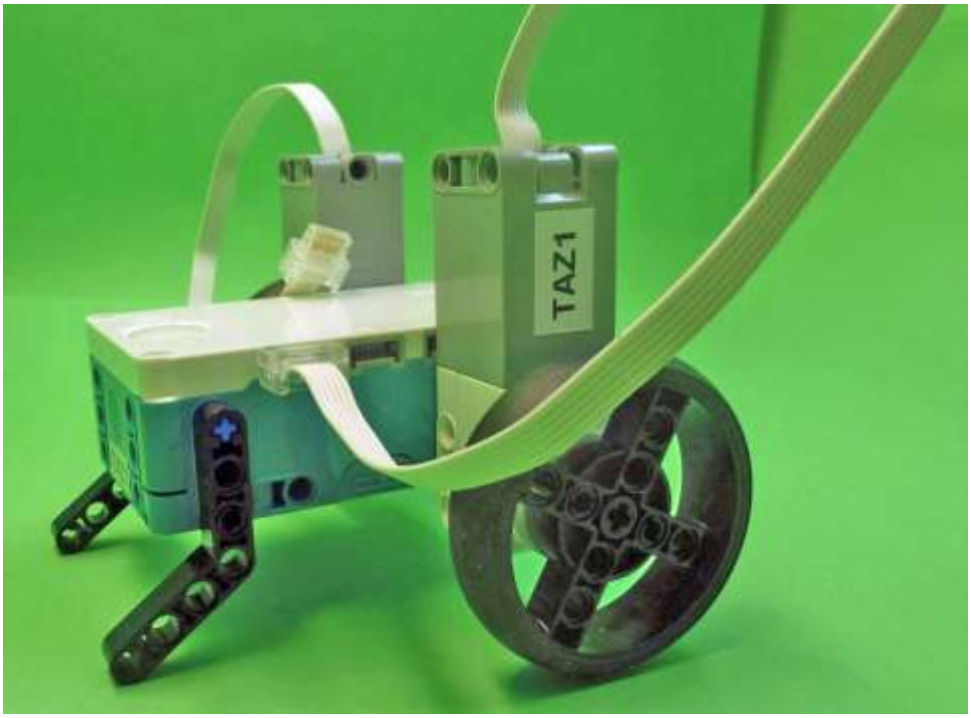
Join them together.





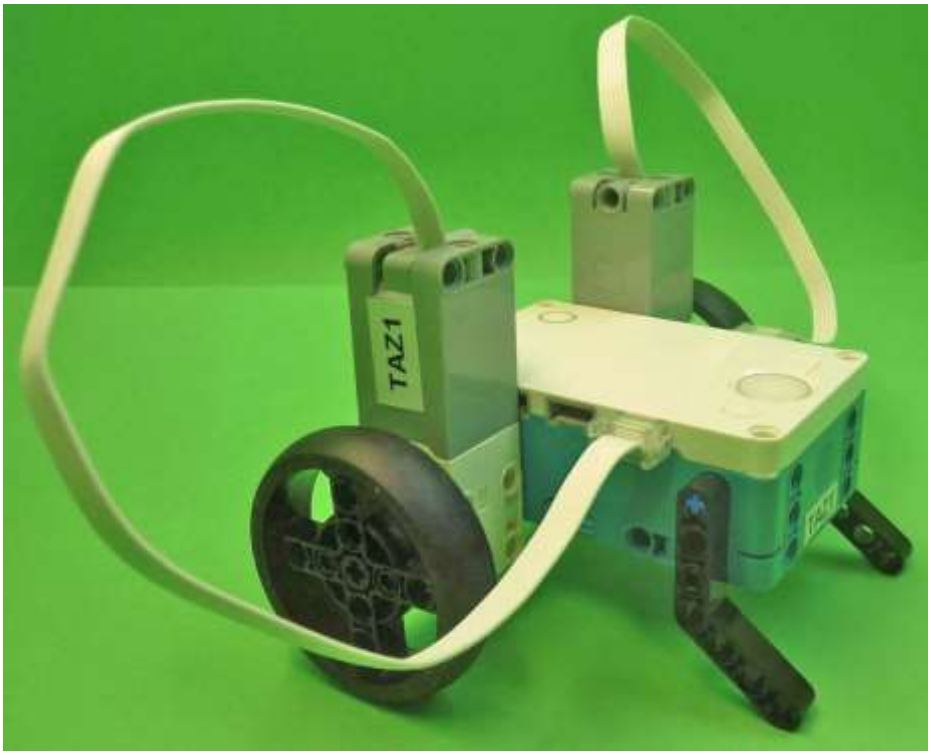
TAZ1 Build Step 7

Compare the cable plug and the slot in the computer brick. The plug only goes in one way – DO NOT try to force it in upside down. When you have the plug the right way around, carefully put the plug in to the slot.



TAZ1 Build Step 8

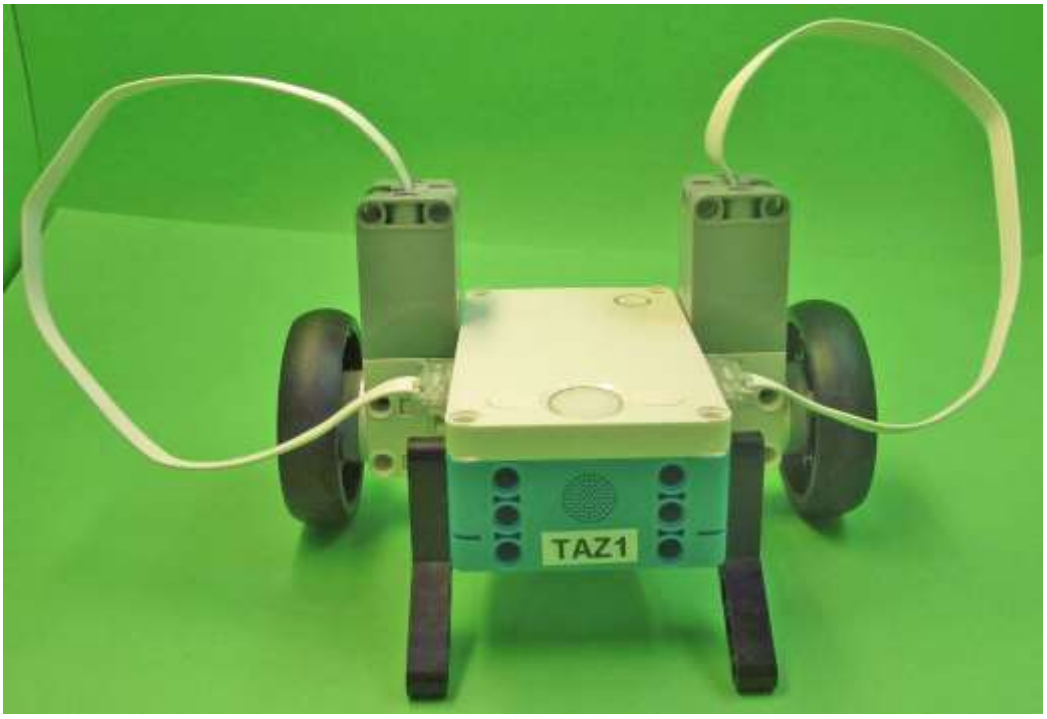
Compare the cable plug and the slot in the computer brick. The plug only goes in one way – DO NOT try to force it in upside down. When you have the plug the right way around, carefully put the plug in to the slot.



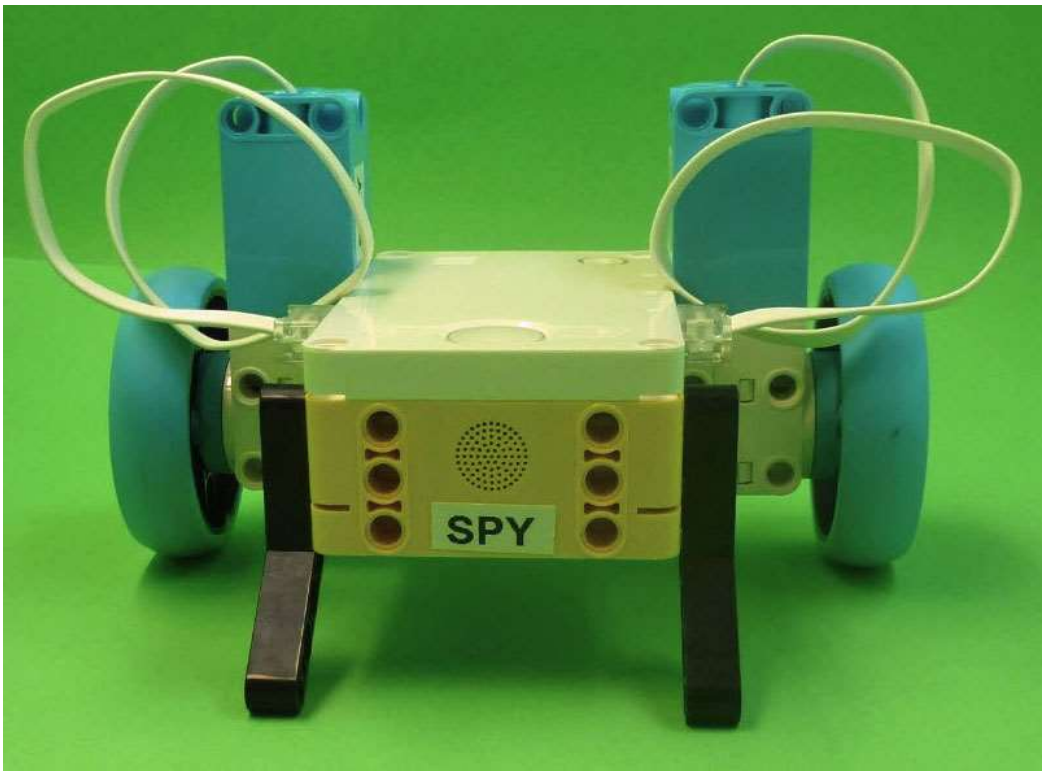
TAZ1 Build Step 9

Congratulations – You have built your first LEGO robot!

TAZ1 looks like this:



If you have followed this build using a LEGO Spike Set, your first LEGO Robot (we called ours “SPY”), will look like this:

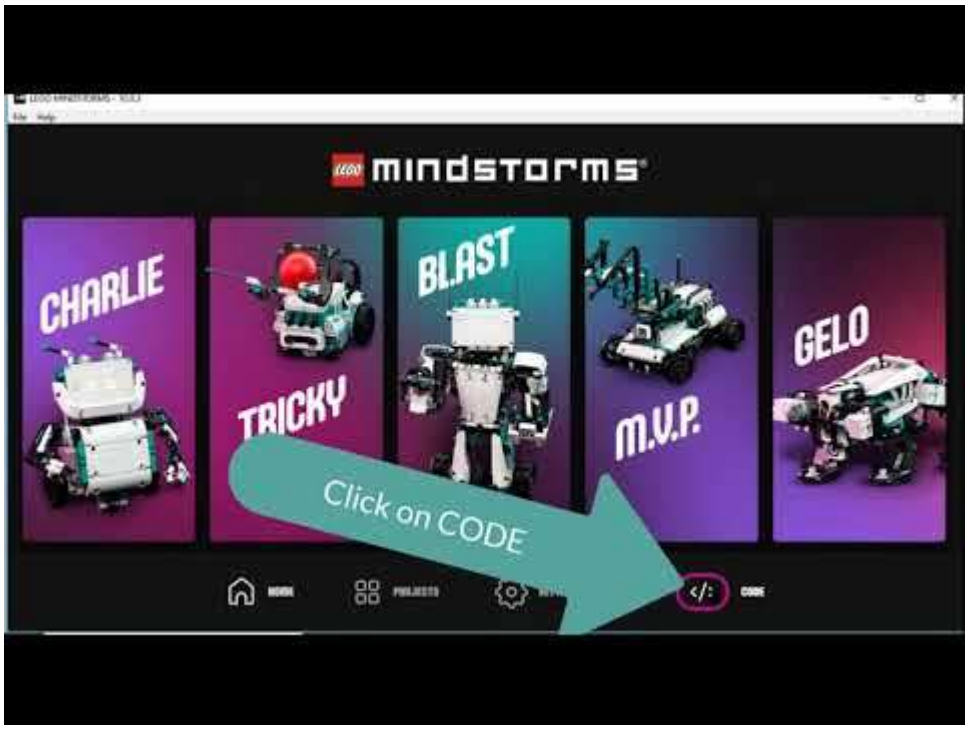


First Scratch and Python Code using our TAZ1 LEGO Inventor 51515 set Robot

Before our Robot Inventor 51515 set can be used for our first big Challenge, we need to check that we can get tiny programs running using our computer equipment.

In this video we demonstrate how to run tiny Scratch code with our TAZ1 Robot via USB, Scratch code with our Robot connected via Bluetooth, Python with our Robot connected via USB, and Python with our Robot connected via Bluetooth.

If these work, we can start on larger code projects with the confidence that our combined computer and Robot set-up is very likely to be correct.



Run the video by clicking on the image above, or by typing the link below into a browser!

https://youtu.be/g9rLvGroIqQ

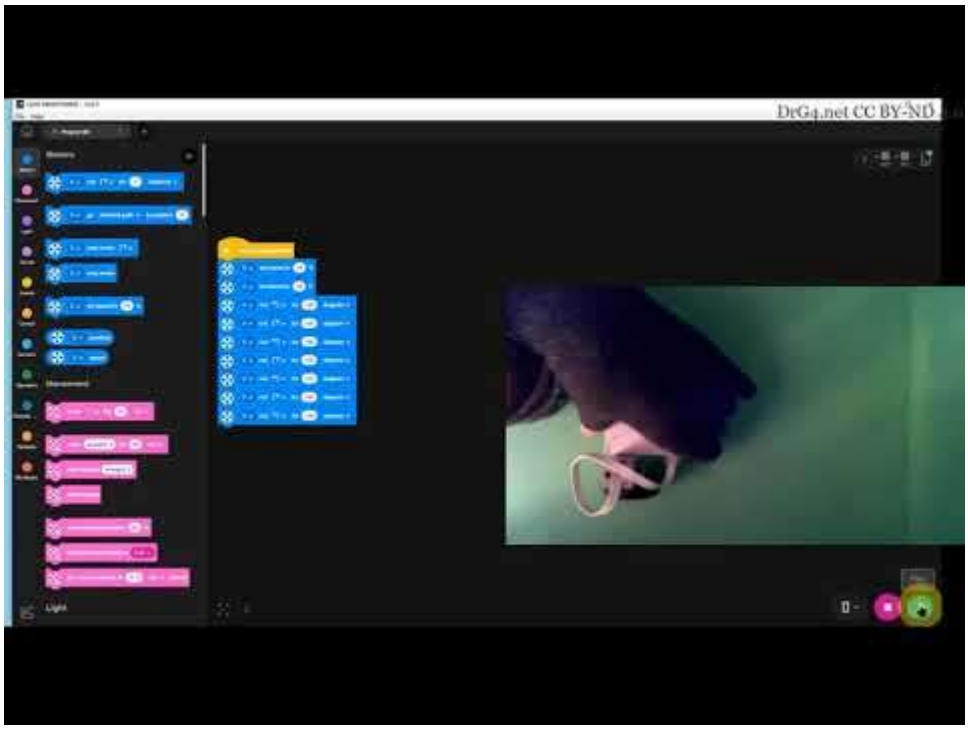
“Approaching An Alien” (TAZ1 Challenge)

This is the first "Absolute Beginners" Challenge for our LEGO 51515 Robot. We imagine that an Alien Ambassador has arrived on Earth. Since we are uncertain if the Alien is warlike, we will send a robot to investigate.

But how to communicate with an Alien? We look at what is probably the most alien animal on Earth, and compare it to us. We then demonstrate how to approach the Alien (hopefully) safely. We then get a bit concerned and retreat in panic!

We have found that “creating our Alien” can be a good-fun class art project. However, if you are short of time, one of the three downloadable images on this web page could be used to wrap around a bottle to represent an Alien.

Since this is our first "Absolute Beginners Challenge", we will show more detail than we will use in our later video tutorials.



Run the video by clicking on the image above, or by typing the link below into a browser!

https://youtu.be/QGL7ZkekubU

Adding Back Wheels to TAZ1 Robot

TAZ1 is good on smooth surfaces. However, when TAZ1 has an adventure on the rough floorboards, or on the carpets with ridges that we have found in some schools, TAZ1 can have problems going around corners when the back beams hit bumps.

The video below demonstrates how to add two small wheels to the back of your Robot.

Run the video by clicking on the image above, or by typing the link below into a browser!

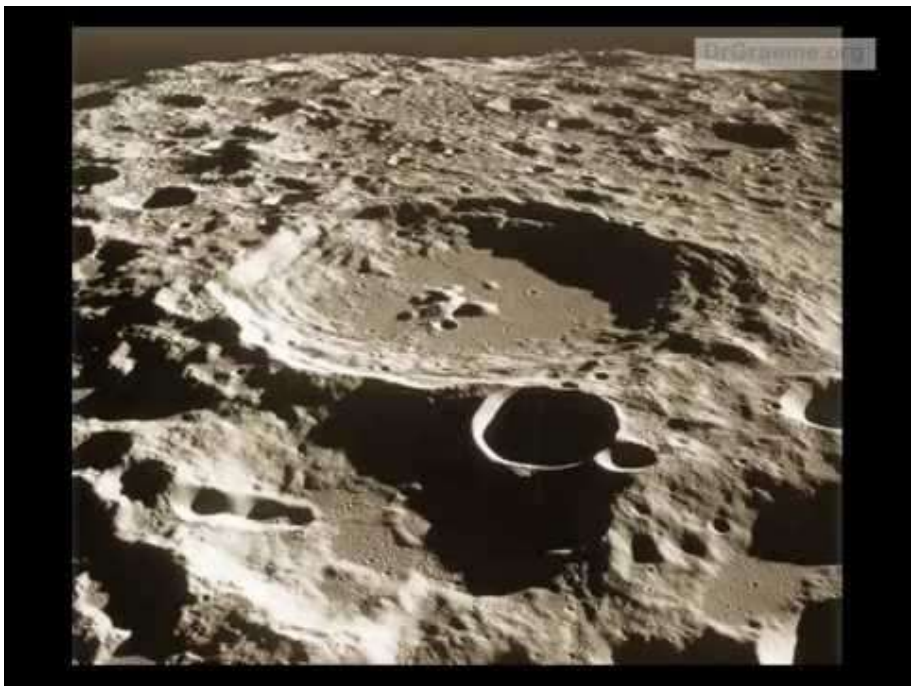
https://youtu.be/ggFLM2oFNOM

"Around the Moon" (TAZ1 Challenge)

This is the second "Absolute Beginner's Challenge" for our LEGO 51515 Robot. We imagine that our Robot is a space ship whose mission is to loop around the Moon and land safely back on Earth.

Let us set the scene

by using a video of an older LEGO robot:



Run the video by clicking on the image above, or by typing the link below into a browser

https://youtu.be/aq5sNrHw2Io

Next, we need a pretend "Earth" for our pretend Robot spacecraft to leave, and then back come safely back to land after the journey into space. A pretend "Moon" to go around, would also be useful.

You can see a possible Earth/Moon arena image on the next page. This page gives an Earth-Moon separation of just under 6 inches (≈15 cms). If you want your Earth and Moon to be further apart (as mentioned in the video above) you can find some useful hints by either going to Appendix 1 of these notes, or by clicking here.

An image of the moon that can be used to wrap around a bottle to form the pretend "Moon" is on the page following the Earth/Moon arena image.

How to Teach TAZ1 to Move using LEGO Scratch.

In this Challenge we teach our Robot how to go "out into space" alongside our pretend Moon, circle around our pretend Moon, and try to land safely back on the Earth, without being stranded out amongst the asteroids!

First we have to obtain our arena.

Print out the next two pages of this document. Place the Moon image (page 24) around a bottle or piece of wood. You may have to use sticky tape to make it connect to your bottle, carton or piece of wood.

Place your Robot on your pretend Earth, and your "Moon" on the Moon image on your arena.
The scene will probably look something like the image below.

If you need a bigger arena, some assistance based on our past teaching is available in Appendix 1 of this document, or by clicking here.

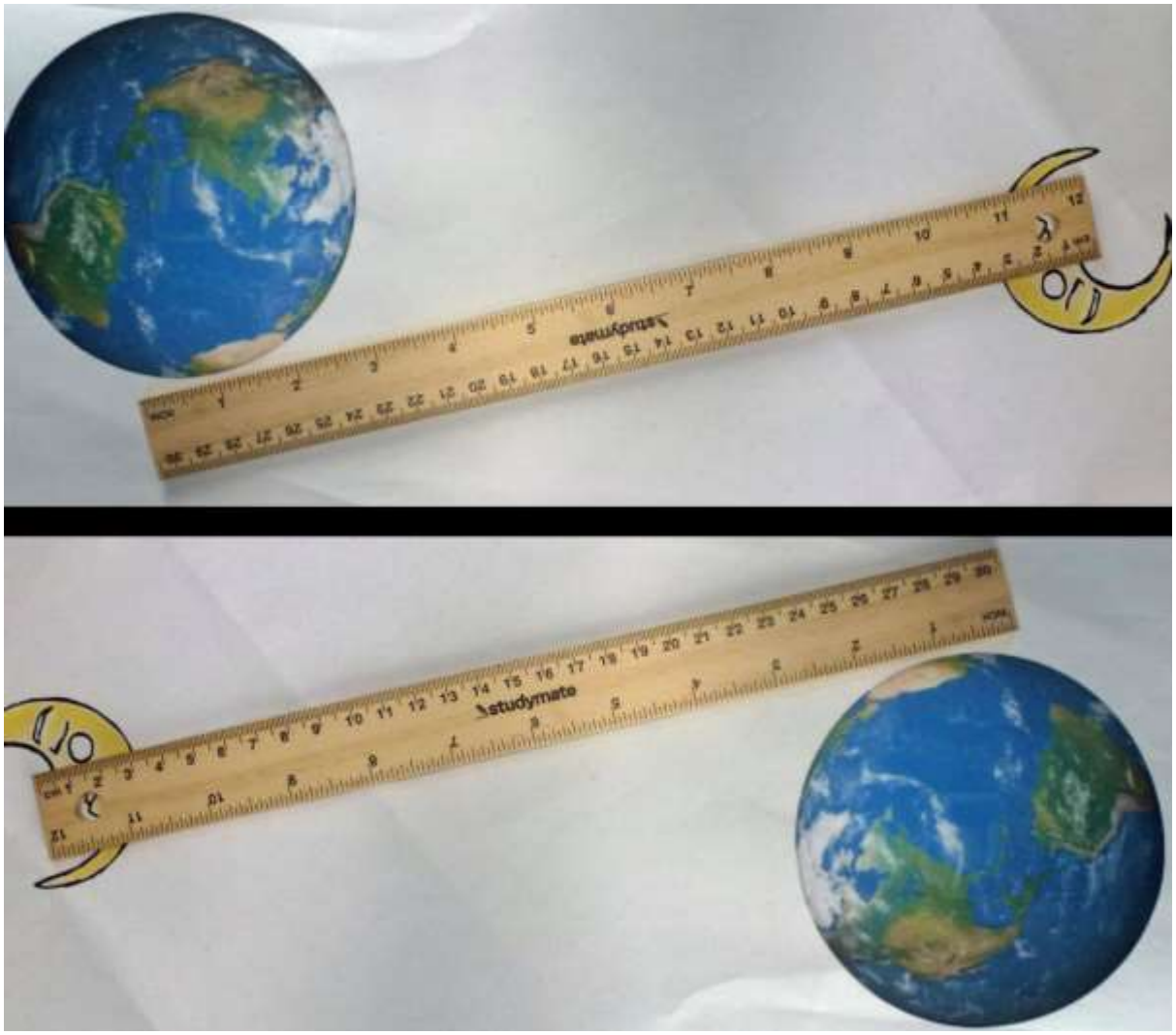
The video below demonstrates how to start this Challenge

Run the video by clicking on the image above, or by typing the link below into a browser
https://youtu.be/dw59ZckNQV0
If this video is sufficient guidance, continue reading from page 29. If you prefer text-based guidance, continue reading from the next page.

Teaching Your Robot to go straight

To start up LEGO Robot Inventor, go to your Windows 10 start icon and select the **MINDSTORMS** item. Click on it. Next, click on **CODE**.

Next, we need to know how far to send our Robot forwards to arrive near our pretend Moon. .



Take a ruler and measure this distance. In our case it is about 23 cm (about 9 inches).

To connect your Robot to your computer, click on the screen icon with a small red dot on the top right of your screen. Then click on **Bluetooth**, and follow the on-screen instructions to connect your Robot to your computer using Bluetooth.

Next click on the **Connect** button at the bottom of the screen. You will now see that the icon on the top right of the screen now has a green dot instead of the red dot. The green dot means that your Robot and your computer are connected by Bluetooth. Good work!

Next look at the LEGO Scratch commands on the left-hand side of the screen, we find a pink command which says, **"move straight:0 for 10 cm"**. Click on this and bring it underneath the yellow "**when program starts**" command. Change the 10 cm to 23 cm.

To see if our command teaches our Robot to move from our pretend Earth to a position alongside our pretend Moon, click on *the round* ***green circle*** *with the white triangle* in the bottom right of your screen. What happens?

Oh dear. Nothing happens. *Click on the* ***red circle*** to stop the program running.

The problem is that we have not told our Robot which motors we want it to use when it moves forward.

Find the command which says, "**set movement motors to A+B**". Place it between the yellow and the pink commands in your list of instructions.

Now check your Robot and see that the motors are in fact plugged in to slots E and F on your Robot. Change the Scratch command **A+B** to **E+F** by clicking on the E and F rectangles in the hub diagram that we see when we click on the A+B. So now we have the correct command. Good. Now start your Robot again by clicking on the green circle on the bottom right of the screen.

Hurrah! Your Robot moves forward.

However, you will notice that the green circle at the bottom of the screen is still rotating even though our Robot has stopped. This is because we have not put a "stop" command at the end of our program. Click on the round red stop icon to stop the code running.

Find the yellow "**stop all**" command. Add it to the end of your program. Click on the "all" and select the "**and exit program**" option.

Have another run. This time you will note that there is no longer a circle rotating on the green start command at the bottom right of your screen, and your program has ended correctly. Excellent!

Your Robot arena will probably now look something like the image on the next page.

Teaching your Robot how to go around a curve.

Next, we need a command to go in a curved path around our pretend Moon.

Again, find our pink "**move straight:0 for 10 cm**" command. Move it just under our previous similar command.

This time, however, click on the "**straight:0**" and you will see an arrow within a circle. Move this in a clockwise direction so that the tip of the arrow goes to your right, until the number reaches about 40. Why 40? We do not know what number is a good one, so we just guess. 40 seems as good a number as any other number! What distance should our Robot move? Again, let us guess a distance. Change the **10** to **40**. We can always change it later and have another run if we are wrong. Now try a run.

Well, looks good, apart from the fact that our Robot seems to have ended up heading out towards Mars!

Change the turn number to 50, and the distance number to 80 cm. Let us run again.

That looks much better. We need to go a bit further because we need the Robot pointing back to Earth, so we can use a "**move straight:0 for 10 cm**". command to end up back on Earth. We have to guess or measure a number to replace the "**10**" .

You finish the "Around the Moon" Challenge yourself! 😊

Because this is a Challenge, we are not going to tell you the exact instructions to get your Robot safely back to Earth!

Experiment!

Change each of the numbers in your commands and see how they change where your Robot goes.

Now have fun finding out how to teach your Robot how to leave your pretend Earth, go around your pretend Moon, and land safely back on your pretend Earth. ? Let us see if you can solve this Challenge all by yourself! 😊

There are many different "correct" answers to this Challenge. A "correct" answer is one that lands your robot safely back on Earth. If you are in a class, probably each member of the class may have a different program. Having different programs is fine. Take a look at the other solutions and see how they differ from yours. Can you change your program, and still have your Robot land safely back on earth?

At the web page linked below, you can see some extra ways that other students have sent their Robots "Around the Moon". Some are quite fancy! Have fun seeing if you can change your program to make your Robot go "Around the Moon" like theirs?

Good luck, and have fun sending your Robot around your Moon. 😊

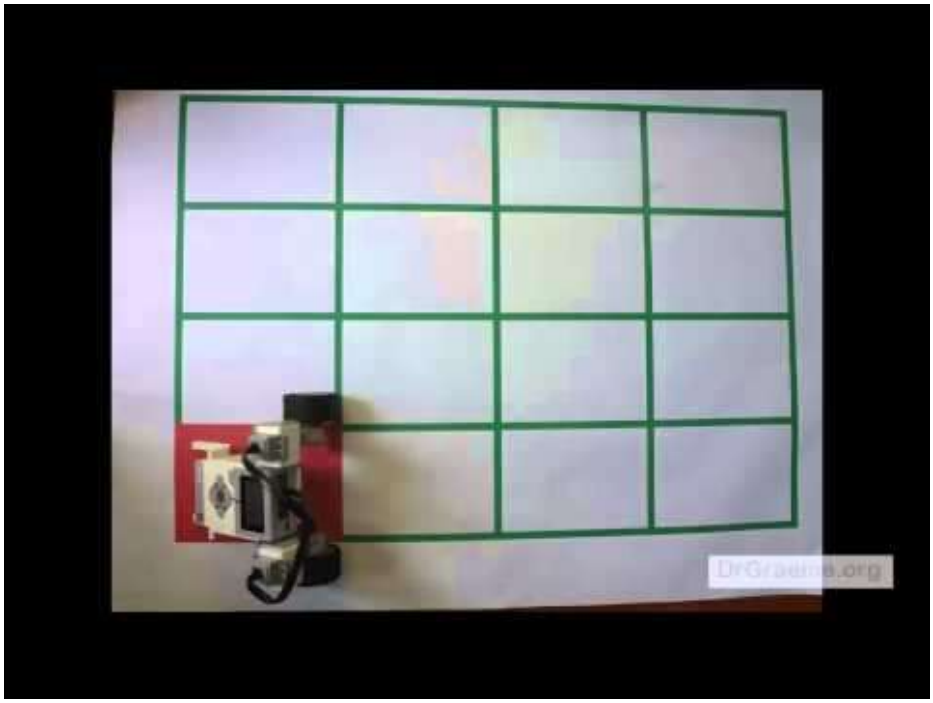
Further assistance:

If you need some more help, some is available by going to Appendix 1 of this document, or by clicking here.

"Cleaning a Floor" (TAZ1 Challenge)

Cleaning floors is not always fun. Let us teach a robot to do this for us.

Our pretend "floor" is divided into squares, and to "clean" this floor our Robot must pass over each square



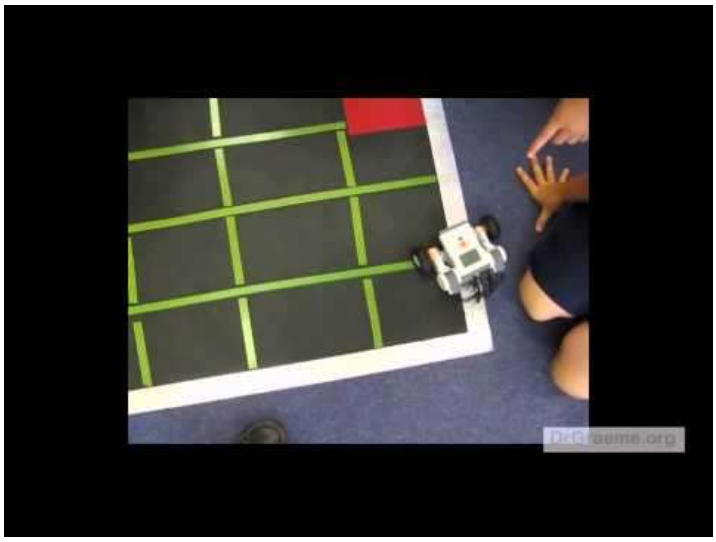
To see an overview of this Challenge, click on the image above, or type this link into a browser https://youtu.be/THm8CH3xsBA

If you have access to an A1 printer, a pdf template that we have used for this tutorial can be downloaded from this link

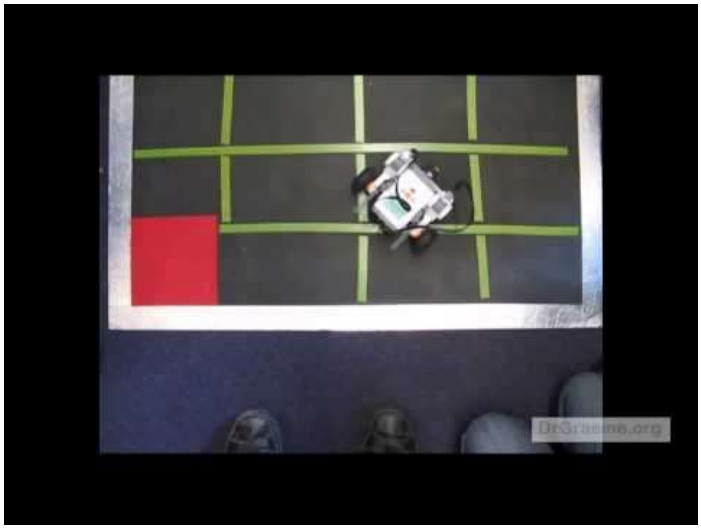
The squares can be passed in any order. Because this is a Challenge, we are not giving you detailed instructions about how to teach TAZ1 to clean

the floor. Use the "Around the Moon" commands you have already learnt to solve this Challenge.

You might get some good ideas by watching the very different ways that other students, using older Robots, have "cleaned their floors". These videos are from Huonville School and a TAG workshop.



Click on the image below, or type this link into a browser https://youtu.be/lTMPJYptDm4



Click on the image below, or type this link into a browser https://youtu.be/toolefmtjgA

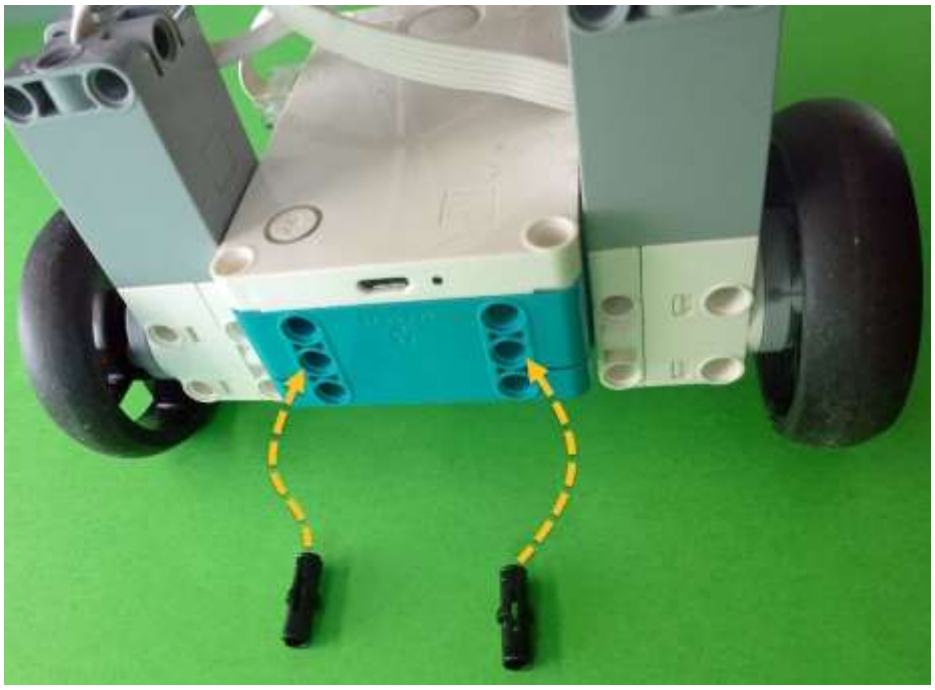
If you want some extra help in this Floor Cleaner Challenge, then the hints in either of the following links may soon prove useful. Appendix 2 of these notes, or (still under construction) by clicking on https://drgrae.me/51515-teacher-mentor-notes-floor-cleaner/

Adding a Color Sensor to our TAZ1 Robot

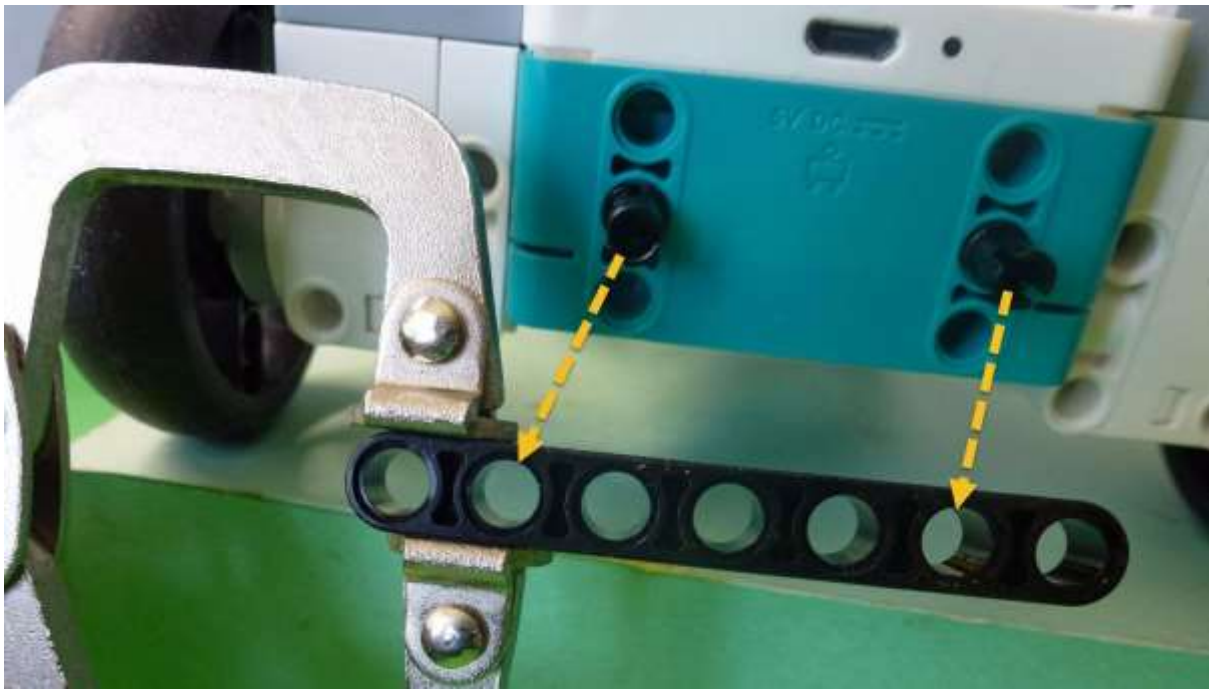
Our wonderful LEGO Robot Inventor 51515 set includes a Color Sensor.

If we add this Color Sensor to our robot, it will allow our robot to detect the colors blue, green, yellow, red, brown and the shades white and black. Sounds good! Let us add one to our TAZ1 Robot.

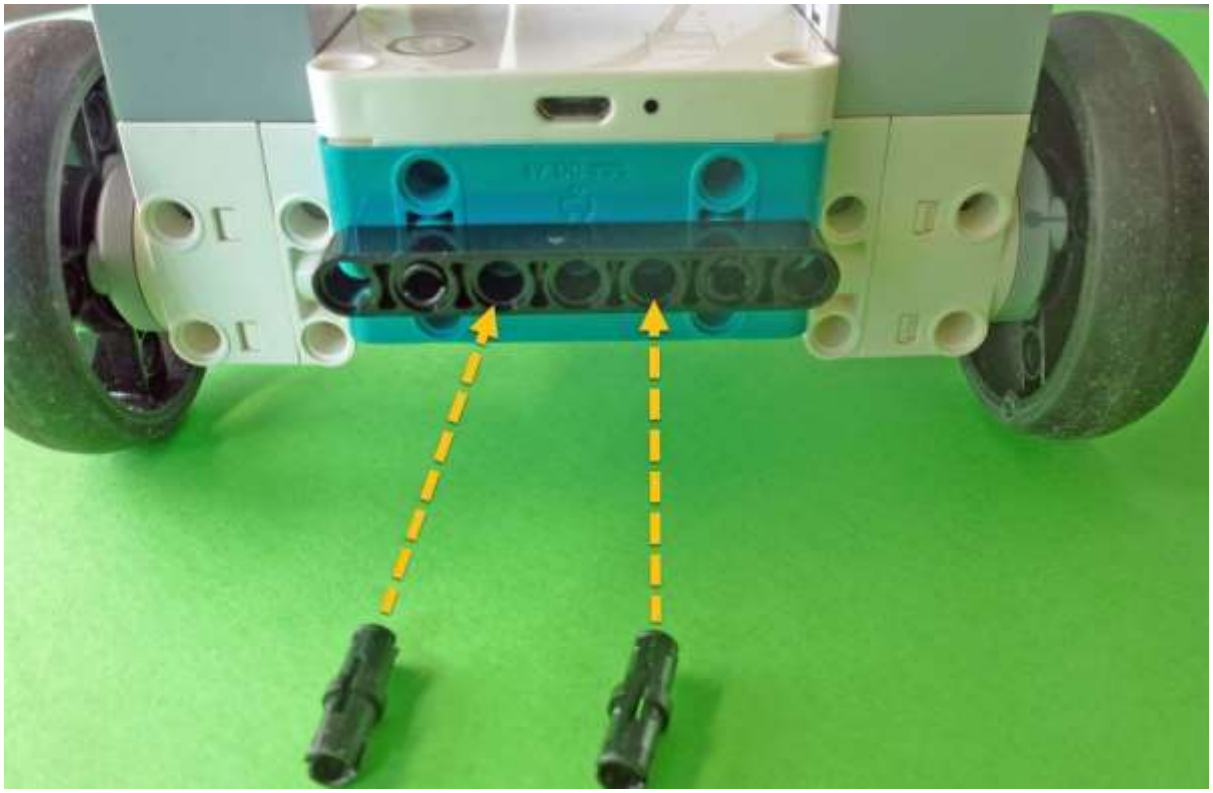
First, find two black pins, and attach them to TAZ1 as shown.



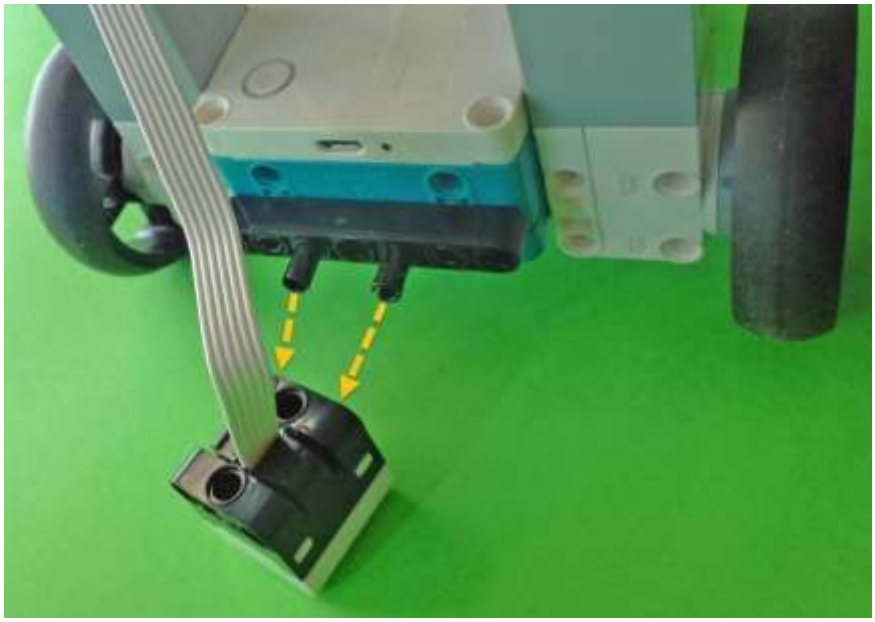
Secondly, find a 7-hole black beam, and attach it as shown, (ignore the silver clamp. It was used to hold the beam still for the photograph. 😊)



Add in two more black pins.



Attach them to the positions as shown. Now we can add in our Color Sensor (see next page).



Finally, we can plug the cable from the Color Sensor into slot C on our TAZ1 Robot.

Good work! Next we can teach TAZ1 to stop when it runs over a colored line.

Teaching TAZ1 to "Stop at a Line"

If you are playing with your TAZ1 robot at home, it is probably almost inevitable that your Robot will end up in some hard-to-reach spot, for example under a sofa. It would be nice if we could put a black or colored line around the area in which we want our Robot to play, and be able to teach our Robot to stop as soon as it sees the black or colored line. Using our Robot Inventor set's Color Sensor and Scratch, we can do that.

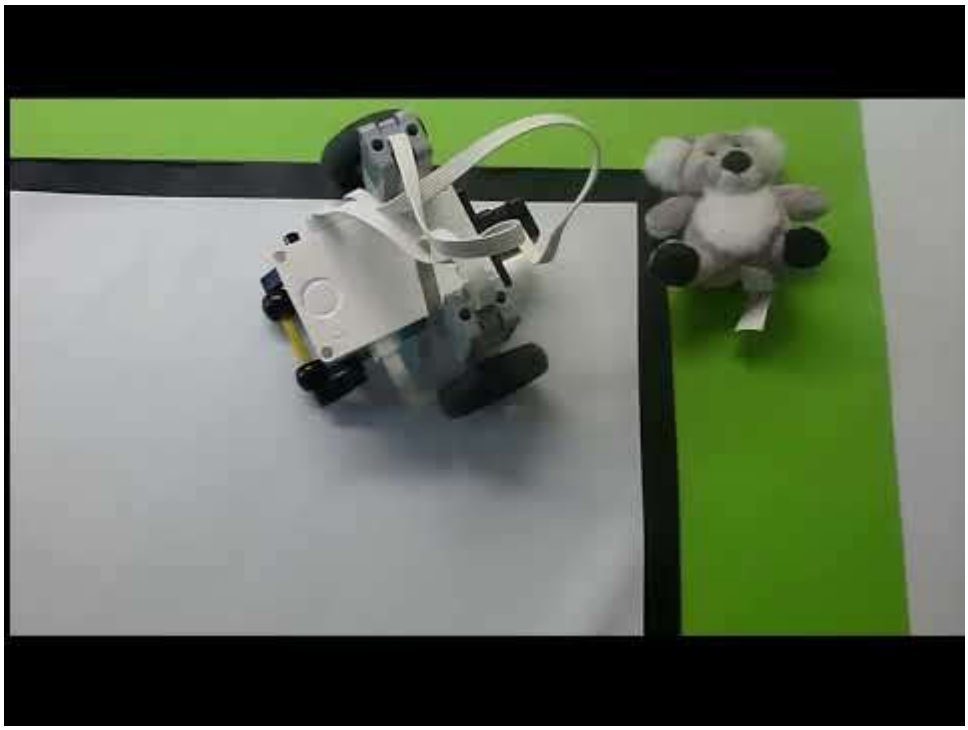
Click on the image above, or on https://youtu.be/obWiXlTs53A , to find out how.

When TAZ1 uses our Color Sensor, we can teach it to stop on lines of many colors. Mostly our Color Sensor is reliable, although sometimes we can get a surprise! 😊

Teaching TAZ1 to Play SUMO

SUMO is a traditional Japanese style of wrestling. The wrestlers try to push each other out of the ring. We would not have much chance of competing against a genuine Japanese SUMO master, but we can have fun with Robot SUMO.

Traditionally a circular ring is used, however for home or classroom SUMO we usually use any shape that has a dark surround. A cardboard sheet from a stationary store, with black tape around the edge, works well. Try it – and if you are in a classroom, ask your teacher about a Robot SUMO event for your classroom.



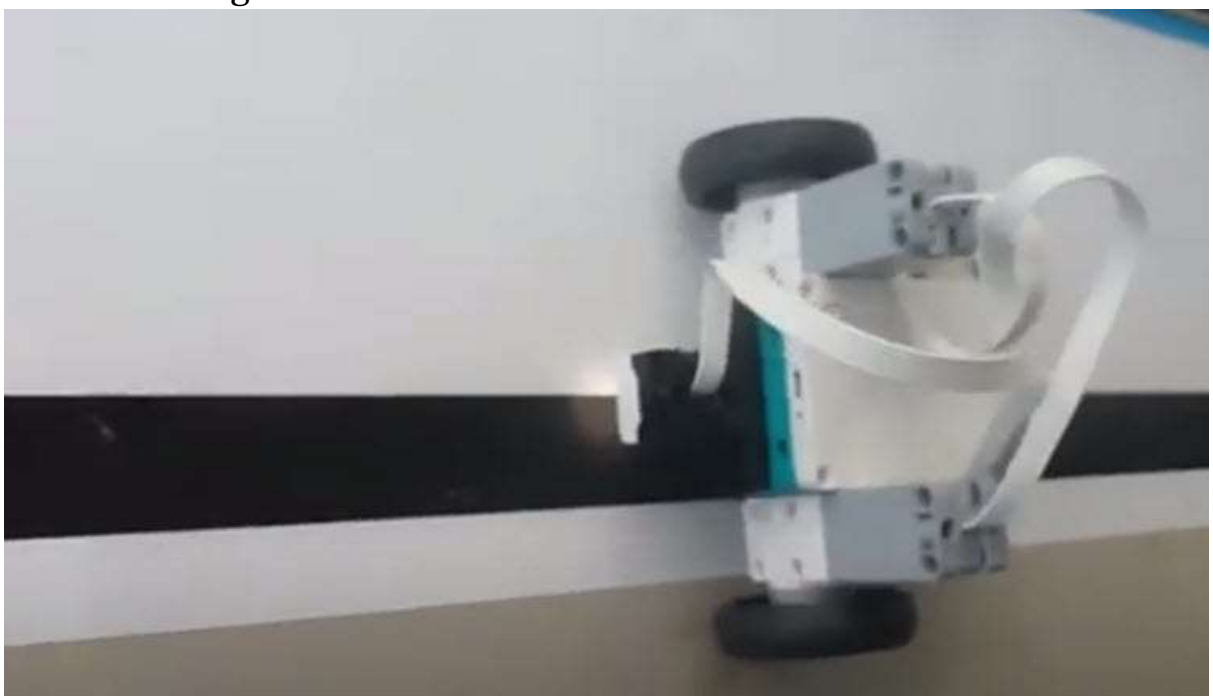
To watch the video, click on the image above, or on https://youtu.be/W0zlY-rLS9Q

There are a lot of big Robot-SUMO competitions, but in this video we use robots made from LEGO's Robot Inventor 51515 sets, using Scratch code. In the video we use TAZ1 and TAZ2, but you could probably build Robots that will be better for SUMO. Why not try?

TAZ1 Follows a Colored Line (Method 1)

Teaching your robot to follow a line, all by itself, without you steering it, is one of the very first steps in teaching your robot some “artificial intelligence”.

The LEGO Robot Inventor 51515 set has a very nice, compact sensor that can detect colors. We can use this sensor, combined with Scratch code, to follow colored lines, as well as black and white lines. Click on the picture, or on the link below the image, to see how we can teach our TAZ1 Robot to follow straight and curved colored lines.



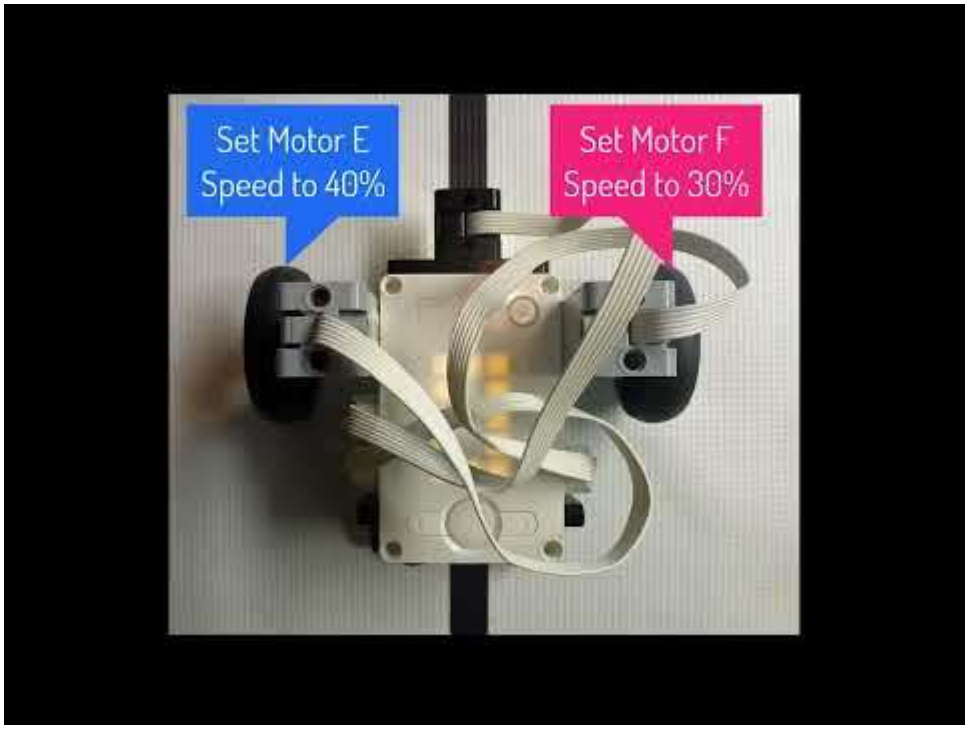
This tutorial can be seen by clicking on the following link:

https://youtu.be/-cz6qFV9-2g

Have fun! 😊

TAZ1 Follows a Line (Method 2)

This is called a “zig zag” or “bang bang” line follower method, that was widely used in student robot competitions featuring the older LEGO EV3 and LEGO NXT robots. It has the advantage of allowing an expert student to “tune” their robot’s “line following” performance to suit an individual competition arena, but has the disadvantage of requiring many trial runs to optimize the numbers used in the code. It can be used for both black/white and colored lines. This method uses Scratch code. It is certainly worth trying! 😊



This tutorial can be seen by clicking on the following link:

https://youtu.be/iEoevwZJ1sE

Have fun! 😊

More “Soon”.

We aim to gradually add tutorials to this downloadable pdf document on a monthly basis. We wish we could go faster, but realistically the time we have available for producing these fun activities is severely limited. ☹

Hopefully more soon. 😊

Appendix 1:
Extra Help for "Around the Moon" Challenge.

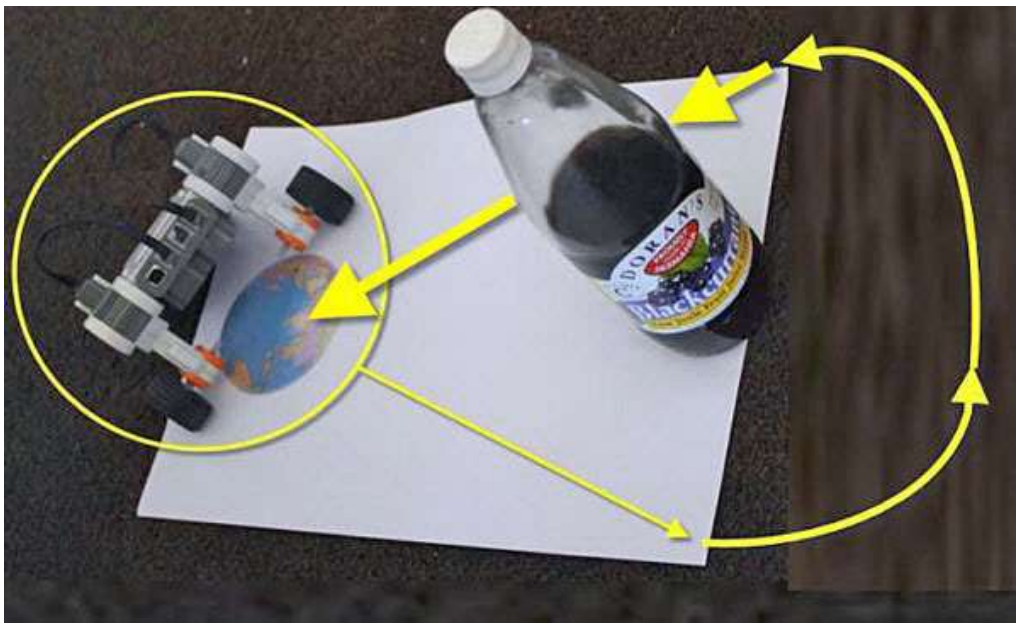
New Idea:

Students teach their Robots to run in a curved path.

Purpose:

Students have already achieved the task of making their Robots go a known distance forwards and backwards in a mostly straight line. The purpose of this Challenge is to add to their skills the concept and practice of teaching their Robot how to proceed in a gentle, controlled curve.

The Challenge:

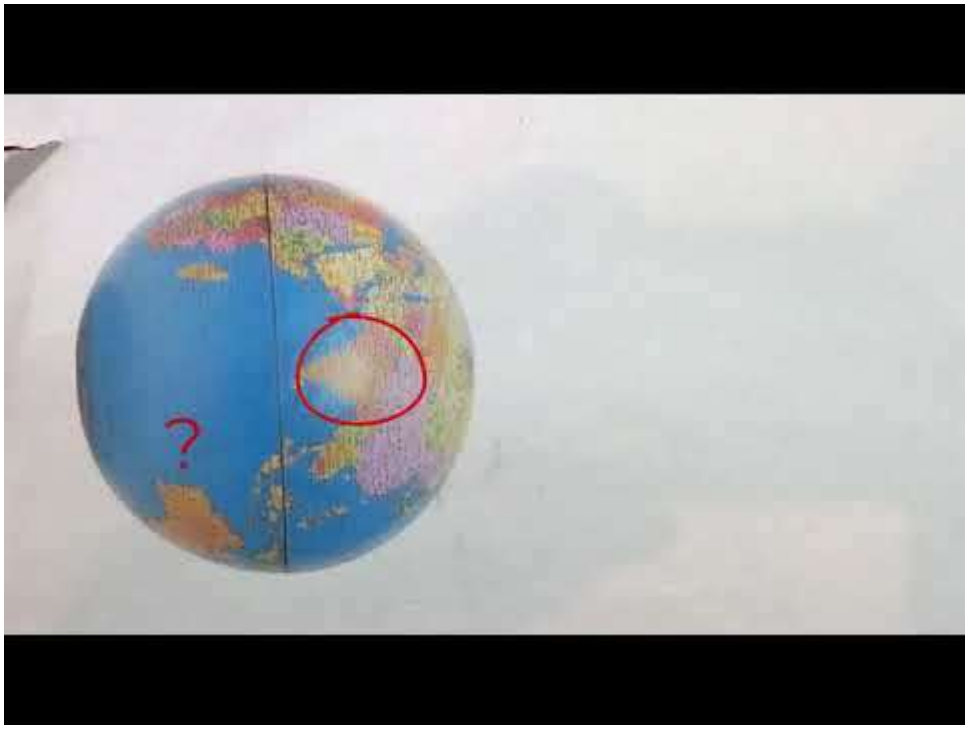


The Challenge is to leave the "Earth" (the blue circle on the left below), circle the "Moon" (the nice, heavy, water-filled bottle on the right below), and instead of being "lost in space" and "doing a tour of the asteroids", the Robot should preferably end up safely back on "Earth" (inside the blue circle).

Constructing an Arena.

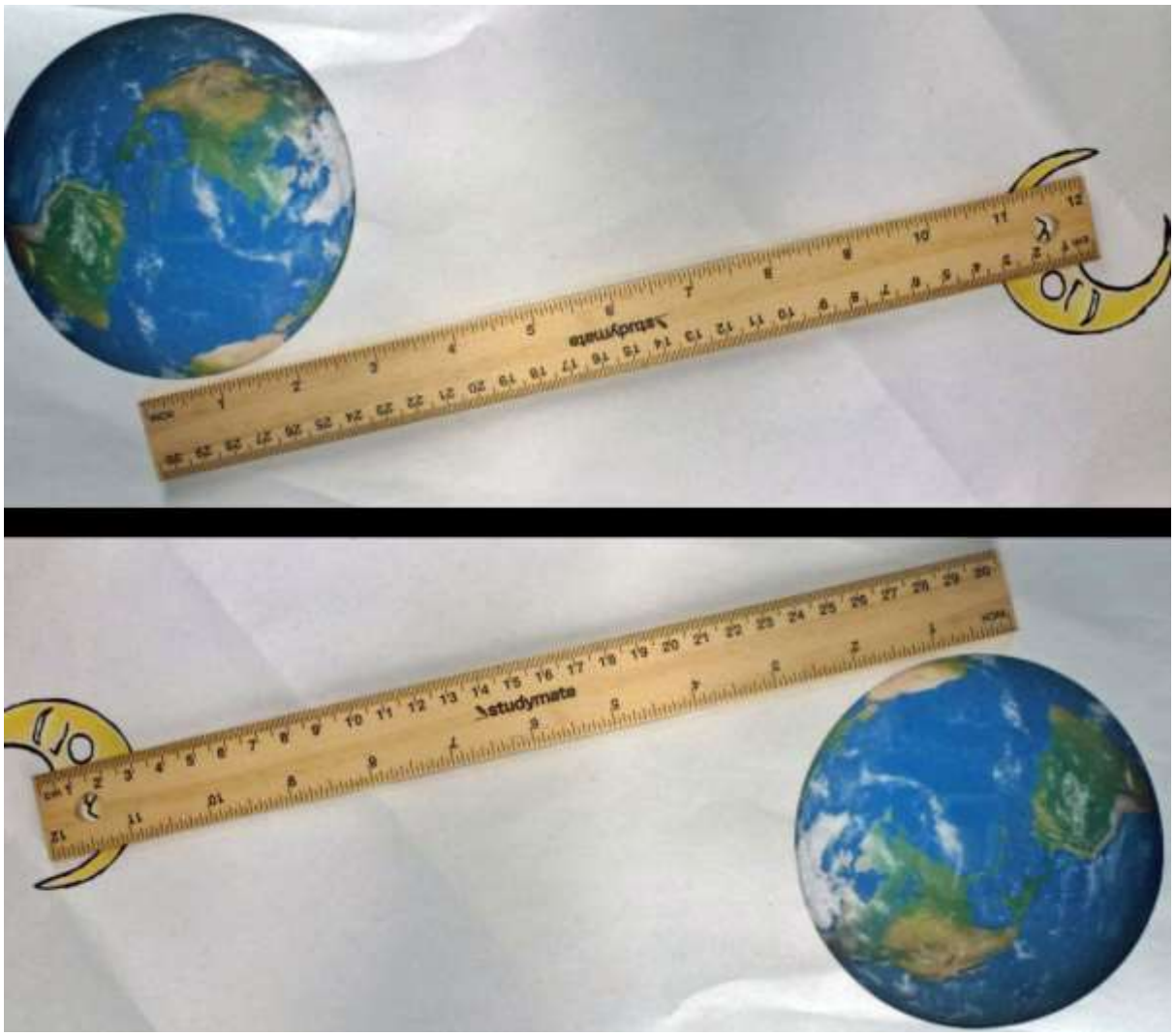
Theoretically, it is not necessary to use a pre-constructed arena; a couple of marks on the floor would suffice. However, if the "Earth" and the "Moon" move when they are hit by errant Robots, this can cause the following students much frustration because the Earth-to-Moon distance will almost certainly change, and their carefully crafted programs will not work the second time they run them! After experimentation at several schools, I found an arena just about necessary in practice!

The video below summarises some variations of the Arena that some of our schools used. If you do not like videos, some of this information is also included in the web page below this video.



Click on the image above, or on https://youtu.be/flWdxLBdCcc

After experimentation at several schools, I found an arena just about necessary in practice! These are the arena distances I found convenient to use in the classrooms in which I assisted.



If you have access to an A3 or A4 printer, these free downloadable "Around the Moon" arena templates could be useful.

Click on, or type in to your browser https://drg2.com/extra-downloads

The free downloadable image of the Moon below could be useful to wrap around a bottle. Because of concerns about breakage, glass bottles were banned and so we used plastic soft drink plastic drink bottles of about 1 liter capacity filled with water. Personally, I used an unopened green lime soft drink bottle, as an opened one was less likely to spill. I used a green one in honor of the old myth (Cecil Adams quotes John Heywood's Proverbes (1546): "The moon is made of a greene cheese," (greene meaning new, unaged.) But hey - no need to copy my whimsy, use whatever color you like! The weight of the liquid in the bottle made the

"Moon" less likely to move when bashed by errant student Robots. So far, I haven't had a plastic bottle burst when accidentally trodden on by a misguided student, but it would still be advisable to choose a reasonably sturdy bottle if one is available.

“Moon” images suitable for wrapping around a bottle can be downloaded from here :

Click on, or type in to your browser https://drg2.com/extra-downloads

The moon image with a black background is a bit more like space appears to astronauts. The white background is a Moon image that uses a lot less of that expensive printer ink! 😊

If you have a friend who has carpentry skills, a wooden block of similar size could be a more environmentally friendly option than a plastic bottle.

No Printer?

Some of the schools we assisted did not have access to either an A3 or A4 printer. They made their arenas from cardboard, often as a student project. As an example, I constructed an arena from a sheet of black cardboard (I used black because astronauts comment that space appears black) measuring 84 cms. by 15 cms (approx. 33 inches by 6 inches). The blue circle shown on the right side of the diagram below was cut from blue cardboard by tracing round a CD (approx. 12 cms or 4 ¾ inches diameter) – blue because the Earth is called "the Blue planet" because of the amount of its surface covered by water. The "Moon" was cut from green/yellow cardboard by tracing around a jam-jar lid (approximately 765 mm or 3 inches diameter) – green because of John Heywood's previously quoted "Proverbes" (see above). But whatever cardboard you have left over from your last class project should be fine.

For the cardboard arena, the distance between the nearest points of the blue and green/yellow circles was approx. 61 cms. or 2 feet. I used these dimensions because several arenas can fit nicely into the classrooms in which I assist, and they do not cause problems transporting them from School to School. Apart from these constraints, none of these dimensions is really critical, as long as they do not change during the Challenge.

You can see one of our cardboard arenas on the top of the next page.

Sample "Around the Moon" Run – LEGO Robot Inventor

An example of a run using LEGO's 51515 Robot Inventor can be seen by clicking on the image above, or by clicking on:

https://youtu.be/j-GtAGei7xM

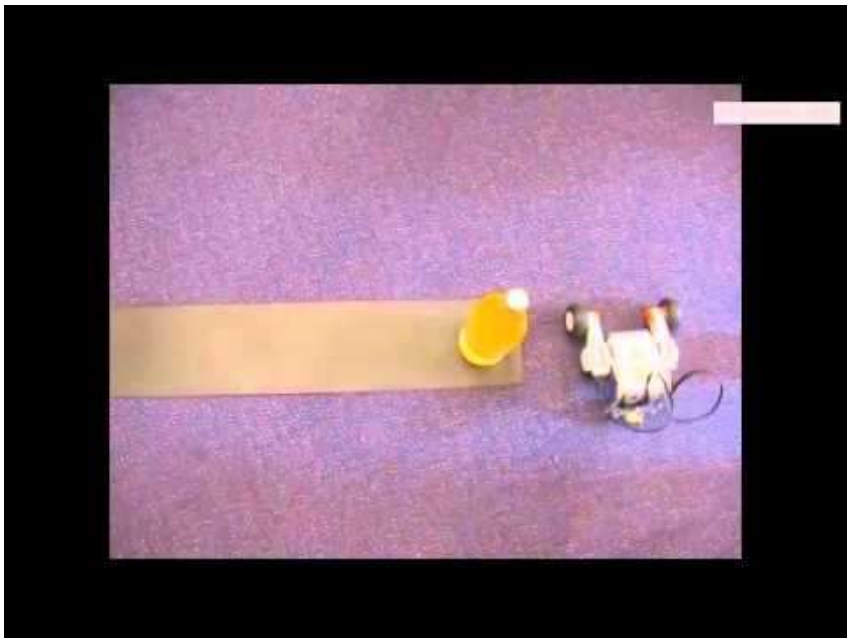
Past Students Teaching Their Robots to go "Around the Moon"?

Students typically take quite a few attempts to get from "Earth", "Around the Moon", and back to land safely back on "Earth". The video on the next page shows some (mostly) successful LEGO space voyages achieved by students using older (NXT and EV3) generations of LEGO sets that could, perhaps, help inspire your Robot Inventor efforts. Use these runs as an inspiration for your own Robot Inventor runs!

Click on the image above, or type into your browser https://youtu.be/6Tl2sVL-dyg

Extension Suggestions:

Our aim was that every student could achieve success in our tutorials. This meant that we had to provide some extension suggestions for the students who achieved success more quickly. The video below shows more advanced "Around the Moon" variations that students in our past classes found both challenging & fun to achieve.



Click above, or type into your browser https://youtu.be/4nr6Pqx3y8A

To explain the "Sufi" reference in the video above, the student who coded the "Sufi dance" into his "Robot Moon Expedition" was inspired by a YouTube "travel" video similar to the one below (*some religious references, optional*).

Click above, or type in to your browser https://youtu.be/fHjFgOfoZ7M

Source of Materials

The cardboard sheets can be obtained from an Office Supplies shop or an Art Goods supplier. Since Tasmania has stopped being self-governing,

we now use the Australian dollar, and prices of these sheets varied from about $AU4 to $AU6.

To go back to “Around The Moon”, click here.

Appendix 2:
Extra Help for "Floor Cleaner" Challenge

There are very many paths that our TAZ1 Robot can take as it cleans our pretend floor. In the videos that we have suggested you watch, you will have seen a lot of very ingenious ways that past students have sent older LEGO Robots around our pretend floor. However, none have so far managed to use a LEGO Robot Inventor Robot to clean a floor.

Let us see if we can produce some Scratch Code to send TAZ1 around our pretend floor.

In the following video (click here), we demonstrate just about the simplest possible Code to send TAZ1 around the complete floor. See if you can do better! 😊

A Robot Cleaner Score Sheet (A4 printer), and a Floor Cleaner Arena (A1 printer), both in pdf format, can be downloaded from here.

To go back to the "Floor Cleaner Challenge", click here.

Acknowledgement

This site is being built using the knowledge of Chen Ying, Yaya Lu and Graeme Faulkner. All are unpaid volunteers in this endeavor. We have no connection to LEGO, and receive no reimbursement for this voluntary work.