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LEGO Bowling Workbook



LEGO Bowling

Robots are devices, sometimes they run basic instructions via electric circuitry or on most occasions they can be programmable. Some robots can sense and interact with their environment and perhaps even begin to learn about it with the incorporation of Artificial Intelligence. Alternatively, robots may be created for a certain purpose such as factory robots, repeating the same task.

Within this activity book you will be developing your own LEGO Mindstorm NXT project, to solve a given challenge.

1) Robotics

Consider the following questions to begin understanding robotics and the importance of giving clear, concise instruction:

If I were a robot, what “body parts” do I need to complete the following tasks:

- a) Walking forward
- b) Walk to a wall and stop before hitting it
- c) Follow a line on the floor
- d) Find the nearest wall

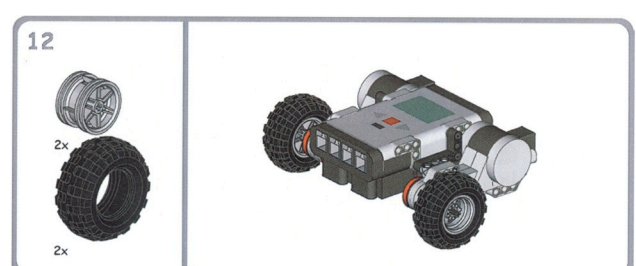
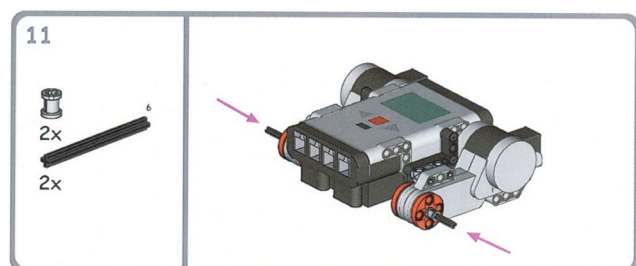
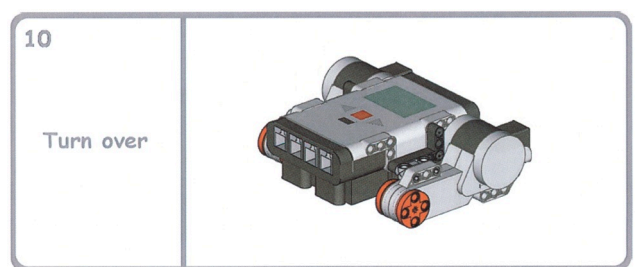
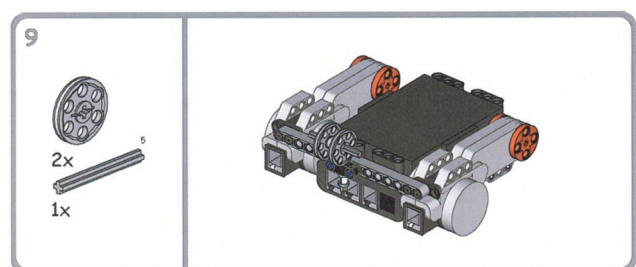
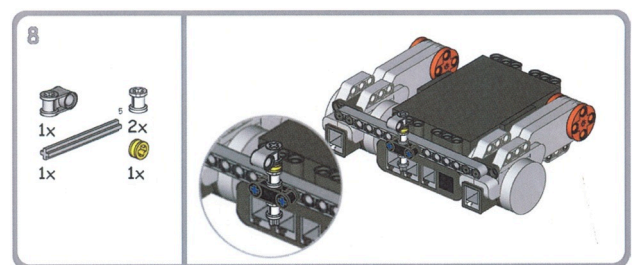
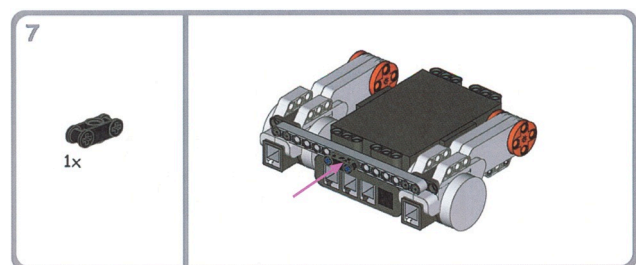
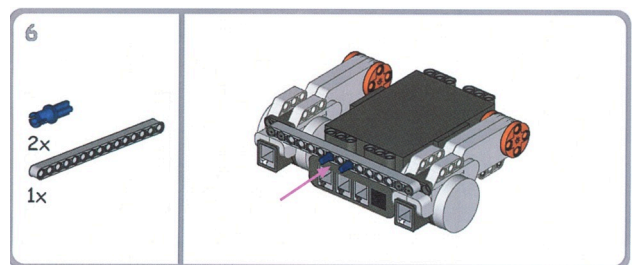
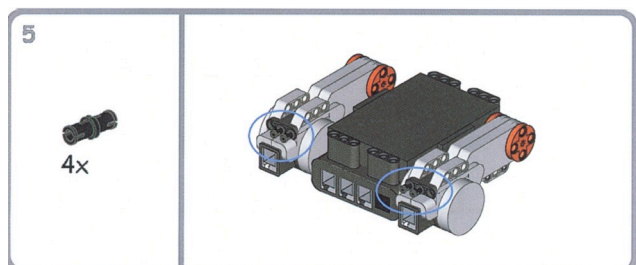
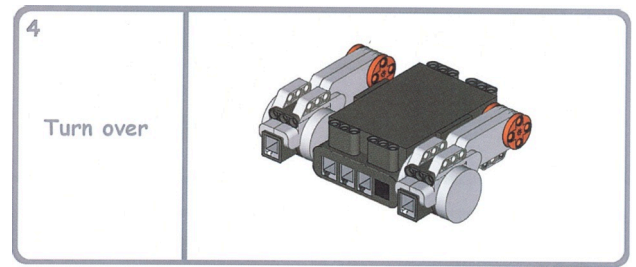
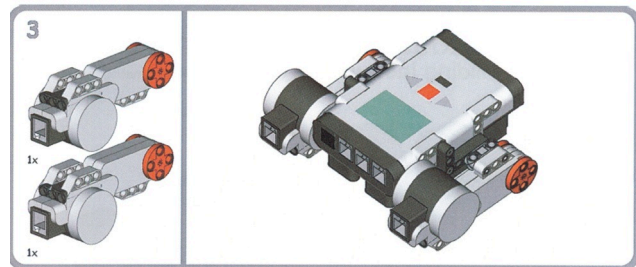
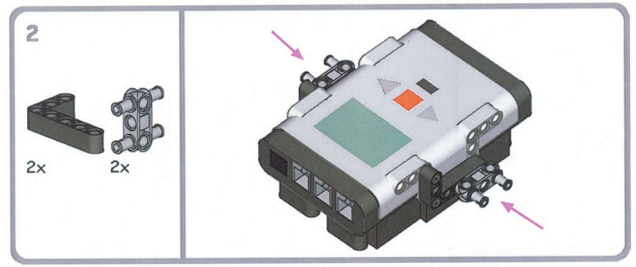
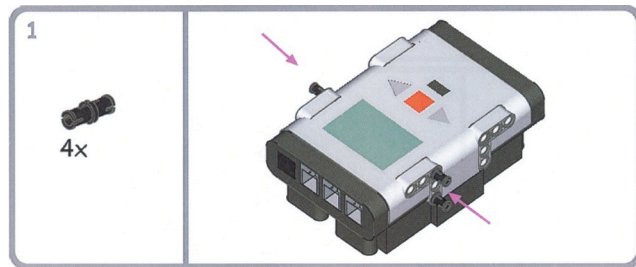
You will be applying the above knowledge to the development of your own LEGO robotics kit. The LEGO Mindstorms NXT robot is a programmable kit, which can be used to create many different robots. The 3 main parts of the robot are as follows:

- **The NXT** - you can think of this as the brain of the robot. The NXT has 4 ports labelled A, B, C and D, these are used to connect to the servo motors. The other 4 ports labelled 1, 2, 3 and 4 are used to connect to the sensors. Also on the NXT, is a micro-USB port to connect the NXT to your computer, ready to upload your programs on to it.
- **Servo motors** - these give your robot the ability to move. These are attached to a variety of different parts to create wheels, grabbing arms or even lifting mechanisms. They also provide feedback to the NXT of how many rotations have been made.
- **Sensors** - a range of sensors is available that the robots can use to learn about the environment surrounding it. Sensors include ones that can detect certain colours, or distance, or even detect shadows (black and white).

2) Building

To put together your basic robotic kit, follow the instructions on the following page.

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3) Ports

After creating the robot, connect the attached motors to Ports B and C on the Mindstorm NXT. This is so the NXT can send messages to the attached motors.

Now that the basic NXT model has been built, you could begin giving the robot some code to follow. But first you should ensure you have the basic programming skills to apply to the drag and drop environment.

Cargo-Bot is a free iPad application where users can program a robotics arm to move around boxes from an initial set-up to a given final set-up. The aim is to get thinking about 3 main programming constructs: basic instructions, conditional

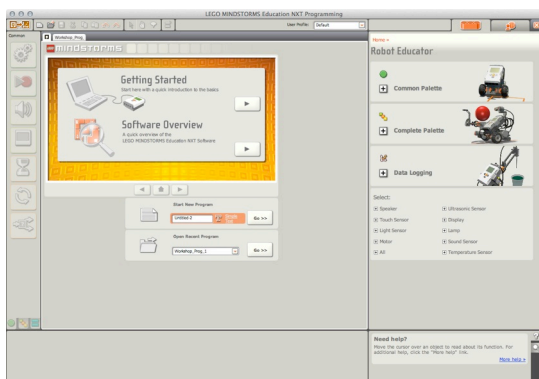


4) Cargo-Bot

Download Cargo-Bot onto an iPad if it is not already available. Have a go at the tutorials on the application, there are helpful hints available to you for each level. See how far you can get.

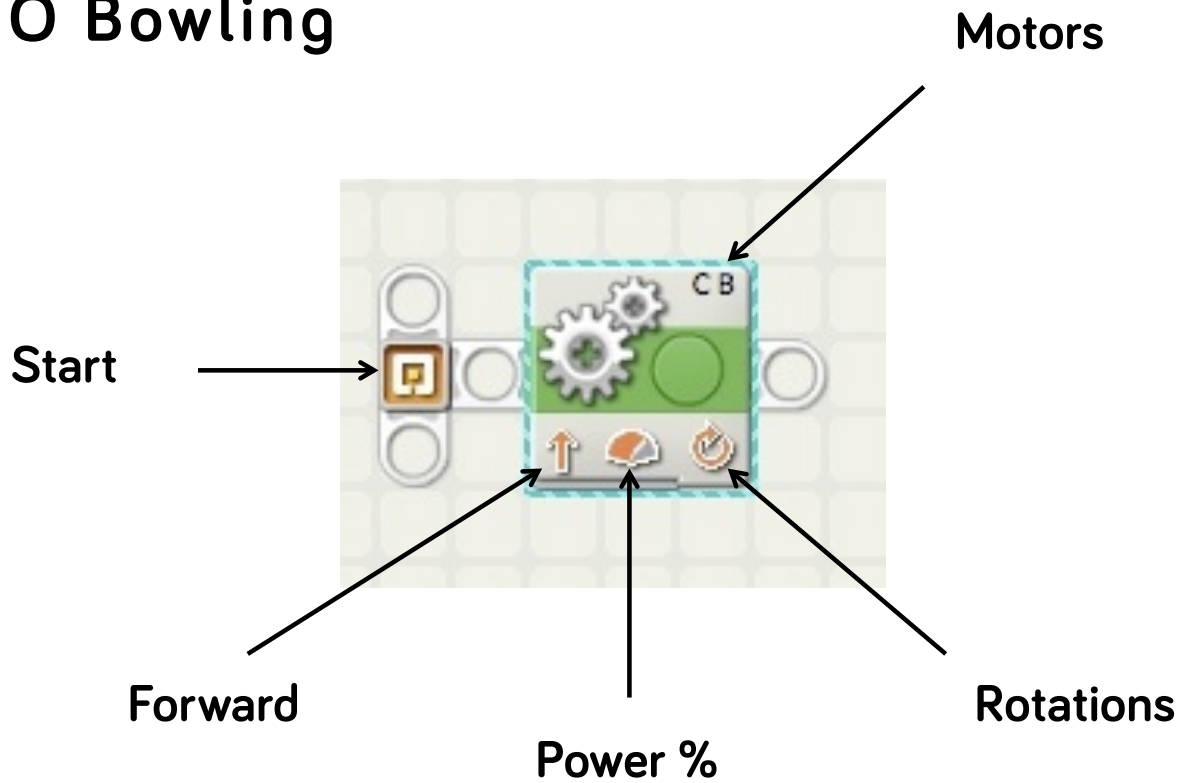
Have you noticed the 3 star score system? To complete the level, you will get 2 stars. To achieve all 3 stars you must find a way of completing the level with the shortest solution.

At this stage you should be familiar with the importance of providing clear, concise instructions in addition recognising that there are a variety of ways a singular task can be completed.



LEGO Mindstorm NXT robots come with their own coding environment, the software is a drag and drop environment similar to Scratch, Alice, GameSalad etc. It is an all in one tool which allows you to write program to control the LEGO Mindstorms robot. A CD-ROM will come with the Robotics kit, this may already be installed on your computer if you are within a Technocamps workshop. Open up the program (it should look like the image on the left).

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5) Understanding rotations

Write code for your robot to achieve the following, once it has been implemented you can upload it onto the robot using the USB cable:

“Program your robot to move to the end of the table you are working on and to stop at the edge”

You need to roughly decide how far the robot moves per rotation and work out how many of those it will take to get the closest to the end of the table without falling off!

6) Bowling alley - no sensors

Write code for your robot to achieve the following:

“Move down the Bowling Alley, stop at the red line then reverse back up the Bowling Alley and stop at the green line”

At this stage no additional components can be used, keep it simple and work out the amount of rotations. How many pins does your robot knock over this time?

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Sensors enable the robot to learn more about the environment it is in. There are several different sensors that come with the LEGO Mindstorm NXT kit, such as below:

- **Touch sensor:**

This can be used to give your robot a sense of touch. It detects when it is being pressed and when it is released. This could be used to make your robot act on a command as a result of coming in contact with a wall or object etc.

- **Sound sensor:**

This can be used to get your robot to listen to its environment. It can be used to detect both decibels (dB) and adjusted decibels (dBA). A decibel is a measurement of sound pressure. For example, you could use this to make your robot act on a command when it detects whether or not there is a conversation going on in the room.

- **Light sensor:**

This is one of two sensors that can be used to make your robot see its environment. The light sensor can be used to distinguish between light and dark. This could be used to create a robot that detects if the light in a room is switched on or off, or even create a robot that follows a thick black line, such as a race track.

- **Ultrasonic sensor:**

This is the second of the two sensors that can be used to make your robot see its environment. The ultrasonic sensor enables your robot to see and detect objects. You could use this to make your robot avoid objects, detect movement or sense/measure distances.

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7) Table task revisited

Write code for your robot to achieve the following:

“Program your robot to move to the end of the table you are working on and to stop at the edge”

Use a sensor to achieve this task without relying on the calculation of rotations.

For the next task, try using the “colour” sensor, which sensing RGB colour combinations. RGB stands for Red, Green, Blue. The sensor shines red, green and blue light on an object and the light that is reflected back is collected by a light sensor. This information can be used to distinguish colours from one-another and instruct your robot to act upon a command given that a particular colour has been sensed.

8) Bowling alley revisited

Write code for your robot to achieve the following:

“Move down the Bowling Alley, stop at the red line then reverse back up the Bowling Alley and stop at the green line”

Use a colour sensor to complete this task.



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