3D LED science display with Scratch

Make a 3D LED science display with Scratch on the Raspberry Pi

Step 1 You will make

Produce a scientific or natural 3D installation. You will create your own 3D crafted model, and add LEDs and maybe some sound, to craft your very own digital demonstration.

You will:

- Connect multiple LEDs to a Raspberry Pi
- Use multiple pins to control LEDs using Scratch
- Control LEDs using random patterns or inputs

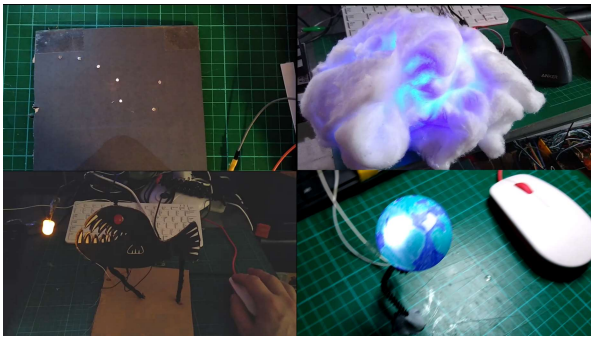
In order to complete this project you will need:

Hardware

- A Raspberry Pi computer
- Jumper wires
- LEDs
- Crafting materials

Software

- Scratch 3 Desktop - **This project can not be completed using the online Scratch 3 editor**, and must be completed using a Raspberry Pi with the desktop version installed.



Anglerfish by Jess Smith, in the **Sea Creatures Collection** (https://thenounproject.com/spess.22/collection/sea-creatures).

If you need to print this project, please use the **printer-friendly version** (https://projects.raspberrypi.org/en/projects/projectName/print).

Step 2 Get inspiration

You are going to create a science and nature model using some craft materials, some LEDs, a Raspberry Pi, and Scratch.

You can get ideas for your own project by having a look at some of our example projects.

Have a look at the video of the following four projects, so you can see the types of creation you can make.

There is a blinking constellation of stars, a thunder cloud, an interactive anglerfish, and an illuminated globe.

Step 3 Choose your model

Now it's time to work on your own project. You may have lots of ideas already, or you may need to take a few minutes to decide on a theme.

Think about the model you would like to make. You could copy or adapt one of the examples in the video in the previous step, or you could come up with something completely different.

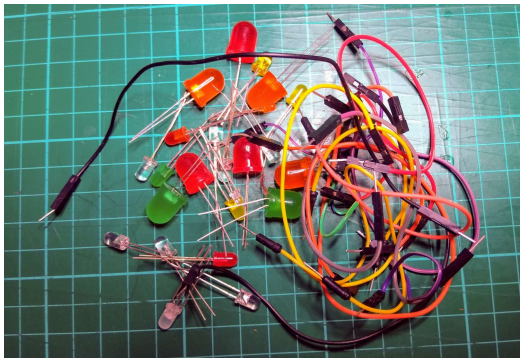
For example:

1. You could use cotton wool and a pair of blue LEDs to make your own 3D thunder cloud
2. You could use a ping-pong ball and a red LED to make a 3D model of Mars
3. You could use a yellow LED and create your own model of a firefly

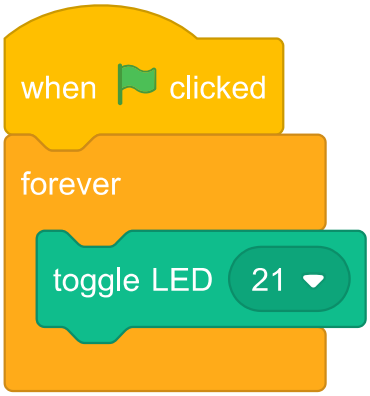
There are many questions you need to ask yourself before you start creating your model. Have a think about the questions below.

Once you have chosen what you want to make a model of, consider what craft materials will you need, and are they readily available to you?

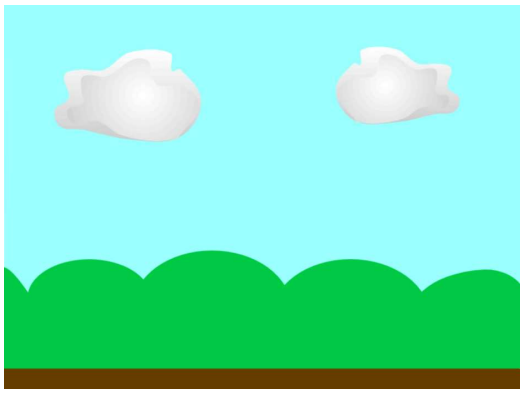
How many LEDs will you need for your model? What colours will they be? Have you got enough jumper wires for what you are planning to make?



Once you have built your model, how will the LED or LEDs be controlled? Do you want them to light up randomly, in a regular pattern, be continuously lit, or will they be controlled using mouse or keyboard events?



Do you want to add sound effects to your model? Will there be graphics on the screen in addition to your model? Do you want people to be able to interact with the screen?



Step 4 Build your model

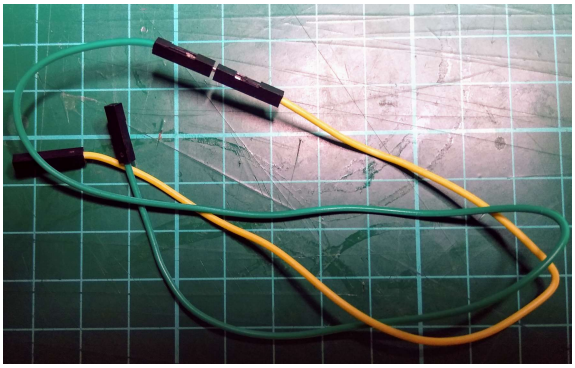
Now that you have an idea, it's time to build your model. Below are a few tips that might help you to produce the model you want.

Using a craft or utility knife

Craft and utility knives are very useful when making models, but you must be very careful when using them, as they are extremely sharp and can easily cause an injury. If you are using a craft or utility knife, make sure you have a responsible adult with you, or ask them to do the cutting for you if you prefer. It's also a good idea to use a cutting mat to protect the surface you are working on. If you don't have a cutting board, a kitchen chopping board is a great alternative.

Joining together jumper wires

You might need extra-long wires to attach your LED to your Raspberry Pi pins. You can do this by 'daisy chaining' wires together. For instance, to make an extra-long Socket-Socket wire, you can attach an Socket-Pin wire to a Socket-Socket wire.



The problem with this method is that often the wires will become detached from each other. You can use a small piece of tape to secure the connection.

Short circuits

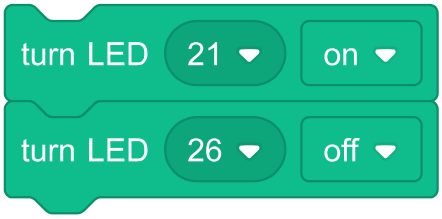
As the legs of the LEDs are often exposed, it is easy for to create a **short circuit** if the exposed legs touch each other. This will stop your LED from working. A little bit of tape wrapped around each LED leg will prevent this.

This will also help to keep the LED attached to its jumper wires.

Multiple LEDs

You might have only used a single LED in your projects before, but you can use lots of LEDs if you want to. Each LED will need its long leg attached to a numbered pin and the short leg attached to a ground pin. You can see the location of all the numbered pins and ground pins in the diagram below.

To control the LEDs, you just change the pin number in your Scratch program so it corresponds to the pin the LED is attached to.



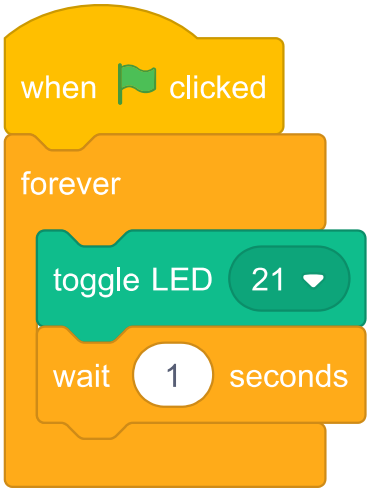
Step 5 Control your LEDs

You should now have your model built and your LEDs wired up to your Raspberry Pi. Make sure you remember which numbered pins you used, because now it is time to add some code to control your LEDs.

Have a look at the options below for some different ideas on how the LEDs can be turned on and off.

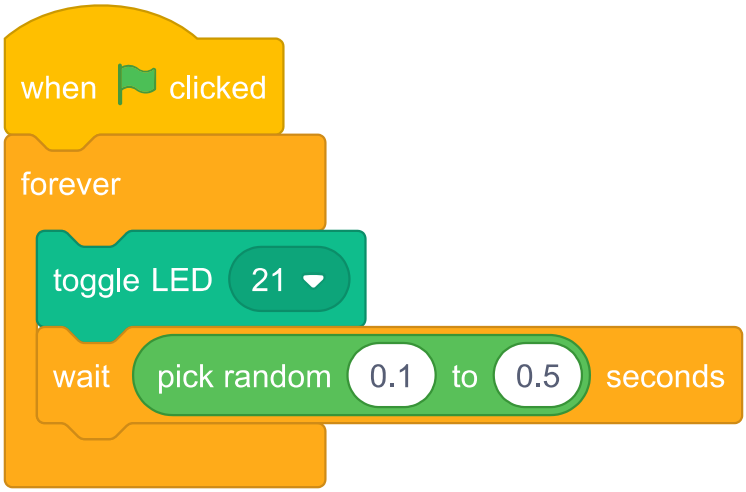
Blink a regular pattern

The following blocks will create a regular blinking pattern for an LED. By changing the `wait` time, you can make the LED blink faster or slower.



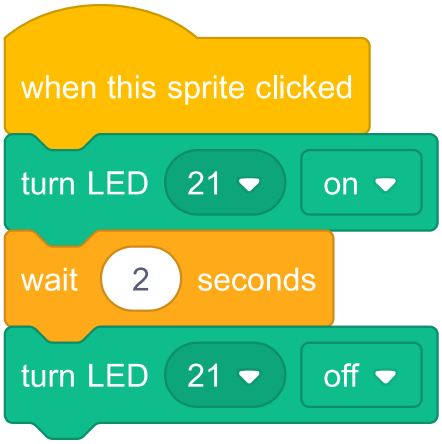
Random blinking

By using the `pick random` block, the blinking of the LED appears to be completely random. Changing the values used in the `pick random` block will change how quickly the LED blinks.



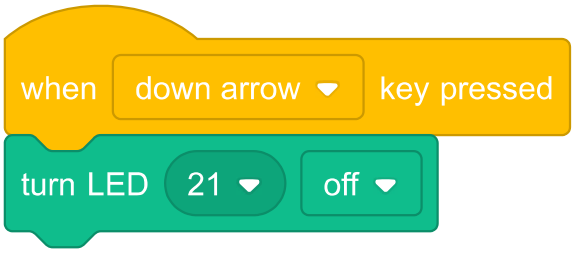
Click a sprite to control an LED

By using the `when this sprite clicked` block, the LED can be turned on for a few seconds.



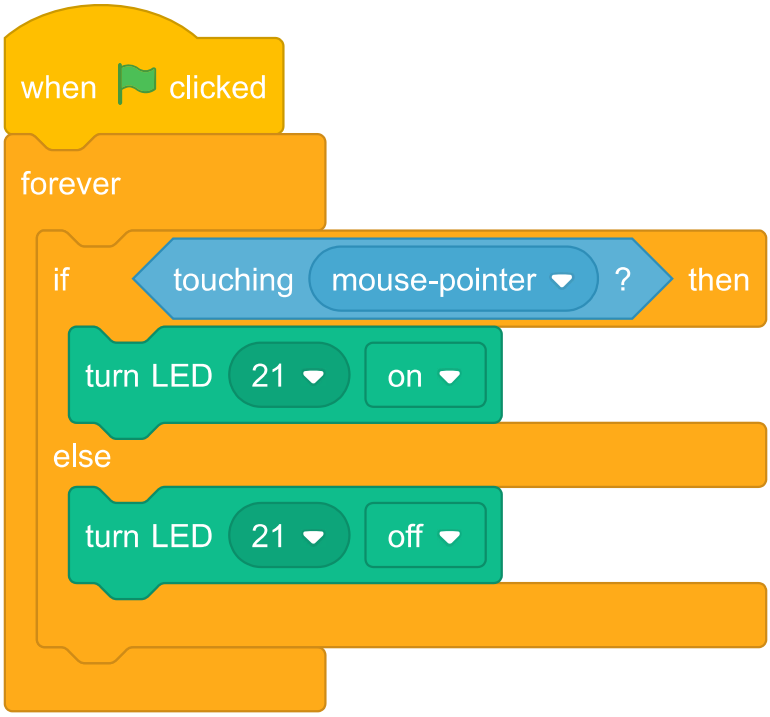
Press a key to control an LED

By using the `when key pressed` block, an LED can be turned on and off by using the keyboard attached to your Raspberry Pi.



Using the Sensing menu to control an LED

The `sensing` menu has blocks that can detect events that happen in Scratch and you can use these to trigger your LEDs. Here's an example using the mouse pointer. When a sprite is touched by the mouse pointer, the LED will come on, and then turn off when the pointer moves away.

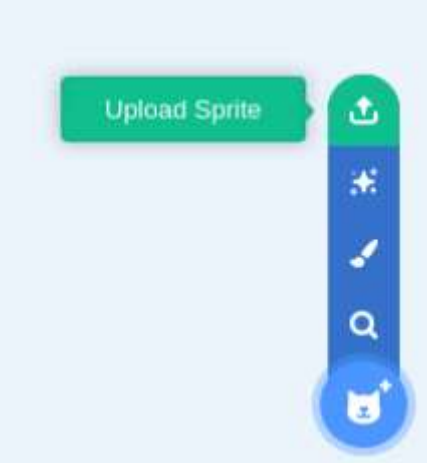

when clicked
forever
if touching mouse-pointer ? then
turn LED 21 on
else
turn LED 21 off

Step 6 Add graphics and sound

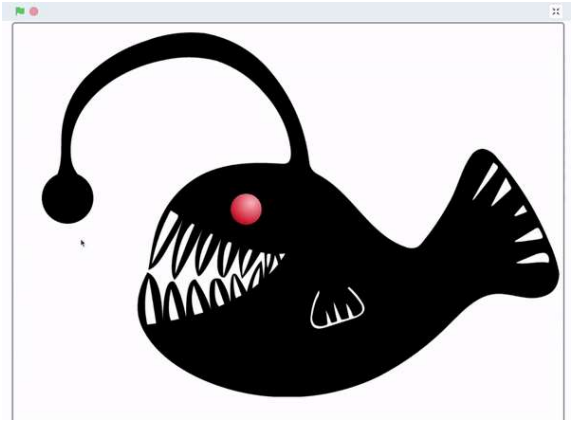
This step is optional, but you might like to add some graphics and sound to your project. This might be so that people who are using your model are able to control the LEDs, or it might simply be to add some extra effects to your project.

Simulate your project on screen

If you have used an image from Scratch itself as part of your project, or a digital image of your own, you can import it into your Scratch project. Click on the **Choose a Sprite** icon and select **Upload Sprite**.



You can then use the image to copy what your actual model does. Here's the anglerfish example, where clicking on the sprites on the screen illuminates the LEDs and the sprites change their brightness.

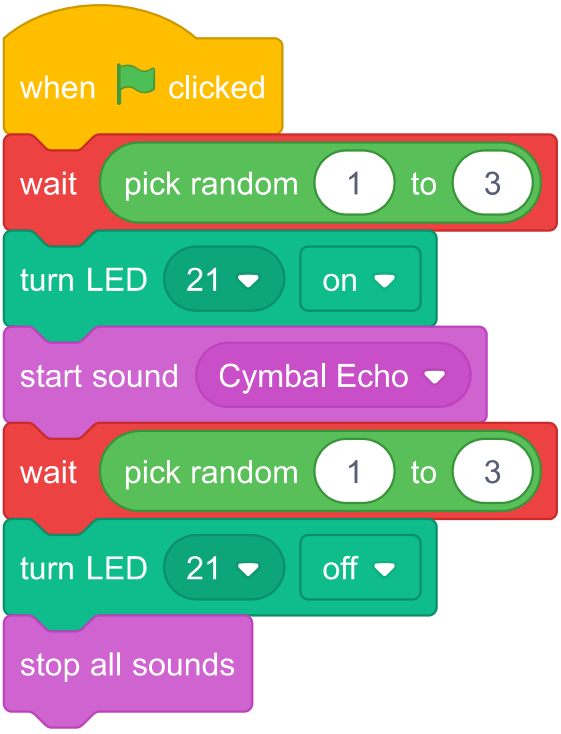


Add a photograph of your project

You could take photos of your project in action, and then import them as backdrops into your Scratch project, so that the image on the screen shows what is happening with the model. Here's an example of the thunder cloud project, using four photographs as different backdrops. The backdrop changes each time the LED comes on.

Add some sound effects to your project

You could add sound to your Scratch project, so that when the LEDs are turned on or off, Scratch plays a sound effect. For instance, these code blocks will start and stop a sound, in time with an LED turning on and off.



Step 7 Share your project

Because you have created a physical project, the best way to share your work is to record a video of your project in action. You could use a mobile phone to record your project working, and also show the code on your Raspberry Pi's screen.

Once you have created your video, you can share it on video hosting sites. The most popular is **YouTube** (www.youtube.com), although if you are under 13 you will need to use the account of a responsible adult, with their permission.

Here's an example of one of the projects shown earlier, shared on YouTube.

Why not invite your friends to create a project? Let them know how you had fun.

Upgrade your project

Depending on how you designed your project, there are **lots** of ways you could improve and upgrade your work.

You could:

- Increase the number of LEDs on your project (remember to use the correct Pin numbers in your code!)
- Create physical buttons to activate your LEDs and connect them to the Raspberry Pi (have a look at the **Stress Buster** (https://projects.raspberrypi.org/en/projects/rpi-stress-buster-with-scratch/3) project for reminders!)
- Design and build more sturdy parts and enclosures for your display with better materials or components.

This example shows an Interactive World Map cut from plywood using a laser cutter and made into the top of a box which holds all the electronics. When the buttons are pressed, Scratch recognises this and uses the `Text to Speech` Scratch Extension to read out facts about the continent associated with the button. An LED also lights up the relevant continent inside the box, while the Scratch program displays a map backdrop on screen with the same continent coloured to match the LED.

What next?

If you are following the **Physical computing with Scratch and the Raspberry Pi path** (https://projects.raspberrypi.org/en/pathways/physical-computing-with-scratch) pathway, you can move on to the **Musical instrument project** (projects.raspberrypi.org/en/projects/scratchpc-musical-instrument)

If you want to have more fun exploring Scratch, then you could try out any of **these projects** (https://projects.raspberrypi.org/en/projects?software%5B%5D=scratch&curriculum%5B%5D=%201).
