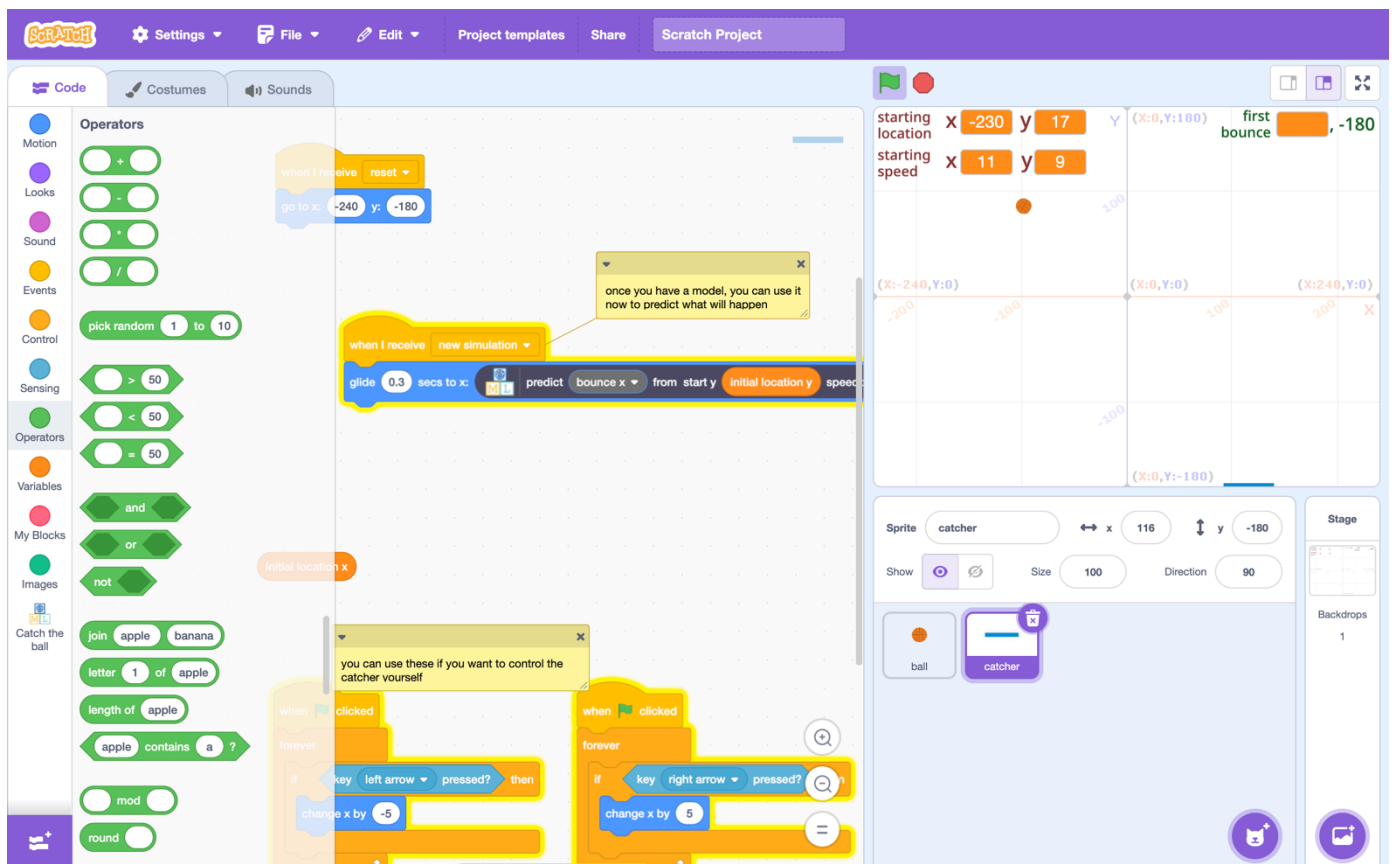




Catch the ball

In this project you will train a computer to predict where a ball will land.

You will teach the computer to make these predictions by giving it examples of many bouncing balls.



This project worksheet is licensed under a Creative Commons Attribution Non-Commercial Share-Alike License
<http://creativecommons.org/licenses/by-nc-sa/4.0/>

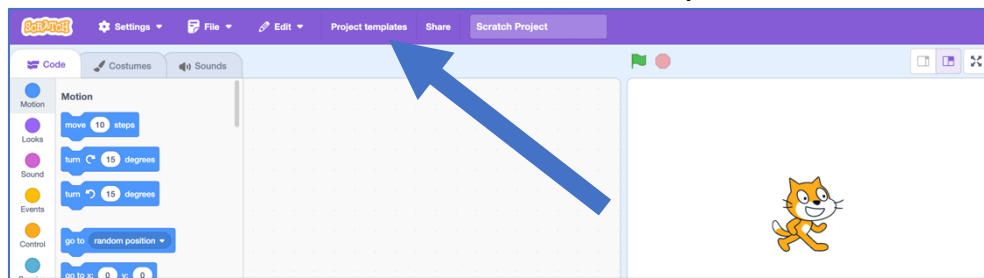
1. Go to <https://machinelearningforkids.co.uk/> in a web browser
2. Click on **“Get started”**
3. Click on **“Try it now”**
4. Click the **“+ Add a new project”** button.
5. Name your project **“Catch the ball”** and set it to learn how to **“predict numbers”**.
Click the **“Create”** button

The screenshot shows the 'Start a new machine learning project' form. The 'Project Name' field is filled with 'Catch the ball'. The 'Project Type' dropdown menu is open, showing 'predicting numbers' as the selected option, with a 'beta' tag. A tooltip is visible next to the dropdown, listing options: 'To recognise words, sentences or paragraphs, choose "recognising text"', 'To recognise photos, diagrams or pictures, choose "recognising images"', 'To recognise sets of numbers or multiple choices, choose "recognising numbers"', 'To recognise voices or sounds, choose "recognising sounds"', and 'To predict numbers, choose "predicting numbers"'. The 'Storage' dropdown is set to 'In your web browser'. At the bottom right, there are 'CREATE' and 'CANCEL' buttons.

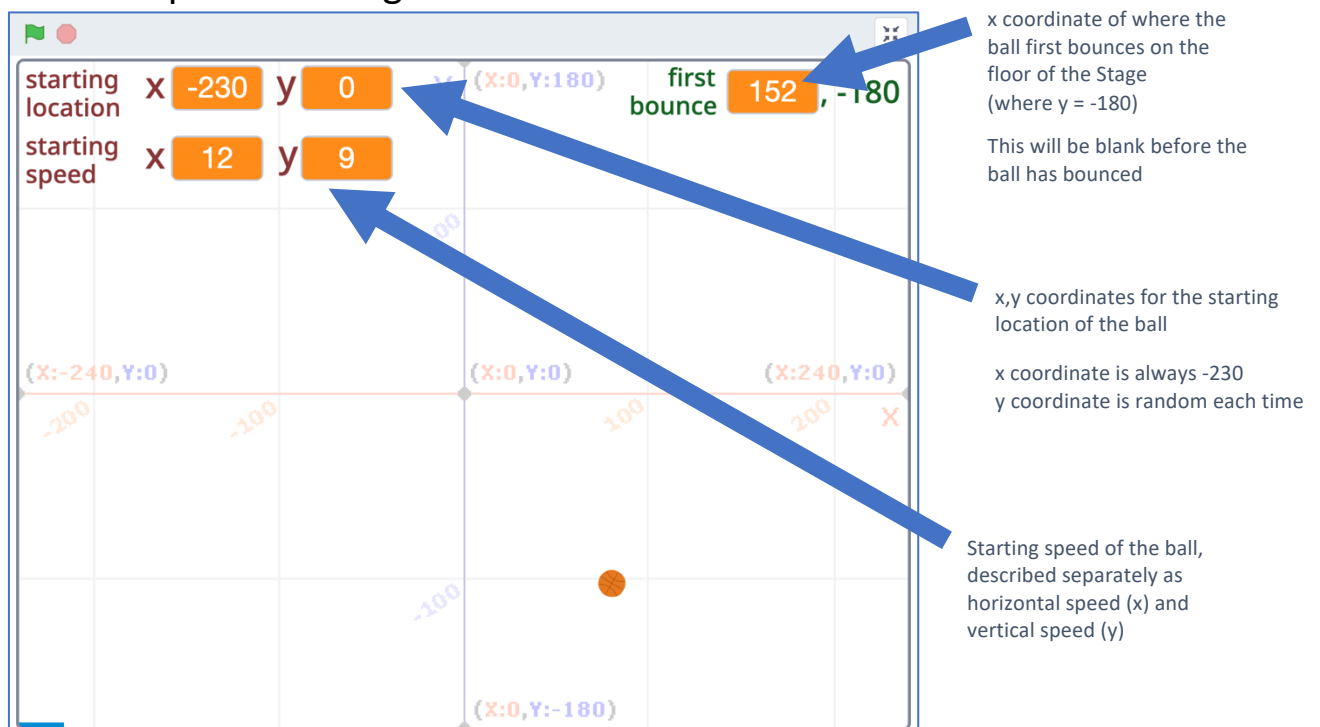
6. You should see **“Catch the ball”** in your list of projects. Click on it.
7. We'll start by looking at what we'll be training the computer to do.
Click the **Make** button.

The screenshot shows the project page for 'Catch the ball'. It features three main buttons: 'Train', 'Learn & Test', and 'Make'. The 'Train' button is described as 'Collect examples of what you want the computer to predict'. The 'Learn & Test' button is described as 'Use the examples to train the computer to make predictions'. The 'Make' button is described as 'Use the machine learning model you've trained to make a game or app in Scratch'. A large blue arrow points from the 'Learn & Test' button towards the 'Make' button.

8. Click on the **Scratch 3** button, and then click on **Scratch by itself**
9. In the new Scratch window that opens, click on **Project templates**
10. Click on the “**Catch the ball**” template
11. Try clicking on the **Green flag**



A ball will be fired from the left side of the Stage, towards the right, at a random speed and angle.



The goal of this project is to predict where the ball will bounce (the first time).

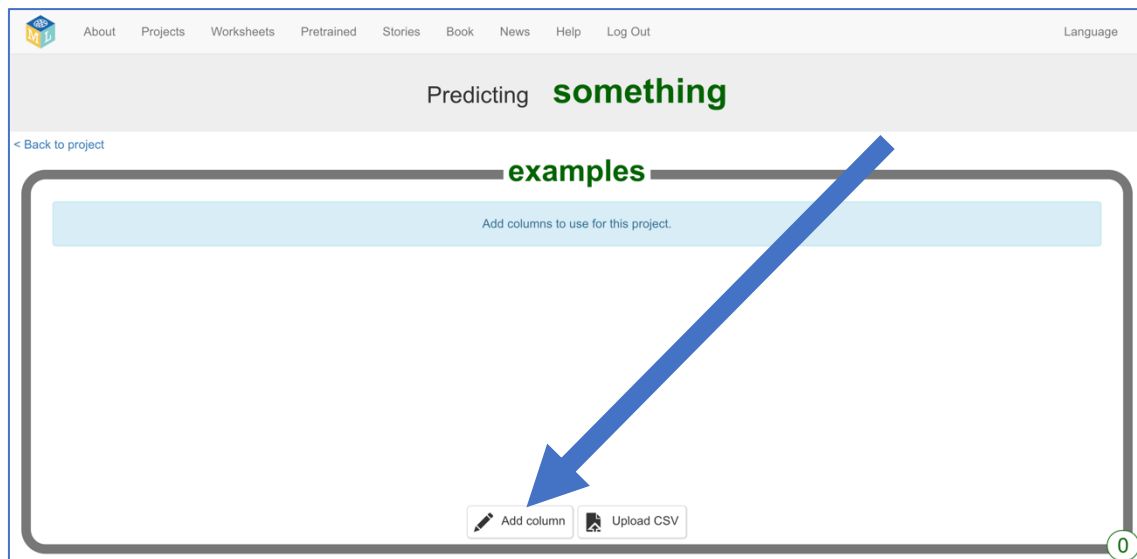
You will train the computer, using examples of observing the ball bouncing, so it can learn to predict where the ball will go (before it starts moving).

12. Close the Scratch window and go back to the training tool

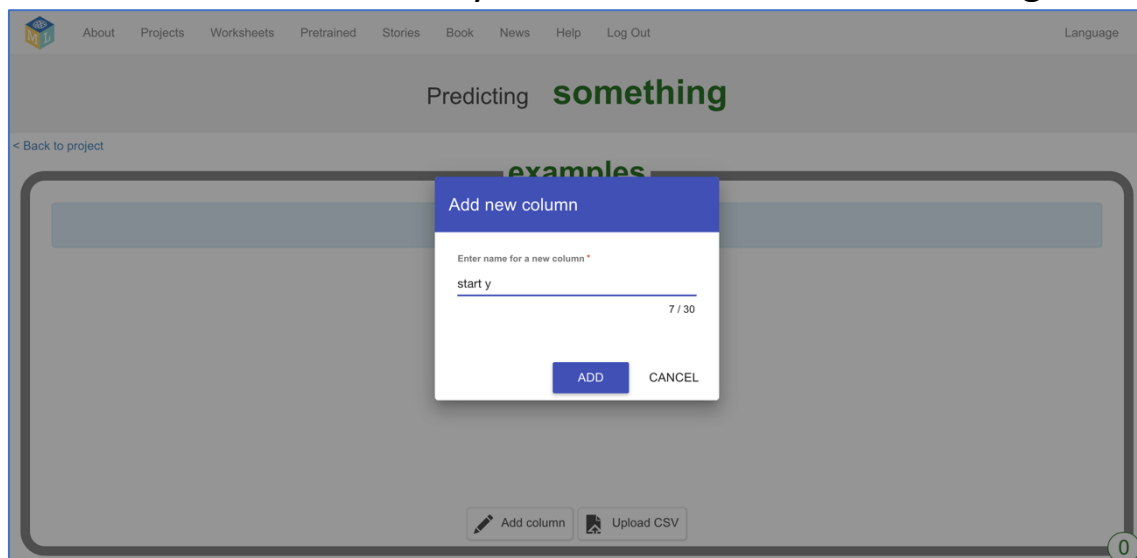
13. Click on **Back to project**

14. Next, we'll describe the data that we'll be using for the project.
Click the **Train** button

15. Click the **Add column** button

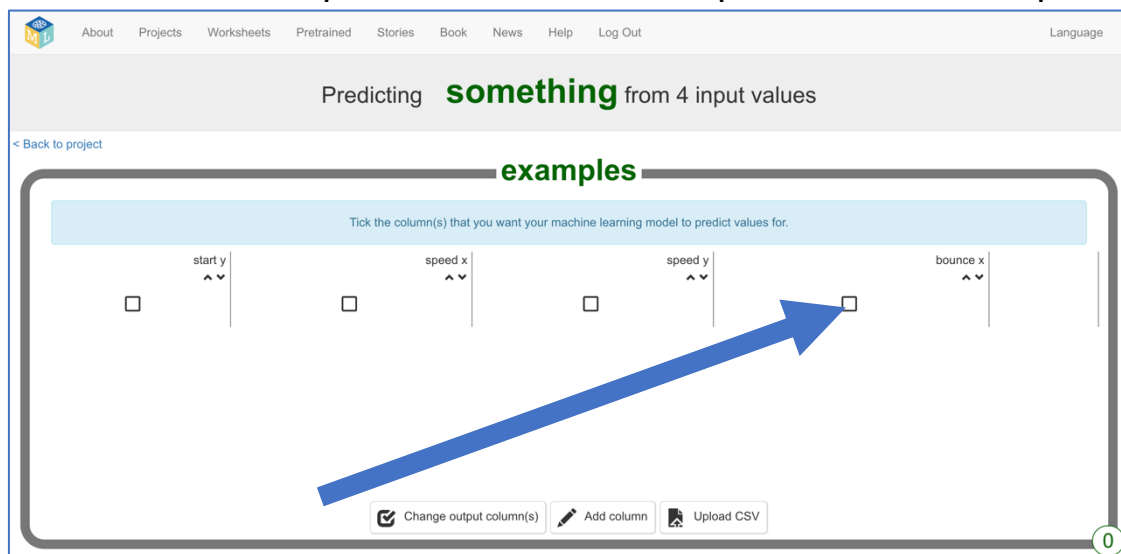


16. Enter a name for the y coordinate of the ball's starting location

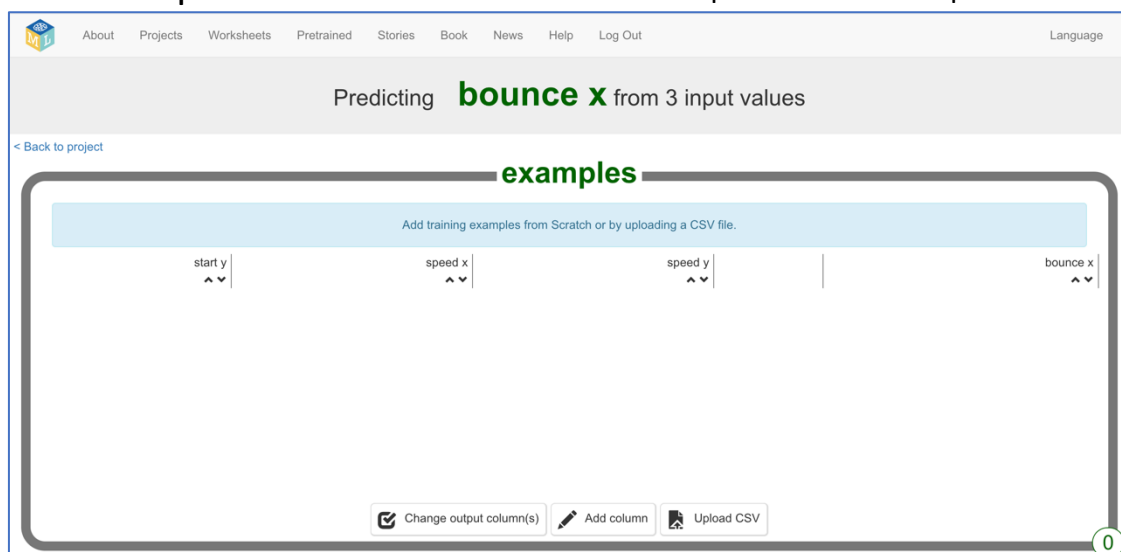


17. Click on **Add**

- 18.** Click the **Add column** button again, and create a column for the starting horizontal (x) speed of the ball : “speed x”
- 19.** Click the **Add column** button again, and create a column for the starting vertical (y) speed of the ball : “speed y”
- 20.** Click the **Add column** button again, and create a column for the x coordinate of the first bounce : “bounce x”
- 21.** Click the checkbox underneath the “**bounce x**” column to indicate that this is the output value that the computer will learn to predict



- 22.** You should have:
- * Three input columns — values you have at the start of a new bouncing ball simulation
 - * One output column — the value that the computer will learn to predict

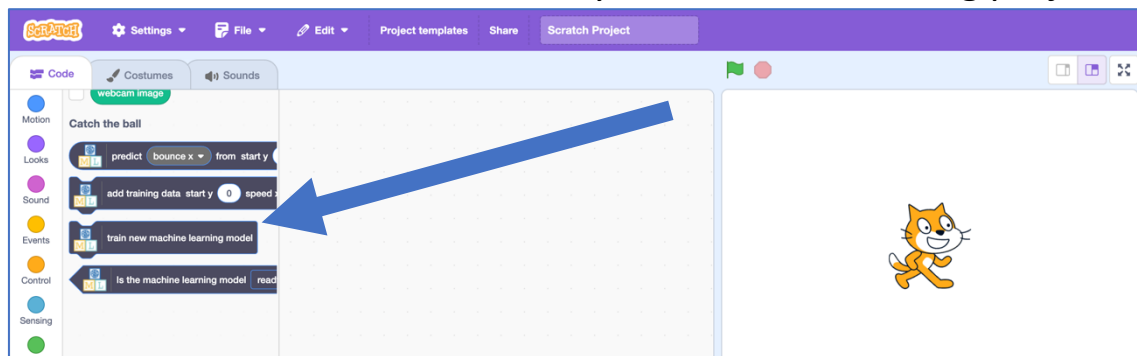


23. Click on **Back to project**

24. It is time to collect training examples to train the computer.
Click the **Make** button

25. Click the **Scratch 3** button and then click on **straight into Scratch**

26. In the Scratch window that opens, scroll to the bottom of the toolbox to see the new blocks for your machine learning project



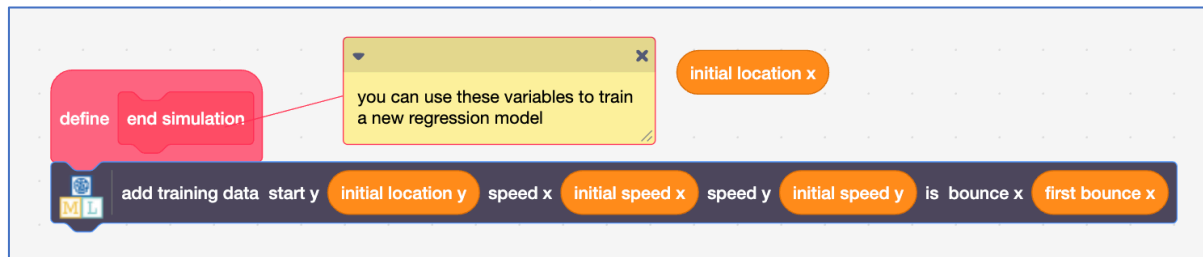
27. Click on **Project templates** & open the “**Catch the ball**” template

28. Find the “**end simulation**” block in the “**ball**” sprite



The code in this block will be run at the end of every simulation. This is after the ball has finished bouncing, so the first bounce coordinates will be available.

29. Update the code so that it stores the values for each simulation to use to train your machine learning model



Notice that we're not using the x coordinate for the initial ball location as it is always the same – the computer can't learn anything from it now.

30. Click on the **Green Flag**

31. Let the simulation play for **ten** balls

32. In the training tool window, go back to the **Train** page
Keep the Scratch window open as you will return to it in a moment

33. Review the training examples that you have collected

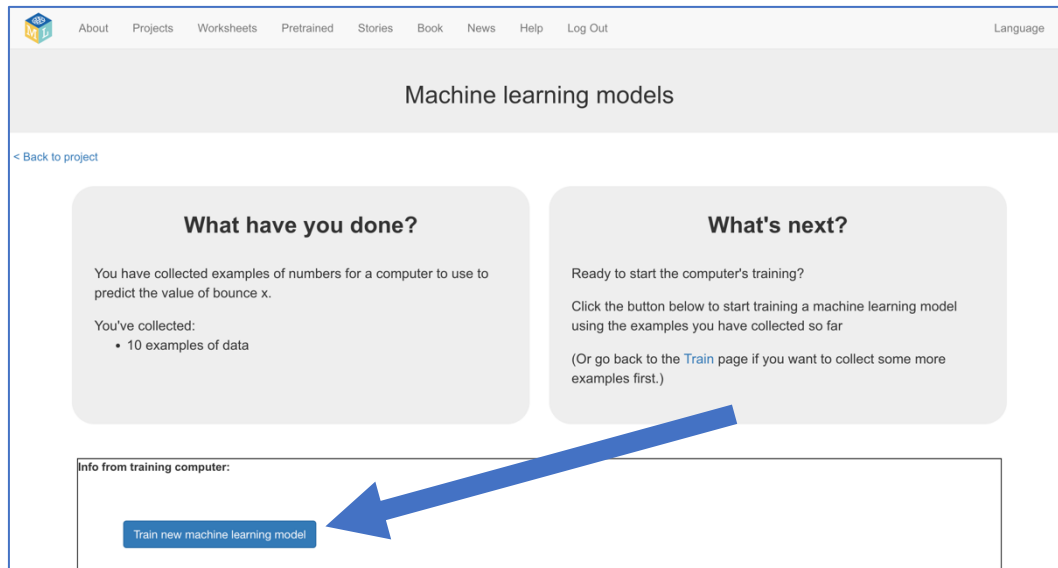
The screenshot shows the training tool window with the title 'Predicting bounce x from 3 input values'. Below the title is a '< Back to project' link. The main area is titled 'examples' and contains a table with 10 rows of training data. The table has four columns: 'start y', 'speed x', 'speed y', and 'bounce x'. Each column has a small up/down arrow icon next to its header. At the bottom of the table are four buttons: 'Change output column(s)', 'Upload CSV', 'Download CSV', and 'Delete all'. A small circle with the number '10' is in the bottom right corner of the window.

start y	speed x	speed y	bounce x
19	12	8	166
-4	5	9	15
-42	5	8	-10
-62	9	8	148
-4	13	9	129
-54	16	11	-6
9	7	8	99
40	7	9	134
-93	10	8	170

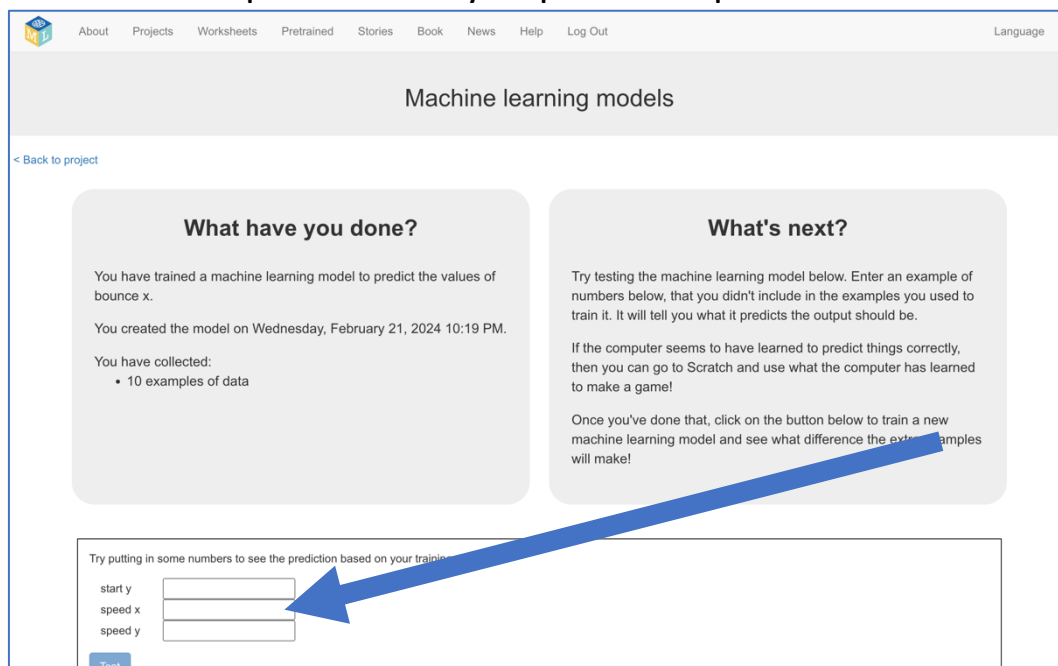
34. Click on **Back to project**

35. Click the **Learn & Test** button

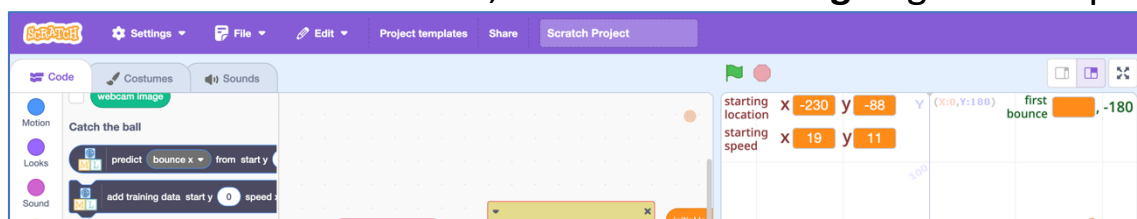
36. Click on **Train new machine learning model**



37. You have your first machine learning model.
It can make a prediction if you provide input values here.



38. In the **Scratch** window, click the **Green Flag** to get new input values



39. Enter the input values and click on the **Test** button
The predicted x coordinate of the first bounce will be displayed

Try putting in some numbers to see the prediction based on your training.

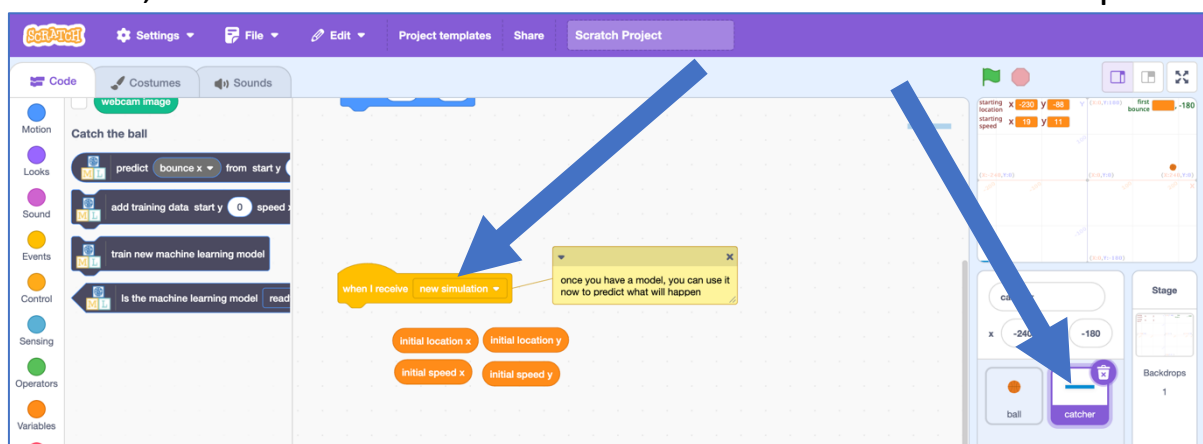
start y	<input type="text" value="-88"/>
speed x	<input type="text" value="19"/>
speed y	<input type="text" value="11"/>

Test

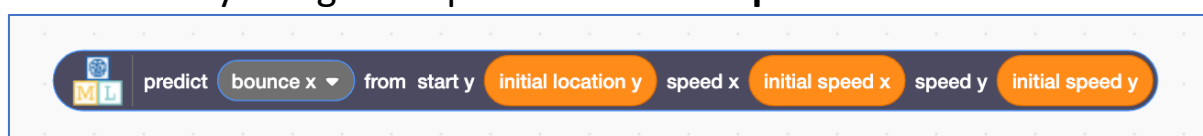
Prediction:

bounce x

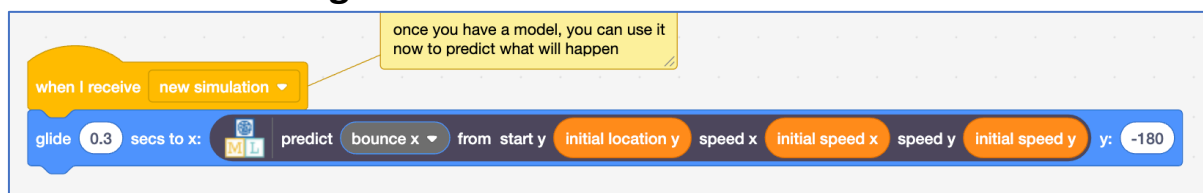
40. Next, we'll use the prediction in Scratch. Return to the Scratch window, and find the "**new simulation**" code in the "**catcher**" sprite



41. Start by using the input variables in a **predict** block

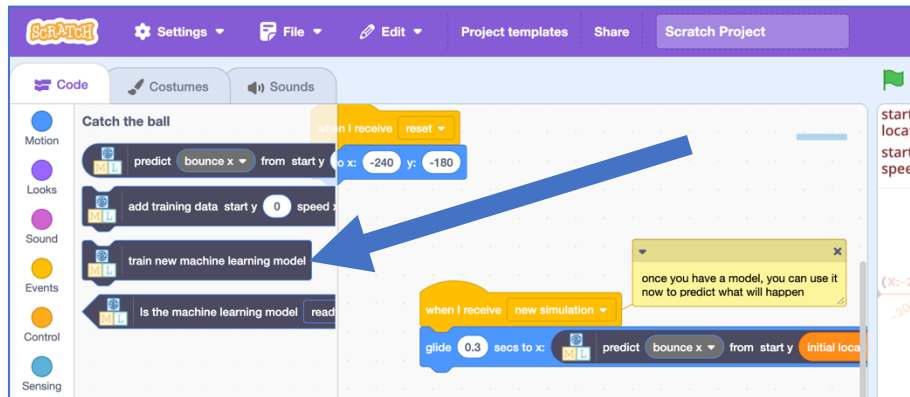


42. Add this to a **glide** block and add it all to the **new simulation** hat



43. Click on the **Green Flag** again.
The "**catcher**" sprite should move to where the ball will bounce.

- 44.** If the catcher sprite doesn't move, this may be because your trained model was not detected by Scratch. Click on the **"train new machine learning model"** block to train a new one



- 45.** Observe a few ball simulations. How many balls is the catcher sprite able to catch?

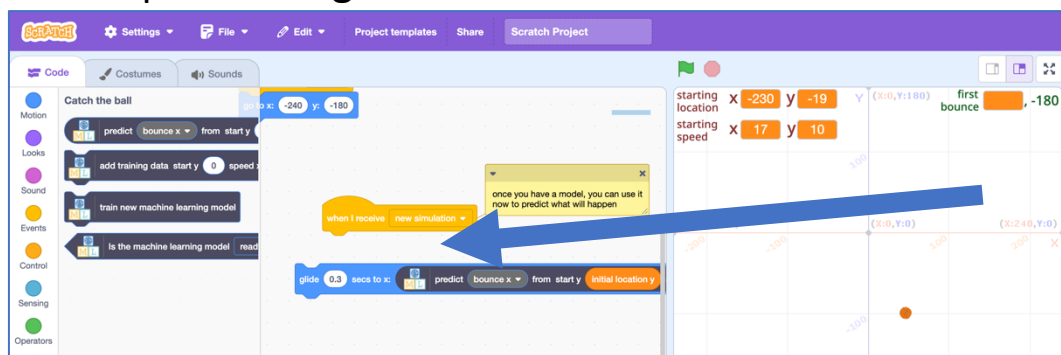
What have you done so far?

You've started to train a computer to make a prediction of the most likely output number, based on a few different input numbers. Instead of trying to write rules to be able to do this, you are doing it by collecting examples. These examples are being used to train a machine learning "model".

The type of model you have trained is called a "regression" model.

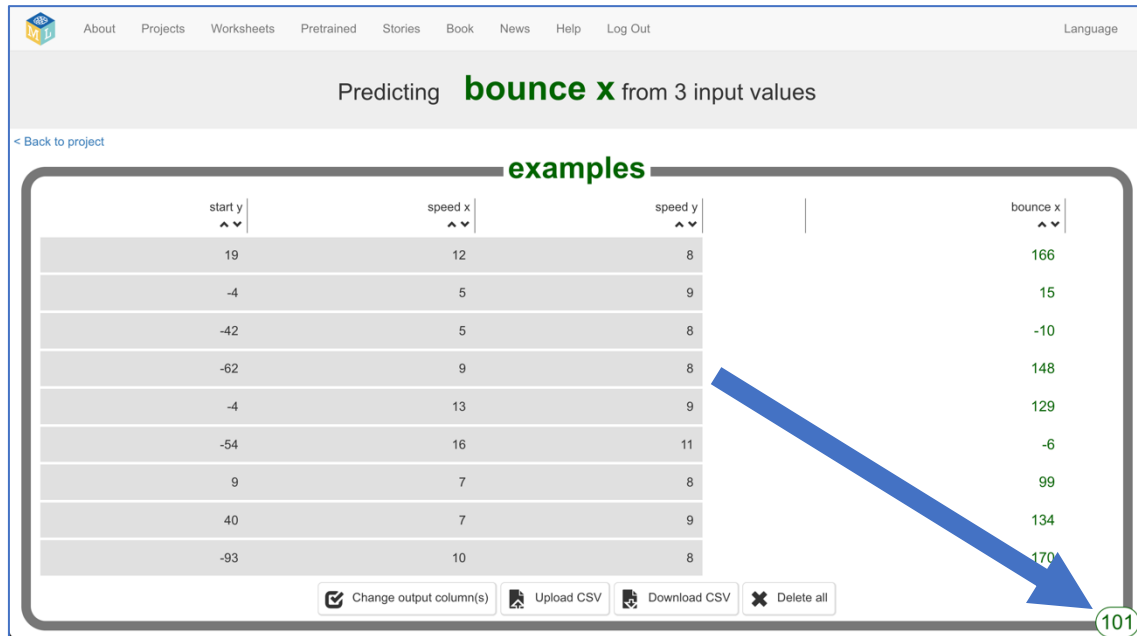
With only ten training examples, your model is probably not making good predictions. More training examples should help it learn to do better.

- 46.** Separate the **glide** block from the **new simulation** hat



47. Click the **Green Flag** again and leave the simulation running to collect lots more training examples.

48. You can review the training examples you have collected while your Scratch project runs. The number of examples is displayed in the corner.



Predicting **bounce x** from 3 input values

< Back to project

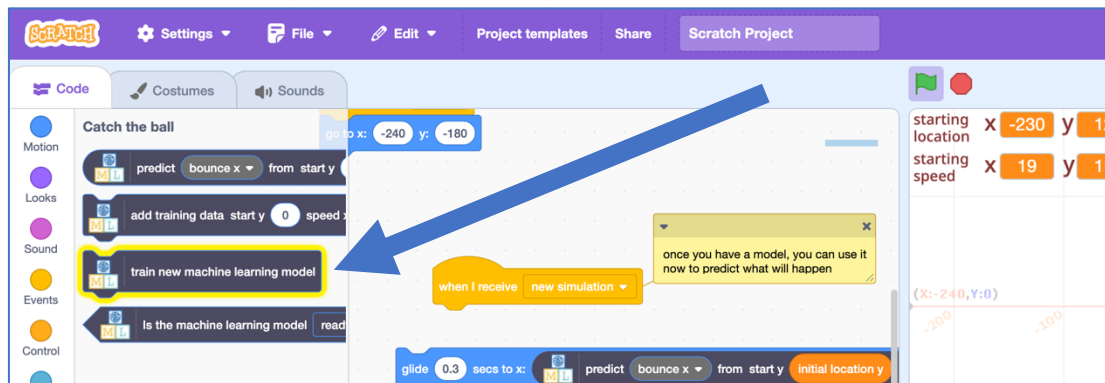
examples

start y	speed x	speed y	bounce x
19	12	8	166
-4	5	9	15
-42	5	8	-10
-62	9	8	148
-4	13	9	129
-54	16	11	-6
9	7	8	99
40	7	9	134
-93	10	8	170

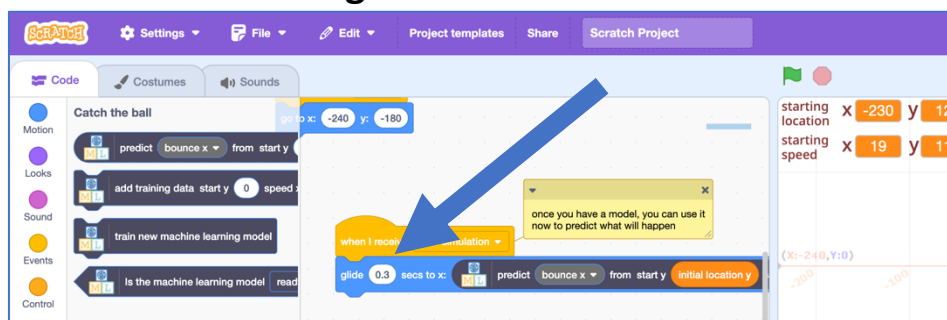
Change output column(s) Upload CSV Download CSV Delete all

101

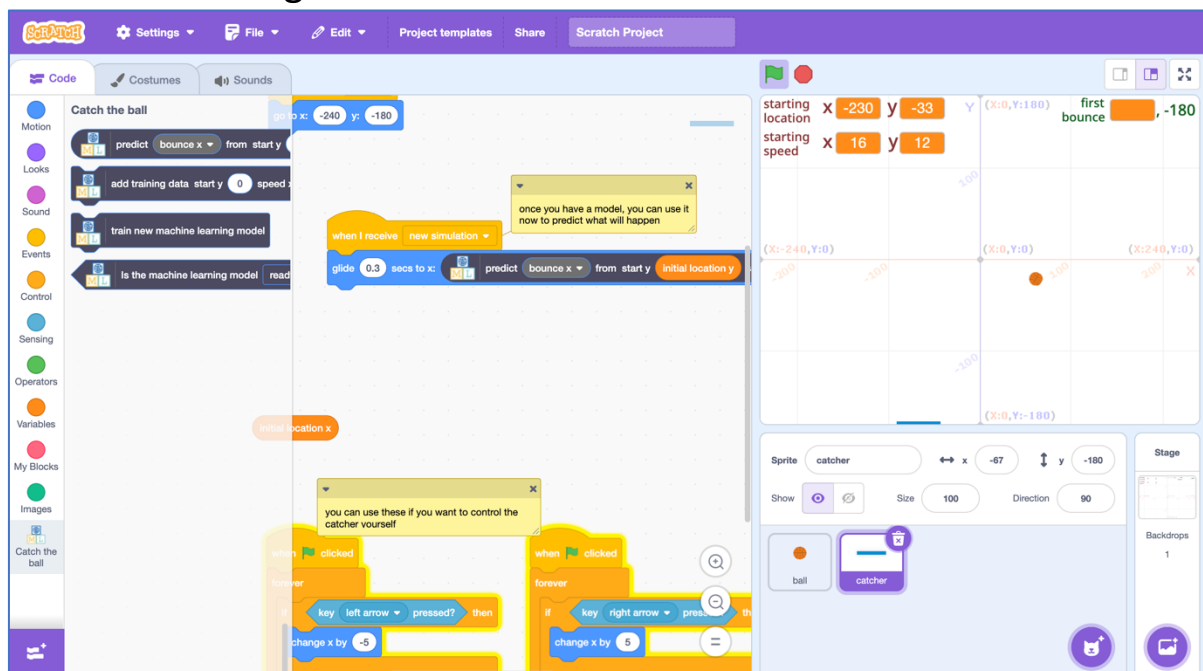
49. Click on the “train new machine learning model” block to train a new model using your new, larger set of training examples



50. Re-attach the glide block to the new simulation hat



51. Click the **Green Flag** again to run the simulation with your improved machine learning model



What have you done?

You've improved the accuracy of your regression model by increasing the number of training examples that the model has had to learn from.

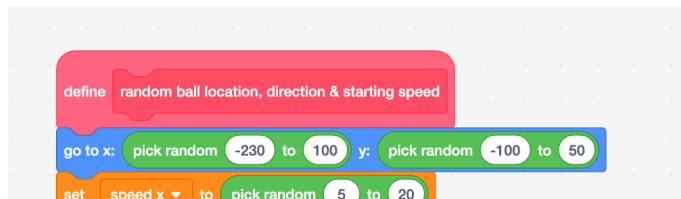
The computer learns from patterns in the examples you give it, and uses these to make predictions about the most likely output value.

Ideas and Extensions

Try the project again but make it more complicated!

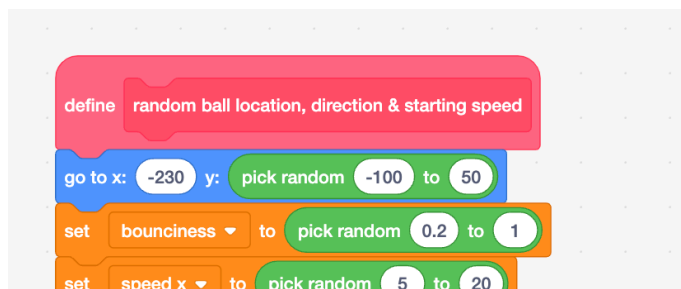
Change the starting x coordinate

Change the Scratch project code for the ball sprite to make the ball start at a random x coordinate.



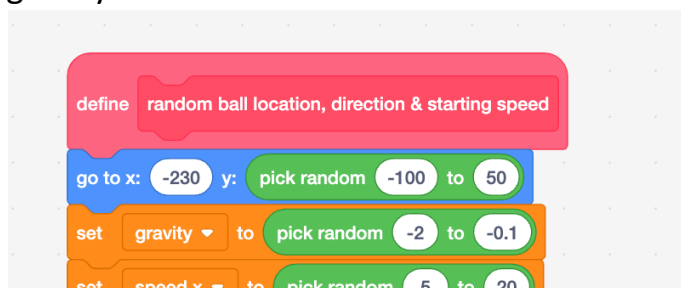
Change the bounciness

Change the Scratch project code for the ball sprite to vary how bouncy the ball is.



Change gravity

Change the Scratch project code for the ball sprite to vary the effect of gravity on how the ball flies.



Use one (or more!) of these as an additional input variable.

Can you create a machine learning model that can predict the affect that it will have on where the ball bounces?