

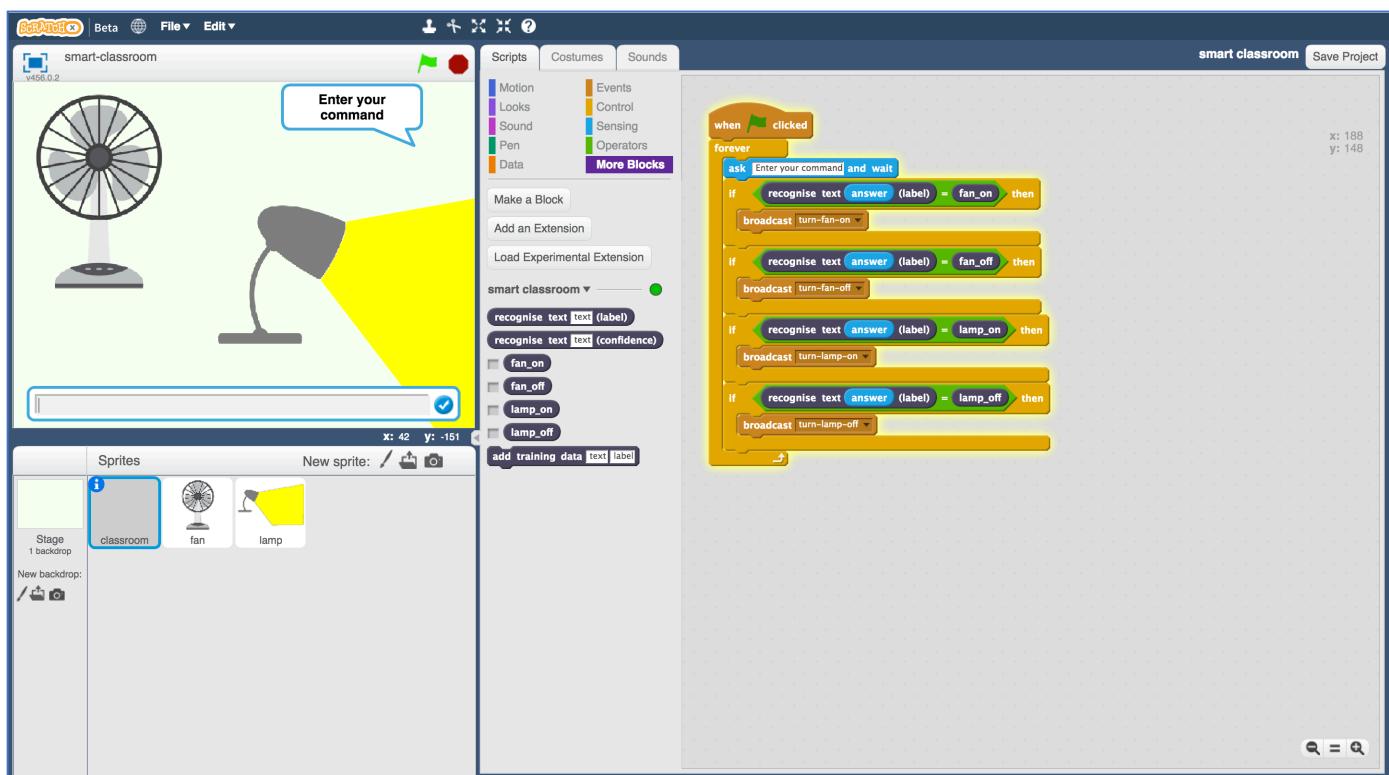
# Smart Classroom

In this project you will make a virtual classroom that can react to what you say to it.

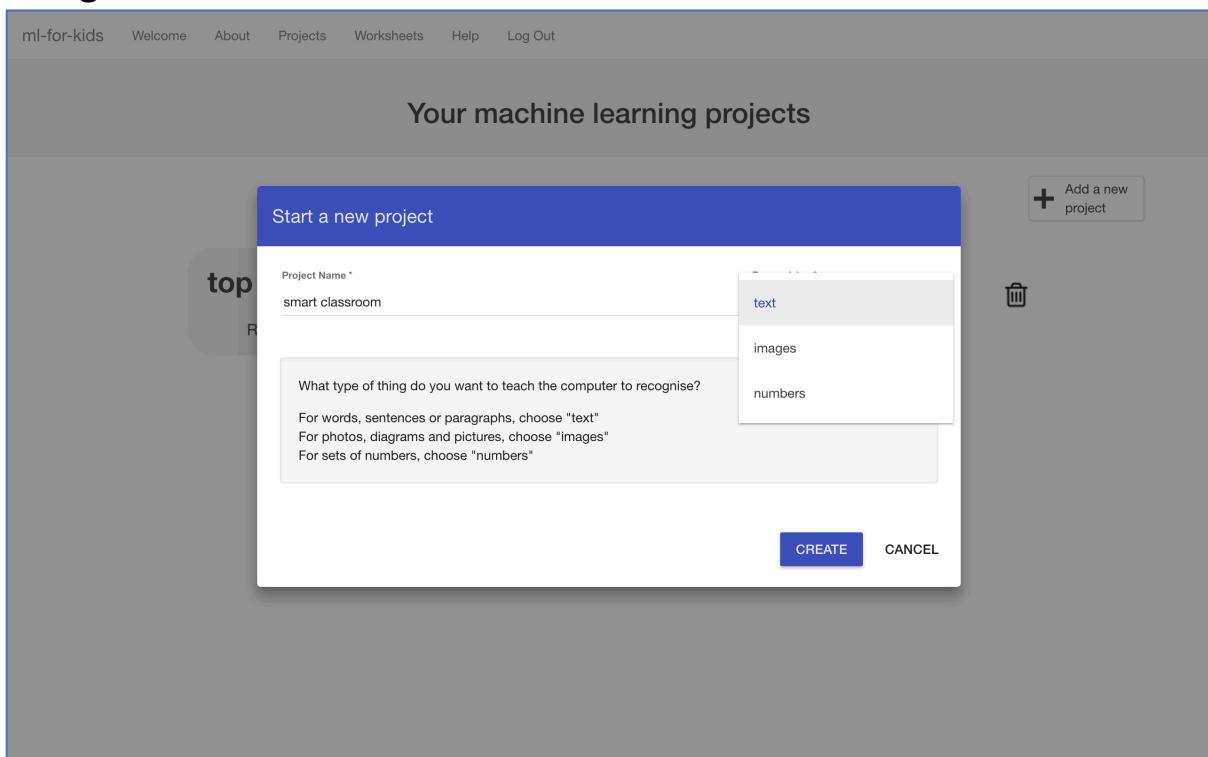
You'll be able to control the virtual devices in the classroom by saying what you want.

To start with, you'll program a list of rules for understanding commands, and learn why that approach isn't very good.

Next, you will teach the computer to recognise commands for different devices by giving it examples of each.



- 1.** You'll need the **smart-classroom.sbx** starter file for this project.  
*If you haven't got this, ask your teacher or group leader.*
- 2.** Go to <https://machinelearningforkids.co.uk/> in a web browser
- 3.** Click on “**Get started**”
- 4.** Click on “**Log In**” and type in your username and password  
*If you don't have a username, ask your teacher or group leader to create one for you.*  
*If you can't remember your username or password, ask your teacher or group leader to reset it for you.*
- 5.** Click on “**Projects**” on the top menu bar
- 6.** Click on the “**+ Add a new project**” button.
- 7.** Name your project “smart classroom” and set it to learn how to recognise “**text**”



- 8.** You should now see “smart classroom” show up in the list of your projects. Click on it.

The screenshot shows a web interface for managing machine learning projects. At the top, there is a navigation bar with links: ml-for-kids, Welcome, About, Projects, Worksheets, Help, and Log Out. Below the navigation bar, the title "Your machine learning projects" is displayed. There are two project cards: "top trumps" and "smart classroom". Each card has a delete icon (trash can) to its right. A button at the top right of the card area says "+ Add a new project".

Project Name	Description	Action
top trumps	Recognising numbers as win, draw or lose	Delete
smart classroom	Recognising text	Delete

- 9.** We'll start by getting a project ready in Scratch. Click on the **Scratch** button.

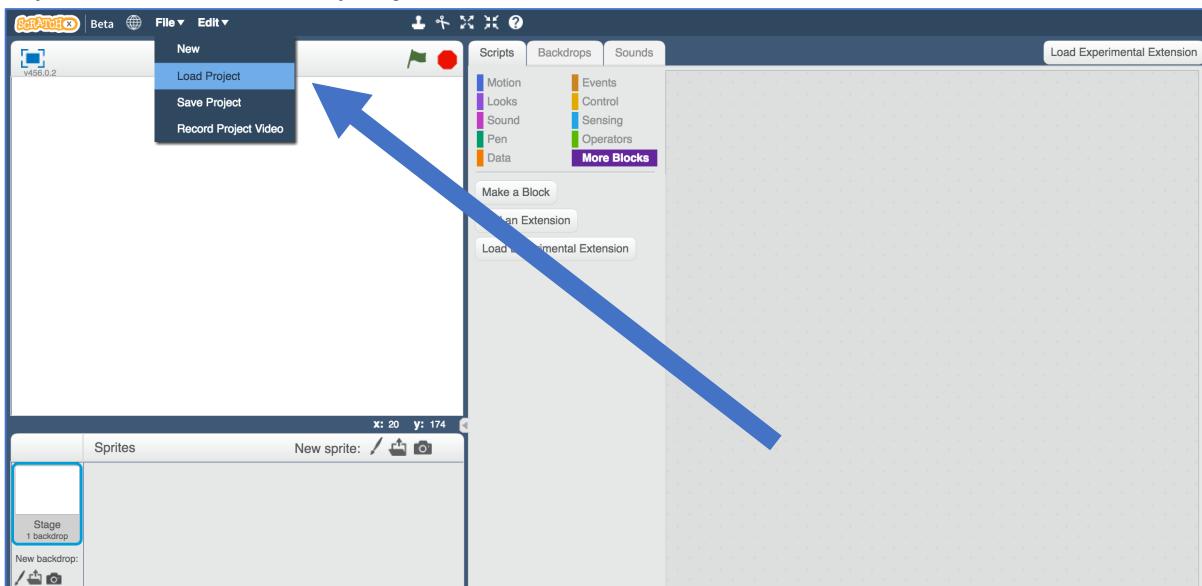
*The next page will warn you that you haven't done any machine learning yet, but clicking on **Scratch by itself** will launch Scratch.*

The screenshot shows the details for the "smart classroom" project. At the top, the project name "smart classroom" is displayed. Below it are three buttons: "Train", "Learn & Test", and "Scratch". Each button has a corresponding description below it.

Option	Description
Train	Collect examples of what you want the computer to recognise.
Learn & Test	Use the examples to train the computer to recognise text.
Scratch	Use the machine learning model you've trained to make a game in Scratch.

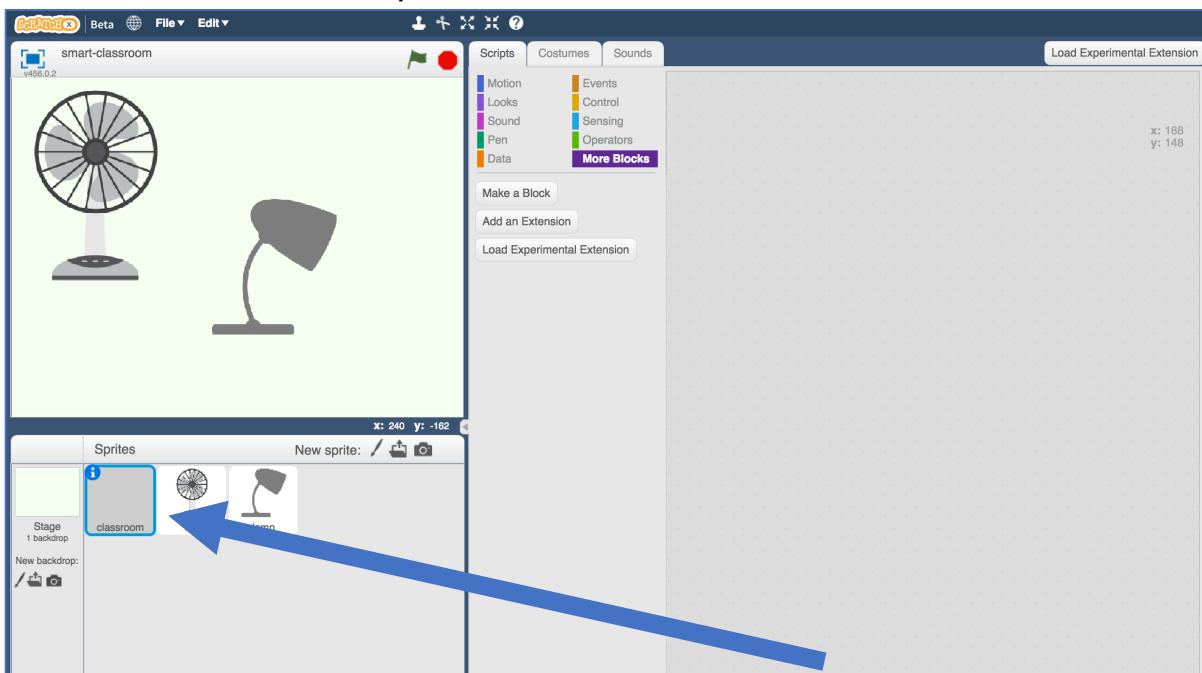
## 10. Load the smart-classroom.sbx template file

Use File -> Load Project as shown below. Click OK if you're asked to replace the current project.

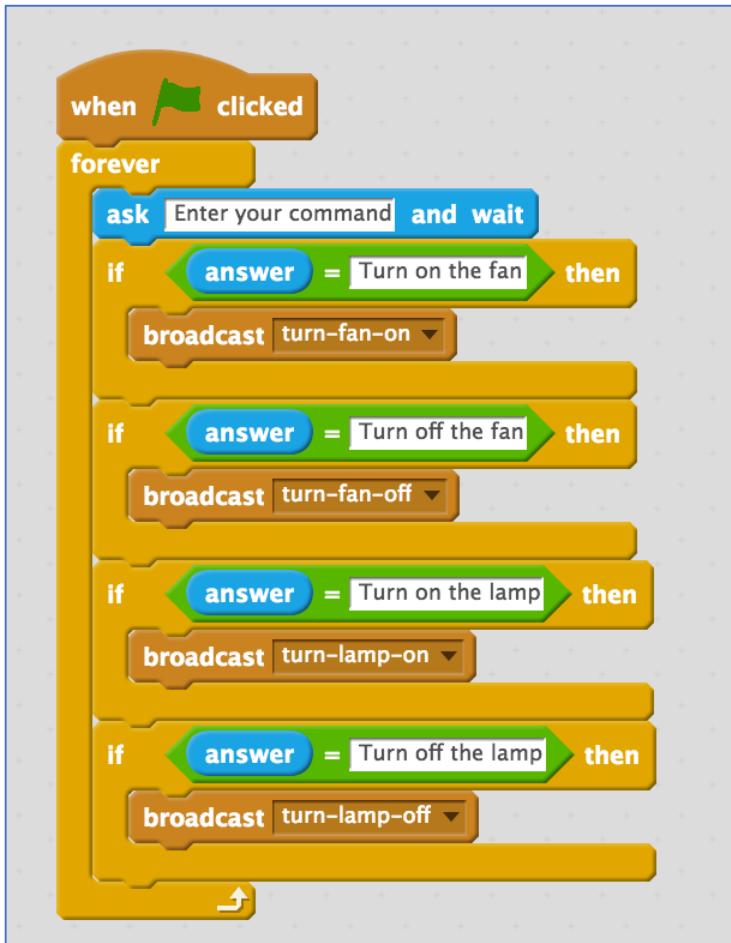


## 11. You should see two sprites on the stage ("fan" and "lamp") with a third invisible sprite called "classroom".

Click the "classroom" sprite so that it is selected as shown below.



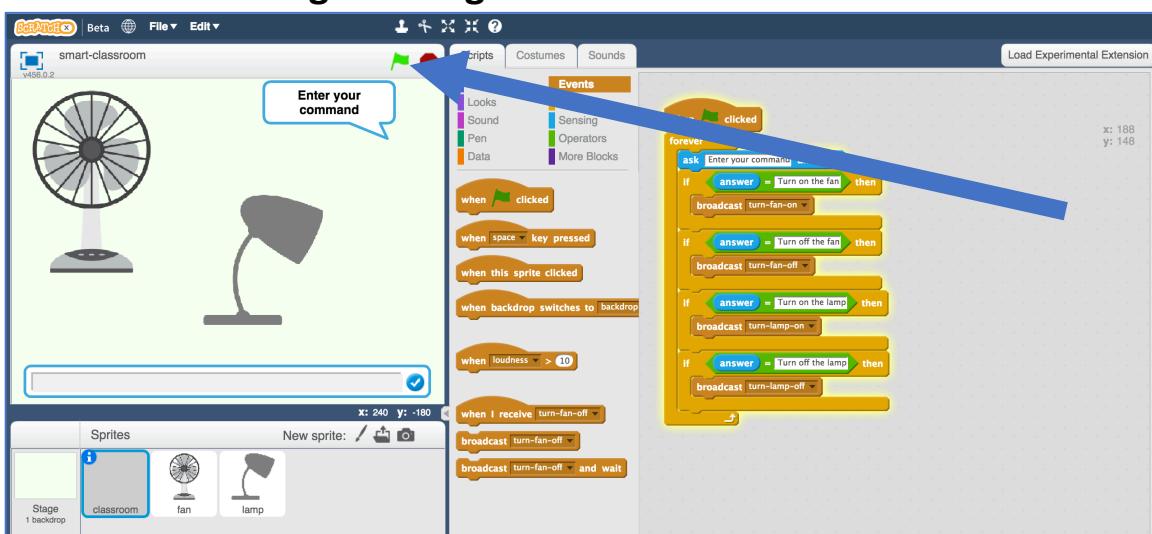
**12.** Click on the **Scripts** tab and enter the following script.



**13.** Save your project.

*Click on **File** -> **Save Project** to save the project to a file.*

**14.** Click on the green flag to test.



## 15. Type in a message and watch it react!

Type “Turn on the lamp” and press enter. The lamp should turn on.

Try “Turn off the lamp”, “Turn on the fan”, and “Turn off the fan”.

They should all work.

Type anything else, and nothing will happen!

Even if you just make a small spelling mistake, it won’t match.

If you don’t get it exactly right, nothing will happen.

## What have we done so far?

You’ve programmed the virtual classroom to react to commands using a simple rules-based approach.

If you want it to understand commands phrased differently, you would need to add extra **if** blocks.

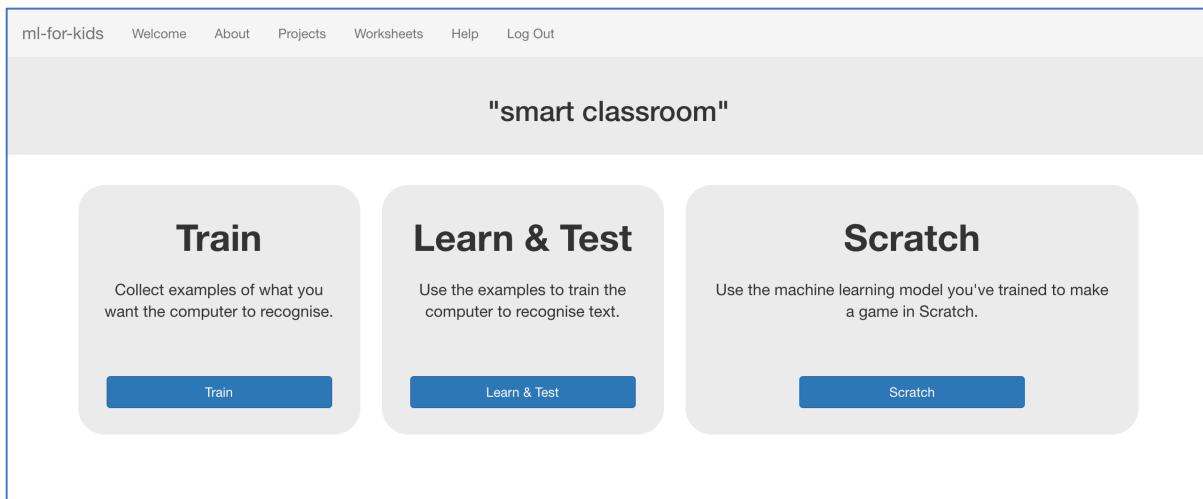
The problem with this is that you need to predict exactly what command the smart classroom assistant could ever get. Making a list of every possible message would take forever.

Next, we’ll try a better approach: teaching the computer to recognise the commands for itself.

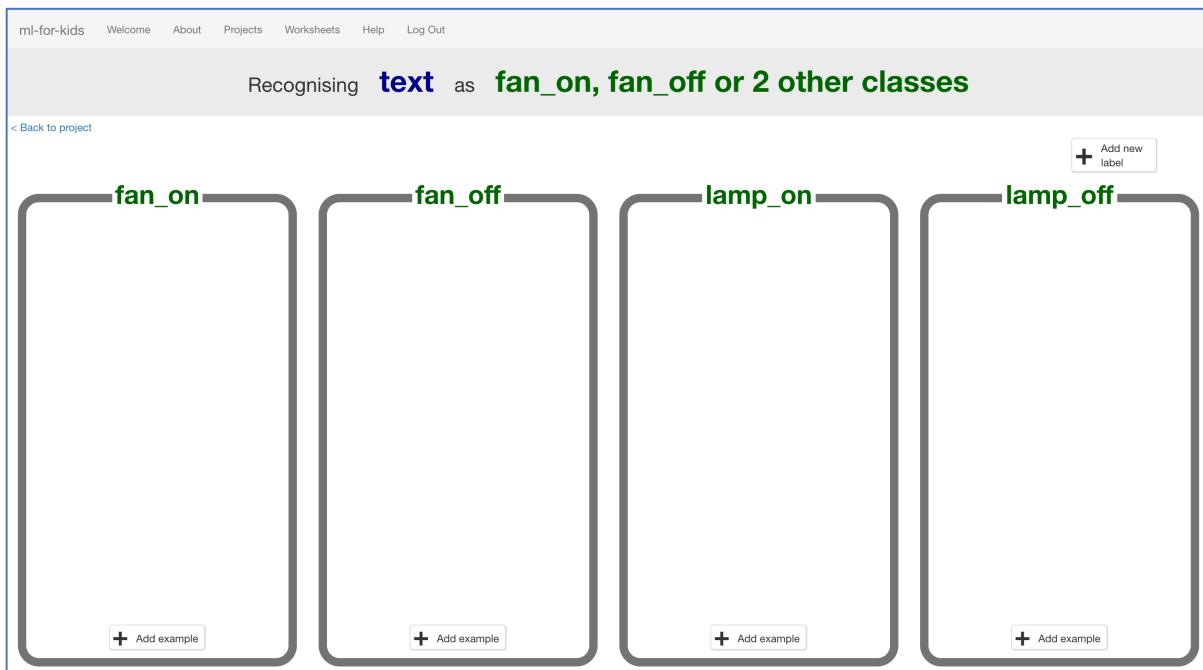
## 16. Close the Scratch window and go back to the Training tool.

## 17. Click on the “< Back to project” link.

**18.** We need to collect some examples to train the computer.  
Click the **Train** button.



**19.** Click on “+ Add new label” and call it “fan on”.  
Do that again, and create a second bucket called “fan off”.  
Do that again, and create a third bucket called “lamp on”.  
Do that again, and create a fourth bucket called “lamp off”.



**20.** Click on the “Add example” button in the “fan on” bucket, and type in a way to ask for the fan to be turned on.  
*For example, you could type “Please can you switch on the fan”.*

**21.** Click on the “Add example” button in the “fan off” bucket, and type in a way to ask for the fan to be switched off.  
*For example, you could type “I want the fan off now”*

**22.** Do the same for the “lamp on” and “lamp off” buckets.

**23.** Repeat steps 20-22 until you’ve got at least **six** examples of each.

*Be imaginative!*

*Try and think of lots of different ways to ask each command.*

*For “fan on” you could complain that you’re too hot.*

*For “fan off” you could complain that it’s too breezy.*

*For “lamp on” you could complain that it’s too dark or that you can’t see.*

*For “lamp off” you could complain that it’s too bright.*

The screenshot shows a web interface for labeling text examples. At the top, a navigation bar includes links for 'ml-for-kids', 'Welcome', 'About', 'Projects', 'Worksheets', 'Help', and 'Log Out'. Below this, a title bar reads 'Recognising **text** as **fan\_on, fan\_off or 2 other classes**'. A 'Back to project' link is visible on the left. The main area contains four labeled buckets:

- fan\_on**: Examples include "Can we turn the fan on?", "Can you switch on the fan?", "fan on", "I need some air", "I want the fan on", "I'd like the fan on, please", "I'm too hot", "It's too hot in here", "Please switch the fan on", "Please turn on the fan", and "Turn on the fan".
- fan\_off**: Examples include "Can we have the fan off now", "fan off", "I don't want the fan on any more", "I'm cold", "I'm feeling too cold", "It's too breezy", "It's too windy", "It's too windy in here", "Please can you turn off the fan", "Switch off the fan", and "Turn the fan off".
- lamp\_on**: Examples include "Can we have some light on?", "Can we have the lamp on?", "I can't see", "I can't see. Let's have some light.", "It's too dark", "It's too dark in here.", "It's too dark. I can't see anything.", "Lamp on", "Light on", "Please turn on the lamp", and "Turn on the lamp".
- lamp\_off**: Examples include "Can you turn off the lamp?", "Can you turn the light off", "Could you turn the light off please?", "It's too bright", "Lamp off", "Lamp off please", "Please can you switch the light off", "Please make it darker", "Please turn off the lamp", and "Turn off the lamp".

In the top right corner of the main area, there is a button labeled '+ Add new label'.

**24.** Click on the “< Back to project” link, then click the “Learn & Test” button.

## 25. Click on the “Train new machine learning model” button.

*As long as you’ve collected enough examples, the computer should start to learn how to recognise commands from the examples you’ve written.*

The screenshot shows the 'Machine learning models' page. At the top, there is a navigation bar with links: ml-for-kids, Welcome, About, Projects, Worksheets, Help, and Log Out. Below the navigation bar, the title 'Machine learning models' is centered. Underneath the title, there is a link '< Back to project'. The page is divided into two main sections: 'What have you done?' and 'What's next?'. The 'What have you done?' section contains text about collected examples and a bulleted list of 12 examples. The 'What's next?' section contains text about starting training and a link to the 'Train' page. At the bottom of the page, there is a box labeled 'Info from training server:' which contains a 'Train new machine learning model' button.

## 26. Wait for the training to complete. This might take a minute or two.

*While waiting, try to complete the machine-learning multi-choice quiz at the bottom of the page.*

The screenshot shows the 'Machine learning models' page during the training process. The 'What have you done?' section indicates that training has started since Saturday, July 8, 2017, 8:22 PM, and notes that it can take longer if the server is busy. The 'What's next?' section suggests waiting for the model to finish training or taking a quiz. At the bottom, there is a box labeled 'Info from training server:' containing training status information: Model started training at Saturday, July 8, 2017 8:22 PM, Current model status: Training, and Model will automatically be deleted after Saturday, July 8, 2017 10:22 PM. There is also a 'Cancel training' button.

**27.** Once the training has completed, a Test box will be displayed.

Try testing your machine learning model to see what the computer has learned.

Type in a command, and press enter. It should be properly recognised as one of the four commands.

*Test it with examples that you haven't shown the computer before.*

*If you're not happy with how the computer recognises the messages, go back to step 20, and add some more examples.*

*Make sure you repeat step 25 to train with the new examples though!*

The screenshot shows a web-based machine learning interface. At the top, there's a navigation bar with links: ml-for-kids, Welcome, About, Projects, Worksheets, Help, and Log Out. Below the navigation is a main title 'Machine learning models'. A sub-section title 'What have you done?' contains information about the trained model: 'fan\_on', 'fan\_off', and 2 other classes, created on Saturday, July 8, 2017 at 8:22 PM. It also lists collected examples for 'fan\_off', 'fan\_on', 'lamp\_off', and 'lamp\_on'. To the right, under 'What's next?', instructions advise testing the model with new text to see its recognition accuracy. It also suggests going back to the 'Train' page if things are getting too wrong. Below this, a 'Test' section allows users to input text and click a 'Test' button. At the bottom, there's an 'Info from training server:' section with details: Model started training at Saturday, July 8, 2017 8:22 PM, Current model status: Available, and Model will automatically be deleted after Saturday, July 8, 2017 10:22 PM. Buttons for 'Delete this model' and 'Train new machine learning model' are also present.

## What have we done so far?

You've started to train a computer to recognise commands to control two classroom devices.

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".

This is called "supervised learning" because of the way you are supervising the computer's training.

The computer will learn from patterns in the examples you've given it, such as the choice of words, and the way sentences are structured. These will be used to be able to recognise commands.

## 28. Click on the "< Back to project" link, then the "Scratch" button.

*This page has instructions on how to use the new blocks in Scratch from your project. Keep this page open so can check back on how to use them.*

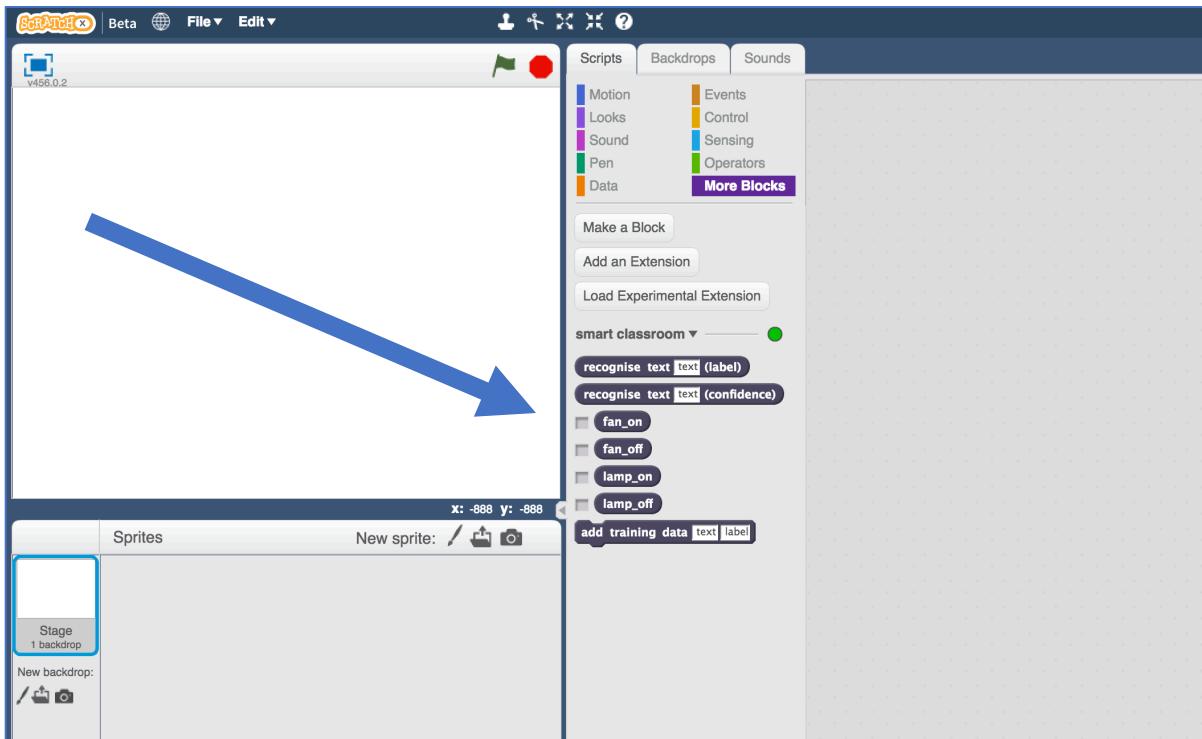
The screenshot shows a web-based guide for using machine learning in Scratch. At the top, there's a navigation bar with links for 'ml-for-kids', 'Welcome', 'About', 'Projects', 'Worksheets', 'Help', and 'Log Out'. Below the navigation is a title 'Using machine learning in Scratch'. A 'Back to project' link is visible on the left. The main content area contains several sections with text and images:

- A section about adding blocks to the 'More Blocks' tab in Scripts, with a note about the 'recognise text [text] (label)' block.
- A section about the 'confidence' block, with a note about the 'recognise text [text] (confidence)' block.
- A section about using labels like 'fan.on' and 'fan.off' in scripts.
- A section titled 'This means you can do something like this:' showing a Scratch script:

```
ask [enter some text here] and wait
if [recognise text [answer] (label) = [fan.on v]] then
[say [I think that was fan.on!] v]
```
- A section showing the Scratch interface with the 'More Blocks' tab selected, displaying the 'recognise text' blocks.
- A note about the colored circle next to the project name indicating training status.
- A legend for the colored circles:
  - Green: means your model is trained and ready to go
  - Yellow: means your model hasn't finished training yet
  - Red: means something went wrong. Go back to the Learn & Test page to see what went wrong with training.

**29.** Click the “Open in Scratch” button at the bottom of that page to launch the Scratch editor.

*You should see new blocks in the “More blocks” section from your “smart classroom” project.*



**30.** Load the Scratch project you saved before.

**Click on File -> Load Project**

**Click OK when it asks to replace the current project**

## Tips

### More examples!

The more examples you give it, the better the computer should get at recognising your instructions.

### Try and be even

Try and come up with roughly the same number of examples for each command.

If you have a lot of examples for one command, and not the others, the computer might learn that command is more likely, so you'll affect the way that it learns to recognise messages.

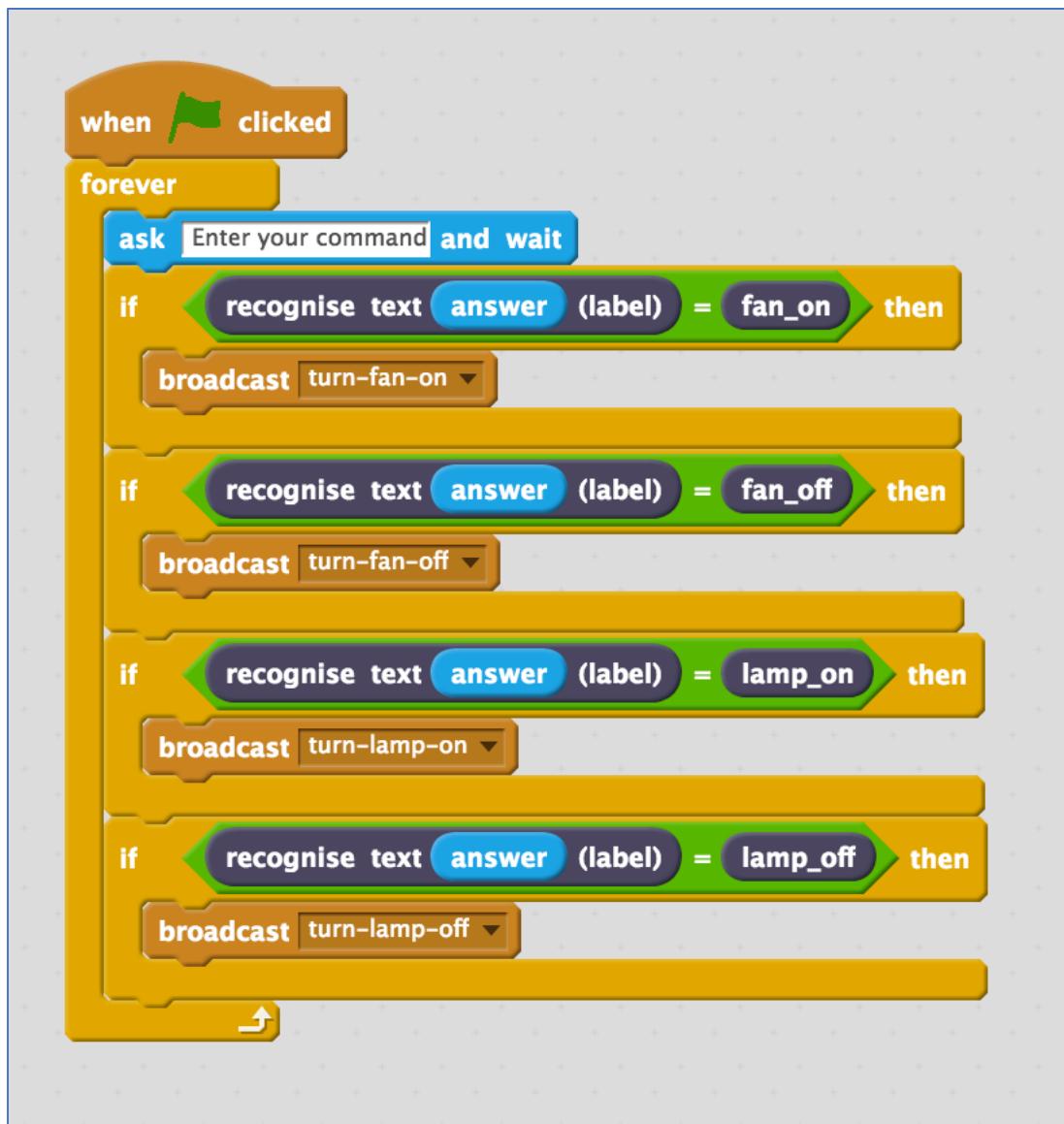
### Mix things up with your examples

Try to come up with lots of different types of examples.

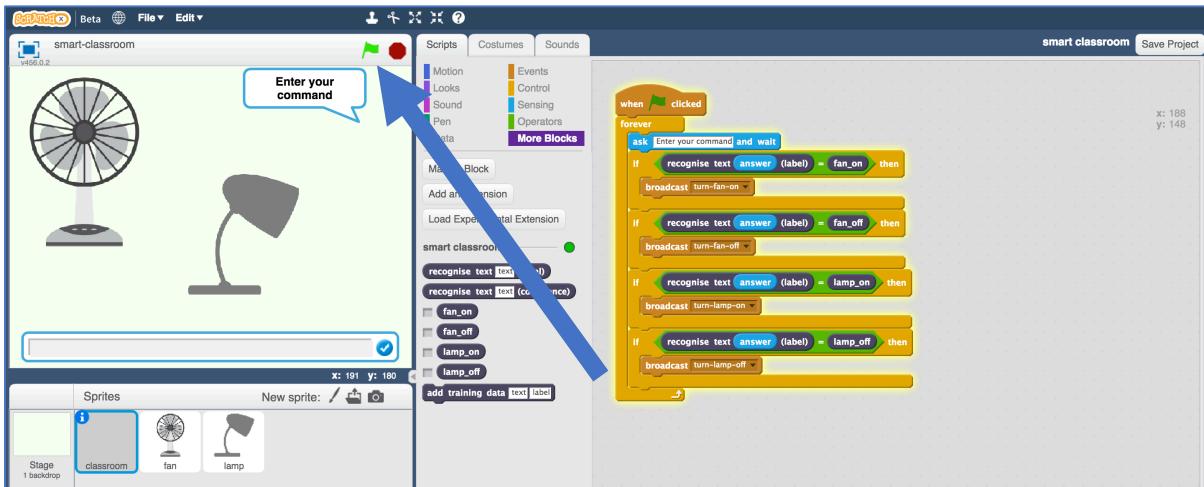
For example, make sure that you include some long examples and some very short ones.

**31.** Click on the “**Scripts**” tab, and update the script to use your machine learning model instead of the rules you made before.

*The “recognise text ... (label)” block is a new block added by your project. If you give it text, it will return the label for one of the four commands based on the training you’ve given to the computer.*



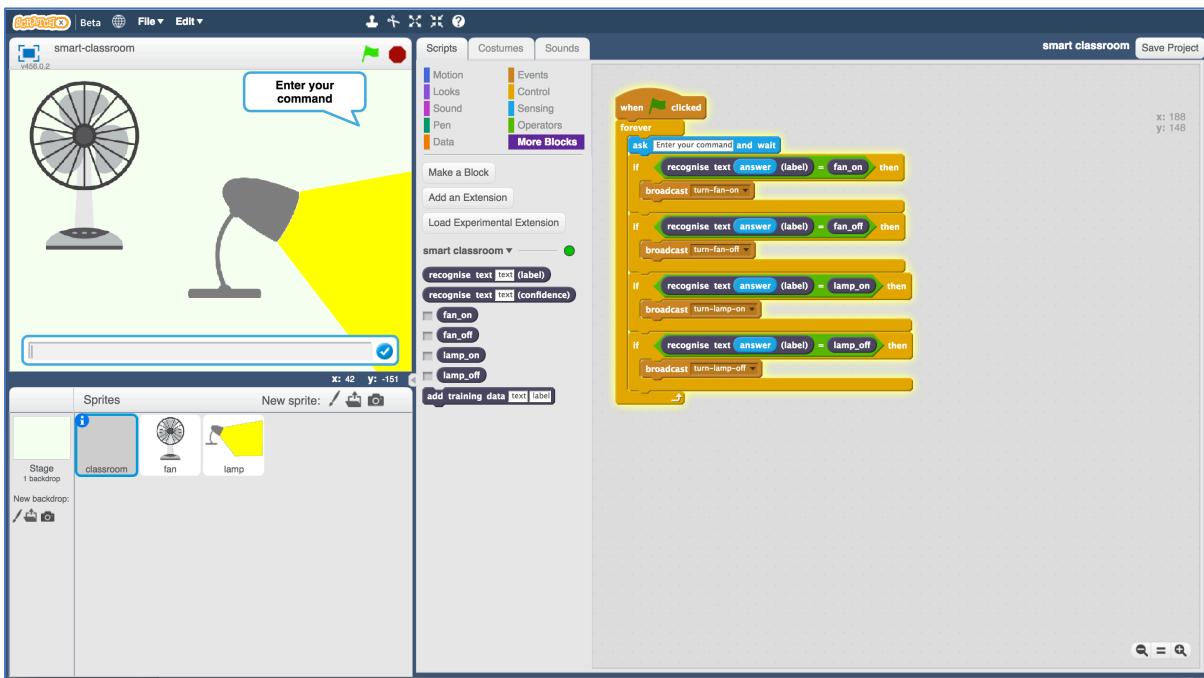
## 32. Click the green flag to test again.



## 33. Test your project

Type a command and press enter. The fan or lamp should react to your instructions.

Make sure you test that this works **even for messages that you didn't include in your training**.



## 34. Save your project.

Click **File -> Save Project**

## What have we done so far?

You've modified your Scratch smart classroom assistant to use machine learning instead of your earlier rules-based approach.

Training the computer to be able to recognise instructions for itself should be much quicker than trying to make a list of every possible command.

The more examples you give it, the better it should get at recognising instructions correctly.

**35.** Leave Scratch open (we'll come back in a moment) but go back to the **Learn & Test** page in the Training tool.

Type a message into the Test box that has nothing to do with lamps or fans.

*For example, "make me a cheese sandwich"*

< Back to project

**What have you done?**

You've trained a machine learning model to recognise when text is fan\_on, fan\_off or 2 other classes.

You created the model on Saturday, July 8, 2017 8:22 PM.

You've collected:

- 12 examples of fan\_off,
- 11 examples of fan\_on,
- 12 examples of lamp\_off,
- 12 examples of lamp\_on

**What's next?**

Try testing the machine learning model below. Enter an example of text below, that you didn't include in the examples you used to train it. It will tell you what it recognises it as, and how confident it is in that.

If the computer seems to have learned to recognise things correctly, then you can go to [Scratch](#) and use what the computer has learned to make a game!

If the computer is getting too many things wrong, you might want to go back to the [Train](#) page and collect some more examples. Once you've done that, click on the button below to train a new machine learning model and see what different the extra examples will make!

Try putting in some text to see how it is recognised based on your training.

make me a cheese sandwich

Test

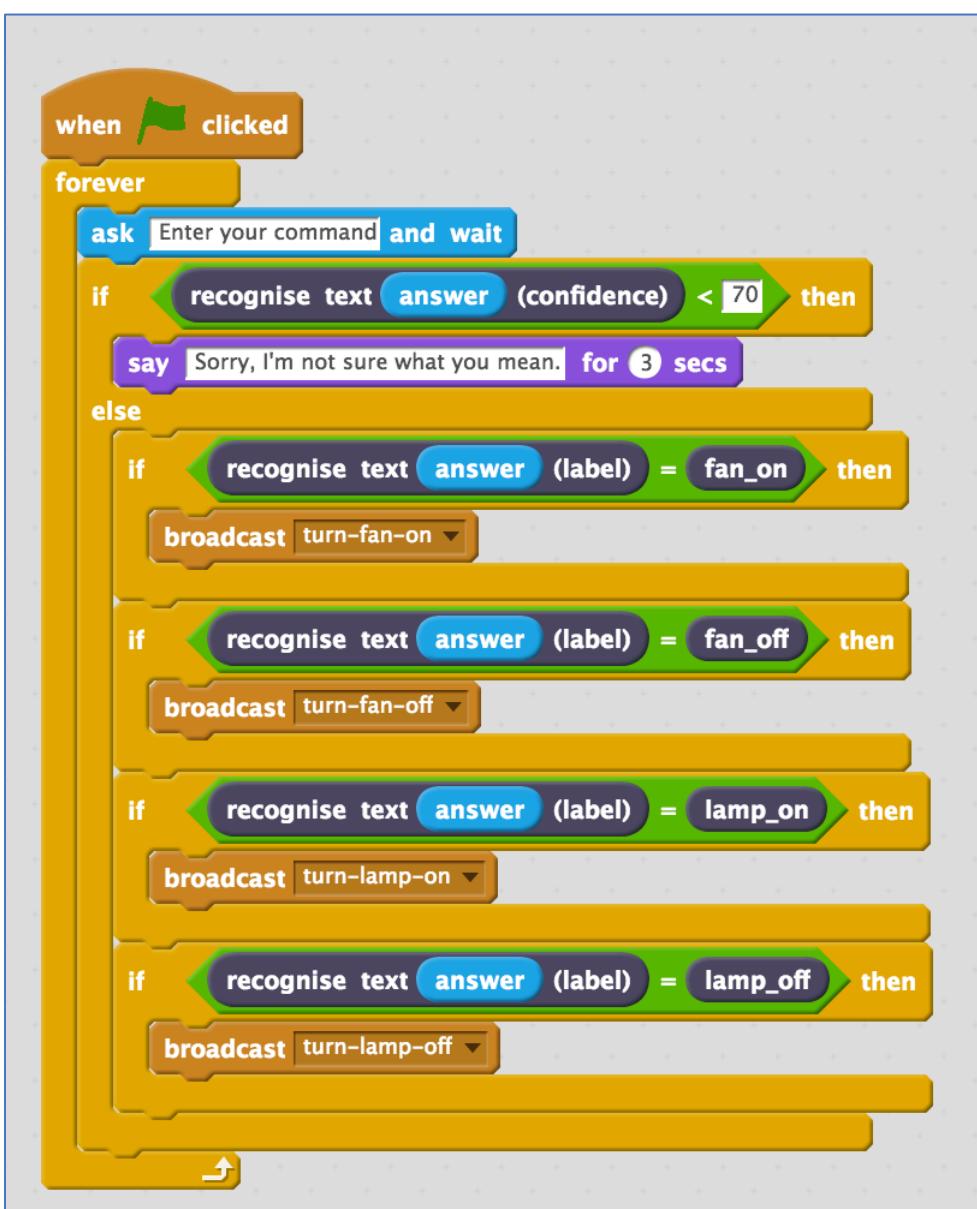
Recognised as **lamp\_off**  
with 21% confidence

**36.** Look at the confidence score, and check that it's very low. Compare this with the score you get from commands like "turn on the lamp".  
***This is the computer's way of telling you that it's not very certain it understands your command, because it doesn't look like what it learned from your examples.***

**37.** Go back to Scratch.

*You can open your saved project from before if you closed the window.*

**38.** Modify the script for the "classroom" sprite so that it uses this confidence score.



## **39.** Click the **green flag** and test again

*Try typing commands that have nothing to do with the fan or lamp.*

*Try asking for something to be turned on or off.*

*Check that your classroom reacts in the right way.*

## **40.** Save your project

*You've finished!*

### What have we done?

You've trained a smart assistant – like a simple version of the assistants you can get on modern smartphones (like Apple's Siri or Google's Assistant) or virtual assistant devices (like Amazon's Alexa or Google's Home).

You've used it to create a smart classroom assistant in Scratch, using machine learning instead of your earlier rules-based approach.

Training the computer to be able to recognise instructions was hopefully much easier than trying to make a list of every possible command. And the more examples you give it, the better it gets at recognising instructions and the more confident it gets in doing that.

And now, if it's not sure what you mean, it will ask you to try again.

## Ideas and Extensions

Now that you've finished, why not give one of these ideas a try?

### Try another device

Instead of just a fan and a lamp, can you add another device to your smart classroom?

### Try different confidence limits

Is 70% the right threshold to use to decide whether the computer has recognised the command?

Experiment with different values until you have a value that works well for your machine learning model.

If you choose a number that is too high, the computer will say “Sorry I’m not sure what you mean” too often.

If you choose a number that is too low, the computer will get too many things wrong.

### Do it for real!

Have a look at the smart assistants that developers have made for Amazon’s Alexa : <http://amzn.to/2sxy1hw>

Developers made these in the same way that you did this project – creating labels for the commands they wanted it to recognise, and then collecting examples of how those commands might be phrased to train the Alexa to be able to understand them.

Find an Alexa Skill that you think sounds good. Look at the commands it can understand – can you think how you could’ve trained it?