

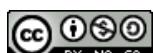
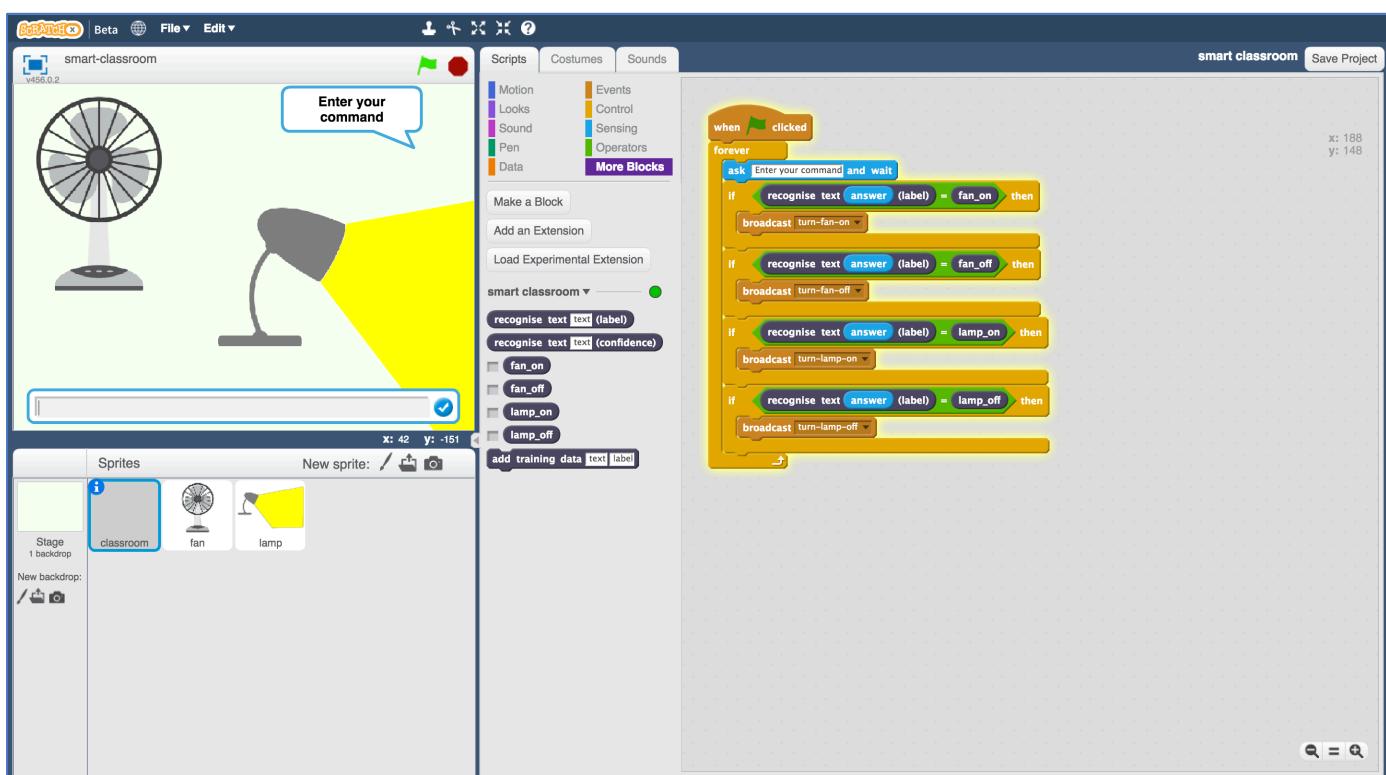
Smart Classroom

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.



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. 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 the “**+ Add a new project**” button.
7. Name your project “smart classroom” and set it to learn how to recognise “**text**”.

Click **Create**

The screenshot shows a web page titled "Start a new machine learning project". At the top, there is a navigation bar with links: ml-for-kids, Welcome, About, Projects, Worksheets, News, Help, and Log Out. Below the title, there is a "Project Name *" input field containing "smart classroom". Underneath, there is a "Recognizing *" dropdown menu with "text" selected. To the right of the dropdown, a tooltip-like box asks "What type of thing do you want to teach the computer to recognise?" and provides three options: "For words, sentences or paragraphs, choose \"text\"", "For photos, diagrams and pictures, choose \"images\"", and "For sets of numbers or multiple choices, choose \"numbers\"". At the bottom right are two buttons: "CREATE" and "CANCEL".

- 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 title, a brief description, and a delete icon. A button labeled "Add a new project" with a plus sign is located in the top right corner of the main content area.

| Project | 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 the **Scratch** button.

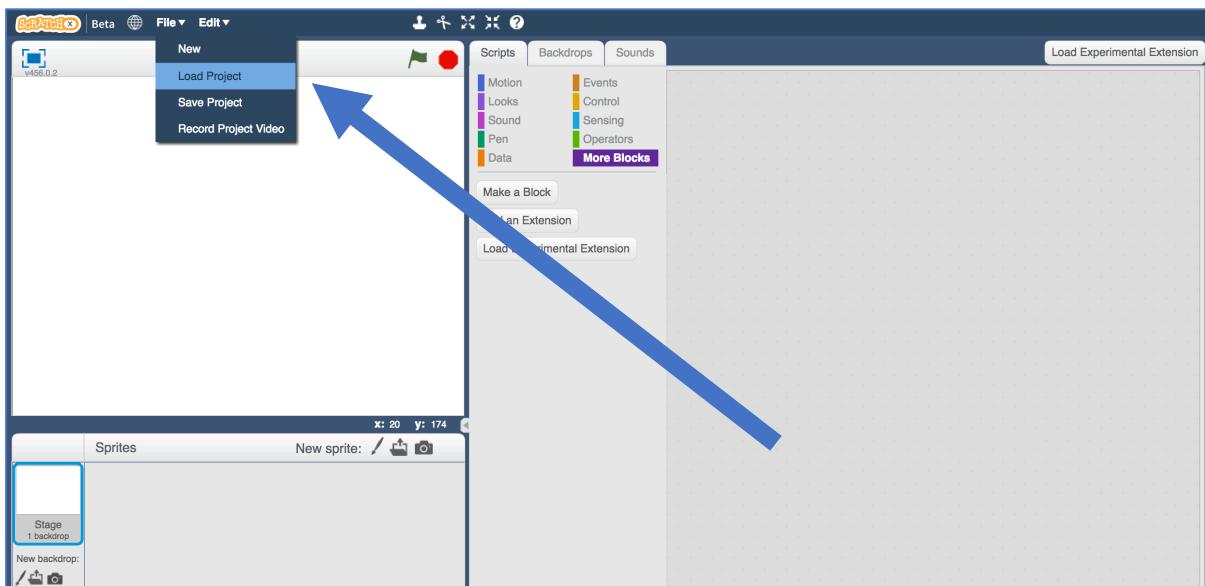
*The next page will warn you that you haven't done any machine learning yet, but clicking on **Scratch by itself** will launch Scratch.*

The screenshot shows the "smart classroom" project page. At the top, the project name "smart classroom" is displayed. Below the project name, there are three main options: "Train", "Learn & Test", and "Scratch". Each option has a brief description and a blue "Start" button. The "Train" section says "Collect examples of what you want the computer to recognise." The "Learn & Test" section says "Use the examples to train the computer to recognise text." The "Scratch" section says "Use the machine learning model you've trained to make a game in Scratch."

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

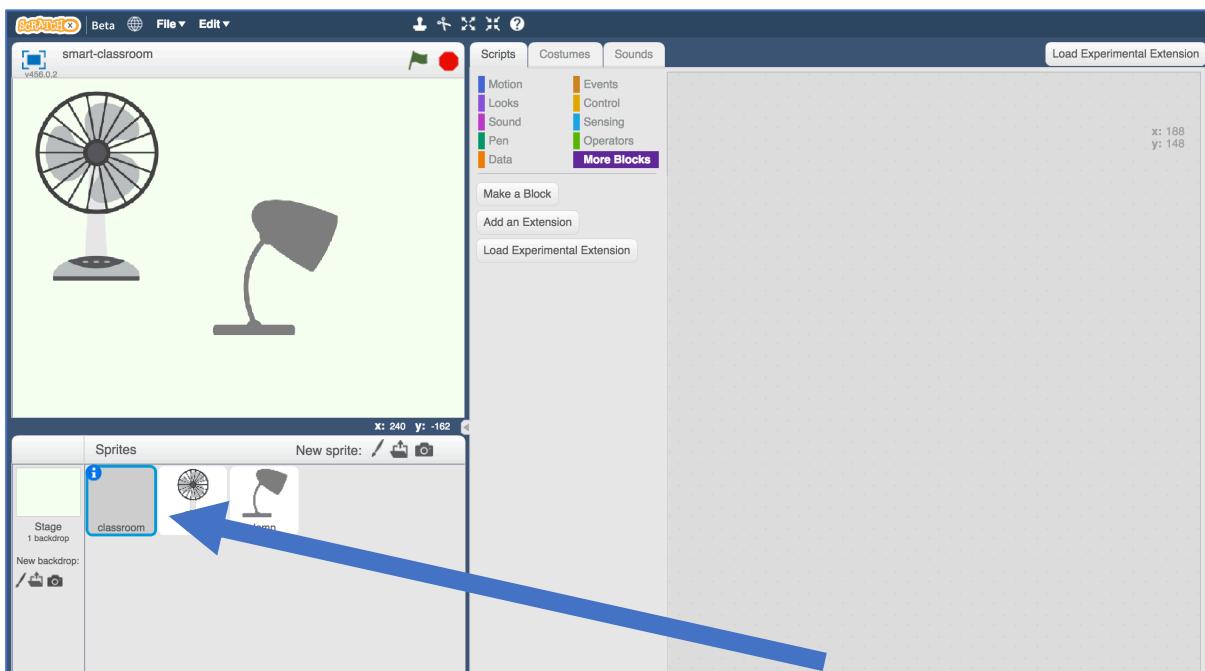
10. Load the smart-classroom.sbx template file

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

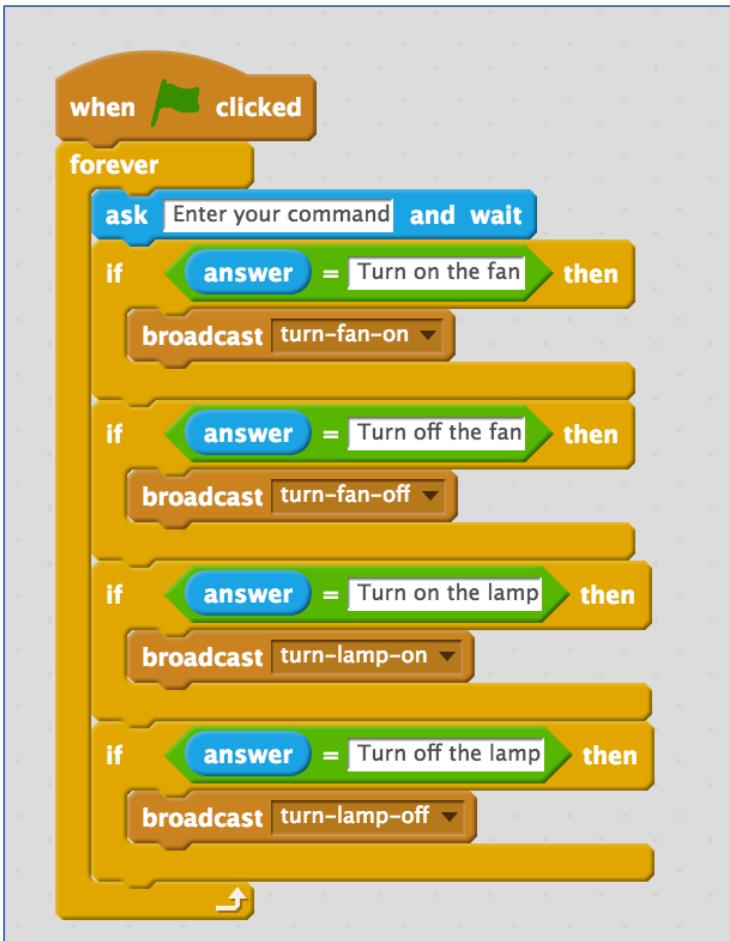


11. You should see two sprites on the stage ("fan" and "lamp") with a third invisible sprite called "classroom".

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



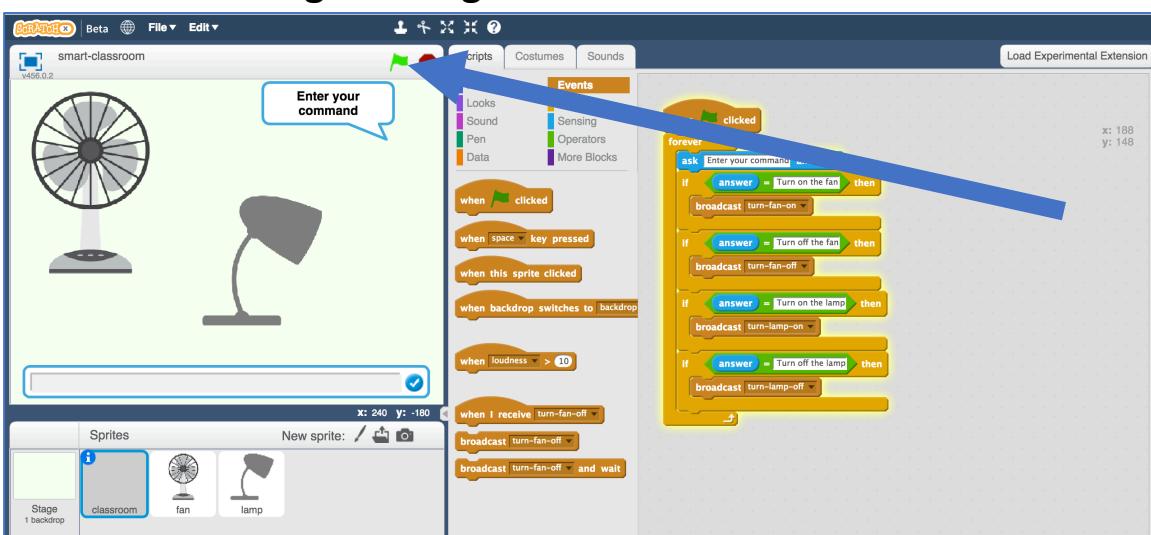
12. Click on the **Scripts** tab and enter the following script.



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 you 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.

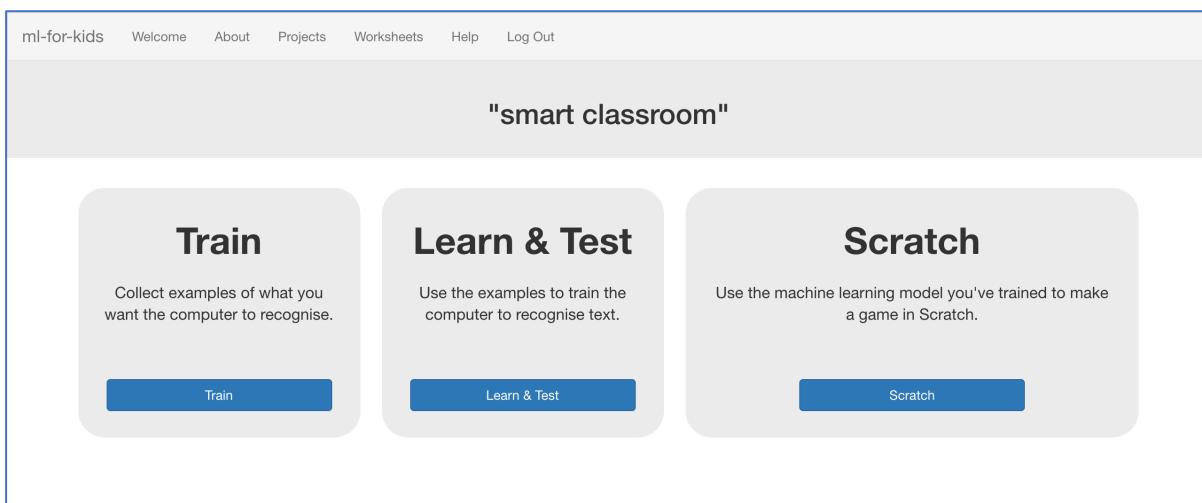
The problem with this is that you need to predict exactly what command the smart classroom assistant could ever get. Making a list of every possible message would take forever.

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

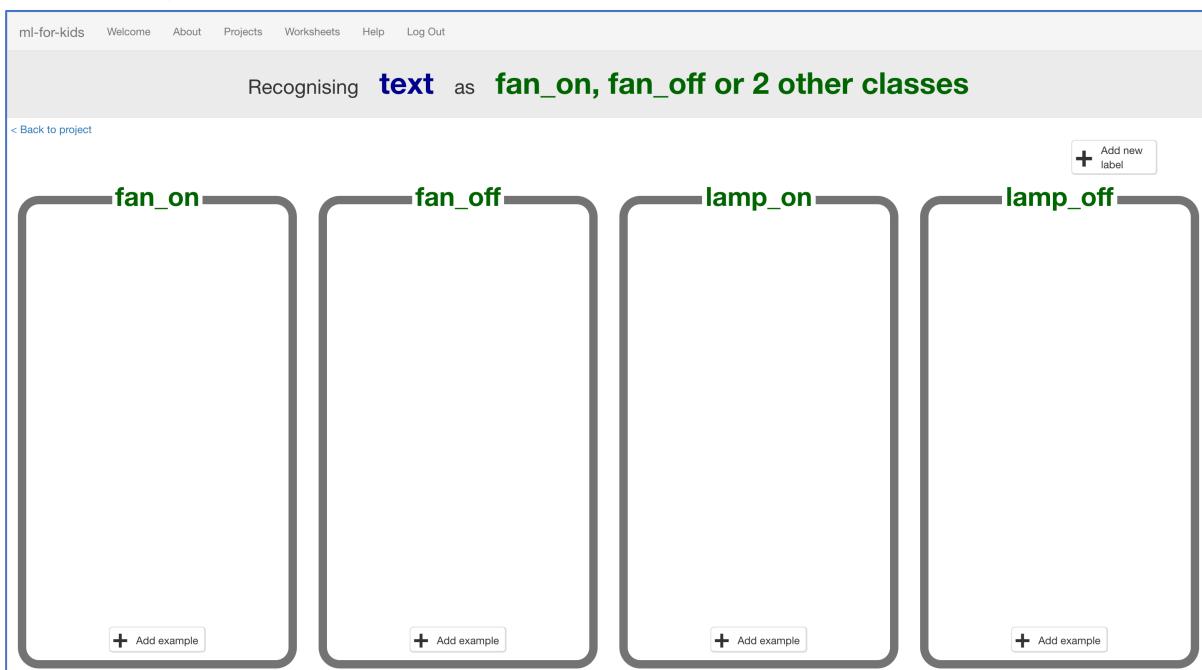
16. Close the Scratch window and go back to the Training tool.

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 a machine learning project. 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, the title 'Recognising **text** as **fan_on, fan_off or 2 other classes**' is displayed. There are four main sections, each representing a class:

- 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 off the fan".
- 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.", "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".

Each section has a '+ Add example' button at the bottom right. A 'Back to project' link is located at the top left, and an 'Add new label' button is at the top right.

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. On the left, a section titled 'What have you done?' contains text about collecting examples and a bulleted list: '12 examples of fan_off, 11 examples of fan_on, 12 examples of lamp_off, 12 examples of lamp_on'. On the right, a section titled 'What's next?' contains text about starting training and a note to go back to the Train page if more examples are needed. At the bottom, there is a box labeled 'Info from training server:' containing 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. 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 details: 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. A 'Cancel training' button is also present.

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 application interface for a machine learning project. At the top, there's a navigation bar with links: ml-for-kids, Welcome, About, Projects, Worksheets, Help, and Log Out. Below the navigation, the title "Machine learning models" is centered. A sub-header "What have you done?" is followed by text: "You've trained a machine learning model to recognise when text is fan_on, fan_off or 2 other classes." and "You created the model on Saturday, July 8, 2017 8:22 PM." Below this, a list of collected examples is provided:

- 12 examples of fan_off,
- 11 examples of fan_on,
- 12 examples of lamp_off,
- 12 examples of lamp_on

On the right, under "What's next?", there's a section about testing the model with new text. It says: "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." It also includes instructions for using Scratch and a note about getting things wrong. At the bottom of this section is a "Test" button.

In the center, there's a text input field with placeholder text "Try putting in some text to see how it is recognised based on your training." and a "Test" button to its right.

At the very bottom, there's a "Info from training server:" section with the following details:

| | |
|--|---------------------------------|
| Model started training at: | Saturday, July 8, 2017 8:22 PM |
| Current model status: | Available |
| Model will automatically be deleted after: | Saturday, July 8, 2017 10:22 PM |

Below this information are two buttons: "Delete this model" and "Train new machine learning model".

What have you 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.

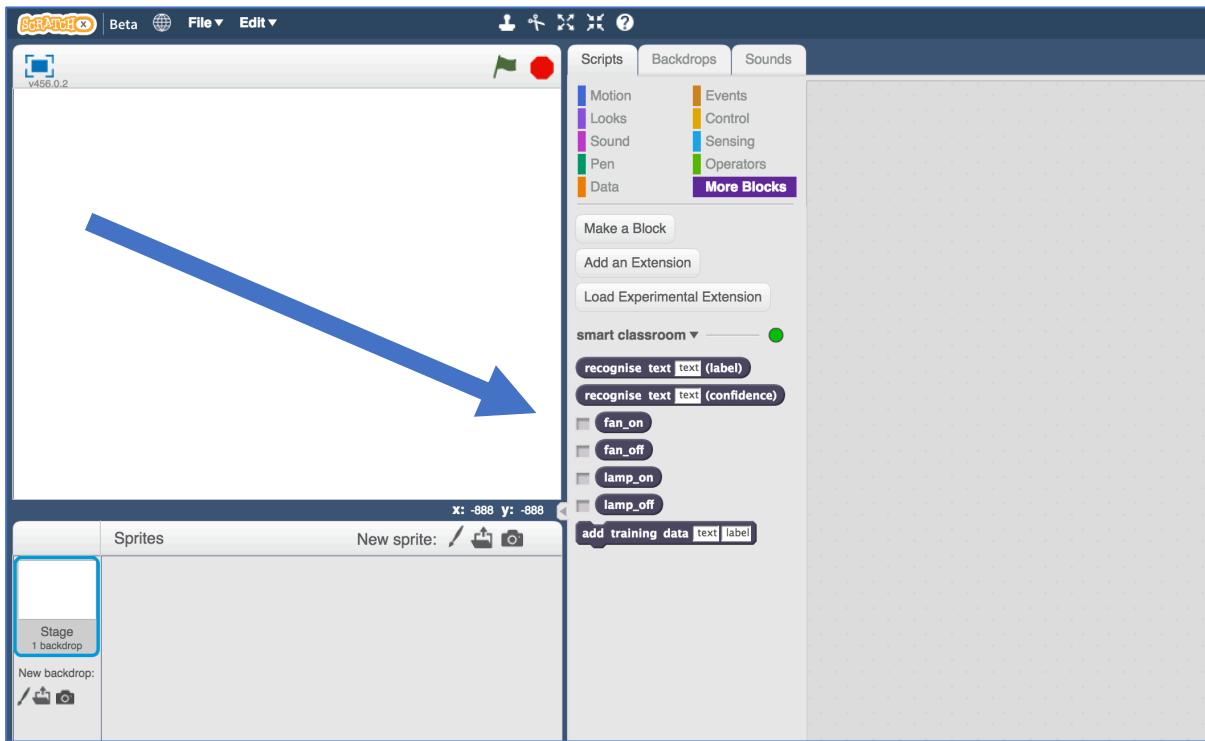
This page has instructions on how to use the new blocks in Scratch from your project. Keep this page open so can check back on how to use them.

The screenshot shows a web page titled "Using machine learning in Scratch". At the top, there is a navigation bar with links: "ml-for-kids", "Welcome", "About", "Projects", "Worksheets", "Help", and "Log Out". Below the title, there is a "Back to project" link. The main content area is divided into two sections:

- Left Section:** Describes the addition of machine learning blocks to the "More Blocks" tab in Scratch scripts. It includes descriptions and examples for three blocks:
 - recognise text [text] (label)**: Put text in the input for this, and it will return the label that your machine learning model recognises it as.
 - recognise text [text] (confidence)**: This will return how confident your machine learning model is that it recognises the type of text. (As a number from 0 - 100).
 - fan.on**, **fan.off**, **lamp.on**, **lamp.off**: These blocks represent the labels you've created in your project, so you can use their names in your scripts.
- Right Section:** Shows a screenshot of the Scratch script editor with the "More Blocks" tab selected. It displays the "recognise text" blocks. A note says: "It will look something like this - except with the name of your project." Below the editor, a note states: "The coloured circle next to your project name tells you if your machine learning model is okay." It includes a legend:
 - ● means your model is trained and ready to go
 - ● means your model hasn't finished training yet
 - ● 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.

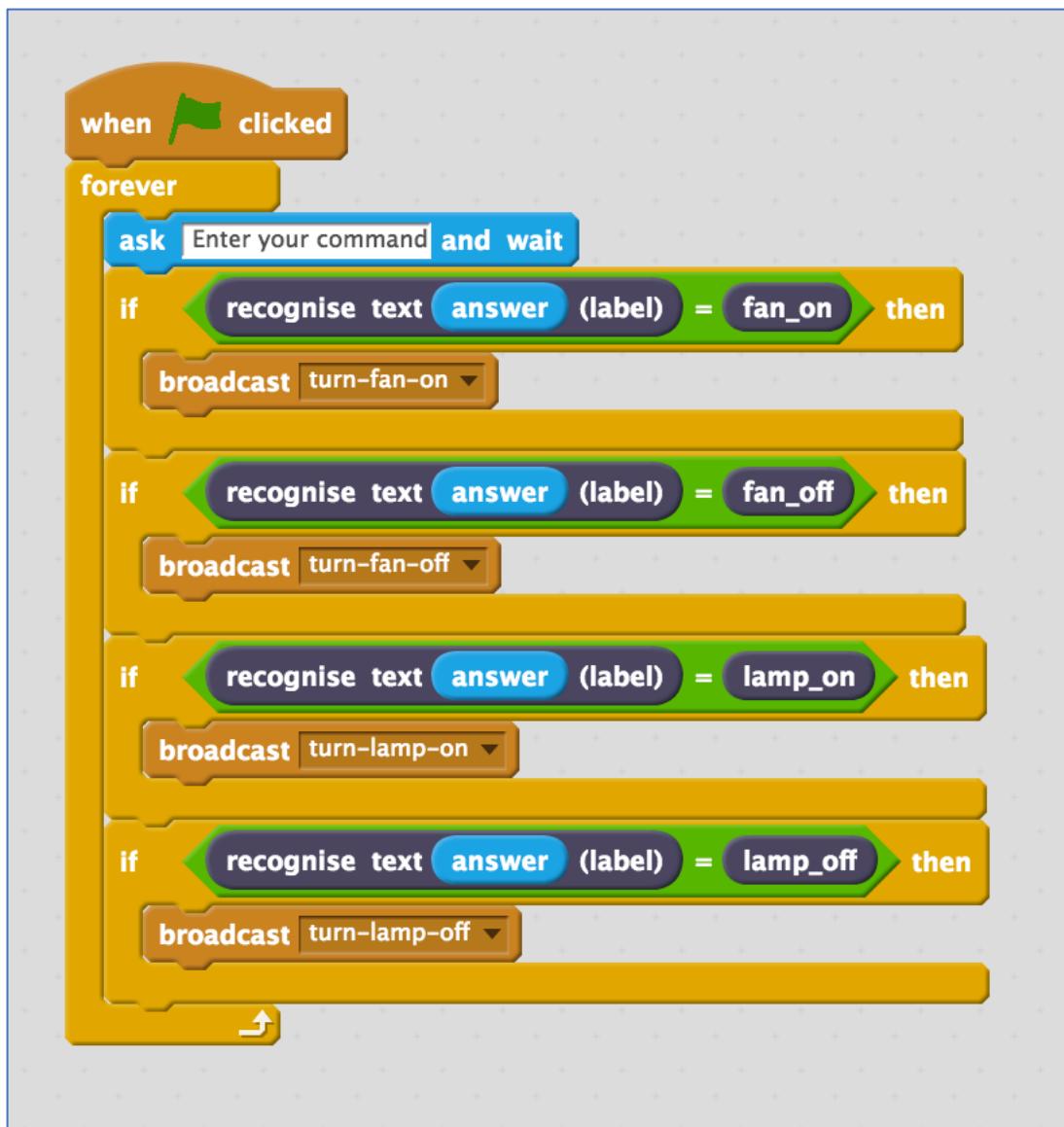
Mix things up with your examples

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

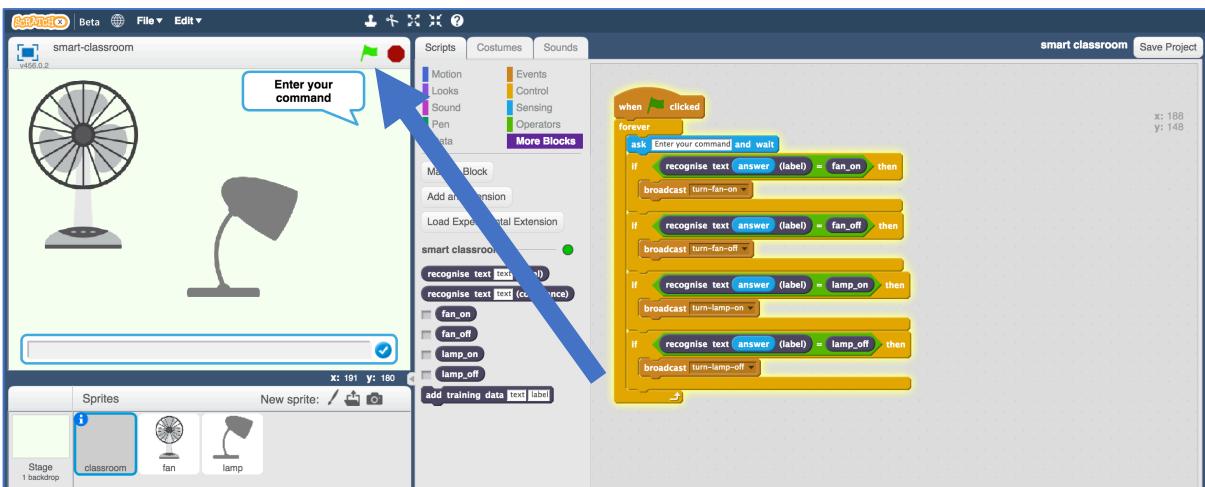
For example, make sure that you include some long examples and some very short ones.

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.



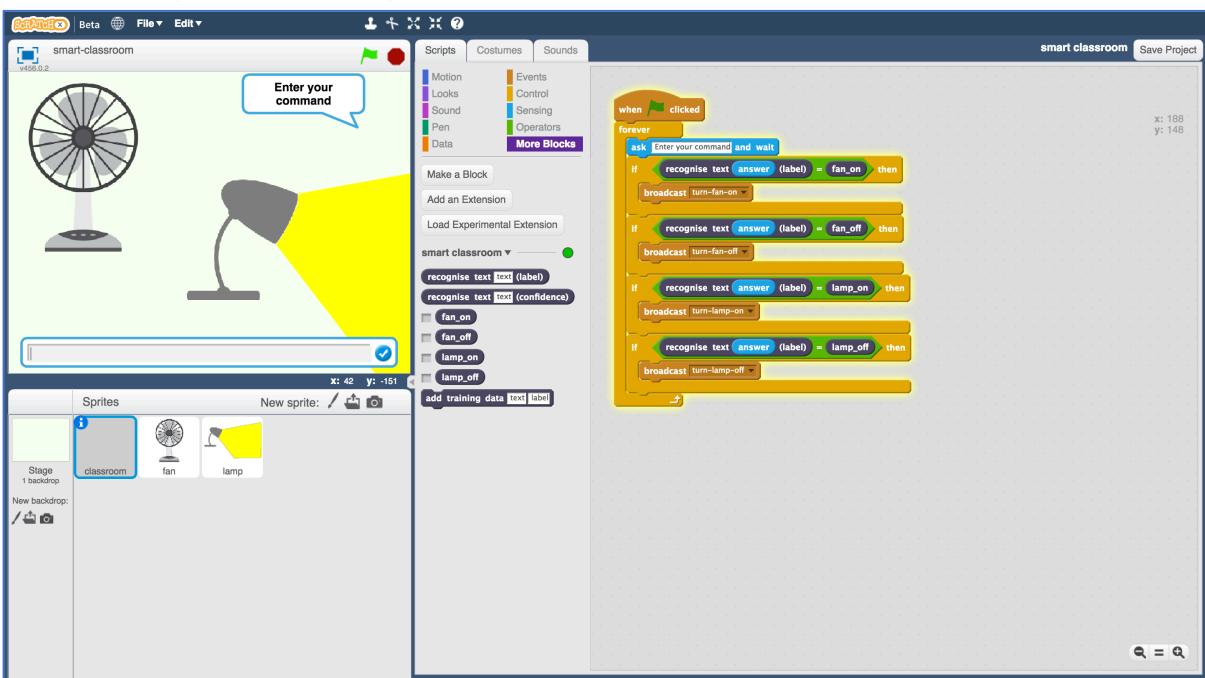
32. Click the green flag to test again.



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 you 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.

Test

make me a cheese sandwich

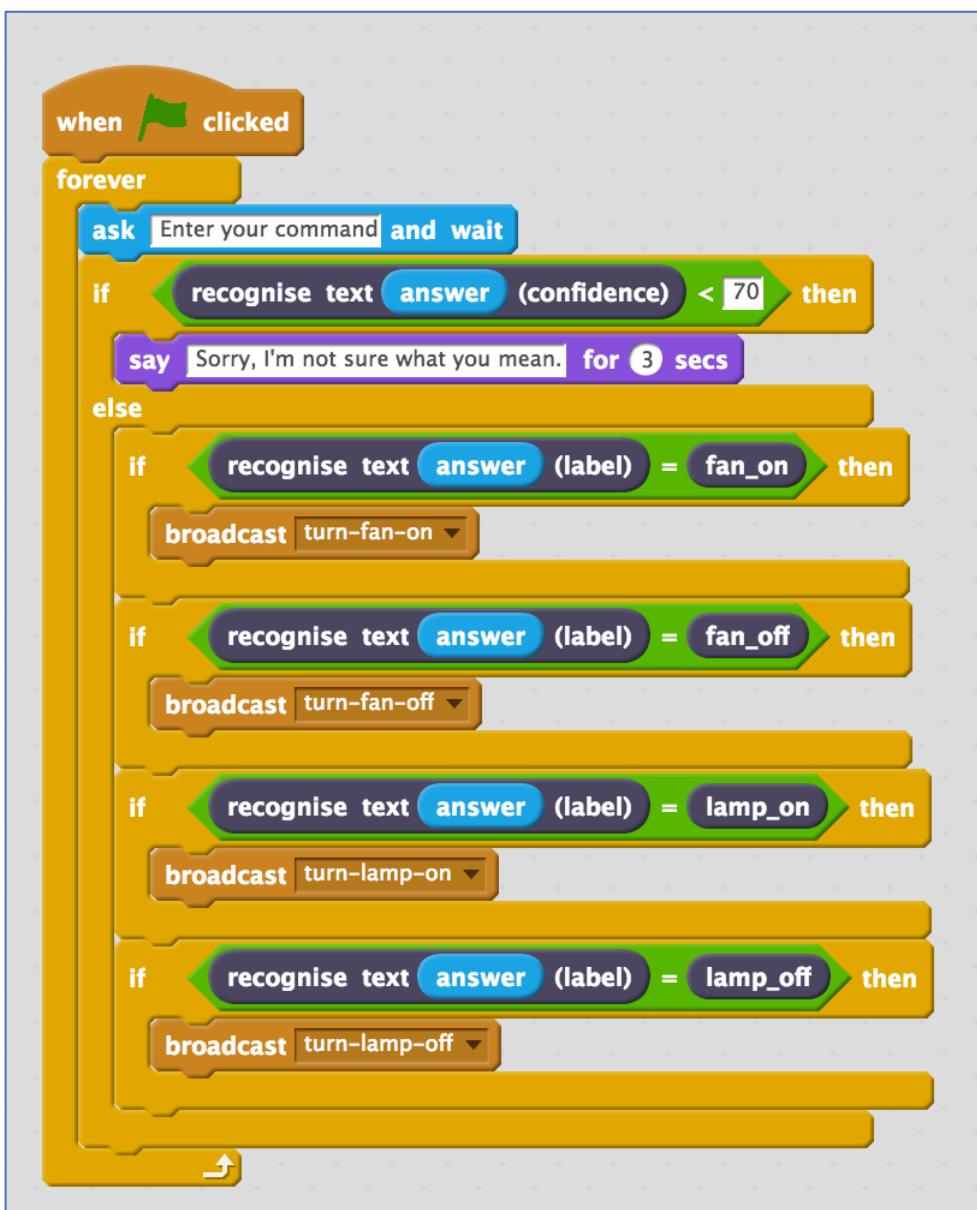
Recognised as **lamp_off**
with 21% confidence

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 you 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?