Machine Learning For Kids :: Teachers' notes

Worksheet	Smart Classroom
Activity	Create a smart assistant in Scratch that lets you control virtual devices.
Objective	**Teach a computer to recognise the meaning of your commands** • How computers can be trained to recognise the intent behind writing. • Confidence thresholds indicate when the machine cannot recognise the meaning. • How virtual assistants (e.g. Apple Siri, Amazon Alexa, Google Home) work.
Difficulty level	Beginner
Time estimate	1 hour (for full version of the project, where students try making it without machine learning first) or 45 minutes (if students only make a machine learning project)
Summary	Students will train a machine learning model to recognise the meaning of instructions. They will use this in Scratch to make a virtual assistant like Alexa that will respond to commands.
Topics	digital assistants, confidence thresholds, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students. There are **two versions of the worksheet** – one that assumes students will try making the assistant without machine learning first and compare, the other assumes students will only use machine learning.
Files	Starter file (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Conversation** 1 workspace per student One "Lite" API key is free but can only be used to create 5 workspaces One "Standard" API key can be used to create to create 20 workspaces more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• No known issues General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Make Me Happy
Activity	Create a character in Scratch that smiles if you say nice things to it and cries if you say mean things to it.
Objective	**Teach a computer to recognise compliments and insults** • How computers can be trained to recognise emotional tone • How supervised learning builds systems that can deal with unexpected input
Difficulty level	Beginner
Time estimate	45 minutes
Summary	Students will train a machine learning model to recognise compliments and insults by typing examples of kind statements and mean statements. They will use this in Scratch to make a character that reacts to messages based on sentiment.
Topics	sentiment analysis, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Conversation** 1 workspace per student One "Lite" API key is free but can only be used to create 5 workspaces One "Standard" API key can be used to create to create 20 workspaces more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Younger students may get carried away when writing insults to train the machine learning model. It may be helpful to set boundaries for what language is appropriate. • Time management is important for this project. Students often lose track of time drawing their face and don't leave enough time for training or coding. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Snap
Activity	Make a card game in Scratch that learns to recognise pictures of your card.
Objective	**Teach a computer to recognise what icons look like** • Learn how computers can be trained to recognise pictures
Difficulty level	Beginner
Time estimate	1.5 hours (for full version of the project, where the students make their own cards) or 45 minutes (if students are provided with pre-made cards)
Summary	Students will make cards with different coloured icons. They will train a machine learning model to recognise what the icons look like by taking pictures of them with a computer webcam. They will use this in Scratch to make a Snap game where the computer recognises if it chooses a matching card.
Topics	image classification, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students. There are **two versions of the worksheet** – depending on whether students will make their own cards, or if you will give them pre-made cards.
Files	Starter file (download from https://machinelearningforkids.co.uk/worksheets)
Resources	Paper, scissors, felt pens (for full project, where the students make their own cards) or Pre-made cards (download and print the "Additional project resources")
Technology	Web-cam
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Visual Recognition** 1 custom model per student One "Lite" API key is free but can only be used to create 1 custom model One "Standard" API key can be used to create to create multiple custom models more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Students will be taking photos and uploading them to a secure site, where they are kept until their photo or project is deleted. As long as only cards are visible in photos they take, then students will not be identifiable from this. If this raises concerns it may be sensible to obtain parental permission. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Mailman Max
Activity	Make a postal sorting office in Scratch that can recognise handwritten postcodes on envelopes.
Objective	**Teach a computer to recognise handwriting** • Learn how computers can be trained to recognise handwriting • Learn how "optical character recognition" is used to automate tasks like recognising postcodes on letters
Difficulty level	Beginner
Time estimate	1 hour
Summary	Students will draw letters on the screen using an on-screen canvas. This will train a machine learning model to recognise some handwriting. They will use this in Scratch to make a project that can automatically sort letters based on the postcodes they write on them.
Topics	optical character recognition, handwriting recognition, image classification, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	mailman-max.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Visual Recognition** 1 custom model per student One "Lite" API key is free but can only be used to create 1 custom model One "Standard" API key can be used to create to create multiple custom models more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Some children may struggle with the coordination needed to write letters on the screen by dragging the mouse pointer on the canvas. Reassure them that it doesn't need to be perfect, and that training the computer to recognise messy handwriting with examples of messy handwriting is fine! General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Car or Cup
Activity	Train the computer to be able to sort photos into groups.
Objective	**Teach a computer to recognise pictures of objects** • How computers can be trained to recognise pictures. • The important of variety in training machine learning systems.
Difficulty level	Beginner
Time estimate	45 minutes
Summary	Students will train a machine learning model to recognise pictures of cars or cups. They will use this to make a project in Scratch that sorts a pile of photos into two groups.
Topics	image classification, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	car-or-cup.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Access to an image search site (e.g. Google Images, Bing Images, etc.)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Visual Recognition** 1 custom model per student One "Lite" API key is free but can only be used to create 1 custom model One "Standard" API key can be used to create to create multiple custom models more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Students will need Internet access to search for pictures of cars and cups to train the computer with. Depending on the age of the students, close supervision may be appropriate to ensure safe searching. • The starter Scratch project includes a test set of images. Accuracy will be affected by how similar these are to images the students select to train with. For example, if students collect examples of only sports cars to train the computer to recognise cars, this may struggle to recognise non-sports cars. If this happens, encourage them to think about why it's getting things wrong, and how they could improve this by collecting a more varied set of photos to train the computer with. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Pac-Man
Activity	Create a Pac-Man game in Scratch that learns how to avoid the ghost.
Objective	**Teach a computer to play a game** • How machines are taught to play games • Decision tree learning as a way for computers to learn how to play games.
Difficulty level	Intermediate It needs an understanding of 2D coordinates. The Scratch scripts are slightly complex.
Time estimate	1 hour
Summary	Students will train Pac-Man by playing the game in Scratch. The machine learning model will be trained based on the moves that they make while playing. They will use this model to get Pac-Man to play by itself.
Topics	AI in games, decision tree learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	pacman.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	None

Help

Potential issues	• Time management is important for this project. Students often lose track of time while playing Pac-Man and don't leave enough time for training or coding. It may be helpful to time-box the sections (initial trying out of the game, training the model, testing the model) to keep the class on track. • There is more than one way to avoid the ghost. For example, doing laps of the map. Or flipping back and forth swapping places with the ghost. Let students find their own preferred strategy (there is no "right" way) and see if the Pac-Man they train learns to adopt their strategy. • Encourage students to keep their two Scratch projects separate – one for training Pac-Man, the other to use that training to let the computer play. That means if Pac-Man isn't very good, they can easily go back and add more training. • It is important to close and re-open the Scratch browser window after each time a machine learning model is trained, otherwise Scratch will keep using previous moves. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Tourist Info
Activity	Create a mobile app in Scratch that recommends tourist attractions based on people's interests.
Objective	**Teach a computer to make recommendations** • The impact of training bias on machine learning systems • Ethical questions introduced by training bias in machine learning systems.
Difficulty level	Intermediate It can involve a lot of typing. Although simple to implement, appreciating the objectives requires an understanding of the implications of machine learning so this is more effective as a follow-on to another project.
Time estimate	1 hour (for full version of the project, where the students make more of the Scratch project) or 45 minutes (if students use the shorter-version of the project with a more pre-made Scratch file)
Summary	Students will train a machine learning model to make recommendations to holiday-makers based on their descriptions of likes and interests. They will use this in Scratch to make a mobile app. They will then be guided to make this more biased, and to consider the impact of bias in AI.
Topics	training bias, recommendations, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students. There are **two versions of the worksheet** – depending on the amount of Scratch coding to do.
Files	Starter file (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Conversation** 1 workspace per student One "Lite" API key is free but can only be used to create 5 workspaces One "Standard" API key can be used to create to create 20 workspaces more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Students will type about 25 short sentences. For some younger children, this might not be achievable in a single lesson, so you may wish to allow extra time. Alternatively, it might be better to do this as a "whole class project" (create the project yourself and tick "whole class project") so that the class only have to write 25 sentences between all of them. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Sorting Hat
Activity	Create a Sorting Hat like in Harry Potter, that puts you in a school House based on what you say.
Objective	**Teach a computer to recognise use of language** • How computers can recognise patterns such as choice of words, phrasing and sentence construction
Difficulty level	Intermediate It can involve a lot of typing.
Time estimate	1 – 2 hours (if students are training their own models, depending on how fast they can type) or 45 minutes (if students work together on a whole class project)
Summary	Students will collect quotes from Harry Potter characters, and sort these based on the school House that the character is in. These will be used to train a machine learning model to recognise the use of language from people in each house.
Topics	text classification, supervised learning, crowd sourcing

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students. There are **two versions of the worksheet** – one that assumes students will work individually, the other assumes students will work together as a whole class.
Resources	Access to Harry Potter books or access to websites with Harry Potter quotes
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Conversation** 1 workspace per student (if students are training their own models) or 1 workspace per class (if students work together on a whole class project) One "Lite" API key is free but can only be used to create 5 workspaces One "Standard" API key can be used to create to create 20 workspaces more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Approximately 40 sentences are needed for training (10 examples x 4 Houses). If students are each doing this individually, you should allow enough time for this much typing. Copying-and-pasting quotes from websites can be quicker. • If students aren't happy drawing a Sorting Hat, they could find a photo to use General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Rock, Paper, Scissors
Activity	Make a Rock, Paper, Scissors game in Scratch that learns to recognise hand shapes.
Objective	**Teach a computer to recognise shapes** • How computers can be trained to recognise pictures. • The important of variety in training machine learning systems.
Difficulty level	Intermediate Taking the training photos of your own hand needs coordination.
Time estimate	45 minutes
Summary	Students will train a machine learning model to recognise pictures of hand shapes. They will use this to make a project in Scratch that plays rock, paper, scissors.
Topics	image classification, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	rock-paper-scissors.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Technology	Web-cam
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Visual Recognition** 1 custom model per student One "Lite" API key is free but can only be used to create 1 custom model One "Standard" API key can be used to create to create multiple custom models more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Students will be taking photos of their hands and uploading them to a secure site, where they are kept until their photo or project is deleted. As long as only their hands are visible in photos they take, then students are unlikely to be identifiable from this. If using laptops, angling the screen towards the ceiling helps with this. However, if the chance of photos accidentally including students raises concerns it may be sensible to obtain parental permission. • Students often take a large number of very similar training photos. This is less likely to be accurate than photos of hands in a variety of positions and angles. It's helpful to highlight this and encourage students to think about why it is the case. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Judge a Book
Activity	Make a game in Scratch to test whether it really is possible to judge a book by its cover.
Objective	**Teach a computer to recognise visual style** • How effectiveness of a machine learning system can be measured by comparing performance against humans.
Difficulty level	Intermediate The Scratch script is slightly complex. The term "genres" may require explanation. The idea of measuring performance by comparing answers against those of another human can require some explaining.
Time estimate	1 hour
Summary	Students will use a library or book retailer website to collect photos of book covers, and use these to train a machine learning model to recognise the genre of a book, based on a picture of it's cover. They will use this to make a project in Scratch.
Topics	image classification, supervised learning

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	judge-a-book.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Access to a library or book retailer site (e.g. Amazon, etc.)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	**Watson Visual Recognition** 1 custom model per student One "Lite" API key is free but can only be used to create 1 custom model One "Standard" API key can be used to create to create multiple custom models more detail at: https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf

Help

Potential issues	• Students will need Internet access to search for pictures of book covers to train the computer with. Depending on the age of the students, close supervision may be appropriate to ensure safe searching. • Using a site that already sorts books by genre can help to make the training more efficient. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Noughts and Crosses
Activity	Create a noughts and crosses game in Scratch that learns how to beat you.
Objective	**Teach a computer to play a game** • How machines have been taught to play games since the 1960's. • Decision tree learning as a way for computers to learn how to play games.
Difficulty level	Advanced The Scratch script is long and complex. Most of it is provided in a starter project file, but finding the right places to make changes needs care.
Time estimate	1 – 1.5 hours
Summary	Students will train the computer to play noughts and crosses by playing the game in Scratch. The machine learning model will be trained based on the moves that they make while playing.
Topics	decision tree learning, reinforcement learning, categorical data

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	noughts-and-crosses.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	None

Help

Potential issues	• Time management is important for this project. Students often lose track of time while playing the game and don't leave enough time for training or coding. It may be helpful to time-box the sections (initial trying out of the game, training the model, testing the model) to keep the class on track. • The most common bug in student Scratch scripts is to make the wrong choice in orange drop-down blocks (e.g. choosing "history nought top-right" instead of "history cross top-right"). Encourage students to copy carefully. Working in pairs can help avoid mistakes. • It is important to close and re-open the Scratch browser window after each time a machine learning model is trained, otherwise Scratch will keep using previous moves. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Top Trumps
Activity	Train a computer to be able to play the Top Trumps card game in Scratch.
Objective	**Teach a computer to play a game** • Collecting training is easier than manually labelling training data. • Computers can learn to play games where the correct answer cannot be known, by predicting the likelihood of each outcome.
Difficulty level	Advanced The Scratch script is long and complex. Most of it is provided in a starter project file, but finding the right places to make changes needs care.
Time estimate	1 – 2 hours
Summary	Students will train the computer to play Top Trumps by playing the game in Scratch. The machine learning model will be trained based on the choices that they make while playing.
Topics	decision tree learning, reinforcement learning, categorical data

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	top-trumps.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	None

Help

Potential issues	• The most common bug in student Scratch scripts is to make the wrong choice in orange drop-down blocks (e.g. choosing "you" instead of "computer"). Encourage students to copy carefully. Working in pairs can help avoid mistakes. • The computer is trained using the decisions made by the student when they play. This is inverted when used by the computer to make decisions. (e.g. the computer chooses a move that will result in "lose" because the best move for the computer is one that results in the player "losing"). • It is important to close and re-open the Scratch browser window after each time a machine learning model is trained, otherwise Scratch will keep using previous moves. General troubleshooting and help at https://machinelearningforkids.co.uk/help

Machine Learning For Kids :: Teachers' notes

Worksheet	Headlines
Activity	Train a computer to recognise headlines from national newspapers.
Objective	**Test the computer's ability to recognise use of language** • How computers can be taught to recognise the source of writing • How machine learning systems are tested.
Difficulty level	Advanced The Scratch script is long and complex. Most of it is provided in a starter project file, but finding the right places to make changes needs care. The concept of testing and accuracy can require some explanation.
Time estimate	1 – 2 hours
Summary	Students will collect examples of headlines from national newspapers. These will be used to train a machine learning model based on language in headlines. They will measure the accuracy of this model in a test framework in Scratch.
Topics	text classification, supervised learning, testing

Setup

Each student will need:

Print-outs	Project worksheet (download from https://machinelearningforkids.co.uk/worksheets) Blocks in Scratch scripts are colour-coded, so printing in colour will make it easier for students.
Files	headlines.sbx (download from https://machinelearningforkids.co.uk/worksheets)
Access	Username and password for machinelearningforkids.co.uk

Class account will need:

API keys	None

Help

Potential issues	• Some national newspapers use langauge in their headlines that may not be appropriate for younger children. You may want to tell your class which newspapers to choose if you have concerns. • It is important to close and re-open the Scratch browser window after each time a machine learning model is trained, otherwise Scratch will keep using previous output. General troubleshooting and help at https://machinelearningforkids.co.uk/help