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| **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** | | 45 minutes - 1 hour (depending on whether students try making it without machine learning first) |
| **Summary** | | Students will train a machine learning model to recognise the meaning of instructions. They use this in Scratch to make a virtual assistant 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 **different versions of the worksheet** – one where students try making the assistant without machine learning first to compare, others where students only use machine learning. |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | **Watson Assistant -** 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/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet screenshots are based on Scratch 3, but the project can also be done using Scratch 2.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | What does Twitter think? |
| **Activity** | | Use machine learning in Scratch to analyze sentiment of discussion in social media |
| **Objective** | | **Teach a computer to recognise the sentiment of public discussion**   * How computers can be trained to recognise the sentiment behind writing. * How sentiment analysis is used to measure public opinion |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 1 hour |
| **Summary** | | Students will choose a topic and search for tweets about that. They’ll copy examples and use these to train a machine learning model to classify the sentiment of tweets. They use this in Scratch to analyze Twitter messages & represent this in a live graph. |
| **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 |
|  | **Access** | Access to twitter.com (no username or account needed) |
| Class account will need: | | |
|  | **API keys** | **Watson Assistant -** 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/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
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| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * This activity involves reading unfiltered messages from Twitter. As such, it is not appropriate for younger students. * Not all topics lead to an effective project. Help students find a topic that people express opinions about. If they choose a common word (e.g. “Starbucks”) they may find most tweets mention it as a location without expressing an opinion. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   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. |
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| **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. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet screenshots are based on Scratch 3. You may prefer to use Scratch 2 instead, however students may find it harder to find some blocks.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Zombie Escape! |
| **Activity** | | Train a robot to help you escape the zombies. |
| **Objective** | | **Teach a computer to make predictions**   * How computers can be trained to make predictions based on experiences. * How feature selection is choosing what values the computer should learn from * How AI systems make recommendations to assist people making decisions * How machine learning systems can be visualised using tree diagrams |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 45 minutes - 1 hour |
| **Summary** | | Students will train a machine learning model to predict how to avoid zombies. They use this in Scratch to make a virtual assistant that will recommend how to play a game. |
| **Topics** | | supervised learning, decision trees, feature selection |
| **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** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
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| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Advice** | | * Choosing more than five sensors will work (and can result in a more accurate model) however it makes the Scratch script more complicated to make. * Choosing fewer sensors (e.g. 3) will make the Scratch script much simpler, however it may result in ML models performing less well. * I wouldn’t recommend sharing the following information with students until the end of the lesson, but if it’s helpful for you to answer their questions about what they’re seeing in their projects, the zombie behaviour is as follows:   **Lighting** – Zombies don’t like harsh lighting. They prefer no lighting at all, and like halide lighting least of all. In order (from least likely to have zombies to most): halide, halogen, fluorescent, incandescent, none.  **Humidity** – Zombies like it damp. The more humid, the more likely to find a zombie.  **Temperature** – Zombies prefer room temperature – very cold or very hot temperatures make zombies less likely. The colder/hotter, the less likely they are. This has a big difference on whether you’ll find zombies.  **Wall colour** – Zombies very slightly prefer dark colours like black or brown, but this only makes a very small difference to which rooms they’re in.  **Floor type** – Zombies don’t care about floor type. This makes no difference.  **Number of chairs** – Zombies don’t use chairs. This makes no difference.  **Room size** – Zombies prefer bigger rooms, but this makes only a small difference.  **Number of windows** – Zombies can get in through the windows, so more windows do make zombies a bit more likely.  **Brightness** – Zombies prefer the dark. Darkness makes them much much more likely. This makes a bigger difference than anything else.  **Noise levels –** Zombiesdon’t care about noise. This makes no difference.  **Number of mirrors** – Mirrors help make you jump when you see a zombie, so a mirror in the room will make a zombie a little more likely, but the number of them doesn’t matter. **Room number** – Zombies don’t read, so the hotel room number makes no difference.  There is some correlation between the values – e.g. halide lighting and number of windows can make a higher brightness more likely, whereas no lighting and no windows makes a lower brightness more likely.  The relative impact of the different sensor values can be seen below:    This means a student who picks: “room number”, “noise”, “flooring”, “chairs”, “wall colour” as their five sensors will have a machine learning model that performs very poorly and will probably make mostly inaccurate predictions.  It also means a student who picks: “brightness”, “temperature”, “humidity”, “lighting”, “windows” as their five sensors will have a very accurate machine learning model that allows for a perfect escape. |

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| **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)  45 minutes (if students are provided with pre-made cards) |
| **Summary** | | Students make cards with different symbols. They will train a machine learning model to recognise what the symbols look like by taking pictures of them with a computer webcam. They 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. |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: [https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will take photos and upload them to a secure site. If only cards are visible in photos they take, students will not be identifiable. If this raises concerns it may be sensible to obtain parental permission. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Face Finder |
| **Activity** | | Make a video face filter in Scratch that turns your face into a cartoon. |
| **Objective** | | **Use a computer that has been trained to recognise what faces look like**   * Learn how computers can be trained to recognise faces |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 0.5 hours |
| **Summary** | | Students make a Scratch project with sprites that follow different parts of their face. |
| **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. |
|  | **Technology** | Web-cam |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * There is no need for students to create an account or log on to do this project. * Videos/photos taken by the webcam for this project are not uploaded to anywhere and will not leave their computer. All of the analysis is performed in the web browser. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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)  45 minutes (if students are provided with pre-made cards) |
| **Summary** | | Students make cards with different symbols. They will train a machine learning model to recognise what the symbols look like by taking pictures of them with a computer webcam. They 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. |
|  | **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 |
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|  | **API keys** | **Watson Visual Recognition -** 1 custom model per student  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: [https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
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| **Help** | | |
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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Laser Eyes |
| **Activity** | | Make a game with voice-activated laser eyes |
| **Objective** | | **Use a computer that has been trained to recognise what faces look like**   * Learn how computers can be trained to recognise faces   **Teach a computer to recognise sounds**   * Learn how computers can be trained to recognise words |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train a speech recognition model to recognize a single command. They will make a Scratch project with performs an action when that command is heard. They will use a pre-trained face detection model so that sprites follow their face in the webcam. |
| **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. |
|  | **Technology** | Web-cam |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Semaphores |
| **Activity** | | Make a voice-controlled game that you play by moving your arms |
| **Objective** | | **Use a computer that has been trained to recognise the way your arms are pointed**   * Learn how computers can be trained to recognise poses   **Teach a computer to recognise sounds**   * Learn how computers can be trained to recognise words |
| **Difficulty level** | | Advanced |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train a speech recognition model to recognize a few commands. They will make a Scratch project with performs an action when that command is heard. They will use a pre-trained pose detection model that can draw a semaphore from the way their arms are seen in the webcam. |
| **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. |
|  | **Technology** | Web-cam |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
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| **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)  45 minutes (if students are provided with pre-made cards) |
| **Summary** | | Students make cards with different symbols. They will train a machine learning model to recognise what the symbols look like by taking pictures of them with a computer webcam. They 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. |
|  | **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”) |
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|  | **Access** | Username and password for machinelearningforkids.co.uk |
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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Emoji Mask |
| **Activity** | | Make a video face filter in Scratch that adds an emoji mask to your face. |
| **Objective** | | **Use a computer that has been trained to recognise what faces look like**   * Learn how computers can be trained to recognise faces |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 1 hour |
| **Summary** | | Students make a Scratch project with sprites that follow different parts of their face. |
| **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. |
|  | **Technology** | Web-cam |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * There is no need for students to create an account or log on to do this project. * Videos/photos taken by the webcam for this project are not uploaded to anywhere and will not leave their computer. All of the analysis is performed in the web browser. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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 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 sort letters based on the postcodes they write on them. |
| **Topics** | | | optical character recognition, handwriting recognition, image classification |
| **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 Visual Recognition -** 1 custom model per student  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **Help** | | | |
| **Potential issues** | | | * Some children struggle to write letters by dragging the mouse pointer on the canvas. Reassure them it doesn’t need to be perfect, and training the computer to recognise messy handwriting with examples of messy handwriting is fine! * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet says to use Scratch 3, but you can use Scratch if only Internet Explorer is available.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | | |
| **Worksheet** | | | Ink blots |
| **Activity** | | | Train two different machine learning models to recognize pictures, test them using ink blot paintings, and compare the answers that they give. |
| **Objective** | | | **Teach a computer to recognise objects in a picture**   * Learn how computers can be trained to recognise images * Learn how the behaviour of machine learning systems is described in the media |
| **Difficulty level** | | | Intermediate |
| **Time estimate** | | | 1 hour |
| **Summary** | | | Students work in pairs – one trains an ML model to recognize pictures of animals, the other trains an ML model to recognize pictures of fruit. They test both of these with the same set of ink blot paintings taken from a Rorschach test, and compare the responses that their ML models give.  Finally, they learn about the MIT AI research project that this is based on and are asked to think about the way this was described in different news articles. |
| **Topics** | | | image classification, bias, ethics in AI |
| **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 Visual Recognition - 2** custom models per pair of students  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **Help** | | | |
| **Potential issues** | | | * Students will look at the responses from an AI system at <http://norman-ai.mit.edu/> Some describe things that could be upsetting to younger children. Review these before deciding if this project is appropriate for your class. * You may prefer to train the ML models for your students, to reduce the number of API keys that this worksheet requires. Create “whole class” projects so that they can all create their own robots based on your ML models.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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 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. |
|  | **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 (if students are training their own models)  or  1 custom model per class (if students work together on a whole class project)  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students need Internet access to search for pictures of cars and cups to train the computer with. 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 the students’ training images. For example, if students collect examples of 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. * Dragging and dropping doesn’t work in Internet Explorer. You can provide your students with a different web browser (Firefox or Chrome work well) or explain to them how to copy/paste image URLs from a page. * You cannot drag and drop pictures between different types of browser. In other words, you can’t drag a picture from a Firefox window to Machine Learning for Kids running in Chrome. Or from a Chrome window to Machine Learning for Kids running in Firefox. You need to use the same type of web browser for both. * Only jpg and png images can be used. If students find other image types (e.g. gif files) and try to drag them into their training buckets, they’ll get an error. Explain to them that this is okay, and they should just choose a different picture. * If there is a problem with any of the pictures they find, they’ll be shown as a red box. They can click on the cross for these broken images to remove them.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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. |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train Pac-Man by playing in Scratch. The machine learning model will be trained based on how they play. They will use this 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. |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Time management is important. Students lose track of time while playing Pac-Man and don’t leave time for coding. It may be helpful to time-box 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. 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. * The worksheet screenshots are based on Scratch 3. You may prefer to use Scratch 2 instead, however students may find it harder to find some blocks.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Find It! |
| **Activity** | | Create a mobile hide-and-seek game in App Inventor that learns to recognise objects |
| **Objective** | | **Teach a computer to recognise pictures**   * How computers can be trained to recognise pictures. * How to use machine learning in a mobile app. |
| **Difficulty level** | | Advanced |
| **Time estimate** | | 1 hour - 2 hours (depending on the students’ experience with App Inventor) |
| **Summary** | | Students will train a machine learning model to recognise pictures of objects. They use this in App Inventor to make a mobile app that classifies photos. |
| **Topics** | | image classification, supervised learning, mobile apps |
| **Setup** | | |
| Each student will need: | | |
|  | **Device** | An Android mobile phone or tablet |
|  | **Print-outs** | Project worksheet (download from <https://machinelearningforkids.co.uk/worksheets> )  Blocks in App Inventor scripts are colour-coded, so printing in colour will make it easier for students |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
|  | **Access** | Access to App Inventor at http://ai2.appinventor.mit.edu |
| 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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | |
| If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project worksheet is available in MS Word format so you can **modify it to suit your class**. | | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * A video of the finished app in action is available at <https://youtu.be/dIjU6rmuoGc>   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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  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 |
| **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. |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | **Watson Assistant -** 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/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **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.  Or, do this as a “whole class project” (create the project yourself and tick “whole class project”) so the class writes 25 sentences between them. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet uses Scratch 3. You can use Scratch 2 instead if preferred.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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 Assistant**  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/IBM/taxinomitis-docs/raw/master/docs/pdf/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 * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet screenshots are based on Scratch 3. You may prefer to use Scratch 2 instead, however students may find it harder to find some blocks.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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. |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students take photos of their hands and upload them to a secure site. As long as only hands are visible, students are unlikely to be identifiable. If using laptops, angling the screen towards the ceiling helps. However, if photos accidentally including students is a concern it may be useful to obtain parental permission. * Students often take very similar training photos. This is less likely to be effective than photos of a variety of positions and angles. It’s helpful to highlight this and encourage students to think about why. * ML models for image projects sometimes take a few minutes to train. Students can continue to work on their Scratch project scripts while they wait. Warn them that their Scratch script won’t work until the model has finished training, though.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Shoot the bug |
| **Activity** | | Train a computer to play a Breakout-style arcade game in Scratch. |
| **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** | | Beginner |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train a model by playing a game in Scratch. The machine learning model will be trained based on how they play. They will use this 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. |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * You may want to encourage students to modify the game before they start training their model – such as by removing, or moving and resizing, the obstacle. * Collecting training examples can be quite time-consuming, so the template includes almost all of the coding required for this project. If you have time, you may want to remove some of the scripts from the template to give your students a chance to implement it themselves. For example, code blocks like how the ball bounces off obstacles may provide an opportunity to discuss the maths involved. * Creating this as a whole-class project and allowing all students to contribute training examples to a shared pool of training data should train a much more effective machine learning model.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Find It! |
| **Activity** | | Create a mobile hide-and-seek game in App Inventor that learns to recognise objects |
| **Objective** | | **Teach a computer to recognise pictures**   * How computers can be trained to recognise pictures. * How to use machine learning in a mobile app. |
| **Difficulty level** | | Advanced |
| **Time estimate** | | 1 hour - 2 hours (depending on the students’ experience with App Inventor) |
| **Summary** | | Students will train a machine learning model to recognise pictures of objects. They use this in App Inventor to make a mobile app that classifies photos. |
| **Topics** | | image classification, supervised learning, mobile apps |
| **Setup** | | |
| Each student will need: | | |
|  | **Device** | An Android mobile phone or tablet |
|  | **Print-outs** | Project worksheet (download from <https://machinelearningforkids.co.uk/worksheets> )  Blocks in App Inventor scripts are colour-coded, so printing in colour will make it easier for students |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
|  | **Access** | Access to App Inventor at http://ai2.appinventor.mit.edu |
| 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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | |
| If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project worksheet is available in MS Word format so you can **modify it to suit your class**. | | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * A video of the finished app in action is available at <https://youtu.be/dIjU6rmuoGc>   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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  Collecting the book cover images can be time-consuming.  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 the 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. |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Help** | | |
| **Potential issues** | | * A beginner level version of the worksheet is available that skips the bit where the machine learning model performance is compared with a person’s. * 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. * Dragging and dropping doesn’t work in Internet Explorer. You can provide your students with a different web browser (Firefox or Chrome work well) or explain to them how to copy/paste image URLs from a page. * You cannot drag and drop pictures between different types of browser. E.g. you can’t drag a picture from a Firefox window to Machine Learning for Kids running in Chrome. You need to use the same type of web browser for both. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.     General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Confused |
| **Activity** | | Learn about how computers can be confused and can make mistakes if they're trained badly. |
| **Objective** | | **Teach a computer to recognise fruit**   * Variation in training data is essential for a reliable machine learning system. * The “Russian Tank” problem. |
| **Difficulty level** | | Intermediate  As a project that explores why machine learning sometimes doesn’t work, it’s perhaps more effective as a follow-on to another project. |
| **Time estimate** | | 45 minutes |
| **Summary** | | Students will use a pre-prepared poor training set of images to train a machine learning model, and then try it for themselves in Scratch to see the impact of overfitting. |
| **Topics** | | image classification, supervised learning, overfitting |
| **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 Visual Recognition -** 1 custom model per student  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Help** | | |
| **Potential issues** | | * The provided data-set of pre-prepared training photos represents a version of “The Russian Tank problem” story. Two versions of the story are summarised in the student worksheet. You may wish to allow time for students to discuss the stories and the implications to make sure they understand them. * Dragging and dropping doesn’t work in Internet Explorer. You can provide your students with a different web browser (Firefox or Chrome work well) or explain to them how to copy/paste image URLs from a page. * You cannot drag and drop pictures between different types of browser. In other words, you can’t drag a picture from a Firefox window to Machine Learning for Kids running in Chrome. Or from a Chrome window to Machine Learning for Kids running in Firefox. You need to use the same type of web browser for both. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet screenshots are based on Scratch 3. You may prefer to use Scratch 2 instead, however students may find it harder to find some blocks.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Noughts and Crosses (Scratch) |
| **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  Setting up the project is a little complex, and the script block that needs to be added in Scratch is a little long. |
| **Time estimate** | | 1 hour |
| **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 |
| **Also…** | | *A demo version of this project is available for use at events like Science Fairs, where each child has only a minute or two to try an activity. The notes below are about the classroom version of the project.* |
| **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** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **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. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Noughts and Crosses (Python) |
| **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** | | Intermediate  Only two new lines need to be added to the sample Python code |
| **Time estimate** | | 1 hour |
| **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. |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * The sample code is available on GitHub but you might find it easier to provide the code for your students * The sample code has been tested with Python 3 but should work with Python 2 * The sample code needs **requests** and **pygame**. You might find it useful to get these installed first. (e.g. pip3 install pygame) * If students name things in their project differently to the worksheet, they will see problems with the sample code. Updating the constants at the top of the code should help with this.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Fooled |
| **Activity** | | Learn about how computers can be confused and can make mistakes if they're trained badly. |
| **Objective** | | **Teach a computer to recognise fruit**   * Variation in training data is essential for a reliable machine learning system. * The “Russian Tank” problem. |
| **Difficulty level** | | Intermediate  As a project that explores why machine learning sometimes doesn’t work, it’s perhaps more effective as a follow-on to another project. |
| **Time estimate** | | 45 minutes |
| **Summary** | | Students will create a poor training set of images to train a machine learning model, and then try it for themselves in Scratch to see the impact of overfitting. |
| **Topics** | | image classification, supervised learning, overfitting |
| **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 Visual Recognition -** 1 custom model per student  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Help** | | |
| **Potential issues** | | * The project represents a version of “The Russian Tank problem” story. Two versions of the story are summarised in the student worksheet. You may wish to allow time for students to discuss the stories and the implications to make sure they understand them. * Dragging and dropping doesn’t work in Internet Explorer. You can provide your students with a different web browser (Firefox or Chrome work well) or explain to them how to copy/paste image URLs from a page. * You cannot drag and drop pictures between different types of browser. In other words, you can’t drag a picture from a Firefox window to Machine Learning for Kids running in Chrome. Or from a Chrome window to Machine Learning for Kids running in Firefox. You need to use the same type of web browser for both. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **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. |
|  | **Access** | | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | | |
|  | **API keys** | | None |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **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”). * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | | |
| **Worksheet** | | | Newspaper shelves |
| **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 |
| **Difficulty level** | | | Intermediate  The project is easy to make, but typing in headlines for training data can be time-consuming |
| **Time estimate** | | | 1 hour |
| **Summary** | | | Students will collect examples of headlines from national newspapers. These will be used to train a machine learning model based on the use of language in headlines. They will create a Scratch project that puts a newspaper on the right shelf based on predicting which newspaper a new headline is from. |
| **Topics** | | | text 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. |
|  | **Access** | | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | | |
|  | **API keys** | | **Watson Assistant**  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://machinelearningforkids.co.uk/apikeys-guide> |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **Help** | | | |
| **Potential issues** | | | * Some newspapers use language that may not be appropriate for younger children. Tell your class which newspapers to choose if you have concerns. * If you would like to save time, you could modify the worksheet to use two or three newspapers instead of four. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |
| **Machine Learning For Kids :: Teachers’ notes** | | | |
| **Worksheet** | | | Headline testing |
| **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 for this project 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** | | | 2-3 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. |
|  | **Access** | | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | | |
|  | **API keys** | | **Watson Assistant**  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/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Help** | | | |
| **Potential issues** | | | * Some national newspapers use language 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. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | | |
| **Worksheet** | | | Locate Larry |
| **Activity** | | | Make a Where’s Wally? game in Scratch and teach the computer to find your character. |
| **Objective** | | | **Teach a computer to find something in a picture**   * How computers can be trained to recognise pictures. * How image pre-processing is used to find a small item in a larger picture |
| **Difficulty level** | | | Intermediate  The project is reasonably straightforward but builds on being able to do image classification of individual images. It’s better used as a follow-on project to another images project. |
| **Time estimate** | | | 1 hour |
| **Summary** | | | Students will make a Scratch project that generates a scene, cuts it into a grid of smaller squares, and trains an image classifier on those grid squares. |
| **Topics** | | | image classification, supervised learning, image pre-processing |
| **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 Visual Recognition -** 1 custom model per student  One “Lite” API key is free but can only be used to create 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **Help** | | | |
| **Potential issues** | | | * Machine Learning models for image projects sometimes take up to 5 minutes to train. Students can continue to work on their Scratch project scripts while they wait, if you like. They won’t be able to run the project until the machine learning model is ready, however. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet screenshots are based on Scratch 3. You may prefer to use Scratch 3 instead, however students may find it harder to find some blocks.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Journey to School |
| **Activity** | | Train the computer to be able to predict how you travel to school in the morning. |
| **Objective** | | **Teach a computer to make predictions**   * Predictive analytics can be used to identify patterns in structured data. |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 45 minutes |
| **Summary** | | Students will train a predictive model based on survey results. |
| **Topics** | | predictive model, testing, accuracy |
| **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 |
|  | **Other** | Students will need to conduct a travel survey first, using the results to train the computer. Sample results are included in the project worksheet. |
| Class account will need: | | |
|  | **API keys** | None |
| **Help** | | |
| **Potential issues** | | * The most time-consuming part of this project is designing a survey and carrying it out. After that, there is not very much to do. * Design your own survey! Consider using this as inspiration, but do your own survey on your own topic. Can this be combined with any other projects that the students are already doing? * There are sample survey results in the worksheet in case that is helpful, but if the students aren’t involved in designing and carrying out the survey, then the activity becomes largely a data entry exercise which may not be interesting for them. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | School Library |
| **Activity** | | Create a school librarian in Scratch that suggests who a reading book might be suitable for. |
| **Objective** | | **Teach a computer to make recommendations**   * Predictive models can be used to make recommendations. |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 1 hour |
| **Summary** | | Students will train a predictive model based on attributes of books. |
| **Topics** | | predictive model, recommendations |
| **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 |
|  | **Resources** | Students will need access to several books, sorted by reading level. The project was written for a school group that have their computer suite in the school library. |
| Class account will need: | | |
|  | **API keys** | None |
| **Help** | | |
| **Potential issues** | | * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Titanic |
| **Activity** | | Train the computer to be able to predict who survived the sinking of the Titanic. |
| **Objective** | | **Teach a computer to predict outcomes**   * Predictive analytics can be used to identify patterns in structured data. |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 45 minutes |
| **Summary** | | Students will train a predictive model based on historical data. |
| **Topics** | | predictive model |
| **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 |
|  | **Other** | A way of creating and running Python programs |
| Class account will need: | | |
|  | **API keys** | None |
| **Help** | | |
| **Potential issues** | | * This project asks children to think about reasons why people would and wouldn’t survive after a ship sinks. This might be upsetting for some children, so consider whether it is appropriate for your class before using. * The Python code the students will run uses the library “requests”. There is a link on the student page to install requests, but I’d recommend doing this before the class. See <https://3.python-requests.org/user/install/#install> for more info. * If you have time, get your students to find the information about the movie characters themselves. Download the original Word doc of the worksheet from <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> , delete the info about Jack and Rose, and write a step to find it themselves. * Reviewing and understanding the training data is the most significant part of this project. Allow a lot of time for this. You could invite them to speculate about possible patterns first (e.g. Men were more likely to survive if they had a wife and children with them as families might have been kept together? Or men were more likely to survive if were alone as they could’ve been more selfish?) and then look to see if the data matches that. You could invite them to find patterns in the data and then theorize for reasons after. Or you could let them do a bit of both.  They should spend time looking for and thinking about patterns in the data. * Make it clear that the computer will be looking for patterns in the data (but not interpreting, speculating or theorizing about those patterns). * After the session, encourage the students to think of other applications of a predictive model. What other sets of numerical and categorical (multiple-choice) data can they think of that might have patterns a computer could learn?   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | | |
| **Worksheet** | | | Chatbots |
| **Activity** | | | Create a chatbot that can answer questions about a topic of your choice. |
| **Objective** | | | **Teach a computer to recognise questions**   * How computers can be trained to recognise the intent behind writing. * How chatbots are used to automate answering people’s questions |
| **Difficulty level** | | | Beginner |
| **Time estimate** | | | 1 hour |
| **Summary** | | | Students will train a machine learning model to recognise questions by typing examples of how those questions could be asked. They will use this in Scratch to make a character that answers those questions. |
| **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 Assistant -** 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/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **Help** | | | |
| **Potential issues** | | | * The worksheet tells students to make a chatbot that can answer five questions. If you think that might be too much typing for your students, you could tell them to train it to answer three or four questions instead. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead. * The worksheet screenshots are based on Scratch 3. You may prefer to use Scratch 2 instead, however students may find it harder to find some blocks. * There is a version of this project that uses Python instead of Scratch. Chatbots are a text-based project, so this is a good fit for using Python for students starting to learn about text-based programming.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Face Lock |
| **Activity** | | Make a phone in Scratch that can only be unlocked if it recognises your face. |
| **Objective** | | **Teach a computer to recognise what faces look like**   * Learn how computers can be trained to do facial recognition * Learn how facial recognition can be used for authentication |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 1 hour |
| **Summary** | | Students will train a machine learning model to recognise their face, by taking pictures with a computer webcam. They will use this in Scratch to make a phone that unlocks if it recognises the owner’s face. |
| **Topics** | | facial recognition, biometrics, 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. |
|  | **Resources** | Toys with faces (if you don’t want the students to take photos of their own face) |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: [https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will be taking photos of their face and uploading them to a secure site, where they are kept until their photo or project is deleted. You may need to obtain parental permission before running this activity.  Alternatively, you could tell them to take photos of toys with faces (e.g. Lego figures, cuddly toys, action figures, etc.) instead. The screenshots in the student worksheet uses Lego figures as an example of this. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Chameleon |
| **Activity** | | Make a chameleon in Scratch that changes colour to match its background. |
| **Objective** | | **Teach a computer to recognise colours**   * Learn how computers can be trained to recognise the predominant colour of an object |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 1 hour |
| **Summary** | | Students will train a machine learning model to recognise colours by taking pictures of coloured objects with a computer webcam. They will use this in Scratch to make a character that recognises the colour and changes costume to match. |
| **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. |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: [https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will be taking photos and uploading them to a secure site. As long as only the objects 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. * Machine learning models can sometimes take up to 5 minutes to train. It is okay for students to work on their Scratch projects during this time, rather than wait for this to complete first. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Shy Panda |
| **Activity** | | Make a character in Scratch that stops dancing if it recognises you looking at it |
| **Objective** | | **Teach a computer to recognise pictures**   * Learn how computers can be trained to recognise an object |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 45 minutes |
| **Summary** | | Students train a machine learning model to recognise pictures by taking photos of their face with a webcam. They use this in Scratch to make a character that recognises what they’re doing. |
| **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. |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: [https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will be taking photos of their face and uploading them to a secure site, where they are kept until their photo or project is deleted. If this raises concerns it may be sensible to obtain parental permission. * Machine learning models can sometimes take up to 5 minutes to train. It is okay for students to work on their Scratch projects during this time, rather than wait for this to complete first. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | | |
| **Worksheet** | | | Virtual Pet |
| **Activity** | | | Make a virtual pet in Scratch that learns to recognise what you are doing |
| **Objective** | | | **Teach a computer to recognise pictures**   * Learn how computers can be trained to recognise an object |
| **Difficulty level** | | | Intermediate |
| **Time estimate** | | | 45 minutes |
| **Summary** | | | Students will train a machine learning model to recognise pictures by taking photos of objects with a computer webcam. They will use this in Scratch to make a character that recognises what they are doing. |
| **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. |
|  | **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 2 custom models  One “Standard” API key can be used to create to create multiple custom models  more detail at: [https://github.com/IBM/taxinomitis-docs/raw/master/docs/pdf/machinelearningforkids-apikeys.pdf](https://github.com/dalelane/ml-for-kids/raw/master/doc/machinelearningforkids-apikeys.pdf) |
| **Customizing** | | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | | |
| **Template** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates> | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> | |
| **Help** | | | |
| **Potential issues** | | | * Students will be taking photos and uploading them to a secure site. As long as only the objects are visible in photos they take, students will not be identifiable. If this raises concerns it may be sensible to obtain parental permission. * Machine learning models can sometimes take up to 5 minutes to train. It is okay for students to work on their Scratch projects during this time, rather than wait for this to complete first. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Alien Language |
| **Activity** | | Make an alien character in Scratch that learns to recognise an alien language. |
| **Objective** | | **Teach a computer to recognise sounds**   * Learn how computers can be trained to recognise words |
| **Difficulty level** | | Beginner |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train a sound recognition system to recognize two sounds in a pretend alien language. They use this in Scratch to make an alien character that can understand and carry out their commands. |
| **Topics** | | sound recognition, 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. |
|  | **Technology** | Microphone |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will record their voice and use that to train a machine learning model. This can work using a microphone built in to a laptop but the background noise can make this tricky with a large class all doing it at once. Using dedicated microphones (such as a headset microphone) can be a big help with this. * Younger students may enjoy inventing their own alien language. Encourage them to invent words that are weird and different! Older students may feel self-conscious making weird noises with their voice and may prefer doing things like finger clicks or jangling a bunch of keys instead. Either approach is fine. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Jargon Buster |
| **Activity** | | Make a meeting assistant in Scratch that listens for when certain words are mentioned, and displays a definition of them when they are heard. |
| **Objective** | | **Teach a computer to listen for words**   * Learn how computers can be trained to listen for specific key words |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train a sound recognition system to recognize key words. They use this in Scratch to make a project that reacts to hearing them and displays a definition. |
| **Topics** | | sound recognition, speech recognition, 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. |
|  | **Technology** | Microphone |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will record their voice and use that to train a machine learning model. This can work using a microphone built in to a laptop but the background noise can make this tricky with a large class all doing it at once. Using dedicated microphones (such as a headset microphone) can be a big help with this. * Including examples of the student talking (but not mentioning their chosen key words) in the “background noise” bucket can greatly improve how projects perform. This is mentioned in the student worksheet, but it’s worth highlighting it in case students don’t realize. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Secret Code |
| **Activity** | | Make a spy in Scratch and teach it to recognize your secret code words. |
| **Objective** | | **Teach a computer to recognise speech**   * Learn how computers can be trained to recognise words |
| **Difficulty level** | | Intermediate |
| **Time estimate** | | 1 hour |
| **Summary** | | Students train a speech recognition system to recognize words. They use this in Scratch to make a spy that recognizes the words, and guide it around a town. |
| **Topics** | | speech recognition, sound recognition, 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. |
|  | **Technology** | Microphone |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Project template files & worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Project templates** | | <https://github.com/IBM/taxinomitis-docs/tree/master/scratch-templates>  Scratch 3 templates end .sb3 Scratch 2 templates end .sb2 |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * Students will record their voice and use that to train a machine learning model. This can work using a microphone built in to a laptop but the background noise can make this tricky with a large class all doing it at once. Using dedicated microphones (such as a headset microphone) can be a big help with this. * Some students may feel self-conscious recording their voice. The project can be done with non-voice sounds like finger clicks or jangling a bunch of keys instead. You can suggest this as an alternative if that helps. * “https://machinelearningforkids.co.uk” is a long URL to type for some children. You may find it easier to set up a bookmark that they can click on instead.   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |

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| **Machine Learning For Kids :: Teachers’ notes** | | |
| **Worksheet** | | Phishing |
| **Activity** | | Create a Python program that can predict if a URL is legitimate |
| **Objective** | | **Teach a computer to recognize phishing web links**   * How computers can be trained to make predictions based on experiences. * How feature selection is choosing what values the computer should learn from * How machine learning systems can be visualised using tree diagrams * How machine learning is used to recognize malicious or suspicious web pages |
| **Difficulty level** | | Advanced |
| **Time estimate** | | 45 minutes - 1 hour |
| **Summary** | | Students will train a machine learning model to predict if a URL is for a legitimate webpage or a phishing page. They use this in Python to test new URLs.  The project ends with students reviewing AI research papers, which they should be able to understand at a high level if they’ve followed the project carefully. |
| **Topics** | | supervised learning, decision trees, feature selection |
| **Setup** | | |
| Each student will need: | | |
|  | **Print-outs** | Project worksheet (download from <https://machinelearningforkids.co.uk/worksheets> ) |
|  | **Access** | Username and password for machinelearningforkids.co.uk |
| Class account will need: | | |
|  | **API keys** | None |
| **Customizing** | | |
| If you use **PRIMM** approaches with your class, add a step where students predict how the project template works.  If you want to **increase the amount of coding** involved, delete some of the code from the project template and add steps to the worksheet so students code it themselves.  If you want to **encourage problem solving**, delete some of the detail in the worksheets and provide more general instructions instead.  Worksheets in MS Word format are available so you can **modify them to suit your class**. | | |
| **Worksheets** | | <https://github.com/IBM/taxinomitis-docs/tree/master/project-worksheets/msword> |
| **Help** | | |
| **Potential issues** | | * The sample code is available on GitHub but you might find it easier to provide the code for your students * The sample code has been tested with Python 3 and will need some modifying if you wish to use Python 2 * The sample code needs third-party libraries **requests, dateutil, whois**. You might find it useful to get these installed first. (e.g. pip3 install -r requirements.txt)   General troubleshooting and help at <https://machinelearningforkids.co.uk/help> |