How do machines learn?

This resource was developed by teachers within the Royal Society Schools Network

KS3

Lesson time: 1 hour

Introduction

Machine learning is a disruptive technology, promising exciting and sometimes scary developments to our daily lives. So students are aware of the way technology is developing, this lesson models machine learning (ML) in an accessible way to KS3 students. They'll be led through the principles and pitfalls of ML and are encouraged to think about its wider applications and implications on society.

It is an excellent way to introduce the concept of alogrithms to students.

An important misconception to note is that people often assume artificial intelligence (AI) and machine learning (ML) are interchangeable terms. In fact they are not, and in actuality AI is an abstract concept whereas ML is a process or an action. ML is carried out using programmed algorithms, designed to fulfil a purpose. For example, ML can identify the size and site of a tumour, so that medical practitioners are better placed to diagnose and take action against a cancer.

Learning objectives:

- Define machine learning and identify some of it's uses
- Create an algorithm to identify butterflies
- Suggest some errors that could occur with machine learning

Curriculum key words

Algorithm Taxonomy

Curriculum links

National Computing Programmes of Study:

- Key stage 3 Aims bullet point 1.
- Key stage 3 Aims bullet point 2.

Equipment needed

- sheet with 10 x butterfly images;
- sheet with 5 x different butterfly images;
- sheet with 5 x bird images;
- computer with internet and projector.

Resources

- butterfly ID machine sheet (see resource appendix).

How do machines learn?

Starter activity: what is machine learning?

(Approximately 15 minutes)

Watch a short clip from the recorded live stream of the lecture You and AI - The Practical Applications of AI (start 31:33 mins, end 32:35 mins) to introduce the topic. The clip describes the difference between machine learning and artificial intellengence (AI).

Discuss with the class “what is a machine learning and why is it important?”.

Key points that should be elicited from the students should include:

- machine lenaring is a practical process, whereas AI is theoretical and hard to define;
- machine learning utalises or consists of algorithms, written by humans; and
- machine learngin takes a data imput, and makes a prediction.

Activity A: is it a butterfly or a bird?

(Approximately 35 minutes)

Part A

Get the class, or students in small groups, to look at 10 different images of butterflies. From the 10 images, ask the students to individually write a list identifying what each image has in common with each other. Ensure that they write the list with each point on a separate line.

Ask the students to compare their lists with a partner. Where they agree on a point, e.g. ‘butterflies have 4 legs’, write the number 1 next to it. Where they have written a point but thier partner has not, write the number 0.5 next to it.

Ask the students to find the average of thier points eg:

1, 1, 1, 0.5, 1, 0.5, 0.5, 1, 1, 1 = 8.5/10 = .85

They have now produced an simple algorithm that carries out machine learning!

They can now apply thier 10 points to 5 x images of butterflies they have not seen before. The higher the average is above 0.5 the greater the likelihood that what they are looking at is a butterfly (all their images should come out above 0.5 – if not, they need to go back to their list of 10 defining features, and amend them).

Part B

Watch a second short clip from the same video You and AI - The Practical Applications of AI (start 34:19 mins, end 35:35 mins).

With a partner, ask the students to agree 10 features of a butterfly (they can use their answers from part A) . Using five pre-sourced images of butterflies and five images of birds, calculate the likelihood of the image being a bird or butterfly. Use the "Butterfly ID" recording template (see the end of this document).

The closer to an average of 1, the more likely it is that the image they are looking at is a butterfly.

Note: The learning machine is now being used to apply a taxonomy. Not only are the students identifying what may be butterflies but they may, as a consequence, be identifying birds as well. The lower the score the more likely it is that the image is of a bird.

With the class, discuss the need to take into account the features that may distinguish a bird from another animal, such as a giraffe, as well as a butterfly. The students should realise that the decision that an image is not a butterfly does not automatically make it a bird. A new algorithm would need to be written and more data analysed for the students to be sure the image is a bird.

This provides the link into the massive data sets that are required by machine learning algorithms to make predictions.

Part C

Watch a third short clip from the same video You and AI - The Practical Applications of AI (start 47:40 mins, end 49:22 mins). This clip introduces the use of machine learning to make predictions on the weather.

Discuss with the students the following question "How can using machine learning enable humans to make intelligent decisions?"

Key points that should be elicited from the students should include:

- Machine learning can process lots of numerical data, using mathematics, that a human would not be able to;
- Machine learning can take into account lots of different factors at the same time – complicated code;
- Machine learngin can help to gather lots of observations and build a bigger picture (data assimilation) such as a 3d model.
- Machine learning can make predictions based on current information
- These predictions are made without letting emotions or tiredness interfear;

A good example of above can be found in this short clip from the recorded live stream of the lecture You and AI – The Challenges to Making Machines Play Fair (start 13:30 mins, end 14:30 mins). This clip describes the use of machine learning to identify cancerous cells, and cells being affected by cancer.

Plenary:

(Approximately 5 minutes)

Using the butterfly identification experience, ask the students to explain the algorithm used to predict whether an image is a butterfly (this can be done as a *Think Pair Share* exercise).

Ask the students to describe how the algorithm can be modified so that the processes can be applied to classifying other objects or events, e.g. identifying a tumour, whether a planet can support life, diagnosing illnesses.

Resource: butterfly ID machine

Common feature **score /1**