



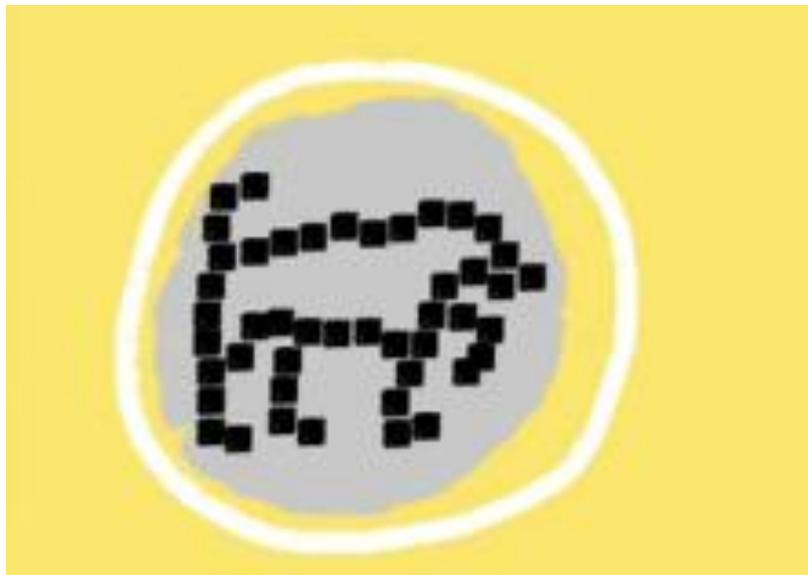
Key Stage 4 – Picture this

Notes for teachers

At a glance

Scientists at the University of Oxford are developing and improving computer programs that can learn. Often it is useful to feed computer programs a series of images and to get the computer to identify or sort them in some way, but how do computers create or store images?

In this lesson students will explore how bitmap images can be stored or displayed using binary notation, how the image can be compressed using RLE and information about meta-data that is stored with the image.



Learning Outcomes

- Students can describe how an image can be represented by binary numbers
- Students can apply run line encoding to a binary string
- Students can describe some of the meta data that is stored along with an image

Each student will need

- Access to a computer (optional)
- Pupil worksheet, pencil, eraser
- Extra squared paper
- Coloured pencils (optional)



Possible Lesson Activities

1. Starter activity

- Watch the Oxford Sparks 'What is Machine Learning?' video.
- Explain that in the video computers are shown pictures of dogs and cats. However, in order to store or analyse the pictures computers have to convert pictures to 1s and 0s (binary).
- Either as a whole class or with students working in small groups on a computer use a computer program that allows you to zoom in on a JPEG or BITMAP image (Windows Picture viewer works fine for this). As the zoom level increases you should be able to see the picture is made up of individual squares. Each square is a PIXEL (short for Picture Element).

2. Main activity: Coding and Decoding images

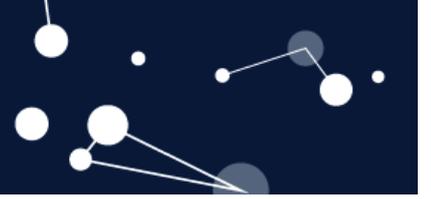
- Hand out the first page of the student worksheet.
- Get students to work through the examples in the worksheet. Here they will be decoding a simple image of a smiley face made of black or white pixels (see answer sheet below) as well as creating and encoding their own black and white image.

3. Main activity: RLE & Colour

- Hand out the second page of the student worksheet.
- Pictures are often compressed so they take up less storage space. One way to do this is to make the picture less detailed in some way (by reducing the number of pixels used or by reducing the number of colours in the picture). These are **lossy** compression methods. An example of a lossy compression method for audio files is to remove audio that is higher or lower than the human ear can hear.
- One way to reduce the size of picture files without losing any data is to use Run Length Encoding (RLE). Here a series of 32 zeroes followed by 17 ones might be encoded as 320171 (32x0 then 17x1). Students shorten the code for the smiley face they created earlier by using this form of RLE. In practice this is a simplification of what really happens, for example in the short form above 32 and 17 would need to be converted to binary notation.
- The worksheet briefly explains how a four colour picture can be encoded using an extension of the method used for black and white pictures. Students could be challenged to create and encode their own 4 colour pictures on squared paper as they did for the black and white pictures earlier.

4. Plenary: Meta Data

- In order to recreate a picture correctly from binary notation the computer needs to use meta data. In particular it needs to know the size (height/width in pixels) and colour depth (related to the number of different colours).
- In addition to the meta data needed to recreate the image, modern digital cameras often store a lot of other meta data alongside an image. This might include information about the make/model of camera and the settings used as well as the GPS position, data and time that a



picture was taken, etc.

- If students have access to computers they could use an exif viewer (link to an online exif viewing tool below) to view some of the meta data of images published online.

Answers to student worksheet

Page 1

00000000									
01100110		■	■			■	■		
00000000									
00011000				■	■				
01000010		■					■		
01000010		■					■		
00111100			■	■	■	■			
00000000									

Page 2

00000000110011000000000000110000100001001000010001111000000000 (smiley face)

Can be shortened to

90 21 20 21 120 21 40 11 40 11 20 11 40 11 30 41 100 (digits shown separated for ease of reading)

How many colours could you use with a colour depth of 3?

If you have a colour depth of 3 then you can use all the binary numbers using 3 digits from 000 to 111 to each represent a colour. Since 111 is 7 in binary this means there are 8 possible colours (corresponding to the numbers 0-7 in decimal notation).

Here are the eight possible combinations:

000 001 010 011 100 101 110 111

Weblinks

- Oxford Sparks Machine Learning animation page <http://www.oxfordsparks.ox.ac.uk/content/what-machine-learning>
- Meta Data viewer - <http://exif.regex.info/exif.cgi>.