

Solutions

Chapter 2: Understanding data

Table 2.1, page 18

Analog data type	Method of capture (digitising)
text	Typing on keyboard, OCR, speech recognition
image	Scanning, digital camera, created directly using image editing software
audio	microphone
animation	Scanning or photographing individual images
video	Digital camera, ADC

Web probe: Moore's law, page 19

Students' infographics should convey the idea that Moore's law predicts that the number of transistors in an integrated circuit (such as a CPU) doubles approximately every two years.

The observation is named after Gordon Moore, the co-founder of Fairchild Semiconductor and Intel. Moore predicted this rate of growth would continue for at least another decade.

Activity: Counting in binary, page 20

Table 2.2

Place value of column	10^2	10^1	10^0
	100	10	1
			0
			1
			2
			3
			4
			5
			6
			7
			8
			9
	1	0	
	1	1	
	1	2	
	1	3	
	1	4	
	1	5	
$= 1 \times 10 + 5 \times 1$			

Table 2.3

Place value of column	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
	128	64	32	16	8	4	2	1
					0	0	0	0
					0	0	0	1
					0	0	1	0
					0	0	1	1
					0	1	0	0
					0	1	0	1
					0	1	1	0
					0	1	1	1
					1	0	0	0
					1	0	0	1
					1	0	1	0
					1	0	1	1
					1	1	0	0
					1	1	0	1
					1	1	1	0
					1	1	1	1

$$= 1 \times 4 + 0 \times 2 + 1 \times 1$$

Class activity: Binary body race, page 21

- 1 **a** 6
b Correct row is circled in red on table above.
- 2 **a** 10
b Correct row is circled in purple on table above.
- 3 Students' responses will vary.
- 4 Table below shows how to count 0–50 in binary.

Decimal (Denary) (base 10)	Binary (base 2)	Decimal (Denary) (base 10)	Binary (base 2)	Decimal (Denary) (base 10)	Binary (base 2)
0	0	17	10001	34	100010
1	1	18	10010	35	100011
2	10	19	10011	36	100100
3	11	20	10100	37	100101
4	100	21	10101	38	100110
5	101	22	10110	39	100111
6	110	23	10111	40	101000
7	111	24	11000	41	101001
8	1000	25	11001	42	101010
9	1001	26	11010	43	101011
10	1010	27	11011	44	101100
11	1011	28	11100	45	101101
12	1100	29	11101	46	101110
13	1101	30	11110	47	101111
14	1110	31	11111	48	110000
15	1111	32	100000	49	110001
16	10000	33	100001	50	110010

Magic binary cards, page 22

Note: a pdf for this activity is provided in online resources.

How the trick works: The first number on each card is a place value of one column in the binary table. Each card on which the secret number appears indicates a binary '1' appears in that place value column. Therefore, the sum of all first numbers on each card chosen, will give the secret number.

Review: Binary and decimal conversion, page 23

- Computers are built using switches that can only show one of two states: on or off.
Binary numbers also require only two states and can be used to represent many types of data.
- $0000\ 0110 = 6$
 - $0110\ 0011 = 99$
 - $1010\ 1100 = 172$
- $4 = 100$
 - $64 = 1000000$
 - $63 = 0111111$
- $1111 = 15$
- $1111\ 1111 = 255$
- Students' responses will vary.

Translate a small snippet of binary ASCII code, page 25

The answer is BINARY (MUST be written in caps!)

Web probe: Unicode, page 28

- 1 No response required.
- 2 é (lower case e with acute) and ü (lower case u with German umlaut/diaeresis)
- 3 U+597D 好
hăo means good or well and is part of the greeting 'hello'.
- 4 S O S

Activity: Comparing bitmap and vector images, pages 32–33

4

Table 2.9

File	File size	Vector or bitmap?	Special features of file type?
final logo.ai	78 KB	Vector	Adobe Illustrator (original artwork source file)
final logo.jpg	1.1 MB	Bitmap	Suitable web
final logo.psd	3 MB	Bitmap	Adobe Photoshop
final logo.svg	15 KB	Vector	Open standard suitable web
final logo.png	406 KB	Bitmap	Generic
final logo.tif	91.1 MB	Bitmap	High quality suitable for high-resolution printing

- 5 Draw format files are much smaller than paint formats as they are based on mathematical descriptions of shapes rather than individual pixels. Photoshop paint files are larger as they store additional data needed for that application, such as separate layers, where present.

Web probe: MP3, page 35

Human hearing range is roughly 20 Hz to 20 000 Hz. A scientific theory states that the sampling frequency must be greater than twice the maximum frequency needed. Thus the sampling rate had to be greater than 40 kHz.

44.1 kHz sampling frequency allows an extra 2.05 kHz to widen the band to allow more accurate sampling of the analog signal.

Also, 44 100 is the product of the squares of the first four prime numbers ($2^2 * 3^2 * 5^2 * 7^2$) and this allows it to be split exactly in many ways.

Activity: Sampling sound, page 35

- 1 0101, 0111, 0100, 1001, 0000, 1100, 0110
- 2 It would be reasonably close, as the samples closely match the original analog wave shape.

Web probe: Video streaming, page 38

The most common use of streaming is when users watch digital video content and/or digital audio content on a computer over the Internet. Streaming is the alternative method to downloading, where the whole digital video or audio file must be downloaded before starting to watch/listen to it.

There are challenges with streaming content on the Internet. If the user does not have enough bandwidth, they may experience degradation or stops in the content. Two popular streaming services are YouTube, which contains video and audio files on a large range of topics, and Netflix, which streams movies and TV shows. Another challenge is that delivery using packets (see Chapter 4: Understanding Networks) is not a suitable method with streaming because if loss of packets occurs users experience a dropout in transmission. Other protocols have been developed to overcome this.

Review: Binary representation, pages 38–9

Identify

1 ASCII, UNICODE

2

- OCR
- Taking a photograph with a digital camera *or* scanning a printed analogue image
- Record using microphone
- Record using microphone and line inputs where possible from instruments

3 Video places the greatest demand on bandwidth as it requires the loading or streaming of multiple image frames per second. In the case of streaming video, lowest resolutions require 300 MB to 600 MB per hour, standard definition requires 700 MB to 1.2 GB per hour, high definition requires 3 GB per hour and ultra-high definition can use up to 18 GB per hour.

Analyse

4 Digitised sound converts analog real world sound into digital form by sampling ‘slices’ and representing these as binary numbers. The analog sound wave is approximated by recording its value at regularly spaced moments. Each of these ‘samples’ is stored as a number measuring wave height at that moment. Sample rate describes the number of samples taken each second and sample size refers to the accuracy of the measure.

5 Image bit depth refers to the number of bits available to describe and record the colour of each pixel in the image.

Similarly, audio bit depth refers to the number of bits available to record the measure of amplitude of an analog audio signal.

6 1 080 000 bits or 135 000 bytes

Investigate

- 7** MIDI (Musical Instruments Digital Interface) artificially represents the sounds of at least 128 instruments using software by representing each note data with pitch, volume, duration, vibrato and other features of sounds using built-in data (primitives) for recreating the sound of the chosen instrument. It is incapable of representing speech or other real-world sounds that are not previously defined by its software.