

Exercise walk-through

1.2

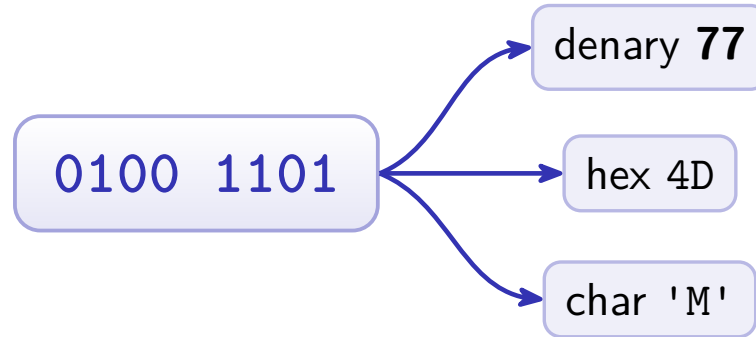
Multimedia

A-Level Computer Science

Information Representation

AS Computer Science ■ Topic 1

A-Level Computer Science

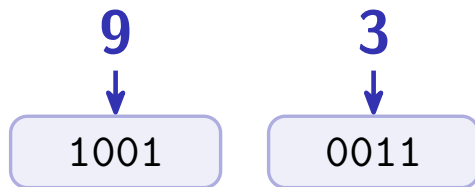


What we will cover

- 1 Number systems
- 2 Binary arithmetic
- 3 BCD & hexadecimal
- 4 Character codes
- 5 Images
- 6 Sound
- 7 Compression

Binary Coded Decimal

In **BCD**, each denary digit gets its own 4 bits.



In pure binary the same number is 0101 1101 – a **different pattern** of the same 8 bits.

- only 0000–1001 are valid; 1010–1111 unused
- each digit drives a display directly, and money avoids binary rounding



Drives a 7-segment display

Exercise 2.1

2.1 State what **colour depth** means, and write the formula for a bitmap's file size. [2]

Exercise 2.1

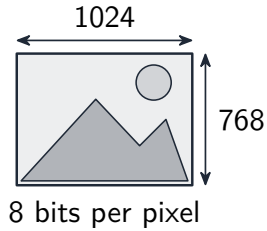
2.1 State what **colour depth** means, and write the formula for a bitmap's file size. [2]

2.1

- colour depth = the number of **bits used per pixel**
- size = width $\times$ height $\times$ colour depth

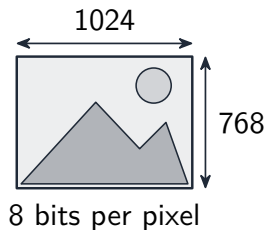
Exercise 2.2

2.2 Calculate the file size of a 1024×768 bitmap at 8 bits per pixel. Give your answer in **KiB**, showing your working. [3]



Exercise 2.2

2.2 Calculate the file size of a 1024×768 bitmap at 8 bits per pixel. Give your answer in **KiB**, showing your working. [3]



2.2

- size in bits = width $\times$ height $\times$ colour depth

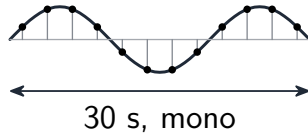
$$1024 \times 768 \times 8 = 6\,291\,456 \text{ bits}$$

- $\div 8$ for bytes, $\div 1024$ for KiB

$$\frac{6\,291\,456 \text{ bits}}{8 \times 1024} = \mathbf{768 \text{ KiB}}$$

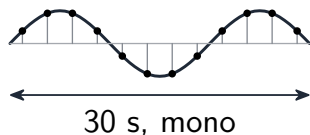
Exercise 2.3

2.3 A 30-second **mono** sound clip is sampled at 16 kHz (16 000 Hz) with 8-bit resolution. Calculate its file size in **KiB**. [3]



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2.3

- size in bits = sampling rate $\times$ resolution $\times$ duration $\times$ channels

$$\text{size (bits)} = \text{sampling rate} \times \text{resolution} \times \text{duration} \times \text{channels}$$

$$16\,000 \text{ Hz} \times 8 \text{ bits} \times 30 \text{ s} \times 1 = 3\,840\,000 \text{ bits}$$

- $\div 8$ for bytes, $\div 1024$ for KiB

$$\frac{3\,840\,000 \text{ bits}}{8 \times 1024} = \mathbf{468.75 \text{ KiB}}$$

Exercise 2.4

2.4 Give one reason a **vector** graphic is a good choice for a company logo. [1]



Exercise 2.4

2.4 Give one reason a **vector** graphic is a good choice for a company logo. [1]



2.4

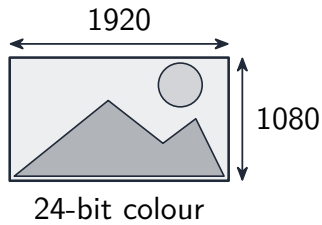
- any one: it stays **sharp at any size** (a logo is used large and small); the file is small

Exercise 3.1 (a)

3.1 A photo is 1920×1080 pixels with a colour depth of 24 bits.

(a) Calculate the file size in **MiB**. Show your working.

[3]

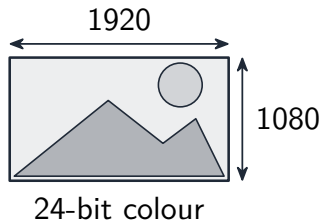


Exercise 3.1 (a)

3.1 A photo is 1920×1080 pixels with a colour depth of 24 bits.

(a) Calculate the file size in **MiB**. Show your working.

[3]



(a) size in bits = $1920 \times 1080 \times 24$

$$1920 \times 1080 \times 24 = 49\,766\,400 \text{ bits}$$

- $\div 8 \div 1024 \div 1024$ for MiB

$$\frac{49\,766\,400 \text{ bits}}{8 \times 1024 \times 1024} \approx \mathbf{5.93 \text{ MiB}}$$

Exercise 3.1 (b)

3.1 A photo is 1920×1080 pixels with a colour depth of 24 bits.

(b) State **one** change to the image that would reduce its file size, and explain its effect on quality. [2]

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3.1 A photo is 1920×1080 pixels with a colour depth of 24 bits.

(b) State **one** change to the image that would reduce its file size, and explain its effect on quality. [2]

(b) e.g. **lower the colour depth** (or the resolution)

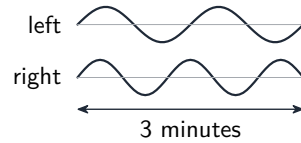
- smaller file, but fewer colours / less detail

Exercise 3.2 (a)

3.2 A 3-minute song is recorded in **stereo** (2 channels), sampled at 44.1 kHz with 16-bit resolution.

(a) Calculate the file size in **MiB**. Show your working.

[3]

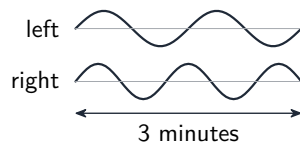


Exercise 3.2 (a)

3.2 A 3-minute song is recorded in **stereo** (2 channels), sampled at 44.1 kHz with 16-bit resolution.

(a) Calculate the file size in **MiB**. Show your working.

[3]



(a) $t = 3 \text{ min} = 180 \text{ s}$; stereo = 2 channels

- size in bits = rate $\times$ resolution $\times t \times$ channels

$$\text{size (bits)} = \text{sampling rate} \times \text{resolution} \times \text{duration} \times \text{channels}$$

$$44\,100 \text{ Hz} \times 16 \text{ bits} \times 180 \text{ s} \times 2 = 254\,016\,000 \text{ bits}$$

- $\div 8 \div 1024 \div 1024$ for MiB

$$\frac{254\,016\,000 \text{ bits}}{8 \times 1024 \times 1024} \approx \mathbf{30.28 \text{ MiB}}$$

Exercise 3.2 (b)

3.2 A 3-minute song is recorded in **stereo** (2 channels), sampled at 44.1 kHz with 16-bit resolution.

(b) Explain the effect on the recording of **halving** the sampling rate.

[2]

Exercise 3.2 (b)

3.2 A 3-minute song is recorded in **stereo** (2 channels), sampled at 44.1 kHz with 16-bit resolution.

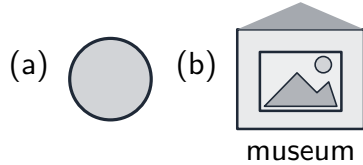
(b) Explain the effect on the recording of **halving** the sampling rate. [2]

(b) fewer samples per second

- the file is roughly **half the size**, but high-pitched sounds are lost / quality drops

Exercise 3.3

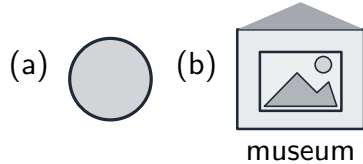
3.3 (a) State **two** pieces of data a vector graphic would store to describe a single circle.[2]



(b) A museum scans old paintings to put online. Justify whether a bitmap or a vector format is the better choice. [2]

Exercise 3.3

3.3 (a) State **two** pieces of data a vector graphic would store to describe a single circle.[2]



(b) A museum scans old paintings to put online. Justify whether a bitmap or a vector format is the better choice. [2]

3.3

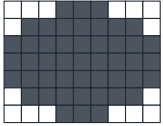
(a) any two of: centre position (x, y) ; radius; line/fill colour; line width

(b) **bitmap**

- a painting has continuous, per-pixel tonal detail that cannot be described as a few shapes

Exercise 3.4

3.4 Explain why a bitmap logo looks blocky when it is enlarged, but a vector logo stays sharp. [2]



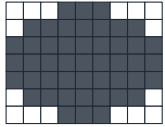
bitmap



vector

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bitmap



vector

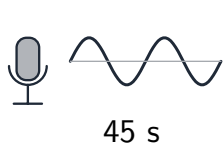
3.4

- a bitmap has a fixed number of pixels; enlarging it makes each pixel bigger, so the squares show
- a vector stores shapes and is **re-drawn** at the new size, so edges stay smooth

Exercise 3.5 (a)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(a) The sound is sampled at 44.1 kHz with a sample resolution of 16 bits, in **stereo** (two channels). **Estimate** the file size in **mebibytes**, showing your working. [4]



Exercise 3.5 (a)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(a) The sound is sampled at 44.1 kHz with a sample resolution of 16 bits, in **stereo** (two channels). **Estimate** the file size in **mebibytes**, showing your working. [4]



45 s



badge

Full solution 3.5 (a)

(a) $t = 45$ s; stereo = 2 channels

- size in bits = rate $\times$ resolution $\times t \times$ channels

$$44\,100 \text{ Hz} \times 16 \text{ bits} \times 45 \text{ s} \times 2 = 6.35 \times 10^7 \text{ bits}$$

- $\div 8$ for bytes

$$\frac{6.35 \times 10^7 \text{ bits}}{8} = 7.94 \times 10^6 \text{ bytes}$$

$$\frac{7.94 \times 10^6 \text{ bytes}}{1\,048\,576 \text{ bytes MiB}^{-1}} = \mathbf{7.6 \text{ MiB}}$$

Exercise 3.5 (b)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(b) The recording is re-sampled at 22.05 kHz with an 8-bit resolution. **Describe** the effect on the file size and on the **accuracy** of the recording. [3]

Exercise 3.5 (b)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(b) The recording is re-sampled at 22.05 kHz with an 8-bit resolution. **Describe** the effect on the file size and on the **accuracy** of the recording. [3]

(b) halving both the sampling rate and the resolution divides the size by **four**, to about 1.9 MiB

- the lower rate captures fewer samples per second, so high frequencies are lost
- the smaller resolution records each sample more coarsely, so the waveform is a poorer match and quantisation noise increases

Exercise 3.5 (c)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(c) The badge is stored as a bitmap 600 pixels wide and 400 pixels high, using a colour depth of 24 bits. **Estimate** the file size in **kibibytes**. [3]

Exercise 3.5 (c)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(c) The badge is stored as a bitmap 600 pixels wide and 400 pixels high, using a colour depth of 24 bits. **Estimate** the file size in **kibibytes**. [3]

(c) size in bits = width $\times$ height $\times$ colour depth

$$600 \times 400 \times 24 = 5\,760\,000 \text{ bits} = 720\,000 \text{ bytes}$$

$$\text{KiB} = \frac{\text{bytes}}{1024} = \frac{720\,000 \text{ bytes}}{1024 \text{ bytes KiB}^{-1}} = \mathbf{703 \text{ KiB}}$$

Exercise 3.5 (d)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(d) **Explain** why the actual file on disk is **larger** than your answer to (c). [2]

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(d) **Explain** why the actual file on disk is **larger** than your answer to (c). [2]

(d) the file also stores **metadata** in a header – the dimensions, the colour depth, the file format

- it may include a colour palette or padding, none of which the pixel calculation counts

Exercise 3.5 (e)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(e) The badge uses only 6 distinct colours in large flat areas. **Explain** how **run-length encoding** would compress it, and **state** why it works far better on this image than on a photograph. [4]

Exercise 3.5 (e)

3.5 A school records a 45-second announcement and also stores a scanned photograph of the school badge.

(e) The badge uses only 6 distinct colours in large flat areas. **Explain** how **run-length encoding** would compress it, and **state** why it works far better on this image than on a photograph. [4]

(e) run-length encoding replaces each run of identical pixels with **one colour value and a count**

- large flat areas of one colour become very short records, so the file shrinks a great deal
- in a photograph adjacent pixels almost always differ slightly
- so runs are one pixel long and the encoding stores a count beside every pixel, which can make the file **bigger** than the original