

# Unit 2—Data...

HCCS STEM—Computer Science, IT, Engineering, Food/Nutrition, Business Studies

## What do I need to be able to do?

1. explain that computers use **binary (0s and 1s)** because they understand two simple states, and I can define computer storage units such as **bits, nibbles, and bytes**. I can also convert **positive whole numbers between 0 and 255** from **denary** into **8-bit binary** and back.
2. understand how computers represent **text, images, and sound, using binary**. This includes text using **character sets like ASCII**, images made of **pixels** with properties like **colour depth**, and sound is created by **sampling** using **bit depth** and **sample rate**.
3. perform simple **binary arithmetic**, such as adding two 8-bit binary integers, understand **binary shifts** which can quickly multiply or divide numbers, and explain how **two's complement** represents negative integers in binary. I can also convert the shorthand **hexadecimal** system, and understand the difference between **lossy and lossless data compression**.

01010101

128 64 32 16 8 4 2 1  
2<sup>7</sup> 2<sup>6</sup> 2<sup>5</sup> 2<sup>4</sup> 2<sup>3</sup> 2<sup>2</sup> 2<sup>1</sup> 2<sup>0</sup>

The size of a digital sound file depends on the sound wave being sampled. This process involves measuring the sound's amplitude at regular intervals, where the **sample rate** is the number of measurements taken per second, and the **bit depth** (or sample depth) is the number of bits used to record each individual measurement's detail. The overall size of the sound file is then determined by multiplying the sample rate by the bit depth and the total duration of the sound.

**Lossy compression** permanently removes some data from a file to reduce its size, which means the quality may be affected, and the original cannot be perfectly restored. In contrast, **lossless compression** reduces file size without losing any of the original data, allowing the file to be fully restored to its original state.

## Keywords

1. **Binary** is the number system that computers use, made up of only the digits **0s and 1s**.
2. A **bit** is the most basic unit of data storage in computers, representing a single **0 or 1**.
3. A **byte** is a common unit of computer storage consisting of **8 bits**.
4. **Hexadecimal** is a **base 16 number system** that is often used as a simpler way to represent binary values.
5. A **pixel** is the smallest identifiable area of an image, with its colour represented by a **binary value**.
6. **Colour depth** indicates the **number of bits used** for each pixel in an image, which determines how many different colours can be shown.
7. **Lossy compression** is a technique that **permanently removes some data** from a file to reduce its size, which can affect quality.

Hexadecimal Numbering System (base 16)  
Characters = 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

E 4 C = 14x256 + 4x16 + 12x1

256's place 16's place 1's place

A **binary shift** involves moving all the bits in a binary number either to the **left** or to the **right**. Shifting bits to the left **multiplies** the number by a power of two, while shifting bits to the right **divides** the number by a power of two.

**Two's complement** is used to represent negative numbers using binary. The leftmost bit indicates if the number is positive (0) or negative (1) representing **-128**.

| No of Bits per pixel (Colour Depth) | No of possible colours       |
|-------------------------------------|------------------------------|
| 1                                   | 2                            |
| 4                                   | 2 <sup>4</sup> = 16          |
| 8                                   | 2 <sup>8</sup> = 256         |
| 24                                  | 2 <sup>24</sup> = 16,777,216 |

11 1 ← Carry bits → 11

|           |           |           |
|-----------|-----------|-----------|
| 1001101   | 1001001   | 1000111   |
| + 0010010 | + 0011001 | + 0010110 |
| 1011111   | 1100010   | 1011101   |

101100110101 (binary)

↓ ↓ ↓

B 3 5 (hex)

## 10 Test your understanding questions

Here are 10 multiple-choice questions summarising the whole unit:

1. What are the only two digits used in the binary number system that computers understand?  
a) A and F b) 0 and 1 c) 0 and 9 d) 1 and 2
2. Which of the following defines a byte?  
a) A single 0 or 1 b) 4 bits c) 1024 bytes d) 8 bits
3. When converting a positive denary whole number between 0 and 255 to 8-bit binary, how is the largest denary value of 255 represented?  
a) 0000 0000 b) 0101 0101 c) 1000 0000 d) 1111 1111
4. How do computers primarily represent text characters like letters and symbols?  
a) By converting them directly to denary numbers. b) Using character sets like ASCII, which assign specific binary codes to characters. c) By storing tiny pictures of each character. d) By using hexadecimal values only.
5. In bitmap images, what is the smallest individual component that holds a single colour value represented in binary?  
a) A byte b) The resolution c) The colour depth d) A pixel
6. When analogue sound is converted to a digital format by sampling, what term refers to the number of measurements taken of the sound wave per second?  
a) Bit depth b) Amplitude c) Sample interval d) Sample rate
7. What is one key advantage of using hexadecimal notation in computer science?  
a) It uses fewer digits than binary. b) It is a base 2 number system like binary. c) It directly represents analogue data. d) It is primarily used for calculating image sizes.
8. What happens to the value of a binary number when its bits are shifted one position to the left?  
a) The number is halved. b) The number is squared. c) The number becomes negative. d) The number is doubled.
9. What is the primary purpose of Two's Complement in binary representation?  
a) To make binary numbers easier to read. b) To represent only positive integers. c) To increase the speed of binary arithmetic. d) To represent both positive and negative whole numbers using binary.
10. Which type of data compression permanently removes some of the original data from a file?  
a) Lossy compression b) Lossless compression c) Archive compression d) Dictionary compression

## 10 Test your understanding answers

1b, 2d, 3d, 4b, 5d, 6d, 7a, 8d, 9d, 10a