ICT – Analogue and Digital Data – Binary

1 of 20 – Welcome

Welcome to this session on analogue and digital data (known as binary).

By the end of this session, you will:

* Know what is meant by analogue data
* Know what is meant by digital data
* Understand what binary (notation) is
* Know how binary is used in technology

2 of 20 – Introduction to analogue data

**What is analogue data?**

Analogue data – sometimes referred to as analog data, organic data, or real-world data – is something that occurs in the real and natural world i.e. it is not found in a digital setting.

It is something that is represented in a physical sense, like the human voice, for example, or temperature and it is also something that is subject to change. For an example, consider how often the temperature changes over the course of a week, or even a day.

The data can be represented by an electrical signal of some kind (for example, how we monitor sound waves), but a certain type of conversion – changing analogue into something else – needs to take place before this data can be processed by technological systems.

3 of 20 – Examples of analogue data

The human voice and the outside temperature, as mentioned earlier, are both common examples of analogue data. Anything that transmits sound waves will also rely on analogue data, for example:

* Microphones
* Loudspeakers
* Headphones

We can also consider different sensors, as these are not only used to measure temperature (changes) but they can also be used to measure things such as water pressure – making this another example of analogue data in a real-life setting.

4 of 20 – Introduction to digital data

**What is digital data?**

Digital data can be thought of as being a representation of something – typically as a number sequence, or a numerical value.

The reason for this representation is that once data has been converted into digital data, it can then be understood by different technology systems (in ways that analogue data cannot).

When digital data is processed by computers, the computer itself is relying on a binary system. This system shows different file types – such as audio or video, for example – in a sequence of binary characters which the computer can properly understand.

We’ll talk more about binary later in this session.

5 of 20 – Examples of digital data

For real life examples of digital data we can consider things such as digital clocks, and even Morse code (this is a code where the letters of the alphabet are represented by a sequence of short and long dashes, and dots). Digital data can also be found in a number of other places, such as:

* Computer and laptops
* Mobile phones
* MP3 players

**Remember:** broadly speaking if data is somehow computerised, or adapted to be computer friendly, then this means it is digital data, rather than analogue.

6 of 20 – Converting analogue to digital

In order for a computer to understand certain real life data, i.e. analogue data, a conversion needs to take place. This turns the original data into digital data, which is something that a computer system will be able to understand and process and this is where binary systems come in.

Even though a change in how the data is formed is taking place, it is important to remember that digital data storage is very reliable.

Computers will sometimes encrypt this data, too, meaning the data is protected by codes, or sometimes passwords. This not only makes the data more secure, but it also means that even if someone else gained access to the data, they would not understand it anyway!

Digital devices can now check for mistakes or changes in the original data as well, to ensure it stays how it was originally recorded.

7 of 20 – Question 1

What is analogue data?

Choose all that apply:

1. Data that occurs in a real-life setting
2. Data that is always changing
3. Data that is not digital
4. Data that is represented by a number sequence

The correct answers are A and C, data that occurs in a real-life setting and data that is not digital.

8 of 20 – Question 2

Where might we encounter digital data?

Choose all that apply:

1. Computers
2. Laptops
3. The human voice
4. Sound waves
5. Mobile phones

The correct answers are A, B and E, computers, laptops and mobile phones.

9 of 20 – Question 3

Using the following choice of words; **reliable**, **digital**, **real-life data**, **changes**, **codes**, **access** and **encrypting**, fill in the blanks for the paragraph below:

For a computer to understand real-life data, the data itself must be converted to **blank** data. Digital data storage is actually a very **blank** method of storage, and it is also extremely safe. Computers can ensure your data stays private by **blank** it. This means that your data is disguised by **blank** or passwords, so if anyone gains **blank** to it, they will not be able to understand the data anyway. Digital data can also be checked for **blank** or mistakes, meaning that **blank** can stay the same, in terms of content, as when it was originally recorded.

The correct paragraph should read:

For a computer to understand real-life data, the data itself must be converted to **digital** data. Digital data storage is actually a very **reliable** method of storage, and it is also extremely safe. Computers can ensure your data stays private by **encrypting** it. This means that your data is disguised by **codes** or passwords, so if anyone gains **access** to it, they will not be able to understand the data anyway. Digital data can also be checked for **changes** or mistakes, meaning that **real-life data** can stay the same, in terms of content, as when it was originally recorded.

10 of 20 – Introduction to binary

Binary is the number system used to bridge the gap between analogue and digital data. By using the binary system to convert analogue data into digital data, information is made computer friendly (i.e. the computer is able to read and process the data).

Binary, sometimes called binary notation, is a system based around two digits; these are 0 and 1.

The use of just two numbers makes binary a base 2 number system; unlike our everyday number system which is classified as base 10. This everyday system that we use is also referred to as denary.

Binary notation is understood by every part of a computer, which is why binary is used in all types of computerised data. If a computer is going to properly understand processes in the natural world, then binary is the only way to make sure that real life data is computerised and recorded effectively.

11 of 20 – Binary in practice

Binary can be found in a number of different computer components, such as: in RAM, in a hard disk drive, and in a DVD.

When binary is used in RAM, the binary system is represented in different transistors – these are noted as either having an electrical charge (making them 1 in the binary system) or as not having an electrical charge (making them 0 in the binary system).

Binary notation is also used in DVDs, where the reflective surface of a disk to a laser is either 1 (in the binary system) or 0 (in the binary system). Here 1 marks whether the disk is reflective while 0 marks whether it is not reflective.

12 of 20 – Breaking binary down

Binary notation is made up of bits, in this context, a bit means a binary digit (**remember:** binary is made up of 1s and 0s).

Counting in binary works a little differently to counting in our everyday number system. While place values in the everyday number system run as: 1, 10, 100, and so on, place values in binary run as: 1, 2, 4, 8 and so on.

**Remember:** our everyday number system is base 10 but binary is base 2.

So in binary notation each place value increases to 2 times its original size as the number sequence goes on (this can also be described as increasing by the power of 2).

13 of 20 – Breaking binary down part 2

Binary and denary figures can be placed on a chart, so you can observe the pattern that is followed by each set of numbers when a conversion takes place. In a binary-denary chart there will be column headings for each set of numbers.

The binary numbers – which will run across the top of the chart – will start at 1, and this will be listed on the **right-hand side**. On the **left-hand side** of 1 will be the next number in the binary sequence, which will be **double** the starting number, i.e. 2.

Every left-hand number in the binary sequence will be double the number that is listed to its right. See the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| 8 | 4 | 2 | 1 |

14 of 20 – Binary chart

The chart below shows binary conversions in practice:

|  |
| --- |
| Binary pattern |
| Place value 128 | Place value 64 | Place value 32 | Place value 16 | Place value 8 | Place value 4 | Place value 2 | Place value 1 |
| Denary number | 0 |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  | 1 |
| 2 |  |  |  |  |  |  | 1 | 0 |
| 3 |  |  |  |  |  |  | 1 | 1 |
| 4 |  |  |  |  |  | 1 | 0 | 0 |
| 5 |  |  |  |  |  | 1 | 0 | 1 |
| 6 |  |  |  |  |  | 1 | 1 | 0 |
| 7 |  |  |  |  |  | 1 | 1 | 1 |
| 8 |  |  |  |  | 1 | 0 | 0 | 0 |
| 9 |  |  |  |  | 1 | 0 | 0 | 1 |
| 10 |  |  |  |  | 1 | 0 | 1 | 0 |

The denary numbers in the left-hand side headings are level with their binary equivalents, listed on the right-hand side boxes of the chart.

From the chart above we can see that denary 2 is equal to binary 10.

**Tip:** binary place values must add up to their denary number, for example 31 denary equals 1 1 1 1 1 binary (because place values 16, 8, 4, 2, and 1 all combine to make 31).

15 of 20 – Binary inside computers

Computers are designed to understand binary so easily because computer memory is actually built around binary logic. The binary figures highlighted earlier in this session are already inside your computer before any new data is even added.

Binary logic is also used to calculate the amount of data that a processor can handle – without it slowing down the machine, or any of the individual components – and it helps users to identify the number of bits that are used in memory addresses.

When thinking about computer memory, you might have heard the terms 32-bit or 64-bit. These are binary representations of how much memory any given computer has. Note that this is a big increase from earlier processors that were often 8-bit, or 16-bit if users were lucky.

16 of 20 – Question 4

Indicate whether the following statements are true or false.

Binary is a number system that converts real life data into digital data, making it computer friendly.

True

False

The correct answer is: True

The binary system is a base 10 number system.

True

False

The correct answer is: False

Binary is used throughout a whole computer, including the RAM, the hard disk drive, and on DVDs.

True

False

The correct answer is: True

In the binary system each place value increases by 5 for a new number.

True

False

The correct answer is: False

17 of 20 – Question 5

Using the binary chart below, can you work out what the binary equivalent is for denary 10?

|  |
| --- |
| Binary pattern |
| Place value 128 | Place value 64 | Place value 32 | Place value 16 | Place value 8 | Place value 4 | Place value 2 | Place value 1 |
| Denary number | 0 |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  | 1 |
| 2 |  |  |  |  |  |  | 1 | 0 |
| 3 |  |  |  |  |  |  | 1 | 1 |
| 4 |  |  |  |  |  | 1 | 0 | 0 |
| 5 |  |  |  |  |  | 1 | 0 | 1 |
| 6 |  |  |  |  |  | 1 | 1 | 0 |
| 7 |  |  |  |  |  | 1 | 1 | 1 |
| 8 |  |  |  |  | 1 | 0 | 0 | 0 |
| 9 |  |  |  |  | 1 | 0 | 0 | 1 |
| 10 |  |  |  |  | 1 | 0 | 1 | 0 |

Choose one answer below:

1. 1 0 0 0
2. 1 0 1 0
3. 1 0 1
4. 1 0 0 1

The correct answer is B, 1 0 1 0.

18 of 20 – Question 6

Using the binary chart below, can you follow the pattern to work out the binary equivalent for denary 22?

|  |
| --- |
| Binary pattern |
| Place value 128 | Place value 64 | Place value 32 | Place value 16 | Place value 8 | Place value 4 | Place value 2 | Place value 1 |
| Denary number | 0 |  |  |  |  |  |  |  | 0 |
| 1 |  |  |  |  |  |  |  | 1 |
| 2 |  |  |  |  |  |  | 1 | 0 |
| 3 |  |  |  |  |  |  | 1 | 1 |
| 4 |  |  |  |  |  | 1 | 0 | 0 |
| 5 |  |  |  |  |  | 1 | 0 | 1 |
| 6 |  |  |  |  |  | 1 | 1 | 0 |
| 7 |  |  |  |  |  | 1 | 1 | 1 |
| 8 |  |  |  |  | 1 | 0 | 0 | 0 |
| 9 |  |  |  |  | 1 | 0 | 0 | 1 |
| 10 |  |  |  |  | 1 | 0 | 1 | 0 |

Choose one answer below:

1. 1 0 1 1 0
2. 1 0 0 0 1
3. 1 1 1 1 1
4. 1 0 1 1 1

The correct answer is A, 1 0 1 1 0.

19 of 20 – End

Well done. You have completed this session on analogue and digital data.

In this session we have covered:

* What is meant by analogue data
* What is meant by digital data
* What binary (notation) is
* How binary is used in technology

If you have any questions about any of these topics, make a note and speak to your tutor for more help.