

# **Data Representation**

**Numeric Data** 

**Computer Systems** 

## **Learning Intentions**



By the end of this lesson you will be able to:

- Represent positive integers in binary up to 32 bits
- Describe and use the two's complement system to represent negative integers
- Describe the range of the numbers that can be represented using the two's complement system
- Describe the relationship between the mantissa/exponent and the range/precision of a floating point number
- Represent a real number in floating point representation

#### Integers and Real Numbers



We will look at two types of numbers

- Integers
- Real Numbers

Integers are whole numbers, they have no decimal portions.

Real numbers are numbers that have a decimal portion.

#### **Decimal Numbers**



We use the **decimal**(denary) or base 10 system This means we have 10 digits: 0-9



Because of our ten fingers?

Computers use the binary or base 2 system
There are only two digits: 0 and 1
Each figure is known as a **bit**Binary dig**it** 



Off and On

#### **Decimal Numbers**



Lets look at how a decimal number is made up: 173

Hundreds	Tens	Units
1	7	3

Technically this is:

10 <sup>2</sup>	10 <sup>1</sup>	10 <sup>0</sup>
Hundreds	Tens	Units
1	7	3

### **Binary Numbers**



Lets look at how the same number is stored in binary: 1010 1101

128	64	32	16	8	4	2	1
1	0	1	0	1	1	0	1

This number is constructed as shown above.

These values come from:

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>
1	0	1	0	1	1	0	1

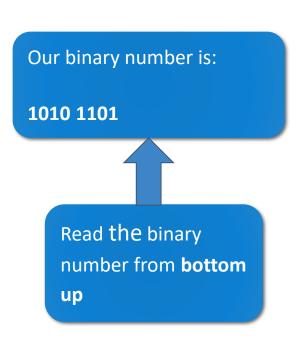
### **Converting decimal to binary**



Let's look at the same example:

173/2 = 86	r <b>1</b>
86/2 = 43	r <b>0</b>
43/2 = 21	r <b>1</b>
21/2 = 10	r <b>1</b>
10/2 = 5	r <b>0</b>
5/2 = 2	r <b>1</b>
2/2 = 1	r <b>0</b>
1/2 = 0	r <b>1</b>

Binary Number = **1010 1101** 



#### **How to convert from Binary**



1. Create your table with the values in the top

128	64	32	16	8	4	2	1
0	1	1	0	0	1	1	0

- 2. Insert your binary value into the table
- 3. Add the place values that have a binary 1 in them: 64+32+4+2 = 102

### Advantages of the Binary system



Less rules of arithmetic.

 This means that there are less operations to be programmed

0's and 1's are easier to represent digitally.

 Using magnetic media or pits/lands on CD's

Any drop in voltage does not affect the data.

 0 and 1 – There is either some signal or no signal

#### **Summary**



Binary only has **two** values— **0 & 1**A single 0 or 1 is known as a **bit**Binary Digit

The place values in binary start on the right at 1 and double every time going to the left.

#### **Advantages of Binary:**

- 1. There are less rules of arithmetic.
- 2. 0's and 1's are easier to represent.
- 3. Any drop in voltage doesn't effect data.