3 Data Representation

3.13 Numbering Systems

- An **integer** is any whole number.
  $\mathbb{Z} = \{\dots, -2, -1, 0, 1, 2, \dots\}$
- A **natural number** is a whole number that is used for counting.
  $\mathbb{N} = \{0, 1, 2, \dots\}$
- A **rational number** is any value that can be expressed as a fraction.
  $\mathbb{Q}$
- An **irrational number** cannot be expressed as a fraction, and has an endless series of non-repeating digits.

  An irrational number cannot be correctly represented using a finite number of digits, therefore a **rounding error** will occur.

A **real number** is any natural, rational or irrational number. The **set of real numbers** $\mathbb{R}$ is defined as the set of all possible real world quantities.

Ordinal numbers describe the numerical position of objects - first, second, etc.

- Natural numbers are used for **counting**.
- Real numbers are used for **measurement**.
- Ordinal numbers are used as **pointers** to a particular element in a sequence, or to define the position of something in a list.

Number Bases

- **Denary** uses the digits 0 through 9 and has a base of 10.
- **Binary** uses only the digits 0 and 1 and has a base of 2.
- **Hexadecimal** uses digits 0-9 and letters A to F and has a base of 16.

The numbering base can be written as a subscript 11_{16}.

The hexadecimal system is used as the **shorthand for binary**, since

- It is simple to represent a byte in just two digits.
- **Fewer mistakes** are likely to be made in writing a hex number than a string of binary digits.
- It is easier for computer users to **remember a hex number** than a binary number.

Colour codes often use hexadecimal to represent the RBG values, as their are easier to remember than a 24-bit binary string.