# Numbers and Computing

- Number – A unit of an abstract mathematical system subject to the laws of arithmetic.
- Natural number – The number 0 and any number obtained by repeatedly adding 1 to it.
- Negative number – A value less than 0, with a sign opposite to its positive counterpart.
- Integer – A natural number, a negative of a natural number, or zero

# Numbers and Computing

- Rational number – An integer or the quotient of two integers (division be zero excluded).
- Base – The foundational value of a number system, which dictates the number of digits and the value of digit positions.
- Positional notation – A system of expressing numbers in which the digits are arranged in succession, the position of each digit has a place value, and the number is equal to the sum of the products of each digits by its place value.

# Numbers and Computing

- If a number in base-R number system has n digits, it is represented as

$$d_n * R^{n-1} + d_{n-1} * R^{n-2} + ... + d_2 * R + d_1$$

$$943 = 9 * 10^2 + 4 * 10^1 + 3 * 10^0$$
$$943 = 9 * 100 + 4 * 10 + 3 * 1$$
$$943 = 900 + 40 + 3$$

# Numbers and Computing

- Our number system is base 10.
- The base could be any number.
- If the base is 13, the number 943 will be 1576 in base 10.
- Both numbers will represent the same number.

$$943 = 9 * 13^2 + 4 * 13^1 + 3 * 13^0$$
$$943 = 9 * 169 + 4 * 13 + 3 * 1$$
$$943 = 1521 + 52 + 3$$

# Numbers and Computing

- The base 2 (binary) number system is important in computing.
- Number systems that are powers of 2 such as base 8 (octal) and base 16 (hexadecimal) are also used.
- Base value specifies the number of digits in a system.
  - Base 10 – (0 – 9)
  - Base 2 – (0 – 1)
  - Base 8 – (0 – 7)

# Numbers and Computing

- The number 943 would not exist in any base less than base 10 since the digit 9 does not exist in those bases.
- In bases higher than 10, symbols are used to represent decimal values 10 and beyond.
- The 16 digits in the base 16 are:
  - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

# Numbers and Computing

- Decimal equivalent of 754 in octal (base 8)
- $7 * 8^2 + 5 * 8^1 + 4 * 8^0 = 448 + 40 + 4 = 492$
- Decimal equivalent of 1010110 in binary

$$
\begin{aligned}
1010110 &= 1 * 2^6 + 0 * 2^5 + 1 * 2^4 + 0 * 2^3 + 1 * 2^2 + 1 * 2^1 + 0 * 2^0 \\
&= 1 * 64 + 0 * 32 + 1 * 16 + 0 * 8 + 1 * 4 + 1 * 2 + 0 * 1 \\
&= 64 + 0 + 16 + 0 + 4 + 2 + 0 \\
&= 86
\end{aligned}
$$

# Numbers and Computing

| Binary | Octal | Decimal |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 1 | 1 |
| 10 | 2 | 2 |
| 11 | 3 | 3 |
| 100 | 4 | 4 |
| 101 | 5 | 5 |
| 110 | 6 | 6 |
| 111 | 7 | 7 |
| 1000 | 10 | 8 |
| 1001 | 11 | 9 |
| 1010 | 12 | 10 |

# 8, 16, 32, 64 bit computers

- Computers are binary machines – store either 0 or 1.
- A storage unit is called a bit.
- Bytes – a group of 8 bits.
- Words – a group of bytes.
- Length of a word is the word length of the computer.
- PCs started as 8 bit systems. Nowadays 64 bit systems are getting more and more common.

# Graphics

- Computers used CRTs as displays from 1960s.
- Vector graphics composed of thin lines.
- Pixel based raster displays became dominant.
- Original IBM PC could display only text.
- VGA, SVGA standards.
- Line drawing to complex 3D imagery – real time ray-tracing getting closer.

# Multimedia

- Research on computer generation of music.
- Combine graphics, audio and animation.
- Growth of Interactive CD-ROMs.
- Increasing sophistication of Sound Cards.
- Real-time multimedia presentations.
- Interactive multimedia – hypermedia.

# Networking

- From large single machines to smaller machines which are connected together.
- The Ethernet – 1973 and still going strong.
- Rise of file servers and LANs.
- ARPANET – packet switching to share lines.
- TCP/IP and friends.
- The Internet.

# Capabilities and Limitations

- Not truly intelligent.
- Can only follow instructions.
- Limits imposed by hardware.
  - Speed, size etc.
- Limits imposed by software.
  - Algorithmic limits etc.
- Will be discussed in detail later.

Thank You.