Tutorial: Data representation

Aim

The aim of this tutorial is for students to be able to confidently convert between binary, decimal and hexadecimal. Note for exams and assignments you may be asked to show working, so that will be an important part of this tutorial.

Questions

1. Show how the following integers can be represented as 8-bit (unsigned) binary integers:

a) 37
b) 89
c) 4
d) 126
e) 298

2. Determine the decimal value of the following (unsigned) binary integers:

a) `0b1100`
b) `0b100100`
c) `0b11111111`

3. How many bits are required to represent the following decimal numbers as unsigned binary integers?

a) 12
b) 147
c) 384
d) 1497
e) 2048

4. What are the hexadecimal representations of the following integers?

a) 67
b) 142
c) 1348

5. What are the decimal values of the following hexadecimal numbers?

a) `0x1B`
b) `0xA7`
c) `0x8CE`

6. Convert `0b10111110100111001000` to hexadecimal.

7. Convert `0xB25D6` to binary.
8. Determine the following sums:

a) `0b11000100` + `0b00110110`
b) `0b00001110` + `0b10101010`
c) `0b11001100` + `0b00110011`

9. Multiply the following integers and express the result using 8 bits:

a) `0b1001` x `0b0110`
b) `0b1111` x `0b1010`
c) `0b0101` x `0b1010`

10. Convert the following decimals to 8-bit sign magnitude representation:

a) 23
b) -23
c) -48
d) -65

11. Determine the two's complement representation for the quantities in the previous question (Q10).
12. Which numbers are represented by the following single precision floating point (IEEE 754) values?

a) `1 10000010 01010100000000000000000`
b) `0 10001000 10010000001000000000000`

13. Represent the following as a single precision floating point (IEEE 754) number:

a) 1024.0
b) -4.75

14. What is the `ASCII` code (hex) for the following characters?

a) `3`
b) `f`
c) `&`
d) `;`

15. Represent the following Unicode code points in UTF-8 encoding using hexadecimal notation:

a) `U+0043` LATIN CAPITAL LETTER C
b) `U+1F305` SUNRISE
c) `U+00F3` LATIN SMALL LETTER O WITH ACUTE

Extension tasks

1. Explore how numbers and other data are represented in a programming language you are currently learning or using. Are there maximum/minimum values?
2. Write a program in a language of your choice to convert a number between bases.