Data, Logic, and Computing

ECS 17 (Winter 2024)

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Homework 2 - For 1/24/2024

Exercise 1 *(10 points)*

Assuming that there are 149,878 characters in the UNICODE, and that each character is represented with the same number of bits, what is the minimal number of bits needed to store a word with 8 characters using this code?

Let us check first how many bits are needed to store one character in the UNICODE. We can store 2^N natural numbers on N bits. Therefore we want $2^N \geq 149878$, which gives us $N \geq 18$ (note that 17 is not enough, and while 20 would also work, it would not give us the minimum number of bits). The minimal number of bits needed to store a word with 8 characters is therefore $8 \times 18 = 144$.

Exercise 2 *(4 questions, 2.5 points each; total 10 points)*

- *What is the binary representation of the hexadecimal 7A?*

  #7A = $(1111010)_2$

- *What is the hexadecimal representation of the binary number 1100111?*

  $(1100111)_2$ = #67

- *How many bits are there in 22 bytes?*

  A byte contains 8 bits; therefore, there are 176 bits in 22 bytes.

- *What is the largest signed integer that can be stored in one byte?*

  One byte contains 8 bits, but one of those bits is associated with the sign of the integer. Therefore the largest signed integer is $(01111111)_2$, which is 127.

Exercise 3 *(10 points)*

How much space would you need to store a 5 min song that has been sampled at 44.1 kHz, with each data point stored on 16 bits, in stereo (assume no compression).

5 (min) x 60 (seconds/min) x 44,100 (points/second) x 2 (16bits=2bytes) x 2 (stereo) =52,920,000 bytes.

Exercise 4 *(4 questions, 2.5 points each; total 10 points)*

- *Let A be the binary number 1100110 and B the binary number 11100010; find the binary number C that satisfies $A + C = B$.*

  We proceed in 3 steps:

  a) Compute the decimal representation of A and B:
  $A = (1100110)_2 = 102$
  $B = (11100010)_2 = 226$

  b) Solve $A + C = B$
  $C = B - A = 124$

  c) Compute the binary representation of C:
  $C = (1111100)_2$

- *Let A be the hexadecimal number #3FF and B the hexadecimal number #F3F; find the hexadecimal number C that satisfies $A + C = B$.*

  We proceed in 3 steps:

  a) Compute the decimal representation of A and B:
  $A = \#3FF = 1023$
  $B = \#F3F = 3903$

  b) Solve $A + C = B$
  $C = B - A = 2880$

  c) Compute the hexadecimal representation of C:
  $C = \#B40$

- *Let A be the hexadecimal number #3FF and B the binary number 10000000000; find the hexadecimal number C that satisfies $A + C = B$.*

  We proceed in 3 steps:

  a) Compute the decimal representation of A and B:
  $A = \#3FF = 1023$
  $B = (10000000000)_2 = 1024$

  b) Solve $A + C = B$
  $C = B - A = 1$

  c) Compute the hexadecimal representation of C:
  $C = \#1$

- *Let A be the binary number 1000000000 and B the hexadecimal number #226; find the binary number C that satisfies $A + C = B$.*

  We proceed in 3 steps:

  a) Compute the decimal representation of A and B:
  $A = (1000000000)_2 = 512$
  $B = \#226 = 550$

b) Solve $A + C = B$
$C = B - A = 38$

c) Compute the binary representation of C:
$C = (100110)_2$