CS 270 Lecture 1

Outline

- Review General Information Sheet (Handout)
- Overview of the Course
- Data Representation

Overview of Course

- Data Representation
- Introduction to Computer Organization
- Assembler Programming in MIPS
- C and Unix Programming

Data Representation

- Represent Data in Binary
  - Place-Valued Number Systems
    - Integers
    - Real Numbers (Floating Point)
    - Characters
    - Other data

Place-ValuesNumber Systems

- Also known as Positional Number Systems
- Base or Radix
- Digits
  - Base N requires N distinct digits
  - One of the digits will be 0 (or equivalent to 0)

Base 10

- 10 Digits
  - 0,1,2,3,4,5,6,7,8,9

Base 10

- Consider the base 10 number 7438
- This number (sequence of digits) represents
  - $7*10^3 + 4*10^2 + 3*10^1 + 8*10^0$
  - 7000+400+30+8 = 7438
-

Base 10

- Consider the base 10 number 273.61
- This number (sequence of digits) represents
  - $2*10^{2} + 7*10^{1} + 3*10^{0} + 6*10^{-1} + 1*10^{-2}$
  - $200 + 70 + 3 + 0.6 + 0.01 = 273.61$

Place-Valued Number Systems

- General Pattern for a base b number
- b digits
  - $d_0, d_1, \ldots, d_{b-1}$
- The first digit to the left of the decimal point (binary point…) is position 0
- Positions increase by 1 moving to the left and decrease by 1 moving to the right
- Consider the base b number $d_4d_0d_5.d_3d_4$
- The sequence of digits represents (using base 10 digits for the exponents)
- $d_4*b^2 + d_0*b^1 + d_5*b^0 + d_3*b^{-1} + d_4*b^{-2}$

Place-Valued Notation

- Most common bases used in computer science
  - Base 2 (binary)
  - Base 8 (octal)
  - Base 10 (decimal)
  - Base 16 (hexadecimal)

Base 2

- Two Digits
  - 0 and 1
- Consider the base 2 number 100111
- This number represents
  - $1*2^5 + 0*2^4 + 0*2^3 + 1*2^2 + 1*2^1 + 1*2^0$
- Since there are only two digits it is common to write the above expression using only the powers of 2 that are multiplied by 1
  - $2^5 + 2^2 + 2^1 + 2^0$
- This represents to base 10 number
  - $32 + 4 + 2 + 1 = 39$
- To indicate the base of a number a subscript is sometimes used at the end of the number
  - 100111_2

Base 8

- Eight digits
  - 0, 1, 2, 3, 4, 5, 6, 7
- Consider the base 8 number 5072
- The number represents
  - $5 * 8^3 + 0 * 8^2 + 7*8^1 + 2*8^0$
- The is equivalent to the base 10 number
  - 5 * 512 + 0 * 64 + 7 * 8 + 2 * 1 = 2618

Base 16

- Sixteen digits
- Consider the base 16 number B74D
- This number represents
  - $B*16^3 + 7*16^2 + 4*16^1 + D*16^0$
  - $11*16^3 + 7*16^2 + 4*16^1 + 13*16^0$
- This is equivalent to the base 10 number
  - $11*4096 + 7*256 + 4*16 + 13*1 = 46925$

Base 10	Base 2	Base 8	Base 16
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F

Conversion Problems

- Convert between bases
- For example given the base 2 number 11001001 find the equivalent base 10 and base 16 number
- Base 10
  - 201
- Base 16
  - C9

Convert Base 2 to Base 16

- last4Bits(X)
  - last4Bits(11001101)
    - 1101
- bitsExcludingLast4(X)
  - bitsExcludingLast4(11001101)
    - 1100

Convert base 2 to base 16

- concatenate(A, B)
  - concatenate(6, 547)
    - 6547
- base16Digit(X)
  - base16Digit(1100)
    - C

Algorithm to Convert Base 2 to Base 16

Let X be a string of 0s and 1s that is the base 2 representation of the number we want to convert to base 16
B = “” (the empty string)
while X != “”
    Y = last4Bits(X)
    Z = base16Digit(Y)
    B = concatenate(Z, B)
    X = bitsExcludingLast4(X)
B is the base 16 representation of the original X

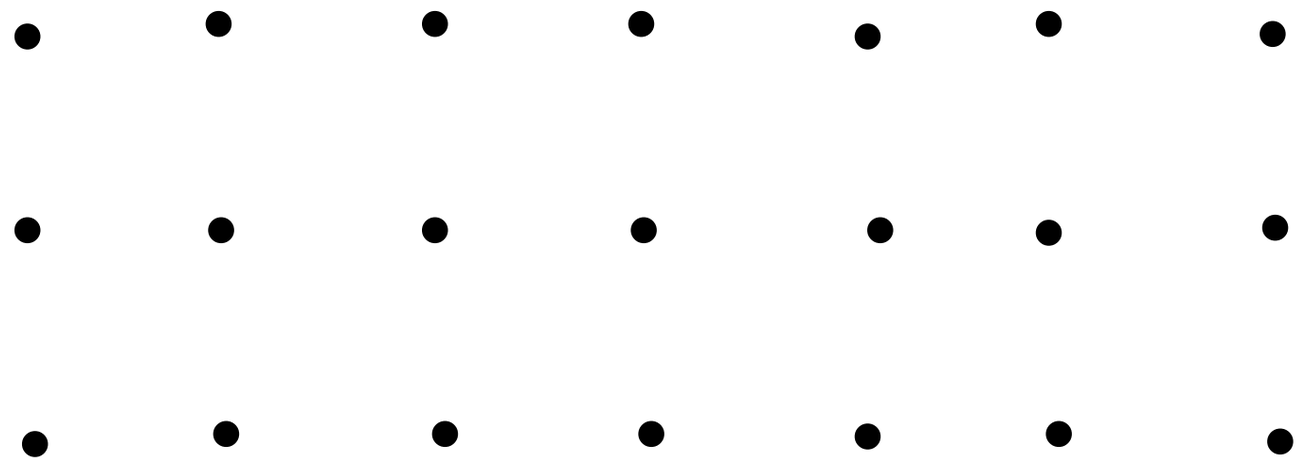
Algorithm to convert base 10 representation to binary representation

Let X be the base 10 integer we want to convert to base 2
B = “”
while X != 0
    Y = X / 2 (integer quotient)
    Z = X % 2
    B = concatenate(Z, B)
    X = Y
B is now the binary representation of the original value of X

Practice Problems

- Convert the following base 10 numbers to base 2
  - 27
  - 43
  - 80
- How can you check your answer?

How Many Dots?



10101_2 25_8 21_{10} 15_{16}