Introduction to Informatics

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Course 04

Revision

- How many different numbers can be stored in eight bits?
- How can we represent the sign bit, and what is its position?
- How can we get the one's complement of the negative number?
- How can we calculate the excess 2^{n-1}?
- How can we get the packed BCD code of the number?
- What is the excess in IEEE 754 floating point representation?
- Who knows the formula of IEEE 754 floating point representation?

Revision – Exercise

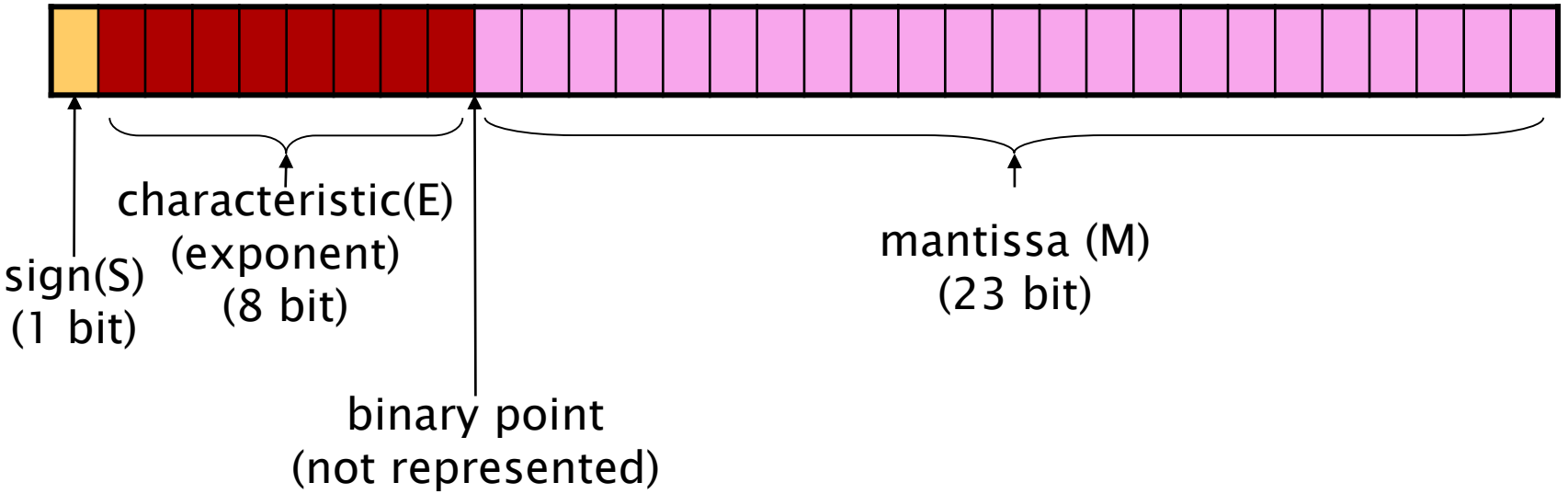
- Represent the given decimal numbers in 8 bits with the following fixed-pointed methods.
  - sign-and-magnitude
  - 1's complement
  - 2's complement
  - excess 127
  - excess 128

  +45, -45
- Represent the given decimal numbers in 16 bits with the following fixed-pointed methods.
  - sign-and-magnitude
  - 1's complement
  - 2's complement
  - excess 2^{15} -1
  - excess 2^{15}

  +1234, -1234
- Define the packed BCD code of the following numbers (with negative numbers use the nine's and ten's complement).

  +5648, -5648

Floating point representation IEEE 754



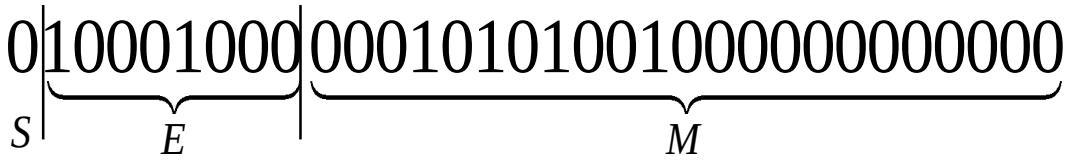
- normalized in binary number system
- normalized to ineger
- characteristic: excess-127
- sign
  - positive number: 0
  - negative number: 1

$$N = (-1)^S \cdot \left(2^{E-127}\right) \cdot (1.M)$$

IEEE 754 standard

Type	Number of bits	Sign bit	Characteristic	Mantissa
single	32	1	8 bit Excess-127	23 bit
double	64	1	11 bit Excess -1023	52 bit

Exercise



- S = 0
- E = 1000 $1000_{(2} = 136_{(10}$
- M = .00010101001$_{(2}$ = .082519531$_{(10}$
- Number = $1.082519531 \cdot 2^9 = 554.25$

Exercise

$$554.25_{(10} = 1000101010.01_{(2} = 1.00010101001 \cdot 2^{9}$$

- S = 0
- E = 127+9= $136_{(10}$=1000 $1000_{(2}$
- M = $.00010101001_{(2}$

$$0100\,0100\,0000\,1010\,1001\,0000\,0000\,0000$$

4 4 0 A 9 0 0 0

Exercise

- Which numbers were represented with the IEEE 754 floating point standard?
  - 01000011000010100000000000000000
  - 11000100100011001010000000000000

Exercise

- Represent the following decimal numbers in 32 bits using the IEEE 754 floating point standard.
  - $987_{(10}$
  - $-203.625_{(10}$

Floating point number representation with excess characteristic

- Represent $148_{(10}$ number in octal system.
  - starting with sign bit
  - the exponent will be 1 digit (in 3 bits), excess-4
  - the fraction part 3 digits

$$148_{(10} = 224_{(8} = 0.224 \cdot 8^3$$

$$0\,1\,1\,1\,0\,1\,0\,0\,1\,0\,1\,0\,0$$

$$0 \quad 7 \quad 2 \quad 2 \quad 4$$

Floating point number representation with excess characteristic

- Represent $1048_{(10}$ number in hexadecimal system.
  - starting with sign bit
  - the exponent will be 1 nibble (4 bits), excess-8
  - the fraction part 4 digits

$$1048_{(10} = 418_{(16} = 0.4180 \cdot 16^3$$

$$\begin{array}{cccccccccc} 0 & 1 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & & B & & & 4 & & & 1 & & & 8 & & & 0 & & & & \end{array}$$

Exercise

- Represent the following numbers in octal system.
  - starting with sign bit
  - the exponent will be 1 digit (3 bits), excess-4
  - the fraction part 4 digit

  a. $-62_{(10}$
  b. $302_{(10}$

- Represent the following numbers in hexadecimal system.
  - starting with sign bit
  - the exponent will be 1 digit (4 bits), excess-8
  - the fraction part 4 digit

  a. $2561.5_{(10}$
  b. $-44621_{(10}$