Bits, Bytes and Intergers

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Outline

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Binary

transformation between bin and dec

- $255_{10} \rightarrow 11111111_2$
- $1010110_2 \rightarrow (2^6 + 2^4 + 2^2 + 2^1)_{10}$
- $0.25_{10} \rightarrow 0.01_2$
- $1.01001_2 \rightarrow (2^0 + 2^{-2} + 2^{-5})_{10}$

transformation between bin and oct, bin and hex

- very easy!

Bit Operations

- Intersection (true if both true)

  &

- Union (true if either true)

  |

- Symmetric difference (true if different)

  ^

- Complement (true if false)

  ~

- Shift

  << >>

Comparision with Logical Operations

- p && *p
- shell commands
  - ||
  - &
  - &&
  - ;

Shift Operations

Left Shift

$x << k$

Right Shift

$x >> k$

- Logical (0)
- Arithmetic (same bit)
  Why?

Outline

Bytes

1 Byte = 8 bits

- Why?
- Expressed by hex numbers

Data Representations

- char 1
- int 4
- float 4
- double 8

Outline

Encoding

- unsigned

$$B2U(X) = \sum_{i=0}^{w-1} x_i 2^i$$

- int

$$B2T(X) = -x_{w-1} \cdot 2^{w-1} + \sum_{i=0}^{w-2} x_i 2^i$$

  ps. same for the non-negative numbers

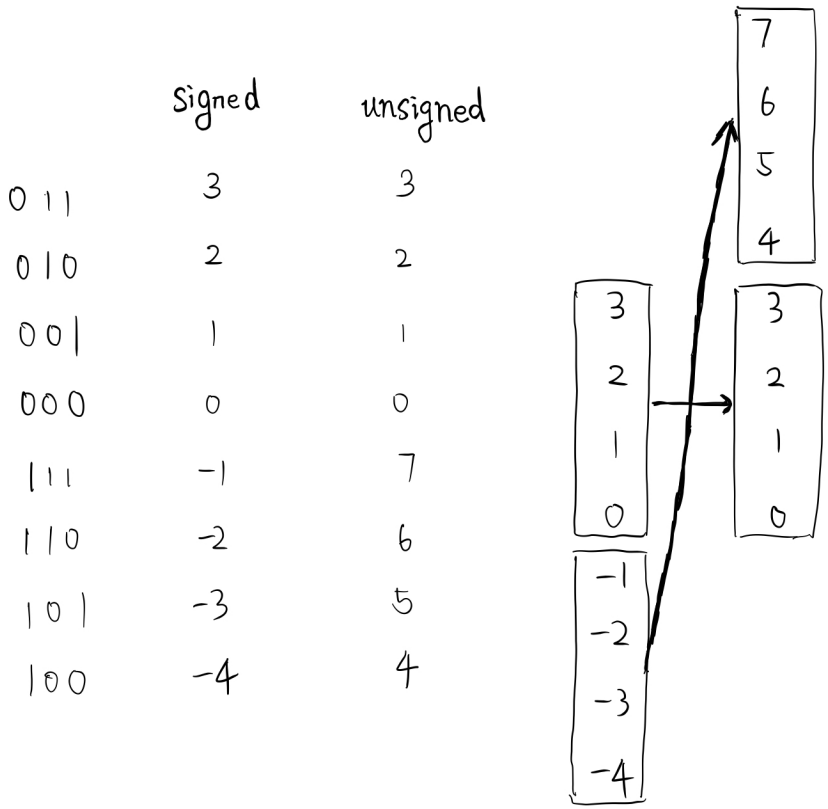
- Obviously, 1 for negative numbers and 0 for non-negative numbers
- Only 1 for 0 (different from float numbers)

Encoding

- Why?
- Logical right shift and arithmetic right shift
  - for non-negative numbers, it is obvious
  - for negative numbers, without consideration about overflow
    - left shift, Logical
    - right shift, Arithmetical

Conversion

- signed and unsigned are compared in unsigned format
- keep bit representations and reinterpret
- some mistakes
- $\pm 2^w$ for a w-bit number



Expanding and Truncating

Expand

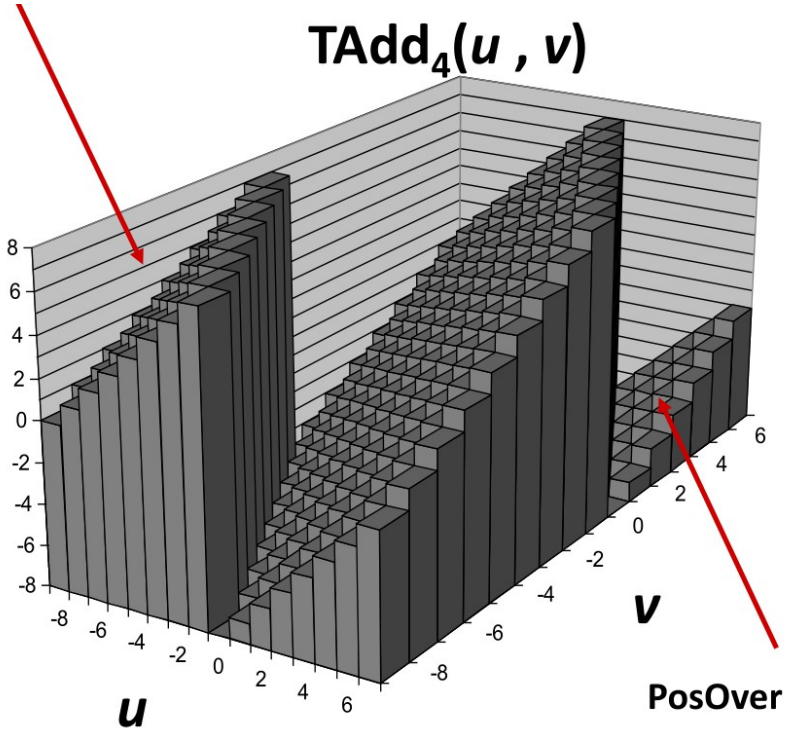
- unsigned: expand 0
- signed: expand sign
- both keep the same result

Truncate

- bits
- reinterpret

Addition

- Two's Complement Addition and Unsigned Addition are the same
- Overflow
  - unsigned: mod
  - signed: NegOver and PosOver

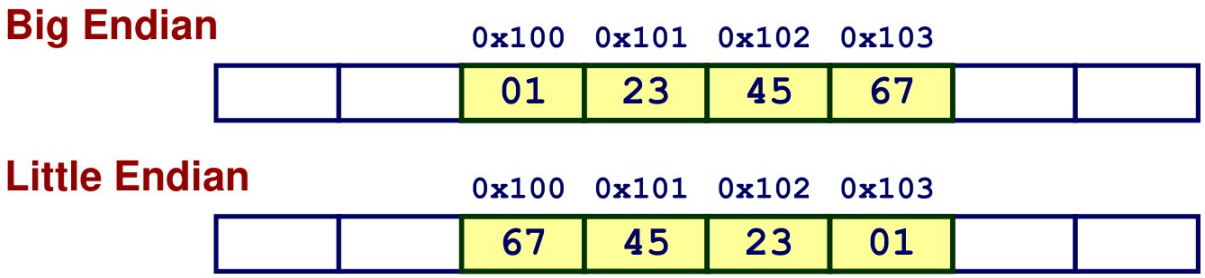


tips for unsigned

- Care about overflow
- Used in mod arithmetic
- To represent sets (dp)

Others

- pointer
- byte ordering



Outline

Exercise

2014.2

假设有下面 x 和 y 的程序定义

```
int x = a » 2;
int y = (x + a) / 4;
```

那么有多少个位于闭区间 [-8,8] 的整数 a 能使得 x 和 y 相等? (　　)

A. 12　　B. 13　　C. 14　　D. 15

Exercise

2016.1

C 语言中的 int 和 unsigned 类型的常数进行比较时，下列表达式及描述正确的是：(注：位宽为 32 位，T MIN =-2,147,483,648，T MAX =2,147,483,647)

A. 0 == 0U，按有符号数进行比较

B. 2147483647U > -2147483647-1，按无符号数进行比较

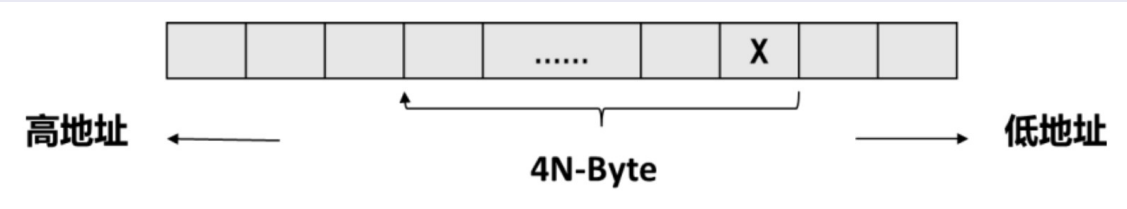
C. (unsigned)-1 < -2，按无符号数进行比较

D. 2147483647 > (int)2147483648U，按有符号数进行比较

Exercise

2017.1

假定一个特殊设计的计算机，将 int 型数据的长度从 4-Byte 扩展为 4N-Byte，采用大端法（Big Endian）。现将该 int 型所能表示的最小负数写入内存中，如下图所示。其中每个小矩形代表一个 Byte，请问 X 位置这个 Byte 中的值是多少?
(请写出各个 Byte 的值)



$A.00000000_2$ $B.01111111_2$ $C.10000000_2$ $D.11111111_2$

Exercise

CMU 2010.2

In two's compliment, what is $-$TMin?

(a) Tmin

(b) Tmax

(c) 0

(d) -1

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