### Computer Organization & Architecture

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## Data Representation & Computer Arithmetic

- What is Data Representation?
- Why is required?

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## Data Representation in Computer Systems

- ullet Representation of a number in a computer system o string of bits.
- Various types of number representation techniques for digital number representation
  - Binary number system
  - Octal number system
  - Decimal number system
  - Hexadecimal number system
- Digital Computers use Binary number system to represent all types of information inside the computers.
- Computer memory location merely stores a binary pattern.
- A byte is a group of eight bits
  - It is the smallest possible addressable unit of computer storage
- A word is a contiguous group of bytes.
  - Word sizes (length) of 16, 32, or 64 bits are most common.

## Binary Number Representations for Integers

- Two types of Integers:
  - Unsigned Integers: 0/ +ve.
  - Signed Integers: 0/+ve/-ve
- Three representation schemes had been proposed for signed integers:
  - Sign-Magnitude representation:  $-(2^{(k-1)}-1)to(2^{(k-1)}-1)$ , for k bits.
  - ② 1's Complement representation:  $-(2^{(k-1)}-1)to(2^{(k-1)}-1)$ , for k bits.
  - 3 2's Complement representation:  $-(2^{(k-1)})to(2^{(k-1)}-1)$ , for k bits.

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## Signed Number Representation

- Positive values have identical representations in all systems, but negative values have different representations.
- In all the three schemes, the most-significant bit (msb) is called the sign bit.
  - represent the sign of the integer: 0 for positive integers and 1 for negative integers.
- The magnitude of the number is interpreted differently in different schemes.

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Derinal

Unsigned

Snm

1,0

2'1

# Example

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## Addition of Unsigned Integers

• Add bit pairs starting from the low-order (right) end of the bit vectors, propagating carries toward the high-order (left) end.

- Example:
- Note: Only overflow can occur
- Can we subtract unsigned number?

## Addition of Signed Integers

- Add the values and discard any carry-out bit.
- The sum will be the algebraically correct value if within the range.

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## Subtraction of Signed Integers

 $\bullet$  To perform X - Y , form the 2's-complement of Y , then add it to X using the add rule.

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$$-\frac{1001}{(-7)} \frac{(-7)}{0100} + \frac{1011}{0100}$$

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ADDITION: 
$$+ (+B) = -(-B) + (-B) = +(-B)$$

(9) 
$$-7$$
 1001 (b)  $(+7)$   $+(+4)$ 

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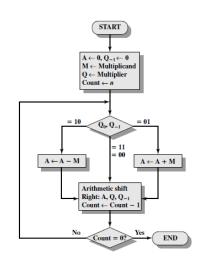
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## Booth's Multiplication Algorithm



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