

# Chapter 4



## *Operations On* *Data* 資料運算

4.1 Source: Foundations of Computer Science © Cengage Learning

### Objectives 學習目標

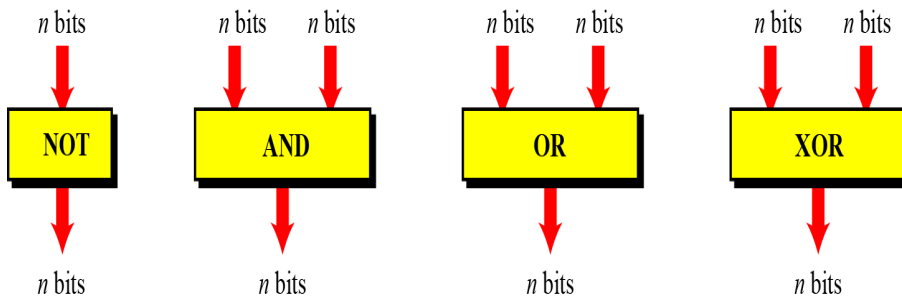
After studying this chapter, students should be able to:

- List the three categories of operations performed on data. 三類資料運算
- Perform **unary**單元 and **binary**二元 **logic operations** on bit patterns.
- Distinguish between **logic shift operations**邏輯移位運算 and **arithmetic shift operations**算術移位運算.
- Perform **logic shift operations on bit patterns**.
- Understand **some applications** of logic and shift operations such as setting, unsetting, and flipping bits.算術與邏輯移位應用
- Perform **addition and subtraction operations** on integers when they are stored in **two' complement** format. 2的補數之加減法

4.2

## Logic Operations at Pattern Level

### 二進位樣式層級之邏輯運算



4.3

## Applications

The four logic operations can be used to modify a bit pattern.

- Complementing** 1的補數 (NOT)
- Unsetting/Clear** 設定為0 (AND)
- Setting** 設定為1 (OR)
- Flipping** 翻轉 (XOR)

4.4

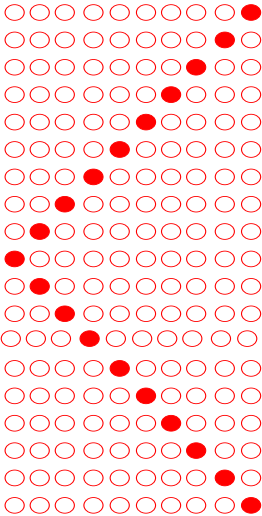
# Shift Operations 移位運算

**Shift operations** move the bits in a pattern, changing the positions of the bits. They can move bits to the left or to the right可左移或右移幾個位元. We can divide shift operations into **two categories**兩大類:

**logical shift operations**邏輯移位運算 and **arithmetic shift operations**算術移位運算.

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## Logical Right/Left Shift Operations 邏輯左移/右移運算



4.6

## Arithmetic Shift Operations 算術移位運算

Arithmetic shift operations assume that the bit pattern is a signed integer in two's complement format. Arithmetic right shift is used to divide an integer by two 右移1位為原值除以2, while arithmetic left shift is used to multiply an integer by two 左移1位為原值乘以2.

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## Arithmetic Operations 算術運算

### Addition and Subtraction of Two's Complement Integers

**Addition**

$$A + B$$

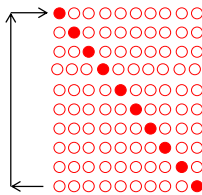
**Subtraction**

$$A - B \leftrightarrow A + (\overline{B} + 1)$$

4.8

## Review Questions

- Given two numbers **5AH** and **E2H**, please show the respective result after 8-bit AND, OR, and **XOR** operations.
- Given a number **112**, how to do operations to get the number **14**.
- Given a 8-bit binary (b7~b0), how to know b5 is 0 or 1?
- Given a number **9**, how to do operations to get the number **144**.
- Show the detailed operations in a computer for **53D-101D** using 8-bit two's complement.
- How to do operations to get the following function.



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