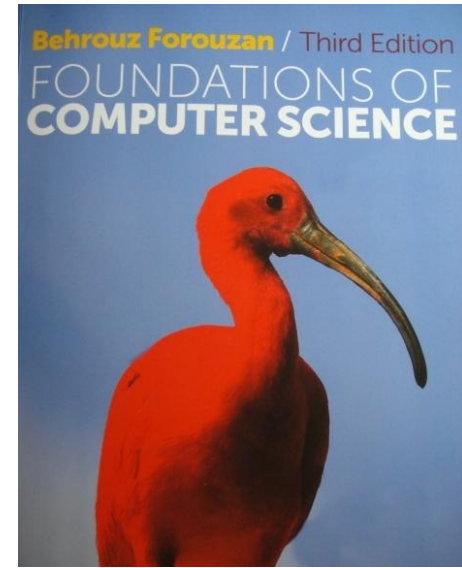


Chapter 3

Data

Storage



Objectives

After studying this chapter, students should be able to:

- ❑ List five **different data types used in a computer**.
- ❑ Describe how **integers** are stored in a computer using unsigned, sign-and-magnitude, and two's complement formats.
- ❑ Describe how **reals** are stored in a computer using floating-point format.
- ❑ Describe how **text** is stored in a computer using one of the various encoding systems.
- ❑ Describe **how audio is stored in a computer** using sampling, quantization, and encoding.
- ❑ Describe **how images are stored in a computer** using raster and vector graphics schemes.
- ❑ Describe **how video is stored in a computer** as a representation of images changing in time.

Example

Show the single-precision (excess_127) floating-point representation of the decimal number **5.75**.

Solution

1. The sign is positive, so $S = 0$.
2. Decimal to binary transformation: $5.75 = (101.11)_2$.
3. Normalization: $(101.11)_2 = (1.0111)_2 \times 2^2$.
4. $E = 2 + 127 = 129 = (10000001)_2$
5. $M = 0111$ and we need to add nineteen zeros at the right of M to make it 23 bits.
6. The presentation is shown below:

0 10000001 011100000000000000000000

Standards of Storing Text

□ **ASCII (American Standard Code of Information Interchange): Using 7 bits for each symbol**

Extended ASCII: Using 8 bits for each symbol

□ **Unicode: Using 32 bits to represent up to 2^{32} symbols** (including graphical and special symbols).

Unicode is suitable for the communication in multiple languages. ASCII and extended ASCII are parts of Unicode.

□ **Other Codes:** such as **big-5 code**, ...

功 (0xA55C) 育 (0xA87C) 許 (0xB35C)

Standard for Storing Audio

MP3 (MPEG Layer 3) uses **44100 samples per second** and **16 bits per sample**. The result is a signal with a bit rate of **705,600 bits per second**, which is compressed using a compression method that discards information that cannot be detected by the human ear.

Other codes:

WMA is lossy compression that was developed by Microsoft.

WV is lossless compression for stream tech. that was developed by David Bryant.

WAV is no any compression that was developed by Microsoft and IBM.

Standards for Storing Image in Raster Graphics

JPEG (Joint Photographic Experts Group) uses the True-Color scheme, but compresses the image to reduce the number of bits (see Chapter 15).

GIF (Graphic Interchange Format), on the other hand, uses the indexed color scheme.

Softwares: Photoshop, PhotoImpact, Corel Painter

Summary of File Formats Used for Bitmap Data

BMP (Bitmap): It is a standard bitmap in Windows. No any compression and True color (24-bit).

JPEG: or rather the JFIF file format, which is mainly used for internet graphics. Lossy compression and True color.

GIF (Graphics Interchange Format): mainly used for internet graphics. Lossless compression and Indexed color (8-bit).

TIFF (Tagged Image File Format): a popular and versatile bitmap file format. Lossless compression and True color.

PNG (Portable Network Graphics): Lossless compression and True color.

EPS: a flexible file format that can contain both bitmap and vector data. It is gradually being replaced by PDF.

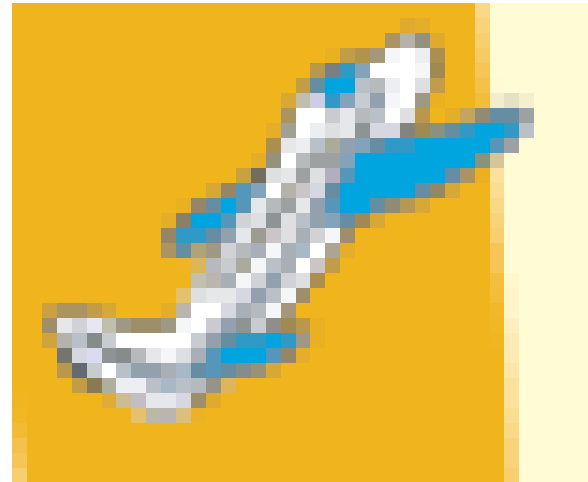
PSD: the native file format of Adobe PhotoShop.

UFO: the native file format of Adobe PhotoImpact.

PICT: file format that can contain both bitmap and vector data but that is mainly used on Macintosh computers and is not very suitable for prepress.

Weakness of Raster Graphics

Raster graphics has two disadvantages: **the file size is big** and **rescaling is troublesome**. To enlarge a raster graphics image means enlarging the pixels, so the **image looks ragged when it is enlarged**.

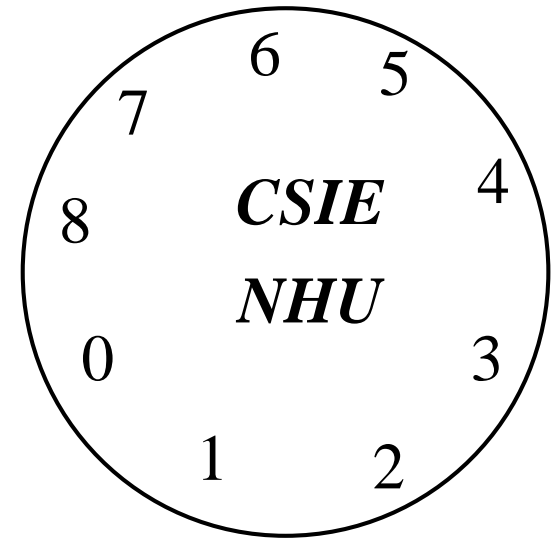
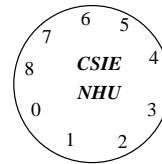


Vector Graphics

The **vector graphic** image encoding method, however, does not store the bit patterns for each pixel. **An image is decomposed into a combination of geometrical shapes** such as lines, squares or circles.

For example, **consider a circle of radius r** . The main pieces of information a program needs to draw this circle are:

1. The radius r and equation of a circle.
2. The location of the center point of the circle.
3. The stroke line style and color.
4. The fill style and color.



Softwares: Illustrator, CorelDRAW, Flash

Summary of File Formats Used for Vector Data

EPS: a flexible file format that can contain both bitmap and vector data. It is gradually being replaced by PDF.

PDF: versatile file format that can contain just about any type of data including complete pages.

PSD: the native file format of Adobe Photoshop.

AI: the native file format of Adobe Illustrator.

CRD: the native file format of CorelDRAW.

Storing Video

Video is a representation of images (called frames) over time. In other words, Video is the representation of information that changes in space (single image) and in time (a series of images).

Standards of Analog TV

NTSC (National Television System Committee, 1953 by USA):

525 lines per frame and 29.97 fps. (Taiwan 1960~2012)

PAL (Phase Alternating Line, 1963 by German): 625 lines per frame and 25 fps.

SECOM (Sequential Color with Memory, 1966 By Frenchman): 625 lines per frame and 25 fps.

Standards of Digital TV

ATSC (Advanced Television Systems Committee, by USA):

Video-MPEG-2 and Audio-Dolby AC-3.

DVB-T (Digital Video Broadcasting, by Europe): Video-MPEG-2 and Audio-MPEG-2. (Taiwan 2012/7~)

ISDB-T (Integrated Services Digital Broadcasting, by Japan):

Video-MPEG-2 and Audio-MPEG-2.

DTMB (Digital Terrestrial Multimedia Broadcasting, by China):

Video-no assignment and Audio-no assignment.

Standards of Digital Video Compression

MPEG-2 (1994): SD resolution **720x480**, low compression rate for DTV broadcasting.

MPEG-4 (1998): HD resolution **1280x1024**, medium compression rate for Mobile video broadcasting.

H.264 / MPEG-4 AVC (2003): Full HD resolution **1920x1080**, high compression rate for Portable cellphone & DTV.

Review Questions

- $111011011_{(2)} = \underline{\hspace{2cm}}_{(10)}$ $111011011_{(2's)} = \underline{\hspace{2cm}}_{(10)}$
- $-113D = \underline{\hspace{2cm}}B$ (8-bit sign-and-magnitude)
 $= \underline{\hspace{2cm}}B$ (8-bit two's complement)
- $-37.125D = \underline{\hspace{4cm}}$.
(IEEE 32-bit floating-point number)
- Please show the range of d a decimal number represented in 8-bit two's complement.
- Describe how text is stored in a computer.
- Describe how image is stored in a computer.
- Describe how audio is stored in a computer.
- Describe how video is stored in a computer.
- Please list each represented application for storing text, audio, and image.