Structured Programming

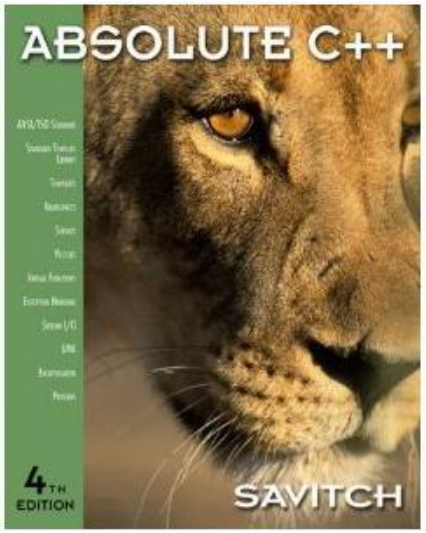
Course – Information

- **Structured Programming – C++**
- **(3 hour lecture + 2 hour lab) a week.**
- **Assessment (100)**

Year Work 10% (During the term)
Mid Term Exam 10% (Week 8)
Practical Examination 10% (Week 15)
Final Exam 70% (Week 16)

Course – Text Book and References

- **Absolute C++,** 4th edition, Walter Savitch, Addison Wesley, 2009.



- **C++ How to program, 7**th edition, Deitel and Deitel Pearson, 2010.

- **References**: ENDLESS list.

Course – Outline

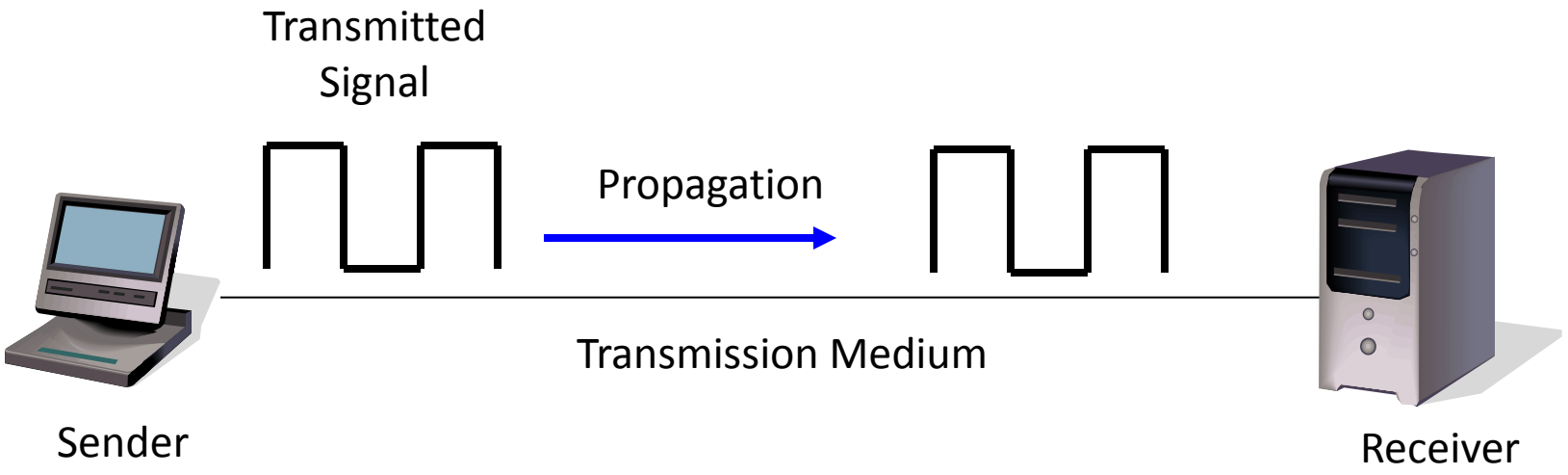
1. Introduction
2. Basics
3. Control Structures
4. Introducing Data Types and Operators
5. Creating Conditional Statements
6. Creating Iteration Statements
7. Functions
8. Recursion
9. Parameters, Overloading, and Reference
10. Arrays
11. Strings
12. Structures
13. Streams and File I/O

Binary-Encoded Data

- Computers store and process data in binary representations
  - Binary means “two”
  - There are only ones and zeros
  - Called bits

11010101100011101011100111

Binary representation of data



Binary-Encoded Data

- Non-Binary Data Must be Encoded into Binary
  - Text
  - Integers (whole numbers)
  - Decimal numbers
  - Alternatives (North, South, East, or West, etc.)
  - Graphics
  - Human voice
  - etc.

Hello ⟶ 11011001…

Binary-Encoded Data

- Some data are inherently binary
  - 48-bit Ethernet addresses
  - 32-bit IP addresses
  - Need no further encoding

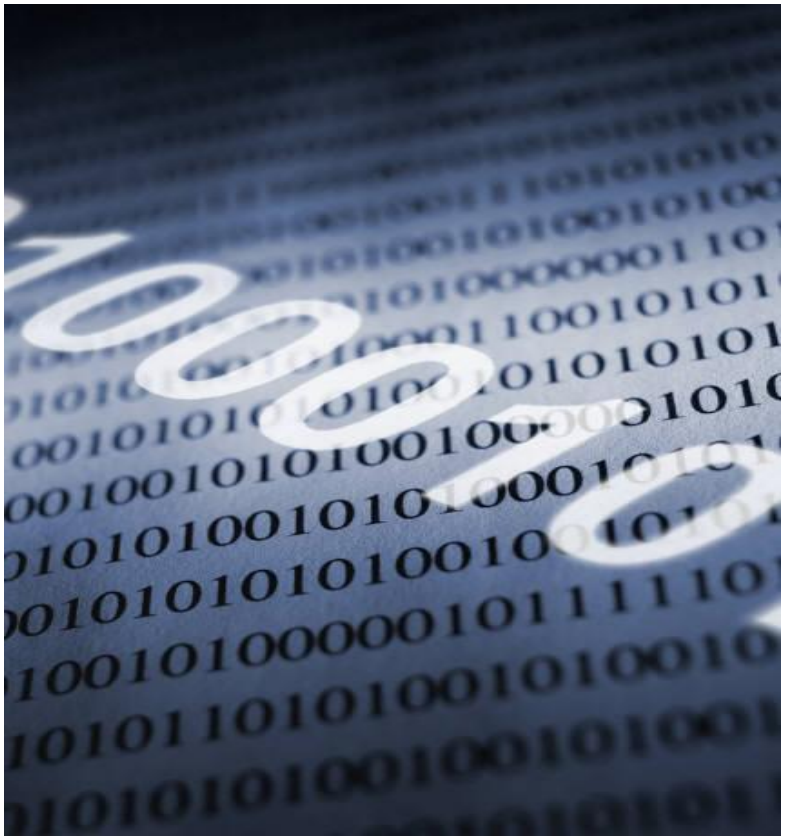


Figure 3-2: Arithmetic with Binary Numbers

Binary Arithmetic for Whole Numbers (Integers)
(Counting Begins with 0, not 1)

Integer	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000

"There are 10 kinds of people—
those who understand binary and those who don't"

Figure 3-2: Arithmetic with Binary Numbers, Continued

Binary Arithmetic for Binary Numbers

Basic Rules

1				
+1	1	1	0	0
+1	+1	+0	+1	+0
=11	=10	=1	=1	=0

Figure 3-2: Arithmetic with Binary Numbers, Continued

Examples

Binary	Decimal
1000	8
+1	+1
=1001	=9
+1	+1
=1010	=10
+1	+1
=1011	=11
+1	+1
=1100	=12

Figure 3-3: Binary Encoding for Alternatives

Encoding Alternatives
(Product number, region, gender, etc.)
(N bits can represent 2N Alternatives)

Number of Bits In Field (N)	Number of Alternatives That Can be Encoded with N bits
1	2 (2^1)
2	4 (2^2)
3	8 (2^3)
4	16 (2^4)
8	256 (2^8)
16	65,536 (2^{16})
…	…

Each added bit doubles the number of alternatives that can be represented

Figure 3-3: Binary Encoding for Alternatives

Bits	Alternatives	Examples
1	$2^1=2$	Male = 0, Female = 1
2	$2^2=4$	Spring = 00, Summer = 01, Autumn = 10, Winter = 11
8	$2^8=256$	Keyboard characters for U.S. keyboards. Space=00000000, etc. ASCII code actually uses 7 bits

Powers of 2

Each additional bit doubles the number of possibilities

Start with one you know and double or halve until you have what you need

E.g., if you know 8 is 256, 10 must be 4 times as large or 1,024.

Memorize for 1, 4, 8, and 16 bits

Bits	Alternatives
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
10	1,024
16	65,536

Figure 3-3: Binary Encoding for Alternatives

- Quiz
  - How many flavors of ice cream can you represent in half a byte of storage?
  - How many bits do you need to represent 64 flavors of ice cream?
  - How many bits do you need to represent 6 sales districts?

Figure 3-4: ASCII and Extended ASCII

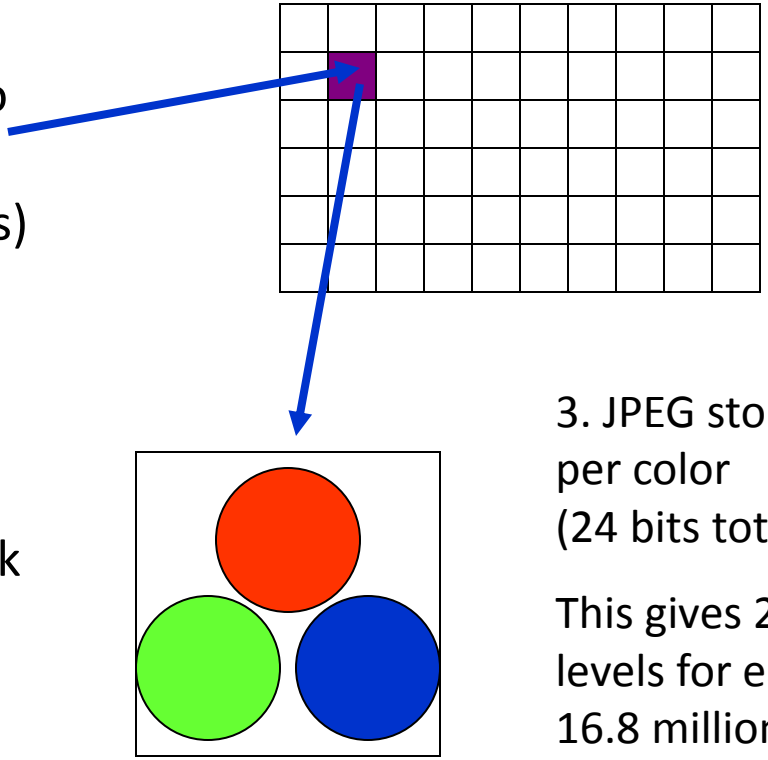
- ASCII Code to Represent Text
  - ASCII is the traditional binary code to represent text data
  - Seven bits per character
    - 2^7 (128) characters possible
  - Sufficient for all keyboard characters (including shifted values)
    - Capital letters (*A* is 1000001) (*A* is 65)
    - Lowercase letters (*a* is 1100001) (*a* is 97)
  - Each character is stored in a byte
    - The 8^{th} bit in a byte normally is not used

Figure 3-4: ASCII and Extended ASCII, Continued

- Extended ASCII
  - Used on PCs
  - Uses a full 8 bits per character
  - 2^8 (256) characters possible
  - Extra characters can represent formatting in word processing, etc.
- Converters
  - Text-to-ASCII and Text-to-Extended ASCII Converters are Readily Available on the Internet

Binary Coding for Graphics Image

- Pixels
  - 1. Screen is divided into small squares called pixels (picture elements)
  - 2. Each pixel has three dots—red, green, and blue. Sometimes a black dot too



3. JPEG stores one byte per color
(24 bits total)

This gives 256 intensity levels for each color or 16.8 million colors overall (256^3)

Binary Coding for Video

- Video is represented as a sequence of frames.
- Each frame is a graphical image as represented in the previous slid.
- How many frame per second?

Binary Coding for sound

- Digitalization
- Sampling Rate