AAB University

Faculty of Computer Sciences

Introduction to Digital Technologies and Circuits

Week 1:

Introduction to Computer Science

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- **An Introduction To Computer Science**

MISCONCEPTION 1: **Computer science is the study of computers**

MISCONCEPTION 2: **Computer science is the study of how to write computer programs**

MISCONCEPTION 3: **Computer science is the study of the uses and applications of computers and software**

- **An Introduction To Computer Science**

Concepts such as:

- Computers,
- Programming languages,
- Software, and
- Applications

are part of the discipline of computer science, but individually they do not capture the richness and diversity of this new field.

- **The Definition of Computer Science**

Computer science the study of **algorithms**

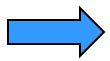
, *including*

1. Their formal and mathematical properties
2. Their hardware realizations
3. Their linguistic realizations
4. Their applications

- **The Formal Definition of an Algorithm**

Algorithm:

a well-ordered collection **of** ***unambiguous and effectively computable*** **operations that, when executed,** ***produces a result*** **and** ***halts in a finite amount of time*****.**



The Formal Definition of an Algorithm

. . . a well-ordered collection . . .

STEP 1	*Do something*
STEP 2	*Do something*
STEP 3	*Do something*
.	
.	
.	
STEP N	*STOP, you are finished*

The Formal Definition of an Algorithm

. . . of unambiguous

and effectively computable operations . . .

*An **unambigiguous** operatinon is one that can be understood and carried out directly by the computing agent without needing to be further simplified or explained.*

***Effectively computable** means there exists a computational process that allows the computing agent to complete that operation successfully.*

The Formal Definition of an Algorithm

. . . that produces a result . . .

Algorithm *must produce a result that is observable to a user, such as a numerical answer, a new object, or a change to its environment.*

RESULT *or* ***ANSWER ?***

The Formal Definition of an Algorithm

. . . and halts in a finite amount of time .

The result must be produced after the execution of a finite number of operations, and we must guarantee that the algorithm eventually reaches a statement that says ***STOP****, you are done or something equivalent.*

The Informal Definition of an Algorithm

Algorithm *is an ordered sequence of instructions that is guaranteed to solve a specific problem.*

It is a list that looks something like this:

STEP 1	*Do something*
STEP 2	*Do something*
STEP 3	*Do something*
.	
.	
.	
STEP N	*STOP, you are finished*

The Informal Definition of an Algorithm

- The operations used to construct algorithms all belong to one of only three categories:

1. *Sequential operations*
2. *Conditional operations*
3. *Iterative operations*

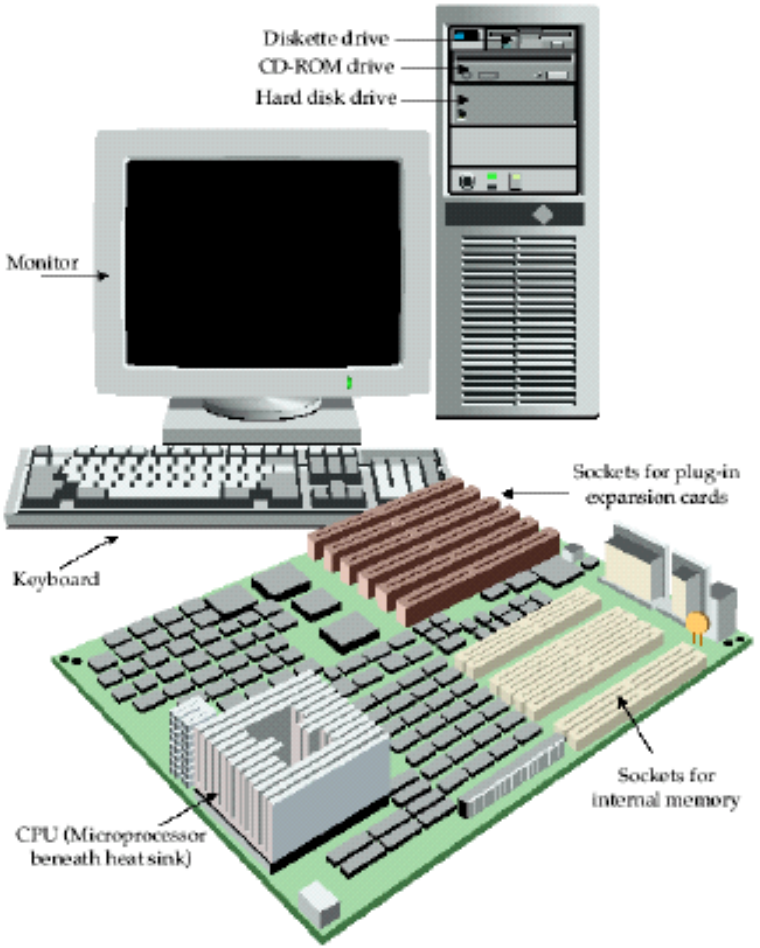
"Algorithm"

al·go·rithm *n. A procedure for solving a mathematical problem in a finite number of steps that frequently involves repetition of an operation; broadly: a* ***step-by-step*** *method for accomplishing some task.*

Abu Ja'far Muhammad ibn-Musa Al-Khowarizmi
(A.D. 780-850)

- *a famous Persian Mathematician*
- *a teacher at the Mathematical Institute in Bagdat*
- *"algebra" (Arabic world al jabr means "reduction")*
- *step-by-step procedures for doing arithmetic operations, on numbers represented in new decimal system*
- *XII century, trans. Into Latin, introd. The base 10 Hindu-Arabic numbering system to Europe*

- The design of digital systems can be divided into three parts:
  - System design
  - Logic design
  - Circuit design

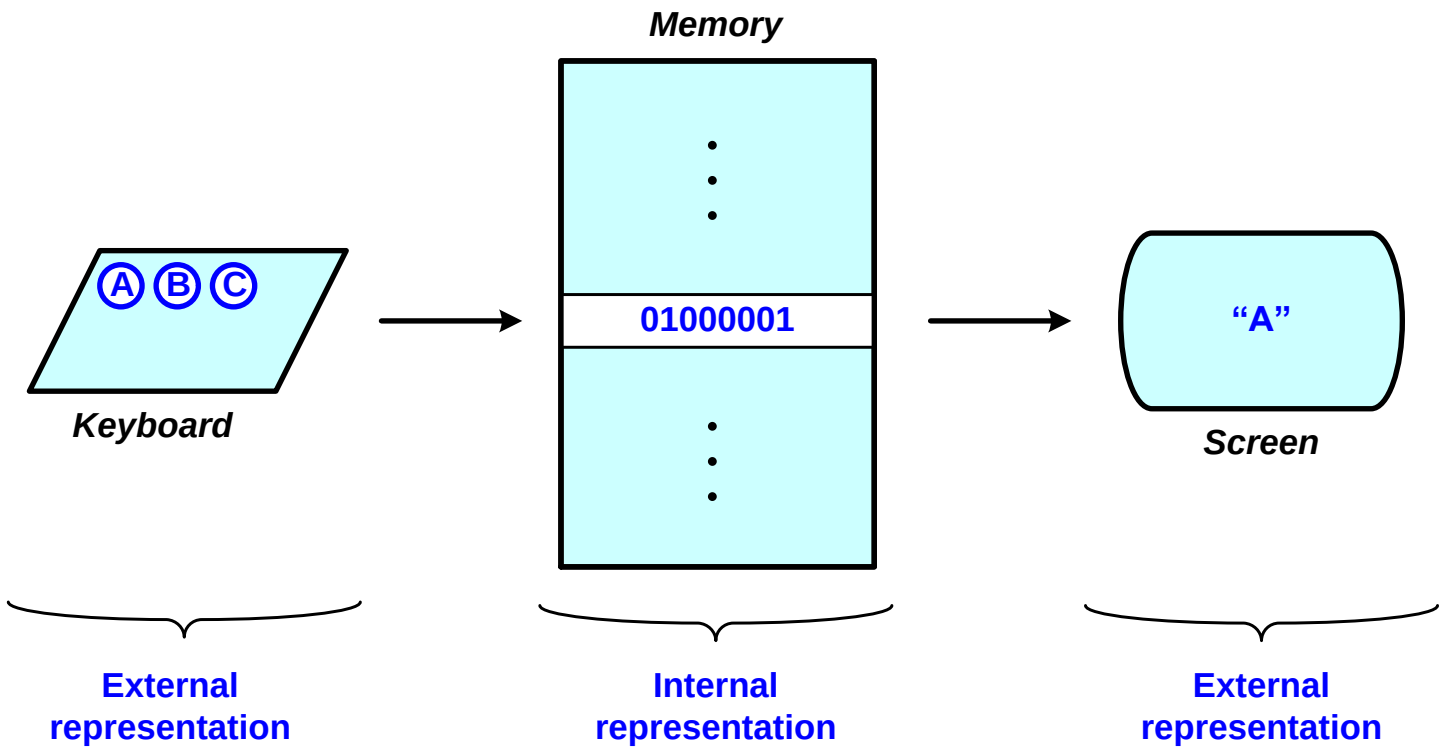


Digital Systems and Binary Logic

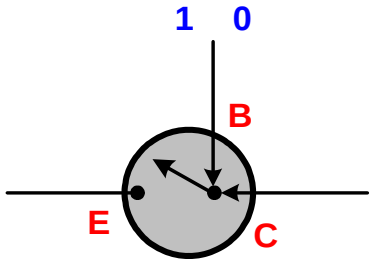
- Digital systems are used extensively in computation and data processing, control systems, communications, and measurement.
- What is the difference between analog and digital systems?
- Why are digital systems capable of greater accuracy than analog systems?
- Why is binary logic used in digital systems?

Binary Logic

- Distinction Between the External and the Internal Representation of Information



Why Binary numbers ?



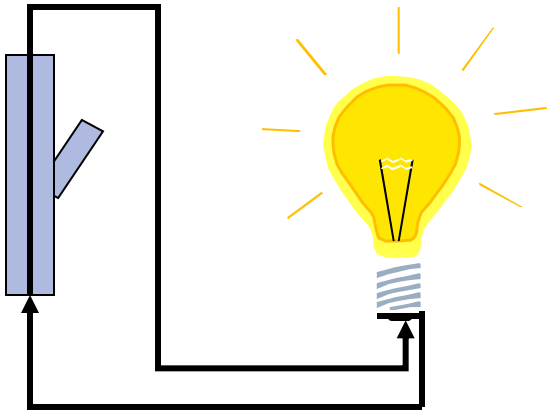
- Computers are made of millions of tiny switches.
- The switches have only two states - OFF & ON.
- OFF = 0 & ON = 1
- So **binary numbers** is the language of all modern computers.

Binary Logic

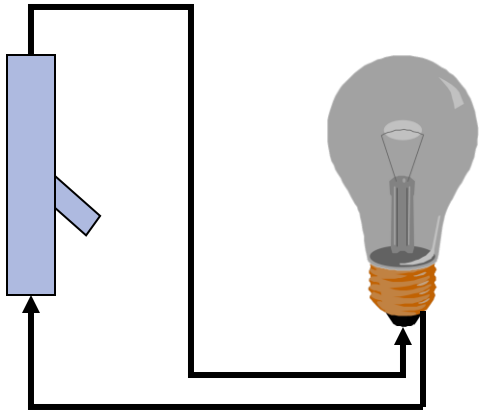
- What is Information?
  - **Numbers**
    - Binary numbers
  - **Text and Symbols**
    - ASCII, UNICODE
  - **Sound**
    - Binary signals
  - **Images**
    - Pixels
  - **Animations**

Binary circuits: Electronic devices are cheapest and function most reliably if they assume only two states.

Closed circuit



Open circuit



Representations of Numbers

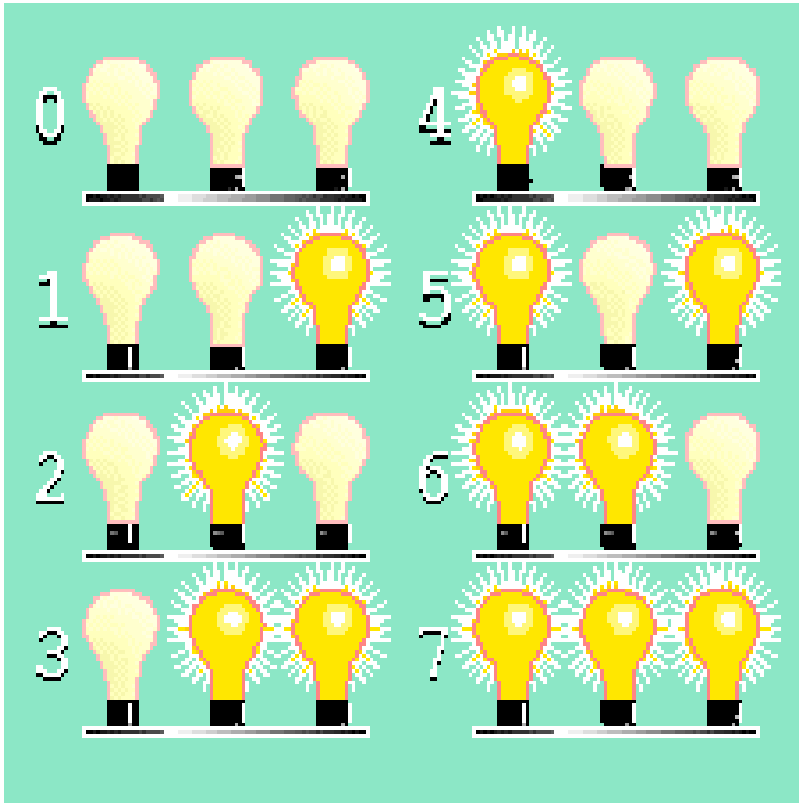
- The three-light system:
  - Has eight possible combinations of on and off.
- Could be used to indicate the numbers **0, 1, 2, 3, 4, 5, 6, 7.**

0 = 000 **4 = 100**

1 = 001 **5 = 101**

2 = 010 **6 = 110**

3 = 011 **7 = 111**



Representations of Numbers

The Decimal System: **B=10** **(0, 1, 2, 3, 4, 5, 6, 7, 8, 9)**

$175 = 1*100 + 7*10 + 5$

$175 = 1 * 10^2 + 7 * 10^1 + 5 * 10^0$

The Binary System: **B=2** **(0, 1)**

$1011 = 1 * 2^3 + 0 * 2^2 + 1 * 2^1 + 1 * 2^0$

$= 1 * 8 + 0 * 4 + 1 * 2 + 1 = 11$

$(1011)_2 = (11)_{10}$

Representations of Symbols and Text

- To store any kind of information in the computer's memory, it must first be transformed into a binary numeric form.
- **Symbols and Text**
  - Includes characters, punctuation, symbols representing numbers.
  - Each symbol can be assigned a numeric value.

Two standardized sets of codes for symbols:

ASCII: American Standard Code for Information Interchange. Can represent 255 different characters/symbols.

UNICODE: More modern code that can represent 65536 characters/symbols (useful for other languages such as Arabic, Chinese).

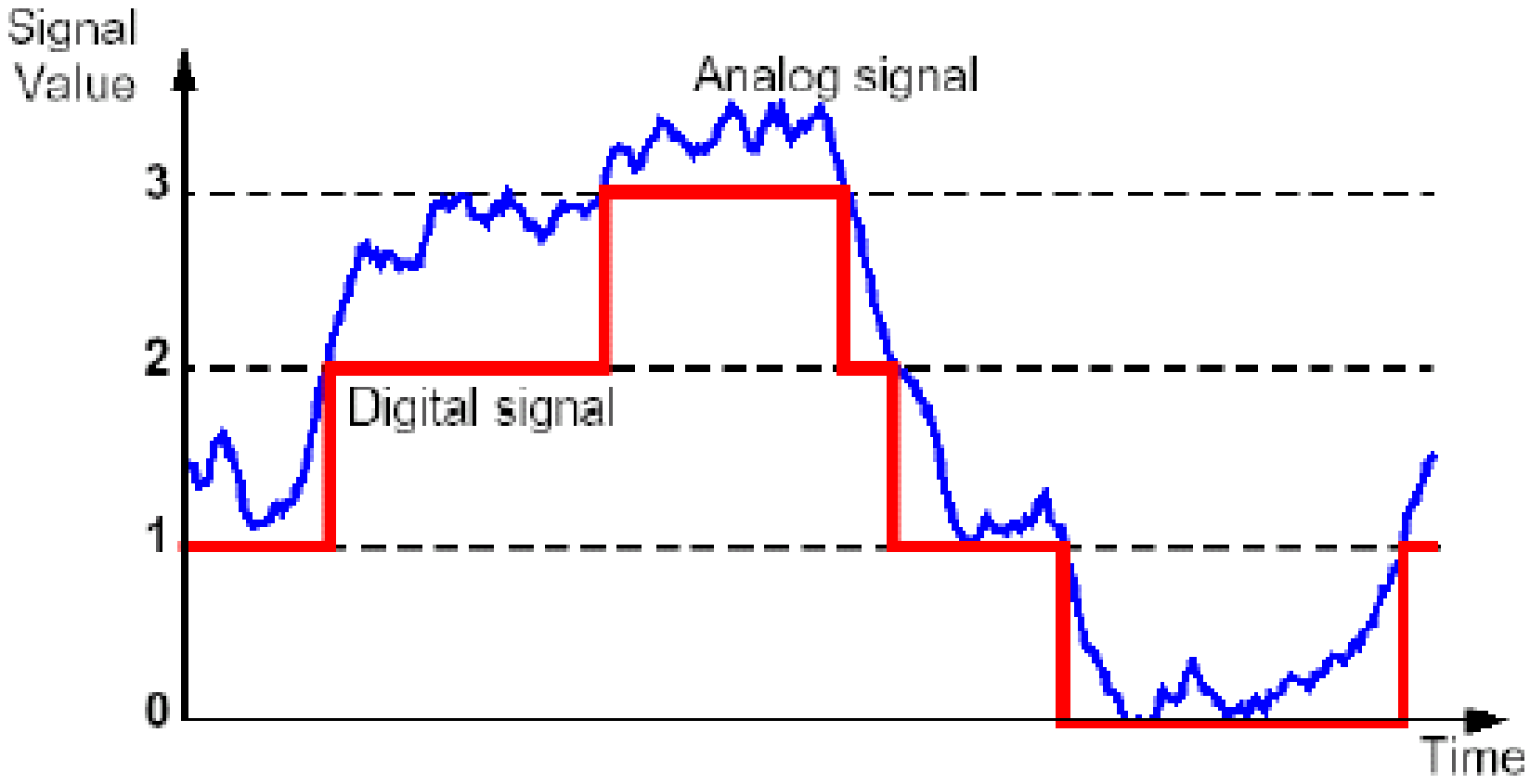
Representations of Symbols and Text

Letters:

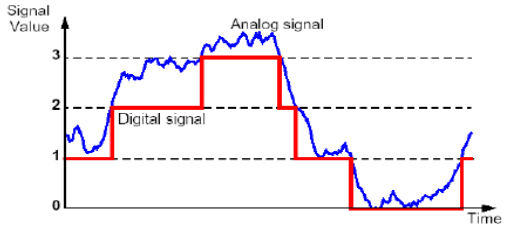
ASCII - (American Standard Code for Information Interchange)

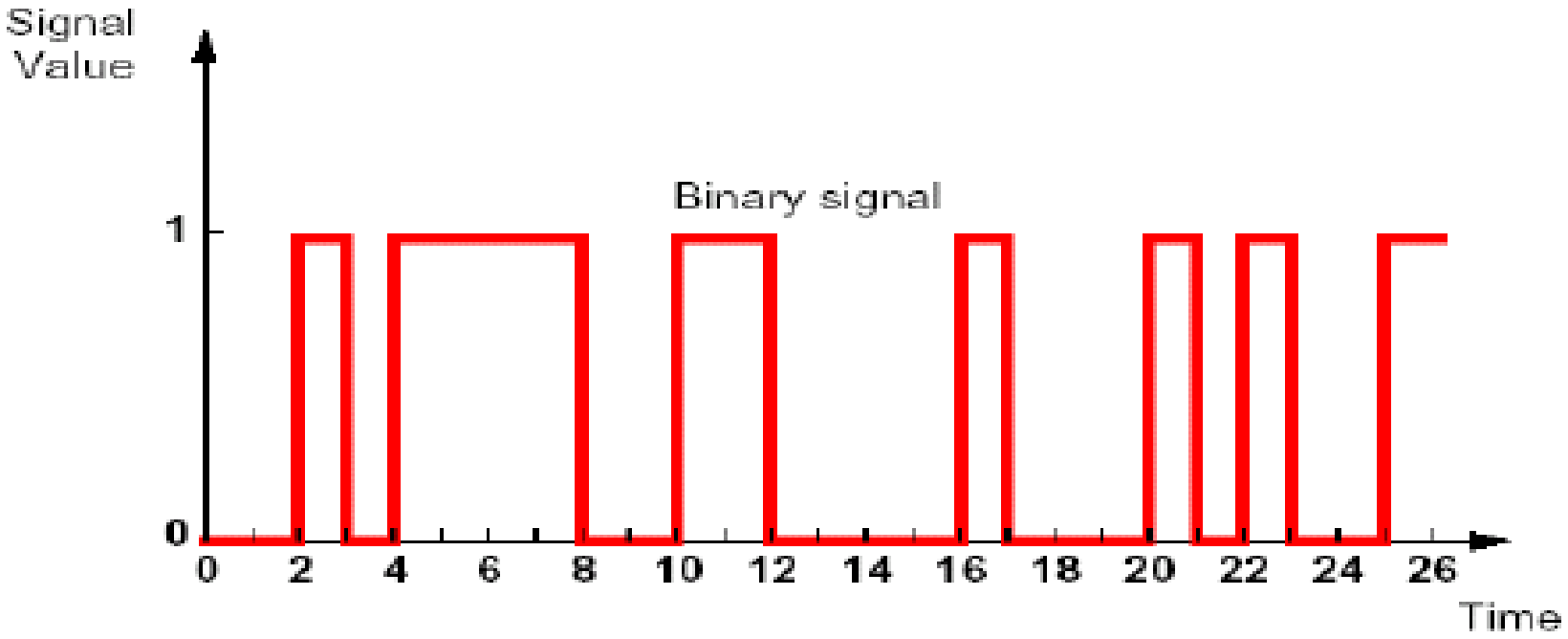
Letter	Decimal Representation	8 bit Binary Representation
A	65	01000001
B	66	01000010
C	67	01000011
D	68	01000100
E	69	01000101
F	70	01000110
G	71	01000111

Analog Signals:



Binary Signals:

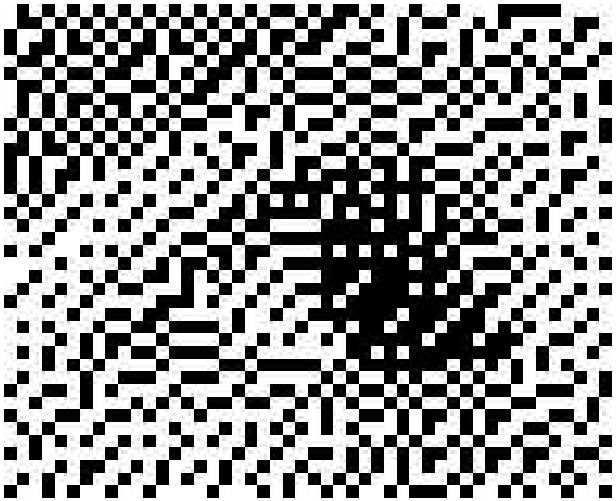




Pictures:

- A picture must be transformed into numeric form before it can be stored or manipulated by the computer.
- Each picture is subdivided into a grid of squares called **pixels** (picture elements).
  - If the squares are small enough, we will see a reasonably good image.

Representations of Images



- In a picture with only black and white pixels:
  - **1** represents black.
  - **0** represents white.

```
0101010101010101010101101011010010010001111100000
0110101010101010101010010110100101100101000001100
1001010101010101010101101100010100001010010101000
1011011010110110101101011001100101101000100010010
0110100101101001011010100010011001001011010100100
1001011011001010110101011101100110010100101011000
0110100100110101100100100010011001101010100100010
0101011011001011001001011101100110010100100100101
0101010101010100110110100010011000101000010101000
1010101010101011000100101100100011010011101000010
0101010101010100010001010001011010000100000011010
1101101010100101001101000110100100111001011010000
1010010101001000101001011001011011000010100000100
1010110100010010010010010111101010110101001011000
1010100001000100100101111101011111001010010010010
0101001010010001001010101011101010110100100100000
1010010000100110011011111010111010101010001001010
0100100101001000110110000111101110110101101010000
0001000000010011001001111111111101101110000000010
1010001010100100110110000101010111010000101010000
0000100001001011010100111111111111111011101000101
0010001010011010101001000111011111101000100100000
0100100101100010010010011110111101011011001001010
1001001000001110100100100101111111110110010010000
```

Representations of Images

- **The baby's picture with smaller pixels - more detail.**

- **The baby's picture with 4 levels of gray.**

Representations of Images

- Photographic quality images have a **gray-scale.**
  - Several shades between black and white are used.
  - 4 level gray-scale means 4 shades are used.
    - Each pixel needs 2 bits:
    - 00 - represents white
    - 01 - represents light gray
    - 10 - represents dark gray
    - 11 - represents black
  - 256 level gray scale means
    - 8 bits per pixel are needed for 256 shades of gray

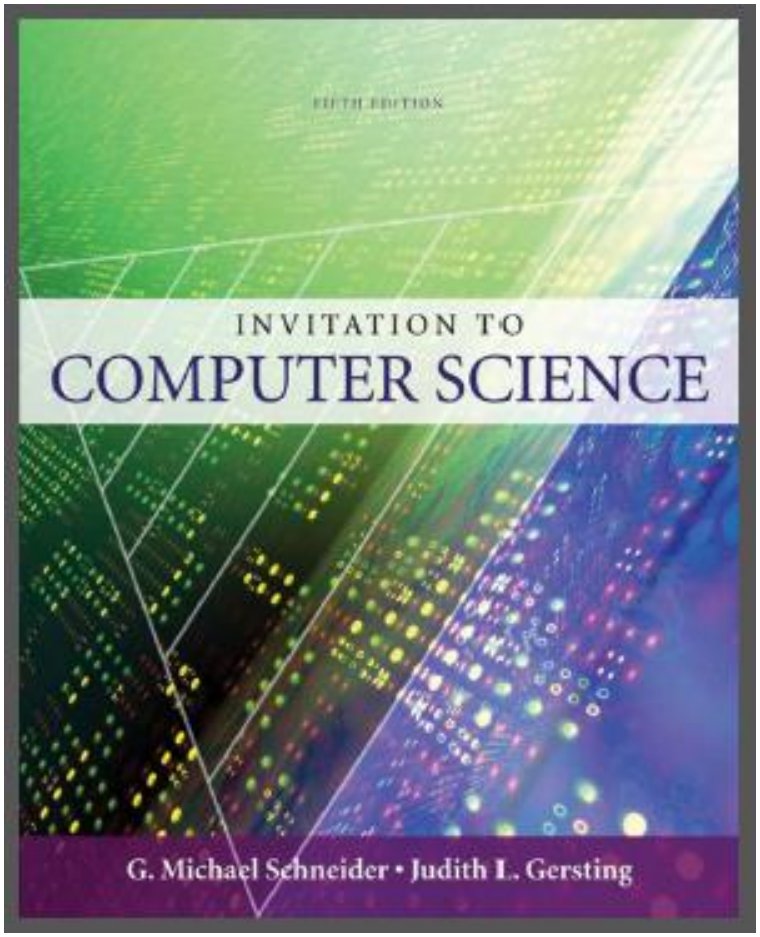
256 levels of gray

Representations of Images

- **Color Images with RGB**
  - Uses three values per pixel
  - One number is used for each of the amounts of **Red**, **Green** and **Blue** on the computer screen.
  - The amounts of Red, Green, and Blue combine like light or paint to create other colors

Full color image

- Reading:
  - Chapter 1



- Questions?!

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