INGE 3016 - Algorithms and Computer Programming (MATLAB)

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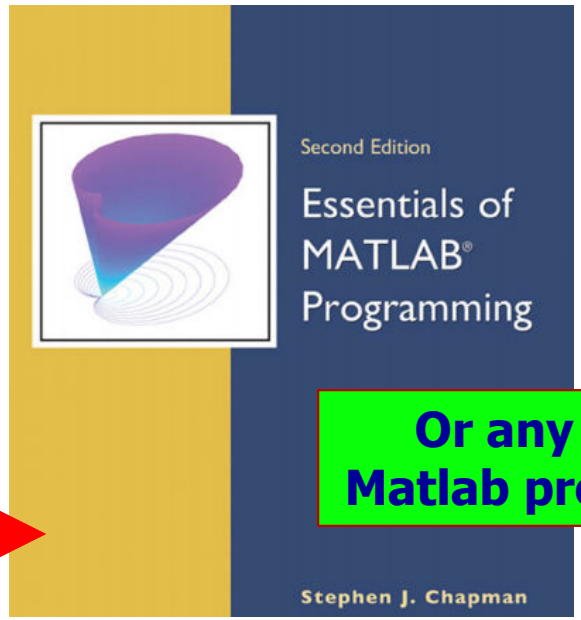
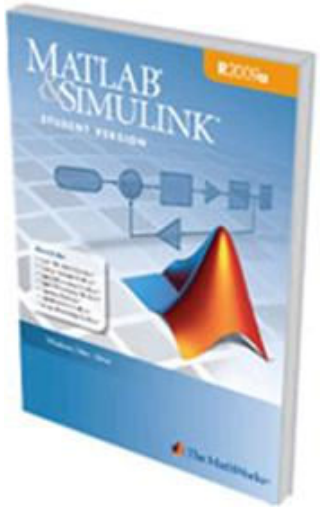
~~Textbook~~, MATLAB…



Or any book on Matlab programming



Student version $49 (bundled $99)
www.mathworks.com
Documentation available online (free) – excellent reference

INGE 3016 - Algorithms and Computer Programming

why you should learn to code?

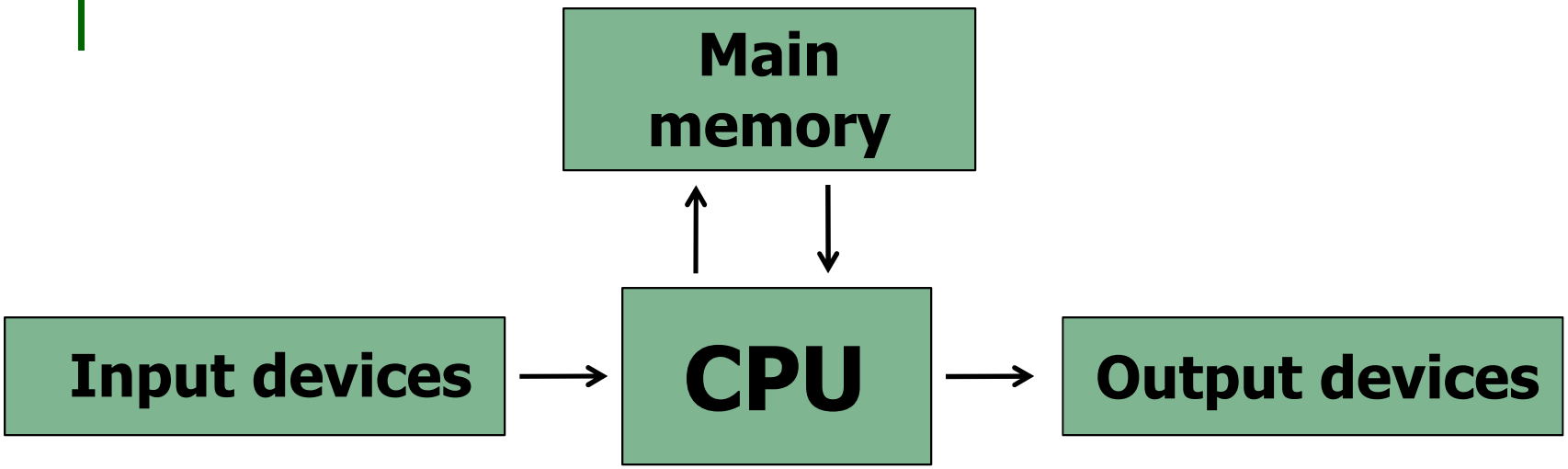
"I think everybody in this country should learn how to program a computer because it teaches you how to think."

Steve Jobs

Computer Science for All (Jan 2016, $4 billion funding) *…to learn computer science and be equipped with the computational thinking skills they need to be creators in the digital economy, not just consumers, and to be active citizens in our technology-driven world.*

MathCad	Useful for general engineering calculations
ANSYS/ABAQUS	State of the art finite element program
OpenSees	State of the art structural analysis program
Matlab/Scilab/	Leading programs in scientific computation

Computer Architecture



CPU: Central Processing Unit
I/O devices: Peripheral devices

Microprocessors

A microprocessor incorporates most or *all of the functions* of a computer's central processing unit (CPU) *on a single integrated circuit* (IC, or microchip)

Microprocessors

Microprocessors can be designed to operate on 4-bit, 16-bit, **32-bit** and **64-bit** words.

All microprocessors use a crystal-controlled clock to control instructions and data movements. The clock rate is specified in **microprocessor cycles per second** (e.g. **2.7 GHz**)

Microprocessor Progression: INTEL

Name	Date	Transistors	Microns	Clock speed	Data width	MIPS
8080	1974	6,000	6	2 MHz	8 bits	0.64
8088	1979	29,000	3	5 MHz	16 bits 8-bit bus	0.33
80286	1982	134,000	1.5	6 MHz	16 bits	1
80386	1985	275,000	1.5	16 MHz	32 bits	5
80486	1989	1,200,000	1	25 MHz	32 bits	20
Pentium	1993	3,100,000	0.8	60 MHz	32 bits 64-bit bus	100
Pentium II	1997	7,500,000	0.35	233 MHz	32 bits 64-bit bus	~300
Pentium III	1999	9,500,000	0.25	450 MHz	32 bits 64-bit bus	~510
Pentium 4	2000	42,000,000	0.18	1.5 GHz	32 bits 64-bit bus	~1,700
Pentium 4 "Prescott"	2004	125,000,000	0.09	3.6 GHz	32 bits 64-bit bus	~7,000

http://computer.howstuffworks.com/microprocessor1.htm

Microprocessor Progression: INTEL

Information about the table:

Transistors is the number of transistors on the chip.

Microns is the width, in microns, of the smallest wire on the chip. For comparison, a human hair is 100 microns thick.

Clock speed is the maximum rate that the chip can be clocked at. Clock speed will make more sense in the next section.

Data Width is the width of the ALU (Arithmetic Logic Unit)

MIPS stands for "millions of instructions per second" and is a rough measure of the performance of a CPU. Modern CPUs can do so many different things that MIPS ratings lose a lot of their meaning, but you can get a general sense of the relative power of the CPUs from this column.

Control of computer operation

The ***operating system (OS)*** is a program that controls the computer as its most basic level and provides the environment for application programs:

-Manages the memory
-Schedules processing operations
-Accesses peripheral devices
-Communicates with the user

Bits or bytes?

A bit is the **basic unit of information** in computing and telecommunications.

In computing can also be defined as a variable that can have **only two possible values**. These two values are often interpreted as **binary digits** and are usually denoted by **0 and 1**. The term "bit" is a contraction of binary digit.

The two values can also be interpreted as logical values (**true/false, yes/no**), algebraic signs **(+/−**), activation states (**on/off**), or any other two-valued attribute.

Bits or bytes?

Historically, a **byte** (**B**) was the **number of bits** (typically 6, 7, 8, or 9) used **to encode a character of text** in a computer. The size of a byte is typically hardware dependent, but the modern *de facto standard* is **8 bits**, as this is a convenient power of 2 (**2^3**).

A **word** is simply a fixed **sized group of bits** that are handled together by the system.

The **amount of data transferred** between the processing part computer and the memory system**, in a single operation**, is most often a word.

Binary prefix

Name	Abbr	Factor	SI size
kilo	K	2^{10}	10^{3}
mega	M	2^{20}	10^{6}
giga	G	2^{30}	10^{9}
tera	T	2^{40}	10^{12}
peta	P	2^{50}	10^{15}
exa	E	2^{60}	10^{18}
zetta	Z	2^{70}	10^{21}
yotta	Y	2^{80}	10^{24}

- La capacidad de mi disco duro es 114054602752 bytes, cual es la capacidad en MB? Cual es la capacidad en bits?

- Un amigo (que es un estofón de las computadoras y además medio pillo) te quiere vender un "flash drive" nuevo por $8, y te dice que tiene una capacidad "c@3r0n@" de 34,359,738,368 bits. Tu otra opción es Wallmart donde un "flash drive" de 5GB cuesta $20. A quien le compras?

Decimal numbers

Decimal numbers (base 10)

0 1 2 3 4 5 6 7 8 9 (ten digits)

1024

Thousands (10^3)	Hundreds (10^2)	Tens (10^1)	Ones (10^0)
1	**0**	**2**	**4**

$1024 = 1*10^3+0*10^2+2*10^1+4*10^0$

Binary numbers

Binary numbers (base 2)

0 1 (2 digits – binary digits “bits”)

10101

2^4	2^3	2^2	2^1	2^0
1	**0**	**1**	**0**	**1**

1*2^4 + 0*2^3 + 1*2^2 + 0*2^1 + 1*2^0 = 21

$10101_2 = 21_{10}$

Binary numbers

How high can we count given a fixed number of bits?

- An n-bit binary number has $\mathbf{2^n}$ possible values.
- Since one of those values represents zero, the largest possible number is $\mathbf{2^n-1}$.
- Verify! What if n=4?

Converting decimal to binary

141_{10} to binary

1. Find the largest power (n) of 2 smaller than the number to be converted. **$2^7=128$ $2^8=256$ n=7**
2. There will be n+1 bits in the corresponding binary number **n+1=8 bits**

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	**?**	**?**	**?**	**?**	**?**	**?**	**?**

3. Find the reminder (R) of the decimal number: **$R=141-2^7=13$**
4. Hopefully you got the idea, continue filling in the blanks

Converting decimal to binary

141_{10} to binary

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	?	?	?	?	?	?	?

$R=141-2^7=13$

$2^4=16$ $2^3=8$

So, from 2^6 to 2^4 fill with zeros and 1 for 2^3

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	0	0	1	?	?	?

$R=13-2^3=5$ $2^2=4$ fill 2^2 with 1

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	0	0	1	1	?	?

Converting decimal to binary

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	0	0	1	1	?	?

$R=5-2^2=1$ $2^0=1$ fill 2^1 with 1 and 2^0 with 1

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	0	0	1	1	0	1

Verify: $2^7+2^3+2^2+2^0 = 128+8+4+1 = 141$

$141_{10} = 10001101_2$

- $51904_{10}=?_{16}$

- What if I have a fractional decimal number?

  $21.375_{10}=?_{2}$

Character Coding

Since computers can handle binary numbers only, **all symbolic data must be represented by binary codes**.

Coding refers to the manner in which alphanumeric data and control characters are represented by sequence of bits.

The American Standard Code for Information Interchange , **ASCII**, is a **7-bit** code (2^7=128 different combinations).

The Extended Binary Coded Decimal Interchange Code, **EBCDIC** (eb'-sih-dik) used **8-bits** (a byte, 2^8=256 different characters)

ASCII conversion chart