Chapter 1

Introduction to Computers and Programming

Introduction

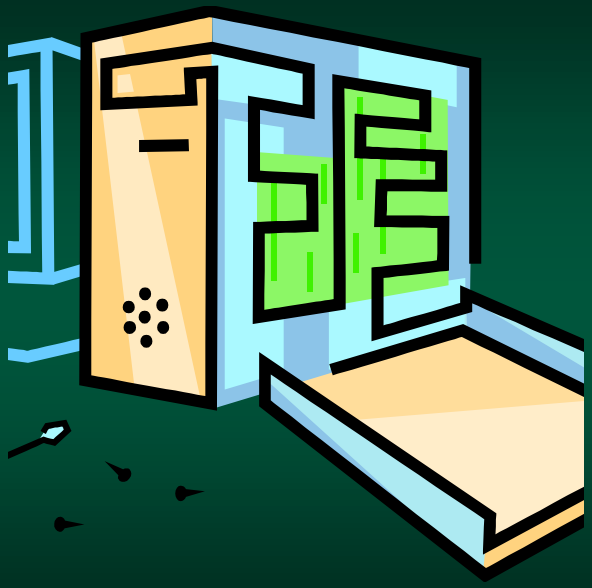
Chapter 1.1

Introduction

- Computers perform any job that their programs tell them to do
- A *program* is a set of instructions that a computer follows to perform a task.
- Programs are commonly referred to as *software*

Creators of Software

- *Programmers* (a.k.a. *Software Developers*) are the individuals that create programs
- They have the training and skills to design, create, and test computer programs

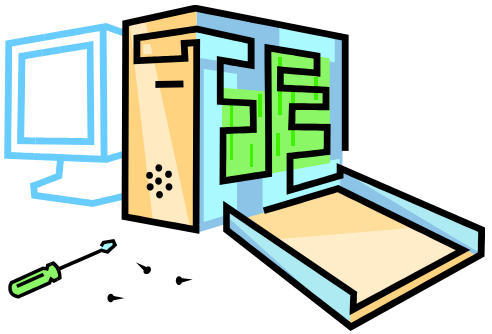


Hardware

Chapter 1.2

Hardware

- The term *hardware* refers to any physical device that a computer is made of
- Computers are, in fact, large systems that consists of different devices that work together



Hardware Categories

- Input Devices
- Process Devices
- Output Devices
- Store Devices

Input Devices

- Convert analog to digital data
- *Input* - feed information into a computer
  - Words and symbols
  - Numbers
  - Pictures
- Common forms of input
  - Keyboard
  - Mouse

Process Devices

- Computers can analyze and create data
- Basic Terms:
  - *Process* - actions used to manipulate data
  - *Processor* - device that processes data
- Common forms
  - Pentium Processor
  - various other chips and hardware

Output Devices

- Convert digital data to analog
- *Output* – send information out of a computer
- Common forms of output
  - Monitor
  - Printers
  - Music and Sound – using speakers

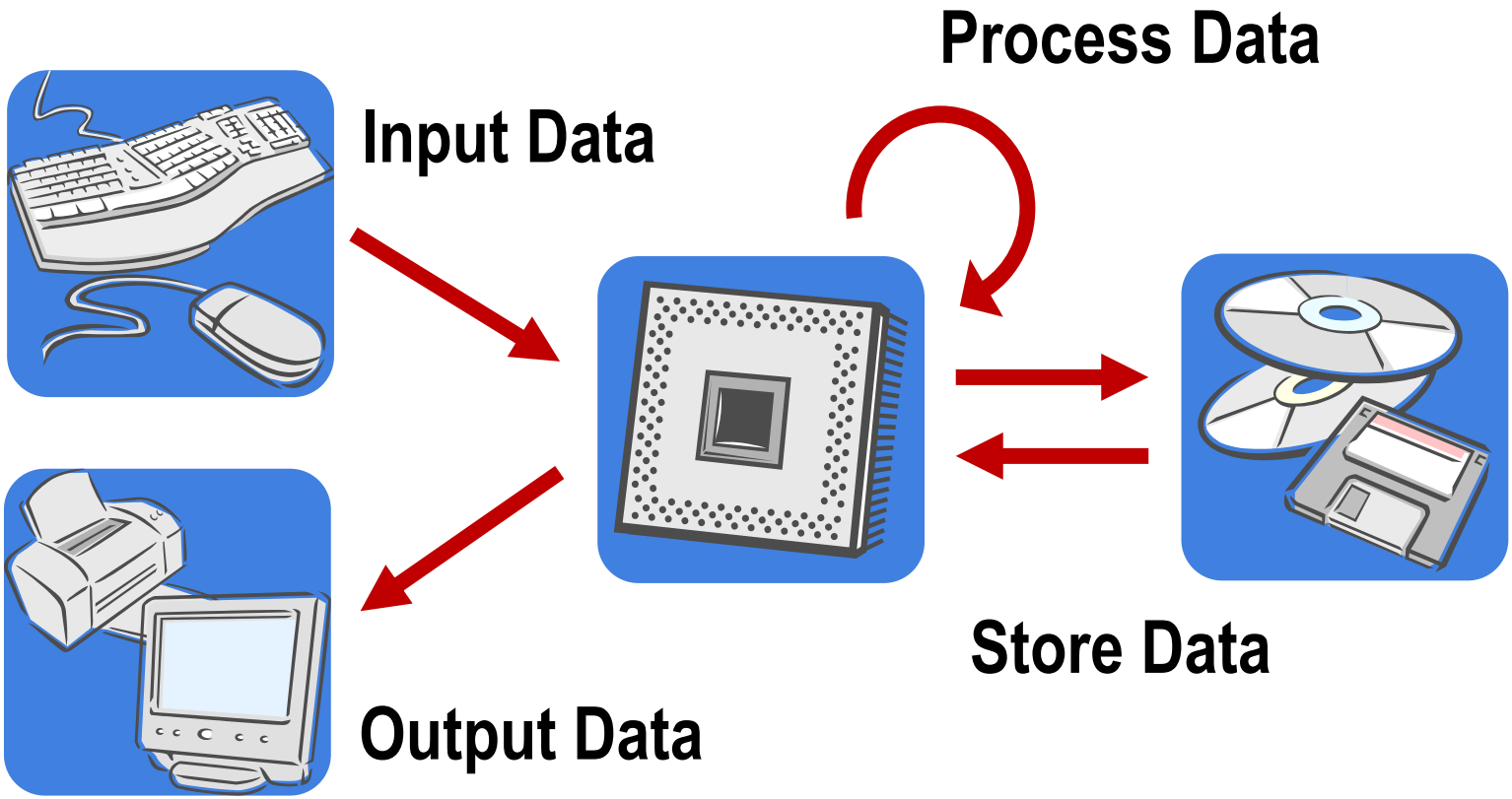
Storage Devices

- Copy data for later use
- The data is kept in digital form
- Common Forms:
  - Memory
  - CD ROM
  - Hard Disk
  - Flash Disks

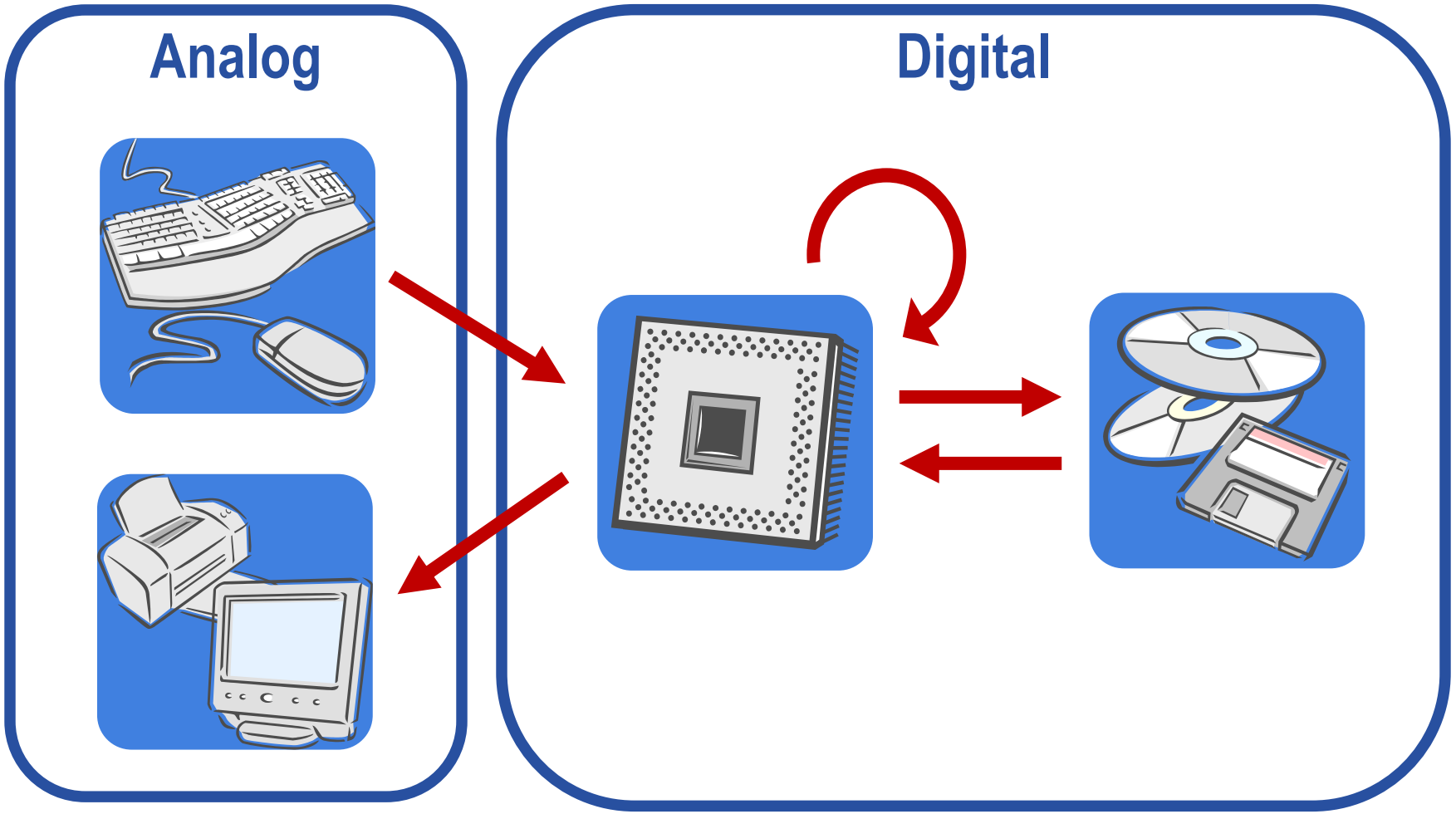
Storage Devices

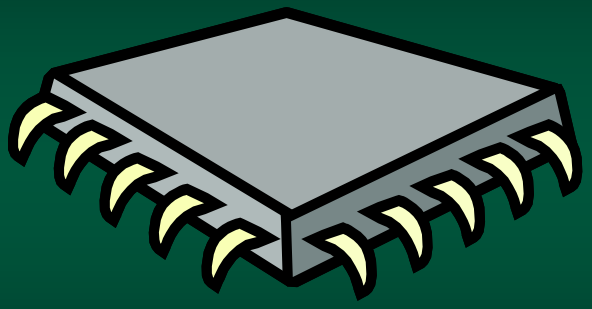
- *Primary* Storage
  - helps run your computer
  - this includes motherboard memory and memory used to run programs
- *Secondary* Storage
  - much slower than primary storage
  - allows data to be stored permanently

Functions of a Computer



Functions of a Computer





The Processor

Chapter 1.2

The Processor

- Performs calculations & logic
  - called the "Arithmetic Logic Unit"
  - registers hold data
- Controls your computer
  - called the "Control Unit"
  - talks to other components
  - talks to ports

The Processor

- Examples
  - Intel Pentium
  - IBM PowerPC
  - MOS 6502
  - ... thousands more

Evolution of the Processor

- Modern processors are small enough to fit in your hand
- And they contain millions of transistors
- The size of computers has changed drastically in the last 70 years
- The first computer was huge by today's standards

ENIAC – Computer of War

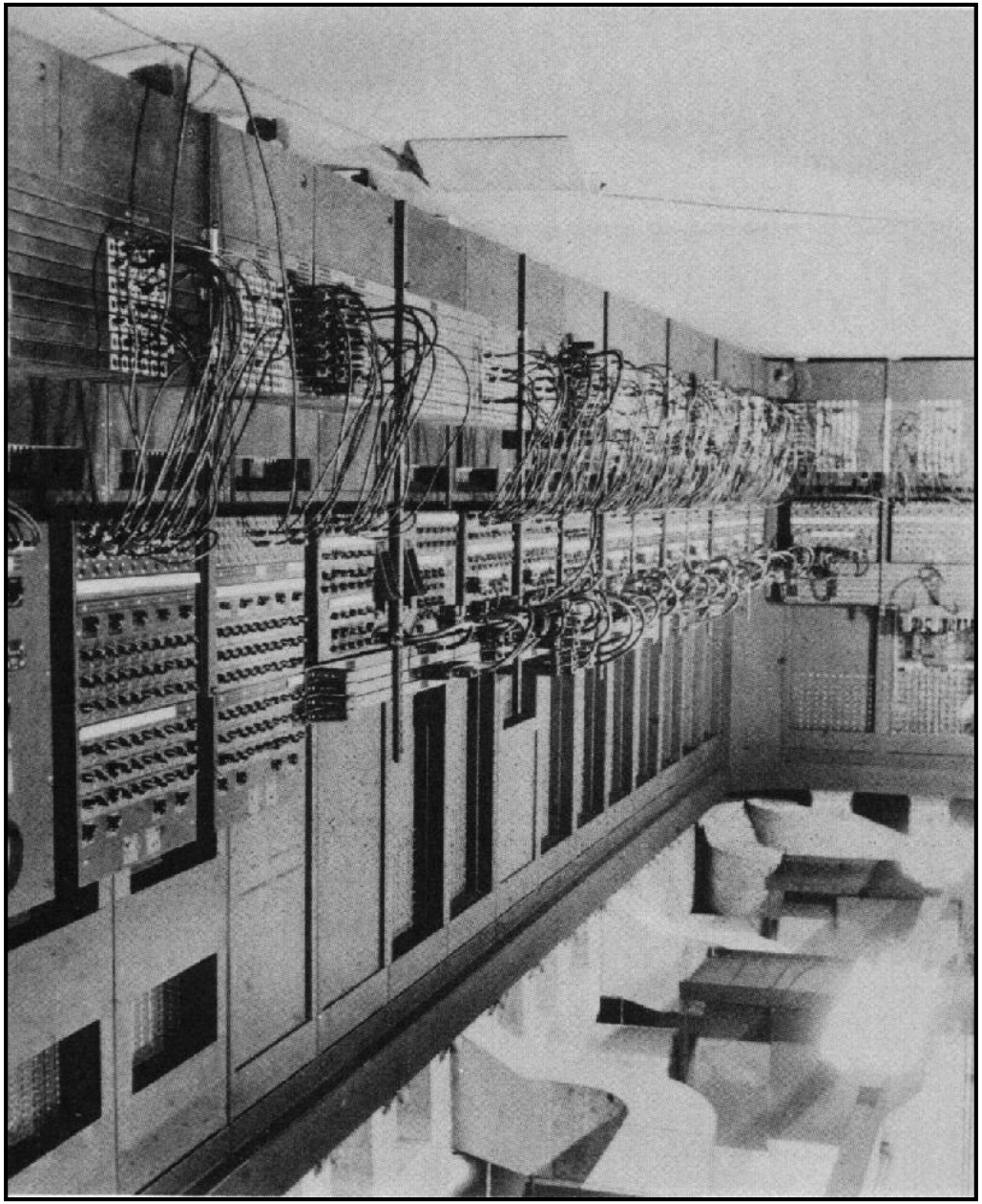
- Electronic Numerical Integrator And Computer
- Development
  - John Eckert and John W. Mauchly
  - U.S. Ballistics Research Laboratory
  - Needed to fight World War II – then Cold War
  - Compute ballistic firing tables

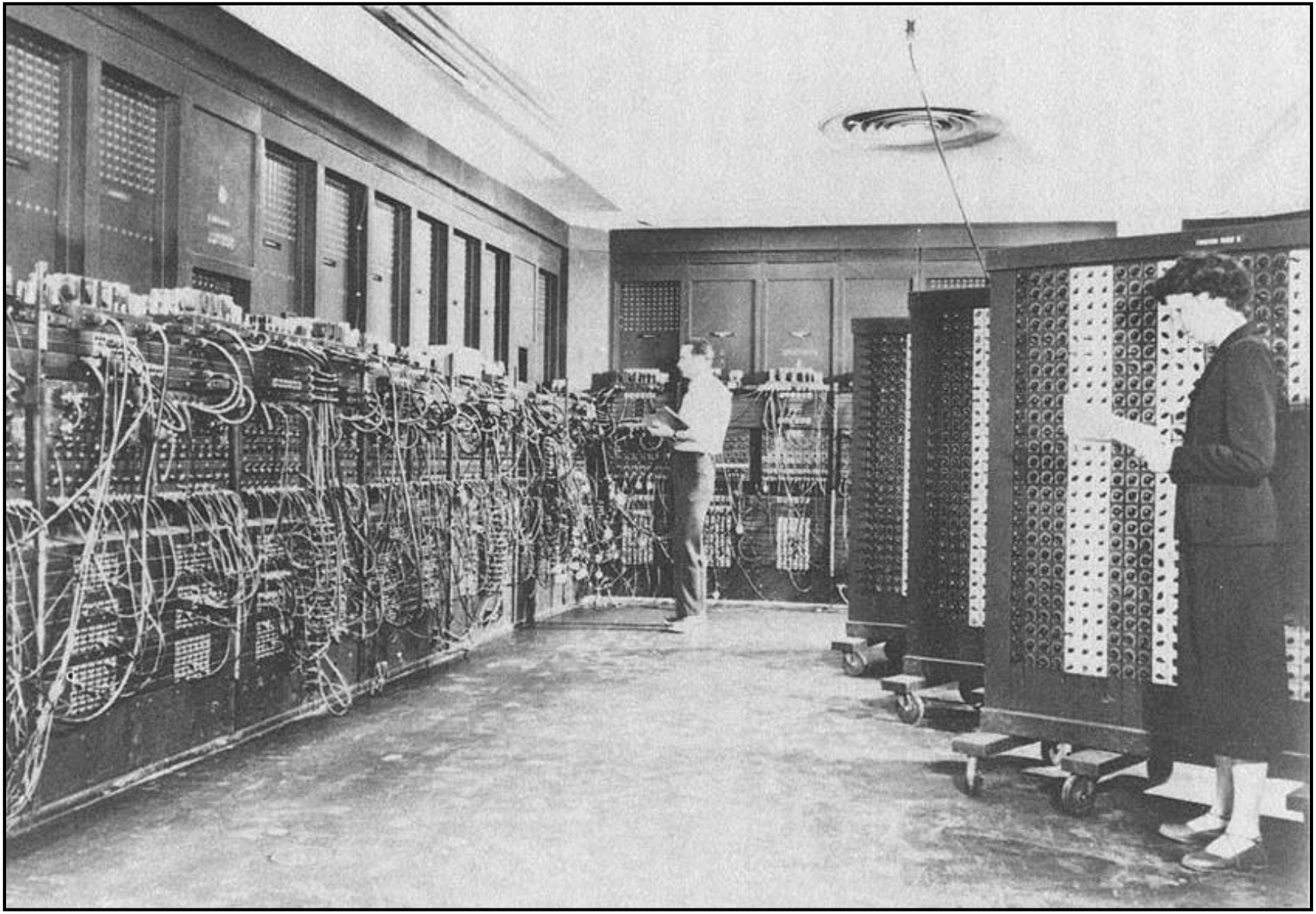
ENIAC – Computer of War

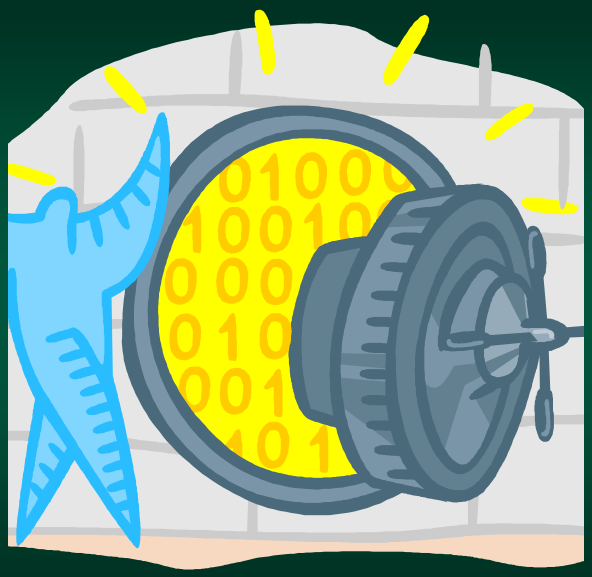
- Designed to be Turing Complete
- Operational in February 1946
- Features
  - 5 KHz (5000 Hz)
  - programmed by rewiring – pre 1948
  - based on decimal – not binary
  - weighed 30 tons,18 feet high, 80 feet long

ENIAC

- A tube burned out once every 2 days
- Retired in 1955
- operational for only 9 years
- *But… in just 9 years... it is estimated to have performed more calculations than all of humanity had ever done prior*







Primary Storage

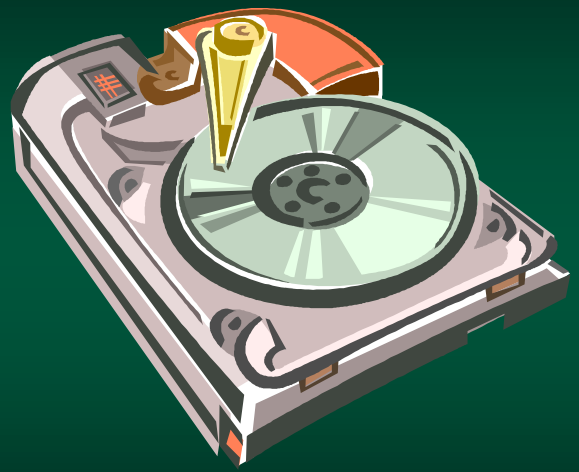
Chapter 1.2

Random Access Memory

- *Random Access Memory* (RAM)
  - memory used to run data and programs
  - fast
  - temporary – it is gone after the computer is turned off (power is lost)
- The more memory you have...
  - the more you can open/run at one time
  - stored on DIMM cards that can be added to motherboards

Virtual Memory

- Used when the system runs out of memory
  - computers with limited RAM can run large programs
  - this is a type of "emergency" memory
- Uses hard disk space
  - slow... not as fast as RAM
  - "invisible" to application software



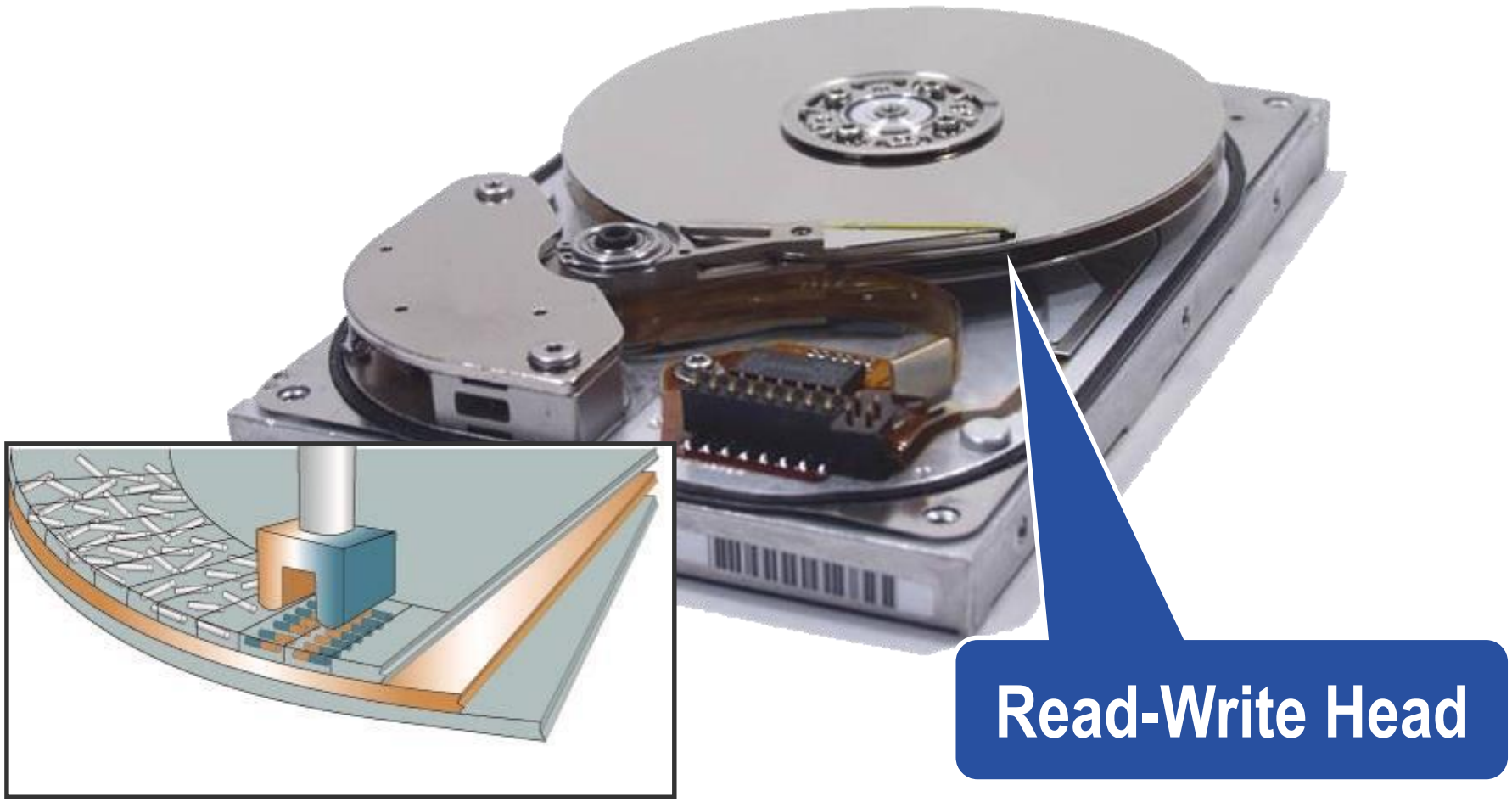
Secondary Storage

Chapter 1.2

Hard Disks

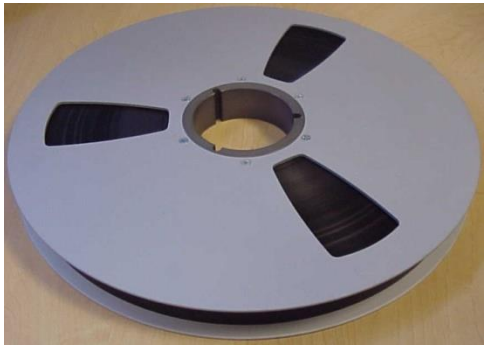
- Use magnets to store data
- Hard disk platter
  - flat, rigid, maintainable disk used to store bits
  - there are multiple platters in each hard drive
- Head crash
  - the read-write head *hits* into a dust particle or other contaminant on the disk
  - head crash damages some data on disk

Inside a Hard Disk



Tape Storage

- Magnetic Media
- Long continuous tape
  - sequential access
  - finding data requires seeking
- Inexpensive
  - lots of storage!
  - often used for backups
  - primarily used in business



Solid State Storage

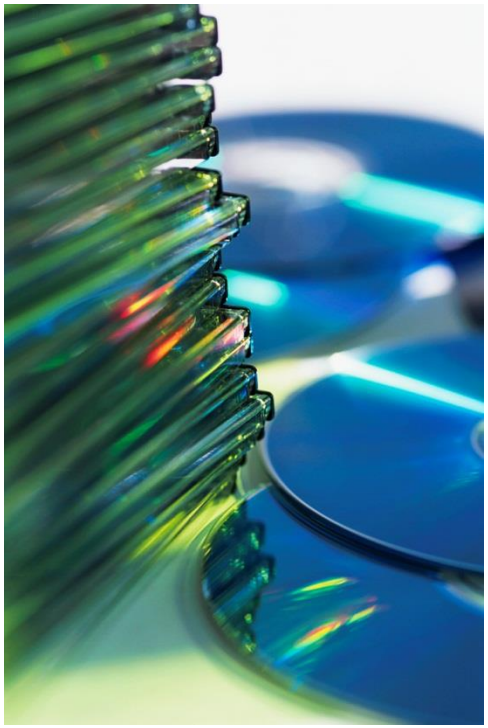
- Data is stored on a low-power chip
- Advantages
  - non-volatile (stored when power is lost)
  - portable
  - versatile – used from digital cameras to computers

Solid State Technology

- Cards
  - Compact Flash
  - MMC
  - Secure Digital
  - Smart Media
- USB Flash Drive
  - Plugs into any USB port
  - Acts like a hard drive

Optical Storage

- Data is read using lasers
  - light spots are called *lands*
  - dark spots are called *pits*
- Safer than magnetic media
  - data not lost over time
  - safe from magnets
  - resists the other elements



Current Mediums

- CD
  - Compact Disk
  - holds 700 MB of data (80 min)
- DVD
  - Digital Versatile Disk
  - holds about 4.7 GB of data
  - double layer can store 8.5 GB

Current Mediums

- Blue-ray
  - Named after blue laser used to read/write the data
  - Official acronym is BD
  - holds about 25 GB of data
  - double layer can store 50 GB

Binary Numbers

Chapter 1.3

What is a Number?

- We use the Hindu-Arabic Number System
  - positional grouping system
  - each position represents a power of 10
- Binary numbers
  - based on the same system
  - use powers of **2** rather than 10

Base 10 Number

The number 1783 is ...

10^4	10^3	10^2	10^1	10^0
10000	1000	100	10	1
0	**1**	**7**	**8**	**3**

1000 + 700 + 80 + 3 = 1783

Binary Number Example

The number 0110 1001 is ...

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
0	**1**	**1**	**0**	**1**	**0**	**0**	**1**

64 + 32 + 8 + 1 = 105

Binary Number Example

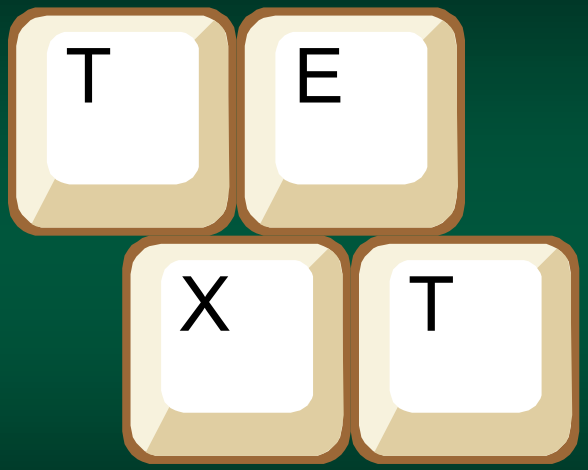
The number 1101 1011 is ...

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	**1**	**0**	**1**	**1**	**0**	**1**	**1**

128 + 64 + 16 + 8 + 2 + 1 = 219

Bits and Bytes

- Everything in a *modern* computer is stored using combination of ones and zeros
- Bit is one binary digit
  - either 1 or 0
  - shorthand for a bit is b
- Byte is a group of 8 bits
  - (Europe did not like the name so they call it an ***octet***)
  - e.g. **`0010 0100`**
  - shorthand for a byte is B

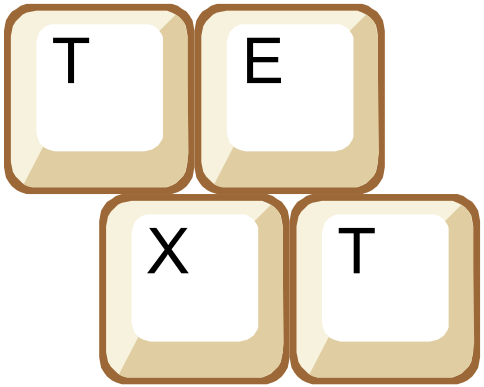


Text in Programming Languages

Chapter 1.3

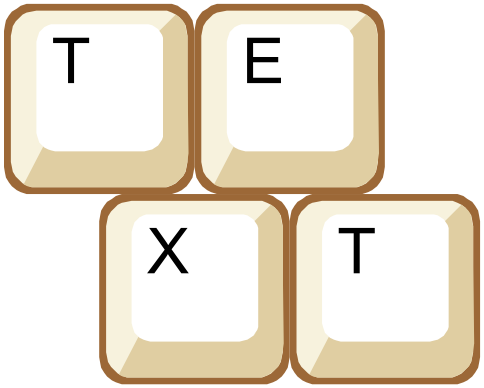
Characters

- Computer often store and transmit textual data
- Examples:
  - punctuation
  - numerals 0 – 9
  - letter
- Each of these symbols is called a *character* and are the basis for written communication



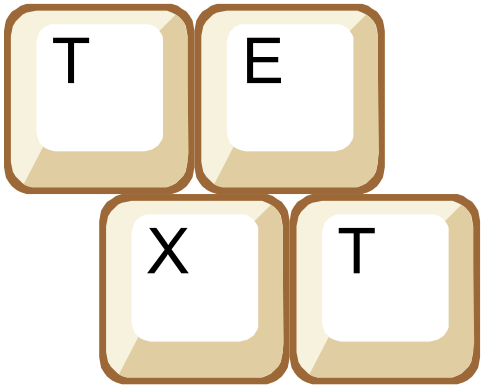
Characters

- Processors rarely know what a "character" is, and instead store each as an integer
- In this case, each character is given a unique value
- The letter "A", for instance, could have the value of 1, "B" is 2, etc…



Characters

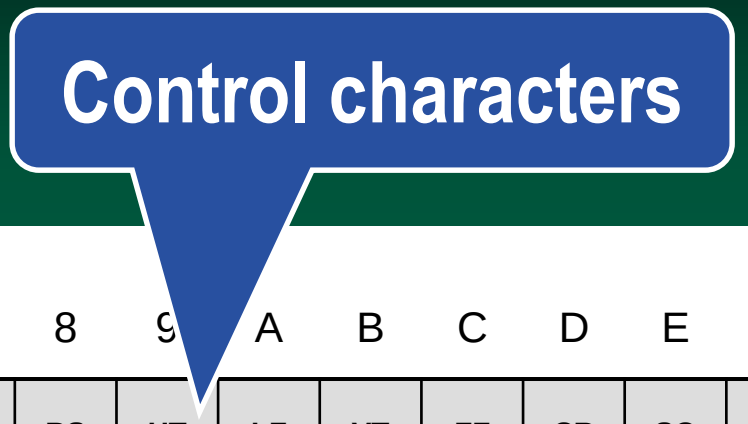
- Characters and their matching values are a *character set*
- There have been many characters sets developed over time



Character Sets

- ASCII
  - 7 bits – 128 characters
  - uses a full byte, one bit is not used
  - created in the 1967
- EBCDIC
  - Alternative system used by old IBM systems
  - Not used much anymore\

ASCII Chart



	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	sp	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

ASCII Codes

- Each character has a unique value
- The following is how "Moe" is stored in ASCII

	Binary	Decimal
M	01001101	77
o	01101111	111
e	01100101	101

Useful Control Characters

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	sp	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

Unicode Character Set

- ASCII is only good for the United States
  - Other languages need additional characters
  - Multiple competing character sets were created
- Unicode was created to support every spoken language
- Developed in Mountain View, California

Unicode Character Set

- Originally used 16 bits
  - that's over 65,000 characters!
  - includes every character used in the World
- Expanded to 21 bits
  - 2 million characters!
  - now supports every character ever created
- Unicode can be stored in different formats

How a Program Works

Chapter 1.4

How a Program Works

- The CPU does all the operations on the computer
- Each operation is called an *instruction*
- The collection of the instructions that be performed on a computer is its *instruction set*

How a Program Works

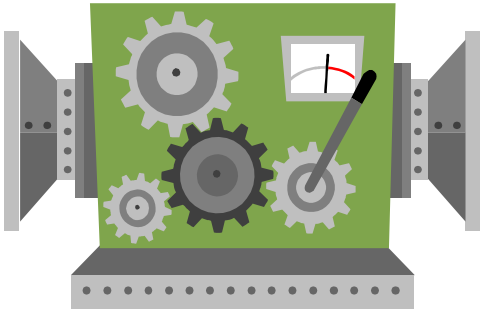
- Examples:
  - read a piece of data
  - add two numbers
  - multiply two numbers
  - moving data around
  - comparing two pieces of data
  - etc…

How a Program Works

- Computer programs, just like everything else on a computer, are just 1's and 0's
- So, the processor only reads, and "understands", binary
- These binary instructions are called *machine language*

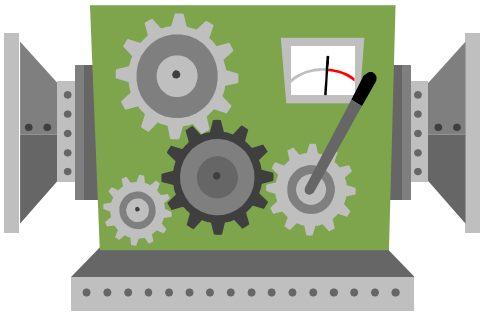
Fetch-Decode-Execute

- When a program is executed, the processor needs to perform three tasks
- These are referred to the *Fetch-Decode-Execute* cycle



Fetch-Decode-Execute

1. Fetch – read the next machine language instruction from memory
2. Decode – Look at the 1's and 0's and determine what it does
3. Perform the operation

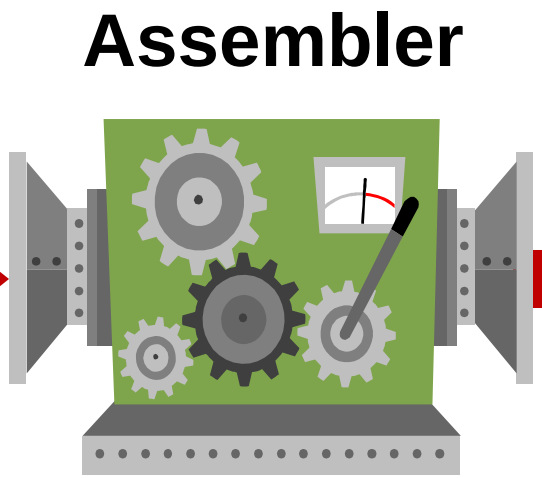


Assembler

- Converts assembly into machine code
- Each computer instruction is written using a *mnemonic* – a short name for the instruction
- Programmers have the full power of the processor – but have to write programs carefully

Assembler

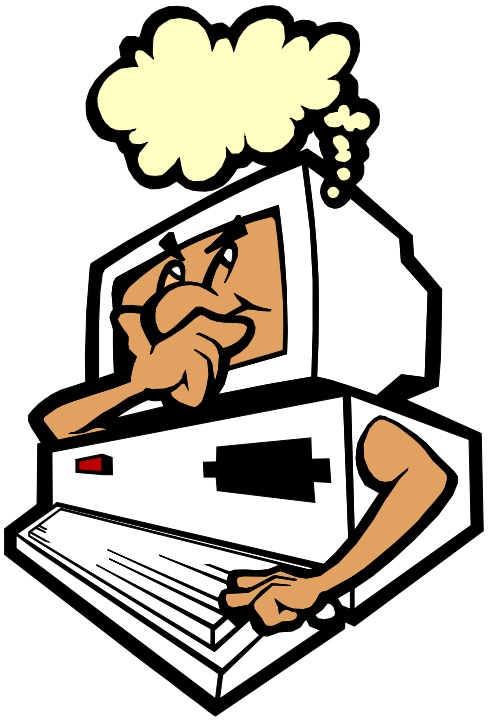
```
mov $1846, %ax
add $42, %ax
mov $list, %bx,
mov $5, %di
mov %ax, (bx,di)
```




```
00010011
10100010
00100101
10011101
10100010
```

High-Level Programming

- Most programs are written in languages such as C#, Java, Visual Basic, etc…
- These are *high-level languages* which are written in simple readable text
- Programs written this way are referred to as *source code*



Programming Languages

- *Language*
  - series of symbols & words that form a meaningful pattern
  - This is true of spoken languages such as English, Spanish, Hindi, Arabic, etc...
- *Programming*
  - language used to write programs
  - there many different programming languages

Example Programming Languages

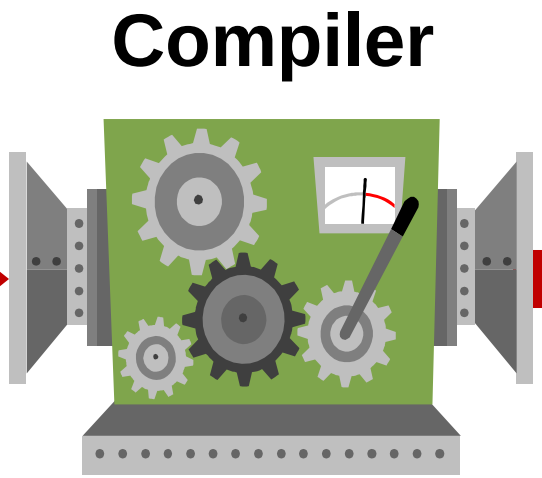
- Ada
- BASIC
- FORTRAN
- COBOL
- C
- C++
- C#
- Java
- JavaScript
- Python
- Ruby
- Visual Basic .NET

Compilers and Interpreters

- *Compilers*
  - convert a high-level language directly to assembly or machine code
- *Interpreters*
  - looks at a high-level language and executes it immediately – using its own code
  - similar to the concept of macros – which might have heard about

Compilers

```
a = 1846;
a += 42;
list[5] = a;
```




```
mov $1846, %ax
add $42, %ax
mov $list, %bx
mov $5, %di
mov %ax, (bx,di)
```

Integrated Development Environments

- Many high-level languages are written in a *Integrated Development Environment* (also called a Integrated Design Environment)
- It is a program designed to help the programmer create the program
- Contains features for debugging, managing, compiling, etc…

Types of Software

Chapter 1.5

Software Major Categories

- System Software
  - runs programs & manages data
  - operating System – Windows, Mac-OS
  - includes utility programs
- Application Software
  - works with the user to perform a task
  - example: Microsoft Word, Solitaire

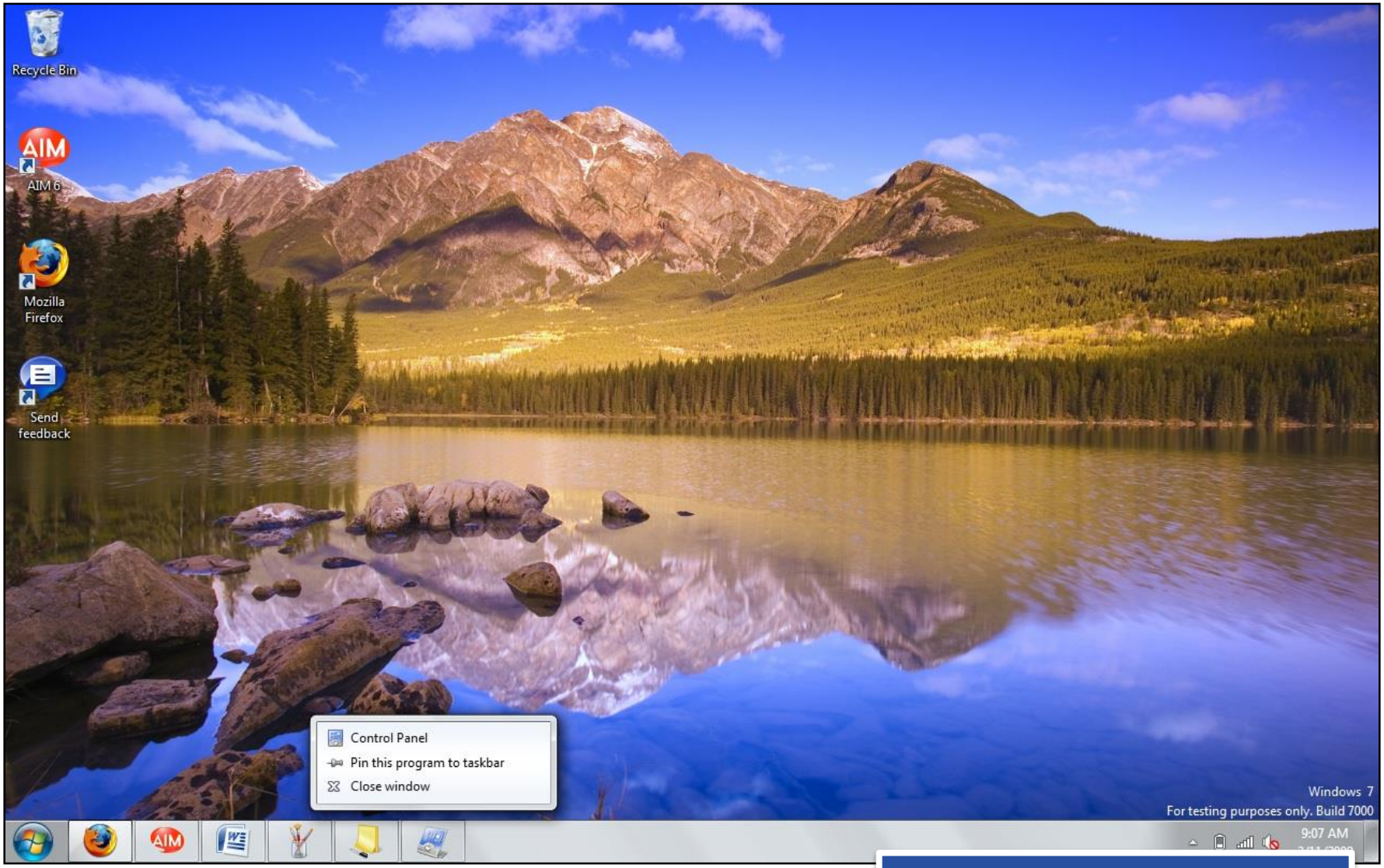
What an Operating System Does

- Master controller for all of the activities that take place within a computer
- Basic Duties:
  - memory management
  - track resources
  - communicate with devices
  - interact with application software
  - interact with the user

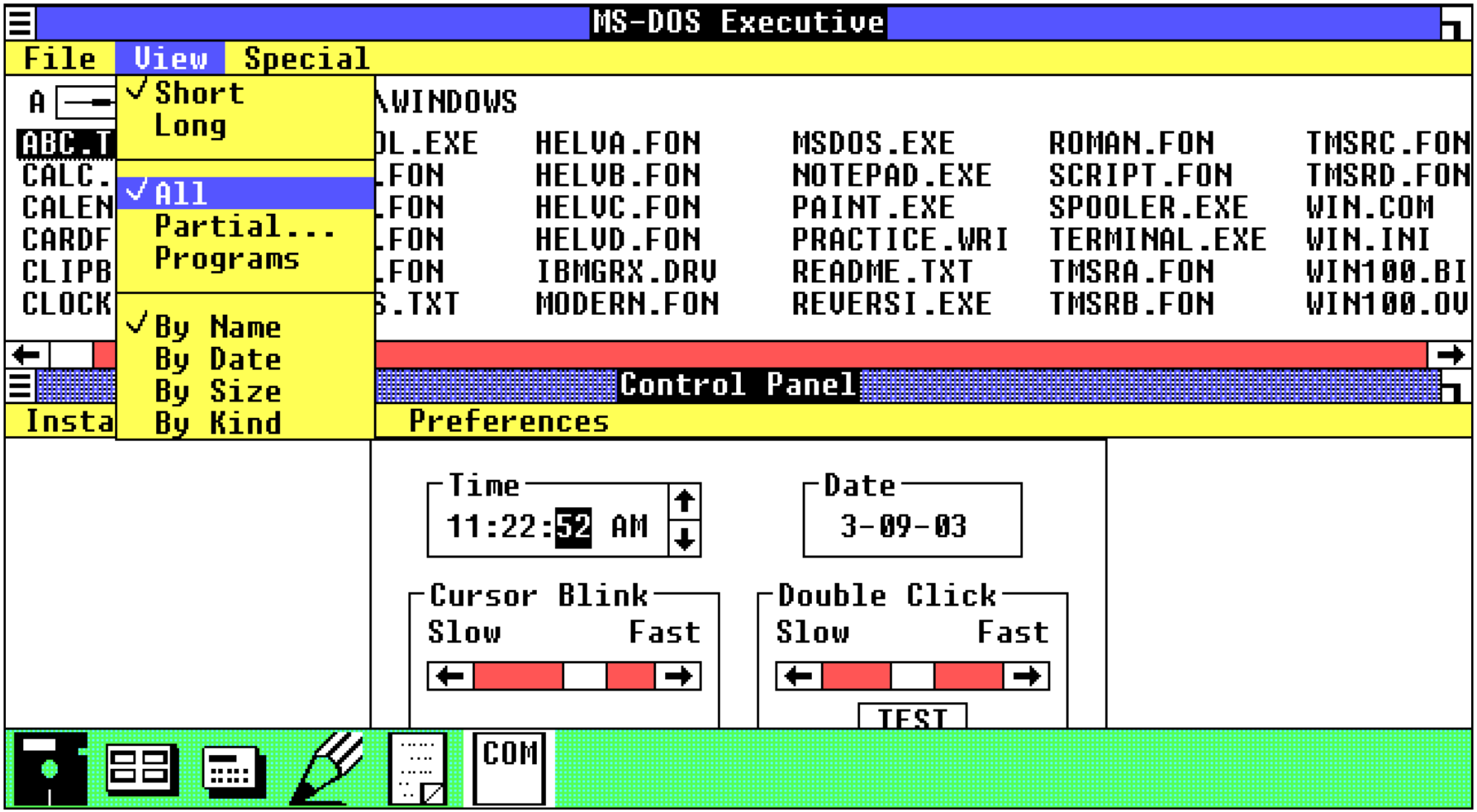
Microsoft Windows

- Created by Microsoft
- The most common operating system on Intel-PCs
- Major Versions:
  - Windows XP – 2001
  - Windows Vista – 2007
  - Windows 7 – 2010
  - Windows 8 - 2012


My Computer
My Documents
Download
GOLD
Shared
Fall 2006
Devin
Mozilla Firefox
Internet Explorer
Microsoft Office Outlook 2003
Notepad
Microsoft Office Word 2003
Microsoft FrontPage
Adobe Photoshop 5.0
Microsoft Visual Basic 6.0
Microsoft Office PowerPoint 2003
All Programs
My Documents
My Pictures
My Music
My Computer
My Network Places
Control Panel
Set Program Access and Defaults
Connect To
Printers and Faxes
Help and Support
Search
Run...
Log Off
Turn Off Computer
start
1:35 PM
Windows XP


Recycle Bin
AIM 6
Mozilla Firefox
Send feedback
Control Panel
Pin this program to taskbar
Close window
Windows 7
For testing purposes only. Build 7000
9:07 AM

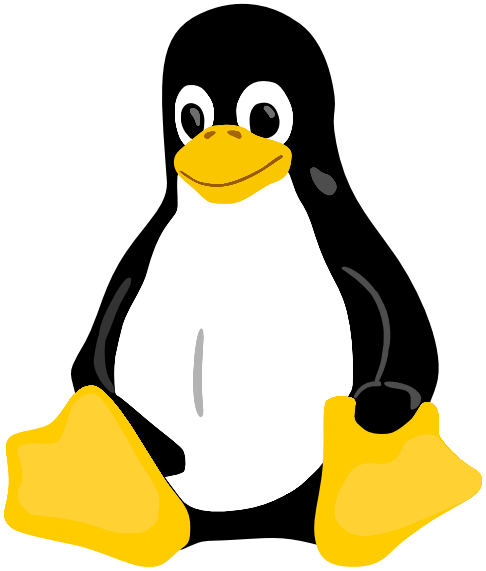
Windows 7

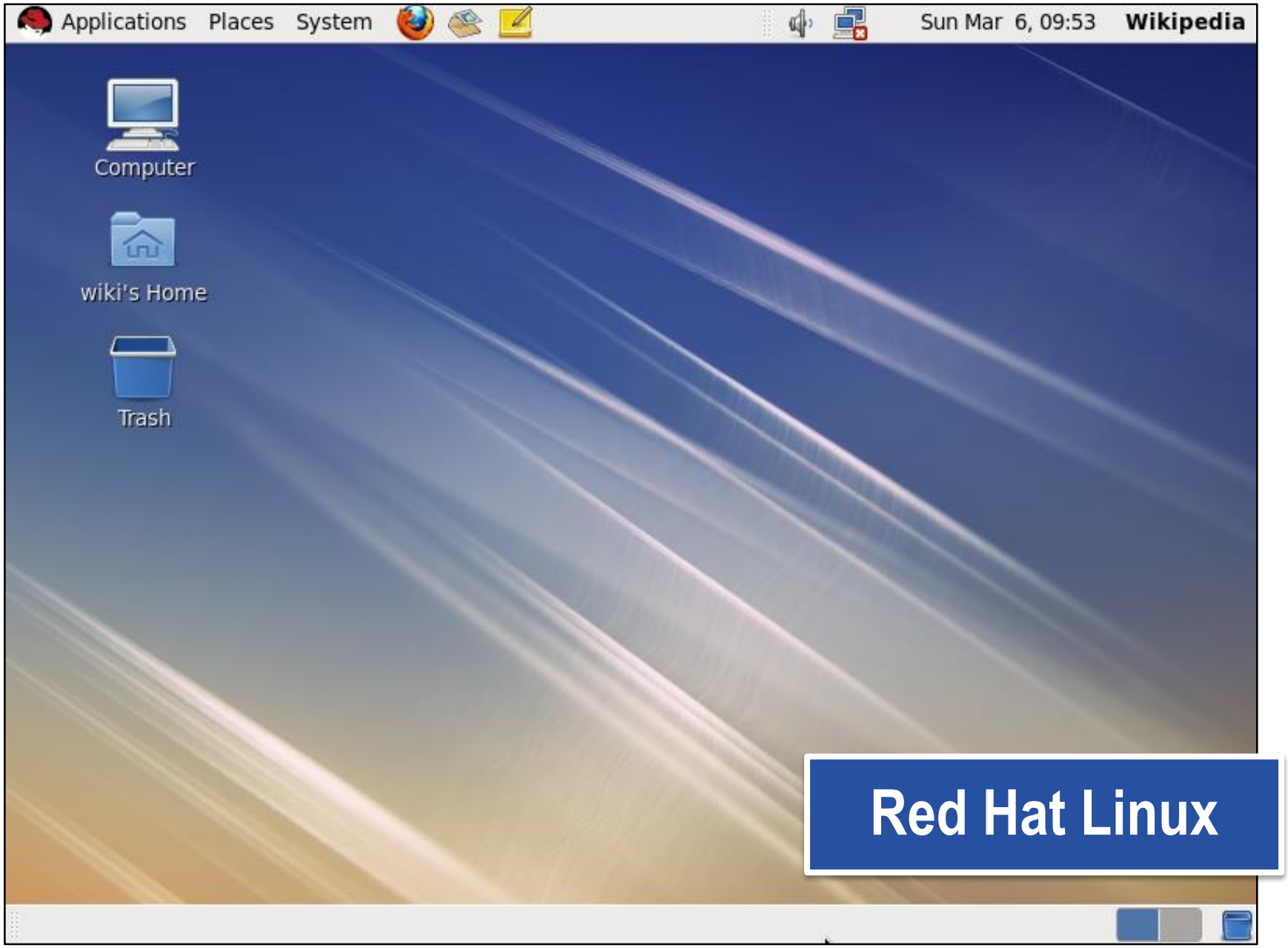

MS-DOS Executive
File
View
Special
Short
Long
All
Partial...
Programs
By Name
By Date
By Size
By Kind
\WINDOWS
DL.EXE
HELVA.FON
MSDOS.EXE
ROMAN.FON
TMSRC.FON
.FON
HELVB.FON
NOTEPAD.EXE
SCRIPT.FON
TMSRD.FON
.FON
HELVC.FON
PAINT.EXE
SPOOLER.EXE
WIN.COM
.FON
HELVD.FON
PRACTICE.WRI
TERMINAL.EXE
WIN.INI
.FON
IBMGRX.DRV
README.TXT
TMSRA.FON
WIN100.BI
S.TXT
MODERN.FON
REVERSI.EXE
TMSRB.FON
WIN100.OV
Control Panel
Preferences
Time
11:22:52 AM
Date
3-09-03
Cursor Blink
Slow
Fast
Double Click
Slow
Fast
TEST
COM

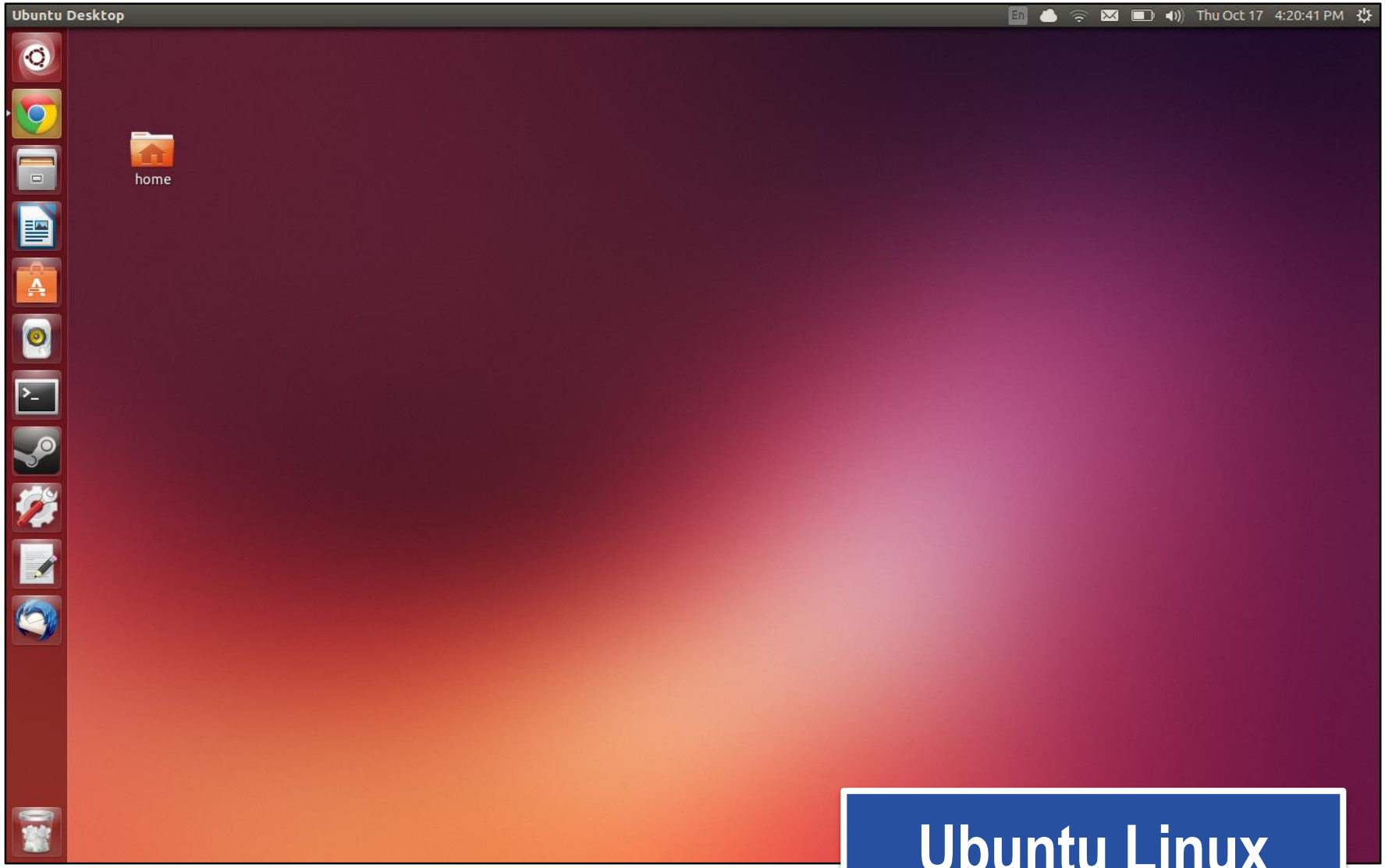
Windows 1

Linux

- Evolved from UNIX
- Multiple competing versions
  - Red Hat
  - Ubuntu
  - Android phones
  - etc....
- Popular for small servers & computer science workstations




Applications
Places
System
Sun Mar 6, 09:53
Wikipedia
Computer
wiki's Home
Trash
Red Hat Linux


Ubuntu Desktop
En
Thu Oct 17 4:20:41 PM
home
Ubuntu Linux

Apple Mac-OS

- Created by the Apple Corporation for the Macintosh
- Major Versions:
  - System 1 – 1984
  - System 6 – 1988
  - System 7 – 1991
  - Mac-OS X – 2001


Finder File Edit View Go Window Help
Mon 9:09 PM
About This Mac
Mac OS X
Version 10.4.6
Software Update...
Processor 1.5 GHz PowerPC G4
Memory 512 MB DDR SDRAM
More Info...
TM & © 1983-2006 Apple Computer, Inc.
All Rights Reserved.
Macintosh HD
About Finder
Finder
The Macintosh Desktop Experience
Finder version 10.4.4
™ and © 1983-2005 Apple Computer, Inc.
All Rights Reserved.
Remove from Dock
Open at Login
Show In Finder
Open