Lecture 3. Software.

SULEYMAN DEMIREL UNIVERSITY

What will we learn today?

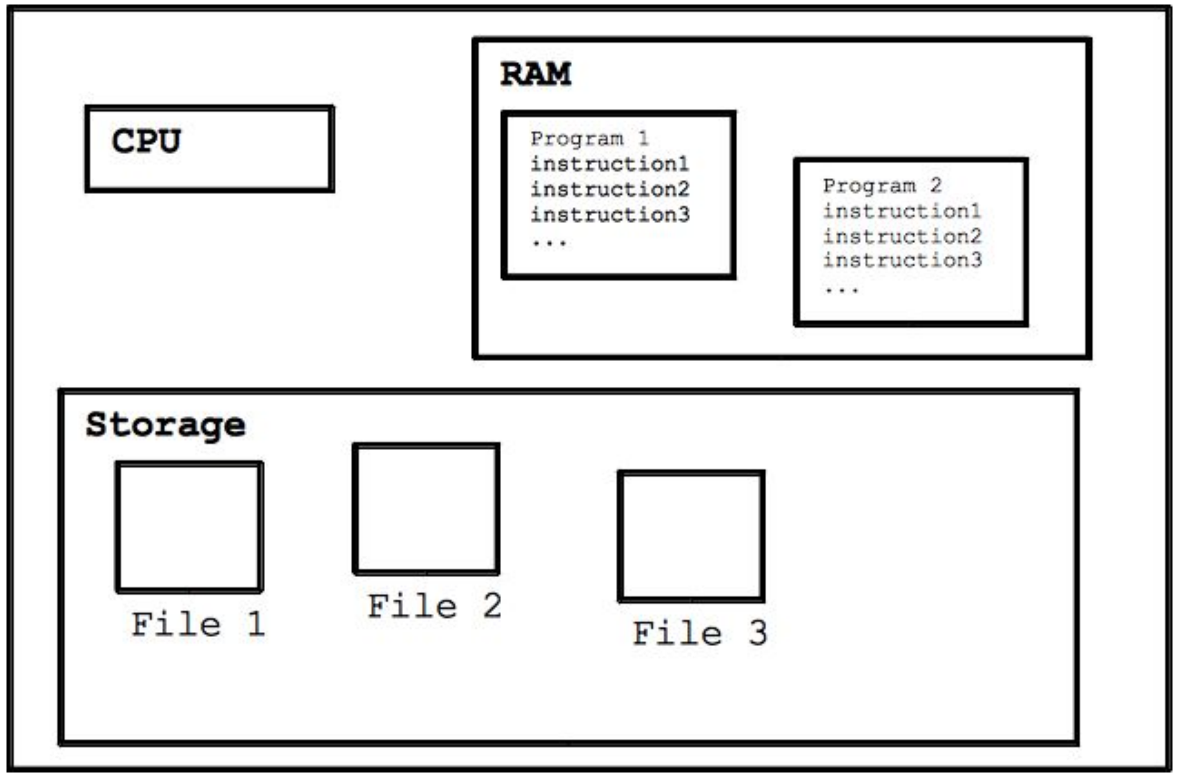
- How to run software on a computer?
- What is a machine code?
- Instructions
- Assembly Language
- Little man computer
- What are programming languages
- Why there are many PLs
- Types of PLs (object-oriented, functional, imperative, declarative)
- What is operating system?
- Types of OS
- Types of software

Hardware Major Parts

CPU - “brain with a mouth” to eat instructions from memory and produces output out of them...

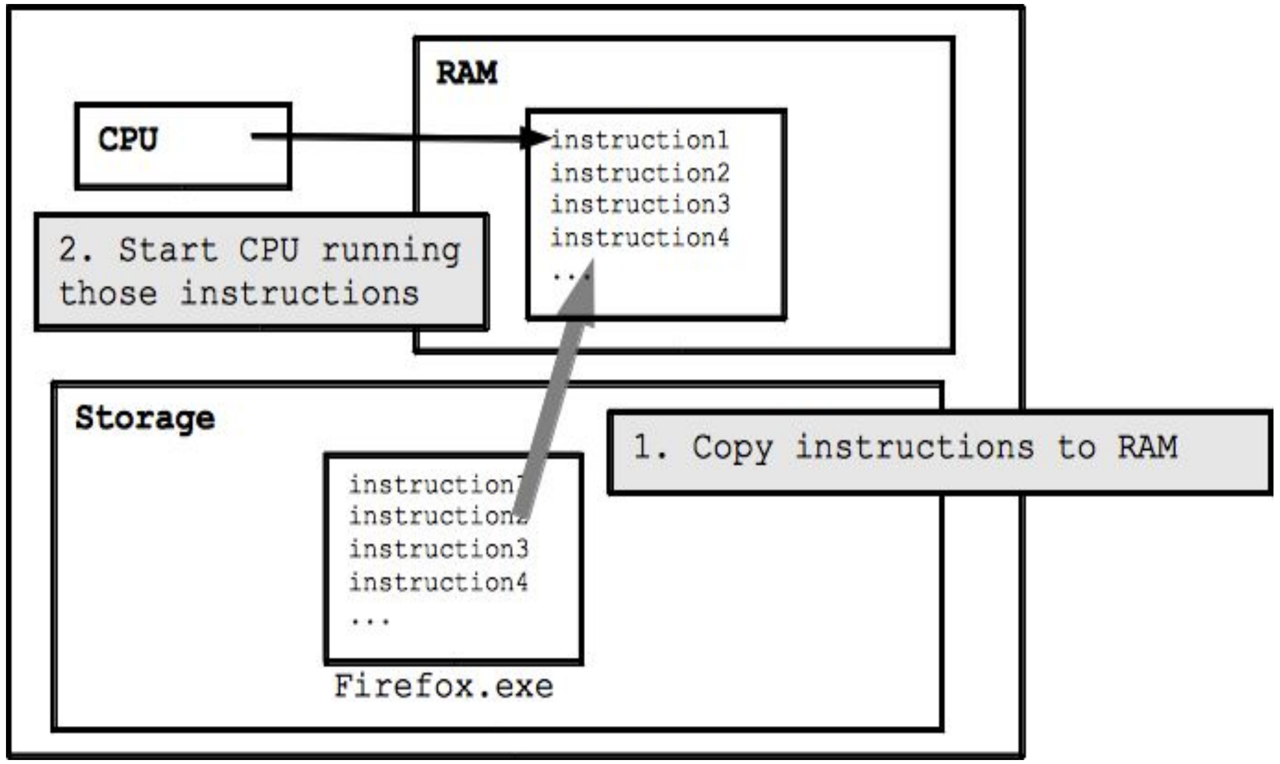
RAM: memory that CPU can access directly. Access time to RAM is faster than that of hard disk. But RAM is smaller in size and more expensive than hard disks.

Storage: larger memory than RAM but with a slower access and cheaper in cost (e.g. hard disks, flash memory, CD/DVD)

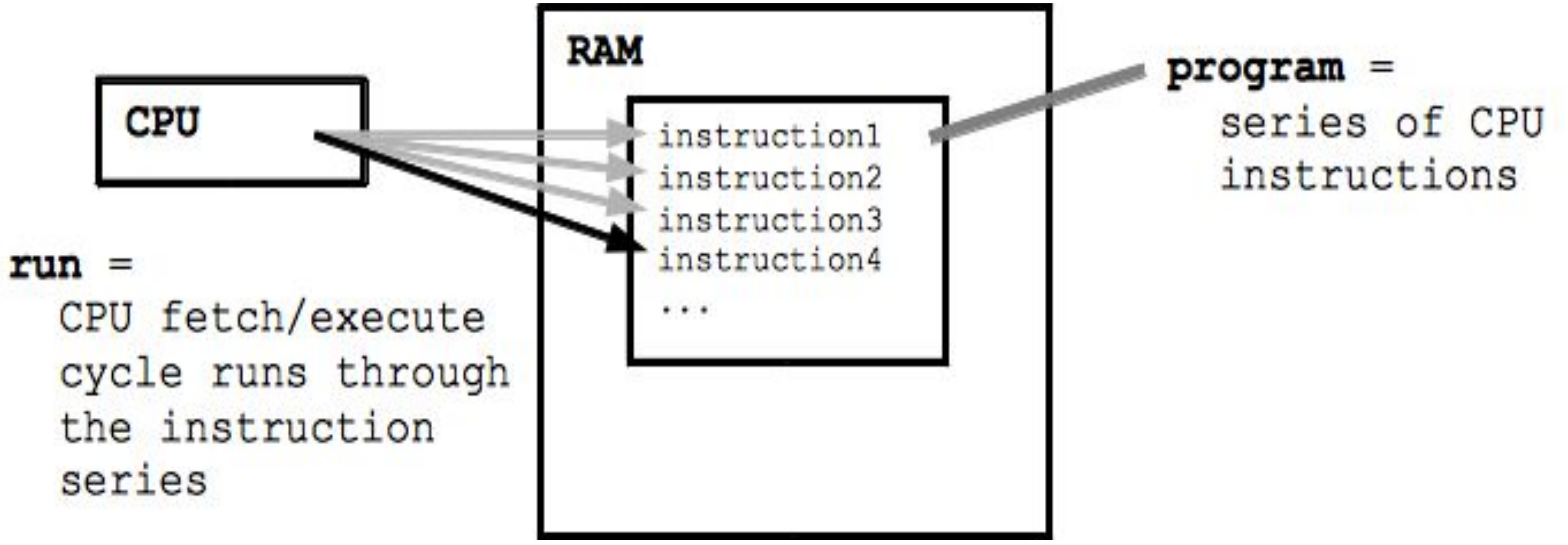


How program starts

- A program, like Firefox.exe (.exe is a Windows convention)
- Firefox.exe is just a file -- can look at it in the file system
- The file Firefox.exe is basically the bytes of millions of instructions
- Double click Firefox.exe to Run
- The instruction bytes are copied up into RAM
- The CPU is directed to start running at the first instruction



Relation between CPU, RAM and program


CPU
RAM
instruction1
instruction2
instruction3
instruction4
...
run =
CPU fetch/execute cycle runs through the instruction series
program =
series of CPU instructions

Software: machine code

- Software - code that runs on the hardware
- CPU implements "machine code" instructions
- Each machine code instruction is extremely simple
  - e.g. add 2 numbers
  - e.g. compare 2 numbers

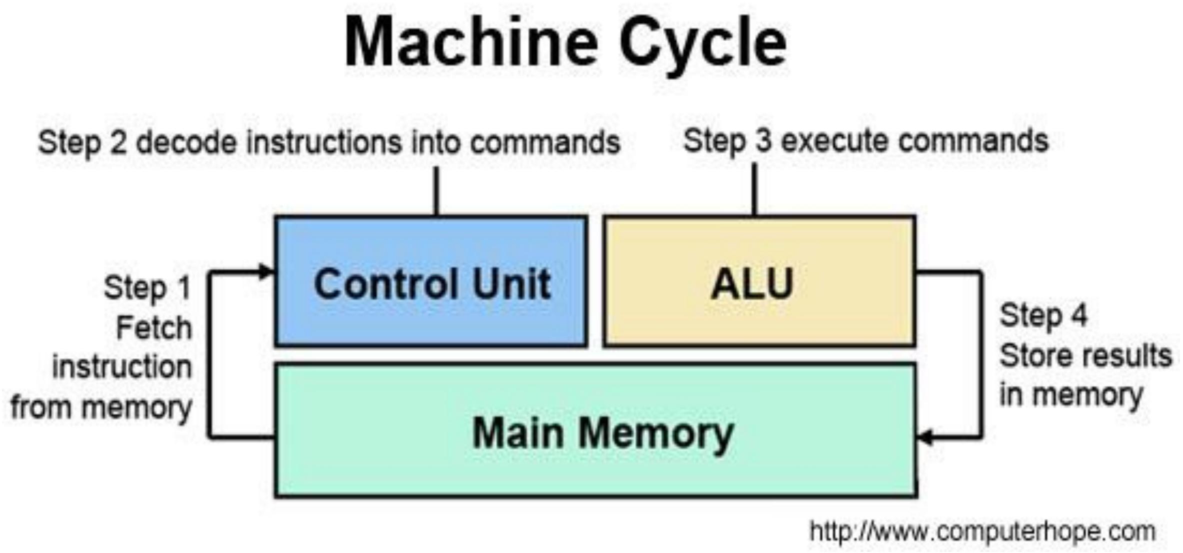
- The language of the machine code is hardwired into the design of the CPU
  - it is not something that can be changed
  - Each family of compatible CPUs (e.g. the very popular Intel x86 family) has its own machine code which is not compatible with the machine code of other CPU families.

Software: machine code

CPU is capable of performing simple instructions if you load them into RAM. For example, addition/subtraction of two numbers, jumping to another instruction. While CPU is performing an instruction, the temporary results are stored inside CPU itself in the fastest, smallest memory locations – registers.

CPU starts by fetching an instruction from RAM and then executes/performs it. Then again fetches and executes... This is all CPU does.

Initially all programs are on hard disk. When user double-clicks a program icon the machine instructions of that program get loaded to RAM where CPU can access them and execute.


Machine Cycle
Step 2 decode instructions into commands
Step 3 execute commands
Step 1 Fetch instruction from memory
Control Unit
ALU
Step 4 Store results in memory
Main Memory
http://www.computerhope.com

What are the instructions?

CPU has list of defined instructions, such as:

add values

store values

copy values

increment value

go to command

What is assembly language

Example: Signals sent to CPU

(10110000 01100001) (read in hex B0 61)

B0 means “Move a copy of the following value into AL (place in a memory)”

Value in AL memory is equal to 61 in hexadecimal

CPU understands only electrical signals, such as:

(10110000 01100001)

But to be understandable to programmers, assembly languages were created.

Assembly languages use words instead of binary commands.

Little Man Computer

- The Little Man Computer (LMC) is an instructional model of a computer.
- The LMC is generally used to teach students, because it models a simple architecture computer - which has all of the basic features of a modern computer.
- It can be programmed in machine code or assembly code

Try it: Little Man Computer

- http://robowriter.info/little-man-computerhttp://robowriter.info/little-man-computer/
- http://peterhigginson.co.uk/LMC/

Little Man Computer

Mnemonic Code	Numeric Code	Instruction
INP	901	Input data
ADD	1xx	Add data
SUB	2xx	Subtract data
STA	3xx	Store data
LDA	5xx	Load data
BRA	6xx	Branch to specified cell
BRZ	7xx	If 0, branch to a specified cell
BRP	8xx	If 0 or positive, branch to a specified cell
OUT	902	Output data
HLT	000	Break execution

xx is the cell number in the memory compartment.

PL vs Assembler

```
if(a > 2)
    b = 3;
else
{
    b = 5;
    c = 8;
}
a = 8;
```

```
MOV A, 200
LGR #2
JZ ELSE
MOV 201, #3
JMP END
ELSE:
MOV 201, #5    ; b = 5;
MOV 202, #8    ; c = 8;
END:
MOV 201, #8    ; a = 8
```

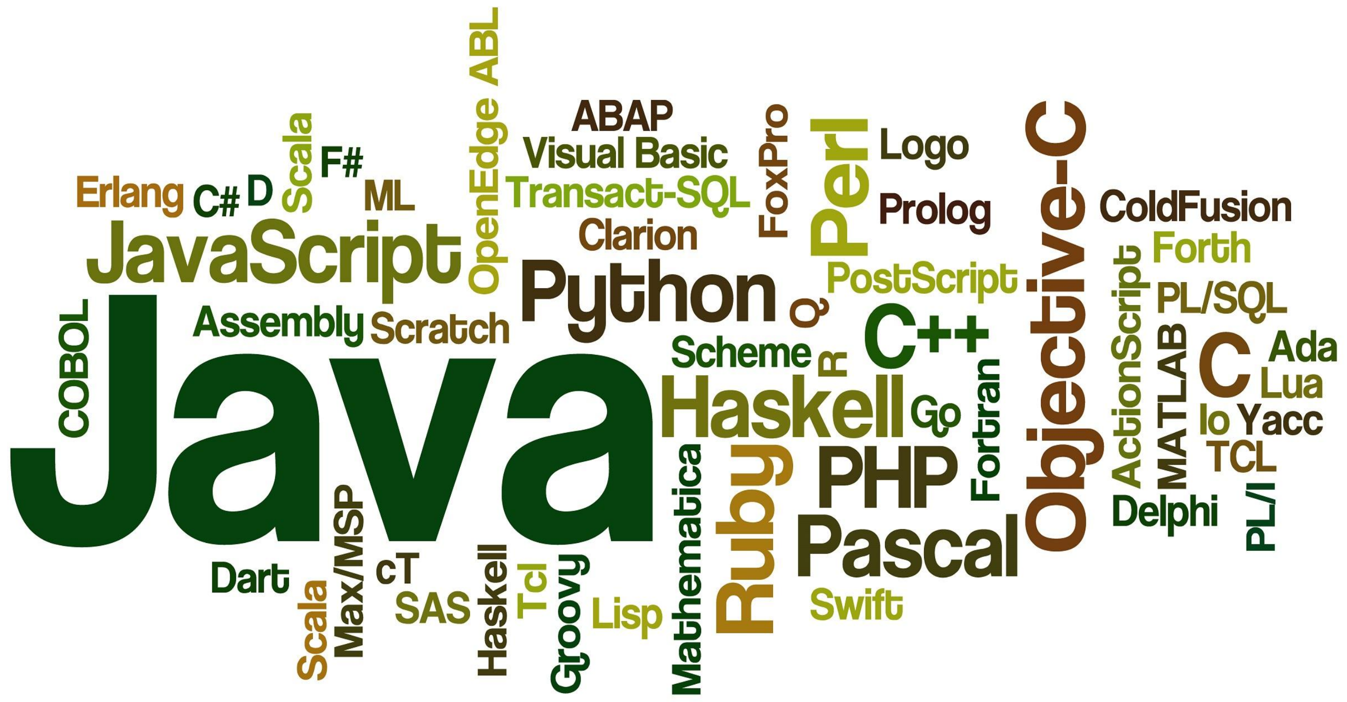
Programming languages (PL)

- PL are translated into machine code
- PL were created to make developing software simple
- Programming Languages has more abstractions
- Like arrays, lists, classes
- functions and etc.
- Programming Languages has more extra lines of code

Why there are many PLs?

People take ideas from different languages and combine them into a new languages. Some features are improved, some are added, some are removed.

Some are modifications of previous languages, like C++ is next step of C, and Java is some modification of C++



Important PLs

- Java - used in web applications, software systems, where software needs security, and frequent changes
- C++ - used in games, and software where speed is the most important. (Windows is written in C++)
- Python - writing software is much faster. Used by scientists because it is easy.
- Ruby - easy to understand, and write complex applications
- PHP - develop fast web-applications
- Javascript - to perform operations in web-browser

Website with more information about different PLs:

http://programming.dojo.net.nz/welcome/index

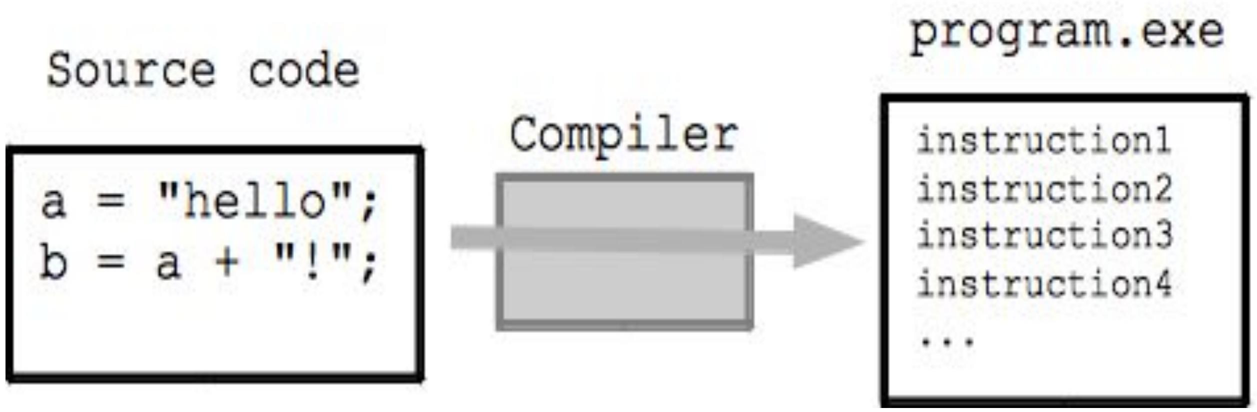
PL comparison

This table has ***imaginary*** numbers. But this numbers shows some intuition

Programming Language	**Execution time**	**Development time**	**Learning time**
Assembler	5ms	14 days	2 years
C	15ms	8 days	1 year
C++	25ms	4 days	1 year
Java	100ms	1 day	6 month
Python	500ms	6 hours	4 month

Computer languages

Programmers write code in a "high" level programming language whereas CPU understands very simple "low" level language.
Programmers say more in less words.
Need for translation from high to low level.
Source code = code in high level language like C++, Java, Python etc.
Compiler = translator from high level to low level CPU/machine language



```
a = "hello";
b = a + "!";
```

```
instruction1
instruction2
instruction3
instruction4
...
```

Compilation Process

Declarative and Imperative languages

- Imperative - The focus is on what steps the computer should take rather than what the computer will do (ex. C, C++, Java).

- Declarative - The focus is on what the computer should do rather than how it should do it (ex. SQL, Scala, Haskell, Erlang).

Declarative programming is when you say what you want, and imperative language is when you say how to get what you want.

Operating system

- What starts Firefox?
- Operating System
- Set of supervisory programs, run when computer first starts
- Administration behind the scenes
- Starting/managing/ending other programs
- Modern computers can run multiple programs at the same time
- Operating system keeps each program run isolated
- Program has its own RAM, its own windows on screen

Modern operating systems: functions

Functions:

Program execution

Memory management

Multitasking

Disk access and file systems

Networking

Security

Operating systems: Desktop

There are three main families of operating systems:

Linux

Fedora, Ubuntu, RedHat, Suse

mostly free

mostly open-source (customizable)

Windows

Most widespread operating system

Windows 3.1, Windows 98, Windows ME, Windows XP, Windows Vista, Windows 7, Windows 8, Windows 10

Operating system is a property of Microsoft

OSX

bundled in Mac computers

cannot work with other computers

well-known for its' pretty and intuitive user interface

Mobile operating systems

- Android
- IOS
- Windows Phone
- Ubuntu Touch OS
- BlackBerry OS

Mobile OS: features

Android

developed by Google

free to manufacturers

to create applications, pay only 20$ and immediately publish

IOS

developed by Apple

only in Apple products

pay 100$ and then wait for approve of developed application

Mobile OS: features

Ubuntu touch OS:

couldn’t find money for publishing

main idea: one OS on mobile phone and desktop computer

BlackBerry:

was popular for its ciphering technology

Windows Phone:

becoming popular in last years

Types of software

Drivers - a device driver or software driver is a computer program allowing OS to interact with a hardware device.

Operating systems have computer-line interface (CLI) to control OS through predefined commands.

Open Source

Some software are published not in form of executable file but in form of code, that is called open-source.

Anyone can change code, and produce his own version of product.

List of notable open-source software: Ubuntu, Firefox, GIMP, Blender, Android, LibreOffice, MySQL