Operating systems

Operating Systems Classification

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Main OS

- OS can be classified according to different criteria
- A possible classification is related to the application domain
  - Scientific computing, services, web, etc.
    - Supercomputing, mainframe, server, workstation, desktop, laptop
  - Special applications
    - Real-time (e.g., safety critical, aerospace), embedded systems (automotive)
    - Handlet device (e.g., bar-code scanners, Personal Digital Assistant, Smartwatch, etc.), smart card

Main OS: Diffusion

All Devices	
SO	**Market**
Android	42.61%
Windows	30.66%
iOS/Mac OS	16.55%
OS X	6.50%
Linux	0.98%
Altri	1.54%

Server	
SO	**Market**
Windows	72.10%
Linux	13.60%
Unix	5.60%
Altri	9.60%

September 2021
http://www.netmarketshare.com/

Windows: 85.23%

Desktop, laptop, etc.	
SO	**Market Share**
Windows 10	58.93%
Windows 7	23.35%
Mac OS X 10.15	4.50%
Windows 8.1	2.95%
Ubuntu	2.57%
Mac OS X 10.14	2.15%
Mac OS X 10.13	1.23%
Linux	1.01%

Windows

- Microsoft
  - Founded in 1975 by Bill Gates and Paul Allen
  - In 1981 introduces MS-DOS
  - In 1985 introduces Windows
    - Operating system with graphical interface based on windows (from which the name)
    - Intel processors oriented
  - Controls 80%-90% of the desktop market (with different versions)
    - 16 bit (Windows 1.0, 1985 – Windows 3.1, 1992)
    - 16/32 bit (Windows 9x, 1993-2000)
    - 32/64 bit (from Windows NT onwards)

Windows: Versions

Server	**Windows NT 3.1, 3.5, 3.51, 4.0 (from 1993), Windows 2000, Windows Server 2003, 2003 R2, 2008, 2008 R2, 2012, 2012 R2**
Device - embedded	**Windows CE, Windows Embedded, Windows Phone, Windows Mobile, Windows RT, …**
Desktop	**Windows 1.01-3.2 (from 1985 to 1993)** **Windows 95, 98, ME (Windows 9x) (from 1993)** **Windows XP (from 2001)** **Windows Vista (from 2007): home, premium, business, enterprise, ultimate** **Windows 7 (from 2009): basic, premium, professional, enterprise, ultimate, thin PC** **Windows 8, 8.1 (from 2012): standard, pro, enterprise** **Windows 10 (from 2015), Windows 11 (from 2021)**

MAC OS

- Apple
  - From 1984 to 2001 offers MAC OS
    - OS graphic only version
    - Structural limits reached at the end of the ’90s due to the lack of
      - Preemptive multitasking
      - Protected memory
  - In 2001 introduces MAC OS X
    - Initially for the Macintosh computer
    - Initially backward-compatible with MAC OS
    - Based on the UNIX BDS architecture and 100% standard POSIX compliant

MAC OS X

- Initially MAC OS X was designed according to a micro-kernel structure
  - Services moved from kernel to user space
  - Communications among modules by means of **message exchange**
    - Performance issues due to frequent communications among user space processes and kernel
- Recent versions of MAC OS X use a three layer hybrid structure that includes
  - The most common UNIX utilities and shells
  - A native Java machine
  - The main scripting languages (Python, Perl, etc.)

MAC OS X: Characteristics

- Proprietary architecture, not open source
  - It can directly execute many GNU Linux programs (with makefile)
  - Micro-kernel
    - Easily extendable and adapted to new hardware architectures
    - High reliability (kernel has limited tasks)
  - High security
    - Limited diffusion
  - Expensive architectures and software
    - Market share mainly kept due to Apple appeal

UNIX/Linux

- UNIX designed in 1970 for programming the PDP11 (Digital minicomputer 1970-1990)
- Despite its quite high portability, many different versions were introduced during the '80s
  - Many organizations (e.g., the USA government) require its standardization
  - Different actual **implementations** may exist for each **standard** (distributed by different "vendors")
    - A **standard** specifies the OS interface
    - An **implementation** is often a subset of the standard

UNIX/Linux: Standard

ISO C	**1972: UNIX migrates form assembler to C language.** **Standard C language versions : ANSI C (1989), ISO C or C90 (1990), C94 (1994), ISO C o C99 (1999), C11 (2011)** **Some aspects on C99:** **https://www.skenz.it/cs/c_language/c99**
POSIX	**POSIX = Portable Operating System Interface** **Family of standards, proposed to promote UNIX systems portability** **Defines the services that a UNIX system must satisfy to be "POSIX compliant"** **Includes the ISO C standard**
SUS	**SUS = Single UNIX Specification** **Project developed from the '80s, POSIX superset.** **Defines what standards an OS has to comply with to qualify for using the "UNIX" trademark**

Unix: Implementations

- Different implementations of the UNIX operating system exist
  - AIX (IBM)
  - Digital Unix (Compaq)
  - HP-UX (Hewlett Packard)
  - IRIX (Silicon Graphics)
  - MacOS X (Apple)
  - FreeBSD (Free Software Foundation)
  - Solaris (Sun Microsystem)
  - Android (Android Inc. first, then Google from 2005)
  - Linux (Ubuntu, Fedora, Debian, etc.)

Linux: Implementations

- Linux
  - Created in 1991 by **Linus** Torvalds (Helsinki)
  - Developed starting from Minix (Tanenbaum)
    - non-commercial OS developed in 1987
  - Designed for educational purposes, rapidly becomes **open software** (main difference with respect to other UNIX systems)
    - Usage and development allowed according to "**GNU** Public License"
  - "Linux" identifies the "kernel"
    - Many distributions exist, but the common element is the kernel

Linux: Distributions

Distribution	Characteristics
Mint	User friendly; versions: Cinnamon, MATE, KDE, Xfce, LMDE
Ubuntu	Based on Debian; first release in 2002; complete and easy; proposes several official flavors: EduUbuntu (educational), Kubuntu (KDE), Kubuntu (Xfce), Lubuntu (Lxde/LXQT), Ubuntu Mobile, etc.
Debian	Includes open software only; first release in 1993 (very old)
Mageia	Fork of **Mandiva** (originally **Mandrake**) dismissed in 2017; available in versions KDE o GNOME
Fedora	Implemented by GNU/Linux, sponsored by Red Hat; first release in 1995
OpenSuSE	Derived from a commercial product (SuSE)
ArchLinux	Distribution for "geeks"
CentOS	For servers; first release in 2003

28.09.2021
www.distrowatch.com

Linux: Distributions

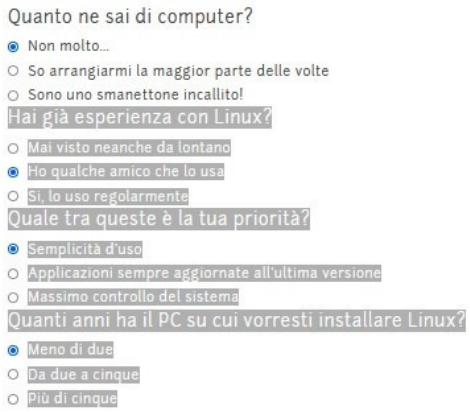
Last 12 months		
1	MX Linux	3304▲
2	Manjaro	2358▼
3	Mint	2050–
4	EndeavourOS	1960▲
5	Pop!_OS	1843▼
6	Ubuntu	1362▲
7	Debian	1282▼
8	elementary	1134–
9	Fedora	980▲
10	Garuda	880▲
11	openSUSE	826–
12	KDE neon	738–
13	Zorin	730▲
14	Solus	699–
15	Arch	569–
16	antiX	555–
17	deepin	508▼
18	Puppy	480▼
19	PCLinuxOS	458–
20	Kali	443–
21	Lite	440▼
22	CentOS	429–
23	ArcoLinux	424–
24	Linuxfx	421▼
25	FreeBSD	419▼
26	Slackware	415▲
27	Mageia	413–
28	Ubuntu Kylin	367▼
29	Q4OS	362▲
30	SparkyLinux	358–

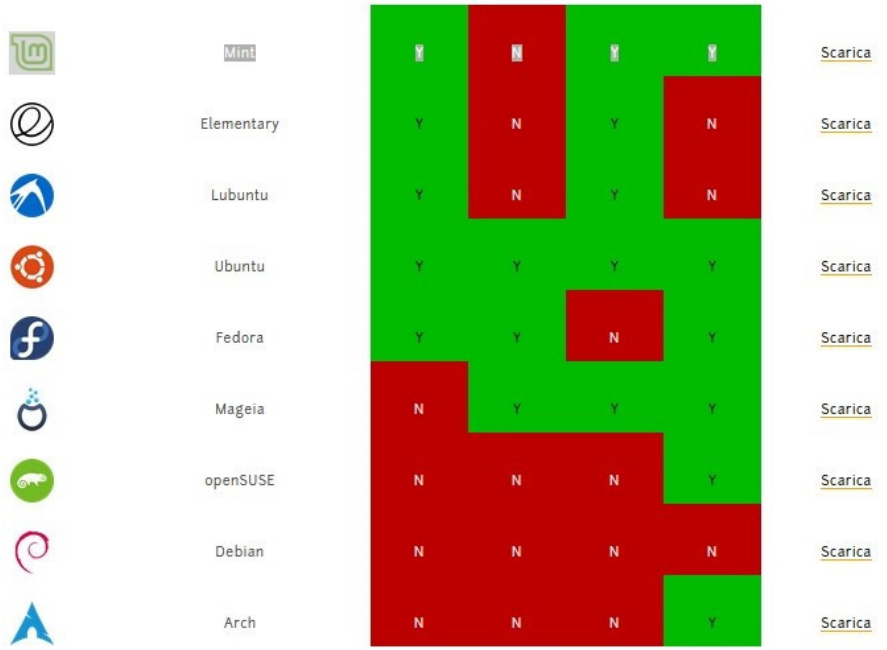
Last 6 months		
1	MX Linux	3163▲
2	EndeavourOS	2576▲
3	Manjaro	2244▼
4	Mint	1926▼
5	Pop!_OS	1546▼
6	Ubuntu	1334▲
7	Debian	1265▼
8	Garuda	1142▲
9	elementary	1130–
10	Fedora	937▼
11	Zorin	846▲
12	openSUSE	825–
13	KDE neon	690▼
14	Solus	609▼
15	antiX	544▼
16	Arch	511▼
17	Lite	471▲
18	Slackware	458▲
19	Artix	435▲
20	PCLinuxOS	427–
21	deepin	423▼
22	Kali	410–
23	Puppy	405▼
24	ArcoLinux	392▼
25	FreeBSD	359–
26	CentOS	355–
27	SparkyLinux	339▲
28	AlmaLinux	331▲
29	Mageia	330▼
30	Q4OS	320▲

Last 3 months		
1	MX Linux	3348▲
2	EndeavourOS	3102▲
3	Manjaro	2279▲
4	Mint	1917▼
5	Pop!_OS	1499–
6	Debian	1376▲
7	Ubuntu	1375▲
8	Garuda	1228▲
9	elementary	1166▼
10	Zorin	970▲
11	Fedora	835▲
12	openSUSE	725–
13	KDE neon	688–
14	Solus	669–
15	Artix	610▲
16	Lite	556▲
17	PCLinuxOS	524▲
18	antiX	512▲
19	Slackware	507▲
20	ArcoLinux	435▲
21	Kali	420▲
22	Arch	416▼
23	SparkyLinux	386▼
24	Puppy	385–
25	Q4OS	332▲
26	Tails	331–
27	Alpine	317▲
28	CentOS	317–
29	FreeBSD	313–
30	Devuan	303▲

Linux: Distributions

- Distributions differ for the following aspects
  - Choice of the software installed by default
  - Initial configurations
  - How it is easy to use
  - Optimization of hardware resources





28.09.2021
https://www.linux.it/distro/

Linux: Characteristics

- OS developed on a global basis
  - The 95% of Hollywood special effects and animations (e.g., Titanic 1997) are developed on Linux systems
  - Debian 4.0 complexity (2007)
    - 283 millions of code lines
    - Without relying on open source the development would require 73000 man-years and 8.16 billion dollars
- Many consider Linux the most advanced OS
  - Reference for kernel development

Linux: Curiosities

- Android
  - Uses a modified version of the Linux kernel
  - Does not adopt the same application of the GNU libraries
    - Linux usually uses the GNU C Library
    - Android usually uses the Bionic C library
  - In other words Android is a Linux distribution, but not a GNU/Linux distribution
    - "In 2018, Android dominated the mobile OS market with 75.16%. In other words 75% of all smartphones are based on Linux."

Comparison

- The comparison among Operating Systems
  - Is difficult
    - Different versions exist with different characteristics (desktop, server, mobile)
    - Prices and support depend on the versions
  - For each statement that you can find on a publication or on internet, another one can be found that contradicts the first

Comparisons

- Most of the debate often reduces to trivial statements
  - Windows:
    - not stable, expensive, not safe (viruses)
  - MAC OS X – IOS:
    - elegant, expensive, stable, proprietary, excellent for graphic applications
  - Linux:
    - Difficult to use, free and open source, stable, virus free, theoretically more efficient

Comparisons

- These considerations may apply only to obsolete OS versions
- Many considerations depend on the personal taste or on the current vogue
- In practice, different OS may co-exist and can be used for different tasks

Synoptic comparison

Characteristics	Windows	MAC OS X	Linux
Price	≥ 100$	≥ 100$	Free
Ease	Easy	Easy	Average
Reliability	Average	Good	Excellent
Software #	High	High	Good
Software cost	≥ 200$	≥ 200$	Free
Hardware support	Very large	Good	Average
Security	Average	Good	Excellent
Open Source	No	No	Yes
Support	Proprietary	Proprietary	Online

Why UNIX/Linux

- Why does the OS course focus on UNIX/Linux?
  - General reasons
    - Without a specific reference the course would be too much abstract
    - More references are not possible with 6 credits
    - Strong link with C programming language
    - Historical reasons
    - Many aspects and learned programs are useful in everyday life
    - Derived OSs used in many embedded devices
      - …and consumer products such as Raspberry PI (https://www.raspberrypi.com/)

Why UNIX/Linux

- Why does the OS course focus on UNIX/Linux?
  - Limits of alternatives
    - Windows
      - Already know
      - Not open
      - Subject of master's courses
    - MAC OS X – IOS
      - Expensive
      - Not available in laboratories
      - Similar to UNIX/Linux