```
#include <stdlib.h>
#include <string.h>
#include <ctype.h>

#define MAXPAROLA 30
#define MAXRIGA 80

int main(int argc, char *argv[])
{
    int freq[MAXPAROLA] ; /* vettore di contatori
    delle frequenze delle lunghezze delle parole */
    char riga[MAXRIGA] ;
    int i, inizio, lunghezza ;
    FILE * f ;

    for(i=0; i<MAXPAROLA; i++)
        freq[i]=0 ;

    if(argc != 2)
    {
        fprintf(stderr, "ERRORE, serve un parametro con il nome del file\n");
        exit(1);
    }

    f = fopen(argv[1], "rt") ;
    if(f==NULL)
    {
        fprintf(stderr, "ERRORE, impossibile aprire il file %s\n", argv[1]);
        exit(1);
    }

    while( fgets( riga, MAXRIGA, f ) != NULL )
```

Operating systems

Introduction to Operating Systems (part B)

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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, etc.), smart card

Main OS: Diffusion

Type	OS	Market Share
Desktop, laptop, etc.	Windows 7	47.21%
	Windows 10	29.00%
	Mac OS	6.35%
	Windows 8.1	5.89%
	Windows XP	5.69%
	Linux	3.04%
	Free BSD	0.10%
	Others	2.72%

Windows 90.79%

September 2018
http://www.netmarketshare.com/

Type	OS	Market
Servers	Windows	49.50%
	Apple	15.62%
	Linux based	19.13%
	Others	3.83%

Type	OS	Market
All devices	Android	48.61%
	iOS / OS X	11.04%
	Windows	14.00%
	Altri	26.34%

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)

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

➢ 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/Linux: Implementations

❖ AT&T Bell Laboratories, Berkeley Software Distribution (BSD), Free-BSD, Solaris (SUN Microsystems), MAC OS X, etc.

❖ Linux

  ➢ Developed starting from Minix (Tanenbaum)

    ▪ non-commercial OS developed in 1987

  ➢ Created in 1991 by **Linus** Torvalds (Helsinki)

  ➢ 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"

  ➢ Many distributions exist, but the common element is the kernel ("Linux" identifies 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

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

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