

Importance of Computers in Physics

Computers have become an integral part of physics research and education. They are used in all areas of physics, whether experimental or theoretical. They can be used to analyze and visualize data, communicate results, run experiments, and monitor equipment .

Computational methods have become an essential tool for physicists to simulate complex physical systems, such as the behavior of atoms and molecules. Computer simulations are also used to solve complex problems such as optimization and machine learning.

In physics education, computers play an important role in advancing learning. They can be used to analyze and visualize data, communicate results, run experiments, and monitor equipment. Some good computer programs that help in learning physics also exist.

Computational physics is the study and implementation of numerical analysis to solve problems in physics. It is sometimes regarded as a subdiscipline of theoretical physics, but others consider it an intermediate branch between theoretical and experimental physics — an area of study which supplements both theory and experiment.

In conclusion, computers have revolutionized the field of physics by providing physicists with powerful tools to simulate complex physical systems, solve complex problems, and advance learning. They have become an essential tool for physicists in all areas of research and education.

Operating Systems used by Physicists



There is no definitive answer to what operating systems are used by physicists, as different physicists may have different preferences and needs.

One of the most common operating systems used by physicists is **Linux**. Linux is an open-source operating system that is widely used for scientific computing and research. Linux has many advantages, such as:

1. It is free and customizable.
2. It has a large and active community of developers and users who contribute to its improvement and support.
3. It has a variety of distributions that cater to different needs and preferences, such as Ubuntu, Fedora, Debian, etc.



4. It has many pre-installed or easily available software and tools for data analysis, simulation, visualization, etc., such as Python, R, MATLAB, Octave, Gnuplot, etc.
5. It is compatible with most hardware and platforms, such as supercomputers, cloud servers, mobile devices, etc.

Some examples of Linux distributions that are specifically designed for scientific purposes are:

- **Bio-Linux**: A Linux distribution for bioinformatics that contains over 500 software packages for biological data analysis.
- **Fedora Scientific**: A Linux distribution for scientific and mathematical computing that includes software for statistics, numerical methods, programming languages, etc.
- **Scientific Linux**: A Linux distribution that is co-developed by Fermilab and CERN for high-energy physics research.

Linux is a versatile operating system that can be customized to meet the specific needs of physicists. It is also open-source, which means that users can modify the source code to suit their requirements.

In addition, Linux-based systems are known for their stability, security, and reliability. They are less prone to crashes and viruses than other operating systems. Linux is, therefore, very popular with physicists. Due to the familiarity with Linux based operating systems, physicists also use **macOS** developed by Apple, as both Linux and macOS can trace their origins to the UNIX operating system.



Another common operating system used by physicists is **Microsoft Windows**. Windows is a graphical operating system that is developed and marketed by Microsoft. Windows has some advantages, such as:

- It is widely used and familiar to most people.
- It has a user-friendly and intuitive interface.
- It has a large market share and support from various vendors and manufacturers.
- It has many commercial software and applications that are popular or exclusive to Windows, such as Microsoft Office, Adobe Photoshop, etc.

However, Windows also has some disadvantages, such as:

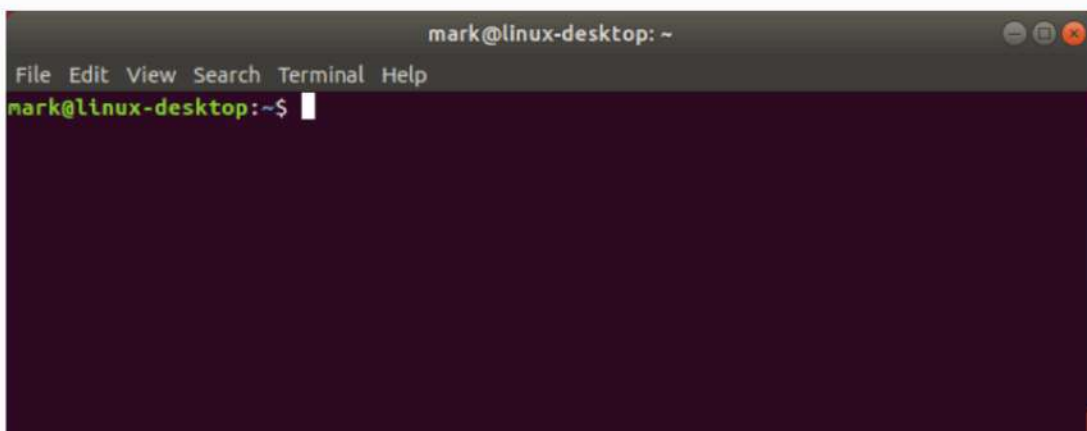
- It is expensive and requires a license to use.
- It has many security threats and vulnerabilities to viruses and malware.
- It is less customizable and flexible than Linux.
- It has less compatibility and support for some scientific software and tools than Linux.

There may be other operating systems that physicists occasionally use. These operating systems have their own advantages and disadvantages, depending on the user's needs and preferences. However, they are generally less popular or prevalent than Linux or macOS among physicists.

Thus, as physicists, it is important for us to familiarize ourselves with the Linux operating system.

Basic Linux Commands

You can type Linux commands in the **terminal** provided by the Linux system. The terminal is a command-line interface that allows you to interact with the system using text commands.



To know about the basic commands, here is a reference which you can refer to:



60 Essential Linux Commands + Free Cheat Sheet

This article will go over 60 basic to advanced Linux commands to help you get the mo...

www.hostinger.com

<https://www.hostinger.com/tutorials/linux-commands>

Here are a few basic commands:

- **ls** – lists a directory's content.
- **pwd** – shows the current working directory's path.
- **cd** – changes the working directory.
- **mkdir** – creates a new directory.
- **rmdir** – removes a folder or path.
- **rm** – deletes a file.
- **cp** – copies files and directories, including their content.
- **mv** – moves or renames files and directories.
- **touch** – creates a new empty file.
- **file** – checks a file's type.
- **zip and unzip** – creates and extracts a ZIP archive.
- **tar** – archives files without compression in a TAR format.
- **nano, vi, and jed** – edits a file with a text editor.
- **cat** – lists, combines, and writes a file's content as a standard output.
- **grep** – searches a string within a file.
- **sed** – finds, replaces, or deletes patterns in a file.
- **head** – displays a file's first ten lines.
- **tail** – prints a file's last ten lines.
- **awk** – finds and manipulates patterns in a file.

- **sort** – reorders a file's content.
- **cut** – sections and prints lines from a file.
- **diff** – compares two files' content and their differences.
- **tee** – prints command outputs in Terminal and a file.
- **locate** – finds files in a system's database.
- **find** – outputs a file or folder's location.
- **sudo** – runs a command as a superuser.
- **su** – runs programs in the current shell as another user.
- **chmod** – modifies a file's read, write, and execute permissions.
- **chown** – changes a file, directory, or symbolic link's ownership.
- **useradd and userdel** – creates and removes a user account.
- **df** – displays the system's overall disk space usage.
- **du** – checks a file or directory's storage consumption.
- **top** – displays running processes and the system's resource usage.
- **htop** – works like **top** but with an interactive user interface.
- **ps** – creates a snapshot of all running processes.
- **uname** – prints information about your machine's kernel, name, and hardware.
- **hostname** – shows your system's hostname.
- **time** – calculates commands' execution time.
- **systemctl** – manages system services.
- **watch** – runs another command continuously.
- **jobs** – displays a shell's running processes with their statuses.
- **kill** – terminates a running process.
- **shutdown** – turns off or restarts the system.
- **ping** – checks the system's network connectivity.

- **wget** – downloads files from a URL.
- **curl** – transmits data between servers using URLs.
- **scp** – securely copies files or directories to another system.
- **rsync** – synchronizes content between directories or machines.
- **Ifconfig** – displays the system's network interfaces and their configurations.
- **netstat** – shows the system's network information, like routing and sockets.
- **traceroute** – tracks a packet's hops to its destination.
- **nslookup** – queries a domain's IP address and vice versa.
- **dig** – displays DNS information, including record types.
- **history** – lists previously run commands.
- **man** – shows a command's manual.
- **echo** – prints a message as a standard output.
- **ln** – links files or directories.
- **alias and unalias** – sets and removes an alias for a file or command.
- **cal** – displays a calendar in Terminal.
- **apt-get** – manages Debian-based distros package libraries.

We shall practice some of these commands on the Linux terminal.

Text Editors

To write scientific programs for execution on the computer, we need to write the program on a text editor. We are free to use any text editors - whether it has a graphical user interface or it runs on the terminal.

Vi Text Editor

A screenshot of a terminal window titled "tburgess@localhost:~". The terminal displays the Vim startup screen, which includes the title "VIM - Vi IMproved", the version "version 8.0.133", and credits "by Bram Moolenaar et al.". It also mentions it was modified by "<bugzilla@redhat.com>" and states "Vim is open source and freely distributable". Below this, there are instructions on how to sponsor development, exit, get online help, or view version information. At the bottom right, it shows "0,0-1" and "All".

tburgess@localhost:~

File Edit View Search Terminal Help

VIM - Vi IMproved

version 8.0.133
by Bram Moolenaar et al.
Modified by <bugzilla@redhat.com>
Vim is open source and freely distributable

Sponsor Vim development!

type :help sponsor<Enter> for information

type :q<Enter> to exit

type :help<Enter> or <F1> for on-line help

type :help version8<Enter> for version info

0,0-1 All

Vi is a powerful and widely used text editor in UNIX and Linux operating systems. It allows you to create, edit and manage text files using keyboard commands. Here is a brief note on vi text editor:

- Vi has three modes of operation: **command mode**, **insert mode** and **last line mode**. You can switch between these modes by pressing certain keys.
- Command mode is the default mode when you start vi. In this mode, you can move the cursor, delete, copy, paste and perform other operations on the text. You cannot insert text in this mode.
- Insert mode lets you insert text into the file. You can enter this mode by pressing i in command mode. To exit this mode, press Esc.
- Last line mode allows you to save, quit, execute commands and perform other tasks. You can enter this mode by pressing : in command mode. To exit this mode, press Esc.
- Some of the common commands in vi are:
 - :w - save the file
 - :q - quit the file
 - :wq - save and quit the file
 - :q! - quit the file without saving
 - h, j, k, l - move the cursor left, down, up and right respectively
 - x - delete the character under the cursor
 - dd - delete the line under the cursor
 - yy - copy the line under the cursor
 - p - paste the copied or cut text after the cursor
 - /pattern - search for a pattern in the file
 - n - move to the next occurrence of the pattern
 - N - move to the previous occurrence of the pattern

Emacs Text Editor

Emacs is a powerful and widely used text editor that runs on many operating systems, such as Linux, BSD, MacOS, Windows and more. It allows you to create, edit and manage text files using keyboard commands and extensions. Here is a brief note on Emacs text editor:

```
File Edit Options Buffers Tools Help
Welcome to GNU Emacs, one component of the GNU/Linux operating system.

Get help          C-h (Hold down CTRL and press h)
Emacs manual      C-h r      Browse manuals    C-h i
Emacs tutorial    C-h t      Undo changes      C-x u
Buy manuals       C-h RET    Exit Emacs        C-x C-c
Activate menubar  M-`

('C-' means use the CTRL key. 'M-' means use the Meta (or Alt) key.
If you have no Meta key, you may instead type ESC followed by the character.)
Useful tasks:
Visit New File    Open Home Directory
Customize Startup Open *scratch* buffer

GNU Emacs 27.1 (build 1, x86_64-pc-linux-gnu, GTK+ Version 3.24.30, cairo version 1.16.0)
of 2022-01-24, modified by Debian
Copyright (C) 2020 Free Software Foundation, Inc.

GNU Emacs comes with ABSOLUTELY NO WARRANTY; type C-h C-w for full details.
Emacs is Free Software--Free as in Freedom--so you can redistribute copies
of Emacs and modify it; type C-h C-c to see the conditions.
Type C-h C-o for information on getting the latest version.
```

- Emacs stands for Editor Macros, and it is a family of text editors that are characterized by their extensibility.
- Emacs has a core program written in C and an extension language called Emacs Lisp, which is a dialect of the Lisp programming language with features to support text editing.
- Emacs has many modes of operation, such as normal editing mode, minibuffer mode, read-only mode, overwrite mode and more. Each mode provides different functions and key bindings for the user⁵.
- Emacs has a rich set of commands for common and complex actions, such as moving, deleting, copying, pasting, searching, replacing, formatting and more. You can invoke commands by pressing certain keys or by typing them in the minibuffer.
- Emacs has a built-in documentation system that provides help and information on any command, function, variable or key binding. You can access the documentation by pressing C-h (Control-h) followed by another key.
- Emacs has a package system that allows you to download and install extensions from various sources. You can use the package manager by typing M-x list-packages (Meta-x list-packages) in the minibuffer⁴.
- Emacs has a wide range of functionality beyond text editing, such as a project planner, mail and news reader, debugger interface, calendar, IRC client and more. You can also use Emacs as a shell, a web browser, an image viewer or a game platform.

QUESTIONS

1. What is computational physics? Why do Physicists need computers?
2. What is an operating system?
3. What is an open-source operating system?
4. What are the advantages of open-source operating systems?
5. Name a few operating systems commonly used by physicists.
6. Name a few Linux distributions/versions.
7. What are the advantages of Linux over other operating systems for scientific computing?
8. Write ten basic terminal commands in Linux.
9. Name a few text editors used within Linux operating systems.
10. Write about the basic commands used within vi text editor.
11. What are the three modes of the vi text editor?