

Linux terminal

Tópicos de Informática para Automação

Mário Antunes

September 22, 2025

Universidade de Aveiro

Welcome to the Command Line!

More Than Just a Black Box

The **Terminal** is your direct, text-based connection to the operating system.

- **Why use it?**

- **Power & Speed:** Execute complex tasks instantly.
- **Automation:** Script repetitive jobs.
- **Efficiency:** Uses minimal system resources.
- **Industry Standard:** Essential for developers and system administrators.

Analogy: A GUI is a restaurant menu. The CLI is speaking directly to the chef.

The Shell & Bash

The **shell** is the program that interprets your commands. The terminal is the window; the shell is the brain inside.

- There are many shells, each with different features:
 - `sh` (Bourne Shell): The original, classic shell.
 - `zsh` (Z Shell): A popular modern shell with extensive customization.
 - `fish` (Friendly Interactive Shell): Focuses on being user-friendly out of the box.
 - `bash` (**Bourne Again SHell**): The most common shell on Linux. It's the de facto standard we will learn today.

The Linux Filesystem (Part 1: Core Directories)

The filesystem is a tree starting from the **root (/)**.

- **/**: The **root directory**. Everything begins here.
- **/home**: Your personal files are here (e.g., **/home/student**).
- **/bin**: Essential user **binaries** (programs like **ls**).
- **/etc**: System-wide **configuration** files.
- **/var**: **Variable** data, like system logs (**/var/log**).
- **/tmp**: For **temporary** files.

The Linux Filesystem (Part 2: Software & Admin)

More important locations you'll encounter.

- `/opt`: **Optional** software. Used by third-party programs you install manually (e.g., Google Chrome).
- `/usr/local`: A place for software you compile or install for all users that isn't part of the standard OS distribution. You'll often find `/usr/local/bin`.
- `/root`: The home directory for the **superuser** (root user). Do not confuse this with the `/` root directory!

Hidden Files & Directories

In your home directory (~), many configuration files are “hidden” by starting with a dot (.). They control how your programs and shell behave.

- **Examples:**

- `~/.bashrc`: Bash shell configuration script. This is a crucial file.
- `~/.config`: A common directory for application settings.
- `~/.themes` or `~/.local/share/themes`: For desktop themes.
- `~/.gitconfig`: Your Git configuration.

Basic Navigation: pwd and cd

Two fundamental commands for moving around.

- **pwd: Print Working Directory.** Shows your current location.

```
$ pwd  
/home/student
```

- **cd: Change Directory.** Moves you to an absolute or relative path.

```
$ cd /var/log      # Move to an absolute path  
$ cd Documents    # Move to a subdirectory
```

Special Navigation Shortcuts with `cd`

`cd` has several useful shortcuts for faster navigation.

- Move up one level:

```
$ cd ..
```

- Go directly to your home directory from anywhere:

```
$ cd ~
```

(Or just `cd` with no arguments)

- Go back to the last directory you were in:

```
$ cd -
```


Listing Directory Contents: `ls`

The `ls` command **lists** the contents of a directory. It's your eyes in the terminal.

- Use **flags** to change its behavior. The most common is `-l` for a long list format.

```
$ ls -l
-rw-r--r-- 1 student student 4096 Sep 19 2025 my_doc.txt
drwxr-xr-x 2 student student 4096 Sep 17 2025 Scripts
```

This shows permissions, owner, size, and modification date.

Seeing Everything with `ls -a`

How do we see those hidden configuration files?

- The `-a` flag tells `ls` to show **a**ll files.

```
$ ls -a  
.  ..  .bashrc  .profile  Documents  Downloads
```

- You can combine flags. `ls -la` is a very common command to get a **l**ong list of **a**ll files.

Creating Directories: `mkdir`

Use the `mkdir` command to **make** a new **directory**.

- **Create a single directory:**

```
$ mkdir my_project
```

- **Create a nested structure:** The `-p` (**p**arents) flag creates the entire directory path, even if the parent directories don't exist yet.

```
$ mkdir -p Documents/Work/2025/Reports
```

Creating & Editing Files: touch & nano

Once you have directories, you need files to put in them.

- **touch:** The fastest way to create a new, empty file.

```
$ touch my_notes.txt
```

- **nano:** A simple, friendly terminal-based text editor.

```
$ nano my_notes.txt
```

- Type your text directly into the window.
- Press **Ctrl+X** to exit.
- Press **Y** to confirm you want to save, then **Enter**.

Getting System Information

The terminal is excellent for quickly checking system status.

- `whoami`: Shows your current username.
- `date`: Shows the current date and time.
- `uname -a`: Shows kernel and system info.
- `top`: Shows running processes in real-time (like Task Manager). Press `q` to quit.

Users: Standard vs. Superuser

Linux is a multi-user system.

- **Standard User** (student): Your day-to-day account with limited privileges.
- **Superuser** (root): The administrator. Has complete power over the system.

To run one command with root privileges, use `sudo` (**Superuser do**).

```
# This needs admin rights, so we use sudo
$ sudo apt update
```

As an administrator, you can manage user accounts from the command line.

- `sudo useradd new_user`: Creates a new user.
- `sudo passwd new_user`: Sets the password for the new user.
- `sudo userdel new_user`: Deletes a user.

Understanding File Permissions

The `ls -l` command shows permissions as a 10-character string like `-rwxr-xr--`.

- **It's read in groups:** Type | Owner | Group | Others
- `r`: Permission to **read** the file.
- `w`: Permission to **write** (modify) the file.
- `x`: Permission to **execute** the file (run as a program).

Managing Permissions with chmod

Use the chmod (**change mode**) command to change permissions.

- You can add (+) or remove (-) permissions for the **u**ser, **g**roup, or **o**thers.

Example: Make a script executable for yourself.

```
# Give the user (u) the execute (x) permission
$ chmod u+x my_script.sh
```

What is a Package Manager?

A package manager is a tool that automates the process of installing, updating, and removing software.

- It handles **dependencies** automatically, so you don't have to install required libraries manually.
- It keeps a database of installed software, making it easy to manage.
- For Debian and Ubuntu-based systems, the primary package manager is **APT** (Advanced Package Tool).

Analogy: Think of apt as an App Store for your terminal.

Updating Package Lists (apt update)

Before you install or search for anything, you should synchronize your local package list with the central software repositories.

- This command **does not** upgrade your software. It just downloads the latest list of what's available.
- This is a privileged operation, so it requires sudo.

```
# Downloads the latest package information  
$ sudo apt update
```

Searching for Packages (apt search)

If you're not sure of the exact name of a program, you can search for it.

- This command searches the names and descriptions of all available packages.
- You don't need sudo to search.

Example: Search for a program that shows system processes, like htop.

```
$ apt search htop
```

Installing Packages (apt install)

Once you know the package name, you can install it.

- apt will automatically download and install the program and any dependencies it needs to run.
- This requires sudo.

Example: Install the htop utility, an interactive process viewer.

```
$ sudo apt install htop
```

After installation, you can run the program by simply typing htop.

Removing Packages (apt remove / apt purge)

Removing software is just as easy as installing it. You have two main options:

1. `apt remove`: Uninstalls the program but leaves its configuration files behind (useful if you plan to reinstall it later).
2. `apt purge`: Uninstalls the program **and** deletes all of its configuration files.

Examples:

```
# Remove htop but keep its config files  
$ sudo apt remove htop
```

```
# Remove htop and all of its config files  
$ sudo apt purge htop
```

`cron` is a system daemon (a background process) that runs scheduled tasks. These scheduled tasks are known as “**cron jobs.**”

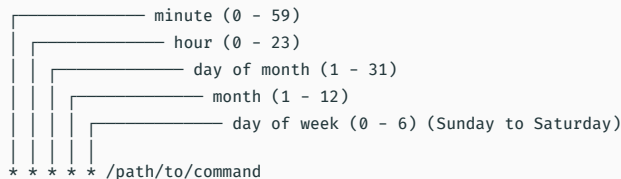
- It's the standard tool for automating repetitive tasks on a schedule.
- You manage your personal list of cron jobs using the `crontab` command.

Common Uses:

- Running a backup script every night.
- Performing system maintenance, like a weekly **ZFS scrub** or a daily **SSD trim**.
- Cleaning up temporary files.

Understanding crontab Syntax

A cron job consists of two parts: the **schedule** and the **command**. The schedule is defined by five fields, often represented by asterisks (*).



minute (0 - 59)
hour (0 - 23)
day of month (1 - 31)
month (1 - 12)
day of week (0 - 6) (Sunday to Saturday)

* * * * * /path/to/command

An asterisk * means “every.” For example, an asterisk in the “hour” field means “every hour.”

For an easy way to generate the correct time string, check out: crontab.guru

Managing Your crontab

You can edit, view, and remove your cron jobs with the `crontab` command and a flag.

- `crontab -e`: **Edit** your crontab file. The first time you run this, it will ask you to choose a text editor (like nano).
- `crontab -l`: **List** your currently scheduled cron jobs.
- `crontab -r`: **Remove** your entire crontab file (use with caution!).

crontab Examples

Here are some practical examples you might add using `crontab -e`.

Example 1: Run a backup script every day at 3:30 AM.

```
# Minute Hour Day(M) Month Day(W) Command
30      3      * * * /home/student/scripts/backup.sh
```

Example 2: Run a system maintenance command every Sunday at 4:00 AM. This example is for a system command like a ZFS storage pool scrub.

```
# Minute Hour Day(M) Month Day(W) Command
0       4      * * 0      /usr/sbin/zpool scrub my-storage-pool
```

Example 3: Check disk space every 15 minutes and log the output. The `>>` appends the output to a log file, and `2>&1` ensures that errors are also logged.

```
# Minute Hour Day(M) Month Day(W) Command
*/15    * * * * /usr/bin/df -h >> /home/student/logs/disk_space.log 2>&1
```

Redirection: Saving Output with >

Don't want to see output on the screen? Save it to a file with >.

Warning: This **overwrites** the file if it already exists.

Example: Save a list of your home directory contents to a file.

```
$ ls -l ~ > my_files.txt
```

Redirection: Appending Output with >>

To **add** output to the end of a file without deleting its contents, use >>.

- This is great for creating log files.

Example: Add a timestamped entry to a log file.

```
$ echo "System rebooted at $(date)" >> system.log
```

The Power of the Pipe |

The **pipe** is one of the most powerful concepts in the shell. It sends the output of one command to be the input of the next.

Think of it as plumbing: Command A -> | -> Command B

Example: Find all `.log` files in a directory.

```
# The output of 'ls' is "piped" to 'grep' to be filtered.  
$ ls /var/log | grep .log
```

Your Environment: Variables

The shell uses variables to store information. By convention, they are in ALL_CAPS.

- \$HOME: Your home directory.
- \$USER: Your username.
- \$PATH: A list of directories where the shell looks for programs.

Example: See the contents of the \$PATH variable.

```
$ echo $PATH  
/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
```

Customizing Your Shell: .bashrc

The `~/.bashrc` file is a script that runs every time you open a new terminal. This is the place to personalize your shell.

You can edit it with a text editor:

```
$ nano ~/.bashrc
```

Remember: Changes won't apply until you open a new terminal or run `source ~/.bashrc`.

Customization Example: Aliases

An **alias** is a shortcut or nickname for a longer command. They save you a lot of typing!

- Add this line to your `~/ .bashrc` file:

```
alias ll='ls -aLF'
```

- Now, when you type `ll` in a new terminal, bash will run `ls -aLF` for you.

Introduction to Bash Scripting

A script is simply a text file containing a sequence of commands.

1. The first line **must** be `#!/bin/bash`. This is called a “shebang.”
2. Add your commands.
3. Use `#` for comments to explain your code.
4. Make the file executable with `chmod +x`.

Scripting Example 1: Hello World

This script uses a variable and the echo command. It's the "Hello, World!" of scripting.

File: hello.sh

```
#!/bin/bash
# A simple hello world script

NAME="Student"
echo "Hello, $NAME!"
```

To run it:

```
$ chmod +x hello.sh
$ ./hello.sh
```

Scripting Example 2: Using `if`

This script uses an `if` statement to check if a file exists before trying to use it.

File: `check_file.sh`

```
#!/bin/bash
# Checks for the existence of the system log file.

FILENAME="/var/log/syslog"

if [ -f "$FILENAME" ]; then
    echo "$FILENAME exists."
    # We could now do something with the file, e.g.
    # tail -n 5 "$FILENAME"
else
    echo "Warning: $FILENAME not found."
fi
```

Scripting Example 3: Looping Over Files

A for loop lets you perform an action on a list of items, like files.

File: add_prefix.sh

```
#!/bin/bash
# Adds "backup_" prefix to all .txt files.

for file in *.txt
do
    # Check if it's a file before moving it
    if [ -f "$file" ]; then
        mv -- "$file" "backup_$file"
        echo "→ backup_$file"
    fi
done

echo "Batch rename complete."
```

Scripting Example 4: Complex Script

This script combines arguments, if, variables, and a program (tar) to create a useful tool.

File: backup.sh

```
#!/bin/bash
# Backs up specified items into a .tar.gz archive.

# Exit if no arguments are provided.
if [ "$#" -eq 0 ]; then
    echo "Usage: $0 <file1> <dir1> ..."
    exit 1
fi

DEST="$HOME/backups"
TIME=$(date +%Y-%m-%d_%H%M%S)
ARCHIVE="$DEST/$TIME-backup.tar.gz"

mkdir -p "$DEST" # Create backup dir if needed
echo "Creating archive ..."

# "$@" holds all command-line arguments.
tar -czf "$ARCHIVE" "$@"

echo "Backup complete: $ARCHIVE"
```

You've now seen the core concepts of the Linux command line:

- **Navigating** the filesystem.
- **Managing** files, permissions, and users.
- **Combining** commands with pipes and redirection.
- **Automating** tasks with shell scripts.

Now, let's apply this knowledge in the practical part of the class.

Bookmark these pages. They are incredibly useful references.

- **Linux Terminal Cheat Sheet:**

- <https://www.geeksforgeeks.org/linux-unix/linux-commands-cheat-sheet/>

- **Bash Cheat Sheet:**

- <https://github.com/RehanSaeed/Bash-Cheat-Sheet>

- **Bash Scripting Cheat Sheet:**

- <https://developers.redhat.com/cheat-sheets/bash-shell-cheat-sheet>