Introduction to Linux

A practical guide for competitive programmers

King Kai Chan · 2026

Agenda

Fundamentals

1. **Introduction** — What is Linux, distributions, why CP
2. **Getting Started** — WSL, setup, resources
3. **Terminal Basics** — Tips, wildcards, man, arguments
4. **Filesystem** — Directory structure, paths, nano

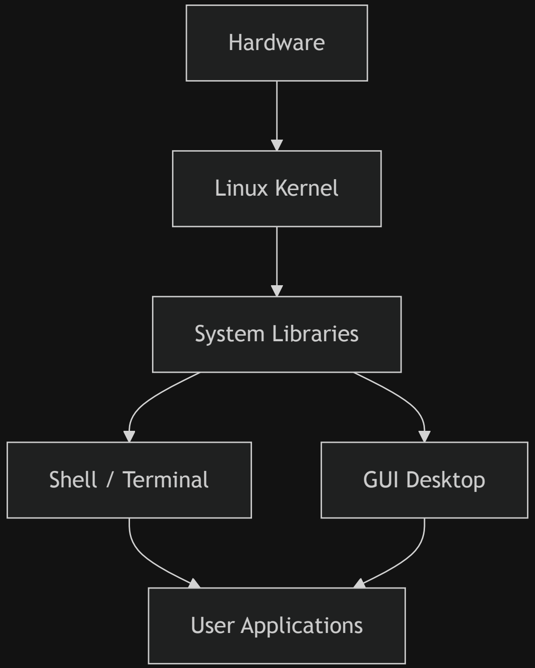
Practical Skills

5. **Essential Commands** — ls, cd, cp, mv, rm, cat, …
6. **Permissions & System** — chmod, sudo, apt
7. **C++ Compilation** — g++, flags, warnings, Makefile
8. **I/O Redirection** — Redirects, piping, chaining

> Interactive playground available at **linux-playground.vercel.app**

What is Linux?

- A **free, open-source** operating system — like Windows or macOS
- Built on the **Linux kernel**, created by Linus Torvalds in 1991
- Powers most servers, supercomputers, and Android devices
- Highly customizable — you can inspect and modify anything



Linux Distributions

A **distribution** bundles the Linux kernel with software, package managers, and desktop environments.

Ubuntu

Most popular desktop distro. Great GUI & community.

Red Hat

Enterprise-focused. Corporate servers.

Fedora

Cutting-edge features. Community-driven.

Arch Linux

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> All distros share the same kernel and shell commands — skills transfer across distributions.

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- **Superior shell** — bash/zsh syntax is far more powerful than Windows cmd
- **Portable scripts** — shell commands work across all Linux distributions
- **Developer ecosystem** — g++, gdb, valgrind, and other tools are first-class citizens

Which Distribution Should I Use?

Ubuntu

- Excellent GUI out of the box
- Largest community & docs
- Best for beginners

Get it: ubuntu.com

WSL (Windows)

- Linux shell inside Windows
- No VM needed, great performance
- Access Windows files from Linux

Get it: Built into Windows 10/11

Arch Linux

- Extremely lightweight
- Highly customizable
- Learn Linux internals

Get it: archlinux.org

> **Recommendation:** Use WSL if you’re on Windows. Use Ubuntu if you want a dedicated Linux machine.

Getting Started

WSL, setup, and resources

Windows Subsystem for Linux (WSL)

WSL lets you run a full Linux environment on Windows — no VM or dual boot needed.

WSL 1

- Translates Linux syscalls to Windows
- **Faster** cross-OS filesystem access
- No full Linux kernel
- Limited hardware support

WSL 2

- Runs a **real Linux kernel**
- Full system call compatibility
- **Docker** and **CUDA** support
- Slightly slower cross-OS file access

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> **For competitive programming**, WSL 2 is recommended — full kernel means everything just works.

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> **Requirements:** Windows 10 version 2004+ or any Windows 11. Run `winver` to check.

How to Learn Linux Efficiently

Resources

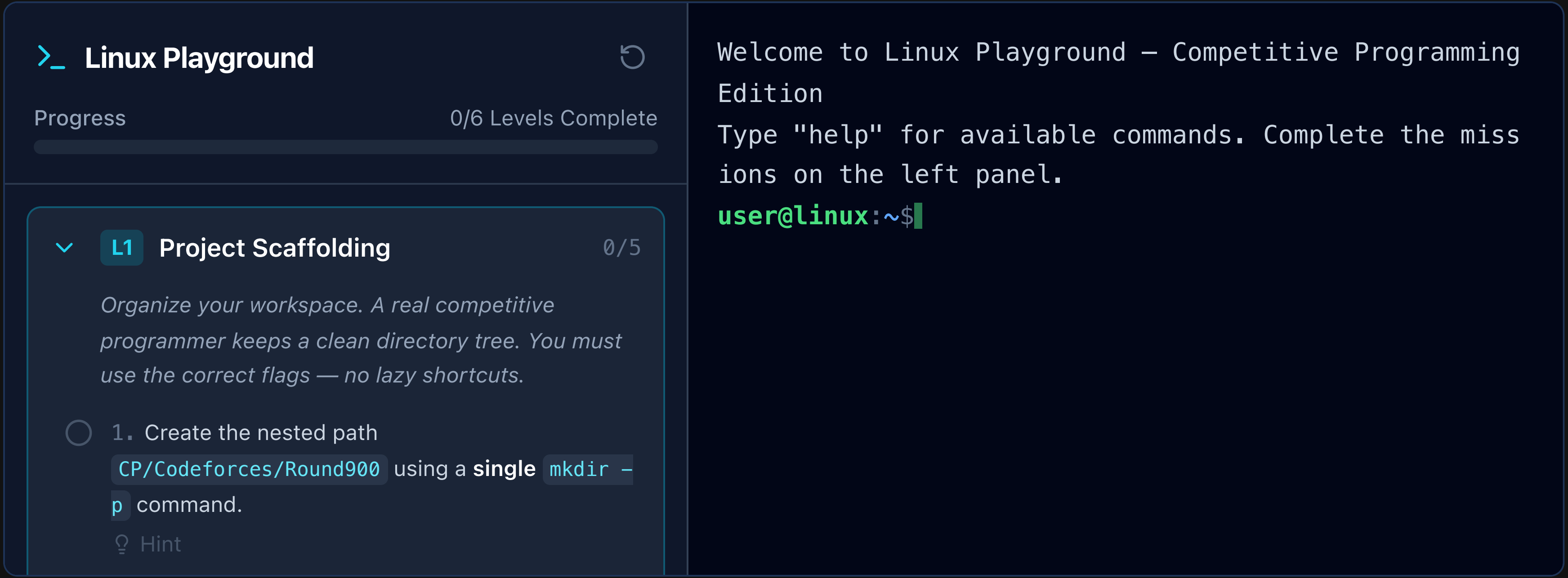
- **Google it** — most problems have been solved
- **Stack Overflow** — Q&A for specific issues
- **ChatGPT / AI** — great for explaining commands
- `man` **pages** — built-in manuals for every command
- **This presentation** — bookmark for reference

Practice

- **Use Linux daily** — muscle memory matters
- **Try the Linux Playground** — interactive missions
- **Break things** — that's how you learn (use WSL)
- **Read error messages** — they tell you what's wrong

Linux Playground — Interactive Practice

Try commands in your browser with guided missions:



Project Scaffolding

Organize your workspace. A real competitive programmer keeps a clean directory tree. You must use the correct flags — no lazy shortcuts.

○ 1. Create the nested path `CP/Codeforces/Round900` using a **single** `mkdir -p` command.

```
Welcome to Linux Playground — Competitive Programming Edition
Type "help" for available commands. Complete the missions on the left panel.
user@linux:~$
```

Visit **linux-playground.vercel.app** — 6 mission levels from basic navigation to contest simulation.

Terminal Basics

Tips, wildcards, manual, and arguments

Opening the Terminal

Ubuntu

Press Ctrl + Alt + T to open the default terminal.

Or search for "Terminal" in the application menu.

WSL

- Open **Windows Terminal** → select Ubuntu tab
- Or type `wsl` in PowerShell
- Or search "Ubuntu" in the Start menu

What You’ll See

```
user@hostname:~$
```

This is your **shell prompt** — it shows the username, machine name, and current directory (`~` = home).

Terminal Tips & Shortcuts

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> **Example:** To reference `this_is_a_super_long_filename`, type `this_is` then press Tab — the terminal completes the rest.

Wildcard Character — `*`

The `*` matches **any sequence of characters** in file/directory names.

```
# Directory contains: 1.txt, 2.txt, 3.txt, notes.md
rm *.txt          # Removes 1.txt, 2.txt, 3.txt (not notes.md)
ls *.md           # Lists only notes.md
```

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ls *.md           # Lists only notes.md
```

More examples with files `file123.txt` and `file456.txt`:

```
ls file*.txt      # Matches both — file + anything + .txt
ls file*          # Matches both — file + anything
ls f*.txt         # Matches both — f + anything + .txt
```

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ls file*          # Matches both — file + anything
ls f*.txt         # Matches both — f + anything + .txt
```

Warning: `rm *` deletes **everything** in the current directory. Always verify with `ls` first!

Reading the Manual — `man`

Every command has a built-in manual page:

```
man cp        # Manual for the cp (copy) command
man ls        # Manual for the ls (list) command
man zip       # Manual for the zip command
```

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Navigating man pages

Key	Action
↑ / ↓	Scroll line by line
Space	Scroll one page down
/pattern	Search for text
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> **Quick alternative:** Most commands support `-h` or `--help` for a shorter summary.

Command Arguments

Arguments modify how a command behaves — like function parameters in code.

Short form (single `-`)

```
ls -a          # all files
ls -l          # long format
ls -la         # combined
rm -rf folder/  # recursive + force
```

Long form (double `--`)

```
ls --all
rm --recursive --force folder/
g++ --version
```

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Common flag conventions

`-f` **force**	`-v` **verbose / version**	`-a` **all**	`-r` **recursive**	`-i` **interactive**	`-o` **output**	`-h` **help**

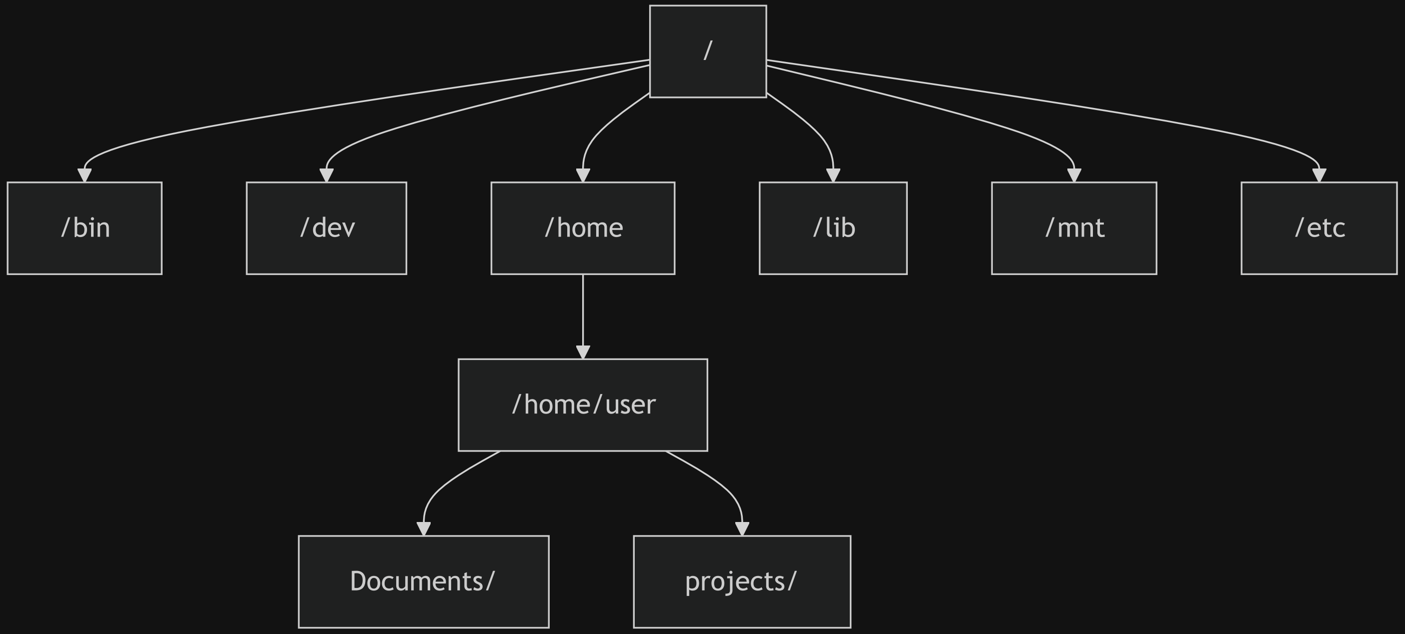
Check the manual or `--help` for any command’s full list of flags.

Linux Filesystem

Directory structure, paths, and navigation

Filesystem Overview

Linux organizes everything in a single tree rooted at `/`.



Unlike Windows (`C:\`, `D:\`), Linux has a **single root** `/` — everything is a subdirectory, including external drives.

Special Directories

Symbol	Name	Meaning
`/`	Root	Top of entire filesystem
`~`	Home	User’s home (`/home/user`)
`.`	Current	Directory you’re in now
`..`	Parent	One level up

```
# Current directory: /home/user/projects
pwd             # /home/user/projects
cd ..           # Now at /home/user
cd ~            # Now at /home/user
cd /            # Now at root
cd ~/projects   # Back to /home/user/projects
```

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cd ~               # Now at /home/user
cd /               # Now at root
cd ~/projects      # Back to /home/user/projects
```

> Your terminal always starts at `~` (home directory) unless you change it with `cd`.

Key System Directories

`/bin` — Essential command executables: `ls`, `cp`, `mv`, `cat`

`/lib` — Shared libraries needed by `/bin` and system binaries

`/dev` — Device files. `/dev/null` discards all data written to it (a "black hole")

`/mnt` — Where external drives and filesystems are temporarily mounted

`/home` — User directories: `/home/user1`, `/home/user2`, etc.

`/etc` — System-wide config files (network, users, services)

Relative vs Absolute Paths

Absolute path

Starts from root `/` — always the same regardless of where you are.

```
/home/user/projects/solution.cpp
```

Relative path

Relative to your current directory.

```
./projects/solution.cpp
../user2/file.txt
```

Example from `/home/user`

Target	Absolute	Relative
File in projects	`/home/user/projects/a.cpp`	`./projects/a.cpp`
Parent	`/home`	`..`
Other user	`/home/user2/file.txt`	`../user2/file.txt`

Text Editor in Terminal — `nano`

`nano` is a simple, beginner-friendly terminal text editor.

```
nano myfile.cpp       # Open (or create) myfile.cpp for editing
```

Essential shortcuts

Shortcut	Action	Shortcut	Action
Ctrl+X	Exit nano	Ctrl+O	Save without exiting
Y → Enter	Save on exit	Ctrl+K	Cut current line
N → Enter	Discard on exit	Ctrl+W	Search text

For advanced editing, look into **vim** or **VS Code** with remote SSH.

Essential Commands

File and directory operations

Command Overview

Navigation

- `pwd` — print working directory
- `ls` — list directory contents
- `cd` — change directory

File Operations

- `mkdir` — create directories
- `touch` — create empty files
- `cp` — copy files/directories
- `mv` — move or rename
- `rm` — remove files/directories

Content & Search

- `cat` — display file contents
- `echo` — print / write to files
- `diff` — compare files
- `grep` — search file contents
- `zip` / `unzip` — archive files

List Directory Contents — `ls`

```
ls             # List files in current directory
ls -a          # Include hidden files (names starting with .)
ls -l          # Long format — permissions, size, date
ls -la         # Both: hidden files + long format
ls /some/path  # List a specific directory
```

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Example output of `ls -la`

```
drwxr-xr-x  4 user user 4096 Feb 15 10:30 .
drwxr-xr-x  3 user user 4096 Feb 14 09:00 ..
-rw-r--r--  1 user user  220 Feb 14 09:00 .bashrc
drwxr-xr-x  2 user user 4096 Feb 15 10:30 projects
-rw-r--r--  1 user user  128 Feb 15 10:25 solution.cpp
```

`d` = directory, `-` = file. Hidden files start with `.` (only shown with `-a`).

Change Directory — `cd`

```
cd /             # Go to root directory
cd ~             # Go to home directory (/home/user)
cd ..            # Go up one level (parent directory)
cd projects      # Enter the "projects" subdirectory
cd ~/projects    # Go to projects under home (absolute via ~)
```

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```

Practical navigation

```
user@linux:~$ cd projects/contest
user@linux:~/projects/contest$ ls
A.cpp  B.cpp  input.txt
user@linux:~/projects/contest$ cd ../..
user@linux:~$ pwd
/home/user
```

The prompt updates to show your current path — always know where you are.

Create Directories — `mkdir`

```
mkdir mydir                        # Create a single directory
mkdir dir1 dir2 dir3               # Create multiple directories
mkdir -p CP/Codeforces/Round900    # Create nested directories (parents too)
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Why `-p` ?

Without it, creating `CP/Codeforces/Round900` fails if parent dirs don’t exist.

```
mkdir CP/Codeforces/Round900         # Error: No such file or directory
mkdir -p CP/Codeforces/Round900      # Creates all missing parents automatically
```

Create Files — `touch`

```
touch file.txt                    # Create an empty file (or update timestamp)
touch a.cpp b.cpp c.cpp           # Create multiple files at once
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Alternative: create with `>`

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> file.txt                        # Also creates an empty file (overwrites if exists)
echo "content" > file.txt         # Create a file with content
```

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> `touch` is safe on existing files — it only updates the timestamp without changing content. `> file.txt` will **erase** an existing file’s content.

Copy — cp

```
cp source.txt dest.txt                 # Copy a file
cp file1.txt file2.txt dest_folder/    # Copy multiple files into a directory
cp -r source_dir/ dest_dir/            # Copy a directory recursively
```

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Key points

- **File** copy — no flags needed
- **Directory** copy — requires `-r` (recursive), otherwise error
- Overwrites existing destination files silently (`-i` to prompt, `-f` to force)

```
cp solution.cpp backup_solution.cpp    # Quick backup
cp -r contest/ contest_backup/         # Backup entire directory
```

Move / Rename — `mv`

```
mv source.txt dest_folder/        # Move file into a directory
mv old_name.cpp new_name.cpp      # Rename a file
mv dir1/ dir2/                    # Move (or rename) a directory
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`mv` vs `cp`

	`cp`	`mv`
Original file	**Kept**	**Removed**
Directory flag	Needs `-r`	No flag needed
Use case	Duplicate	Relocate or rename

`mv` is the standard way to **rename** files and directories in Linux.

Remove — `rm`

```
rm file.txt              # Remove a single file
rm file1 file2 file3     # Remove multiple files
rm -r directory/         # Remove a directory and all its contents
rm -rf directory/        # Force remove — no prompts, even read-only files
```

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```
# Safe workflow: verify before deleting
ls *.o                # Check which .o files exist
rm *.o                # Now remove them
```

Display File Contents — `cat`

```
cat file.txt                  # Print file contents to terminal
cat file1.txt file2.txt       # Print multiple files in sequence (concatenate)
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Example

```
user@linux:~$ cat hello.cpp
#include <bits/stdc++.h>
using namespace std;
int main() {
    cout << "Hello, World!" << endl;
}
```

Useful for quickly viewing short files, checking I/O files, or piping content to other commands.

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For long files, use `less file.txt` (scrollable) or `head -n 20 file.txt` (first 20 lines).

Print & Write — `echo`

```
echo "Hello, World!"               # Print text to terminal
echo "Hello" > file.txt            # Write to file (overwrites)
echo "More text" >> file.txt       # Append to file
```

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```

`>` VS `>>`

Operator	Behavior
`>`	**Overwrites** the file (creates if doesn’t exist)
`>>`	**Appends** to the end of the file

```
echo "line 1" > output.txt     # output.txt → "line 1"
echo "line 2" > output.txt     # output.txt → "line 2"  (line 1 gone!)
echo "line 3" >> output.txt    # output.txt → "line 2\nline 3"
```

Compare Files — `diff`

```
diff file1.txt file2.txt        # Compare two files line by line
diff -Z a.out b.out             # Ignore trailing whitespace
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Reading diff output

```
user@linux:~$ diff expected.out my.out
3c3
< 42
---
> 41
```

`3c3` = line 3 changed · `<` = first file · `>` = second file · **No output** = identical

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`3c3` = line 3 **changed** · `<` = first file · `>` = second file · **No output** = identical

CP tip: Use `diff -Z` to ignore trailing spaces — matches how most online judges compare output.

Search in Files — `grep`

```
grep "hello" file.txt           # Find lines containing "hello"
grep -i "hello" file.txt        # Case-insensitive search
grep -e "regex" file.txt        # Match a regular expression
grep -r "pattern" directory/    # Search recursively in all files
grep -n "pattern" file.txt      # Show line numbers
```

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```

Example

```
user@linux:~$ grep -n "int" solution.cpp
3:int main() {
4:    int n;
7:    int result = n * 2;
```

Useful for finding specific code, searching logs, or checking patterns across a project.

Archive — `zip` / `unzip`

```
zip archive.zip file1 file2 file3       # Zip multiple files
zip -r archive.zip directory/           # Zip a directory (requires -r)
unzip archive.zip                       # Extract all contents
```

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```
zip archive.zip file1 file2 file3       # Zip multiple files
zip -r archive.zip directory/           # Zip a directory (requires -r)
unzip archive.zip                       # Extract all contents
```

Example workflow

```
zip -r contest.zip CP/Codeforces/Round900/    # Package solutions
unzip starter_code.zip                         # Extract downloaded archive
```

`-r` is required when zipping directories (just like `cp` and `rm`).

Permissions & System Management

chmod, sudo, and apt

User Permissions

Linux controls file access with three classes and three operations:

Permission classes

- **Owner** — user who created the file
- **Group** — users in the file’s group
- **Others** — everyone else

Operations

- **r** (read) · **w** (write) · **x** (execute)

Reading `ls -l` output

```
-rwxr-xr-- 1 user group  script.sh
 ^^^  owner permissions   (rwx)
    ^^^ group permissions (r-x)
       ^^^ other perms    (r--)
```

`r` = read, `w` = write, `x` = execute, `-` = denied

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       ^^^ other perms     (r--)
```

`r` = read, `w` = write, `x` = execute, `-` = denied

> If you see "**Permission denied**", you lack the required permission for that operation.

Change Permissions — `chmod`

```
chmod +x script.sh        # Add execute permission
chmod -x script.sh        # Remove execute permission
chmod +r file.txt         # Add read permission
chmod +w file.txt         # Add write permission
chmod +rwx file.txt       # Add all permissions
```

Change Permissions — `chmod`

```
chmod +x script.sh        # Add execute permission
chmod -x script.sh        # Remove execute permission
chmod +r file.txt         # Add read permission
chmod +w file.txt         # Add write permission
chmod +rwx file.txt       # Add all permissions
```

When you’ll need this

The most common CP use case: making a compiled binary or script executable.

```
g++ solution.cpp -o solution
chmod +x solution       # Usually not needed — g++ sets this automatically
./solution

chmod +x compile.sh     # Make a provided shell script runnable
./compile.sh
```

Only the **file owner** or **root** can change permissions.

Superuser — `sudo`

`sudo` runs a command with **root (administrator) privileges.**

```
sudo apt update               # Update package catalogue as root
sudo apt install g++           # Install a package as root
```

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```

Why is `sudo` needed?

- System-wide changes require root permissions
- Your normal account is intentionally restricted for safety
- `sudo` temporarily elevates privileges — prompts for your password

> The **root user** has unrestricted access to everything. Never log in as root daily — use `sudo` when needed.

Package Manager — `apt`

`apt` is Ubuntu’s package manager — an **app store for the terminal.**

```
# Always update the catalogue first
sudo apt update

# Install packages
sudo apt install g++
sudo apt install python3
```

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# Always update the catalogue first
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```
# Upgrade all installed packages
sudo apt upgrade

# Upgrade a specific package
sudo apt install --only-upgrade g++
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```

```
# Upgrade all installed packages
sudo apt upgrade

# Upgrade a specific package
sudo apt install --only-upgrade g++
```

```
# Remove a package
sudo apt remove g++         # Remove the package
sudo apt purge g++          # Remove package AND config files
```

C++ Compilation Workflow

g++, flags, warnings, and Makefile

Installing and Using `g++`

`g++` is the GNU C++ compiler — the standard tool for CP.

```
sudo apt update && sudo apt install g++    # Install
g++ solution.cpp -o solution               # Compile
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sudo apt update && sudo apt install g++     # Install
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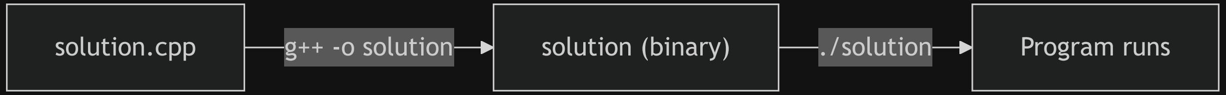
What this does



solution.cpp

g++ -o solution

solution (binary)

./solution

Program runs

`-o solution` sets the output name. Without `-o`, the default is `a.out`.

Compilation Flags

Add flags for C++ standard, optimization, and warnings:

```
g++ solution.cpp -o solution -std=c++17 -O2 -Wall -Wshadow
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Flag	Purpose
`-std=c++17`	Use C++17 standard (structured bindings, `if constexpr`, etc.)
`-O2`	Optimize for execution speed (most judges use this)
`-Wall`	Enable most compiler warnings
`-Wshadow`	Warn when a variable shadows another
`-Wextra`	Even more warnings beyond `-Wall`

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`-Wextra`	Even more warnings beyond `-Wall`

> **Always compile with `-Wall` during practice** — it catches bugs that cost hours in contests.

`-Wall` — Warning Examples

Format string mismatch

```
#include <bits/stdc++.h>
using namespace std;
int main() {
    int x = 5;
    printf("%lld\n", x);
    // Warning: '%lld' expects
    // 'long long int', not 'int'
}
```

Unused variable

```
#include <bits/stdc++.h>
using namespace std;
int main() {
    int x = 5;
    int y = 9;  // Warning: unused 'y'
    printf("%d\n", x);
}
```

`-Wall` — Warning Examples

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using namespace std;
int main() {
    int x = 5;
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```cpp
#include <bits/stdc++.h>
using namespace std;
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    int x = 5;
    int y = 9;  // Warning: unused 'y'
    printf("%d\n", x);
}
```

> Unused variables often indicate a typo — maybe you meant to use `y` instead of `x`. Warnings catch these before they become bugs.

-Wshadow — Variable Shadowing

When an inner scope re-declares a variable name, the outer one is **shadowed**:

```
#include <bits/stdc++.h>
using namespace std;
int main() {
    int x = 5;
    for (int i = 0; i < 3; i++) {
        int x = 9;             // Warning: 'x' shadows a previous local
        printf("%d\n", x);     // Prints 9, not 5!
    }
}
```

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using namespace std;
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    int x = 5;
    for (int i = 0; i < 3; i++) {
        int x = 9;                // Warning: 'x' shadows a previous local
        printf("%d\n", x);        // Prints 9, not 5!
    }
}
```

- Common source of bugs in nested loops
- Inner `x` hides outer `x` — compiles silently without this flag
- **Always compile with** `-Wshadow` to catch these early

Sanitizers — Catch Runtime Bugs

Add sanitizer flags during practice to detect bugs that compile cleanly but crash or produce wrong answers:

```
g++ solution.cpp -o solution -std=c++17 -O2 -Wall -Wshadow \
    -fsanitize=address,undefined
```

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What they catch

Sanitizer	Catches
`address`	Out-of-bounds array access, use-after-free, memory leaks
`undefined`	Integer overflow, null pointer dereference, shift errors

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Sanitizer	Catches
`address`	Out-of-bounds array access, use-after-free, memory leaks
`undefined`	Integer overflow, null pointer dereference, shift errors

> Sanitizers slow your program ~2-3x — use them for **debugging only**, not for timing. Remove them before measuring performance.

Running Binaries

After compilation, run with `./`:

```
g++ solution.cpp -o solution
./solution
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Why `./` is needed

Linux looks for executables in `PATH` dirs (`/bin`, `/usr/bin`). Your current directory isn't in `PATH` — `./` tells the shell to look here.

Measuring execution time

```
time ./solution < input.txt
# real    0m0.032s  ← wall clock time (the one you care about)
# user    0m0.028s  ← CPU time in user mode
# sys     0m0.004s  ← CPU time in kernel mode
```

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# user    0m0.028s  ← CPU time in user mode
# sys     0m0.004s  ← CPU time in kernel mode
```

CP tip: If `real` time exceeds ~1-2s for a typical test case, your solution is likely too slow.

Grader Tasks — Multiple Source Files

Many TFT/IOI problems provide a **grader** — you implement functions, the grader handles I/O.

```
# solution.cpp    — your code (implements functions)
# sample_grader.cpp — provided (contains main, calls your functions)

g++ -o solution solution.cpp sample_grader.cpp -std=c++17 -O2
```

Grader Tasks — Multiple Source Files

Many TFT/IOI problems provide a **grader** — you implement functions, the grader handles I/O.

```
# solution.cpp    — your code (implements functions)
# sample_grader.cpp — provided (contains main, calls your functions)

g++ -o solution solution.cpp sample_grader.cpp -std=c++17 -O2
```

Using a provided compile script

```
chmod +x compile.sh && ./compile.sh     # Make executable and run
cat compile.sh                          # Peek at the compilation command
```

You can also compile manually and add any extra flags you need.

Makefile — Automate Compilation

A **Makefile** saves you from retyping the full `g++` command:

```
% : %.cpp
  g++ $< -o $@ -std=c++17 -Wall -Wshadow -O2
```

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A **Makefile** saves you from retyping the full `g++` command:

```
% : %.cpp
  g++ $< -o $@ -std=c++17 -Wall -Wshadow -O2
```

How it works

- `%` matches any name → `make solution` looks for `solution.cpp`
- `$<` = source file, `$@` = target name
- **Must use tab** for indentation (not spaces)

```
sudo apt install make     # Install make (if needed)
make solution             # Compiles solution.cpp → solution
make A                    # Compiles A.cpp → A
```

Put this Makefile in your working directory — works for any `.cpp` file.

I/O Redirection & Advanced

Redirects, piping, and command chaining

I/O Redirection

Redirect input/output from/to files — essential for testing contest problems.

```
./solution < input.txt                  # Read stdin from file
./solution > output.txt                 # Write stdout to file
./solution < input.txt > output.txt     # Both at once
```

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./solution < input.txt                  # Read stdin from file
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Example workflow

```
echo "23382338" > input.txt             # Create sample input
g++ solution.cpp -o solution            # Compile
./solution < input.txt > output.txt     # Run with redirected I/O
cat output.txt                          # Check the result
```

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Redirect input/output from/to files — essential for testing contest problems.

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Example workflow

```
echo "23382338" > input.txt             # Create sample input
g++ solution.cpp -o solution            # Compile
./solution < input.txt > output.txt     # Run with redirected I/O
cat output.txt                          # Check the result
```

Why not paste input? Large inputs cause terminal lag. File redirection is instant and reproducible.

Why Use I/O Redirection?

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- **Automated testing** — combine with `diff` to verify output:

Why Use I/O Redirection?

- **Large inputs** — pasting thousands of lines into the terminal is slow
- **Speed** — terminal output is much slower than writing to a file
- **Reproducibility** — keep input files for repeated testing
- **Automated testing** — combine with `diff` to verify output:

```
./solution < input.txt > my_output.txt
diff -Z my_output.txt expected_output.txt
```

No output from `diff` = your answer matches exactly.

Command Chaining — &&

Run commands in sequence — next runs only if previous **succeeds**:

```
make solution && ./solution < input.txt                    # Compile + run
sudo apt update && sudo apt install g++                    # Update + install
g++ sol.cpp -o sol && ./sol < in.txt > out.txt && diff -Z out.txt ans.txt
```

Command Chaining — `&&`

Run commands in sequence — next runs only if previous **succeeds**:

```
make solution && ./solution < input.txt                    # Compile + run
sudo apt update && sudo apt install g++                    # Update + install
g++ sol.cpp -o sol && ./sol < in.txt > out.txt && diff -Z out.txt ans.txt
```

`&&` vs `;`

Operator	Behavior
`&&`	Next runs **only if** previous succeeded
`;`	Next runs **regardless** of previous result

Using `&&` is safer — if compilation fails, you won’t run the old binary.

Piping — `|`

The pipe sends **output of one command** as **input to another**:

```
./solution < input.txt | sort         # Sort program output
./solution < input.txt | wc -l       # Count output lines
./solution < input.txt | grep "Error" # Search output
```

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```

Copying output to clipboard

```
cat solution.cpp | clip.exe                    # WSL (Windows)
cat solution.cpp | xclip -selection clipboard  # Linux with xclip
```

Useful when output is too long to select with the mouse.

Terminal Control

Stopping a command

Press Ctrl + C to **terminate** the current command.

Use when:

- Program enters an infinite loop
- Output is flooding the terminal
- You want to cancel an operation

Useful shortcuts

Shortcut	Action
Ctrl + C	Kill current process
Ctrl + Z	Suspend process
Ctrl + D	Send EOF (end input)
Ctrl + L	Clear screen

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Useful shortcuts

Shortcut	Action
Ctrl + C	Kill current process
Ctrl + Z	Suspend process
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Ctrl + L	Clear screen

CP tip: If your solution runs for more than a few seconds, it's likely TLE — Ctrl + C and optimize.

Wrapping Up

Summary

What we covered

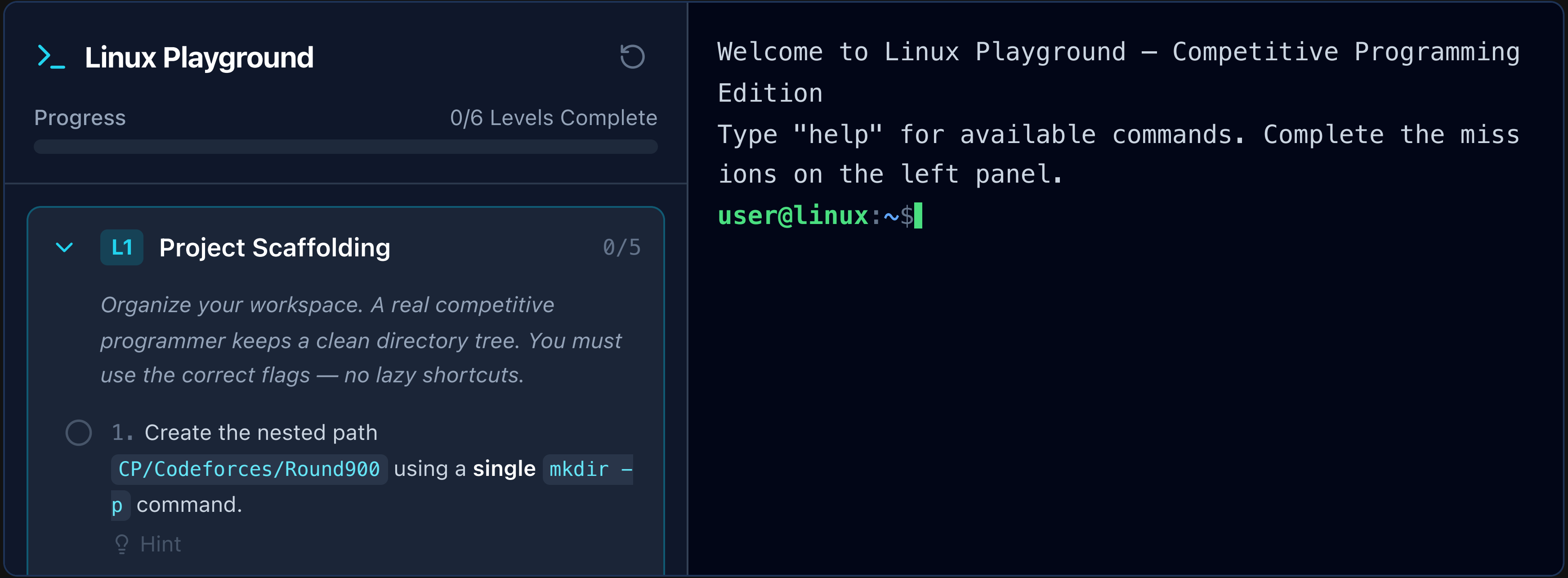
- What Linux is and why it matters for CP
- Navigating the filesystem and terminal
- Essential commands: `ls`, `cd`, `cp`, `mv`, `rm`, `cat`, `mkdir`, `echo`, `diff`, `grep`, `zip`
- Permissions with `chmod` and `sudo`
- Package management with `apt`
- C++ compilation with `g++` and flags
- I/O redirection, piping, and chaining

Compilation cheat sheet

```
# Compile
g++ sol.cpp -o sol -std=c++17 \
    -O2 -Wall -Wshadow

# Run with I/O redirection
./sol < input.txt > output.txt

# Check output
diff -Z output.txt expected.txt

# All in one
make sol && ./sol < in.txt \
    > out.txt && diff -Z out.txt ans.txt
```

Try It Yourself

Practice everything you've learned in the interactive Linux Playground:



Project Scaffolding

Organize your workspace. A real competitive programmer keeps a clean directory tree. You must use the correct flags — no lazy shortcuts.

○ 1. Create the nested path `CP/Codeforces/Round900` using a **single** `mkdir -p` command.

```
Welcome to Linux Playground — Competitive Programming Edition
Type "help" for available commands. Complete the missions on the left panel.
user@linux:~$
```

Complete all 6 mission levels — from basic navigation to a full contest simulation workflow.

Questions?

linux-playground.vercel.app