

**DS105W –
Data for
Data
Science**

Week 03

Operating Systems, File Formats, and Introduction to Git/GitHub

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Operating Systems

16:00 – 16:15

In your  **W03 Practice**, you navigated through files and folders using the Terminal. This might have felt quite different from clicking around with your mouse!

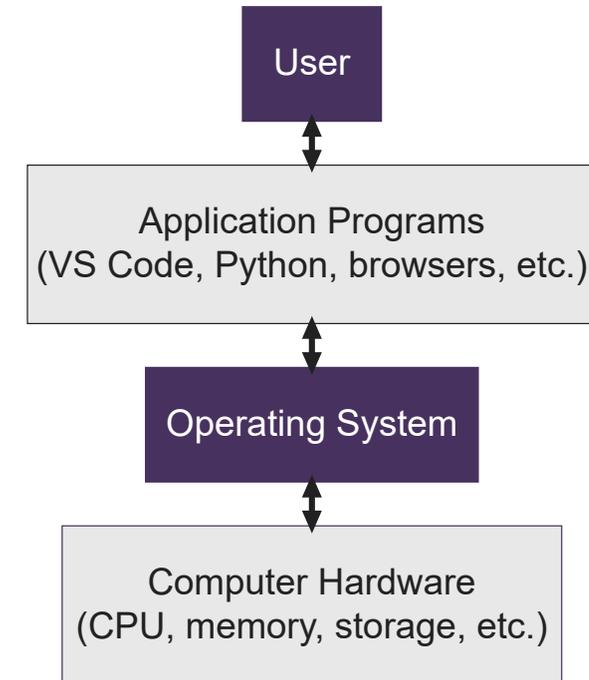
Let's understand what's happening under the hood.



What an Operating System (OS) Does

A computer has four key components:

- **Hardware** provides the basic computing resources
- **Operating System** controls hardware and coordinates resource use
- **Application Programs** define how resources are used (Python, VS Code, web browsers)
- **User** requests actions from the computer



Examples of Operating Systems:



Ubuntu is a  Linux distribution. Windows and macOS are proprietary operating systems.



Why Different OSes Exist

Each operating system has its own history and philosophy:

UNIX & Linux

- UNIX: First major OS, developed at Bell Labs
- GNU/Linux: Free, open-source alternative
- 🤖 Android phones use Linux
- macOS built on Darwin (a UNIX derivative)

Philosophy: Open, portable, simple

Windows

- Microsoft's proprietary OS
- Evolved from MS-DOS → Windows 95 → Windows XP → Windows 10/11
- Dominant in desktop computing
- Office suite drove popularity

Philosophy: User-friendly, commercial

💡 **Why this matters:** Different OSes organise files differently and use different Terminal commands. Understanding this prevents frustration when tutorials use OS-specific syntax.



2 File Systems

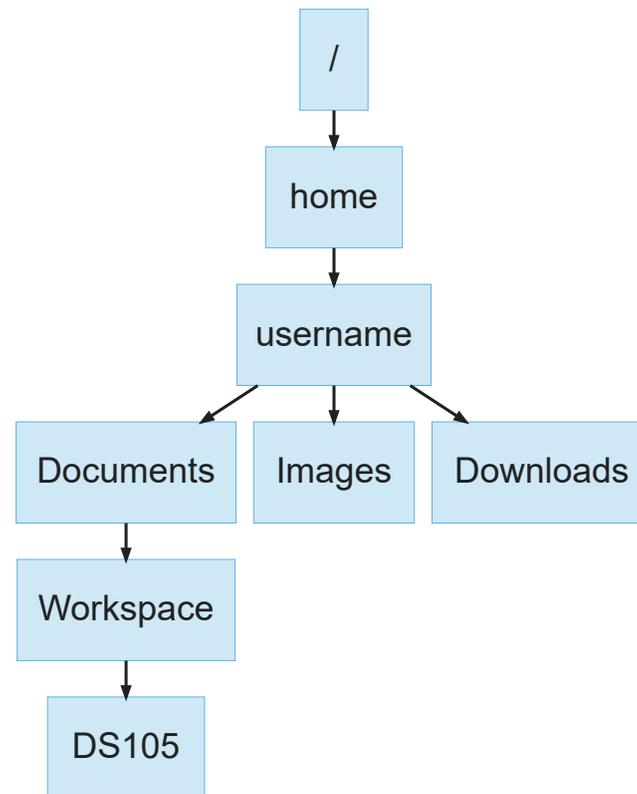
16:15 – 16:30

Each OS organises files and directories differently. Every file has a **path** (its address in the system).



UNIX-like File Systems (Mac/Linux)

The directory structure starts from a single **root directory** called `/`:

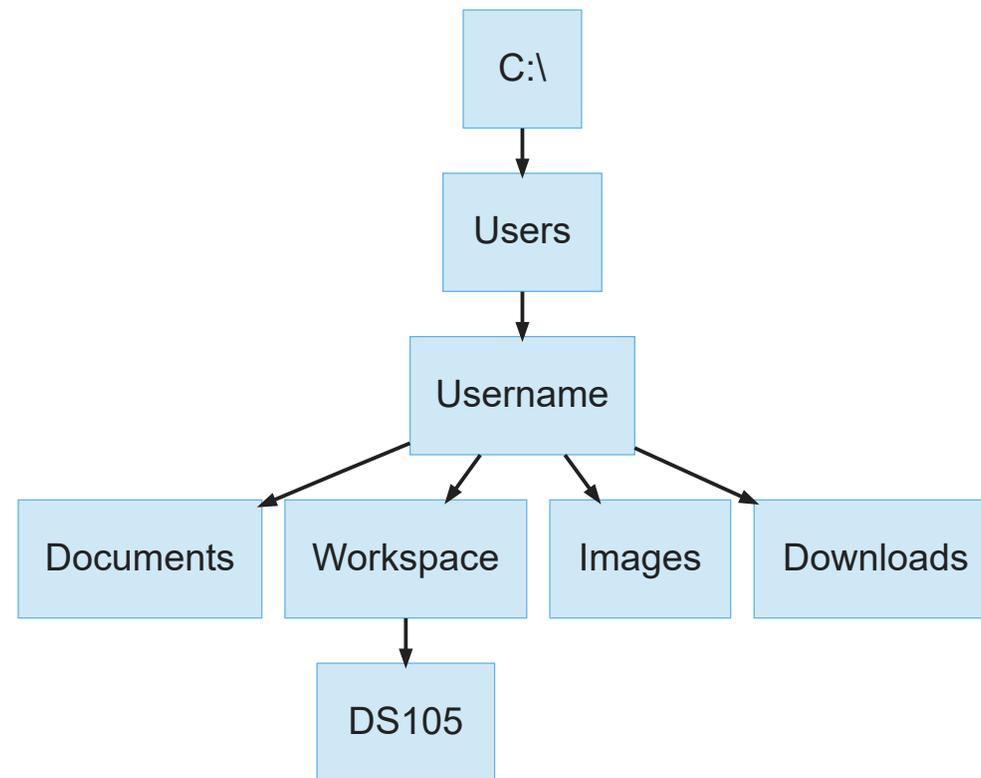


💡 macOS uses `/Users/` instead of `/home/`, but the structure is similar.



Windows File Systems

Windows uses **drive letters** (C:, D:, E:) where each drive is a separate filesystem:



⚠ Windows uses \ (backslash) for paths, Mac/Linux use / (forward slash).



Absolute vs Relative Paths

We can specify file locations in two ways:

Absolute Path:

- Full location from the root directory
- Works from anywhere
- Examples:
 - **Mac/Linux:** `/home/user/Documents/data.csv`
 - **Windows:**
`C:\Users\Username\Documents\data.csv`

Relative Path:

- Location relative to where you are now
- More flexible for sharing code
- Examples:
 - `./data.csv` → file in current directory
 - `../data.csv` → go up one level first
 - `data/weather.json` → file in data subfolder

💡 TIPS

- Use `pwd` in Terminal to find where you are.
- **Always use relative paths in this course for reproducibility!**





Environment Variables

16:30 – 16:35

Environment variables are **system settings** that programs use to find what they need.



What Are Environment Variables?

Special variables that store system-wide settings:

- Where programs are located (`PATH`)
- User's home directory (`HOME`)
- Current directory (`PWD`)
- Temporary file locations (`TEMP`)

 **Think about it:** When you type `python` in Terminal, how does your computer know where the python program is?



Common Environment Variables

Variable	Mac/Linux	Windows	Purpose
\$HOME	/home/username/	%USERPROFILE%	User's home directory
\$PATH	/usr/local/bin:/usr/bin/	C:\Windows\System32\;...	Where OS looks for programs
\$PWD	/home/username/Documents	%CD%	Current directory
\$TEMP	/tmp/	%TEMP%	Temporary files

Try it now:

```
echo $HOME      # Mac/Linux (on Nuvolos)
echo $env:PATH  # Windows PowerShell
```



Terminal Commands & File Formats

16:35 – 16:50

Great notes from your  **W03 Practice!** Let's build on what you discovered.



Terminal Commands Quick Reference

UNIX/Mac/Linux (Nuvolos too!)

```
pwd          # Where am I?  
ls           # What's here?  
cd folder/  # Move to folder  
mkdir newfolder # Create folder  
touch file.txt # Create file  
cat file.csv # View file  
nano file.txt # Edit file
```

Windows PowerShell

```
pwd          # Where am I?  
dir          # What's here?  
cd folder\  # Move to folder  
mkdir newfolder # Create folder  
ni file.txt  # Create file  
gc file.csv  # View file  
notepad file.txt # Edit file
```

💡 Same goals, different commands. In this course, we use UNIX commands (Mac/Linux/Nuvolos).



Plain Text vs Binary Files

Not all files are the same! Understanding the difference helps you know which tools to use.

Plain Text Files:

- Human-readable when opened with text editors
- CSV, JSON, Python scripts (`.py`), Markdown (`.md`)
- Can view with `cat`, edit with `nano` or VS Code
- Store data as characters using encoding like UTF-8

Binary Files:

- Not human-readable (gibberish if opened as text)
- Images (`.png`, `.jpg`), PDFs, databases, executables
- Need specific applications to open
- Store data as raw bytes



File Formats for Data Science

The two most common data formats you'll work with:

CSV (Comma-Separated Values)

```
date,max_temp_c,conditions
2025-10-13,18,cloudy
2025-10-14,22,sunny
2025-10-15,19,rainy
```

- Simple tabular data
- One row per line
- Columns separated by commas
- No nested structures
- Great for final results

JSON (JavaScript Object Notation)

```
{
  "date": "2025-10-13",
  "temp": 18,
  "conditions": "cloudy",
  "location": {
    "city": "London",
    "country": "UK"
  }
}
```

- Structured data
- Supports nested dictionaries
- Common in API responses
- Plain text (human-readable)
- Flexible but more complex



Working with Files in Python

Let me show you how to save and read data files so you don't need to re-download from APIs every time.

Demo Notebook: [week03/W03-NB02-File-Formats.ipynb](#)

We'll cover:

1. Collecting data from an API (recap)
2. Writing/Reading JSON files
3. Writing/Reading CSV files
4. When to use each format

💡 This is critical for your  **W04 Practice:** collect data once, save it, work from the saved file!



Writing JSON Files

Save API data so you don't need to download it repeatedly:

```
import json

# Collect data from API (you learned this in W02)
response = requests.get(url, params=params)
weather_data = response.json()

# Write to JSON file (run this ONCE)
with open('data/july_2024_weather.json', 'w') as f:
    json.dump(weather_data, f, indent=2)

print("Data saved!")
```

What's happening:

- `with open()` creates a connection to the file
- `'w'` means write mode
- `json.dump()` writes the dictionary as JSON
- `indent=2` makes it human-readable
- File closes automatically when done



Reading JSON Files

Read saved data without making another API call:

```
import json

# Read the saved data
with open('data/july_2024_weather.json', 'r') as f:
    loaded_data = json.load(f)

print("Data loaded!")
print(f"We have {len(loaded_data['daily']['time'])} days")
```

Benefits:

-  Faster
(no network wait)
-  Works offline
-  Respectful to API servers (no rate limits)
-  Reproducible
(same data every time)



Writing CSV Files

Transform structured data into simple tabular format:

```
import csv

dates = loaded_data['daily']['time']
temps = loaded_data['daily']['temperature_2m_max']

# Write to CSV
with open('data/july_2024_temps.csv', 'w', newline='') as f:
    writer = csv.writer(f)

    # Header row
    writer.writerow(['date', 'max_temp_c'])

    # Data rows
    for i in range(len(dates)):
        writer.writerow([dates[i], temps[i]])

print("CSV created!")
```

💡 We use `range(len(dates))` to iterate through indices, accessing both lists at the same position.



Reading CSV Files

Read CSV data back into Python:

```
import csv

# Read the CSV
with open('data/july_2024_temps.csv', 'r') as f:
    reader = csv.reader(f)

    # Skip header
    header = next(reader)

    # Read data rows
    rows = list(reader)
    print("First 5 rows:")
    for row in rows[:5]:
        print(f" {row[0]}: {row[1]}°C")
```

This pattern matches what you learned in DataQuest this week!



When to Use JSON vs CSV

Use JSON when:

- Your data has nested structure
- You're storing API responses
- You need to preserve exact data types
- Data has complex relationships

Example: Weather data with location info, multiple measurements, metadata

Use CSV when:

- Your data is simple rows and columns
- You want to open in Excel/Sheets
- You're creating summary tables
- You need maximum compatibility

Example: Final heatwave counts per year (simple table)

 **W04 Practice workflow:** Collect from API → Save as JSON → Analyze → Export summary as CSV





Quick Pair Discussion

Before our coffee break, let's connect what you learned in  **W03 Practice** to what we've covered today. Turn to someone near you (2-3 people).

Your task (3 minutes total):

- **Share one challenge:** What is something that you still find difficult or confusing about the subject of files and the Terminal?

 **Post to Slack:** Drop your pair's key insight in a thread on the `#social` channel. What was the most interesting connection you made?





Coffee Break

After the break:

- Hands-on Git & GitHub setup
- Create your personal course repository
- Move your course files into version control
- Your first commit and push!





Git & GitHub Hands-On

17:00 - 18:00

This hour runs like a lab session. Follow along on your laptop!



What is Git? What is GitHub?

Git:

- Version control system (like “track changes” for code)
- Tracks every change to your files
- Lets you go back to previous versions
- Works on your computer (local)

GitHub:

- Website that stores Git repositories online
- Backup of your work in the cloud
- Makes collaboration possible
- Portfolio of your projects

 **Think of it this way:** Git is the engine, GitHub is the parking garage where you store your car.



The Git Ceremony



Fig 1. The Git workflow we will follow in this course."



Today's Goal

By the end of this hour, you will have:

1. ✓ Created a GitHub account
2. ✓ Created a repository called `my-ds105-notes`
3. ✓ Cloned it to Nuvolos
4. ✓ Moved your week01, week02, week03 folders into the repository
5. ✓ Made your first commits
6. ✓ Pushed your work to GitHub

Everything you need is in the guide on Moodle/website. We'll work through it together!



The Git Ceremony

This workflow pattern will become muscle memory:

```
# 1. Check what changed
git status

# 2. Stage changes
git add .

# 3. Commit with message
git commit -m "Add Week 01 files"

# 4. Push to GitHub
git push
```

We'll practice this ceremony multiple times today. By W04, it'll feel natural!



Let's Get Started!

Open the guide: **Using GitHub & Git for Version Control**

We'll work through each step together.

 **Don't rush!** Git feels overwhelming at first, but we'll practice repeatedly over the coming weeks. Today is just exposure.



Thanks!

See you in Friday's lab where you'll practice Git workflows and start your  **W04 Practice!**

 Questions? Post in the [#help](#) channel on Slack.

