Version Control with Git

Python Course · Git Module

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Module — Version Control with Git

In this module we learn how to **track changes** in our code and **collaborate** with others:

- What is version control and why we need it
- History of Git and its creator
- Git basics and core concepts
- Essential Git commands (add, commit, pull, push)
- What is GitHub and how to use it
- Practical example: pushing a Python app to GitHub

Goal: make your code **safe**, **trackable**, and **shareable**.

The Problem: Code Without Version Control

Imagine working on a project without Git:

```
app.py
app_backup.py
app_final.py
app_final_v2.py
app_final_v2_REALLY_FINAL.py
app_old.py
app_working.py
```

Problems:

- **Lost changes** – accidentally deleted code
- **No history** – can't see what changed or why
- **Collaboration chaos** – multiple people editing the same file
- **No rollback** – can't undo mistakes easily

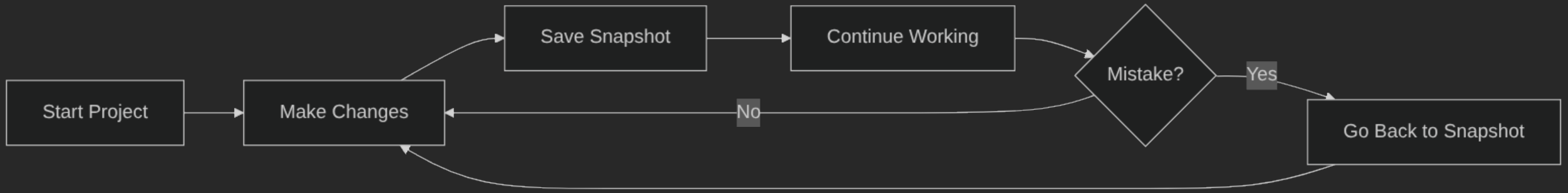
Version control solves all of these problems.

What is Version Control?

Version control is a system that tracks changes to files over time.

Think of it like:

- **Time machine** for your code
- **Undo button** that works across days/weeks
- **Collaboration tool** for teams
- **Backup system** that keeps history



Every "snapshot" (commit) saves the entire state of your project at that moment.

Why We Need Version Control

For Individuals:

- Track what changed and when
- Revert to previous working versions
- Experiment safely (branches)
- Understand your own code evolution

For Professionals:

- Required in almost all software jobs
- Essential for DevOps workflows
- Industry standard for code management
- Foundation for CI/CD pipelines

For Teams:

- Multiple people work on same codebase
- Merge changes automatically
- See who changed what
- Resolve conflicts systematically

The History of Git

Git was created by **Linus Torvalds** in 2005.

Context:

- Linux kernel development needed better version control
- Previous tools were slow, proprietary, or expensive
- Needed something **fast**, **distributed**, and **free**

Design Philosophy:

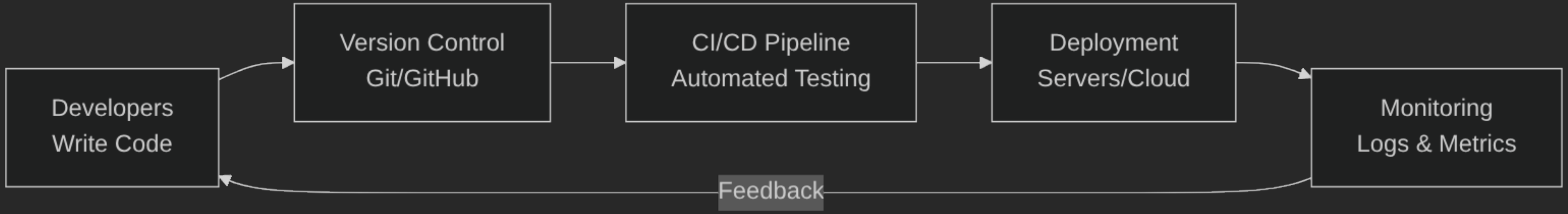
- **Distributed** – every copy is a full repository
- **Fast** – optimized for speed
- **Simple** – core concepts are straightforward
- **Open source** – free for everyone

Git became the **de facto standard** for version control in software development.

What is DevOps?

DevOps = **Dev**elopment + **Op**erations

It's a **culture and set of practices** that bring together software development and IT operations.



Key Principles:

- **Automation** – reduce manual work
- **Collaboration** – devs and ops work together
- **Continuous Integration** – merge code frequently
- **Continuous Deployment** – release often and safely

Why Git is DevOps

Git is a **foundational DevOps tool** because:

1. Enables Collaboration

- Multiple developers work on the same codebase
- Changes are tracked and merged systematically

2. Supports Automation

- CI/CD pipelines trigger on Git events (push, pull request)
- Automated tests run when code changes

3. Provides Traceability

- Every change is logged with author, date, and message
- Essential for debugging and compliance

4. Facilitates Deployment

- Different branches for dev, staging, production
- Rollback to previous versions when needed

5. Integrates with Tools

- GitHub, GitLab, Bitbucket (hosting)
- Jenkins, GitHub Actions (automation)
- Docker, Kubernetes (deployment)

Git Basics — Repository

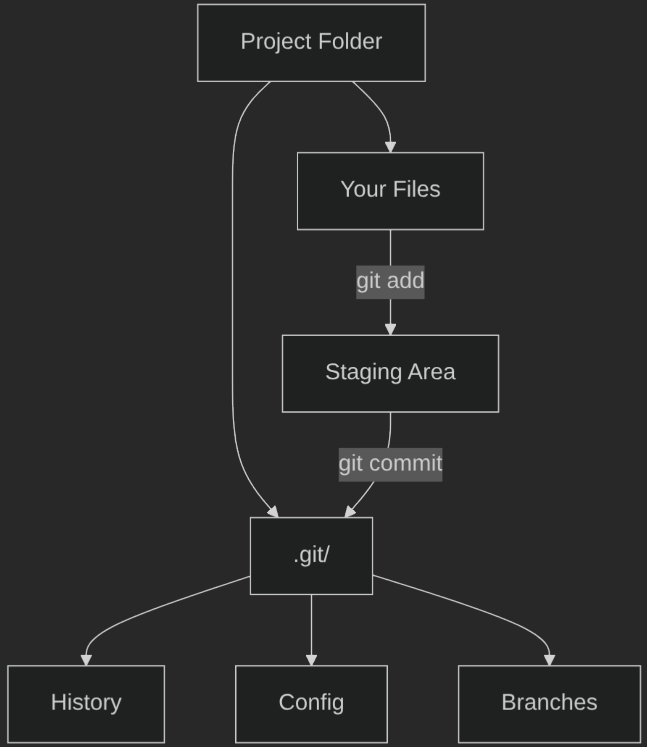
A **repository** (repo) is a folder that Git tracks.

Initialize a repository:

```
cd my_project
git init
```

This creates a hidden `.git` folder that stores:

- All file versions (history)
- Commit messages
- Branch information
- Configuration



Git Basics — Three States

Files in Git can be in three states:

1. **Working Directory**

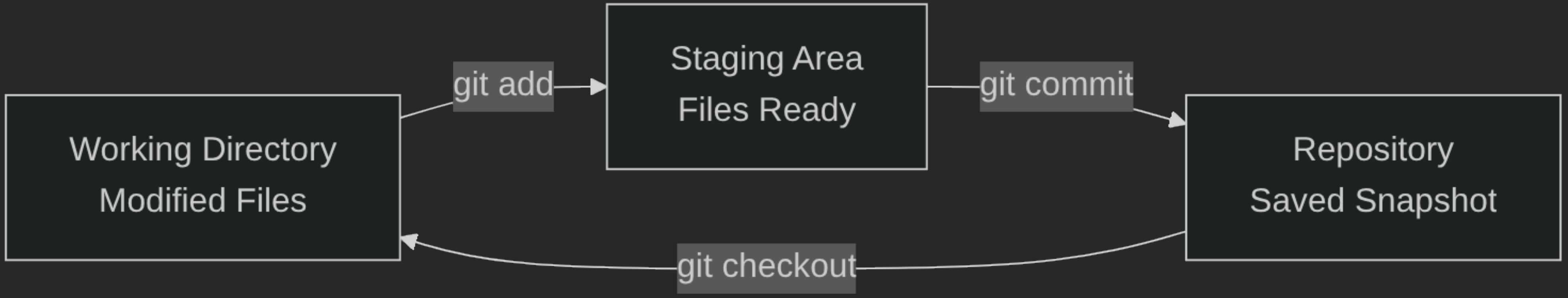
   - Files you're editing
   - Changes not yet staged

2. **Staging Area** (Index)

   - Files marked to be committed
   - Preview of next commit

3. **Repository** (History)

   - Committed snapshots
   - Permanent record



Think of it like:

- **Working Directory** = your desk (work in progress)
- **Staging Area** = package ready to ship
- **Repository** = warehouse (permanent storage)

Git Command — git add

Stage files to be committed.

Add specific file:

```
git add app.py
```

Add all files:

```
git add .
```

Add multiple files:

```
git add app.py config.py utils.py
```

What happens:

- Files move from **Working Directory → Staging Area**
- Changes are **prepared** for commit
- You can review what will be committed

Example workflow:

```
# Edit app.py
vim app.py

# Stage the changes
git add app.py

# Check status
git status
```

Git Command – git commit

Save a snapshot of staged changes.

Basic commit:

```
git commit -m "Add user authentication"
```

Commit with description:

```
git commit -m "Fix login bug

- Resolved issue with password validation
- Added error handling for empty fields"
```

What happens:

- Staged files are **saved** to repository
- A **commit** (snapshot) is created
- You get a **unique commit hash** (e.g., `a1b2c3d`)

Best Practices:

- Write **clear, descriptive** messages
- Commit **logical units** of work
- Commit **often** (small, frequent commits)

Git Command — git status

Check the state of your repository.

```
git status
```

Shows:

- **Untracked files** — new files not added yet
- **Modified files** — changed but not staged
- **Staged files** — ready to commit
- **Branch name** — current branch

Example output:

```
On branch main
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  modified:   app.py

Untracked files:
  (use "git add <file>..." to include in what will be committed)
  config.py

Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)
  new file:   utils.py
```

Git Command — git log

View commit history.

Basic log:

```
git log
```

One-line format:

```
git log --oneline
```

Graphical view:

```
git log --graph --oneline --all
```

Example output:

```
a1b2c3d (HEAD -> main) Add user authentication
e4f5g6h Fix login bug
h7i8j9k Initial commit
```

Each commit shows:

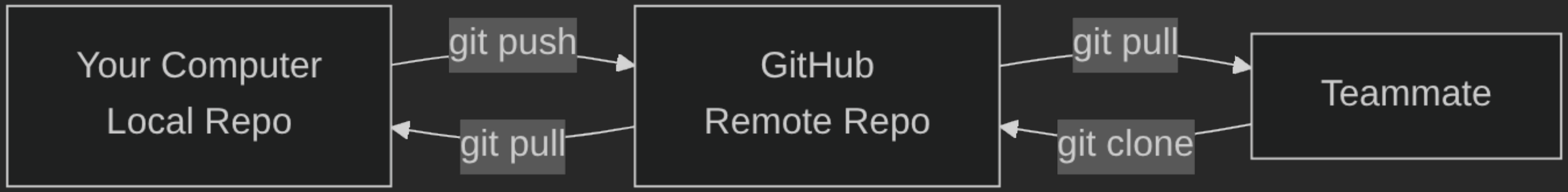
- **Hash** — unique identifier
- **Author** — who made the change
- **Date** — when it was made
- **Message** — what changed

What is GitHub?

GitHub is a **cloud-based hosting service** for Git repositories.

Think of it as:

- **Google Drive** for code
- **Social network** for developers
- **Collaboration platform** for teams
- **Portfolio** for your projects



Key Features:

- **Free hosting** for public repositories
- **Web interface** to browse code
- **Pull requests** for code review
- **Issues** for bug tracking
- **Actions** for CI/CD automation

Git Command – git remote

Connect your local repo to GitHub.

Add remote repository:

```
git remote add origin https://github.com/username/repo-name.git
```

View remotes:

```
git remote -v
```

Remove remote:

```
git remote remove origin
```

Change remote URL:

```
git remote set-url origin https://github.com/username/new-repo.git
```

The name `origin` is a **convention** for the main remote repository. You can have multiple remotes (e.g., `origin`, `upstream`).

Git Command — git push

Upload your commits to GitHub.

Push to main branch:

```
git push origin main
```

First push (set upstream):

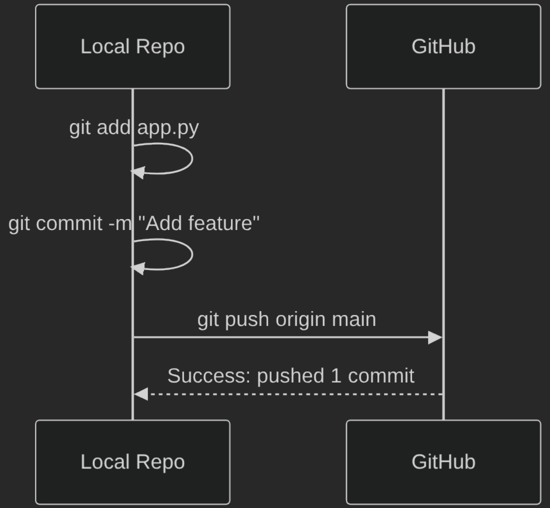
```
git push -u origin main
```

Push all branches:

```
git push --all origin
```

What happens:

- Local commits are **uploaded** to GitHub
- Others can now **see and pull** your changes
- Your code is **backed up** in the cloud



Git Command — git pull

Download and merge changes from GitHub.

Pull from main branch:

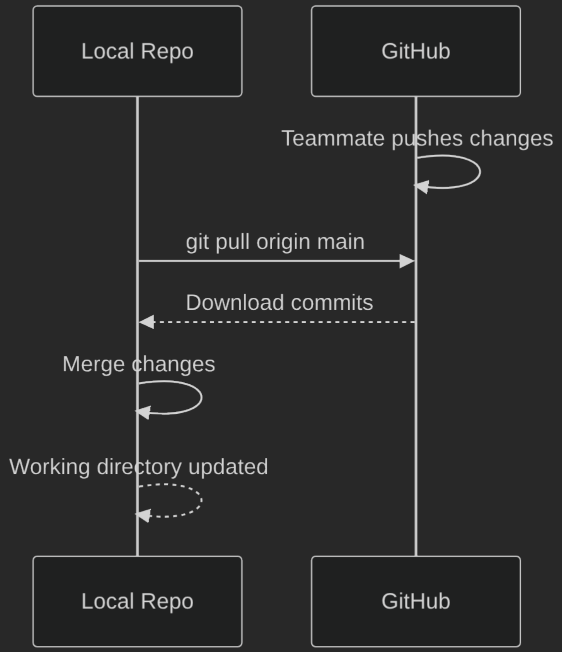
```
git pull origin main
```

Pull and rebase:

```
git pull --rebase origin main
```

What happens:

- **Fetches** latest commits from GitHub
- **Merges** them into your local branch
- Updates your working directory



Always pull before pushing to avoid conflicts!

Git Command – git clone

Copy a repository from GitHub to your computer.

Clone a repository:

```
git clone https://github.com/username/repo-name.git
```

Clone to specific folder:

```
git clone https://github.com/username/repo-name.git my-project
```

Clone with SSH:

```
git clone git@github.com:username/repo-name.git
```

What happens:

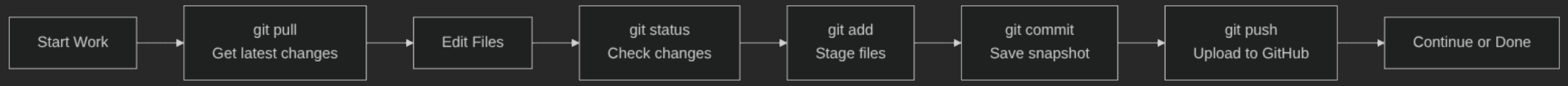
- **Downloads** entire repository
- **Creates** local copy with full history
- **Sets up** remote connection automatically

This is how you:

- **Start** working on existing projects
- **Fork** open-source projects
- **Backup** repositories locally

Complete Git Workflow

Typical daily workflow:



Start Work

git pull
Get latest changes

Edit Files

git status
Check changes

git add
Stage files

git commit
Save snapshot

git push
Upload to GitHub

Continue or Done

Step-by-step:

```
# 1. Get latest changes
git pull origin main

# 2. Make changes
vim app.py

# 3. Check what changed
git status

# 4. Stage changes
git add app.py

# 5. Commit
git commit -m "Add new feature"

# 6. Push to GitHub
git push origin main
```

Practical Example – Setting Up a Project

Let's create a simple Python app and push it to GitHub.

Step 1: Create project locally

```bash
mkdir my-python-app
cd my-python-app
```

Step 2: Initialize Git

```bash
git init
```

Step 3: Create app.py

```python
def greet(name):
    """Greet a user by name."""
    return f"Hello, {name}! Welcome to Python."

def main():
    name = input("Enter your name: ")
    message = greet(name)
    print(message)

if __name__ == "__main__":
    main()
```

Step 4: Create README.md

~~~markdown
# My Python App

A simple greeting application.

## Usage

```bash
python app.py
~~~

Practical Example — First Commit

Step 5: Stage and commit

```
# Add all files
git add .

# Check status
git status

# Make first commit
git commit -m "Initial commit: Add greeting app"
```

Step 6: View history

```
git log --oneline
```

Output:

```
a1b2c3d (HEAD -> main) Initial commit: Add greeting app
```

Your code is now **tracked locally** with Git!

Practical Example — Push to GitHub

Step 7: Create repository on GitHub

1. Go to github.com
2. Click **"New repository"**
3. Name it `my-python-app`
4. **Don't** initialize with README (we already have one)
5. Click **"Create repository"**

Step 8: Connect and push

```
# Add GitHub as remote
git remote add origin https://github.com/yourusername/my-python-app.git

# Push to GitHub
git push -u origin main
```

Step 9: Verify

- Visit `https://github.com/yourusername/my-python-app`
- You should see `app.py` and `README.md`
- Your code is now **on GitHub**!

Practical Example — Making Changes

Step 10: Update the app

Edit app.py:

```python
def greet(name, language="en"):
    """Greet a user by name in different languages."""
    greetings = {
        "en": f"Hello, {name}! Welcome to Python.",
        "es": f"¡Hola, {name}! Bienvenido a Python.",
        "fr": f"Bonjour, {name}! Bienvenue à Python."
    }
    return greetings.get(language, greetings["en"])

def main():
    name = input("Enter your name: ")
    lang = input("Language (en/es/fr): ").lower() or "en"
    message = greet(name, lang)
    print(message)

if __name__ == "__main__":
    main()
```

Step 11: Commit and push changes

```bash
git add app.py
git commit -m "Add multi-language support"
git push origin main
```

Your changes are now **on GitHub**!

Git Configuration — First Time Setup

Before your first commit, configure Git:

Set your name:

```
git config --global user.name "Your Name"
```

Set your email:

```
git config --global user.email "your.email@example.com"
```

Check configuration:

```
git config --list
```

View specific setting:

```
git config user.name
```

These settings are used in **every commit** to identify the author.

Note: Use the **same email** as your GitHub account for proper attribution.

Mini Task — Git Practice

Create an app (or reuse one) and manage it with Git:

Part 1: Local Setup

1. Create folder `some-app`
2. Initialize Git repository
3. Create `some.py` with basic operations
4. Create `README.md` with usage instructions
5. Make initial commit

Part 2: GitHub Setup

1. Create repository on GitHub
2. Connect local repo to GitHub
3. Push your code

Part 3: Enhancements

1. Add a new feature (e.g., power operation)
2. Commit the change
3. Push to GitHub
4. View your commit history on GitHub

Part 4: Documentation

1. Update `README.md` with the new feature
2. Commit and push
3. Verify changes on GitHub

Goal: Practice the complete Git workflow from local to GitHub.

🟩 Thanks!

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