Git Source Control

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🧭 Project Overview

This project documents a full hands-on implementation of Git Flow, based on the article A Successful Git Branching Model. It is designed as a comprehensive guide and training resource for engineers and developers with little to no Git experience.

The objective is to teach:

- How to use version control for collaborative development
- How to organize work using `main`, `develop`, `feature`, `release`, and `hotfix` branches
- How to manage merges, rebase, tagging, and upstream tracking
- How to resolve merge conflicts and preserve project history

📁 Branch Structure Summary

Following Git Flow:

- `main` → Stable, production-ready code (only updated from `release/*` or `hotfix/*`)
- `develop` → Integration branch for all features
- `feature/*` → Short-lived branches for individual features (e.g., `feature/login-ui`)
- `release/*` → Pre-release stabilization branches (e.g., `release/<version>`)
- `hotfix/*` → Emergency fixes branched from `main` (e.g., `hotfix/<version>`)

Tags like `v1.0.0`, `v1.1.0`, and `v<version>` mark official release points.

> 📝 **Note:** Each feature should be developed in a **separate branch** from `develop`. Feature branches follow the naming convention `feature/*`, where `*` is a brief, dash-separated description (e.g., `feature/export-csv`).

⚙️ Git Configuration (Recommended for Team)

SSH Tag Signing Setup

```
git config --global gpg.format ssh # Use SSH key for tag signing


git config --global user.signingkey ~/.ssh/id_ed25519.pub # Sets your public key for tag signing
```

Automatically Set Upstream for New Branches

```
git config --global push.autoSetupRemote true # Auto-sets upstream when pushing new branches
```

Git Line Ending Configuration (Cross-Platform)

Add this `.gitattributes` file:

```
# Use LF (Unix-style) endings for source code
*.c     text eol=lf
*.cpp   text eol=lf
*.h     text eol=lf
*.py    text eol=lf
*.sh    text eol=lf
*.md    text eol=lf
*.txt   text eol=lf

# Treat .git* files as text with LF
.gitignore text eol=lf
.gitattributes text eol=lf

# Use CRLF for Windows batch files (optional, for compatibility)
*.bat   text eol=crlf

# Prevent Git from touching line endings for binary files
*.jpg   binary
*.jpeg  binary
*.png   binary
*.gif   binary
*.pdf   binary
*.zip   binary
*.exe   binary
```

```
git add --renormalize . # Applies .gitattributes settings retroactively
```

```
git commit -m "Normalize line endings using .gitattributes" # Commits normalized line endings
```

🛠️ Core Workflow Commands (Fully Explained)

Create Tag

```
git tag -sa v1.0.0 -m "Initial Version Release" # Creates a signed annotated tag
```

```
git tag -sa v<version> -m "Release Description" # Template for future tags
```

Create `develop` From `main`

```
git checkout main # Switches to main branch
```

```
git pull origin main # Syncs with remote main branch
```

```
git checkout -b develop # Creates and switches to new develop branch
```

```
git push -u origin develop # Pushes develop and sets upstream
```

Create a Feature Branch

```
git checkout develop # Switch to develop
```

```
git pull origin develop # Ensure it’s up-to-date
```

```
git checkout -b feature/my-feature # Create and switch to feature branch
```

Maintain a Feature Branch

```
git add . # Stage all modified and new files
```

```
git commit -m "<your message>" # Commit your changes
```

```
git push # Push changes to remote feature branch
```

Merge a Feature into `develop`

```
git checkout develop # Switch to develop
```

```
git pull origin develop # Update with latest changes
```

```
git merge --no-ff feature/my-feature -m "Merge feature/my-feature" # Merge feature preserving his
```

```
git push # Pushes merged changes
```

Start a Release Branch

```
git checkout develop # Start from develop
```

```
git pull origin develop # Update local develop
```

```
git checkout -b release/<version> # Create and switch to release branch
```

Maintain a Release Branch

```
git add . # Stage all modified and new files
```

```
git commit -m "<your message>" # Commit your changes
```

```
git push # Push changes to remote release branch
```

Finish the Release

```
git checkout main # Switch to main for final release merge
```

```
git merge --no-ff release/<version> -m "Release v<version>" # Merge release into main with histor
```

```
git tag -sa v<version> -m "Tagging release v<version>" # Create signed tag
```

```
git push # Push main branch updates
```

```
git push origin v<version> # Push tag to remote
```

```
git checkout develop # Switch to develop
```

```
git merge --no-ff release/<version> -m "Merge release v<version>" # Merge release back to develop
```

```
git push # Push develop with merged release
```

```
git branch -d release/<version> # Delete local release branch
```

```
git push origin --delete release/<version> # Delete remote release branch
```

Creating a Hotfix Branch

```
git checkout main # Switch to main
```

```
git pull origin main # Sync latest main
```

```
git checkout -b hotfix/<version> # Create hotfix branch
```

Maintain a Hotfix Branch

```
git add . # Stage all modified and new files
```

```
git commit -m "<your message>" # Commit your changes
```

```
git push # Push changes to remote hotfix branch
```

Merge Hotfix into `main` , Tag It

```
git checkout main # Switch to main
```

```
git merge --no-ff hotfix/<version> -m "Apply hotfix v<version>" # Merge hotfix into main
```

```
git tag -sa v<version> -m "Hotfix v<version>" # Tag hotfix version
```

```
git push # Push hotfix to remote
```

```
git push origin v<version> # Push hotfix tag
```

Merge Hotfix into `develop`

```
git checkout develop # Switch to develop
```

```
git pull origin develop # Update local develop
```

```
git merge --no-ff hotfix/<version> -m "Backport hotfix v<version>" # Merge hotfix into develop
```

```
git push # Push changes
```

Clean Up Hotfix

```
git branch -d hotfix/<version> # Delete local hotfix branch
```

```
git push origin --delete hotfix/<version> # Delete remote hotfix branch
```

Syncing Hotfix with Latest Main Code

```
git checkout hotfix/<version> # Switch to hotfix
```

```
git fetch origin # Get latest remote changes
```

```
git merge origin/main --no-ff -m "Sync hotfix with main" # Merge main into hotfix
```

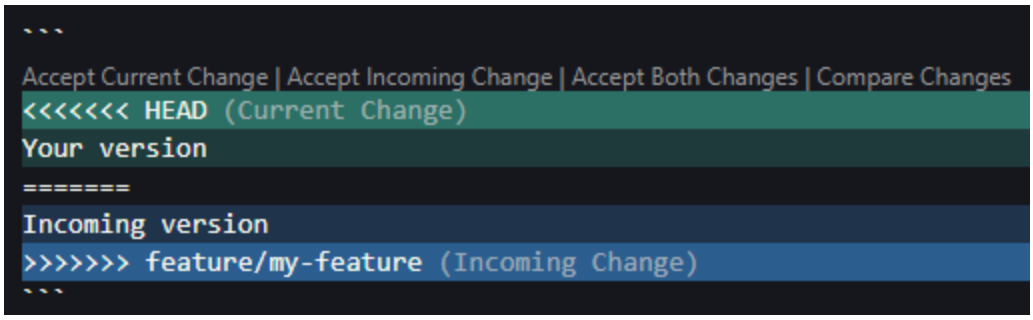
```
git push # Push updated hotfix
```

⚔️ Handling Merge Conflicts in VS Code

1. Start the merge:

```
git merge feature/my-feature # Attempt to merge feature
```

2. VS Code highlights conflicted files
3. Open files to resolve blocks:



4. Use the resolution buttons provided in the editor:
    - **Accept Current Change** – Keeps the version from your current branch (`HEAD`).
    - **Accept Incoming Change** – Uses the version from the branch you're merging in.
    - **Accept Both Changes** – Keeps both versions, stacked one after the other.
    - **Compare Changes** – Opens a side-by-side diff view to help you decide.
5. Save and stage the resolved file:

    ```
    git add . # Stage resolved files
    ```

6. Commit the merge:

    ```
    git commit -m "Resolve merge conflict" # Finalize merge
    ```

7. Push the result to remote repository:

    ```
    git push
    ```

🔁 Reverting a Pushed Commit (Safe Method)

If you've already pushed to the remote and others may have pulled it, the safest way to undo changes is by **reverting** the commit:

```
git revert <commit-hash>
git push
```

This creates a new commit that undoes the changes without modifying the existing history — ideal for shared branches.

🔀 Merge vs Pull vs Rebase Summary

Command	What It Does	When to Use
`merge`	Combines branches with a merge commit	Always use for features, releases, and hotfixes
`pull`	Shortcut for fetch + merge of current upstream branch	Keep local branch up to date
`rebase`	Rewrites commits onto a new base (linear history)	Use only on local/private feature branches

📜 List All Branches in a Git Repository

To view all local branches:

```
git branch
```

To view all remote branches:

```
git branch -r
```

To view both local and remote branches:

```
git branch -a
```

To see branches with their last commit info:

```
git branch -vv
```

📊 Visualizing Git History

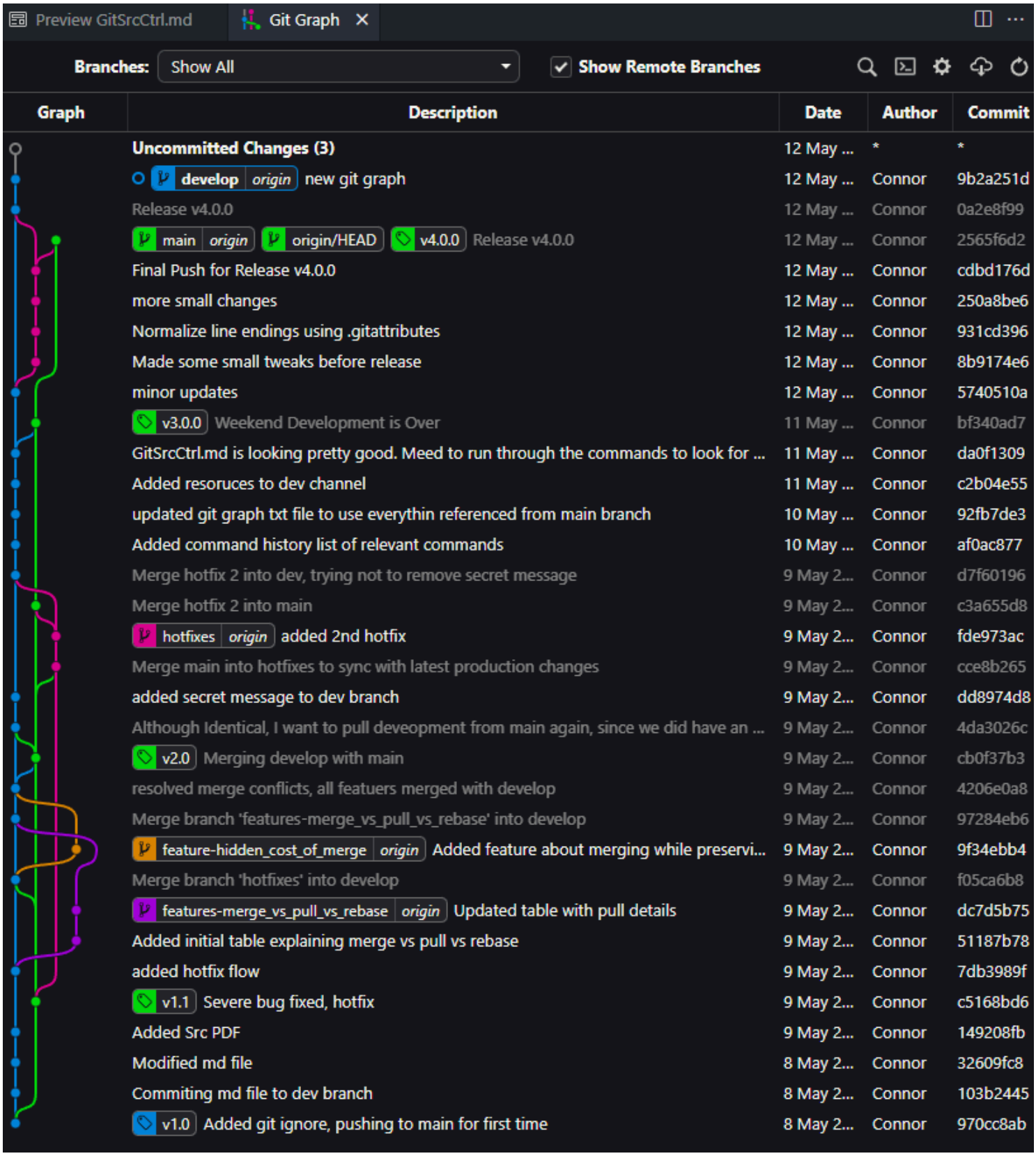
```
git log --oneline --graph --all --decorate # Pretty git history visualization
```

```
git log --oneline --graph --all --decorate > git_graph.txt # Save history view to file
```

🔍 Git Graph (VS Code Extension)

The **Git Graph** extension for VS Code provides a powerful visual interface to explore your Git repository's history. It displays branches, merges, tags, and commit messages in a clean, interactive format.

This graph helps validate whether Git Flow conventions—like release merges, tag placement, and hotfix branching—have been followed correctly.



✅ Key Git Flow Confirmations:

- `release/4.0.0` was created and used for staging commits (e.g., "Final Push for Release v4.0.0").
- The release was merged into `main` and **tagged** `v4.0.0`, as required.
- It was then merged back into `develop`, completing the release cycle.

- The branch reference for `release/4.0.0` is deleted, but its history is preserved via merges.
- Multiple hotfixes exist and are visible with tags (`v1.1` , `v2.0`) and a dedicated `hotfixes` branch.

⚠️ Issues to Note:

- **Hotfix Divergence**:
  The second hotfix (`added 2nd hotfix`) exists on the `hotfixes` branch and was merged into `main` , but **was not merged back into** `develop` .
  - This breaks the Git Flow model, which requires hotfixes to be merged into both `main` and `develop` to prevent regressions.
  - Consider creating a merge commit from `hotfixes` into `develop` to synchronize branches.

Recommendation:

Regularly use Git Graph or `git log --oneline --graph --all --decorate` to audit your branching and merging practices. This ensures alignment with Git Flow and avoids lost fixes or duplicate work.

🧠 Best Practices & Lessons Learned

- Use `--no-ff` to preserve branch history
- One feature per `feature/*` branch from `develop`
- Create `release/*` for each version
- Hotfix from `main` , merge into `main` and `develop`
- Tag releases **after** merging into `main`
- Clean up merged branches
- Avoid rebase on shared branches

🧪 Practice Resources

- Simulate merge conflicts
- Try reverting a merge commit:

```
git revert -m 1 <merge-commit> # Reverts a specific merge
```

- Use `git stash` for managing WIP
- Use reflog to recover deleted branches

📌 Reference Materials

- A successful Git branching model
- `cmd_hist` : full command history
- `git_graph.txt` : visual history output
- This document: internal Git Flow tutorial