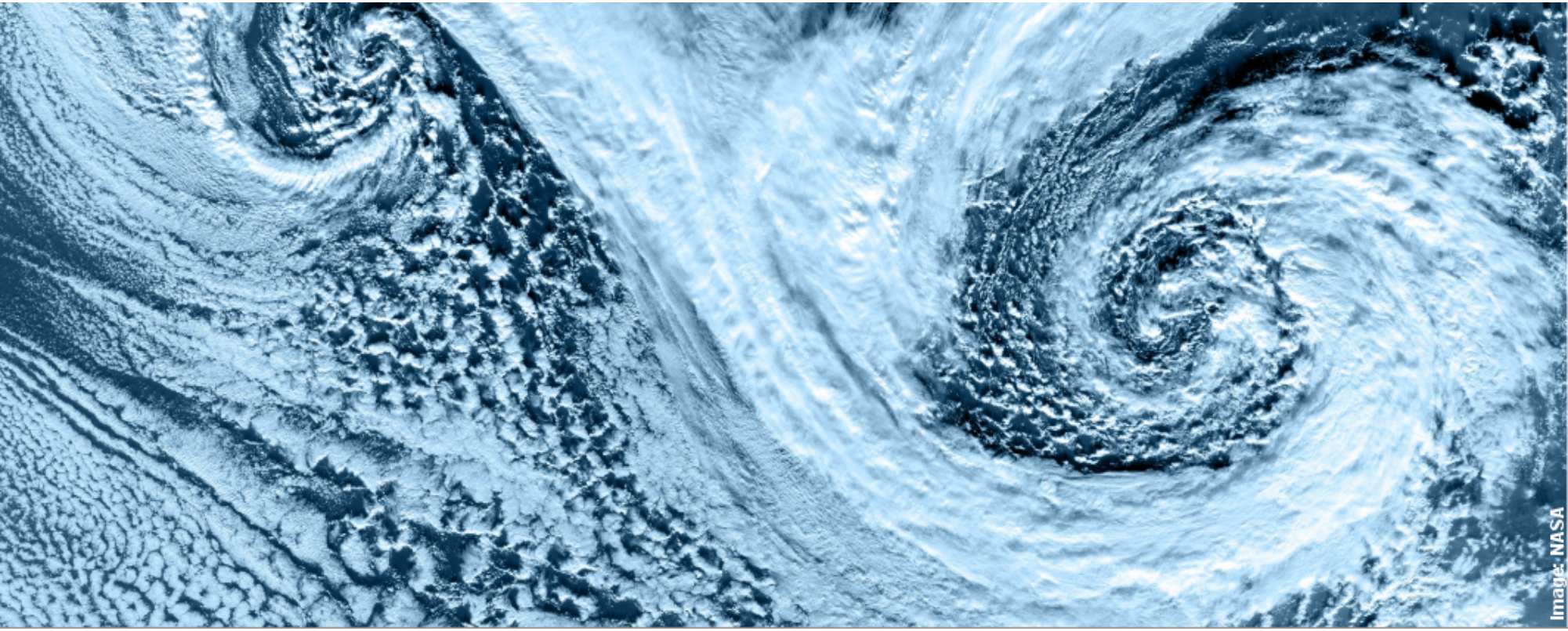
C2SM
Center for Climate
Systems Modeling

ETH zürich

Git and Github

Katie Osterried
C2SM
COSMO General Meeting 2016



Outline

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What is git?

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- Version control system (like SVN)
- Tool for tracking of changes in files in order to:
  - Record reasons for changes
  - Compare with and incorporate versions from other sources
  - Have multiple people developing the same code
  - Maintain several parallel versions of the same code in a systematic way
- Designed for collaborative, open source workflows

Source: https://git-scm.com/downloads/logos

Status of the C2SM git migration

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- C2SM hosted COSMO and related codes were successfully migrated from SVN to git in December 2015
- All the code development history was retained during the migration
- Code is now hosted on github.com in 42 separate code repositories
- Fieldextra and Extpar official versions now hosted on Github

Git Terminology

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1. **repository** : the location of the saved code and its history
2. **branch** : an independent line of development
3. **master** : the default branch
4. **commit** : a snapshot of your project at a certain time
5. **tag** : a frozen reference to a particular commit
6. **HEAD** : the currently checked out commit
7. **index/staging area** : area between working directory and repository
8. **remote** : a repository linked to the local repository

Important differences from SVN

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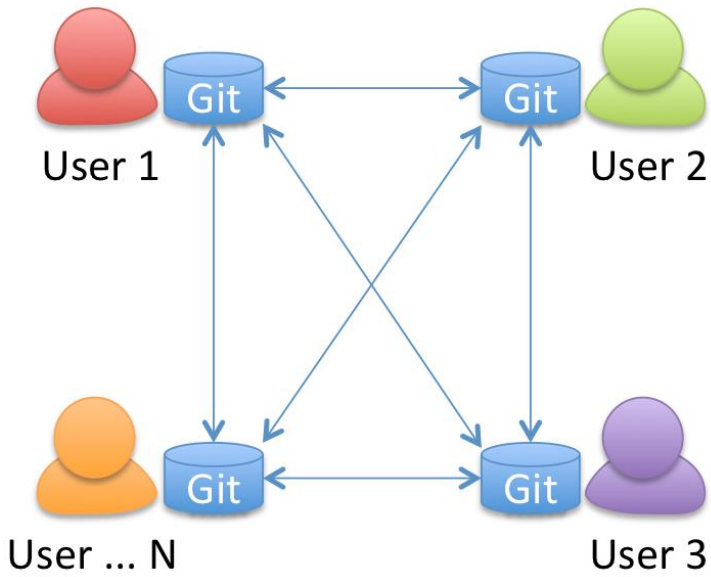
Git is a distributed version control system

- Every user has the whole repository
- Users can save changes to the local repository without a network
- Repositories can be located anywhere and linked together easily
- Workflow for a group must be clearly defined



Source: http://www.codemag.com/Article/1105101

Important differences from SVN

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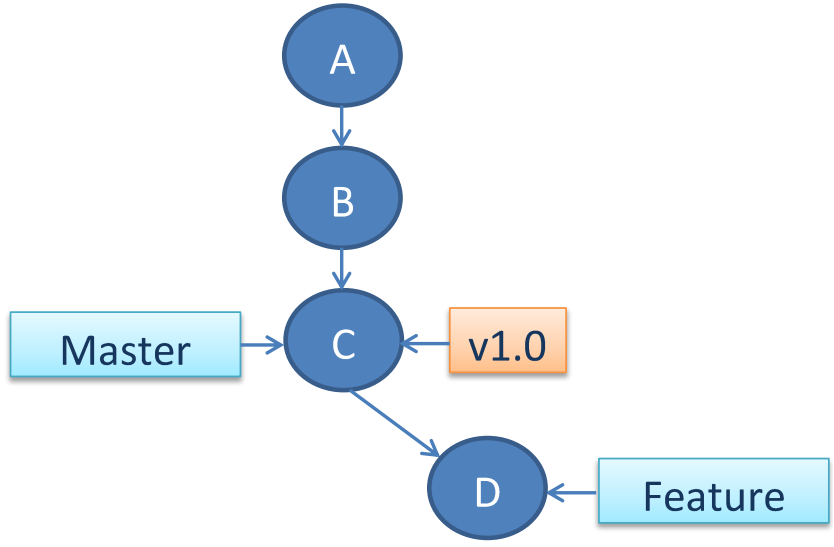
Git uses a strict definition of branches and tags

- Branches and tags are not associated with different directories (like SVN)
- Branches and tags are simply pointers to a certain commit
- The trunk equivalent is called "master" and is no different from any other branch



Important differences from SVN

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Git uses different commit IDs

- Linear revision numbers don't work
- Each commit has a unique identifier generated by an algorithm
- Series of 40 characters and numbers
- Commits can be generally referred to by the first 6-8 characters of the ID

Example: commit f3abe64fc121b75f3f0566c73f2f1a4e8fffd68e

Can be referred to as: f3abe64

Important differences from SVN

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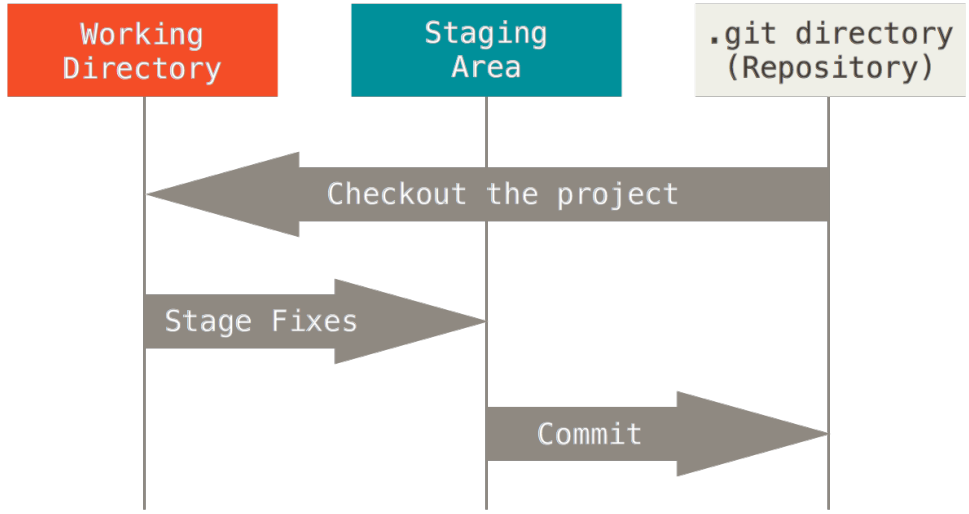
Git uses a staging area

- Additional layer between working directory and repository
- Stores information about what will go in the next commit
- Allows you to group commits logically



Source: https://git-scm.com/book/en/v1/Getting-Started-Git-Basics

Outline

Local git workflow

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1. Start or copy a git repository locally *(git init, git clone)*
2. Make a feature branch for developing *(git branch, git checkout)*
3. Make some code changes
4. Save the code changes to the staging area *(git add)*
5. Save the code changes to the repository *(git commit)*
6. Merge the changes from the feature branch to the master *(git merge)*

How to start a repository

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Commands to start working with git:

git config

- Set configuration variables for git

Usage: *git config user.name "Your Name"*

Usage: *git config --global user.email "youremail@email.com"*

git init

- Creates an empty git repository
- Creates by default the master branch
- Creates the .git folder and contents

Usage: *git init*

git clone

- Copies an existing git repository
- Creates and navigates to the current branch of the copied repository
- Links the original repository as a remote

Usage: *git clone /path_to_original /path_to_copy*

How to make commits

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Commands for saving code changes:

- **git add**
  - Saves code changes to the staging area
  - Can add all or some of the current code changes
  - Can be performed multiple times before a commit

  Usage: *git add /path_to_file*

- **git commit**
  - Saves the changes in the staging area to the repository
  - Creates a unique commit ID
  - Saves a log message from the user

  Usage: *git commit*

How to examine a repository

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Commands for getting information about a repository:

- **git log**
  - Displays the log of all the commits
  - Can be customized through command line options

  Usage: *git log*

- **git status**
  - Shows the status of the working copy
  - States which files have been placed in the staging area
  - Shows which files have been modified but not placed in the staging area

  Usage: *git status*

- **git diff**
  - Shows the changes between two versions of the code
  - Many options for customization

  Usage: *git diff*

How to examine a repository

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Commands for looking at previous commits:

- **git checkout (old commit)**
  - Displays the working copy as it was when the commit was made
  - Should be used for looking at old commits, not development
  - Anything committed will NOT be saved to a current branch

  Usage: *git checkout commitID*

- **git checkout (single file)**
  - Updates the file in the current working copy
  - Used for recovering old versions of files
  - Anything committed WILL be saved to the current branch

  Usage: *git checkout commitID /path_to_file*

How to create and switch to a branch

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Commands for working with branches:

- **git branch**
  - Lists current branches or creates a new one
  - Creates branch from current HEAD
  - Does not automatically switch to new branch

  Usage: *git branch branch_name*

- **git checkout (branch)**
  - Changes the files in the working copy to the branch
  - Local changes are preserved

  Usage: *git checkout branch_name*

Merging without commits

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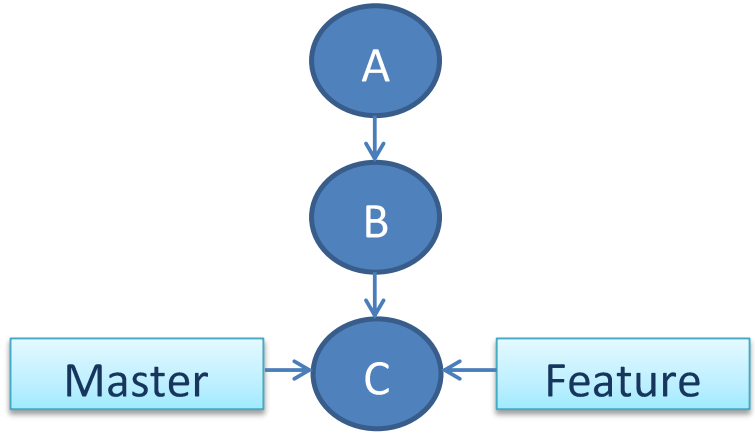
Fast-forward merge is the default behavior

- **git merge**
  - Combines the target branch with the current branch
  - Does not create a commit unless it has to (or you tell it to)
  - Called from the branch you want to merge into

Usage: *git merge branch_name*



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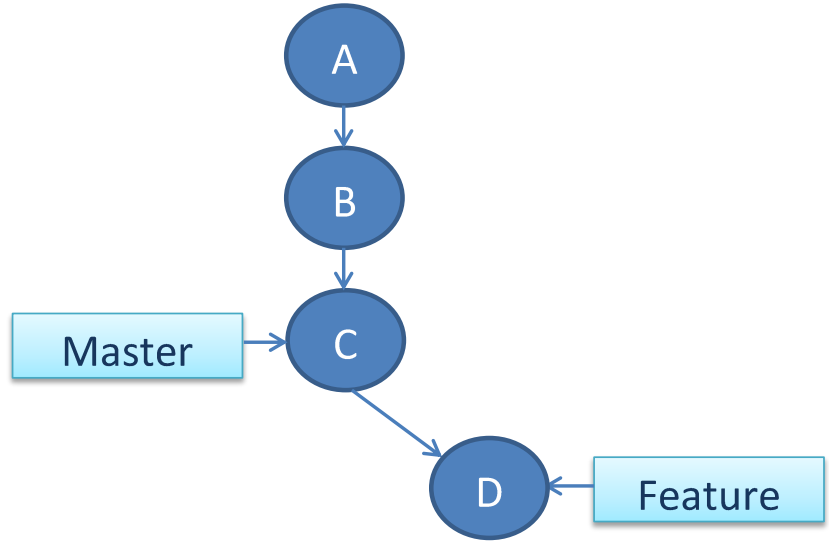

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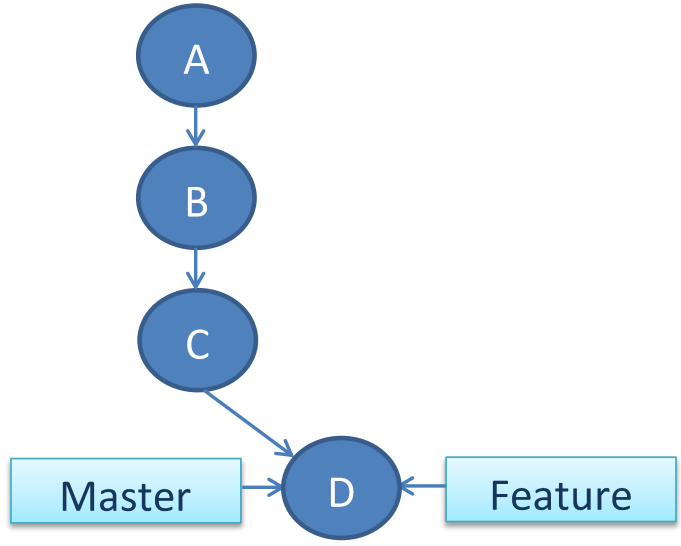

Merging with commits

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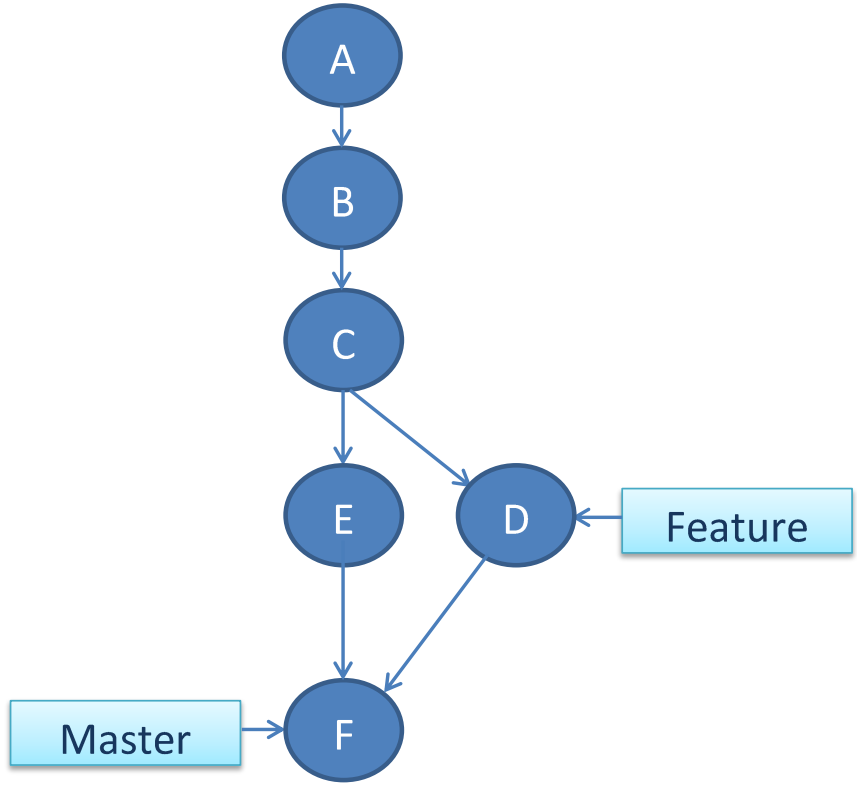
Conflicting merges also occur

- **git merge**
  - A commit is made for a conflicting merge
  - Conflicts must be resolved before merge is completed
    - Remove conflict markers from conflicted files
    - *git add* conflicted file
    - *git commit* conflicted file

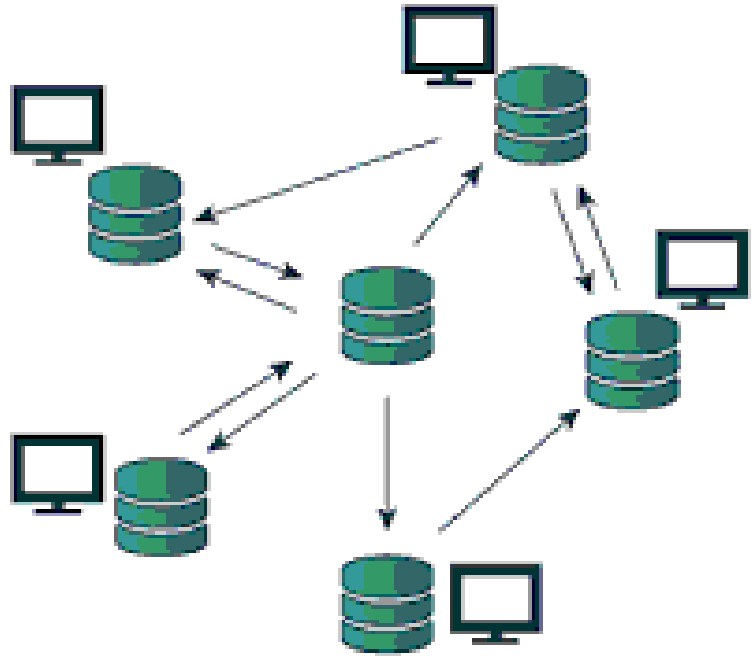
Usage: *git merge branch_name*



Outline

git uses remotes

- Each local repository can connect to multiple remote repositories
- Remotes can be local or across a network
- Remotes can be read-only or read-write access
- Workflow must be clearly defined from the beginning



Source: http://thepilcrow.net/explaining-basic-concepts-git-and-github

How to link to a remote

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Commands for connecting to and examining remotes:

- **git remote**
  - Lists all of the remote repositories
  - Using -v option lists all the remote repositories and their paths

  Usage: *git remote (-v)*

- **git remote add**
  - Connects an existing repository with a remote one

  Usage: *git remote add remote_name /path_to_remote*

- **git remote show**
  - Displays detailed information about the selected remote
  - Lists branches in remote repository and how they are linked to the local repository

  Usage: *git remote show remote_name*

How to get code from a remote

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Commands for exchanging code with remotes:

- **git fetch**
  - Updates data in remote branches of local repository
  - Can then inspect and/or merge this data into local branches

  Usage: *git fetch remote_name*

- **git pull**
  - Updates data in remote branches of local repository
  - Automatically merges remote data into local branches
  - git pull = git fetch + git merge

  Usage: *git pull remote_name*

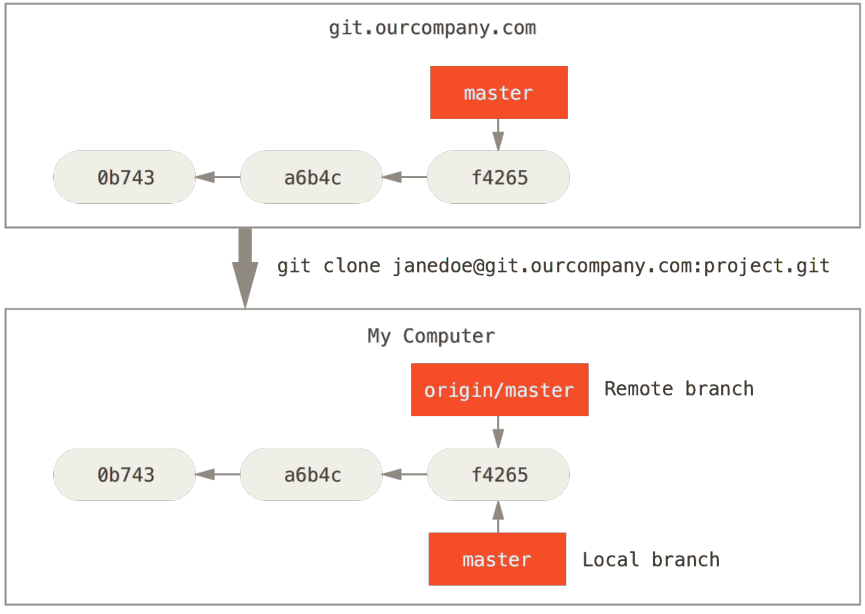
- **git push**
  - Sends changes into remote repository
  - Must do a git fetch and git merge first, to make sure that the local branch is up to date with the remote

  Usage: *git push remote_name branch_name*

Remote branches

Git uses remote branches to track changes to remote repositories

- Branches in the local repository containing data from remotes
- Can be displayed using *git branch -a*
- Created during git clone automatically
- Take the form *remote_name/branch_name*



Source: https://git-scm.com/book/en/v2/Git-Branching-Remote-Branches

Demonstration

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Outline

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Github Web interface for hosting remotes

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- Web services host remote repositories (can be public or private)
- Provide interfaces for visualizing repositories
- Support collaboration and good coding practices
- Can also edit files and make commits there

github
SOCIAL CODING

Source: https://github.com/logos

Permissions

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There are three different levels of permissions for accessing the code repositories on Github:

1. Owners
   - Two or three people only
   - Have complete control over the code repositories
   - Can create or delete repositories, add users, and write to every repository
2. Admins
   - One or two people for each repository (admin-*codename*)
   - Have write and read access to their assigned repository
   - Add new versions of code and incorporate new features and bug fixes
3. Users
   - Everyone who is not an owner or admin
   - Have read access to all of the central repositories

Pull Requests

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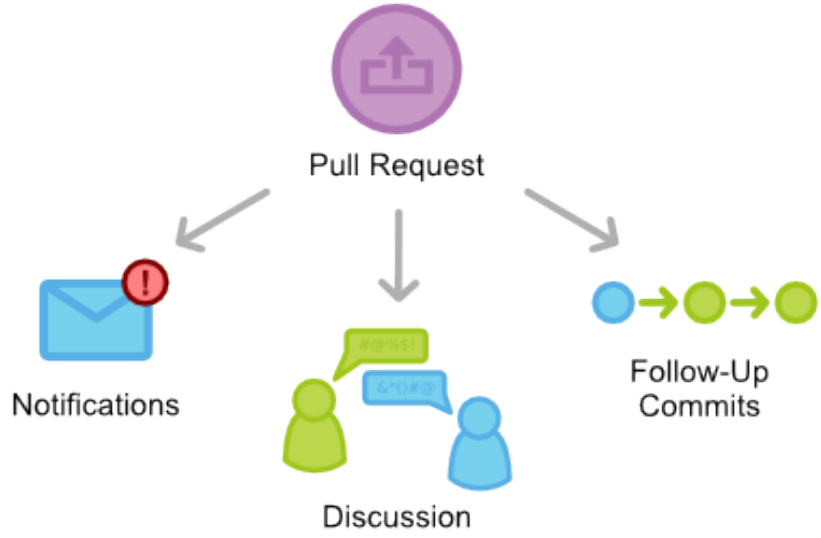
Pull requests are used to review code before merging new features into the main codebase

- Request for changes from a feature branch to be put into central repository
- Generated through web interface (not command line)
- Can be merged using web interface if no merge conflicts exist
- Web interface facilitates review of and commenting on code before pull request is granted



Source: https://www.atlassian.com/zh/git/workflows#!pull-request

Issue tracking

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We use the issue tracker on Github as an organizational tool

- Issue trackers allow you to keep track of known bugs, desired features, and other to-do items for the code
- Issues can be assigned to a specific person
- Other users can subscribe to be notified when known issues are resolved
- Issues can be color-coded and labeled so they are easily filtered
- Anybody with access to the repository can comment on issues

Cosmo-prerelease repository workflow

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1. Copy the repository to your local machine *(git clone)*
2. Make a feature branch for your own development *(git branch)*
3. Make changes to your local repository following the local Git workflow
4. Save the changes to the cosmo-prerelease repository *(git push)*
5. Make a pull request to start the code review process *(Generate pull request using web interface)*
6. Test the branch using the automated testing program Jenkins *('launch jenkins' command in pull request comments)*
7. Once tests have passed and code has been reviewed, the code owner will merge the pull request *(Merge pull request using web interface)*

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Best Practices

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Some best practices when working with Git:

- Choose a workflow at the beginning of a project and stick with it
  - Where will development of new features occur? (branches, forks)
  - What is the naming convention for branches and forks?
  - Who is responsible for the central repository?
  - How will the code review/pull request process work?
- Review code in staging area before committing it
- Commit small logical changes
- Make useful commit messages that can be understood by anyone
  - First line of message should be a one line summary
  - Details of commit follow the summary
- Keep repository clean - remove unused/finished branches

Git Resources

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- **git help**
  - Displays the man page for the given command
  - Displays general git information when no command name is given

  Usage: *git help (command_name)*
- **http://git-scm.com/**
  - Comprehensive description of Git commands and concepts
- **http://gitref.org/**
  - Quick reference guide for commands
- **https://training.github.com/kit/downloads/github-git-cheat-sheet.pdf**
  - Cheat sheet with Git commands

Graphical git tools

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Built-in git graphical tools

- **gitk**
  - Displays changes in a repository; information about commits
  - Cannot be used to make commits
- **git-gui**
  - Used for making changes to a repository
  - Can commit,branch, merge, and interact with remotes
  - Does not show code history

Third party git graphical tools

- **Source Tree**
  - Can commit, branch, merge, and interact with remotes
  - Can view history and commits
  - Only for OS: Mac and Windows
- **SmartGit**
  - Can commit, branch, merge, and interact with remotes
  - Can view history and commits
  - OS: Mac, Linux, and Windows
  - http://www.syntevo.com/smartgit/