Introduction to Git and Github

Software Tools for Business Analytics: Lecture 1
Galit Lukin
Based on Slides By Jackie Baek

MIT

January 6th, 2019

What is Git and GitHub?

- **Git** is an open source, *distributed version control system*.
    - Other version control systems include mercurial, svn, perforce.
    - Git is modern (2005) and most popular.

What is a version control?

- The management of changes to documents (in a codebase)
- Can be used for projects big or small, long-term or short-term.
- Examples of Version Control:
  - Distributed: Git, Mercurial
  - Centralized: SVN, CVS
- Code evolves over time.
- **Version control is a non-negotiable component of any project.**

What is a distributed version control system?

- Software that stores "snapshots" of a project over time.
- These "snapshots" are mirrored every developer's computer

What is a distributed version control system?

- Software that stores "snapshots" of a project over time.
- These "snapshots" are mirrored every developer's computer
- Every developer has the full history of the codebase mirrored on their computer
- Everything is done offline

What is a distributed version control system?

- Software that stores "snapshots" of a project over time.
- These "snapshots" are mirrored every developer's computer
- Every developer has the full history of the codebase mirrored on their computer
- Everything is done offline

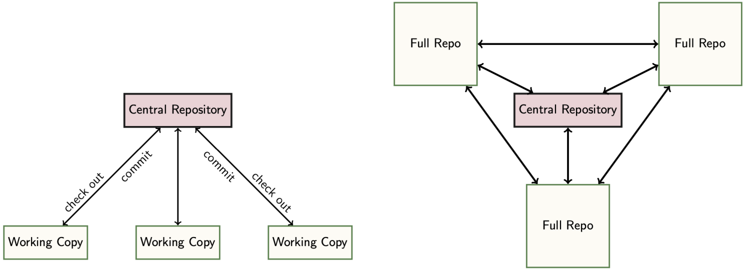


Figure: Left: Centralized, Right: Distributed

What is GitHub?

- **GitHub** is a service that allows you to host projects using Git.
- **Git** is a command-line tool
- **Github** is where developers store their projects as Git repositories

Why should I learn Git?

- Everyone uses it.
  - We'll be using it in this class.
- Backup (in the cloud).
- Versioning with fine granularity.
- Collaboration.
  - But useful even when working by yourself.

Why should I learn Git?

- Everyone uses it.
  - We'll be using it in this class.
- Backup (in the cloud).
- Versioning with fine granularity.
- Collaboration.
  - But useful even when working by yourself.

Can't we just use Dropbox?

Why should I learn Git?

- Everyone uses it.
  - We'll be using it in this class.
- Backup (in the cloud).
- Versioning with fine granularity.
- Collaboration.
  - But useful even when working by yourself.

Can't we just use Dropbox?

- Git gives finer granularity: files vs. lines within a file.
- This granularity is essential when writing code.
- Easy to:
  - share code
  - merge code
  - retract changes
  - look at the full history of the code
  - work in an organized way as an individual and as a group

Terminology

- **repository (repo):** the project that contains all files.

Terminology

- **repository (repo):** the project that contains all files.
- **commit:**
  - As a noun: one snapshot of the repository, a single point in the Git history of the repo
  - As a verb: The action of storing a new snapshot of the project's state in the Git history

Terminology

- **repository (repo):** the project that contains all files.
- **commit:**
  - As a noun: one snapshot of the repository, a single point in the Git history of the repo
  - As a verb: The action of storing a new snapshot of the project's state in the Git history
- **branch:** an active line of development.
  - a single Git repository can track an arbitrary number of branches.

Terminology

- **repository (repo):** the project that contains all files.
- **commit:**
  - As a noun: one snapshot of the repository, a single point in the Git history of the repo
  - As a verb: The action of storing a new snapshot of the project's state in the Git history
- **branch:** an active line of development.
  - a single Git repository can track an arbitrary number of branches.
- **checking out** a branch: updates the files in the working directory to match the version stored in that branch. A way to select which line of development you're working on.
- **HEAD:** the current branch.

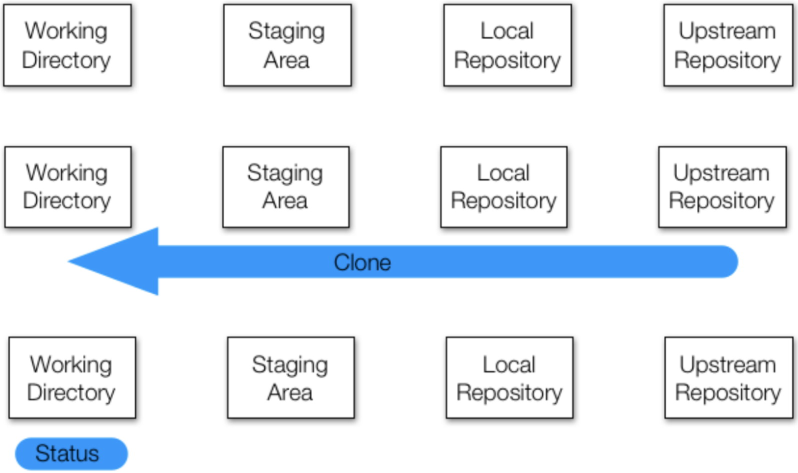
Terminology

- **repository (repo):** the project that contains all files.
- **commit:** one snapshot of the repository.
- **branch:** an active line of development.
- **checking out** a branch: A way to select which line of development you're working on.
- **HEAD:** the current branch.
- **local:** repository sitting on your local machine.
- **remote:** repository sitting on a remote machine (e.g. GitHub).

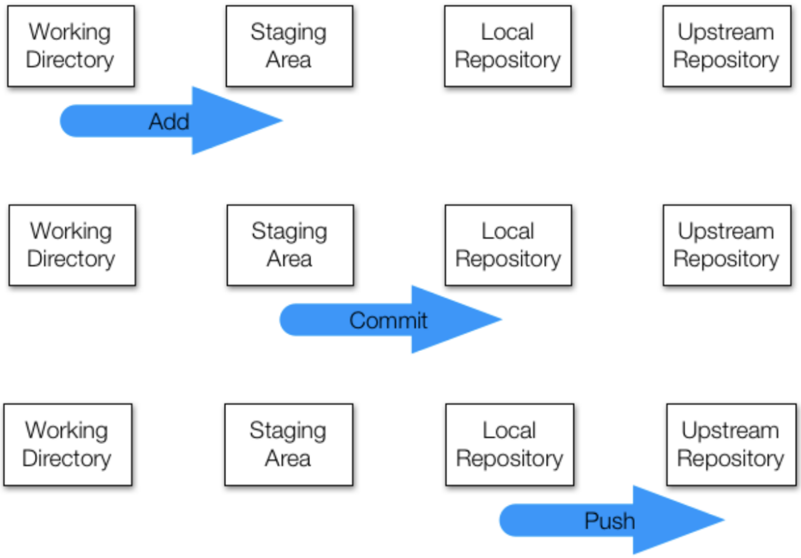
Terminology

- **repository (repo):** the project that contains all files.
- **commit:** one snapshot of the repository.
- **branch:** an active line of development.
- **checking out** a branch: A way to select which line of development you're working on.
- **HEAD:** the current branch.
- **local:** repository sitting on your local machine.
- **remote:** repository sitting on a remote machine (e.g. GitHub).
- **pull:** grab changes from remote (or other branch) to local.
  - **fetch:** downloads commits and files from a remote repository into your local repo
  - **merge:** take two lines of development and integrates them into a single branch
  - pull == fetch+merge
- **push:** update remote with local changes.

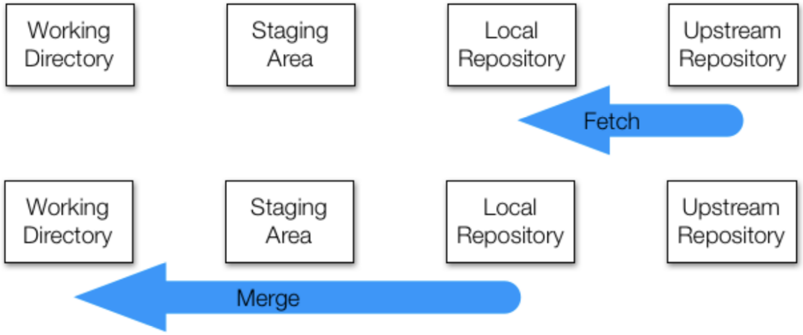
Typical Workflow - Commands



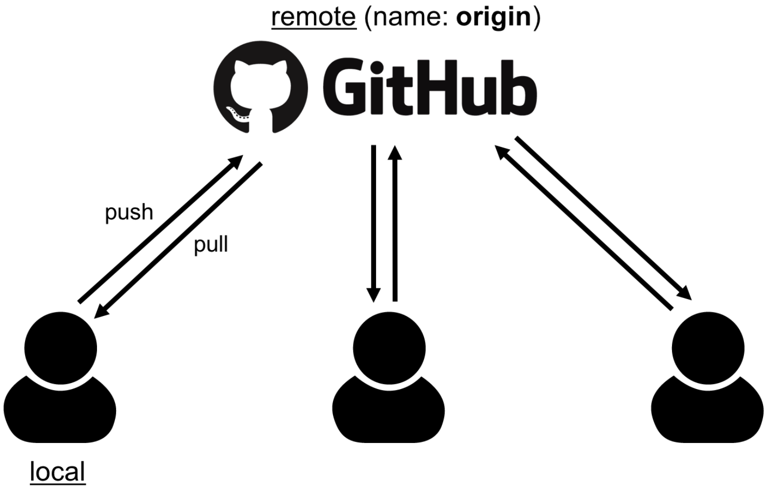
Typical Workflow - Commands



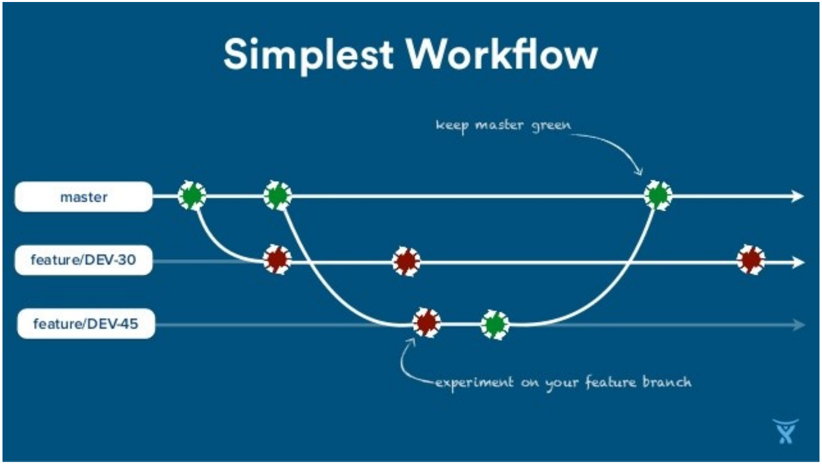
Typical Workflow - Commands



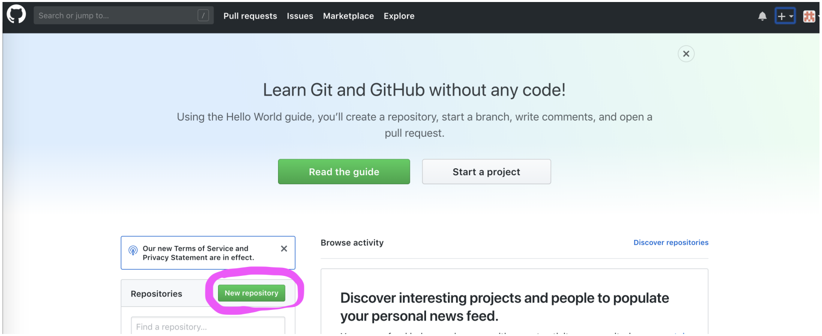
Typical Workflow



Typical Workflow - Branches



Creating a new repository


Learn Git and GitHub without any code!

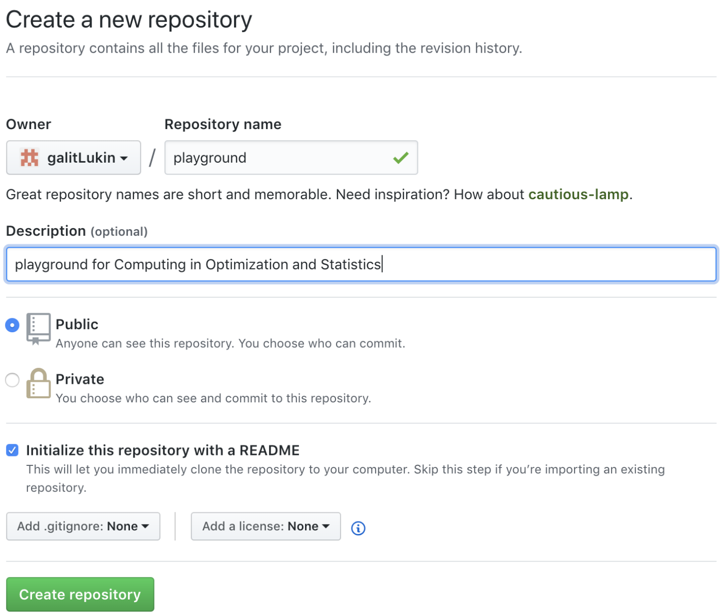
Using the Hello World guide, you'll create a repository, start a branch, write comments, and open a pull request.

Our new Terms of Service and Privacy Statement are in effect.

Browse activity

Discover interesting projects and people to populate your personal news feed.

Creating a new repository



Create a new repository

A repository contains all the files for your project, including the revision history.

Owner / **Repository name**

galitLukin / playground ✓

Great repository names are short and memorable. Need inspiration? How about **cautious-lamp**.

Description (optional)

playground for Computing in Optimization and Statistics

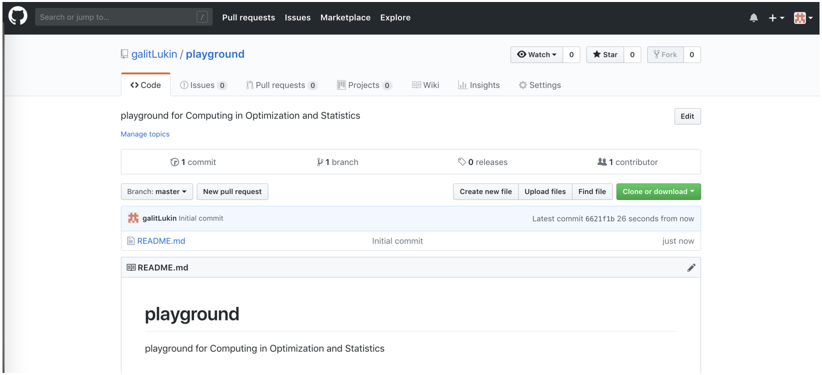
● **Public**
Anyone can see this repository. You choose who can commit.

○ **Private**
You choose who can see and commit to this repository.

✓ **Initialize this repository with a README**
This will let you immediately clone the repository to your computer. Skip this step if you're importing an existing repository.

Add .gitignore: **None** | Add a license: **None**

Creating a new repository



galitLukin / playground

playground for Computing in Optimization and Statistics

1 commit | 1 branch | 0 releases | 1 contributor

galitLukin Initial commit — Latest commit 6621f1b 26 seconds from now

README.md — Initial commit — just now

README.md

playground

playground for Computing in Optimization and Statistics

Cloning a repository

```
$ git clone <URL>
```

- Go to any repository and copy the URL
- This will create a new directory with the same name as the repository name and clone the repo there.

```
$ git clone https://github.com/galitLukin/playground
```

Cloning a repository

```
$ git clone <URL>
```

- Go to any repository and copy the URL
- This will create a new directory with the same name as the repository name and clone the repo there.

```
$ git clone https://github.com/galitLukin/playground
```

```
$ cd playground
$ git status
$ git config core.editor "nano"
```

Let's make some changes

- Create a new file called new_file.txt
  - Add "This is a new file"
- Modify existing_file.txt
  - The year is 2019. $\rightarrow$ The year is 2020.

Let's make some changes

- Create a new file called new_file.txt
  - Add "This is a new file"
- Modify existing_file.txt
  - The year is 2019. $\rightarrow$ The year is 2020.

```
$ cd playground
$ nano new_file.txt
   This is a new file
$ nano existing_file.txt
   interesting -> uninteresting
```

See what changed and your branch's status

```
$ git diff
```

- Shows what changed since the last commit

See what changed and your branch's status

```
$ git diff
```

- Shows what changed since the last commit

```
$ git status
```

- See which changes have been staged, which haven't, and which files aren't being tracked by Git

See what changed and your branch's status

```
$ git diff
```

- Shows what changed since the last commit

```
$ git status
```

- See which changes have been staged, which haven't, and which files aren't being tracked by Git

```
$ git log
```

- Lists the commits made in that repository in reverse chronological order

File states

- Git will notice any file in the directory of the repository.

File states

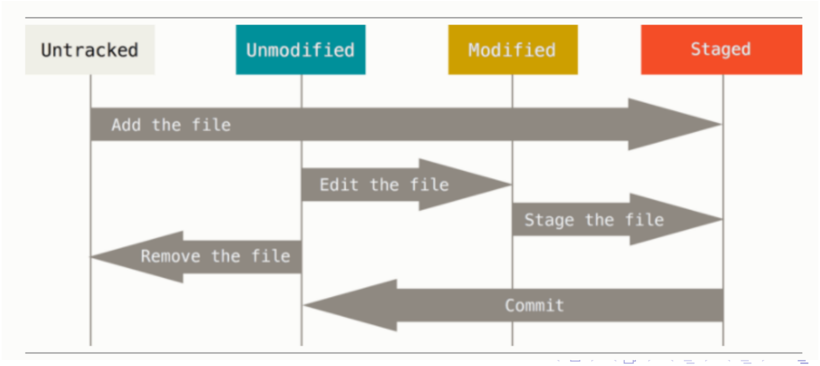
- Git will notice any file in the directory of the repository.
- A file is either **untracked** or **tracked**.

File states

- Git will notice any file in the directory of the repository.
- A file is either **untracked** or **tracked**.
- A tracked file may be:
    1. **Unmodified:** No changes since the last commit.
    2. **Modified:** Changes have been made to it since the last commit.
    3. **Staged:** Changes will be committed in the next commit.

File states

- Git will notice any file in the directory of the repository.
- A file is either **untracked** or **tracked**.
- A tracked file may be:
  1. **Unmodified:** No changes since the last commit.
  2. **Modified:** Changes have been made to it since the last commit.
  3. **Staged:** Changes will be committed in the next commit.



Staging files

```
$ git add <filepath>
```

- Any *untracked* or *modified* file that is added will be *staged*.
- Each such file will be included in the next commit.

Staging files

```
$ git add <filepath>
```

- Any *untracked* or *modified* file that is added will be *staged*.
- Each such file will be included in the next commit.

```
$ git add new_file.txt
$ git add existing_file.txt
```

Use Git add to either:

- Add a new file to the repository (untracked $\rightarrow$ staged)
- Record a change that you made to an existing file (modified $\rightarrow$ staged)

Git commit

```
$ git commit -m <commit message>
```

- This creates a new snapshot of our repository with all changes that we have staged.

Git commit

```
$ git commit -m <commit message>
```

- This creates a new snapshot of our repository with all changes that we have staged.

```
$ git commit -m "Added file and modified existing."
```

- This new snapshot (commit) is saved in our local repository.
- This *does not* push our changes to the remote repository (GitHub).

Git commit

```
$ git commit -am "Added file and modified existing."
```

- The *-a* tells the command to automatically stage files that have been modified and deleted
- New files that Git has not recognized are not affected.

```
$ git add .
$ git commit -am "Added file and modified existing."
```

Interacting with remote

```
$ git push
```

- Update remote repository with local commits.

```
$ git pull
```

- Updates local repository with remote commits.

Merging

- When we ‘git pull‘, Git fetches the remote repository from GitHub and *merges* the new remote updates with our local repository.
- Even if both remote and local modified the same file, Git is *usually* able to correctly merge the two copies.
- We get a **merge conflict** if both parties modified the *same parts of the same file*.

Creating a Merge Conflict

1. Choose a partner to work with.
2. One of you will add their partner as a collaborator on your playground repo (click Settings and then Collaborators).
3. The other partner will clone the their partner's playground repo.

For example:

1. suppose Galit and Ashley decide to work together. Together, they decide that Ashley will clone Galit's playground repo.
2. Galit add Ashley as a collaborator.
3. Ashley clones the Galit's repo.

Make Changes

Each partner should make some changes to the playground repo.

For this exercise, each partner should make a change to existing-file.txt.

Example: Galit works on her original repo. Ashley works on the newly cloned repo.

Once both partners have made (different) changes to the file, each should try to stage-commit-push. This should work for the partner who does this first. The other partner should get an error similar to:

```
To https://github.com/galitLukin/playground.git
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to 'https://github.com/...
hint: Updates were rejected because the remote contains work
hint: that you do not have locally. This is usually caused by
hint: another repository pushing to the same ref. You may want
hint: to first integrate the remote changes (e.g., 'git pull ...
hint: before pushing again....
```

The Mistake

The second partner realizes that they've made a mistake. Before pushing, we should always fetch and merge (or pull) from the remote repo. The partner who attempted to push second did not pull beforehand. If you receive this message, you should realize that someone pushed while you were working. This can be fixed by pulling. What do you expect will happen when this partner pushes?

Resolving the Conflict

The partner who failed to push should try to do a fetch-merge (or pull) sequence.

```
$ git pull
```

```
remote: Enumerating objects: 5, done.
remote: Counting objects: 100% (5/5), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 3 (delta 0), reused 0 (delta 0), pack-reused 0
Unpacking objects: 100% (3/3), done.
From https://github.com/galitLukin/playground
   8bfcca0..b3207b5  master     -> origin/master
Auto-merging existing_file.txt
CONFLICT (content): Merge conflict in existing_file.txt
Automatic merge failed;fix conflicts and then commit the result.
```

Resolving Merge Conflicts

There is a merge conflict because Git does not know which version of the file is correct.

```
$ cat existing_file.txt
```

Resolving Merge Conflicts

There is a merge conflict because Git does not know which version of the file is correct.

```
$ cat existing_file.txt

<<<<<<< HEAD
Edit made by Galit.
=======
Edit made by Ashley
>>>>>>> b3207b5d9cddd22934ccd2fed0a6cc16eefdab73
```

- The markers <<<<<<<, =======, >>>>>>> indicate the conflict.
- The section in between the first two markers is your local change (HEAD), while the bottom section indicates the update from remote.
- Must resolve conflict manually by editing the file, making sure to get rid of the conflict markers.

Resolving Merge Conflicts

There is a merge conflict because Git does not know which version of the file is correct.

```
$ cat existing_file.txt

<<<<<<< HEAD
Edit made by Galit.
=======
Edit made by Ashley
>>>>>>> b3207b5d9cddd22934ccd2fed0a6cc16eefdab73
```

- The markers <<<<<<<, =======, >>>>>>> indicate the conflict.
- The section in between the first two markers is your local change (HEAD), while the bottom section indicates the update from remote.
- Must resolve conflict manually by editing the file, making sure to get rid of the conflict markers.

```
$ nano existing_file.txt
```

Resolving Merge Conflicts

- Together with your partner, decide on what the file should look like and edit the file accordingly.
- After resolving conflicts, we must add the file for staging and commit again.
- Git will automatically create a commit message: "Merge branch 'master' of https://github.com/galitLukin/playground"

Resolving Merge Conflicts

- Together with your partner, decide on what the file should look like and edit the file accordingly.
- After resolving conflicts, we must add the file for staging and commit again.
- Git will automatically create a commit message: "Merge branch 'master' of https://github.com/galitLukin/playground"

```
$ git add existing_file.txt
$ git commit
```

- At this point, we can push.

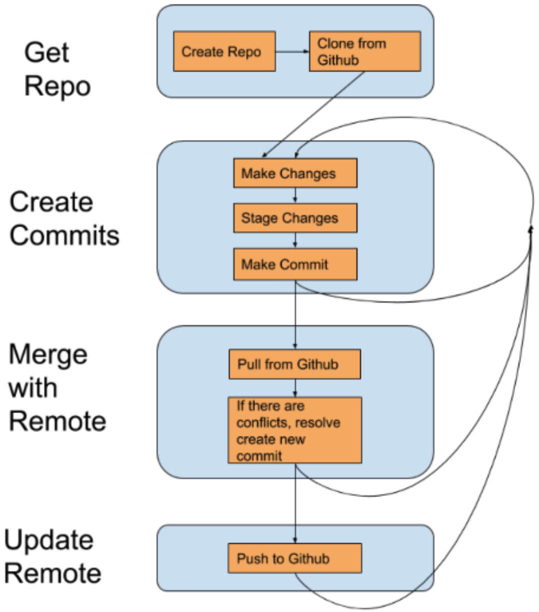
Branching basics

- A branch represents an independent line of development.
- One can use branches to work on multiple things in parallel.
- When working on Feature1 and Feature2 that involve the same files, open a branch for each.
- When each feature is completed, merge its branch back into **master**.
- Default branch is **master**.

Typical Workflow

```
Fetch remote changes.
  $ git pull

(If there are any conflicts, resolve them and commit.
  $ git add <conflicted files>
  $ git commit)

Make changes. Stage modified and new files.
  $ git add <files>

Commit changes.
  $ git commit -m "this is my commit message"

(If editing took a while...
  $ git pull
  And if needed, resolve merge conflicts)

Push local changes to remote.
  $ git push
```

Typical Overall Workflow



Useful tips

- Google is your friend. (e.g. "How to undo merge in Git".)
- Almost anything can be undone, as long as it is committed.
- Commit often, pull often.
- Might take a while to get used to, but is useful knowledge that will improve productivity and collaboration.

Thank you!