

Version Control using Git

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Outline

- **Why we need Git?**
 - Some background
- **Run Git locally**
 - Create a Git repository
 - Working directory and staging area
 - Manage changes
- **Working with Git branch**
 - Create and merge branches
 - Conflict
 - Branch management strategies
- **Working with remote repository**
 - Github


Version Control using Git


Why do we need a Version Control System?


One Simple Reason...


Copy and Rename approach...??


 my_input.dat
DAT File
3.41 KB


 my_input_final.dat
DAT File
3.41 KB


 my_input_final_05032018.dat
DAT File

 my_input_final_good.dat
DAT File
3.41 KB

 my_input_final_no_change.dat
DAT File

 my_input_good.dat
DAT File
3.41 KB

 my_input_improved.dat
DAT File
3.41 KB

 my_input_improved_but.dat
DAT File

What is the problem in the previous slide?

- **Copy files into another directory / make a tarball / rename with timestamps**
 - src_implicit
 - src_explicit_works
 - src_explicit_fails
 - src_20180503.tgz
- **This approach is very common because it is so *simple*.**
- ***However:***
 - It's incredibly error prone
 - Too easy to accidentally overwrite or delete files.
 - Complex to manage.
 - Difficult to compare differences in history.
 - Hard to collaborate with others.
- **Start to learn good habits now.**

Levels of Version Control



chaoseed Follow

Level 5: Private Github repository with access only for you and your team

Level 4: Public Github repository where random people send you strange pull requests

Level 3: Automated backup program saves your files to an external server on a regular basis

Level 2: Back up your files to a flash drive every now and then

Level 1: Copy the source file and add "_old_v2" to the name

Level 0: Copy the line and comment it out

From: <https://nixcraft.tumblr.com/post/177998927172/levels-of-version-control>

What is a Version Control System (VCS)

➤ Definition

- Version control is a system that records changes to a file or set of files over time so that you can recall specific versions later.

What can a VCS do for you?

➤ A VCS can:

- Records changes to a file or set of files over time so that you can recall specific versions later.
- Revert specific files or the entire project back to a previous state.
- Compare changes over time.
- See who made the changes.

➤ Not just for source code:

- LaTeX files
- Text files
- Configuration files
- Input files for a code

➤ *Caution:*

- most VCSs don't handle binary files well.
 - Git LFS
 - Dropbox?

Advantages of using VCS

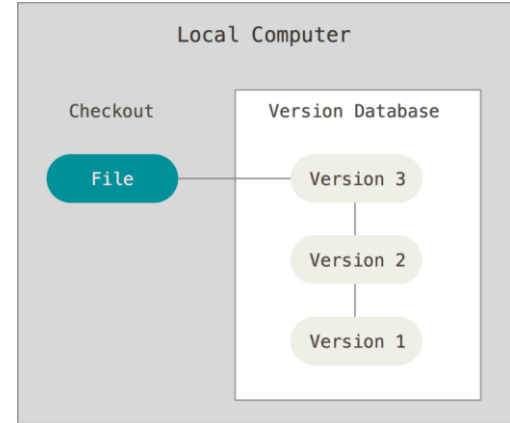
- **Using VCS is liberating**
 - It makes it easy to recover from mistakes.
 - It remember what you did for you.

- ***Best of all:***
 - It's easy to use.
 - Not easy to lose information.

Types of VCS

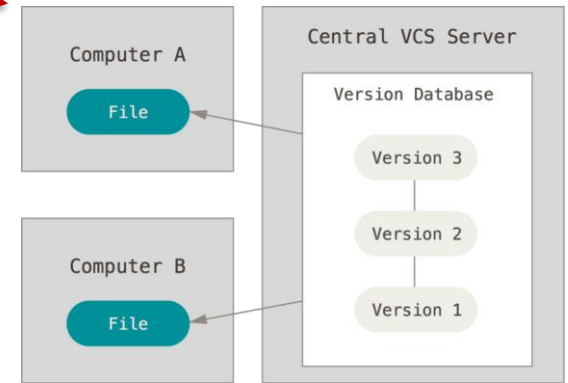
➤ **Different types of VCSs**

– Local VCS



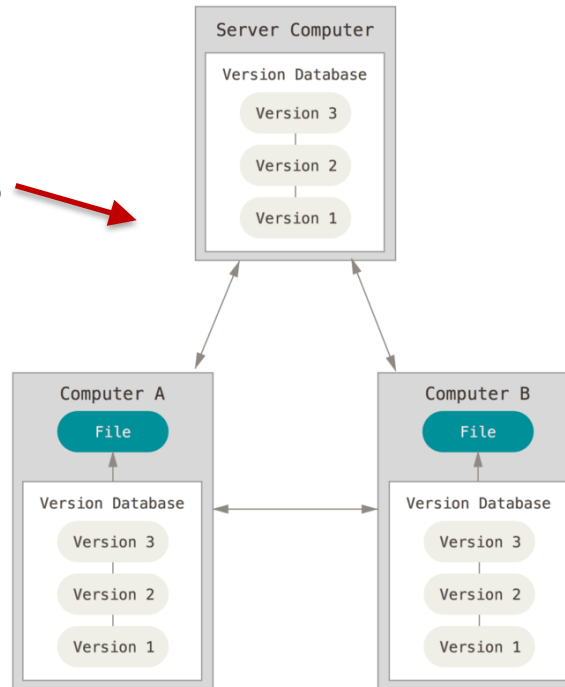
– Centralized VCS

- CVS
- SVN



– Distributed VCS

- Git
- Mercurial
- hg



Advantages of DVCS

- You *don't need* an internet connection to interact with the repo.
- **Duplication: Every clone is really a full backup of all the data. If any server dies any of the client repositories can be copied back up to the server to restore it.**
- **Supports multiple remote repositories, so you can collaborate with different groups of people.**
 - many of the DVCS systems deal pretty well with having several remote repositories they can work with,
 - This allows you to set up several types of workflows that aren't possible in centralized systems, such as hierarchical models.

History of Git

- **Created in 2005 by Linus Torvalds, the creator of Linux, with the goals of:**
 - Speed
 - Simple design
 - Strong support for non-linear development (thousands of parallel branches)
 - Fully distributed
 - Able to handle large projects like the Linux kernel efficiently (speed and data size)

The name "git" was given by Linus Torvalds when he wrote the very first version. He described the tool as "the stupid content tracker" and the name as (depending on your way):

- random three-letter combination that is pronounceable, and not actually used by any common UNIX command. The fact that it is a mispronunciation of "get" may or may not be relevant.
- stupid. contemptible and despicable. simple. Take your pick from the dictionary of slang.
- "global information tracker": you're in a good mood, and it actually works for you. Angels sing, and a light suddenly fills the room.
- "goddamn idiotic truckload of sh*t": when it breaks

Ref: <https://en.wikipedia.org/wiki/Git>

Version Control using Git

Run Git locally

Log onto SuperMike2 and load git module

```
[2018-05-28 20:14.53] ~
[fchen3.DESKTOP-VQAI2A0] ▶ ssh hpctrn01@mike.hpc.lsu.edu
hpctrn01@mike.hpc.lsu.edu's password: █
```

```
[fchen14@mike1 ~]$ module av git
----- /usr/local/packages/Modules/3.2.10/modulefiles/apps -----
git/2.17
[fchen14@mike1 ~]$ module load git/2.17
[fchen14@mike1 ~]$ which git
/usr/local/packages/git/2.17/bin/git
```

First time Git setup

- **Set up your identity. Especially important when you work with other people:**

```
[fchen14@mike1 ~]$ git config --global user.name "Feng Chen"
```

```
[fchen14@mike1 ~]$ git config --global user.email fchen14@lsu.edu
```

- **Checking your settings:**

```
[fchen14@mike1 ~]$ git config --list
```

```
user.name=Feng Chen
```

```
user.email=fchen14@lsu.edu
```

```
core.editor=vi
```

```
core.excludesfile=exclude_git.pattern
```

```
push.default=matching
```

Getting help from Git

- **Different syntax for getting help from command line:**

```
git help <verb>
git <verb> --help
man git-<verb>
```

- **For example:**

```
[fchen14@mike1 ~]$ git help config
[fchen14@mike1 ~]$ git config --help
[fchen14@mike1 ~]$ man git-config
```

- **Example output:**

<pre>Git-CONFIG(1) NAME git-config - Get and set repository or global options SYNOPSIS git config [<file-option>] [type] [-z --null] name [value [value_regex]] git config [<file-option>] [type] --add name value git config [<file-option>] [type] --replace-all name value [value_regex]</pre>	<pre>Git Manual</pre>	<pre>Git-CONFIG(1)</pre>
---	-----------------------	--------------------------

- **More common help source: *google it!***



Git Basic Usage

➤ **What is a repository?**

- A directory (.git/) contains all information regarding the history of your code history.

➤ **Creating a Git repository from an existing directory**

```
$ git init
```

```
[fchen14@mike1 ~]$ mkdir myrepo
```

```
[fchen14@mike1 ~]$ cd myrepo
```

```
[fchen14@mike1 myrepo]$ git init
```

```
Initialized empty Git repository in /home/fchen14/myrepo/.git/
```

```
[fchen14@mike1 myrepo]$ ls .git
```

```
branches  config  description  HEAD  hooks  info  objects  refs
```

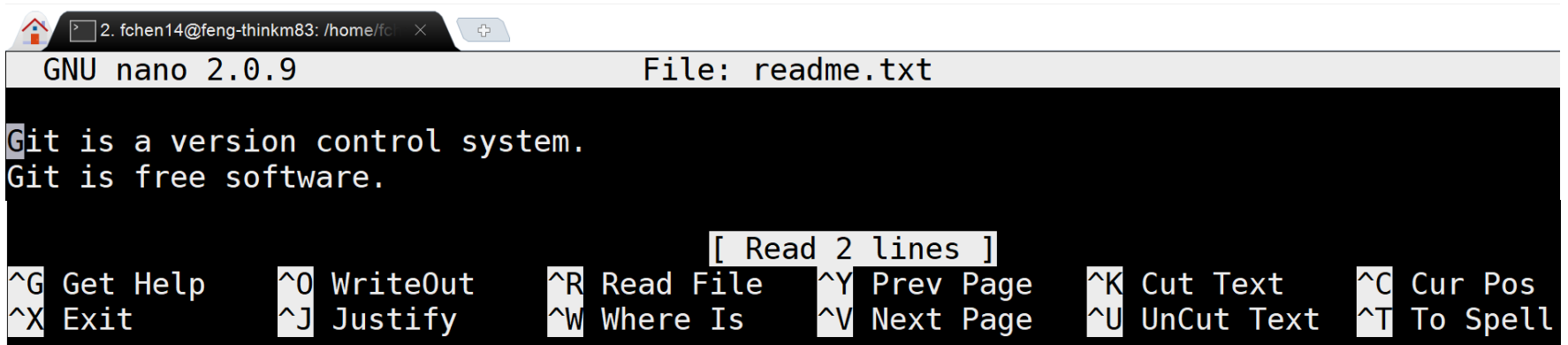
Prepare a readme.txt for the repo

- Create a readme file in the directory ~/myrepo

```
[fchen14@mike1 myrepo]$ nano readme.txt
```

- Add the below two lines of text (using your favorite editor: vi, emacs or nano) to “readme.txt”:

```
Git is a version control system.
Git is free software.
```



```
GNU nano 2.0.9 File: readme.txt
Git is a version control system.
Git is free software.
[ Read 2 lines ]
^G Get Help      ^O WriteOut     ^R Read File    ^Y Prev Page    ^K Cut Text      ^C Cur Pos
^X Exit          ^J Justify      ^W Where Is    ^V Next Page    ^U UnCut Text   ^T To Spell
```

Add “readme.txt” to the repository

➤ **First add the file to the repository**

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

➤ **Commit the file to the repository**

```
[fchen14@mike1 myrepo]$ git commit -m "added a readme file"
[master (root-commit) 666c968] added a readme file
1 file changed, 2 insertions(+)
create mode 100644 readme.txt
```

➤ **Some explanations**

- `git add`: add the readme.txt to the **staging area (index)**
- `git commit -m`: commit your changes to the repo with a message (“-m”)

View New Changes

- **Now change “readme.txt” to the below contents:**

```
Git is a distributed version control system.
Git is free software.
```

- **Use git status to check our results:**

```
[fchen14@mike1 myrepo]$ git status
```

```
On branch master
```

```
Changes not staged for commit:
```

```
(use "git add <file>..." to update what will be committed)
```

```
(use "git checkout -- <file>..." to discard changes in working directory)
```

```
modified:  readme.txt
```

```
no changes added to commit (use "git add" and/or "git commit -a")
```

- **If you do not remember the changes, use git diff**

```
[fchen14@mike1 myrepo]$ git diff
```

```
diff --git a/readme.txt b/readme.txt
```

```
index 46d49bf..9247db6 100644
```

```
--- a/readme.txt
```

```
+++ b/readme.txt
```

```
@@ -1,2 +1,2 @@
```

```
-Git is a version control system.
```

```
+Git is a distributed version control system.
```

```
Git is free software.
```

Commit new changes to the repository

- Same as before, two steps, git add and then git commit:

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

```
[fchen14@mike1 myrepo]$ git status
```

On branch master

Changes to be committed:

(use "git reset HEAD <file>..." to unstage)

```
    modified:   readme.txt
```

```
[fchen14@mike1 myrepo]$ git commit -m "added word distributed"
```

```
[master 08cb0ef] added word distributed
```

```
 1 file changed, 1 insertion(+), 1 deletion(-)
```

```
[fchen14@mike1 myrepo]$ git status
```

On branch master

nothing to commit, working tree clean

Commit another change to the repository

- **Now change “readme.txt” to the below contents:**

Git is a distributed version control system.

Git is free software distributed under the GPL.

- **Add and commit your changes:**

```
[fchen14@mike1 myrepo]$ nano readme.txt
```

```
...add the above changes...
```

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

```
[fchen14@mike1 myrepo]$ git commit -m "appended GPL"
```

```
[master 4dd4cf0] appended GPL
```

```
1 file changed, 1 insertion(+), 1 deletion(-)
```

- **So far, we have 3 versions added to the Git repository “myrepo”**

Review the version history

➤ Use **git log** to review our version history

```
[fchen14@mike1 myrepo]$ git log
commit 4dd4cf05696809c3bd26e3a0ed5c5f2e9aea765a (HEAD -> master)
Author: Feng Chen <fchen14@lsu.edu>
Date: Sat May 5 10:31:38 2018 -0500
    appended GPL
commit 08cb0ef326f5d149cae16ad9201022ea056eafe5
Author: Feng Chen <fchen14@lsu.edu>
Date: Sat May 5 10:06:32 2018 -0500
    added word distributed
commit 666c96898be1ae630c4d958d55482bba9d4516d5
Author: Feng Chen <fchen14@lsu.edu>
Date: Sat May 5 09:12:40 2018 -0500
    added a readme file
```

➤ Or you can use **git log --oneline** for a short version

```
[fchen14@mike1 myrepo]$ git log --oneline
4dd4cf0 (HEAD -> master) appended GPL
08cb0ef added word distributed
666c968 added a readme file
```

Some concepts/terminology

➤ Commit

- Records changes to the repository identified by a SHA-1 hash

➤ HEAD

- A special pointer in Git called HEAD. In Git, this is a pointer to the local branch you're currently on.

➤ SHA-1 hash

- Git uses a checksum mechanism called SHA-1 hash to differentiate and name the commits.
- This is a 40-character string composed of hexadecimal characters (0–9 and a–f) and calculated based on the contents of a file or directory structure in Git.
- Something you would get with:

```
[fchen14@mike1 myrepo]$ shasum readme.txt
```

```
2b1eb3f6006e80d38bbb176fab0747f224c48c03  readme.txt
```

- You will see these hash values all over the place in Git. In fact, Git stores everything in its database not by file name but by the hash value of its contents.

Add a useful command before “Travel”

- First, add a useful git command alias by copy & pasting the following command in your terminal:

```
$ git config --global alias.graph 'log --all --oneline --decorate --graph'
```

- Then type “git graph” in your terminal:

```
[fchen14@mike1 myrepo]$ git graph
* 4dd4cf0 (HEAD -> master) appended GPL
* 08cb0ef added word distributed
* 666c968 added a readme file
```

- We will explain the detailed meanings of the command later.

Jump to previous versions

- **Go back to the version “added word distributed”**

```
[fchen14@mike1 myrepo]$ git graph
```

```
* 4dd4cf0 (HEAD -> master) appended GPL
```

```
* 08cb0ef added word distributed
```

```
* 666c968 added a readme file
```

```
[fchen14@mike1 myrepo]$ git reset --hard HEAD^
```

```
HEAD is now at 08cb0ef added word distributed
```

- **Or you can directly use the SHA-1 hash:**

```
[fchen14@mike1 myrepo]$ git reset --hard 08cb0ef
```

```
HEAD is now at 08cb0ef added word distributed
```

- **Then you can take a look at the content of readme.txt:**

```
[fchen14@mike1 myrepo]$ cat readme.txt
```

```
Git is a distributed version control system.
```

```
Git is free software.
```

What if the previous operation is a mistake?

- **How do I go back to the latest version?**

```
[fchen14@mike1 myrepo]$ git graph
* 08cb0ef (HEAD -> master) added word distributed
* 666c968 added a readme file
```

- **Hint: we need to find the SHA-1 hash of that commit**

- **Solution: use the command `git reflog`:**

```
[fchen14@mike1 myrepo]$ git reflog
08cb0ef (HEAD -> master) HEAD@{0}: reset: moving to 08cb0ef
08cb0ef (HEAD -> master) HEAD@{1}: reset: moving to HEAD^
4dd4cf0 HEAD@{2}: commit: appended GPL
08cb0ef (HEAD -> master) HEAD@{3}: commit: added word distributed
666c968 HEAD@{4}: commit (initial): added a readme file
```

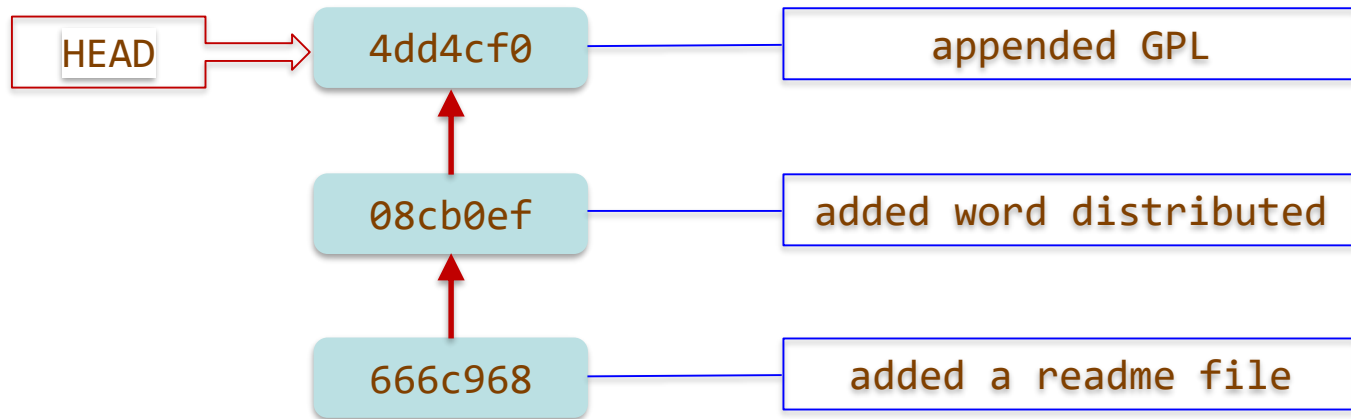
- **Now we can reset to the specific commit (SHA-1 hash):**

```
[fchen14@mike1 myrepo]$ git reset --hard 4dd4cf0
HEAD is now at 4dd4cf0 appended GPL
[fchen14@mike1 myrepo]$ cat readme.txt #verify the content
Git is a distributed version control system.
Git is free software distributed under the GPL.
```

Short Summary - Basic Usage

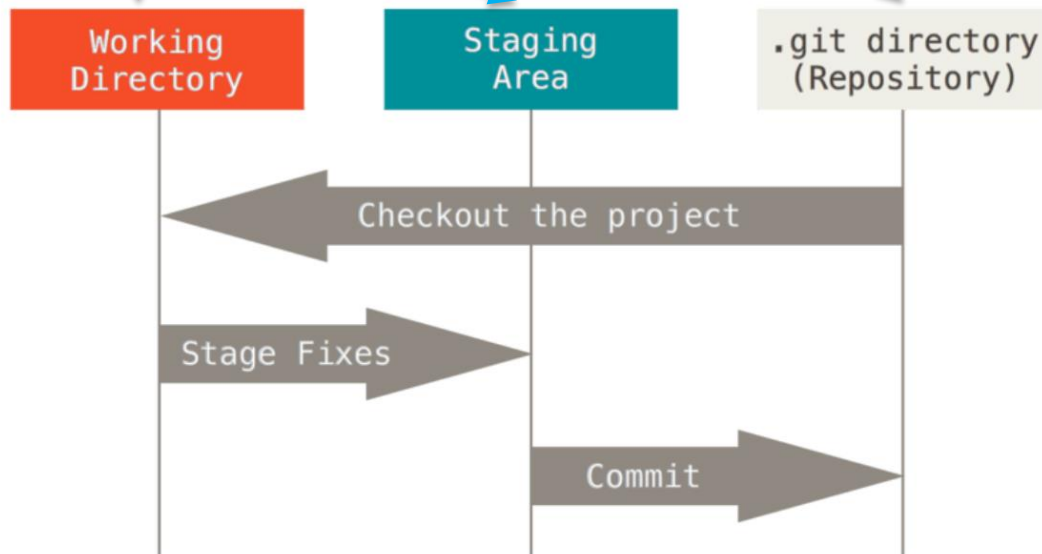
➤ **How do we**

- Initialize a Git repo?
- Add files to the repo? (two steps)
- “Travel” between different commits?



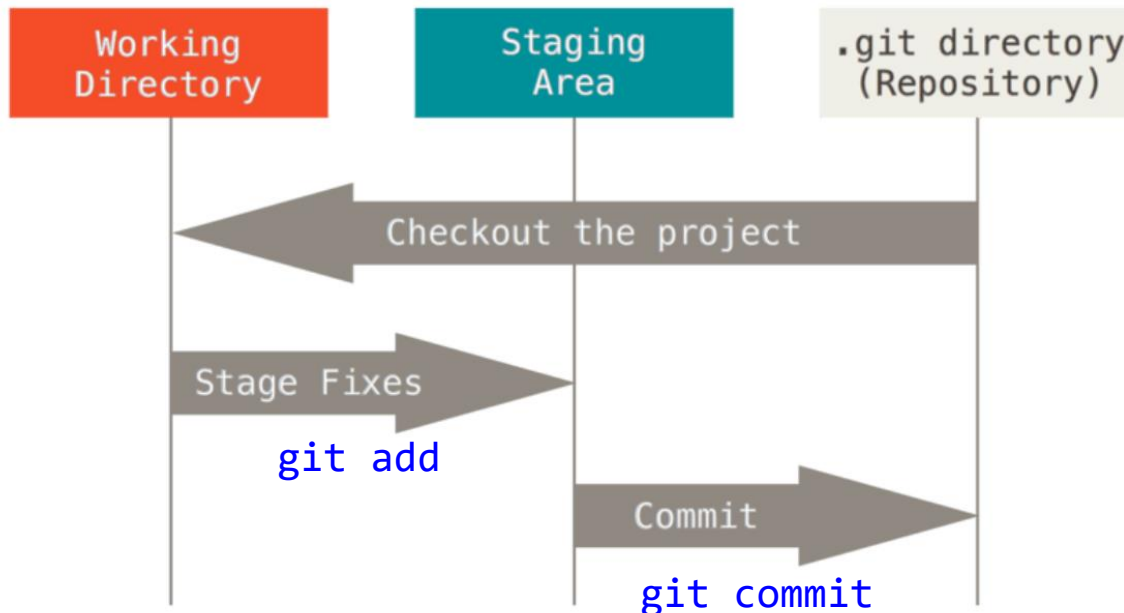
Three main sections of Git

- The **Git directory** (`.git/` directory) where Git stores the meta data and object database for your project.
- The **working directory (working tree)** is a single checkout (snapshot) of one version of the project, i.e. the working directory consist of files that you are currently working on (you see).
- The **staging area** is a file that stores information about **what will go into your next commit**. It's sometimes referred to as the "index", but it's also common to refer to it as the staging area.



Basic Git workflow

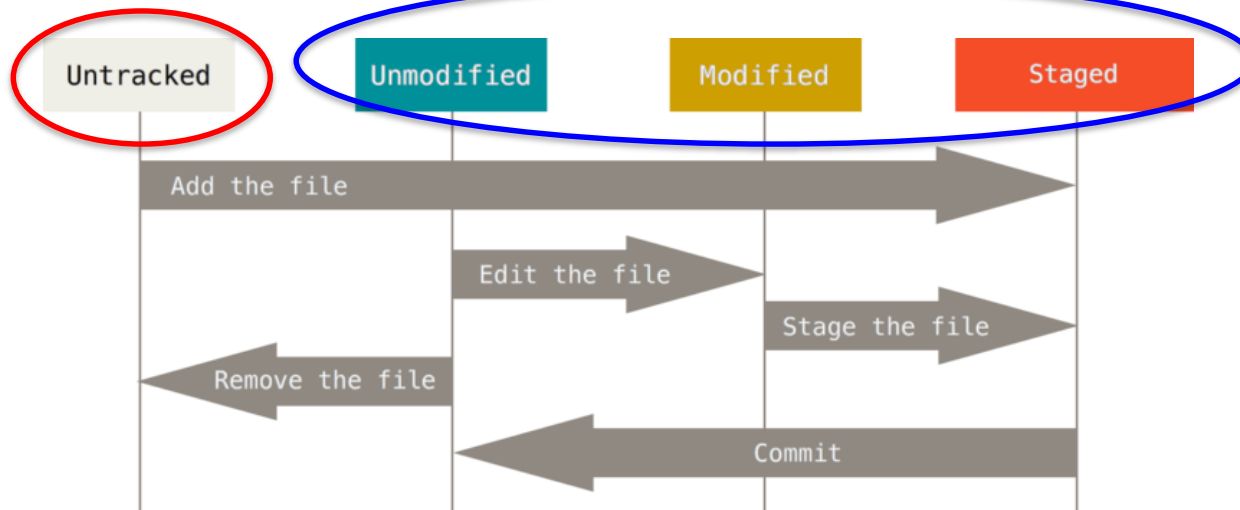
- **You modify files in your working directory.**
 1. `git add`: You stage the files, adding snapshots of them to your staging area.
 2. `git commit`: You do a commit, which takes the files as they are in the staging area and stores that snapshot permanently to your Git directory.



Recording Changes to the Repository

- Git records **changes** to the repository.
- **Two types of files:**
 - Untracked
 - Tracked
- **Two types of changes**
 - Adding a new, previously untracked file
 - Modification of a file already under Git tracking

Tracked after using "git add"



Understanding the Staging area

➤ **Let's do two things to our repo:**

1. Add a new file (license.txt, content can be arbitrary) to the repository:



```

GNU nano 2.0.9 File: license.txt
This is a license file.
    
```

2. Add the below line to the readme.txt:

Git has a mutable index called stage.

➤ **Then use the git status to check our repo status:**

```
[fchen14@mike1 myrepo]$ git status
```

```
On branch master
```

```
Changes not staged for commit:
```

```
(use "git add <file>..." to update what will be committed)
```

```
(use "git checkout -- <file>..." to discard changes in working directory)
```

```
modified:   readme.txt
```

```
Untracked files:
```

```
(use "git add <file>..." to include in what will be committed)
```

```
license.txt
```

```
no changes added to commit (use "git add" and/or "git commit -a")
```


Only add new file to staging area

- **Now we only add license.txt to the staging area:**

```
[fchen14@mike1 myrepo]$ git add license.txt
[fchen14@mike1 myrepo]$ git commit -m "add license"
[master c183956] add license
1 file changed, 0 insertions(+), 0 deletions(-)
create mode 100644 license.txt
```

- **Then check the working directory status**

```
[fchen14@mike1 myrepo]$ git status
```

On branch master

Changes not staged for commit:

(use "git add <file>..." to update what will be committed)

(use "git checkout -- <file>..." to discard changes in working directory)

```
modified:  readme.txt
```

❖ The change of readme.txt is not committed, why?

no changes added to commit (use "git add" and/or "git commit -a")

Managing the changes - Example (1)

➤ **Make the following changes to readme.txt**

1. Add a newline to readme.txt: `Git tracks changes.`

```
[fchen14@mike1 myrepo]$ nano readme.txt
```

2. Add readme.txt to staging area

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

3. Change the last line of readme.txt to: `Git tracks changes of files.`

```
[fchen14@mike1 myrepo]$ nano readme.txt
```

4. Commit the changes

```
[fchen14@mike1 myrepo]$ git commit -m "Git tracks changes"
[master 662a255] Git tracks changes
1 file changed, 1 insertion(+)
```

5. Check the status of the repo

```
[fchen14@mike1 myrepo]$ git status
```

```
On branch master
```

```
Changes not staged for commit:
```

```
(use "git add <file>..." to update what will be committed)
```

```
(use "git checkout -- <file>..." to discard changes in working directory)
```

```
modified:   readme.txt
```

```
no changes added to commit (use "git add" and/or "git commit -a")
```

Managing the changes - Example (2)

➤ **What does `git commit` do?**

- Recall the last workflow:
 - 1st change -> add -> 2nd change -> commit
- Answer: only changes added to the staging area will be committed!

➤ **Use `git diff` to view the differences between the version in the working directory and the repository:**

```
[fchen14@mike1 myrepo]$ git diff -- readme.txt
diff --git a/readme.txt b/readme.txt
index 76d770f..a9c5755 100644
--- a/readme.txt
+++ b/readme.txt
@@ -1,4 +1,4 @@
```

❖ What should be the correct steps for adding the 2nd change?

Git is a distributed version control system.
 Git is free software distributed under the GPL.
 Git has a mutable index called stage.

- Git tracks changes.
- +Git tracks changes of files.

Three usages of “git add”

- **Trace new file**
 - Put file under “git radar”

- **Add changes of files to staging area**

- **Resolve conflict**
 - Explain later...

Short Summary - Staging Area

- **What are the differences between:**
 - Working directory
 - Staging area
 - Repository

Undoing Things

- **How to cancel a change? e.g. what if you need to delete the last line of `readme.txt`?**

```
[fchen14@mike2 myrepo]$ cat readme.txt
```

Git is a distributed version control system.

Git is free software distributed under the GPL.

Git has a mutable index called stage.

Git tracks changes of files.

Don't know why my boss still prefers SVN.

Cancel the changes

➤ Three situations:

- Discard the changes in the working directory.

```
$ git checkout -- <filename>
```

```
[fchen14@mike1 myrepo]$ git checkout -- readme.txt
```

```
[fchen14@mike1 myrepo]$ cat readme.txt
```

Git is a distributed version control system.

Git is free software distributed under the GPL.

Git has a mutable index called stage.

Git tracks changes of files.

- Discard the changes added to the staging area. (2 steps)

```
$ git reset HEAD <filename>
```

```
$ git checkout -- <filename>
```

```
[fchen14@mike1 myrepo]$ git reset HEAD readme.txt
```

Unstaged changes after reset:

```
M      readme.txt
```

```
[fchen14@mike1 myrepo]$ git checkout -- readme.txt
```

- Discard the changes that is already committed?

```
$ git reset --hard <commit-hash>
```

Delete file(s)

➤ **Let's first add a file to the repository:**

```
[fchen14@mike1 myrepo]$ touch test.txt
[fchen14@mike1 myrepo]$ git add test.txt
[fchen14@mike1 myrepo]$ git commit -m "add test.txt"
```

- I do want to remove this file from the repository

```
[fchen14@mike1 myrepo]$ rm test.txt
[fchen14@mike1 myrepo]$ git status
On branch master
```

Changes not staged for commit:

(use "git add/rm <file>..." to update what will be committed)

(use "git checkout -- <file>..." to discard changes in working directory)

deleted: test.txt

no changes added to commit (use "git add" and/or "git commit -a")

```
[fchen14@mike1 myrepo]$ git rm test.txt # what is the alternative command?
```

```
rm 'test.txt'
```

```
[fchen14@mike1 myrepo]$ git commit -m "test.txt"
```

```
[master cdef552] test.txt
```

1 file changed, 0 insertions(+), 0 deletions(-)

delete mode 100644 test.txt

- I deleted the file by mistake? (git checkout -- test.txt)

Move (Rename) files

➤ **Recover the deleted test.txt and rename it to testnew.txt**

```
[fchen14@mike1 myrepo]$ git checkout HEAD^1 test.txt
```

```
[fchen14@mike1 myrepo]$ ls
```

```
license.txt  readme.txt  test.txt
```

```
[fchen14@mike1 myrepo]$ git status
```

On branch master

Changes to be committed:

(use "git reset HEAD <file>..." to unstage)

```
new file:   test.txt
```

```
[fchen14@mike1 myrepo]$ git mv test.txt testnew.txt
```

```
[fchen14@mike1 myrepo]$ git status
```

On branch master

Changes to be committed:

(use "git reset HEAD <file>..." to unstage)

```
new file:   testnew.txt
```

```
[fchen14@mike1 myrepo]$ git commit -m "renamed test.txt to testnew.txt"
```

```
[master 83963bd] renamed test.txt to testnew.txt
```

```
1 file changed, 0 insertions(+), 0 deletions(-)
```

```
create mode 100644 testnew.txt
```

Short Summary - Change management

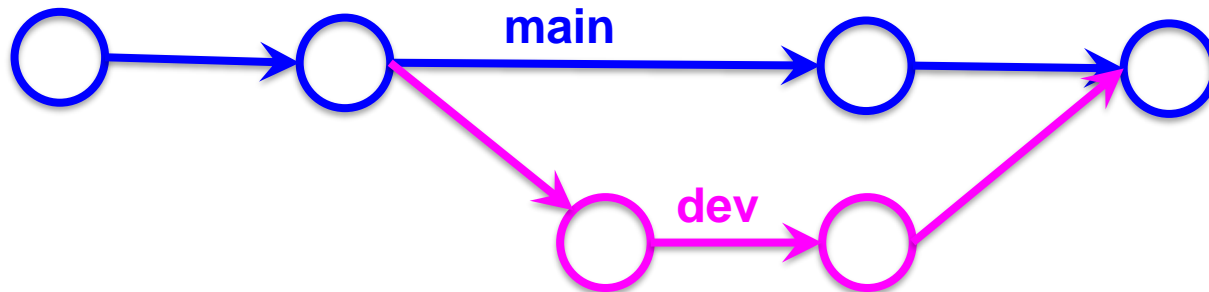
- **Understanding the staging area**
- **Discard changes in 3 different cases**
 - In working directory
 - In staging area
 - Committed
- **Delete and move files**

Git locally

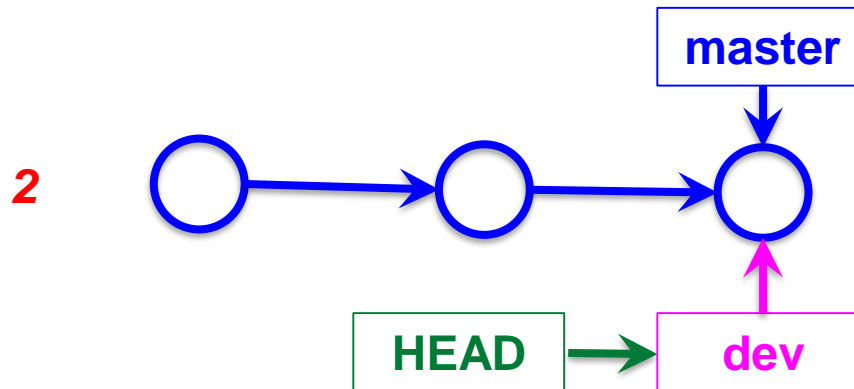
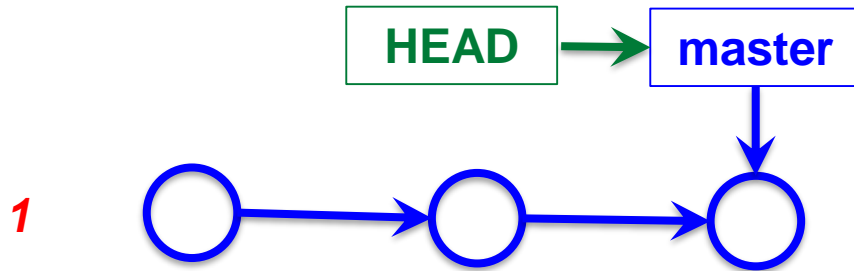
Working with Git branch

Introduction to Git branch

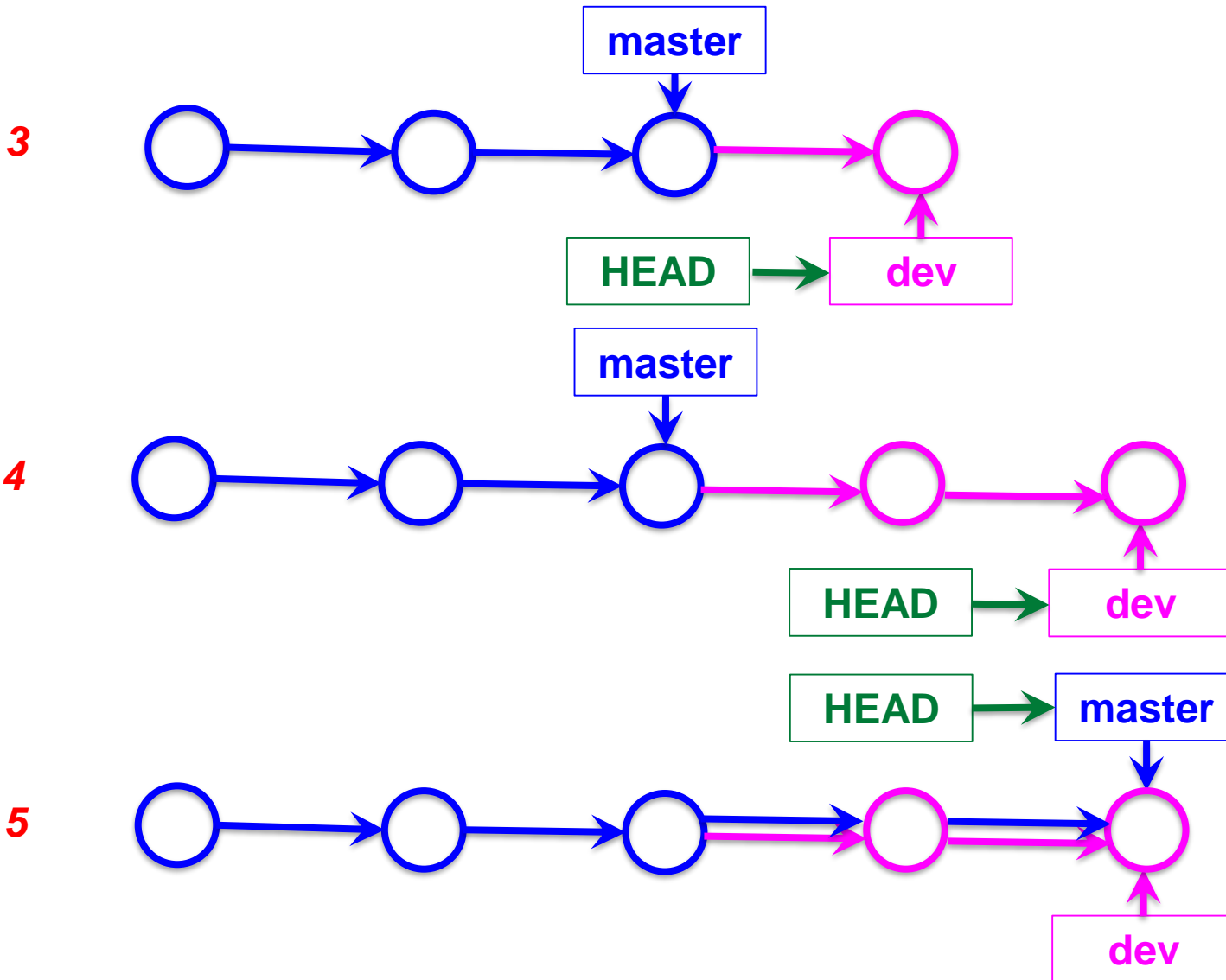
- **A new scenario:**
 - Need to develop a new feature, need 2 weeks
 - The new feature will interfere with the current functions
 - Need to let the new feature separate from the main branch
- *“Some people refer to Git’s branching model as its “killer feature,” and it certainly sets Git apart in the VCS community. Why is it so special? The way Git branches is incredibly lightweight, making branching operations nearly instantaneous, and switching back and forth between branches generally just as fast. Unlike many other VCSs, Git encourages workflows that branch and merge often, even multiple times in a day. Understanding and mastering this feature gives you a powerful and unique tool and can entirely change the way that you develop.”*
 - [Ref: https://git-scm.com/book/en/v2/Git-Branching-Branches-in-a-Nutshell](https://git-scm.com/book/en/v2/Git-Branching-Branches-in-a-Nutshell)



Create and Merge branches (1)



Fast-Forward Merge



Create a dev branch and commit

➤ **Create a dev branch and switch to that branch**

```
[fchen14@mike1 myrepo]$ git branch
* master

[fchen14@mike1 myrepo]$ git checkout -b dev
Switched to a new branch 'dev'

[fchen14@mike1 myrepo]$ git branch
* dev
  master
```

➤ **On dev branch, modify readme.txt by adding a line**

```
Creating a new branch is quick
```

➤ **Commit the changes:**

```
[fchen14@mike1 myrepo]$ nano readme.txt
[fchen14@mike1 myrepo]$ git add readme.txt
[fchen14@mike1 myrepo]$ git commit -m "branch test"
[dev 6fa8c5f] branch test
 1 file changed, 1 insertion(+)
```

Check the difference between branches

- **Switch to the master branch and check the readme.txt**

```
[fchen14@mike1 myrepo]$ git checkout master
```

```
Switched to branch 'master'
```

```
[fchen14@mike1 myrepo]$ cat readme.txt
```

```
Git is a distributed version control system.
```

```
Git is free software distributed under the GPL.
```

```
Git has a mutable index called stage.
```

```
Git tracks changes of files.
```

- **This verifies the change happens only on the dev branch**

Merge dev branch to master branch

- **Merge the work on the dev branch to the master branch:**

```
[fchen14@mike1 myrepo]$ git branch
dev
* master
[fchen14@mike1 myrepo]$ git graph # a pre-defined alias
* 6fa8c5f (dev) branch test
* 83963bd (HEAD -> master) renamed test.txt to testnew.txt
* e9ee24a removed test.txt
...
[fchen14@mike1 myrepo]$ git merge dev
Updating 83963bd..6fa8c5f
Fast-forward
 readme.txt | 1 +
 1 file changed, 1 insertion(+)
```

- **Verify the branch status using our pre-defined command alias**

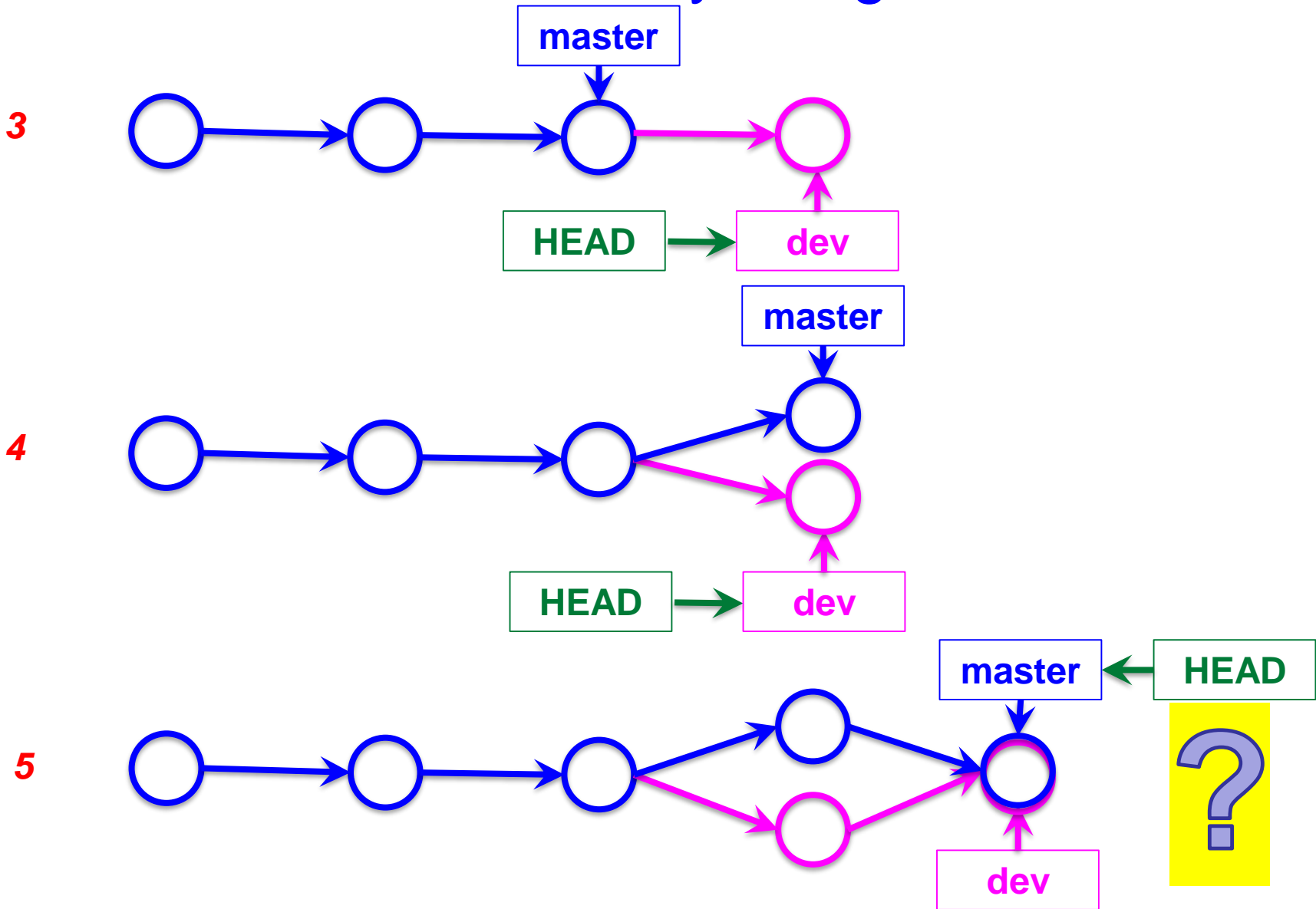
```
[fchen14@mike1 myrepo]$ git graph
* 6fa8c5f (HEAD -> master, dev) branch test
* 83963bd renamed test.txt to testnew.txt
* e9ee24a removed test.txt
* 575744a add test.txt
...
```

Delete branch after merge

➤ **It's safe to delete the branch after merge**

```
[fchen14@mike1 myrepo]$ git branch -d dev
Deleted branch dev (was 6fa8c5f).
[fchen14@mike1 myrepo]$ git branch
* master
[fchen14@mike1 myrepo]$ git graph
* 6fa8c5f (HEAD -> master) branch test
* 83963bd renamed test.txt to testnew.txt
* e9ee24a removed test.txt
...
```

Three-Way Merge



Three way merge and conflict

- **In dev branch, change the last line in readme.txt to:**

Creating a new branch is quick AND simple.

- **In master branch, change the last line in readme.txt to:**

Creating a new branch is quick & simple.

```
[fchen14@mike1 myrepo]$ git checkout -b dev
```

```
Switched to a new branch 'dev'
```

```
[fchen14@mike1 myrepo]$ nano readme.txt # change last line to "AND simple"
```

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

```
[fchen14@mike1 myrepo]$ git commit -m "AND simple"
```

```
[dev 0414374] AND simple
```

```
1 file changed, 1 insertion(+), 1 deletion(-)
```

```
[fchen14@mike1 myrepo]$ git checkout master
```

```
Switched to branch 'master'
```

```
[fchen14@mike1 myrepo]$ nano readme.txt # change last line to "& simple"
```

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

```
[fchen14@mike1 myrepo]$ git commit -m "& simple"
```

```
[master abef850] & simple
```

```
1 file changed, 1 insertion(+), 1 deletion(-)
```

```
[fchen14@mike1 myrepo]$ git merge dev
```

```
Auto-merging readme.txt
```

```
CONFLICT (content): Merge conflict in readme.txt
```

```
Automatic merge failed; fix conflicts and then commit the result.
```

Resolve conflict manually

➤ **Use git status to check the conflict files**

```
[fchen14@mike1 myrepo]$ git status
```

On branch master

You have unmerged paths.

(fix conflicts and run "git commit")

(use "git merge --abort" to abort the merge)

Unmerged paths:

(use "git add <file>..." to mark resolution)

```
both modified:  readme.txt
```

no changes added to commit (use "git add" and/or "git commit -a")

➤ **Use your favorite editor to check the contents of readme.txt**

```
[fchen14@mike1 myrepo]$ cat readme.txt
```

Git is a distributed version control system.

Git is free software distributed under the GPL.

Git has a mutable index called stage.

Git tracks changes of files.

```
<<<<<< HEAD
```

```
Creating a new branch is quick & simple.
```

```
=====
```

```
Creating a new branch is quick AND simple.
```

```
>>>>>> dev
```

Commit after resolving the conflicts

- **Manually resolve the conflicts indicated by Git**

```
<<<<<<< HEAD
```

```
=====
```

```
>>>>>> dev
```

- **We will resolve this conflict by changing the last line to:**

```
Creating a new branch is quick and simple.
```

- **Commit your changes to complete the merge process.**

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

```
[fchen14@mike1 myrepo]$ git status
```

```
On branch master
```

```
All conflicts fixed but you are still merging.
```

```
(use "git commit" to conclude merge)
```

```
Changes to be committed:
```

```
    modified:   readme.txt
```

```
[fchen14@mike1 myrepo]$ git commit -m "resolve conflict"
```

```
[master e732763] resolve conflict
```

Verify git status and delete dev branch

➤ Verify git branch graph

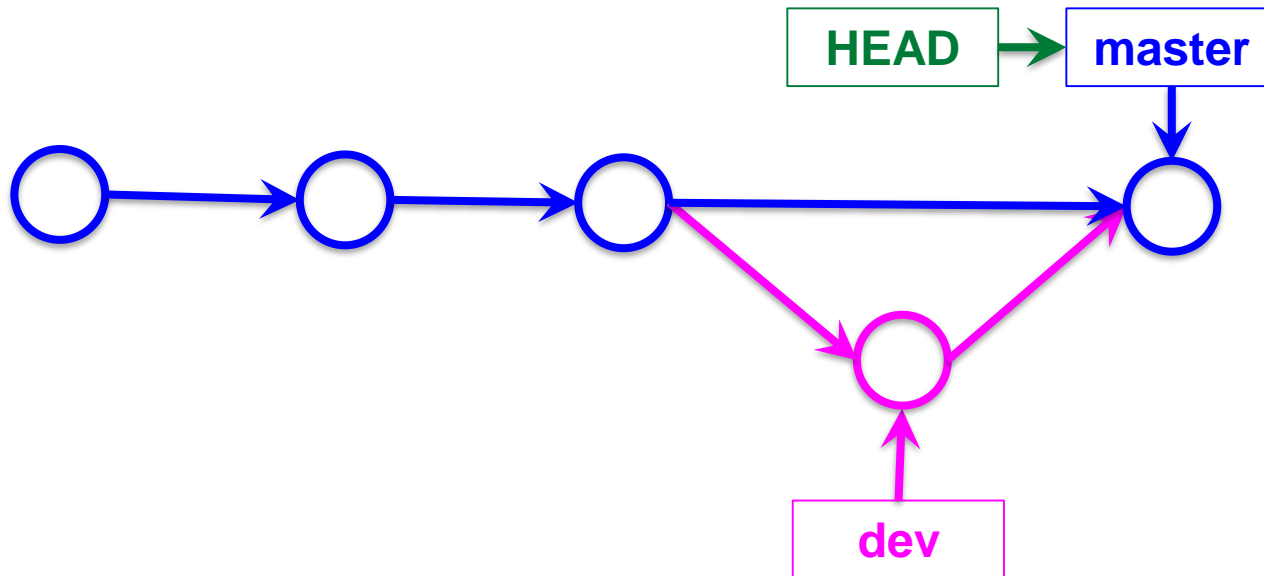
```
[fchen14@mike1 myrepo]$ git graph
*    e732763 (HEAD -> master) resolve conflict
|\
| * 0414374 (dev) AND simple
* | abef850 & simple
|/
* 6fa8c5f branch test
```

➤ Delete the dev branch

```
[fchen14@mike1 myrepo]$ git branch -d dev
Deleted branch dev (was 0414374).
[fchen14@mike1 myrepo]$ git graph
*    e732763 (HEAD -> master) resolve conflict
|\
| * 0414374 AND simple
* | abef850 & simple
|/
* 6fa8c5f branch test
```

Branch Strategy

- Fast-forward merge will lose branch information when the branch is deleted.
- It is suggested to use `--no-ff` even for a fast-forward merge so that the branch information is retained even after branch deletion.

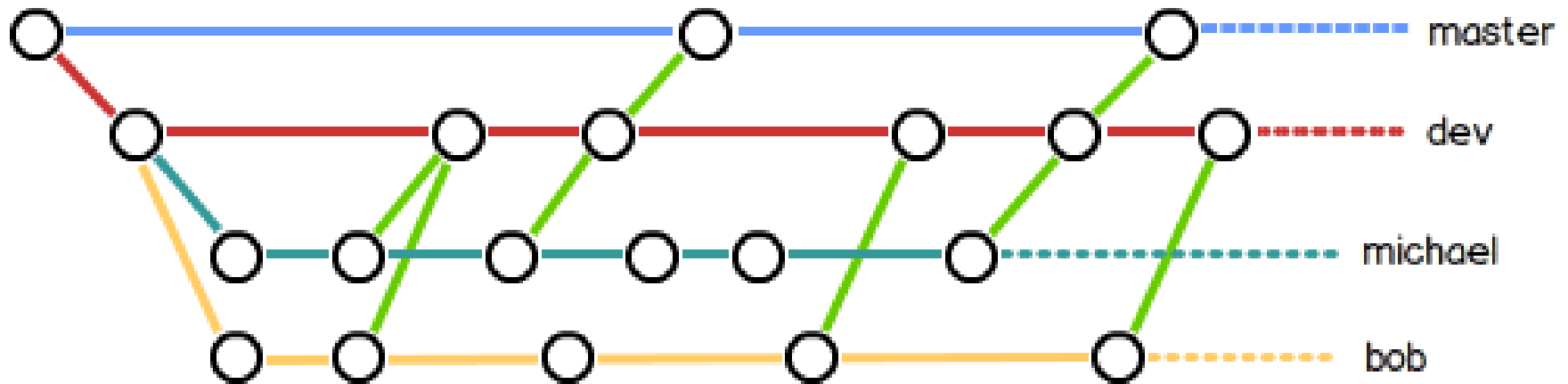


Using --no-ff merge

```
[fchen14@mike1 myrepo]$ git checkout -b dev
Switched to a new branch 'dev'
[fchen14@mike1 myrepo]$ nano readme.txt # add a line
[fchen14@mike1 myrepo]$ git add readme.txt
[fchen14@mike1 myrepo]$ git commit -m "--no-ff merge"
...
[fchen14@mike1 myrepo]$ git checkout master
Switched to branch 'master'
[fchen14@mike1 myrepo]$ git merge --no-ff -m "merge with no-ff" dev
Merge made by the 'recursive' strategy.
 readme.txt | 1 +
 1 file changed, 1 insertion(+)
[fchen14@mike1 myrepo]$ git graph
*    f12ac0f (HEAD -> master) merge with no-ff
|\
| * 03c1409 (dev) --no-ff merge
|/
*    e732763 resolve conflict
```

Group development branch

- Master branch is always stable
- All development work in dev branch, merge to master when necessary
- Every developer has his/her own branch.



Bug branch and git stash

➤ Interrupted workflow

- When you are in the middle of something, your boss comes in and demands that you fix something immediately.

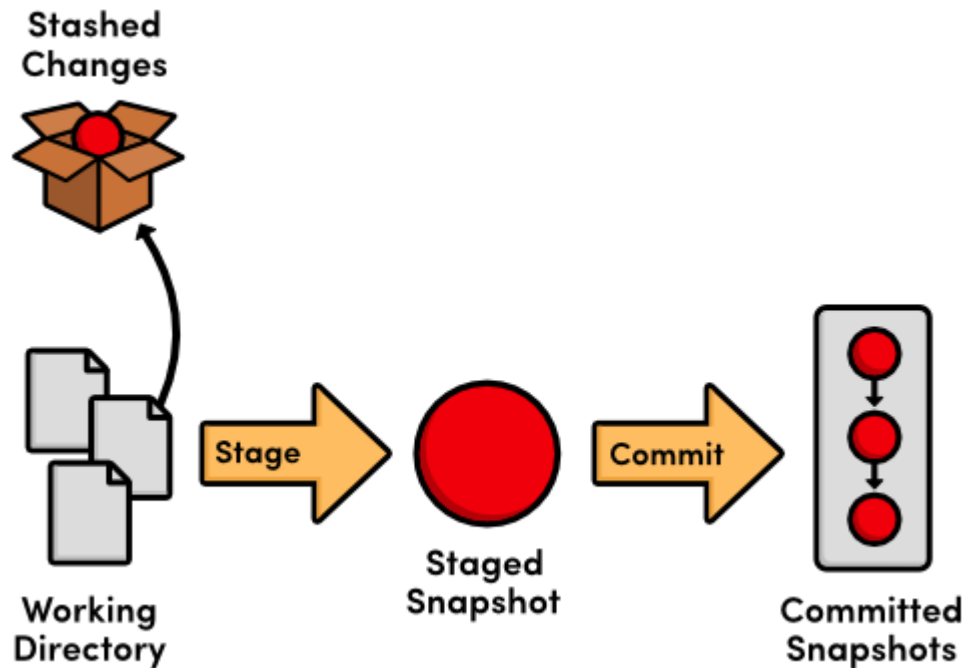
```
# ... hack hack hack ...
$ git checkout -b my_wip
$ git commit -a -m "WIP"
$ git checkout master
$ edit emergency fix
$ git commit -a -m "Fix in a hurry"
$ git checkout my_wip
$ git reset --soft HEAD^
# ... continue hacking ...
```

- You can use git stash to simplify the above, like this:

```
# ... hack hack hack ...
$ git stash
$ edit emergency fix
$ git commit -a -m "Fix in a hurry"
$ git stash pop
# ... continue hacking ...
```

A visualization of “git stash”

- Ref: <https://code.tutsplus.com/tutorials/quick-tip-leveraging-the-power-of-git-stash--cms-22988>



Use git stash (1)

- **Use git stash when you want to record the current state of the working directory and the index, but want to go back to a clean working directory. The command saves your local modifications away and reverts the working directory to match the HEAD commit.**

```
[fchen14@mike1 myrepo]$ git status
```

```
On branch feature
```

```
Changes to be committed:
```

```
(use "git reset HEAD <file>..." to unstage)
```

```
    modified:   testnew.txt
```

```
Untracked files:
```

```
(use "git add <file>..." to include in what will be committed)
```

```
    feature.py
```

```
[fchen14@mike1 myrepo]$ git add feature.py
```

```
[fchen14@mike1 myrepo]$ git stash
```

```
Saved working directory and index state WIP on feature: 5b39dd9 bug fix in readme.txt
```

```
[fchen14@mike1 myrepo]$ git checkout master
```

```
Switched to branch 'master'
```

```
[fchen14@mike1 myrepo]$ echo "fixed bug in main branch." >> readme.txt
```

```
[fchen14@mike1 myrepo]$ git add readme.txt
```

Use git stash (2)

```
[fchen14@mike1 myrepo]$ git commit -m "fixed bug in main"
[master a4c6023] fixed bug in main
 1 file changed, 1 insertion(+)
[fchen14@mike1 myrepo]$ git checkout feature
Switched to branch 'feature'
[fchen14@mike1 myrepo]$ git stash list
stash@{0}: WIP on feature: 5b39dd9 bug fix in readme.txt
[fchen14@mike1 myrepo]$ git stash pop
On branch feature
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)
       new file:   feature.py
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git checkout -- <file>..." to discard changes in working directory)

       modified:   testnew.txt

Dropped refs/stash@{0} (04a1c17075630e449d12635d6e22b830e4db3a06)
```

Short Summary Git branch

- **Two types of merge**
 - Fast-forward
 - Three way
 - Conflict
- **Branch strategy**
- **Interrupted workflow**

Version Control using Git

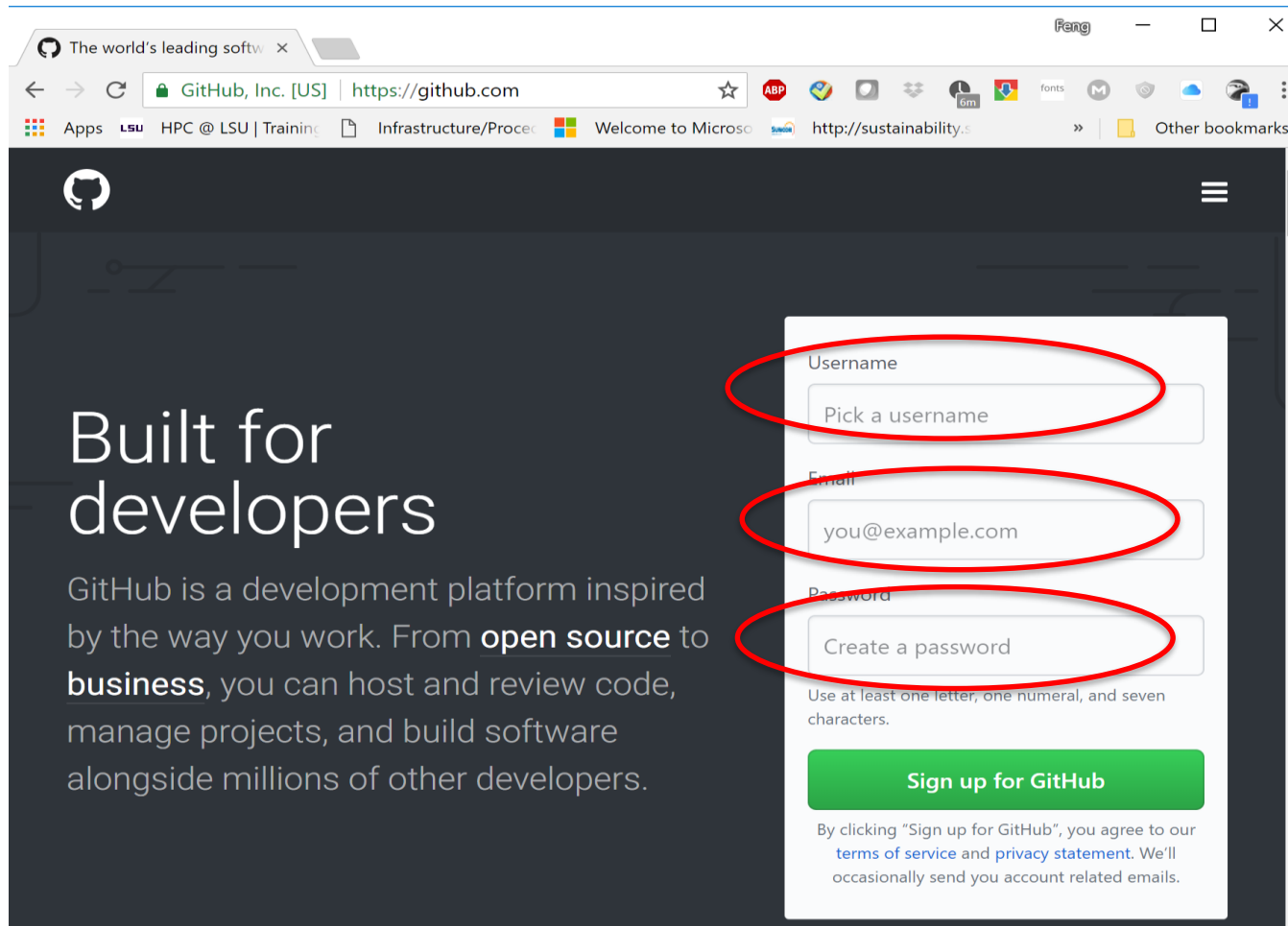
Working with remote repository

What is a remote repository?

- **Remote repositories are versions of your project that are not on your computer.**
- **They usually include:**
 - the history.
 - branches, called the remote branches.
- **Interaction with remote repositories**
 - You push changes from your computer to the remote.
 - You pull changes from the remote to your computer.
- **Why use remote repositories?**
 - backup your work.
 - Collaborate.
 - You can have several remote repositories.

Signup for GitHub

- Sign up a GitHub account at <https://github.com/> if you do not already have one.



Start a project on GitHub

The screenshot shows the GitHub homepage in a web browser. The main heading reads "Learn Git and GitHub without any code!" followed by a sub-heading: "Using the Hello World guide, you'll create a repository, start a branch, write comments, and open a pull request." Below this text are two buttons: a green "Read the guide" button and a grey "Start a project" button. The "Start a project" button is circled in red. At the bottom of the page, there is a navigation bar with "Browse activity" and "Discover repositories" tabs, and a promotional banner for "Custom domains on GitHub Pages gain support for HTTPS".

Create a new repository

Create a New Repository

GitHub, Inc. [US] | <https://github.com/new>

Search GitHub Pull requests Issues Marketplace Explore

Create a new repository

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

Owner: dbxmc

Repository name: myrepo ✓

Great repository names are short and memorable. Need inspiration? How about [jubilant-rotary-phone](#).

Description (optional): my first repository on GitHub

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 ⓘ

Create repository

Push our existing repository

dbxmc/myrepo

GitHub, Inc. [US] | https://github.com/dbxmc/myrepo

This repository Search Pull requests Issues Marketplace Explore

dbxmc / myrepo Unwatch 1 Star 0 Fork 0

Code Issues 0 Pull requests 0 Projects 0 Wiki Insights Settings

Quick setup — if you've done this kind of thing before

Set up in Desktop or HTTPS SSH https://github.com/dbxmc/myrepo.git

We recommend every repository include a README, LICENSE, and .gitignore.

...or create a new repository on the command line

```
echo "# myrepo" >> README.md
git init
git add README.md
git commit -m "first commit"
git remote add origin https://github.com/dbxmc/myrepo.git
git push -u origin master
```

...or push an existing repository from the command line

```
git remote add origin https://github.com/dbxmc/myrepo.git
git push -u origin master
```

Push your current repository to GitHub

- **Copy and paste the commands in the previous slides to push your local master branch to GitHub**

```
[fchen14@mike1 myrepo]$ git remote add origin
https://github.com/dbxmcf/myrepo.git
[fchen14@mike1 myrepo]$ git push -u origin master
Username for 'https://github.com': dbxmcf
Password for 'https://dbxmcf@github.com':
Counting objects: 47, done.
Delta compression using up to 16 threads.
Compressing objects: 100% (42/42), done.
Writing objects: 100% (47/47), 4.19 KiB | 715.00 KiB/s, done.
Total 47 (delta 15), reused 0 (delta 0)
remote: Resolving deltas: 100% (15/15), done.
To https://github.com/dbxmcf/myrepo.git
 * [new branch]      master -> master
Branch 'master' set up to track remote branch 'master' from 'origin'.
[fchen14@mike1 myrepo]$ git status
On branch master
Your branch is up to date with 'origin/master'.

nothing to commit, working tree clean
```

View your remote GitHub repository

The screenshot shows a web browser window displaying a GitHub repository page for 'dbxmc/myrepo'. The page includes navigation tabs for Code, Issues, Pull requests, Projects, Wiki, Insights, and Settings. Below the repository name, there are statistics for 18 commits, 1 branch, 0 releases, and 1 contributor. A row of buttons includes 'Branch: master', 'New pull request', 'Create new file' (circled in red), 'Upload files', 'Find file', and 'Clone or download'. Below this is a commit history table with columns for commit message, file changes, and time ago. The most recent commit is highlighted with a red box and contains the message 'Update remote repo by Adding a new file'. Below the commit list, the content of the selected file 'readme.txt' is displayed, showing text about Git.

Commit Message	Files Changed	Time Ago
Isuhpchelp new test feature		Latest commit 0241613 41 minutes ago
license.txt	understanding the staging area	3 days ago
readme.txt	fixed bug in main	5 hours ago
testnew.txt	new test feature	41 minutes ago

Update remote repo by Adding a new file

```

Git is a distributed version control system.
Git is a free software distributed under the GPL.
Git has a mutable index called stage.
Git tracks changes of files.
Creating a new branch is quick and simple.
Demo of the --no-ff merge.
fixed bug in main branch.
    
```

Update remote repository

The screenshot shows a web browser window with the GitHub interface. The address bar shows the URL `https://github.com/dbxmcfc/myrepo/new/master`. The page title is "dbxmcfc / myrepo". The navigation bar includes "Pull requests", "Issues", "Marketplace", and "Explore". The main content area shows a file editor for "remote_feature" with the text "This is a remote feature". Below the editor is a "Commit new file" dialog box with the commit message "create remote feature" and two options: "Commit directly to the master branch" (selected) and "Create a new branch for this commit and start a pull request". At the bottom of the dialog are "Commit new file" and "Cancel" buttons.

Updating your local copy of the remote branches



- **Use git fetch + git merge**
 - This is equivalent to "git pull"
 - git pull = git fetch + git merge

```
[fchen14@mike1 myrepo]$ git fetch
remote: Counting objects: 3, 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/dbxmcf/myrepo
   0241613..c105f0b  master    -> origin/master
[fchen14@mike1 myrepo]$ git merge # merge the remote branch with local
Updating 0241613..c105f0b
Fast-forward
 remote_feature | 1 +
 1 file changed, 1 insertion(+)
 create mode 100644 remote_feature
```

Explore remote repository

➤ **Showing remote repositories**

```

[fchen14@mike1 myrepo]$ git remote -v
origin  https://github.com/dbxmcf/myrepo.git (fetch)
origin  https://github.com/dbxmcf/myrepo.git (push)
  
```

Summary

- **Why Git?**
- **Git locally**
 - Create repo
 - Working directory/Staging area/Repository
 - Manage the changes
- **Git branch**
 - How to create new branch
 - Merge branch
 - Fast-forward
 - Three way - Conflict
 - Branch management strategy
- **Git remote**
 - Push your local repo to the remote repo
 - Update your local repo from the remote repo

Version Control using Git

Question and Lab Session