# SIAM: Getting Started with Git

based on http://git-scm.com/book and slides by Bart Trojanowski

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April 5, 2017

## Table of Contents

## Overview

## Git

Git is a

- Free and Open Source
- Distributed
- Version Control System.

## Version Control System

Preserve a clear, timely record of software evolution

- Record changes to files
- History can be recalled/inspected

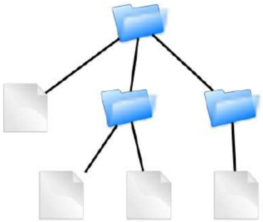
Implications:

- Rollback changes
- Know what collaborators are working on
- Investigate changes when bugs emerge
- Find how and where a particular bug was fixed

## Components

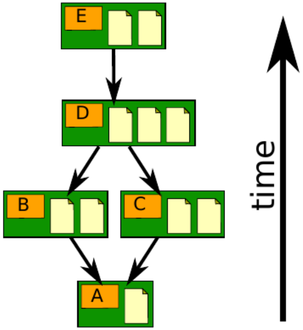
## VCS Components (Working Tree)

- Single checkout of one version of the project
- Directories
- Files



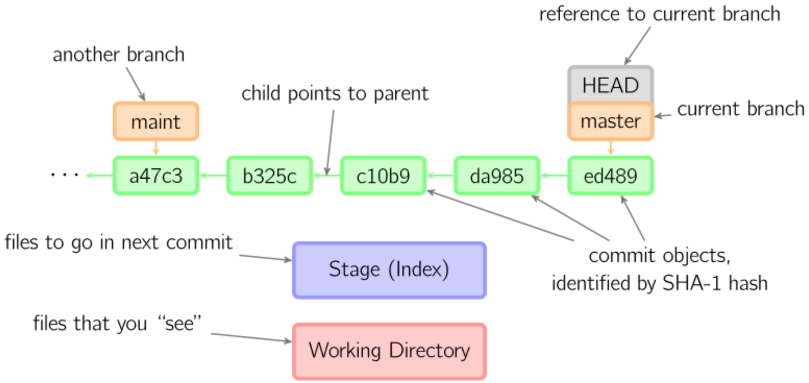
## VCS Components (Repository)

- Files
- Commits
- Ancestry



## VCS Components (References)

- Tags
- Branches
- HEAD
- Index (Staging area)



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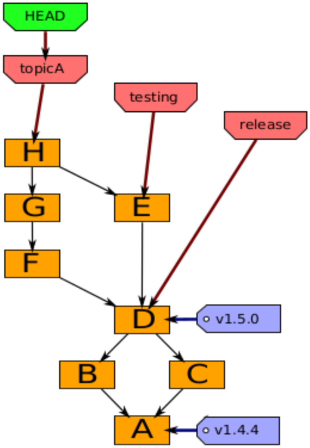
## VCS Components (Example Graph)



## Operations

## VCS Operations

Bootstrap

- `init`
- `clone`
- `checkout`

Modify

- add, delete (`rm`)
- rename (`mv`)
- `commit`

Information

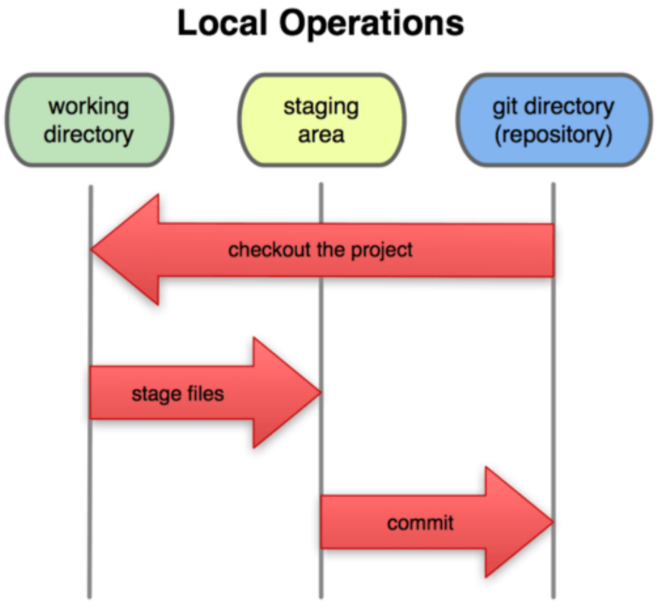
- `status`
- `diff`
- `log`

Reference

- `tag`
- `branch`

Sharing work, backing it up

- `pull`, `fetch`
- `push`


Local Operations
working directory
staging area
git directory (repository)
checkout the project
stage files
commit

[1]

## Bootstrapping

`$ git init`

- creates .git directory and initializes the repository

`$ git clone <URL>`

- replicates a remote repository
- checks out new working tree
- Git URLs
  - /home/user/my-project.git
  - http://github.com/user/my-project.git
  - git://remote.server/my-project.git
  - user@remote.server:my-project.git
  - ssh://user@remote.server/ user/my-project.git

## Initializing Empty Repository

```
$ ls -a
. ..
$ git init
Initialized empty Git repository in
    /home/user/my-project/.git/
$ ls -a
. .. .git
$ ls
$
```

## Staging

- `$ git add <path>`
  - Adds contents of `<path>` to index
  - `$ git add .`
- `$ git rm <file>`
  - Removes files from working tree and index
- `$ git mv <source> <destination>`
  - Moves or renames a file or directory

## Adding our First File

```
$ echo 'Hi, my name is Nathan' > name_file.txt
$ git status
On branch master

Initial commit

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

        name_file.txt

nothing added to commit but untracked files present
     (use "git add" to track)
```

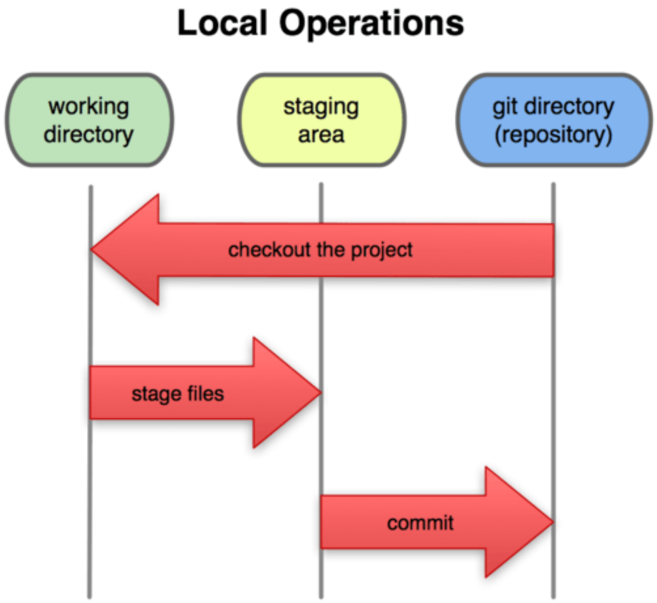
## Adding our First File

```
$ git add name_file.txt
$ git status
On branch master

Initial commit

Changes to be committed:
  (use "git rm --cached <file>..." to unstage)

        new file:   name_file.txt
```


Local Operations
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[1]

## Committing

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

- Creates a commit of staged items
- `$ git commit -m "fixes issue #108"`

## Creating our First Commit

```
$ git commit -m 'Add greeting'

*** Please tell me who you are.

Run

  git config --global user.email "you@example.com"
  git config --global user.name "Your Name"

to set your account's default identity.
Omit --global to set the identity only in this
    repository.

fatal: empty ident name (for <(null)>) not allowed
```

## Creating our First Commit

```
$ git commit -m 'Add greeting'
[master (root-commit) dec6e96] Add greeting
 1 file changed, 1 insertion(+)
 create mode 100644 name_file.txt
```

## Ignoring Files

`.gitignore`

- Text file that specifies files to ignore

## Example .gitignore file

```
*.out
todo_list.txt
```

## Ignoring Files in Status

```
$ ls -a
.   ..   .git   .gitignore   name_file.txt   test2.out
    test.out   todo_list.txt
$ git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will
    be committed)

        .gitignore

nothing added to commit but untracked files present
    (use "git add" to track)
```

## Ignoring Files when Staging

```
$ ls -a
.  ..  .git  .gitignore  name_file.txt  test2.out
    test.out  todo_list.txt
$ git add .
$ git status
On branch master
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

        new file:   .gitignore
$ git commit -m 'Add ignore file'
[master b488e63] Add ignore file
 1 file changed, 2 insertions(+)
 create mode 100644 .gitignore
```

## Inspection

```
$ git status
```

- Displays the working tree status
- staged, unstaged, untracked

```
$ git diff
```

- Displays changes between index and working tree

```
$ git diff --staged
```

- Displays changes between HEAD and index

```
$ git diff HEAD
```

- Displays changes between HEAD and working tree

```
$ git diff <commit> <commit>
```

- Displays changes between two commits

## Spotting Changes

```
$ echo 'I like git' >> name_file.txt
$ git add name_file.txt
$ echo 'Hello, world!' >> name_file.txt
$ git status
On branch master
Changes to be committed:
  (use "git reset HEAD <file>..." to unstage)

        modified:   name_file.txt

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:   name_file.txt
```

## Spotting Changes

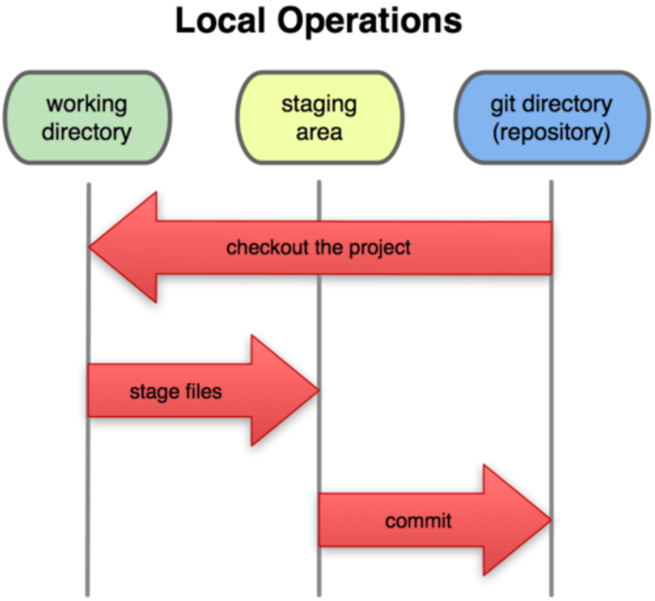
```
$ git diff
diff --git a/name_file.txt b/name_file.txt
index fa864f7..d5e2134 100644
--- a/name_file.txt
+++ b/name_file.txt
@@ -1,2 +1,3 @@
 Hi, my name is Nathan
 I like git
+Hello, world!
```

## Spotting Changes

```
$ git diff --staged
diff --git a/name_file.txt b/name_file.txt
index c987f6b..fa864f7 100644
--- a/name_file.txt
+++ b/name_file.txt
@@ -1 +1,2 @@
 Hi, my name is Nathan
+I like git
```

## Spotting Changes

```
$ git diff HEAD
diff --git a/name_file.txt b/name_file.txt
index c987f6b..d5e2134 100644
--- a/name_file.txt
+++ b/name_file.txt
@@ -1 +1,3 @@
 Hi, my name is Nathan
+I like git
+Hello, world!
```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[1]

## Undoing Changes to Working Directory

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

- Put file from staging area into working directory
- Undo unstaged changes to file

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

- Put file from specified commit into working directory and staging area
- Overwrite unstaged changed to file

The `checkout` command has other uses when dealing with branches (discussed later). Be warned – `git checkout <commit>` without filename argument does not do what you expect.

## Erasing Unstaged Changes

```
$ git checkout name_file.txt
$ cat name_file.txt
Hi, my name is Nathan
I like git
```

## Undoing Changes to Staging Area

The `reset` command is similar to `checkout` for staging area

```
$ git reset
```

- Unstage all changes
- Reset staging area to HEAD

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

- Unstage changes to file
- Reset file in staging area to HEAD

The `reset` command will not touch the working directory unless passed an additional argument. Follow `reset` with `checkout` to undo changes to working directory.

The `reset` command, like `checkout`, has other uses related to branches.

## Erasing Unstaged Changes

```
$ git reset name_file.txt
Unstaged changes after reset:
M       name_file.txt
$ git checkout name_file.txt
$ cat name_file.txt
Hi, my name is Nathan
```

## Viewing History

```
$ git log [<since>..<until>] [-- <path>]
```

- Show commit logs
- `$ git log HEAD~3..HEAD^`
- `$ git log -- file-with-bug.c`

```
$ git show <object>
```

- Show various types of objects
- `$ git show HEAD@{yesterday}`
- `$ git show HEAD:file`

## Viewing Log

```
$ git log
commit 4f6f4a4a4d432a8c22fda5dff7006dfc026e126f
Author: Your Name <you@example.com>
Date:   Mon Apr 3 22:05:50 2017 -0500

    Add ignore file

commit dec6e96fe5ad9d2f419e775c2f4a1b0ac52316e2
Author: Your Name <you@example.com>
Date:   Mon Apr 3 17:37:57 2017 -0500

    Add greeting
```

## Referencing Objects

- `a88dbbe57b9e9fc01f701c45c405647c588e6a6a`
- `a88d`
- `v1.0.3`
- `master`
- `origin/master`
- `HEAD`
- `HEAD^ == HEAD~1`
- `feature_brach@{May.30}`

## Examining Commit Object

```
$ git show dec6e
commit dec6e96fe5ad9d2f419e775c2f4a1b0ac52316e2
Author: Your Name <you@example.com>
Date:   Mon Apr 3 17:37:57 2017 -0500

    Add greeting

diff --git a/name_file.txt b/name_file.txt
new file mode 100644
index 0000000..c987f6b
--- /dev/null
+++ b/name_file.txt
@@ -0,0 +1 @@
+Hi, my name is Nathan
```

## Log Formatting

```
$ git log --pretty=<format>
```

- `oneline`
- `full`
- `format:"hash: %h author: %an date: %ad"`
- see git-log(1) for more options

```
$ git log --graph --pretty=oneline
```

## Using History

```
$ echo 'I like git' >> name_file.txt
$ echo 'Hello, world!' >> name_file.txt
$ git commit -am 'Share more information'
Share more information
 1 file changed, 2 insertions(+)
```

## Using History

```
$ git diff HEAD~2
diff --git a/.gitignore b/.gitignore
new file mode 100644
index 0000000..d0833a3
--- /dev/null
+++ b/.gitignore
@@ -0,0 +1,2 @@
+*.out
+todo_list.txt
diff --git a/name_file.txt b/name_file.txt
index c987f6b..d5e2134 100644
--- a/name_file.txt
+++ b/name_file.txt
@@ -1 +1,3 @@
 Hi, my name is Nathan
+I like git
+Hello, world!
```

## Using History

```
$ git show HEAD~1:name_file.txt
Hi, my name is Nathan
$ git checkout HEAD~1 -- name_file.txt
```

## Branching

```
$ git branch -l
```

- List local branches

```
$ git branch <branchname>
```

- Create new branch on HEAD

```
$ git branch <branchname> <start-commit>
```

- Create new branch on specified commit

```
$ git checkout <branch>
```

- Checkout branch by name

```
$ git checkout -b <branchname> [<start-commit>]
```

- Create and switch to a new branch

## Merging

```
$ git merge <branch>
```

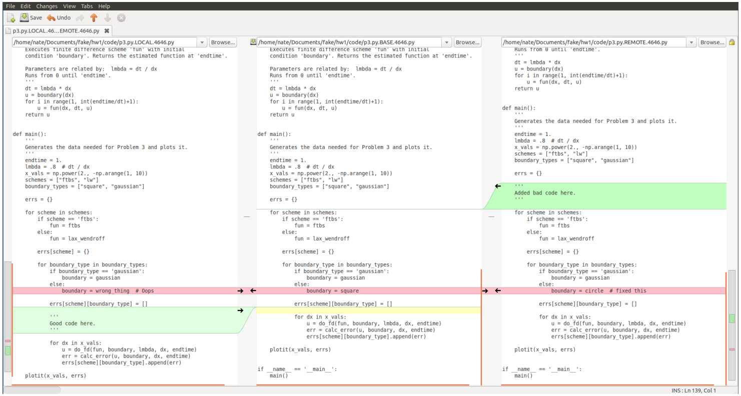
- Incorporates changes from the specified branch into the current branch.
- Conflicts may result
- Any conflicts must be resolved before merge is completed

```
var = 3
<<<<<<< HEAD
x = 0.5 * var
=======
x = 1/2. * var
>>>>>>> origin/master
```

## Mergetool

`$ git mergetool`

- Presents a visual interface to merging
- Example: `$ git mergetool --tool=meld`


File Edit Changes View Tabs Help
Save
Undo
p3.py.LOCAL.46…EMOTE.4646.py
Browse...
INS : Ln 139, Col 1

```
/home/nate/Documents/fake/hw1/code/p3.py.LOCAL.4646.py
    Executes finite difference scheme 'fun' with initial
    condition 'boundary'. Returns the estimated function at 'endtime'.

    Parameters are related by:  lmbda = dt / dx
    Runs from 0 until 'endtime'.
    '''
    dt = lmbda * dx
    u = boundary(dx)
    for i in range(1, int(endtime/dt)+1):
        u = fun(dx, dt, u)
    return u


def main():
    '''
    Generates the data needed for Problem 3 and plots it.
    '''
    endtime = 1.
    lmbda = .8  # dt / dx
    x_vals = np.power(2., -np.arange(1, 10))
    schemes = ["ftbs", "lw"]
    boundary_types = ["square", "gaussian"]

    errs = {}

    for scheme in schemes:
        if scheme == 'ftbs':
            fun = ftbs
        else:
            fun = lax_wendroff

        errs[scheme] = {}

        for boundary_type in boundary_types:
            if boundary_type == 'gaussian':
                boundary = gaussian
            else:
                boundary = wrong_thing  # Oops

            errs[scheme][boundary_type] = []

            '''
            Good code here.
            '''

            for dx in x_vals:
                u = do_fd(fun, boundary, lmbda, dx, endtime)
                err = calc_error(u, boundary, dx, endtime)
                errs[scheme][boundary_type].append(err)

    plotit(x_vals, errs)
```

```
/home/nate/Documents/fake/hw1/code/p3.py.BASE.4646.py
    Executes finite difference scheme 'fun' with initial
    condition 'boundary'. Returns the estimated function at 'endtime'.

    Parameters are related by:  lmbda = dt / dx
    Runs from 0 until 'endtime'.
    '''
    dt = lmbda * dx
    u = boundary(dx)
    for i in range(1, int(endtime/dt)+1):
        u = fun(dx, dt, u)
    return u


def main():
    '''
    Generates the data needed for Problem 3 and plots it.
    '''
    endtime = 1.
    lmbda = .8  # dt / dx
    x_vals = np.power(2., -np.arange(1, 10))
    schemes = ["ftbs", "lw"]
    boundary_types = ["square", "gaussian"]

    errs = {}

    for scheme in schemes:
        if scheme == 'ftbs':
            fun = ftbs
        else:
            fun = lax_wendroff

        errs[scheme] = {}

        for boundary_type in boundary_types:
            if boundary_type == 'gaussian':
                boundary = gaussian
            else:
                boundary = square

            errs[scheme][boundary_type] = []

            for dx in x_vals:
                u = do_fd(fun, boundary, lmbda, dx, endtime)
                err = calc_error(u, boundary, dx, endtime)
                errs[scheme][boundary_type].append(err)

    plotit(x_vals, errs)


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

```
/home/nate/Documents/fake/hw1/code/p3.py.REMOTE.4646.py
    Runs from 0 until 'endtime'.
    '''
    dt = lmbda * dx
    u = boundary(dx)
    for i in range(1, int(endtime/dt)+1):
        u = fun(dx, dt, u)
    return u


def main():
    '''
    Generates the data needed for Problem 3 and plots it.
    '''
    endtime = 1.
    lmbda = .8  # dt / dx
    x_vals = np.power(2., -np.arange(1, 10))
    schemes = ["ftbs", "lw"]
    boundary_types = ["square", "gaussian"]

    errs = {}

    '''
    Added bad code here.
    '''
    for scheme in schemes:
        if scheme == 'ftbs':
            fun = ftbs
        else:
            fun = lax_wendroff

        errs[scheme] = {}

        for boundary_type in boundary_types:
            if boundary_type == 'gaussian':
                boundary = gaussian
            else:
                boundary = circle  # fixed this

            errs[scheme][boundary_type] = []

            for dx in x_vals:
                u = do_fd(fun, boundary, lmbda, dx, endtime)
                err = calc_error(u, boundary, dx, endtime)
                errs[scheme][boundary_type].append(err)

    plotit(x_vals, errs)


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

## Changing Settings

`$ git config --list`

- Lists the current configuration settings

`$ git config <key>`

- Gets the current value of `key`

`$ git config [level] <key> <value>`

- Changes setting `key` to `value`
- Optional `level` determines scope of setting
  - Omitting `level`: repository
  - `--global`: user
  - `--system`: system

## Common Configuration Settings

A few settings you will want to update when first using Git:

```
$ git config --global user.name "John Doe"
$ git config --global user.email johndoe@example.com
$ git config --global core.editor emacs
$ git config --global core.excludesfile ~/.gitignore
$ git config --global merge.tool meld
```

## Getting Help

```
$ git help <command>
```

- Display *a lot* of information about command

Google and StackOverflow are great resources for quick questions. Chances are that almost any `git` question you have has been asked and answered already.

## Sharing

## Remotes

`$ git remote add <name> <url>`

- Adds a remote named `<name>` for the repository at `<url>`

`$ git fetch <remote>`

- Fetches updates from specified remote
- `$ git fetch --all`

`$ git branch -r`

- List remote branches
- Use `$ git merge` to merge these branches

`$ git pull [<remote>] [<branch>]`

- Short for a fetch followed by a merge

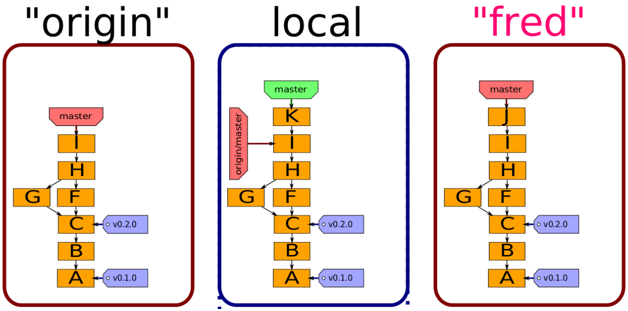
## Git Naming–Disambiguation

Git creates branches automatically in certain cases.

- `HEAD`: special reference that identifies the current branch
- `master`: Default branch created when a repository is first initialized
- `origin`: default name chosen for a remote when cloned
- `<remote_name>/<branch_name>`
  - `origin/master`
  - `upstream/fix-issue-105`

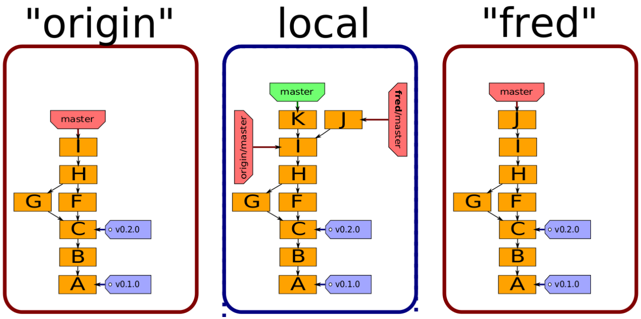
## Remotes Example

“fred” cannot push to “origin”



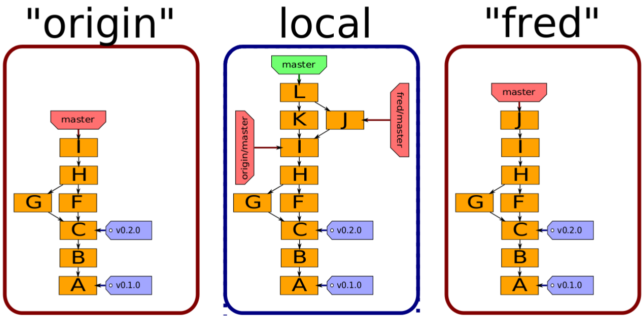
## Remotes Example (continued)

Fetch from “fred”



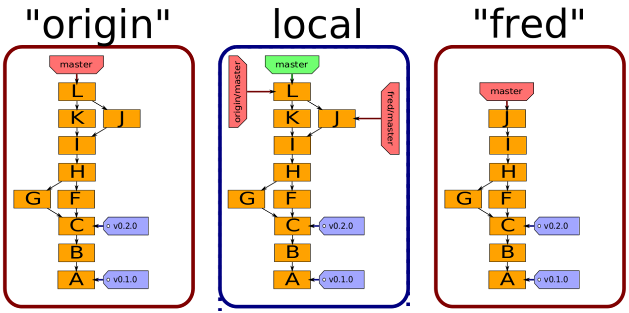
## Remotes Example (continued)

Merge in the changes



## Remotes Example (continued)

Push changes to “origin”



## Challenge Problem

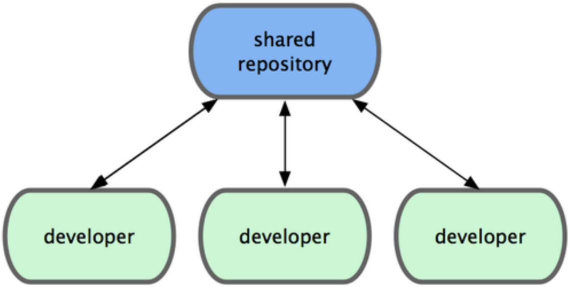
Shape module at `https://github.com/gswg/example.git`

- Clone repository
- Locate and fix bug
- Push fix
  - You may need to fetch and merge with `origin/master`
  - Username: gswg
  - Password: siam2014

## Distributed

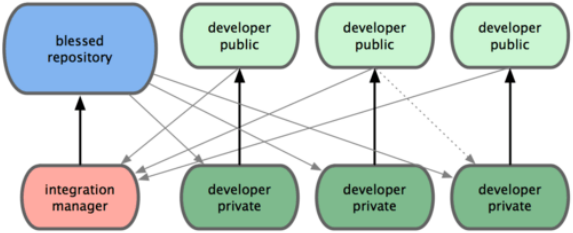
- No central location that keeps track of your data (no single place is more important than another)
- Encourages small commits and frequent merging
- Branches don't affect the main repository and can commit changes without disturbing others
- Work offline
- Rely on a network of trust

## Centralized Workflow



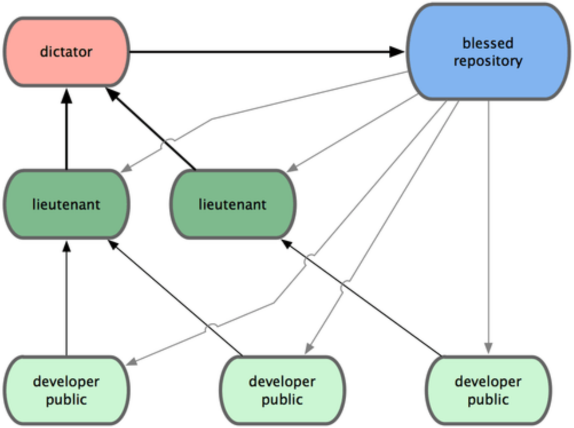
[1]

## Integration-Manager Workflow



[1]

## Dictator and Lieutenants Workflow



[1]

## Free and Open Source

- Downloads at `http://git-scm.com`
- Libgit2: free and open source library for writing custom Git applications

## GitHub

- Powerful web interface for publishing Git repositories
- Simple to view changes and track progress on repositories
- Wiki and bug tracking built into each repository

## Bitbucket

- Similar to GitHub
- Allows private repositories for students

## References

[1] Git Book. URL http://git-scm.com/book.

[2] Git From the Bottom Up. URL
http://ftp.newartisans.com/pub/git.from.bottom.up.pdf.

[3] Git Magic. URL
http://www-cs-students.stanford.edu/~blynn/gitmagic/.

[4] User Manual. URL
http://git-scm.com/docs/user-manual.html.

[5] Code School – Try Git. URL http://try.github.io.

[6] Tech Talk: Linus Torvalds on Git. URL
http://youtu.be/4XpnKHJAok8.

[7] Mark Lodato. A Visual Git Reference. URL
marklodato.github.io/visual-git-guide/.

[8] Bart Trojanowski. Bart's Blog–Intro to Git. URL
www.junkie.net/~bart/blog.