

# Utilities - tmux & git

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Computer Center, Department of Computer Science, NYCU

# Tmux

Terminal Multiplexer

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# What is tmux?

- Terminal Multiplexer
  - Allow open multiple tabs (multiple terminals)

The screenshot displays a tmux terminal window with two panes. The left pane shows the vim editor's help screen for version 7.4.629. The right pane shows system status information and the output of the 'ps' command.

```
VIM - Vi IMproved
      version 7.4.629
  by Bram Moolenaar et al.
 Modified by <bugzilla@redhat.com>
 Vim is open source and freely distributable

  Help poor children in Uganda!
type :help iccf<Enter>      for information

type :q<Enter>              to exit
type :help<Enter> or <F1>   for on-line help
type :help version7<Enter> for version info

NORMAL          unix 100% 1:1
```

```
1 [||||| 4.0%] Tasks: 181, 173 thr; 1 running
2 [||||| 2.6%] Load average: 0.07 0.12 0.13
3 [||||| 1.3%] Uptime: 104 days(!), 02:07:51
4 [||||| 1.3%]
Mem[||||| 2.91G/15.7G]
Swp[||||| 17.6M/4.0G]
```

PID	USER	PRI	NI	VIRT	RES	S	CPU%	MEM%	TIME+	Command
11016	root	20	0	164M	6296	S	3.3	0.0	0:00.05	sshd: ro
30617	fyli	20	0	119M	2252	R	1.3	0.0	0:01.84	htop
31012	fyli	20	0	225M	16652	S	0.7	0.1	0:00.29	vim
820	root	20	0	463M	5424	S	0.7	0.0	4h30:25	NetworkM
31863	hadua	20	0	98M	67316	S	0.7	0.4	5:55.73	(squid-1
756	root	20	0	226M	4064	S	0.7	0.0	2h48:50	vmtoolsd
623	cachien55	20	0	1137M	29476	S	0.7	0.2	2:01.36	python3
11557	yukc	20	0	21056	1464	S	0.7	0.0	8:20.84	tmux new
1111	root	20	0	1310M	44980	S	0.0	0.3	49h41:21	metricbe
1489	root	20	0	1310M	44980	S	0.0	0.3	3h43:18	metricbe
1153	root	20	0	1310M	44980	S	0.0	0.3	3h35:20	metricbe
1137	root	20	0	1310M	44980	S	0.0	0.3	3h38:40	metricbe
11218	root	20	0	1310M	44980	S	0.0	0.3	3h34:36	metricbe
7050	fyli	20	0	213M	15336	S	0.0	0.1	0:02.57	python3
10090	fyli	20	0	21168	1904	S	0.0	0.0	0:00.57	tmux -2

```
F1:help F2:Setup F3:Search F4:Filter F5:Tree F6:SortBy F7:Nice F8:Nice +F
```

```
# linux1 fyli ~ ls /
bin boot dev etc home lib lib64 media mnt net opt proc root run sbin sev sys tmp u usr var
# linux1 fyli ~
```

```
[0] @:bash 1:~ 2:vim" "linux1.cs.nctu.edu.tw" 00:59 09-Sep-20
```

# What is tmux?



SSH

Tmux Client

Tmux Server

# What is tmux?



# Why should I use tmux?

- Keep your working session alive
- By default, shell is **terminated** when connection is lost
  - Including any programs/editors opened
  - Any unsaved changes are **discarded without warning**
- tmux **will not be terminated** when connection is lost
  - Attach to previous sessions!

# Example screenshot of tmux

```
78 cat << EOF
79
80 lctsenz
81
82
83
84
85 EOF
86 echo ""[[1;0m"
87 echo ""[[1;91mATTENTION!!""[[1;0m"
88 echo "Remember to modify ""[[1;91m.gitconfig""[[1;0m to set your own name and email address."
89 echo "Or you can run ""[[1;91mgit config --global user.name \"Your Name\"""[[1;0m to set your name,"
90 echo "and ""[[1;91mgit config --global user.email you@example.com""[[1;0m to set your email address."
91
92 username="whoami"
93 if [ "$(username)" != "lctsenz" ]; then
94   echo "[Git configuration]"
95 fi
96
97 INSERT # master setup.sh sh utf-8(unix) 62% @ 78: 4 @ [79]tr
-- INSERT --
tmux(1)      FreeBSD General Comma 19:34 lctsenz@alumni(140.113.235.116) [~]
nds Manual   TMUX(1)             [TS] % ls -al | wc > outfile
NAME
  tmux - terminal multiplexer
SYNOPSIS
  tmux [-2CluvV] [-c shell-command] [-f file]
  [-L socket-name]
  [-S socket-path] [command [flags]]
DESCRIPTION
  tmux is a terminal multiplexer: it enables a number of terminals to be
  created, accessed, and controlled from a single screen. tmux may be
  detached from a screen and continue running in the background, then later
  reattached.
:
alumni 0-zsh 1-zsh 2-ssh 3-ssh 4-ssh 5-

1 | 2.0% | Tasks: 390, 0 thr; 4 runn
2 | 0.5% | Load average: 0.19 0.21 0
3 | 0.0% | Uptime: 190 days(1), 02:5
4 | 0.6% |
5 | 0.5% |
6 | 0.0% |
7 | 0.5% |
8 | 0.5% |
9 | 0.4% |
10 | 0.0% |
11 | 0.5% |
12 | 0.5% |
13 | 0.0% |
14 | 2.6% |
15 | 1.6% |
16 | 0.5% |
Mem [ 4.68G/16.0G ]
Swp [ 1.88G/2.0G ]
CPU:
  lctsenz 52 0 8844 5856 S 0.0 0.0 0:00.
  lctsenz 52 0 4944 2924 S 0.0 0.0 0:00.
  lctsenz 22 0 8972 5984 S 0.0 0.0 0:00.
  lctsenz 52 0 8972 5988 S 0.0 0.0 0:00.
  lctsenz 52 0 7148 2984 S 0.0 0.0 0:00.
  hlku 20 0 208M 53148 S 0.0 0.3 5h39:
  root -16 0 0 5632 S 0.0 0.0 56h03:
  lctsenz 20 0 21124 9600 S 0.0 0.1 0:18.
  hlku 20 0 108M 44804 S 0.0 0.3 51:20.
F1 | F2 | F3 | F4 | F5 | F6 |
19:34:53
7:34PM up 190days, 2:56, [0.19, 0.21, 0.19]
```

<https://nasa.cs.nctu.edu.tw/sa/sample/.tmux.conf>

# Advantages of tmux

- Multiple sessions, windows, panes
- Keep the sessions, attach/detach anytime
- Powerful window division (panes)
- Share screen by attaching to the same session



# Start tmux

- `tmux`
- `tmux attach [ -t <number> ]`
- `tmux detach`
- `tmux ls`
- `tmux kill-session [ <number> ]`

# tmux 101

Basic operations and configurations

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# Session

- Create new session (open a new browser)
  - Execute outside of any tmux sessions

```
$ tmux
```
- Detach current session
  - When attached in a session

```
$ tmux detach
```

  - Or close the terminal directly
- Attach to previous session

```
$ tmux attach
```

  - Attach only if previous sessions exist

# Multiple sessions (1)

- Open multiple browsers

```
(0) + 0: 4 windows  
(1) + 5: 1 windows  
(2) + 6: 1 windows (attached)  
  
[6] 0: [tmux]* "linux4.cs.nctu.edu.tw" 10:12 09-Sep-20
```

# Multiple sessions (2)

- Open multiple browsers
- List opened sessions (or simply `tmux ls`)

```
$ tmux list-sessions
```

```
0: 1 windows (created Sun Jun 16 18:49:57 2019) [128x38]  
1: 3 windows (created Sun Jun 16 18:50:03 2019) [128x38]
```

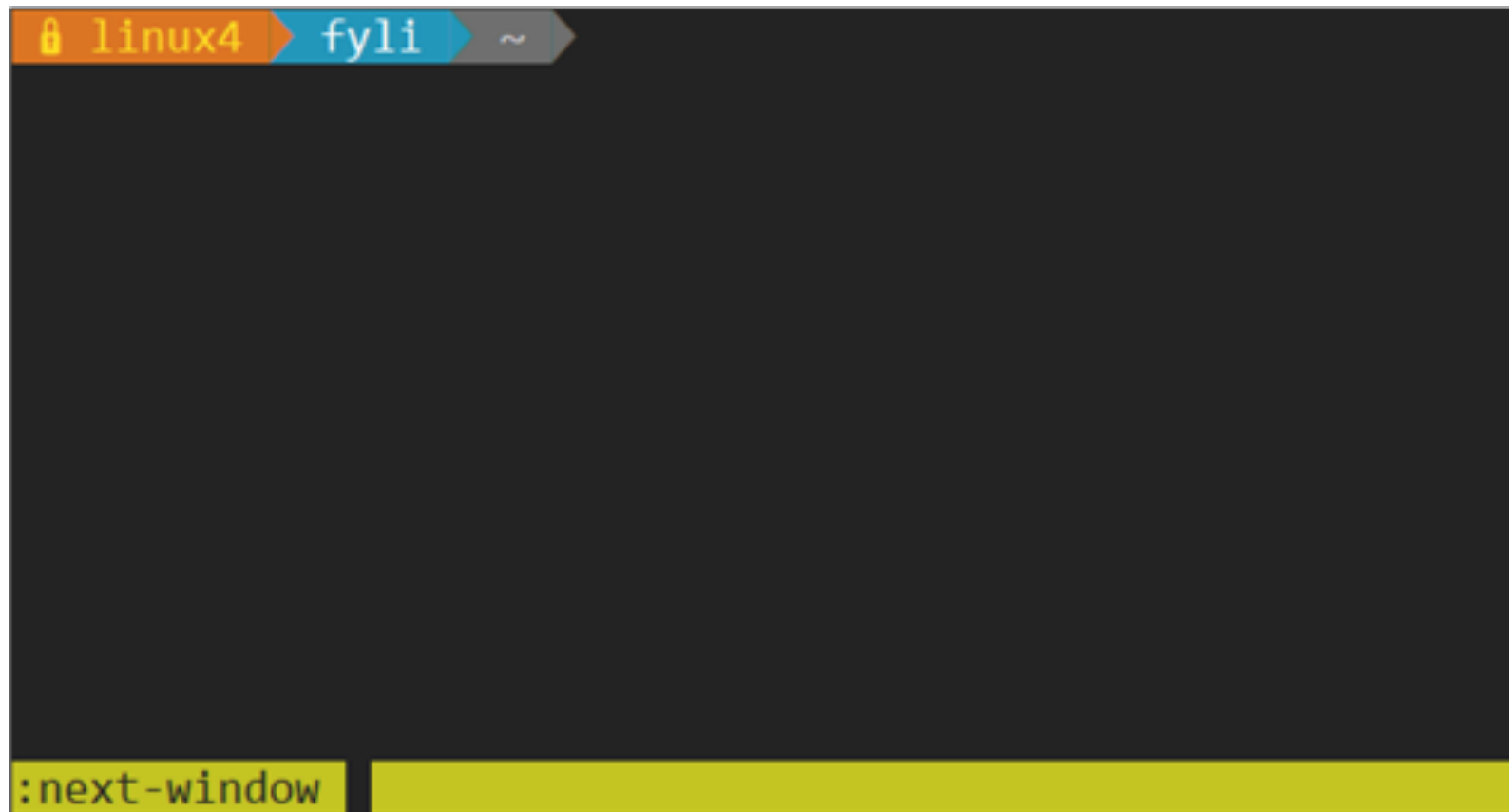
- Attach to previous session by id  
`$ tmux attach -t session-id`

# tmux - bindkey

- Operations start with a special key combination
- Default is C-b
  - Where C is Ctrl (control)

# tmux - command

- Bindkey + :
- Open command prompt and execute tmux commands



The image shows a terminal window with a dark background. At the top, there are three colored tabs: an orange tab with a lock icon and the text 'linux4', a blue tab with the text 'fyli', and a grey tab with a tilde '~'. The main area of the terminal is empty. At the bottom, there is a yellow bar containing the text ':next-window' in a monospaced font.

# Bindkey - Window

bindkey (default is C-b) //C == control	C	new-window
	N	next-window
	P	previous-window
	L	last-window
	<NUM>	select-window -t := <NUM>
	&	confirm-before -p "kill-window #W? (y/n)" kill-window
	,	command-prompt -I "#W" "rename-window '%0%'"
	.	command-prompt "move-window -t '%0%'"



# Bindkey - Pane

bindkey (default is C-b) //C == control	%	split-window -h
	“	split-window
	arrow-key	select-pane
	alt + arrow-kwy	resize-pane
	x	confirm-before -p "kill-pane #P? (y/n)" kill-pane
	{	swap-pane -U
	}	swap-pane -D

# tmux - bindkey

- bindkey + ?

```
bind-key C-b send-prefix [57/57]
bind-key C-o rotate-window
bind-key C-z suspend-client
bind-key Space next-layout
bind-key ! break-pane
bind-key " split-window
bind-key # list-buffers
bind-key $ command-prompt -I #S "rename-session '"
bind-key % split-window -h
bind-key & confirm-before -p "kill-window #W? (y/w
bind-key ' command-prompt -p index "select-window"
bind-key ( switch-client -p
bind-key ) switch-client -n
bind-key , command-prompt -I #W "rename-window '%"
bind-key - delete-buffer
bind-key . command-prompt "move-window -t '%"
[6] 0:[tmux]* "linux4.cs.nctu.edu.tw" 10:34 09-Sep-20
```

# Configuration - tmux.conf

- ~/.tmux.conf
- design yourself style
- colorful

# Configuration - tmux.conf

- ~/.tmux.conf

```
1 set -g status-utf8 on
2 setw -g utf8 on
3 # GENERAL SETTING
4 bind-key r source-file ~/.tmux.conf; display-message "~/.tmux.conf is reloaded"
5 set-window-option -g automatic-rename off
6 set-option -g default-terminal "xterm"
7 set-option -g prefix C-a
8
9 # STATUSBAR STYLE
10 # main
11 set-option -g status-bg colour236
12 set-option -g status-fg colour166
13 setw -g window-status-current-format "#I:#W#F"
14 setw -g window-status-current-fg colour215
15
16 #left
17 set-option -g status-left ""
18 set-option -g status-left-length 0
19
20 #right
21 set-option -g status-right "#h [%Y-%m-%d %H:%M]"
22 # BIND KEY
23 bind -n F8 previous-window
24 bind -n F9 next-window
25 bind -n F10 last-window
26 bind -n M-Right next-window
27 bind -n M-Left previous-window
~
~
~
"~/.tmux.conf" 27L, 698C
0:tbsd21 1:csduty* 2:cshome 3:csschedule- 4:bsd3 5:jail 6:nasa 7:jsh
```

# Configuration - bindkey

- ~/.tmux.conf
  - bind-key ( alias: bind )
  - C ( alias: <Ctrl> )
  - M ( alias: <Alt> )
- bind-key <key> <command>
  - -T key-table ( default table is prefix )
  - -n : alias for -T root => **Don't need to press C-b first**
  - -r : repeat

```
22 # BIND KEY
23 bind -n F8 previous-window
24 bind -n F9 next-window
25 bind -n F10 last-window
26 bind -n M-Right next-window
27 bind -n M-Left previous-window
```

# Configuration - set

- ~/.tmux.conf
  - set-window-option ( alias: setw )

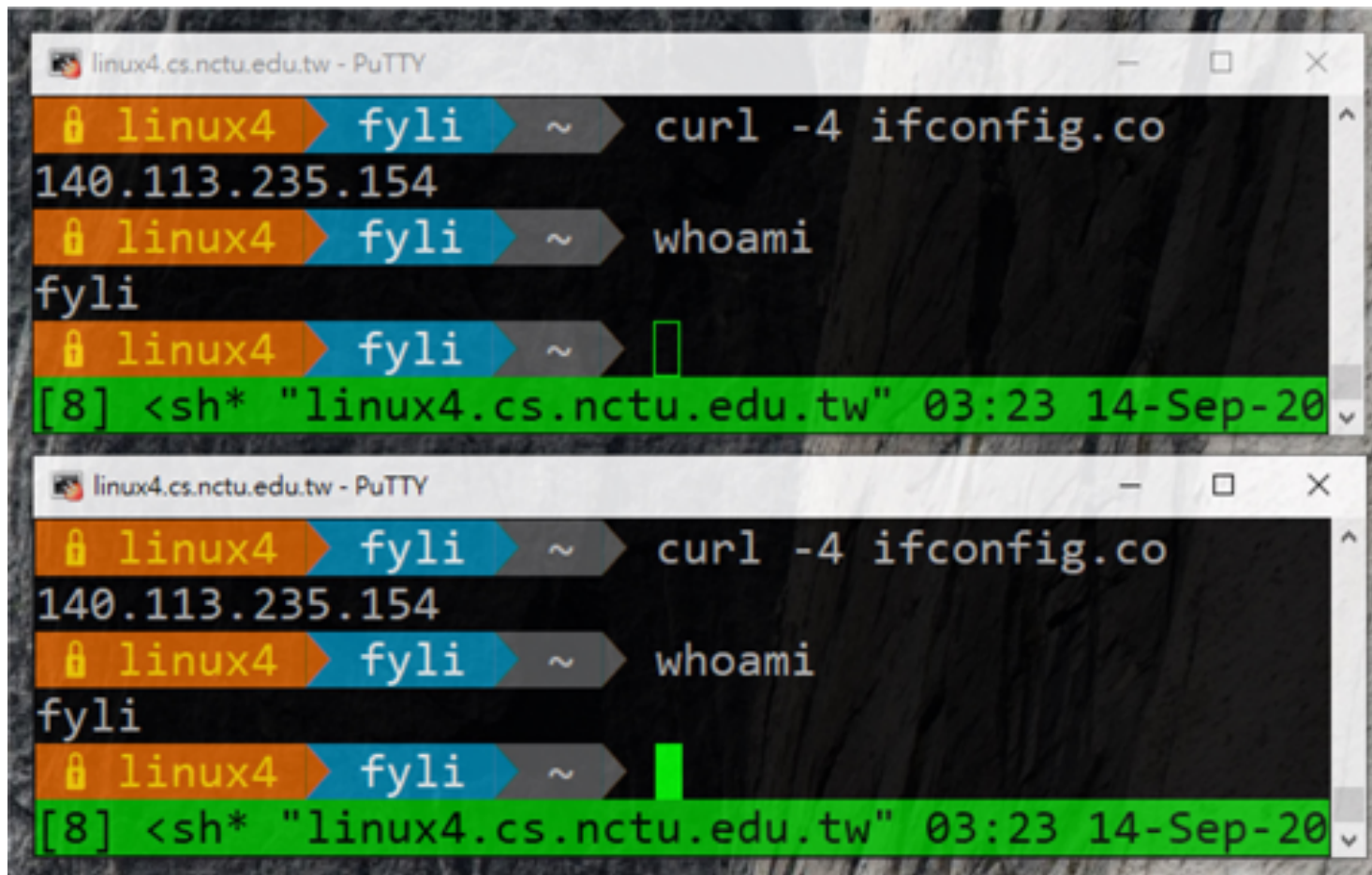
```
1 set -g status-utf8 on
2 setw -g utf8 on
3 # GENERAL SETTING
4 bind-key r source-file ~/.tmux.conf; display-message "~/.tmux.conf is reloaded"
5 set-window-option -g automatic-rename off
6 set-option -g default-terminal "xterm"
7 set-option -g prefix C-a
8
9 # STATUSBAR STYLE
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11 set-option -g status-bg colour236
12 set-option -g status-fg colour166
13 setw -g window-status-current-format "#I:#W#F"
14 setw -g window-status-current-fg colour215
15
16 #left
17 set-option -g status-left ''
18 set-option -g status-left-length 0
19
20 #right
21 set-option -g status-right "#h [%Y-%m-%d %H:%M]"
```

# Configuration - set

colour8	colour1	colour2	colour3	colour4	colour5	colour6	colour7
colour9	colour10	colour11	colour12	colour13	colour14	colour15	colour16
colour17	colour18	colour19	colour20	colour21	colour22	colour23	colour24
colour25	colour26	colour27	colour28	colour29	colour30	colour31	colour32
colour33	colour34	colour35	colour36	colour37	colour38	colour39	colour40
colour41	colour42	colour43	colour44	colour45	colour46	colour47	colour48
colour49	colour50	colour51	colour52	colour53	colour54	colour55	colour56
colour57	colour58	colour59	colour60	colour61	colour62	colour63	colour64
colour65	colour66	colour67	colour68	colour69	colour70	colour71	colour72
colour73	colour74	colour75	colour76	colour77	colour78	colour79	colour80
colour81	colour82	colour83	colour84	colour85	colour86	colour87	colour88
colour89	colour90	colour91	colour92	colour93	colour94	colour95	colour96
colour97	colour98	colour99	colour100	colour101	colour102	colour103	colour104
colour105	colour106	colour107	colour108	colour109	colour110	colour111	colour112
colour113	colour114	colour115	colour116	colour117	colour118	colour119	colour120
colour121	colour122	colour123	colour124	colour125	colour126	colour127	colour128
colour129	colour130	colour131	colour132	colour133	colour134	colour135	colour136
colour137	colour138	colour139	colour140	colour141	colour142	colour143	colour144
colour145	colour146	colour147	colour148	colour149	colour150	colour151	colour152
colour153	colour154	colour155	colour156	colour157	colour158	colour159	colour160
colour161	colour162	colour163	colour164	colour165	colour166	colour167	colour168
colour169	colour170	colour171	colour172	colour173	colour174	colour175	colour176
colour177	colour178	colour179	colour180	colour181	colour182	colour183	colour184
colour185	colour186	colour187	colour188	colour189	colour190	colour191	colour192
colour193	colour194	colour195	colour196	colour197	colour198	colour199	colour200
colour201	colour202	colour203	colour204	colour205	colour206	colour207	colour208
colour209	colour210	colour211	colour212	colour213	colour214	colour215	colour216
colour217	colour218	colour219	colour220	colour221	colour222	colour223	colour224
colour225	colour226	colour227	colour228	colour229	colour230	colour231	colour232
colour233	colour234	colour235	colour236	colour237	colour238	colour239	colour240
colour241	colour242	colour243	colour244	colour245	colour246	colour247	colour248
colour249	colour250	colour251	colour252	colour253	colour254	colour255	colour256

# tmux - share session

- Both side can edit and execute commands



The image displays two screenshots of a terminal window titled "linux4.cs.nctu.edu.tw - PuTTY". The terminal shows a user named "fyli" at the "linux4" prompt. The first screenshot shows the user entering the command "curl -4 ifconfig.co", which outputs the IP address "140.113.235.154". The user then enters "whoami", which outputs "fyli". The second screenshot shows the user entering a command, which is partially obscured by a green highlight. The terminal output shows "[8] <sh\* "linux4.cs.nctu.edu.tw" 03:23 14-Sep-20".



# Reference

- [tmux \(1\)](#)
- tmux shortcuts & cheatsheet
  - <https://gist.github.com/MohamedAlaa/2961058>
- tmux brief introduction (chinese)
  - <https://5xruby.tw/posts/tmux/>

# Appendix: tmux vs. screen

	tmux	screen
Window Split	top-down & left-right	top-down only (default)
	different sessions can have different schemes	scheme must be shared by all sessions
Session	switch between sessions without detach	detach first then re-attach another session
	multiple clients can attach to same session	one session for one client only (force detach)
Profile	.tmux	.screenrc
	highly customizable	<b>less than tmux</b>

# Git

One of the most popular Version Control Systems

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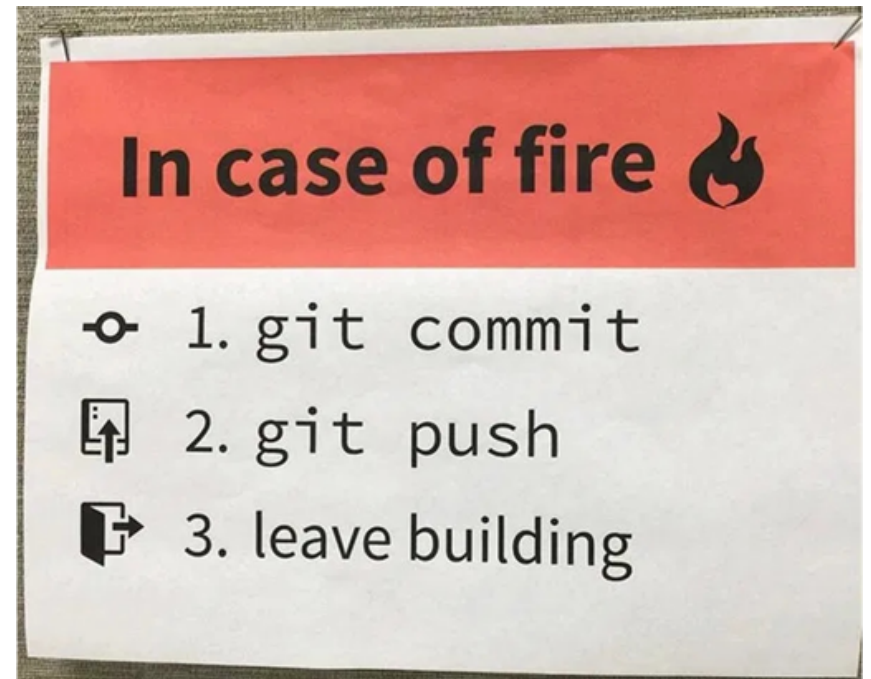
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# Version Control Systems (VCS)

- Also known as Source Code Management (SCM)
- Records changes to a set of files over time so that you can recall specific versions later.
- Easy for developing, finding bug, blame someone else, ...
- Popular tools
  - Git, Subversion (svn), Mercurial (hg)

# Version Control Systems (VCS)

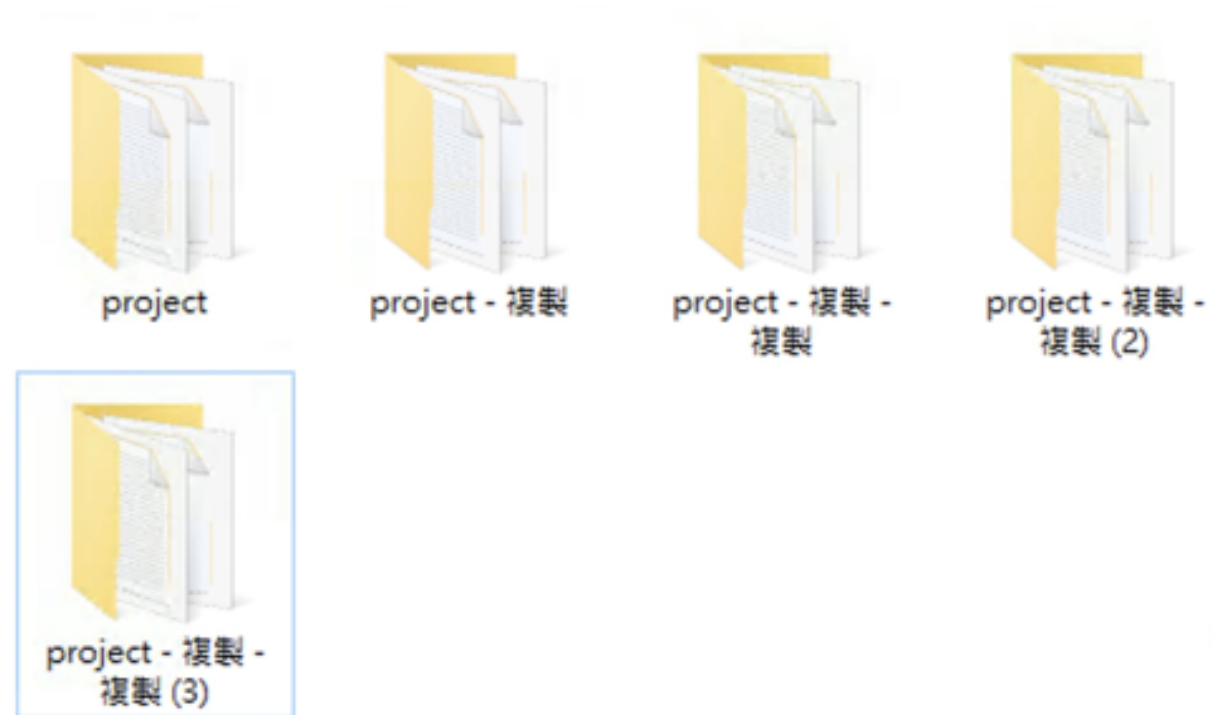
- Web hosting
  - Backup projects
  - Collaborating
  - Commercial providers
    - Github, Gitlab, Bitbucket
  - Self-hosted
    - [git.cs.nctu.edu.tw](http://git.cs.nctu.edu.tw)



# Without VCS

- Copy-paste manually

```
# 2015-11-10  
cp -r project project.bak  
# 2015-11-11  
cp -r project project.bak1  
# 2015-11-12  
cp -r project project.bak2  
# 2015-11-15  
cp -r project project.bak3
```

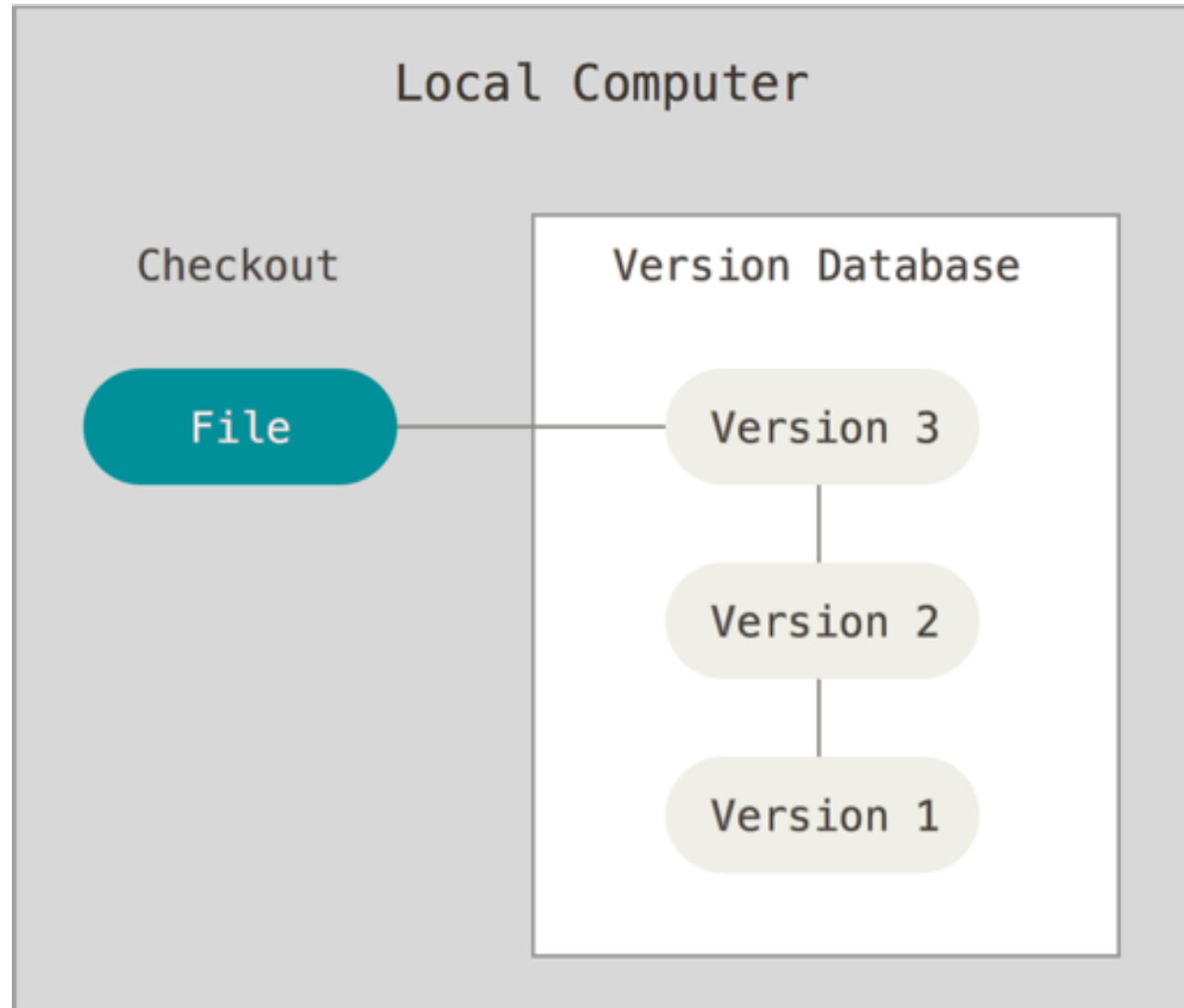


# How VCS works

- In addition to your files, VCS stores extra information under your project folder
  - Hidden folders
    - .git for Git
    - .hg for Mercurial
  - Previous versions of files (compressed)
  - Remote repository information

# Types of VCS (1)

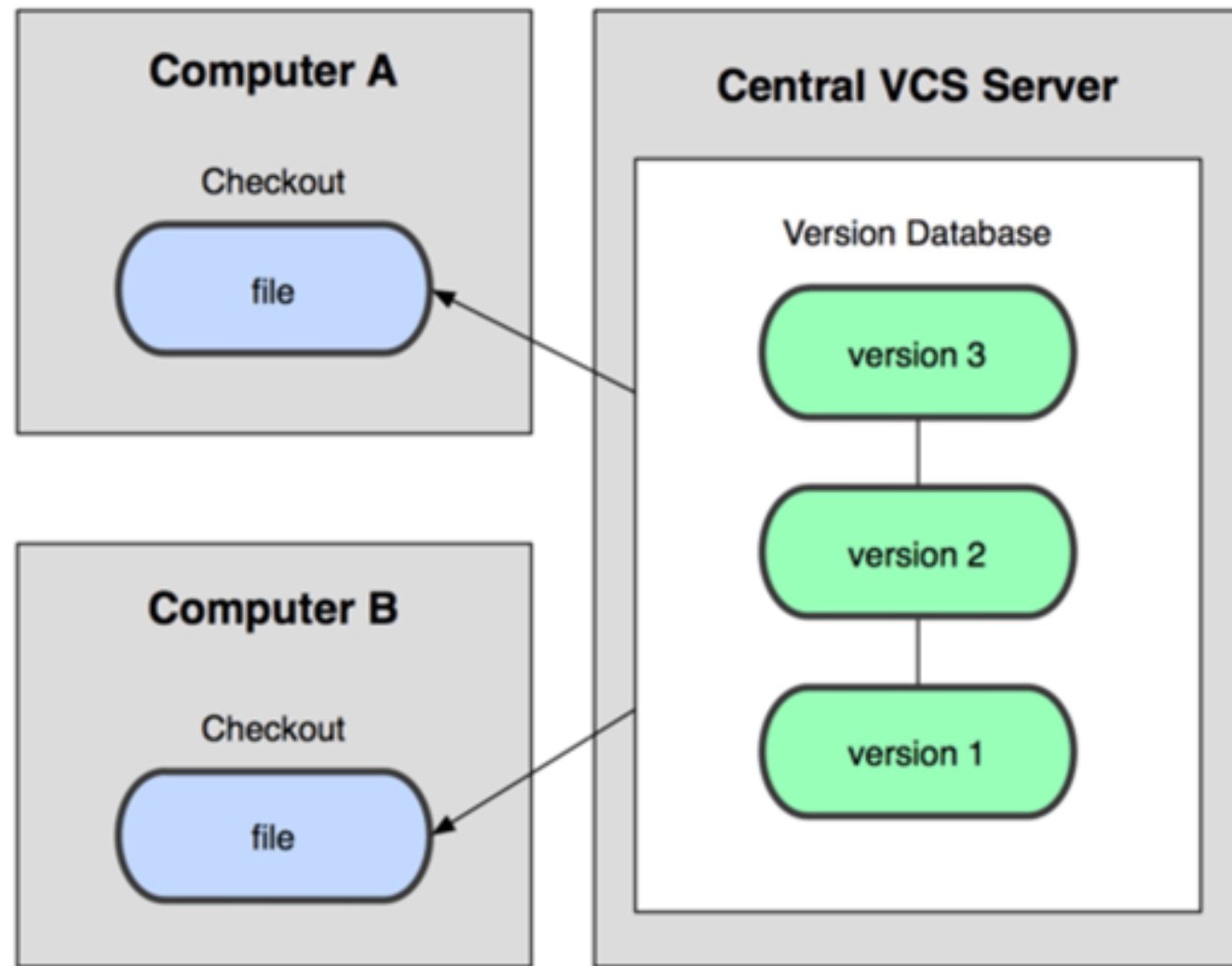
- Local VCS
  - All versions are in local
  - Cannot share with others
  - No remote backup
- Example
  - Manually copy-paste
  - Git/Hg without setting remote upstream





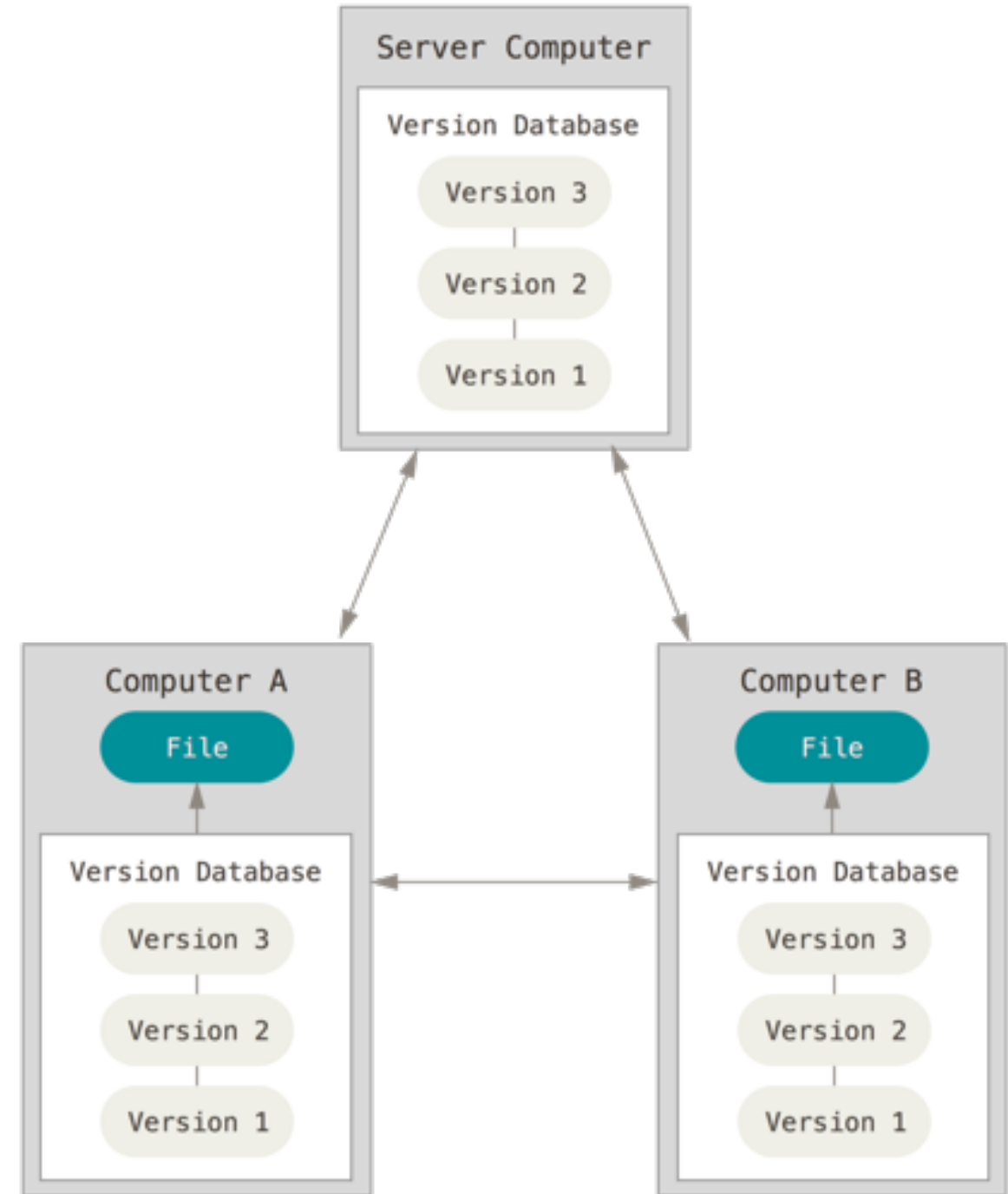
# Types of VCS (2)

- Centralized VCS
  - User can checkout one specific version
  - Remote server has all versions
  - Lost access to other versions if network is down
  - Lost all versions if server is down
- Example
  - Subversion



# Types of VCS (3)

- Distributed VCS
  - Every node has complete copy of versions
  - Offline working
  - Synchronization
    - Usually using a server as the source of truth
- Example
  - Git, Mercurial



# Git

- Distributed VCS
- History
  - Linus Torvalds (the creator of Linux)
  - Source Control Management for Linux Kernel
    - ~2005
      - Using BitKeeper (commercial software)
    - 2005~
      - Developed Git

# Git

- Snapshots, not differences
  - All versions of all files are stored independently
  - Easy for checking out to any version
- Nearly every operation is local
- Git has integrity
  - SHA checking
- Git generally only adds data
  - Delete
    - Store the file in `.git` folder and hide from your workspace
  - Modify
    - Backup the original file to `.git` folder

# Git

- Git is very powerful, with many features
- In this class, we only talk about the very simple one
- We will cover
  - How to install and create repos
  - How to add files/make changes
  - How to create commits
  - How to navigate between versions
  - How to push to remote
- Will NOT cover
  - branching (git branch, git merge, ...)
  - Anything else

Homework 2

# Git - installation

- FreeBSD
  - pkg install git
- Other OS
  - <https://git-scm.com/book/en/v2/Getting-Started-Installing-Git>

```
> git
usage: git [--version] [--help] [-C <path>] [-c name=value]
          [--exec-path[=<path>]] [--html-path] [--man-path] [--info-path]
          [-p | --paginate | --no-pager] [--no-replace-objects] [--bare]
          [--git-dir=<path>] [--work-tree=<path>] [--namespace=<name>]
          <command> [<args>]

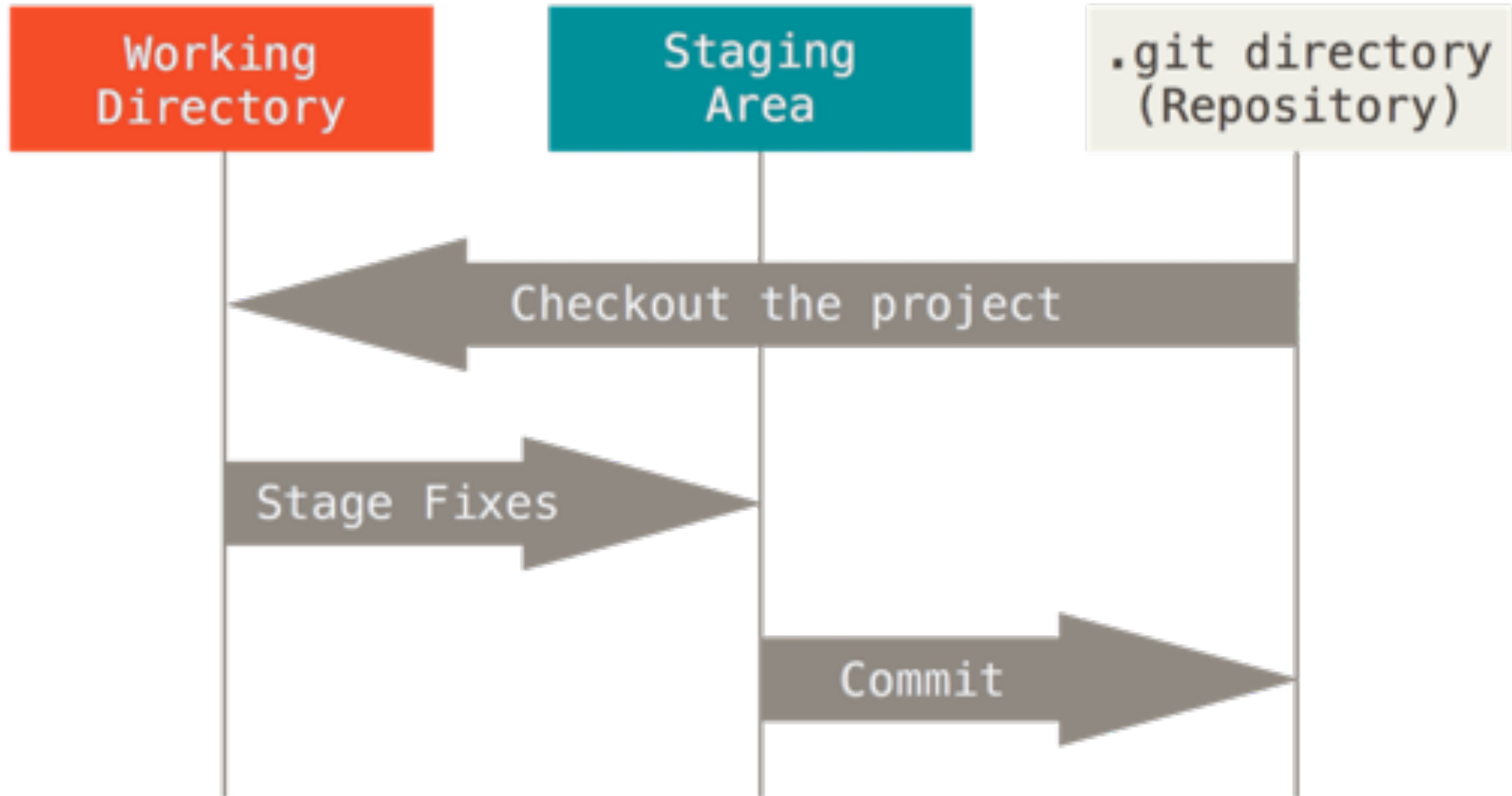
These are common Git commands used in various situations:

start a working area (see also: git help tutorial)
  clone      Clone a repository into a new directory
  init       Create an empty Git repository or reinitialize an existing one
```

# Git - getting started

- Developer information
  - In terminal
    - `$ git config --global user.email "you@example.com"`
    - `$ git config --global user.name "Name"`
  - Or edit manually in `~/.gitconfig`
- Create a new repository
  - `$ mkdir hw2`
  - `$ cd hw2`
  - `$ git init`
    - Initialize an empty project with `.git` directory

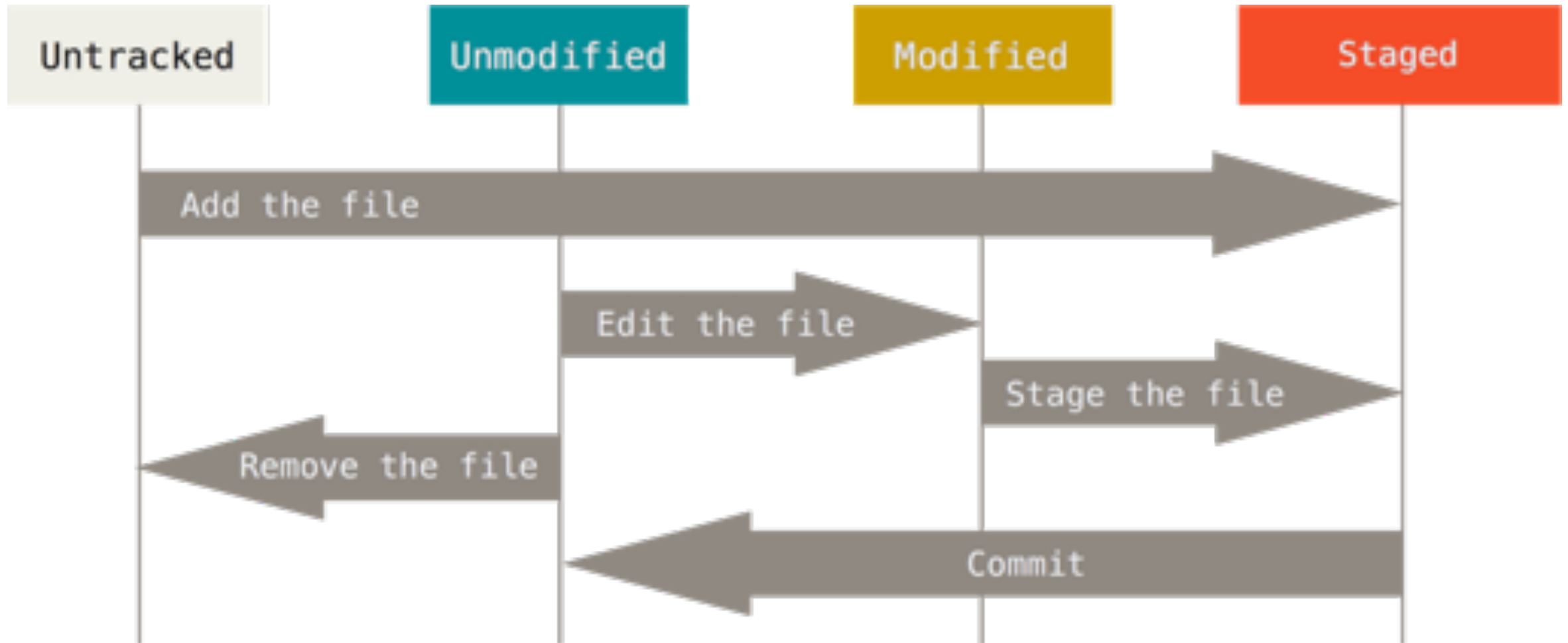
# Git - the three stages





# Git - file lifecycle

- The lifecycle of the status of your files



# Git - basic operations (1)

- git add
  - Add file contents to the index (staged)
  - `$ git add file1 file2...`
  - `$ git add directory`
  - `$ git add .`

# Git - basic operations (2)

- git commit
  - Confirm your staged change and create a commit (revision)
  - Will open default text editor for commit message
  - Useful options
    - -a: stage all modified and deleted path (git add)
    - -m MSG: use MSG as commit message without opening editors

# Git - basic operations (3)

- git status
  - View the working directory status of current project

```
$ git status -s
M README.md          # updated in index
D run.sh             # deleted from index
R src/main.js        # renamed in index
A src/index.html     # added to index
?? src/README.md     # untracked
```

# Git - basic operations (4)

- git diff
  - Compare change with the previous version
    - <https://git-scm.com/docs/git-diff>

```
$ git diff
diff --git a/README.md b/README.md
index 76f177f..f4986c2 100644
--- a/README.md
+++ b/README.md
@@ -1, +1 @@
-# Hi
+# Hello
```

# Git - basic operations (5)

- git log
  - View the commit log (history)
  - Change the log format
    - <http://gits-scm.com/docs/pretty-formats>

```
$ git log

commit 2f2bd00051fbd4d4978b7e96508b97950d6e60b1
Author: lctseng@cs.nctu.edu.tw
Date: Thu Oct 8 17:10:13 2020 +0800

    Initial commit
```

# Git - basic operations (6)

- git checkout
  - Go to other revisions or branches
  - `$ git checkout <commit-id>`
  - Go back to latest change:
    - `$ git checkout master`

```
$ git status
On branch master

$ git checkout 2f2bd00
Note: checking out '2f2bd00'.

$ git status
HEAD detached at 2f2bd00
```

# Git - basic operations (7)

- git bisect
  - Finding problematic commit
  - Flow (similar to binary search)
    - `$ git bisect start`
    - Define endpoints
      - `$ git bisect good <good-commit-id>`
      - `$ git bisect bad <bad-commit-id>`
    - After that, git will checkout to some commit
    - If that commit is good
      - `$ git bisect good`
    - If that commit is bad
      - `$ git bisect bad`
    - After several rounds, git will checkout to first bad commit



# Git - push to remote

- git remote
  - Manage the remote repository
  - \$ git remote add origin  
<https://git.cs.nctu.edu.tw/lctseng/sa-demo.git>
    - Set the remote server & repo for push/pull
- git push
  - \$ git push -u origin master
    - Push to the remote and create the remote master branch
    - Later on, you can simply use "git push"

# Git - pull from remote

- git clone
  - Download the full repository from remote server
  - `$ git clone https://github.com/curl/curl.git`
- git pull
  - Pull the latest revisions from remote in an existing repository