Utilities - tmux & git

lctseng (2019-2023, CC BY-SA)
wnlee and others (1996-2018)

國立陽明交通大學資工系資訊中心
Information Technology Center, Department of Computer Science, NYCU

Tmux

Terminal Multiplexer

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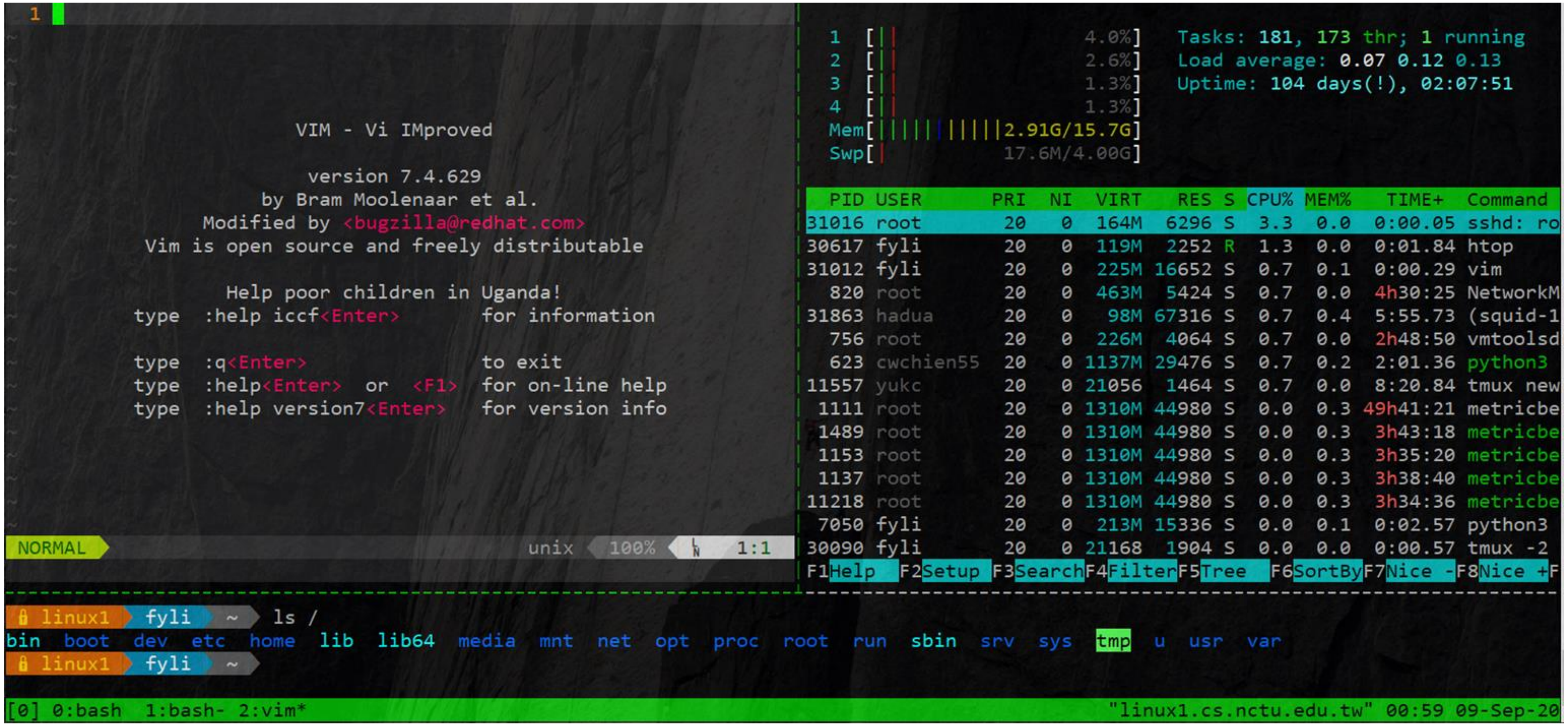
What is tmux?

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



```
  1
~
~
~
~                        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
```

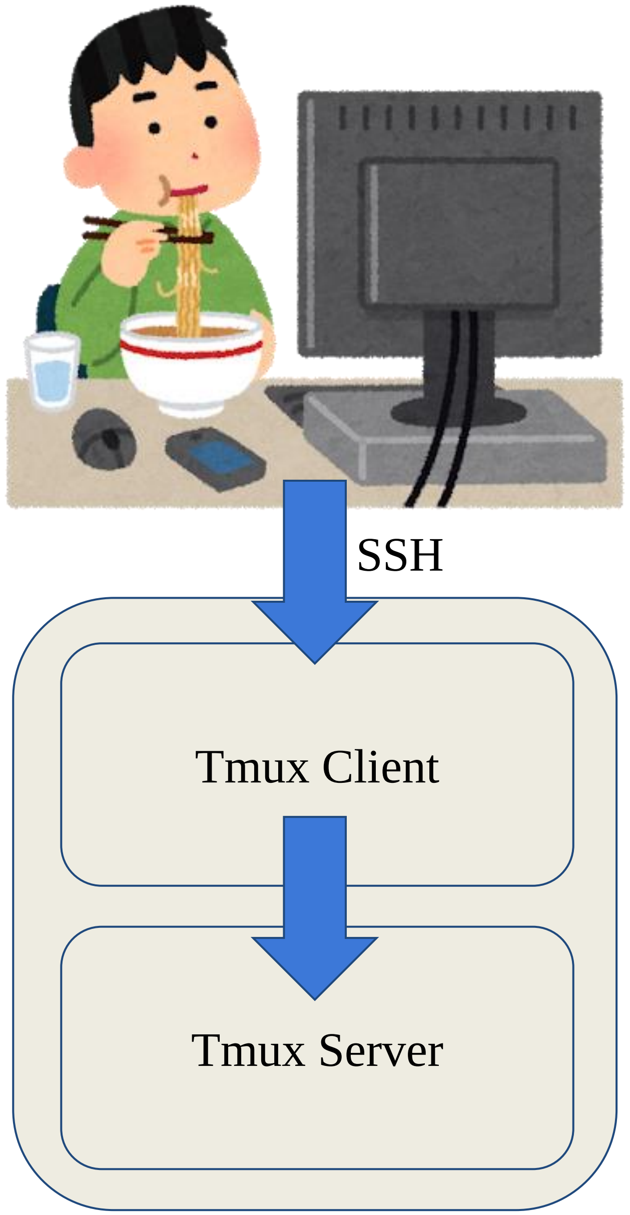
```
  1  [||                    4.0%]   Tasks: 181, 173 thr; 1 running
  2  [||                    2.6%]   Load average: 0.07 0.12 0.13
  3  [||                    1.3%]   Uptime: 104 days(!), 02:07:51
  4  [||                    1.3%]
  Mem[||||||||||||2.91G/15.7G]
  Swp[|             17.6M/4.00G]

  PID USER      PRI  NI  VIRT   RES S CPU% MEM%   TIME+  Command
31016 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 cwchien55  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
30090 fyli       20   0 21168  1904 S  0.0  0.0  0:00.57 tmux -2
F1Help  F2Setup F3SearchF4FilterF5Tree  F6SortByF7Nice -F8Nice +F
```

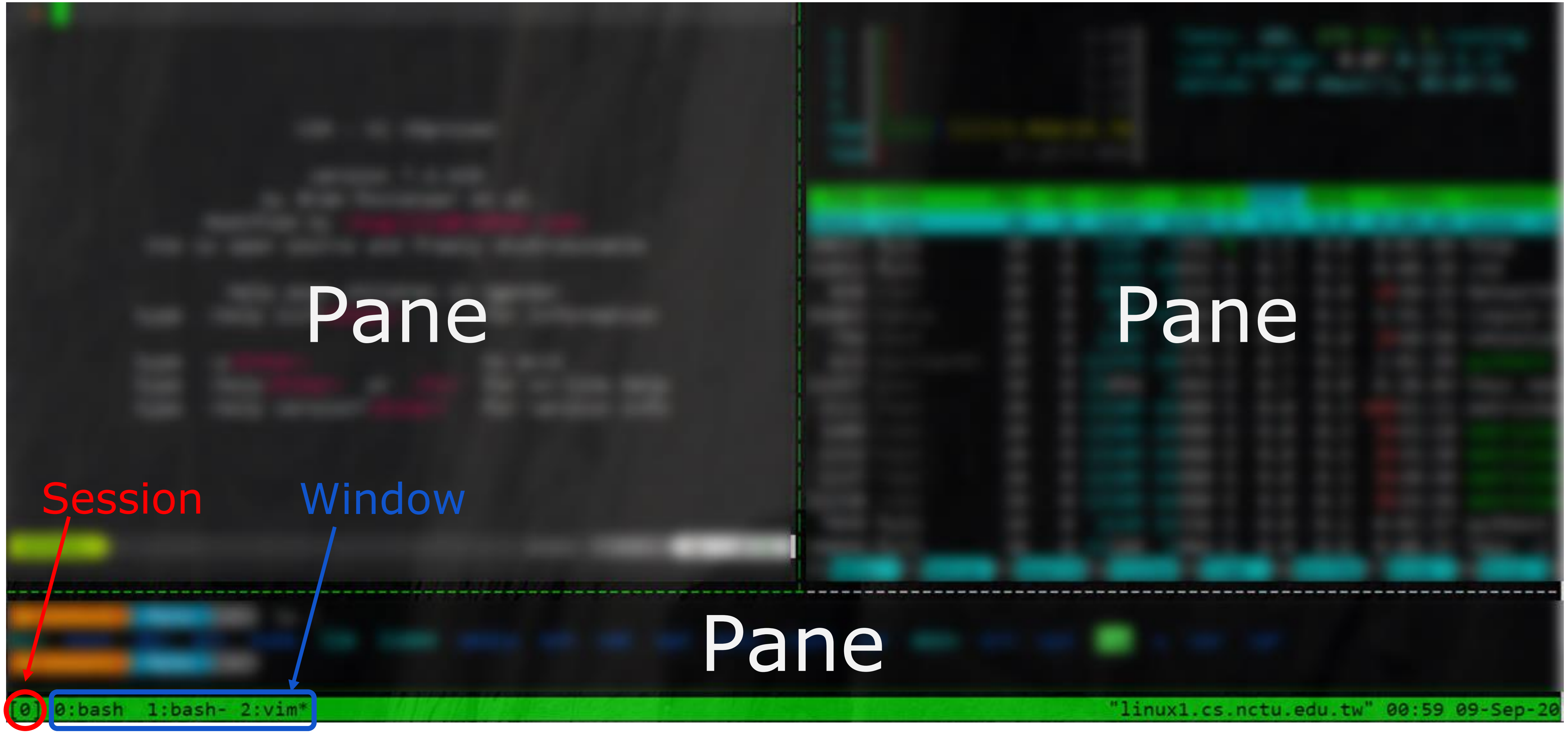
```
 linux1  fyli  ~  ls /
bin  boot  dev  etc  home  lib  lib64  media  mnt  net  opt  proc  root  run  sbin  srv  sys  tmp  u  usr  var
 linux1  fyli  ~

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

What is tmux?



What is tmux?

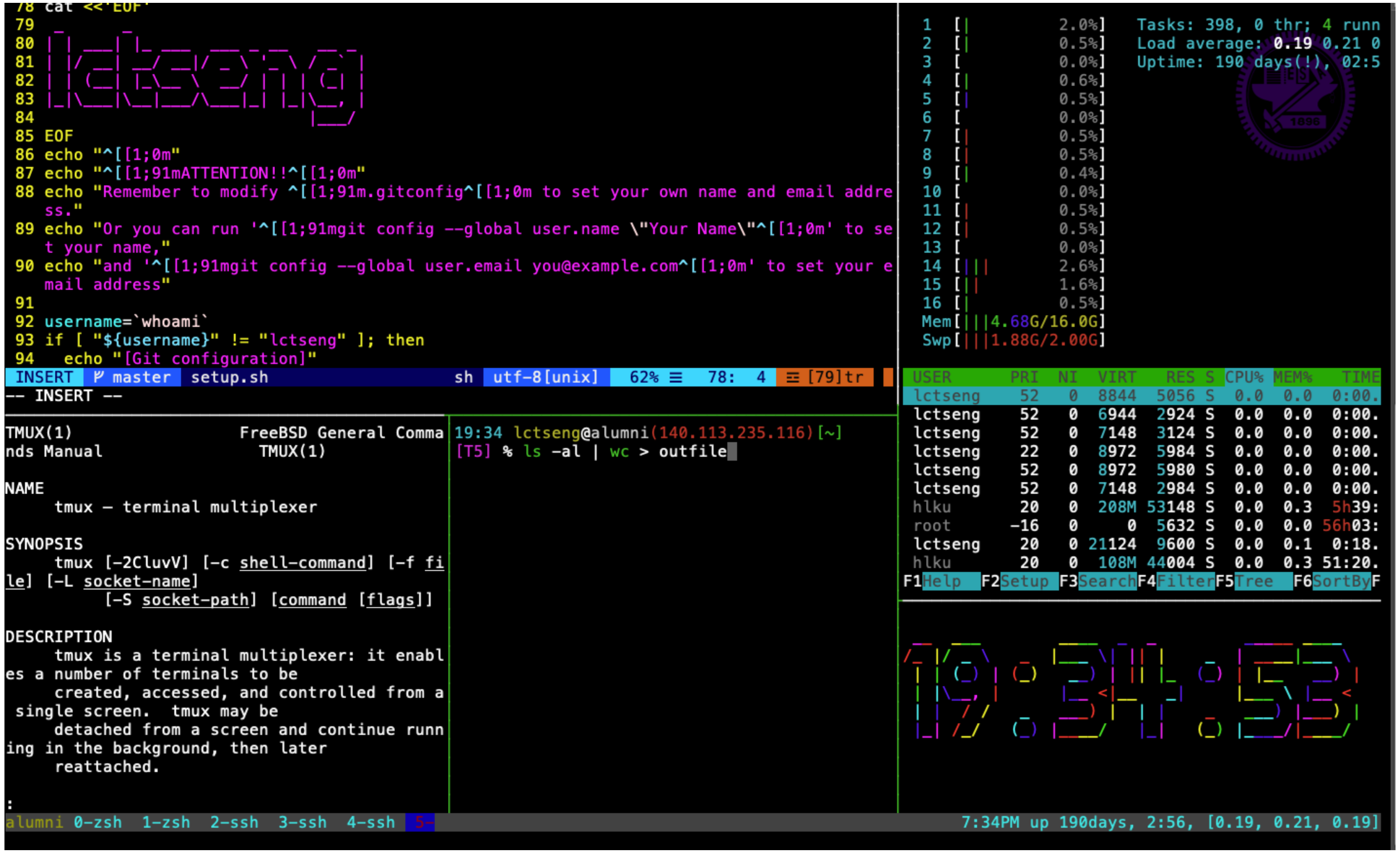


```
[0] 0:bash  1:bash- 2:vim*                                    "linux1.cs.nctu.edu.tw" 00:59 09-Sep-20
```

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



```
cat <<'EOF'
 _      _
| | ___| |_ ___  ___ _ __   __ _
| |/ __| __/ __|/ _ \ '_ \ / _` |
| | (__| |_\__ \  __/ | | | (_| |
|_|\___|\__|___/\___|_| |_|\__, |
                           |___/
EOF
echo "^[[1;0m"
echo "^[[1;91mATTENTION!!^[[1;0m"
echo "Remember to modify ^[[1;91m.gitconfig^[[1;0m to set your own name and email addre
ss."
echo "Or you can run '^[[1;91mgit config --global user.name \"Your Name\"^[[1;0m' to se
t your name,"
echo "and '^[[1;91mgit config --global user.email you@example.com^[[1;0m' to set your e
mail address"

username=`whoami`
if [ "${username}" != "lctseng" ]; then
  echo "[Git configuration]"
 INSERT  ᚹ master  setup.sh                          sh  utf-8[unix]   62% ≡   78:  4  ☲ [79]tr
-- INSERT --
```

```
  1  [|             2.0%]   Tasks: 398, 0 thr; 4 runn
  2  [|             0.5%]   Load average: 0.19 0.21 0
  3  [              0.0%]   Uptime: 190 days(!), 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/2.00G]

 USER       PRI  NI  VIRT   RES S CPU% MEM%   TIME
 lctseng     52   0  8844  5056 S  0.0  0.0  0:00.
 lctseng     52   0  6944  2924 S  0.0  0.0  0:00.
 lctseng     52   0  7148  3124 S  0.0  0.0  0:00.
 lctseng     22   0  8972  5984 S  0.0  0.0  0:00.
 lctseng     52   0  8972  5980 S  0.0  0.0  0:00.
 lctseng     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:
 lctseng     20   0 21124  9600 S  0.0  0.1  0:18.
 hlku        20   0  108M 44004 S  0.0  0.3 51:20.
F1Help  F2Setup F3SearchF4FilterF5Tree  F6SortByF
```

```
TMUX(1)                 FreeBSD General Comma
nds Manual                TMUX(1)

NAME
     tmux – terminal multiplexer

SYNOPSIS
     tmux [-2CluvV] [-c shell-command] [-f fi
le] [-L socket-name]
          [-S socket-path] [command [flags]]

DESCRIPTION
     tmux is a terminal multiplexer: it enabl
es a number of terminals to be
     created, accessed, and controlled from a
 single screen.  tmux may be
     detached from a screen and continue runn
ing in the background, then later
     reattached.

:
```

```
19:34 lctseng@alumni(140.113.235.116)[~]
[T5] % ls -al | wc > outfile
```

```
alumni 0-zsh  1-zsh  2-ssh  3-ssh  4-ssh  5-                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

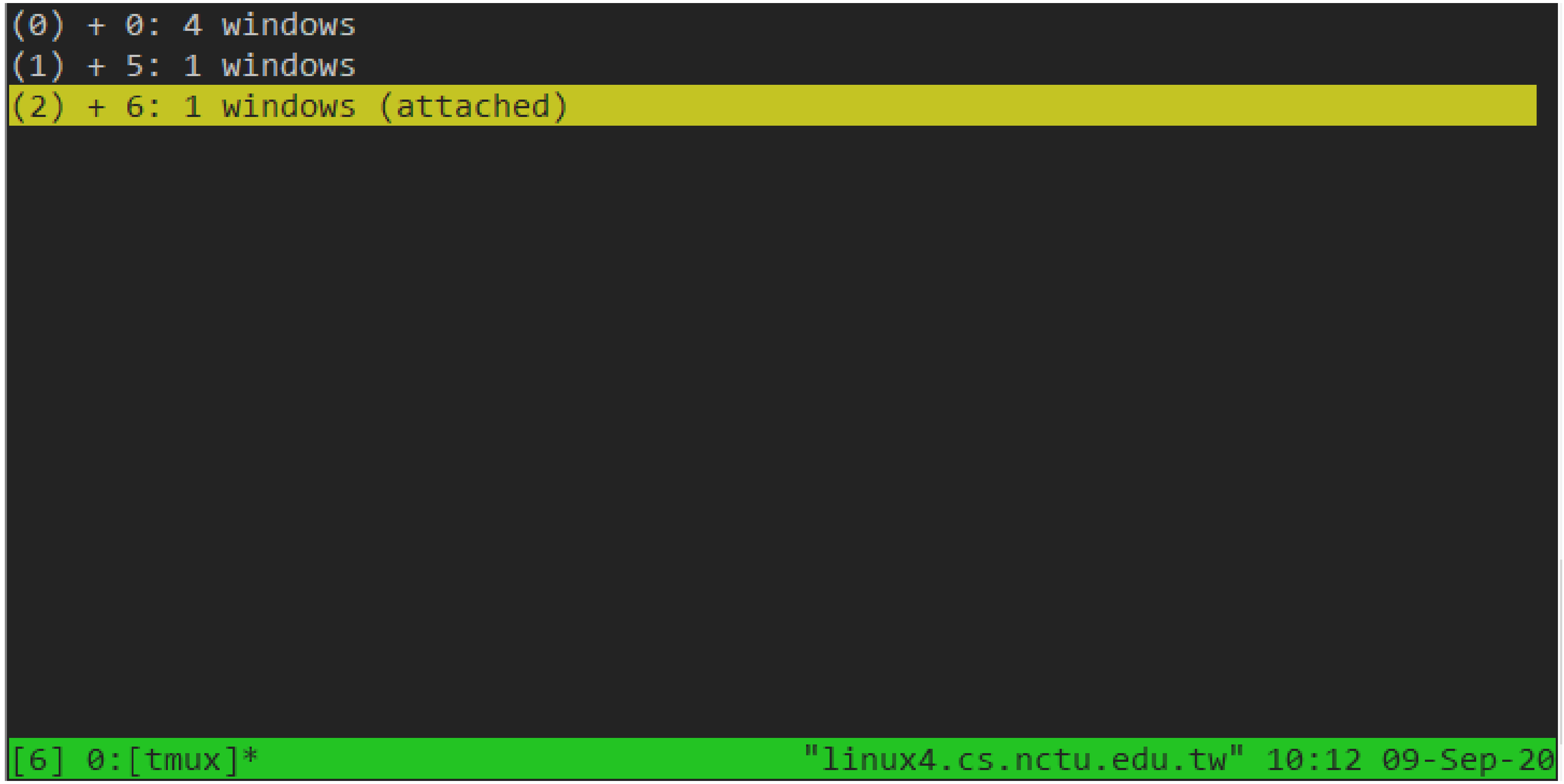
  ```
  $ tmux
  ```
- Detach current session
  - When attached in a session

  ```
  $ 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

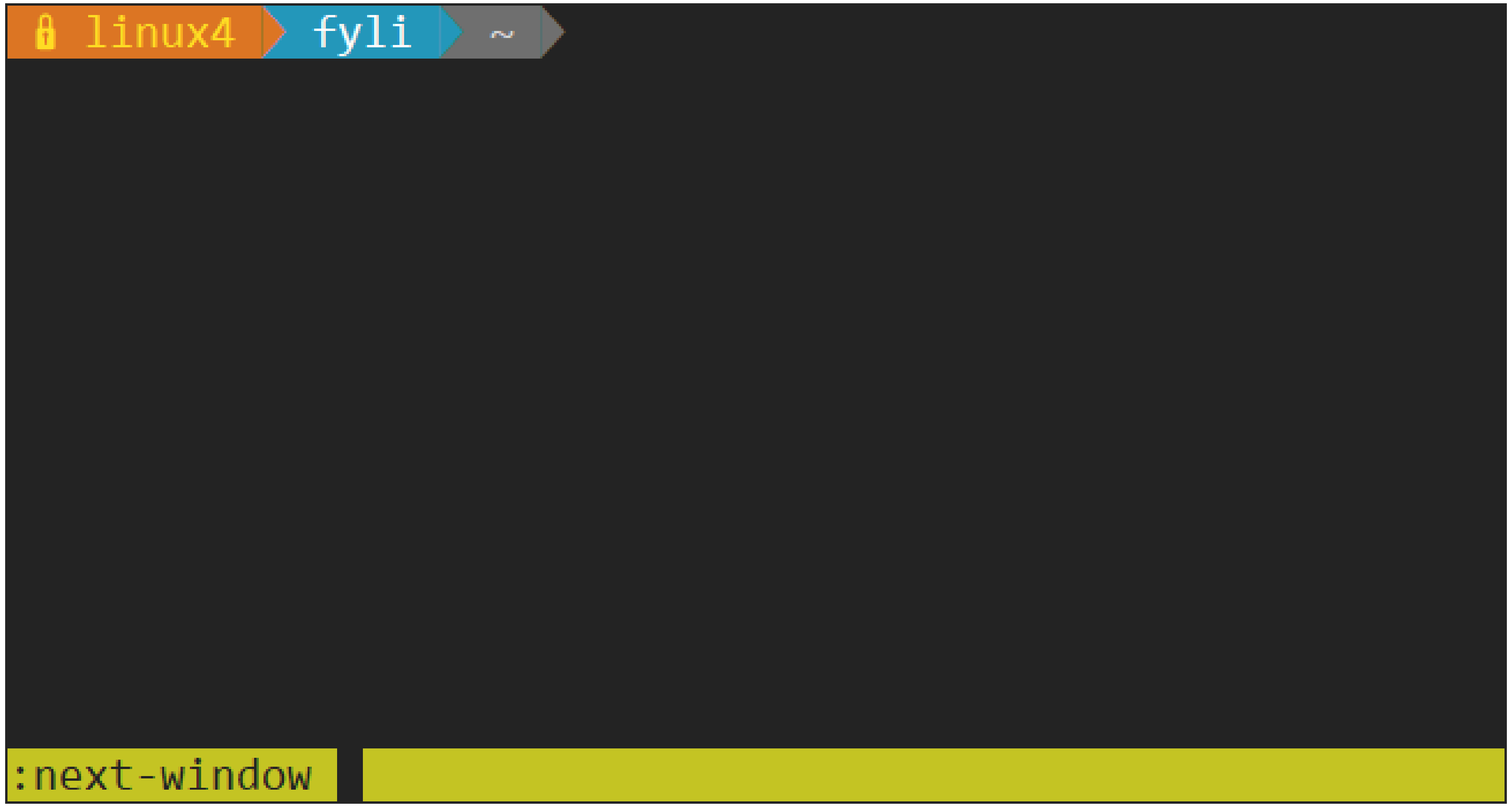
```
$ tmux attach -t session-id
```

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



```
linux4  fyli  ~
```

```
:next-window
```

Bindkey - Window

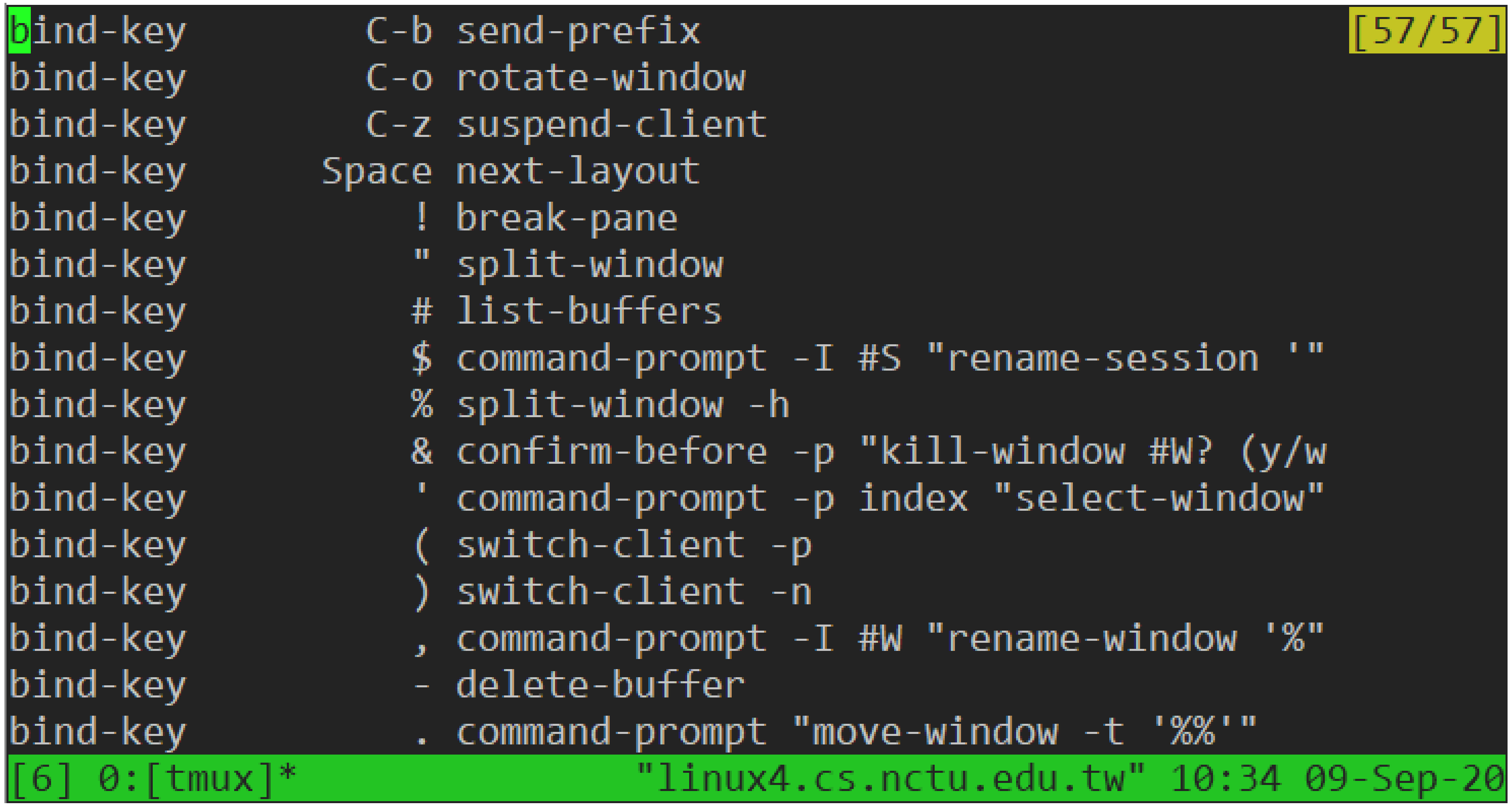
bindkey (default is C-b) //C == control	c	new-window
	n	next-window
	p	previous-window
	l	last-window
	<NUM>	select-window -t := <NUM>
	&	confirm-before -p "kill-window #W? (y/n)" kill-window
	,	command-prompt -I "#W" "rename-window '%%'"
	.	command-prompt "move-window -t '%%'"

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 + ?



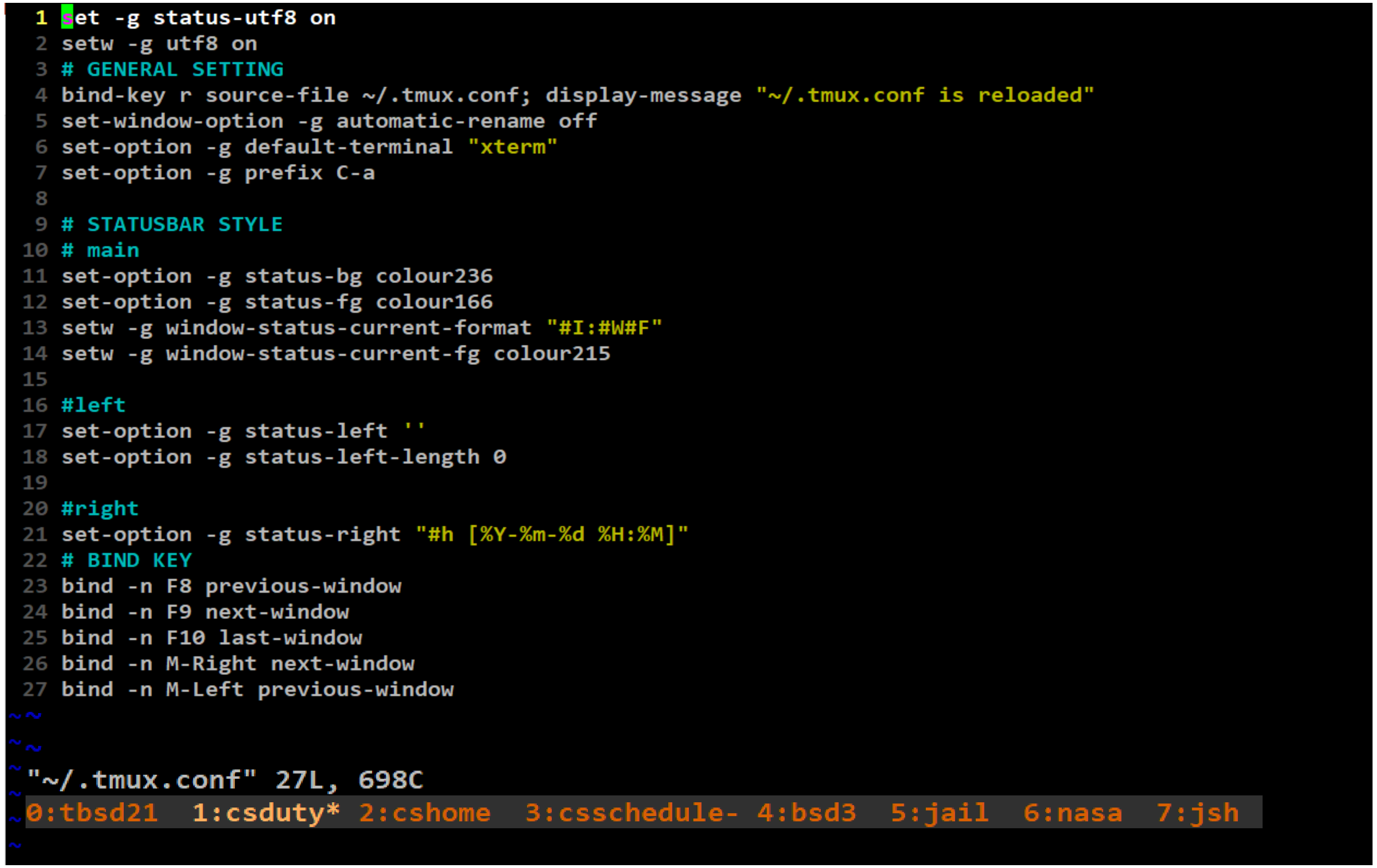
```
bind-key        C-b send-prefix                                    [57/57]
bind-key        C-o rotate-window
bind-key        C-z suspend-client
bind-key      Space next-layout
bind-key          ! break-pane
bind-key          " split-window
bind-key          # list-buffers
bind-key          $ command-prompt -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

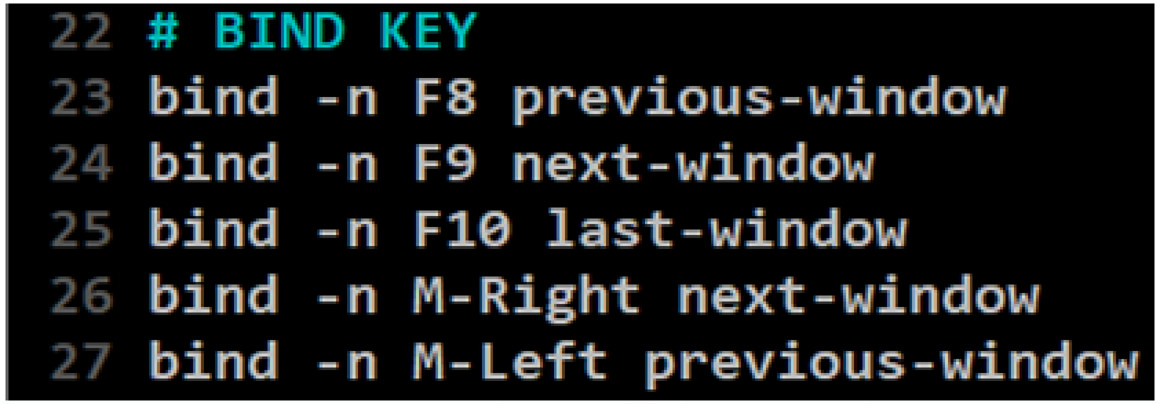
- ~/.tmux.conf



```
set -g status-utf8 on
setw -g utf8 on
# GENERAL SETTING
bind-key r source-file ~/.tmux.conf; display-message "~/.tmux.conf is reloaded"
set-window-option -g automatic-rename off
set-option -g default-terminal "xterm"
set-option -g prefix C-a

# STATUSBAR STYLE
# main
set-option -g status-bg colour236
set-option -g status-fg colour166
setw -g window-status-current-format "#I:#W#F"
setw -g window-status-current-fg colour215

#left
set-option -g status-left ''
set-option -g status-left-length 0

#right
set-option -g status-right "#h [%Y-%m-%d %H:%M]"
# BIND KEY
bind -n F8 previous-window
bind -n F9 next-window
bind -n F10 last-window
bind -n M-Right next-window
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

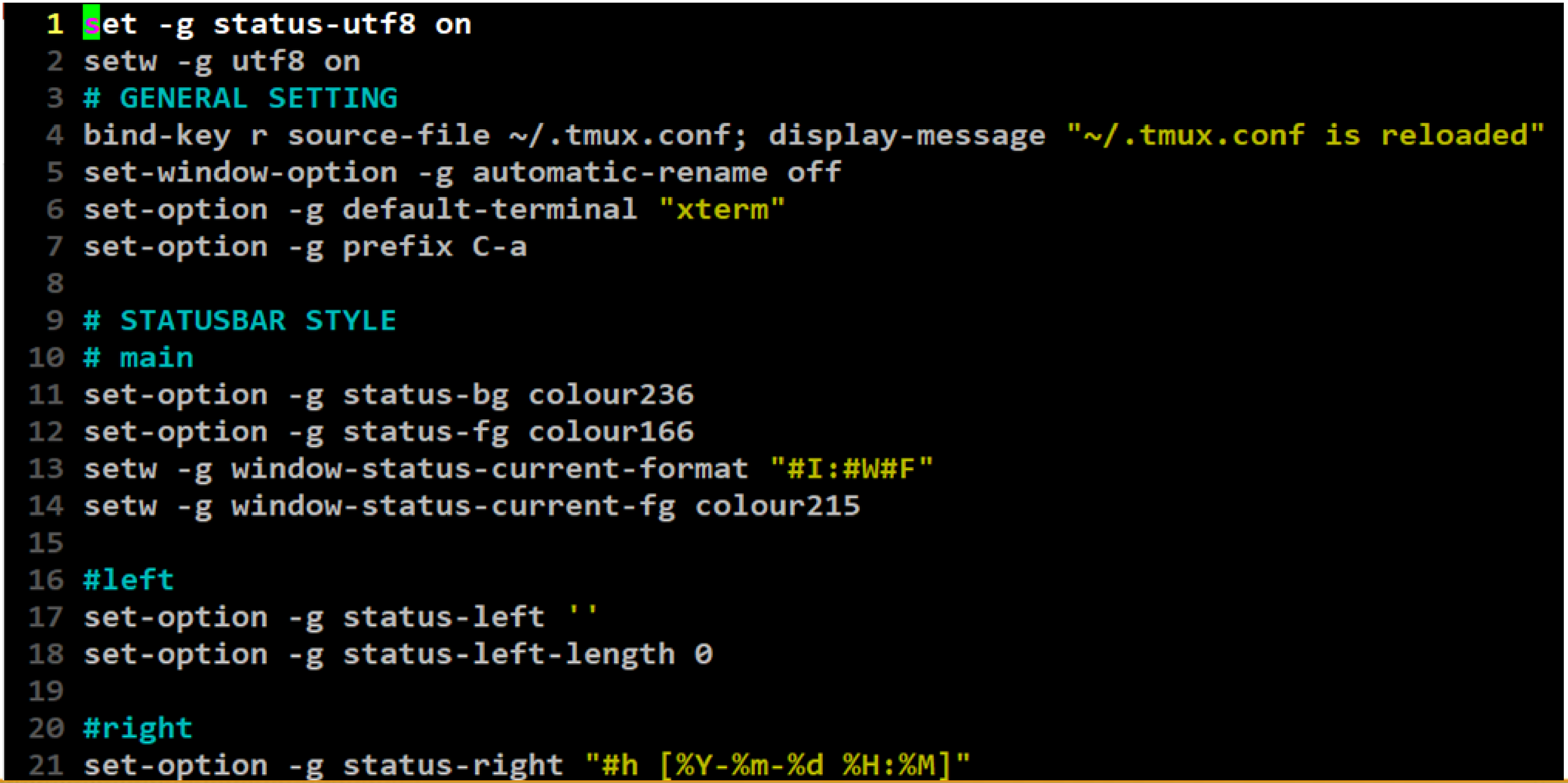
- ~/.tmux.conf
  - bind-key (alias: bind)
  - C (alias: <Ctrl>)
  - M (alias: <Alt>)
- bind-key <key> <command>
  - -T key-table (default table is prefix)
  - -n : alias for -T root => Don’t need to press C-b first
  - -r : repeat



```
# BIND KEY
bind -n F8 previous-window
bind -n F9 next-window
bind -n F10 last-window
bind -n M-Right next-window
bind -n M-Left previous-window
```

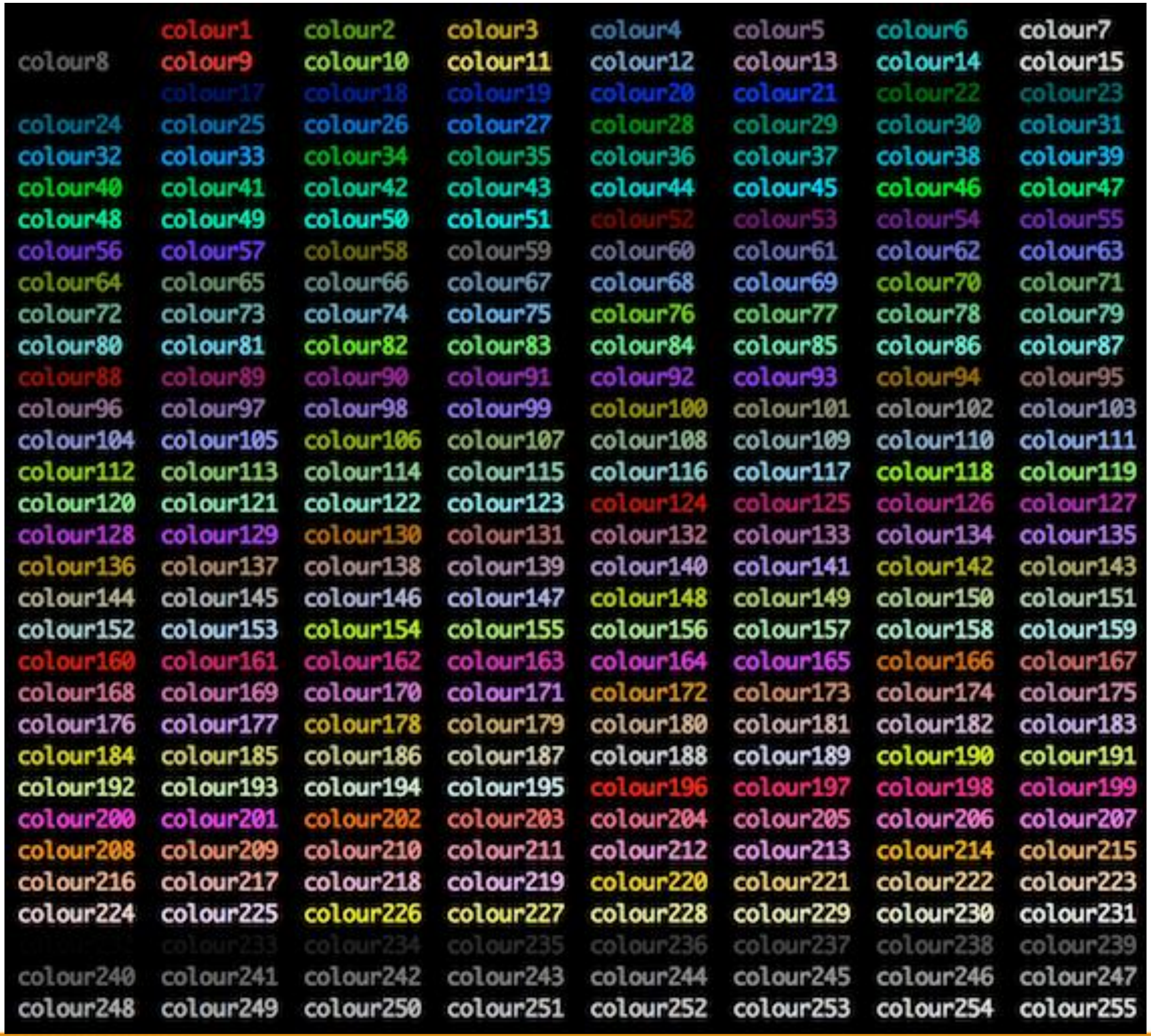
Configuration - set

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



```
set -g status-utf8 on
setw -g utf8 on
# GENERAL SETTING
bind-key r source-file ~/.tmux.conf; display-message "~/.tmux.conf is reloaded"
set-window-option -g automatic-rename off
set-option -g default-terminal "xterm"
set-option -g prefix C-a

# STATUSBAR STYLE
# main
set-option -g status-bg colour236
set-option -g status-fg colour166
setw -g window-status-current-format "#I:#W#F"
setw -g window-status-current-fg colour215

#left
set-option -g status-left ''
set-option -g status-left-length 0

#right
set-option -g status-right "#h [%Y-%m-%d %H:%M]"
```

Configuration - set



```
          colour1   colour2   colour3   colour4   colour5   colour6   colour7
colour8   colour9   colour10  colour11  colour12  colour13  colour14  colour15
          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
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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
```
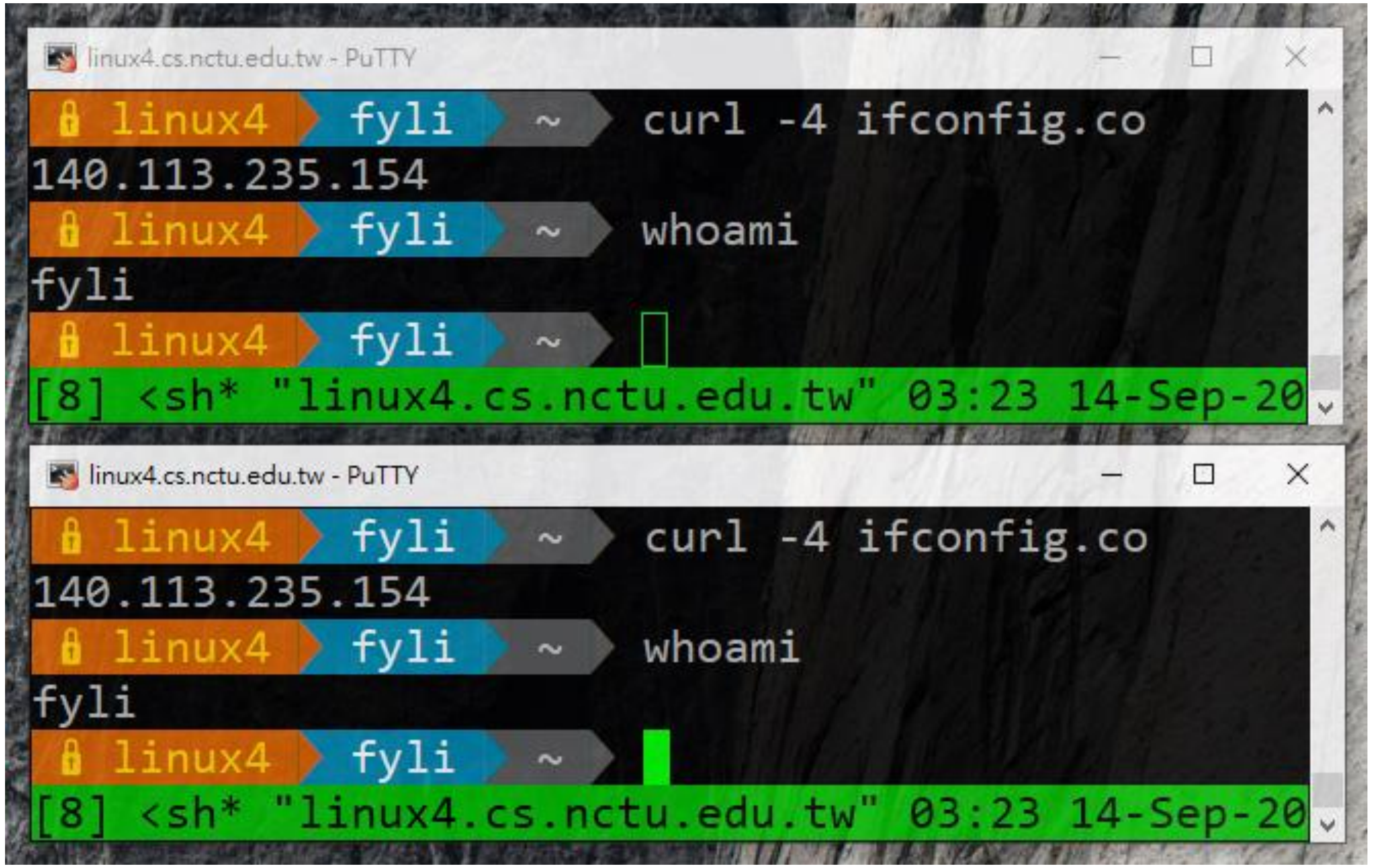

tmux - share session

- Both side can edit and execute commands



```
 linux4  fyli  ~  curl -4 ifconfig.co
140.113.235.154
 linux4  fyli  ~  whoami
fyli
 linux4  fyli  ~ 
[8] <sh* "linux4.cs.nctu.edu.tw" 03:23 14-Sep-20
```

```
 linux4  fyli  ~  curl -4 ifconfig.co
140.113.235.154
 linux4  fyli  ~  whoami
fyli
 linux4  fyli  ~ 
[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	less than tmux

Git

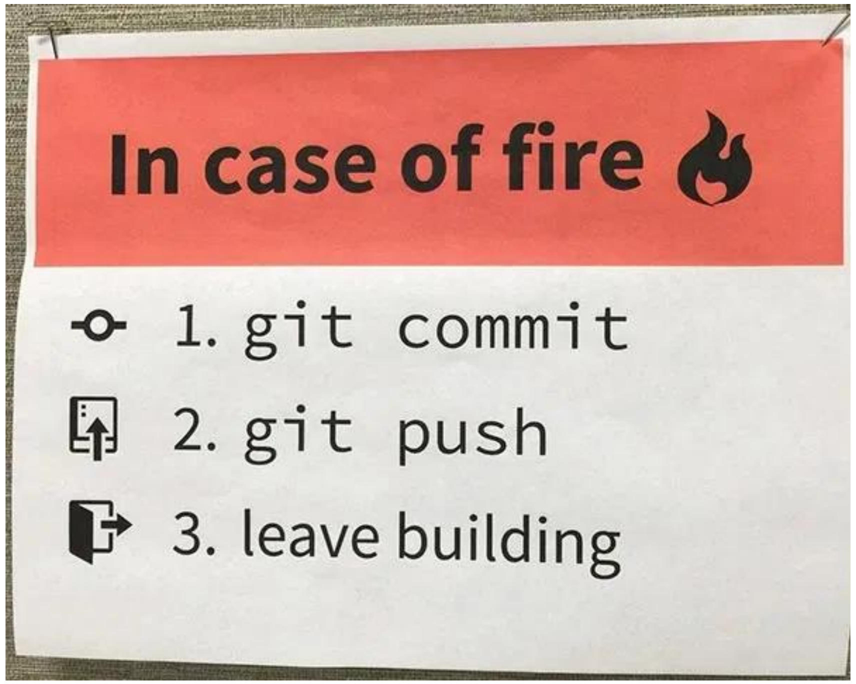
One of the most popular Version Control Systems

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

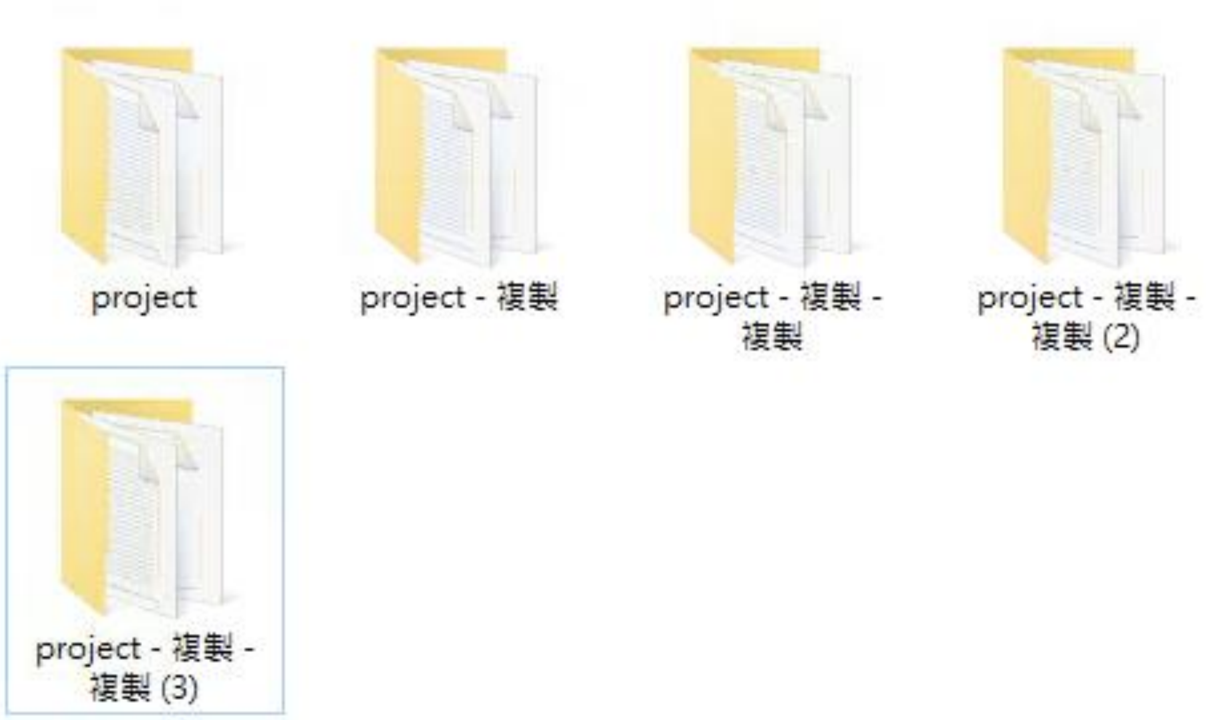

In case of fire

1. git commit
2. git push
3. leave building

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
```

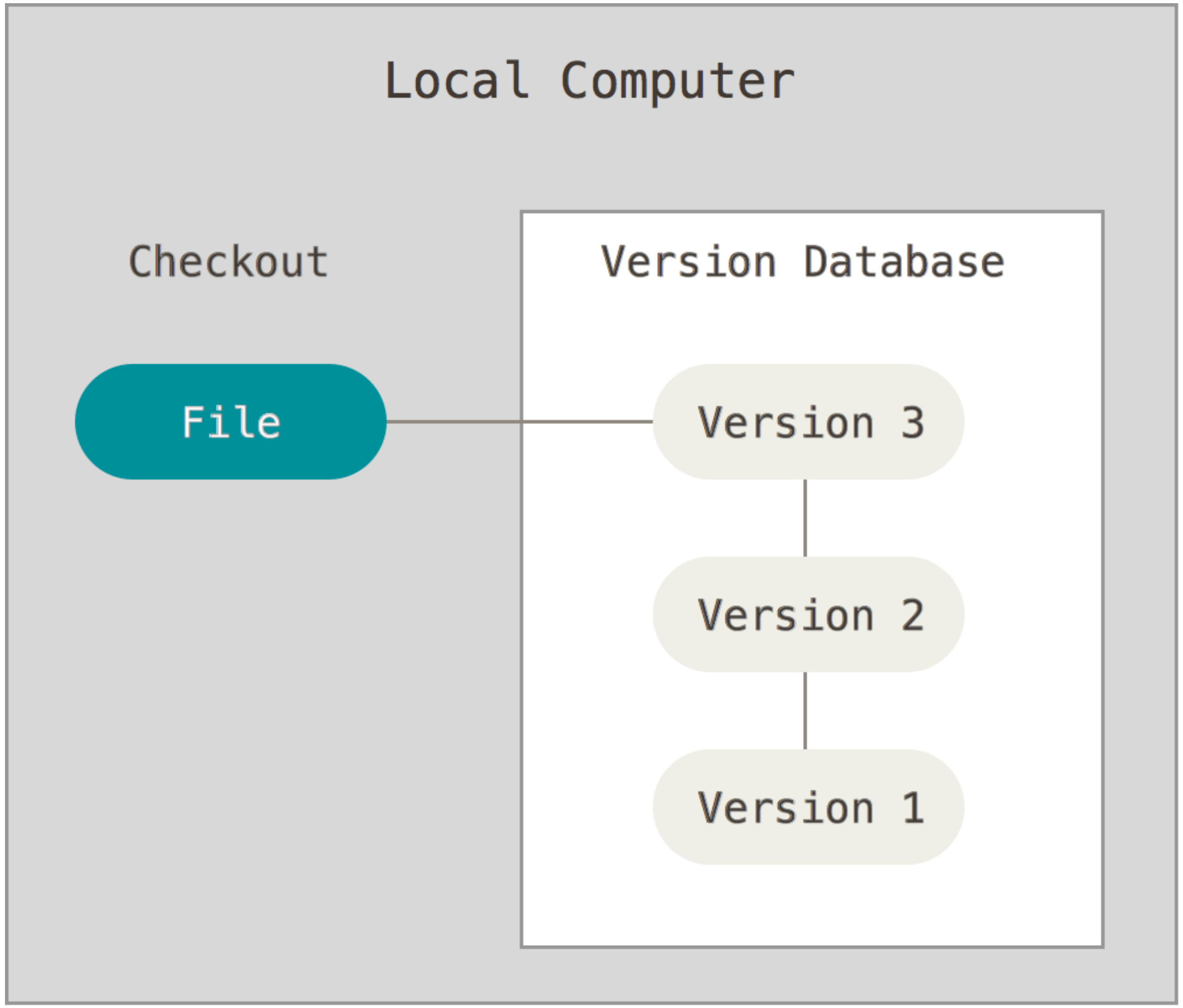


How VCS works

- 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

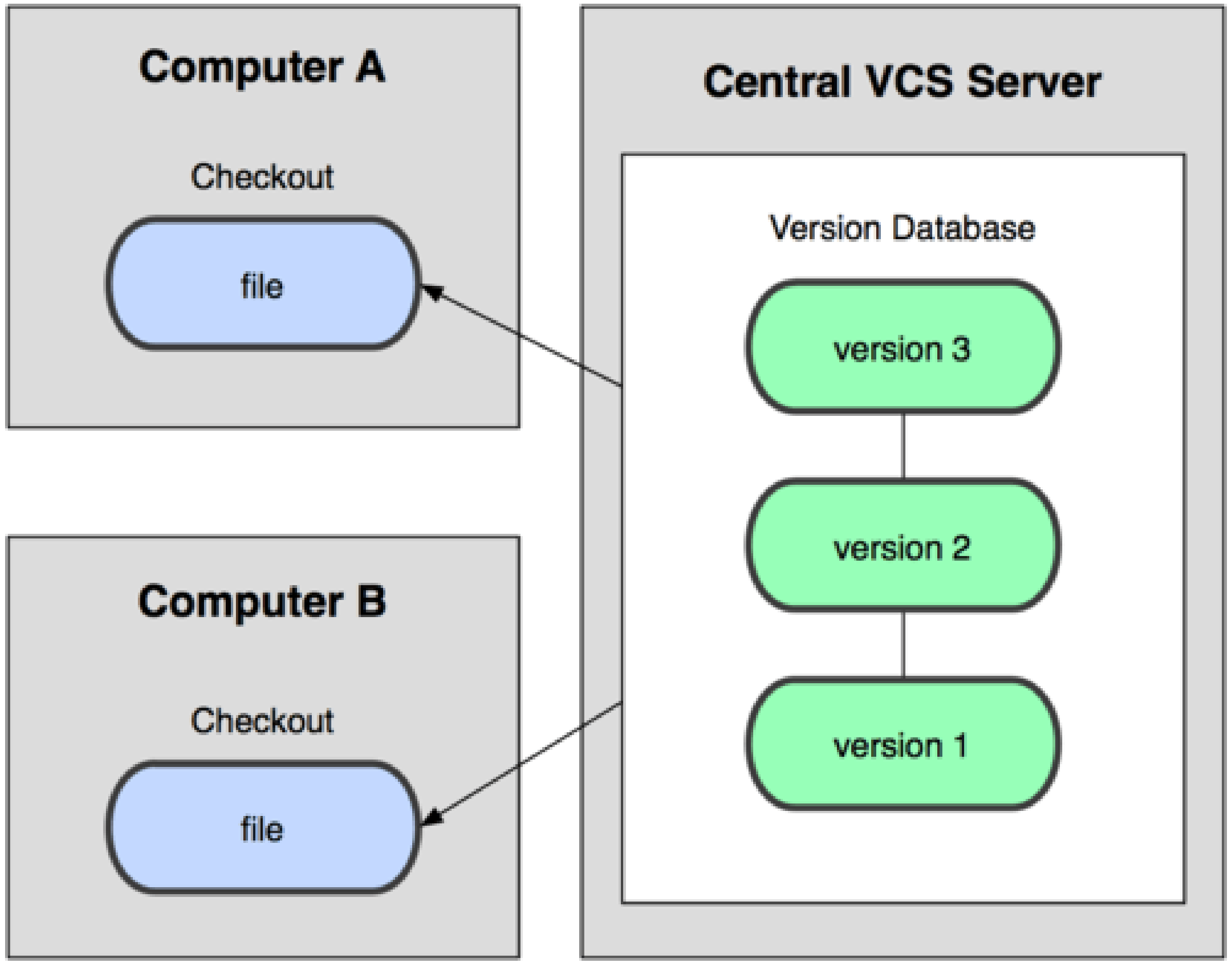
Types of VCS (1)

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



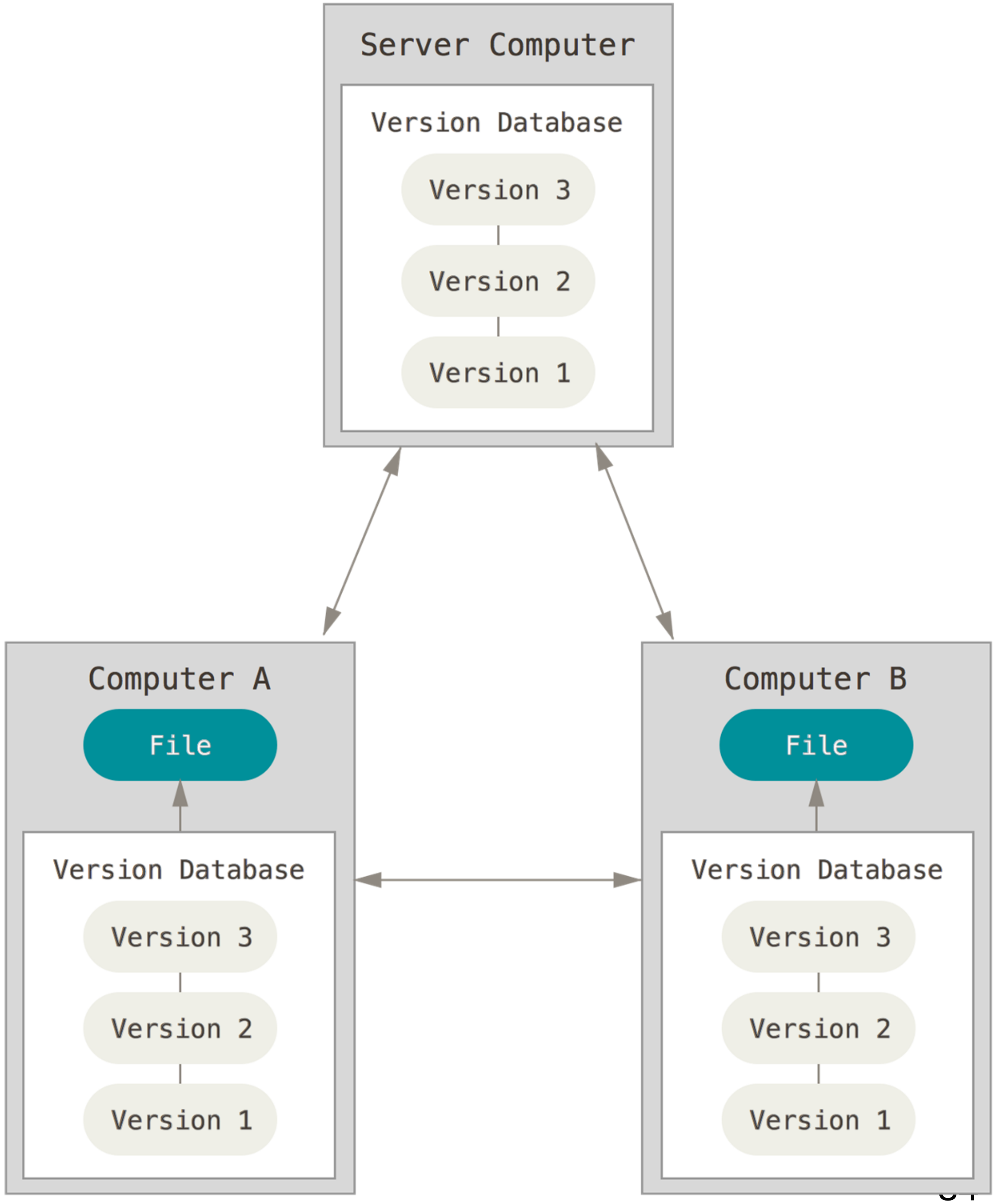
Types of VCS (2)

- 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

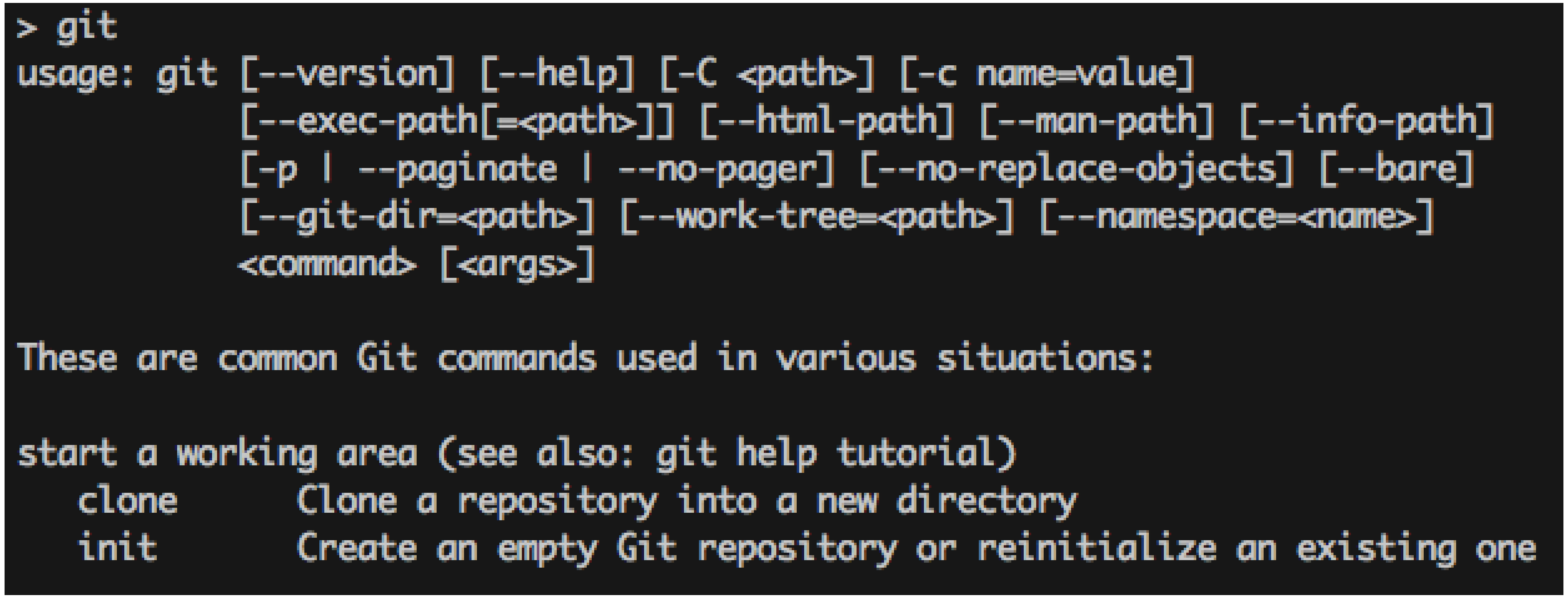
Git

- 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

  Homework 2
- Will NOT cover
  - branching (git branch, git merge, ...)
  - Anything else

Git - installation

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

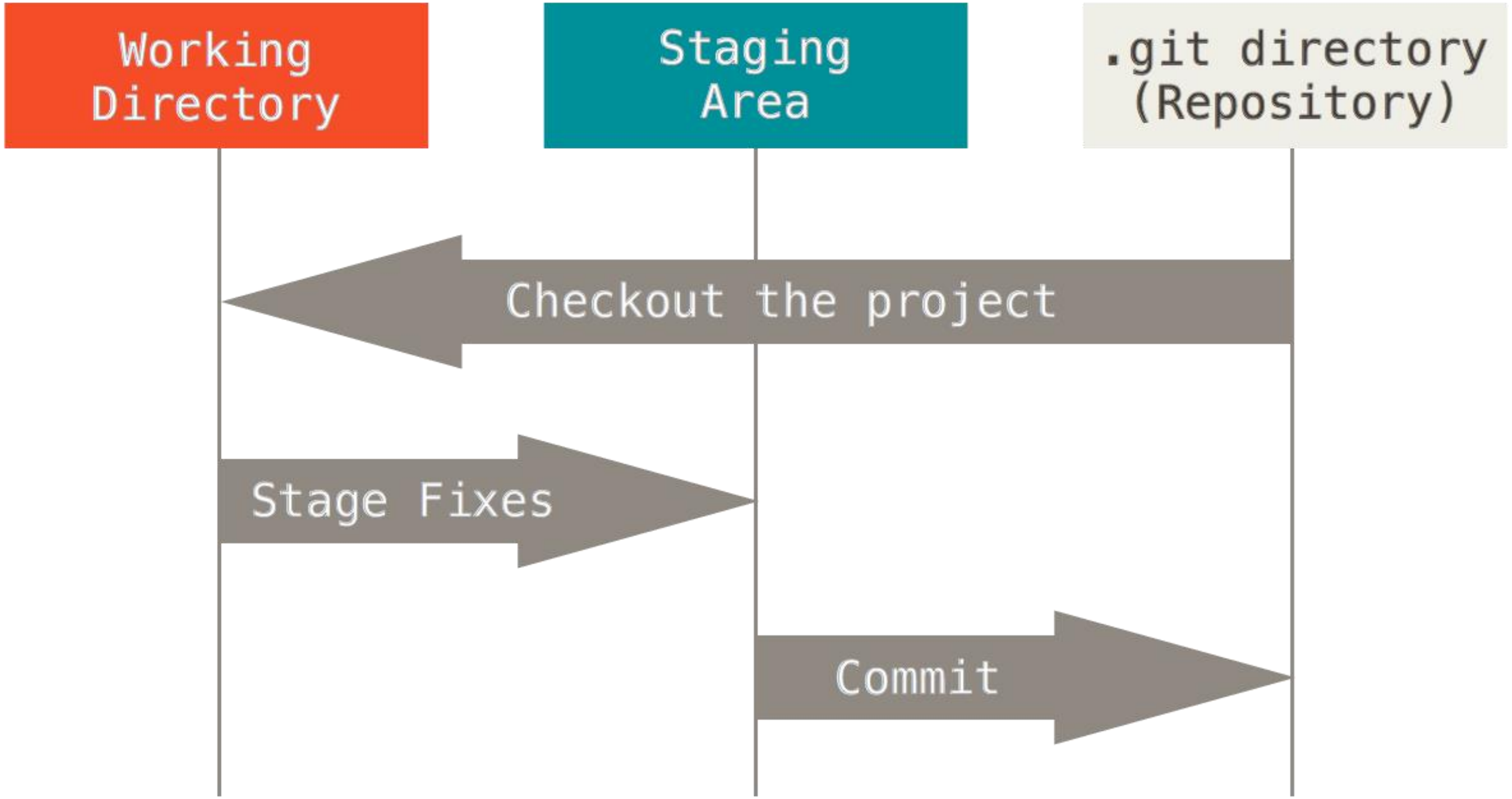


```
> git
usage: git [--version] [--help] [-C <path>] [-c name=value]
           [--exec-path[=<path>]] [--html-path] [--man-path] [--info-path]
           [-p | --paginate | --no-pager] [--no-replace-objects] [--bare]
           [--git-dir=<path>] [--work-tree=<path>] [--namespace=<name>]
         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

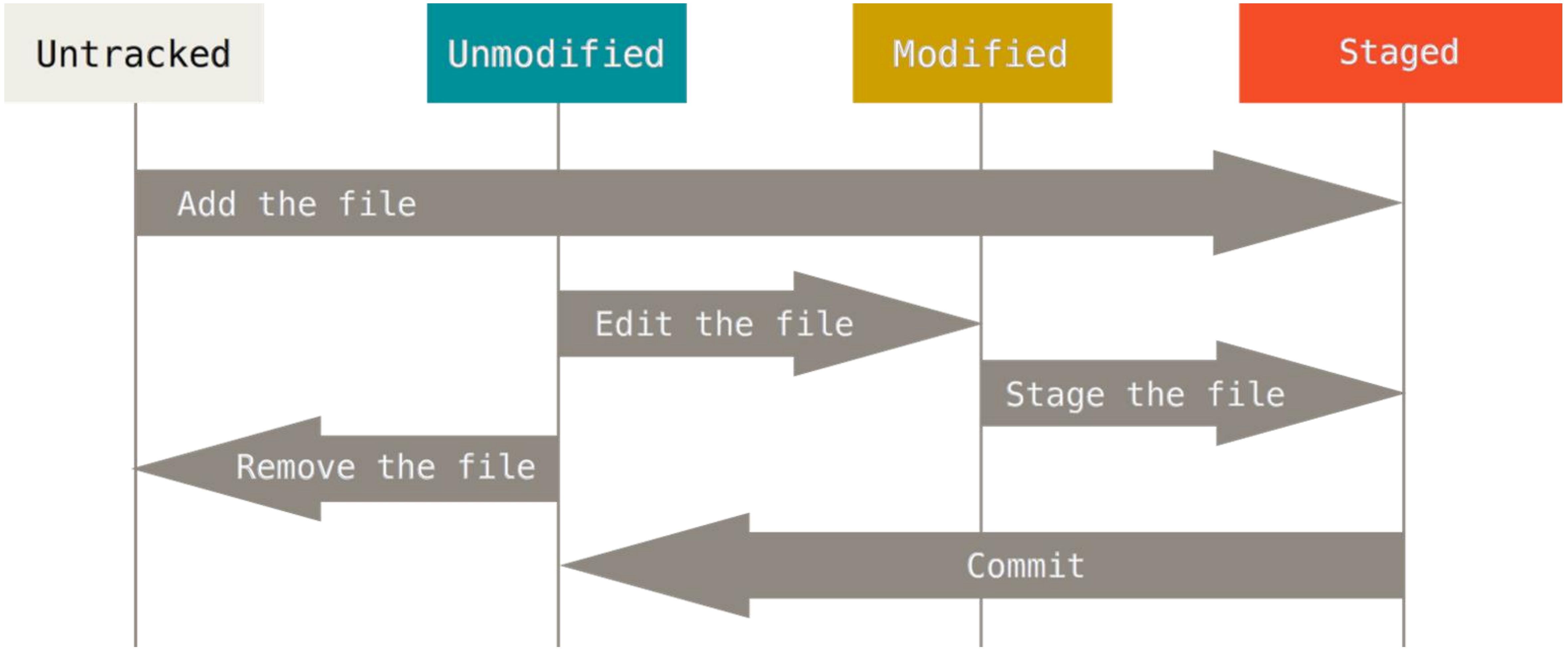
- Developer information
  - In terminal
    - `$ git config --global user.email "you@example.com"`
    - `$ git config --global user.name "Name"`
  - Or edit manually in ~/.gitconfig
- Create a new repository
  - `$ mkdir hw2`
  - `$ cd hw2`
  - `$ git init`
    - Initialize an empty project with .git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