

Linux 基礎

Ice1187

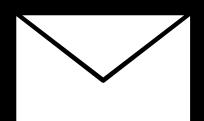
Speaker

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- ▶ Speaker of CyberSec, SECCON



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Course Info

- 簡報連結：<https://github.com/lce1187/My-Slides>
- 練習平台：<https://github.com/lce1187/My-CTF-Challenges>

什麼是 Linux？

- 自由、開放原始碼的作業系統
- 常用於軟體開發、伺服器維運等
- 擁有許多不同分支：
 - Kali Linux
 - Ubuntu
 - Arch Linux



為什麼要學 Linux ?

- 內建許多好用的工具
- 開發者導向，寫程式更方便
- 許多 CTF 現有工具是 Linux only
- 簡單的 CTF 題目都是 Linux-based



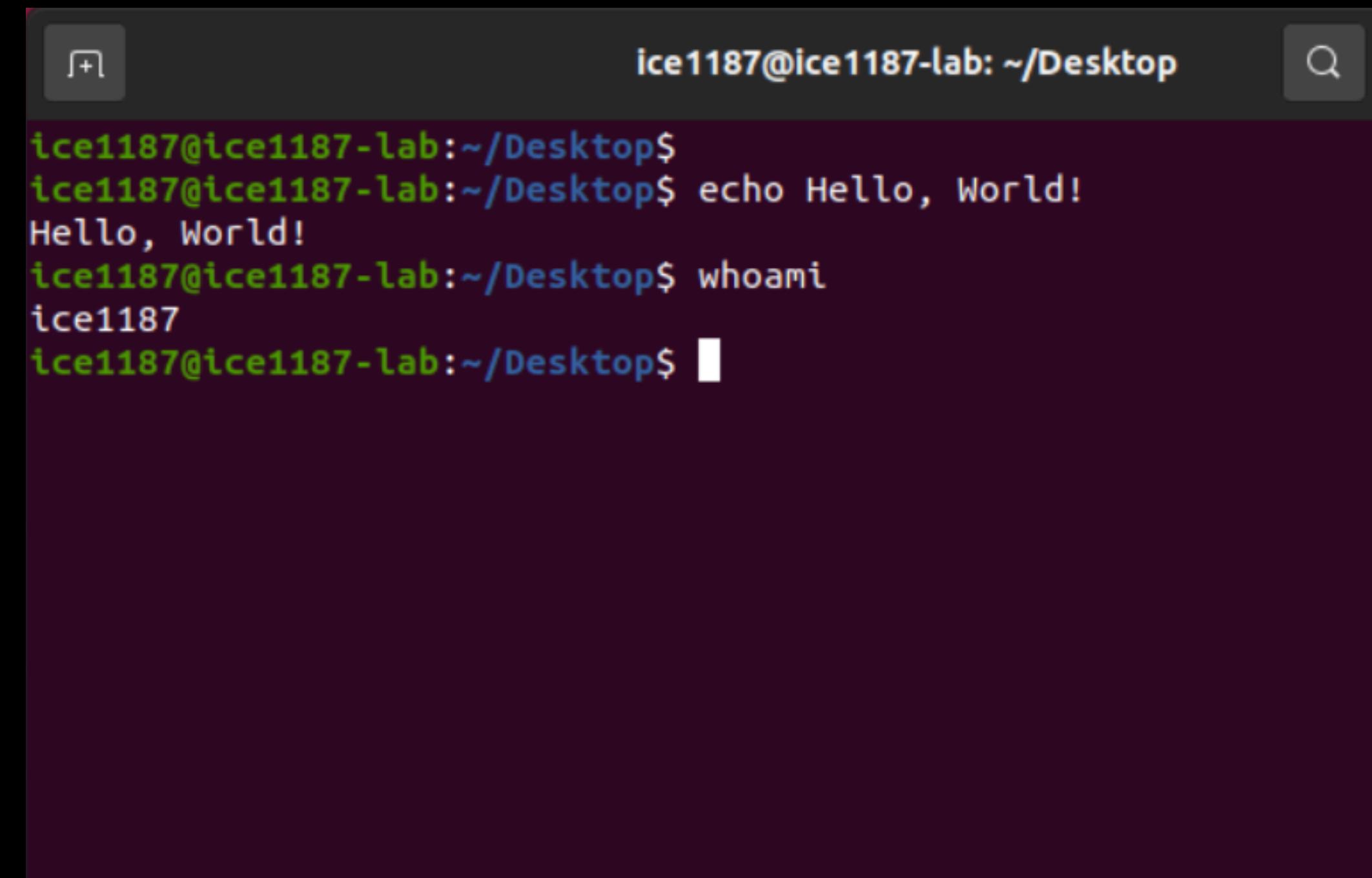
大綱

- ▶ Terminal 終端機
- ▶ File System 檔案系統
- ▶ User & Group 使用者與群組
- ▶ File Permission 檔案權限
- ▶ Network 網路
- ▶ Process
- ▶ Editor 編輯器
- ▶ Compile & Execute 編譯與執行
- ▶ Shell
- ▶ ssh 遠端連線
- ▶ Compress 壓縮/解壓縮
- ▶ Package Manager 套件管理
- ▶ Encoding 編碼
- ▶ 其他 CTF 常用指令

Terminal 終端機

Terminal 終端機

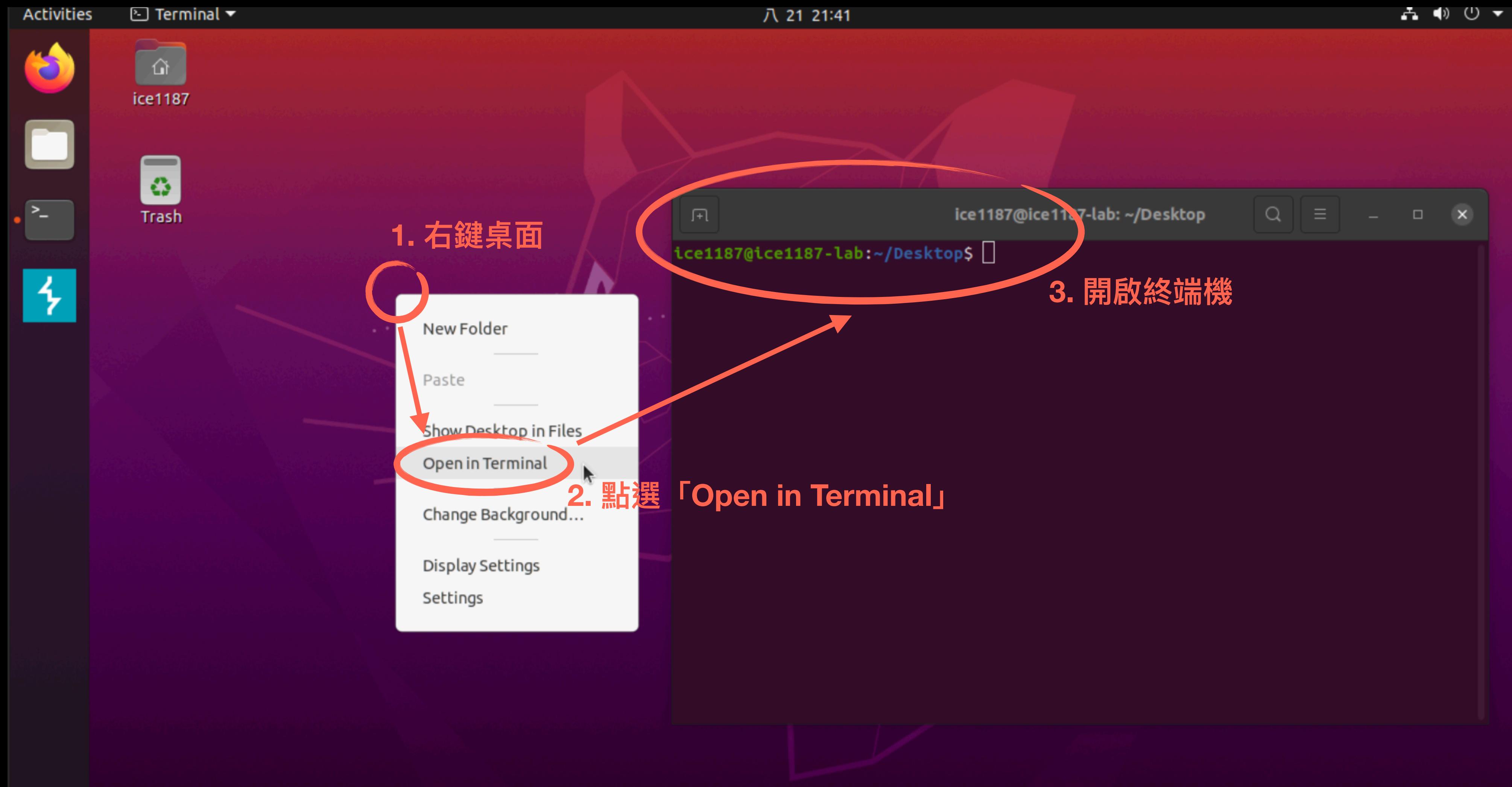
- Linux 核心功能，類似 Windows 的命令提示字元 cmd.exe
- 透過純文字介面操作電腦
- 為什麼要用 Terminal ?
 - ▶ 只需要鍵盤
 - ▶ 打指令很快
 - ▶ 操作自動化



A screenshot of a terminal window titled "ice1187@ice1187-lab: ~/Desktop". The window contains the following text:

```
ice1187@ice1187-lab:~/Desktop$  
ice1187@ice1187-lab:~/Desktop$ echo Hello, World!  
Hello, World!  
ice1187@ice1187-lab:~/Desktop$ whoami  
ice1187  
ice1187@ice1187-lab:~/Desktop$
```

開啟 Terminal



使用方法 – 方向鍵

- 左右鍵 ← →
 - 用途：在字元之間移動
- Ctrl + 左右鍵
 - 用途：在字串之間移動
- 上下鍵 ↑ ↓
 - 用途：上一個 / 下一個輸入過的指令

```
icell187@icell187-lab:~$ echo Hello, CTF!
Hello, CTF!
icell187@icell187-lab:~$ echo Hello, World!
```

使用方法 – Tab

- 用途：在輸入指令時，按下 Tab 可以自動補完，或是顯示提示
- 自動補完：當輸入的指令有一種可能時觸發
- 顯示提示：當輸入的指令有多種可能時觸發

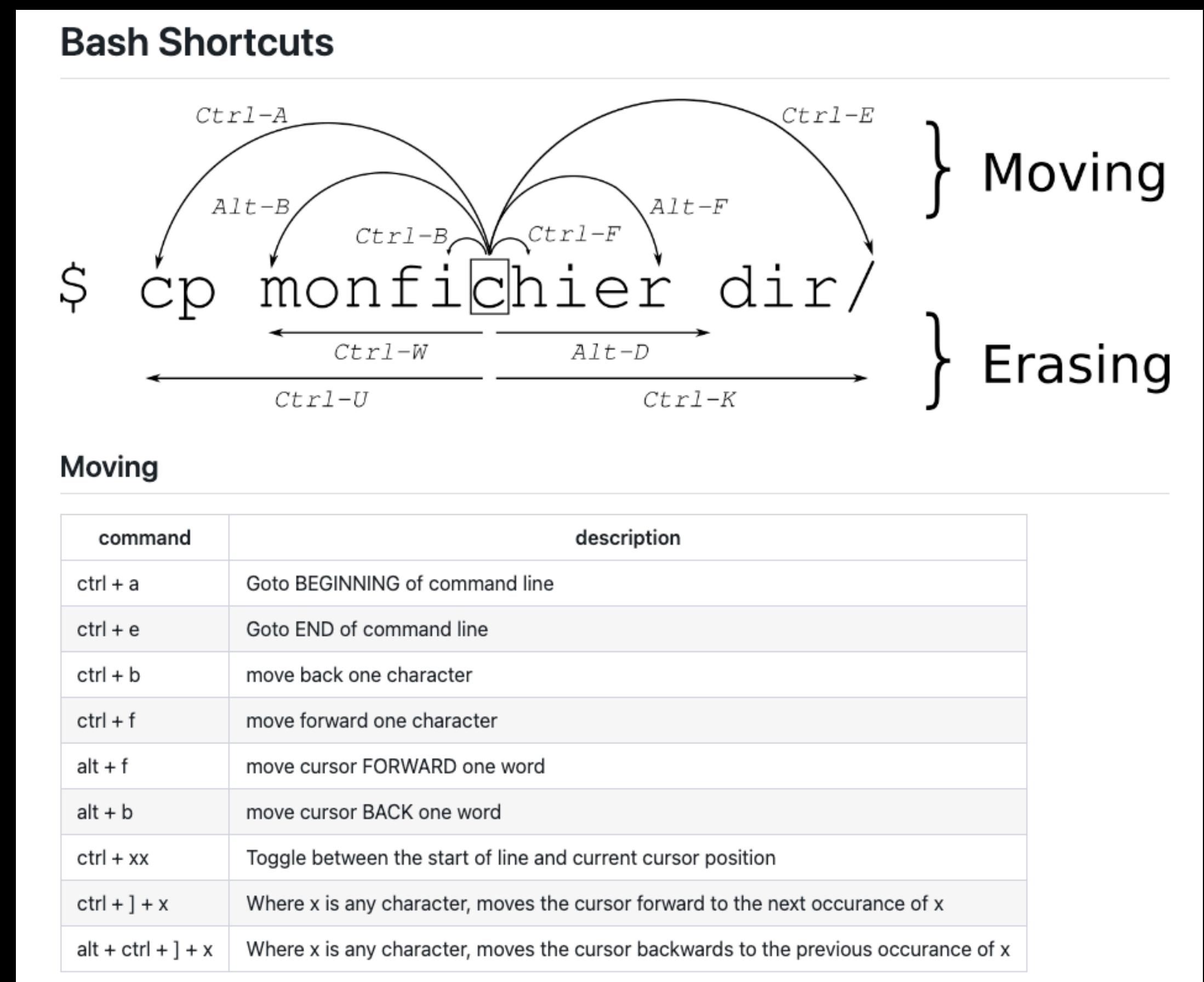
```
icell187@icell187-lab:~$ ec Tab (顯示提示)
echo      ecl      ecl-config  ecm
icell187@icell187-lab:~$ ech
```

```
icell187@icell187-lab:~$ ec
echo      ecl      ecl-config  ecm
icell187@icell187-lab:~$ echo
```

Tab (自動補完)

更多 shortcuts

- 如果想要更快移動與修改指令，可以參考 [Bash Shortcuts](#)



使用方法 – Ctrl+C

- 用途：中斷指令
- 當指令跑到一半，不想繼續執行時，可以用 Ctrl+C 強制中斷指令

```
icell187@icell187-lab:~$ sleep 100
^C
icell187@icell187-lab:~$ █
```

man



- 用途：查看指令或作業系統功能的說明手冊 (**manual**)
- 上下鍵翻動說明，按 q 退出說明頁面

man

- man man

The screenshot shows a terminal window with the following details:

- Title bar:** ice1187@ice1187-lab: ~
- Left pane:** MAN(1)
- Right pane:** Manual pager utils
- Bottom right corner:** MAN(1)

The main content area displays the man(1) page for the 'man' command:

NAME
man - an interface to the system reference manuals

SYNOPSIS

```
man [man options] [[section] page ...] ...
man -k [apropos options] regexp ...
man -K [man options] [section] term ...
man -f [whatis options] page ...
man -l [man options] file ...
man -w|-W [man options] page ...
```

DESCRIPTION

man is the system's manual pager. Each page argument given to man is normally the name of a program, utility or function. The manual page associated with each of these arguments is then found and displayed. A section, if provided, will direct man to look only in that section of the manual. The default action is to search in all of the available sections following a pre-defined order (see **DEFAULTS**), and to show only the first page found, even if page exists in several sections.

Manual page man(1) line 1 (press h for help or q to quit)

At the bottom, there is a status bar with the following information:

- 11% (progress bar)
- 9.0 GB (file size)
- 2.0 kB↓ (download speed)
- 0.0 kB↑ (upload speed)
- 100% (disk usage)

man

- man man

The screenshot shows a terminal window with the following content:

```
ice1187@ice1187-lab: ~
MAN(1)                               Manual pager utils                               MAN(1)

NAME
    man - an interface to the system reference manuals

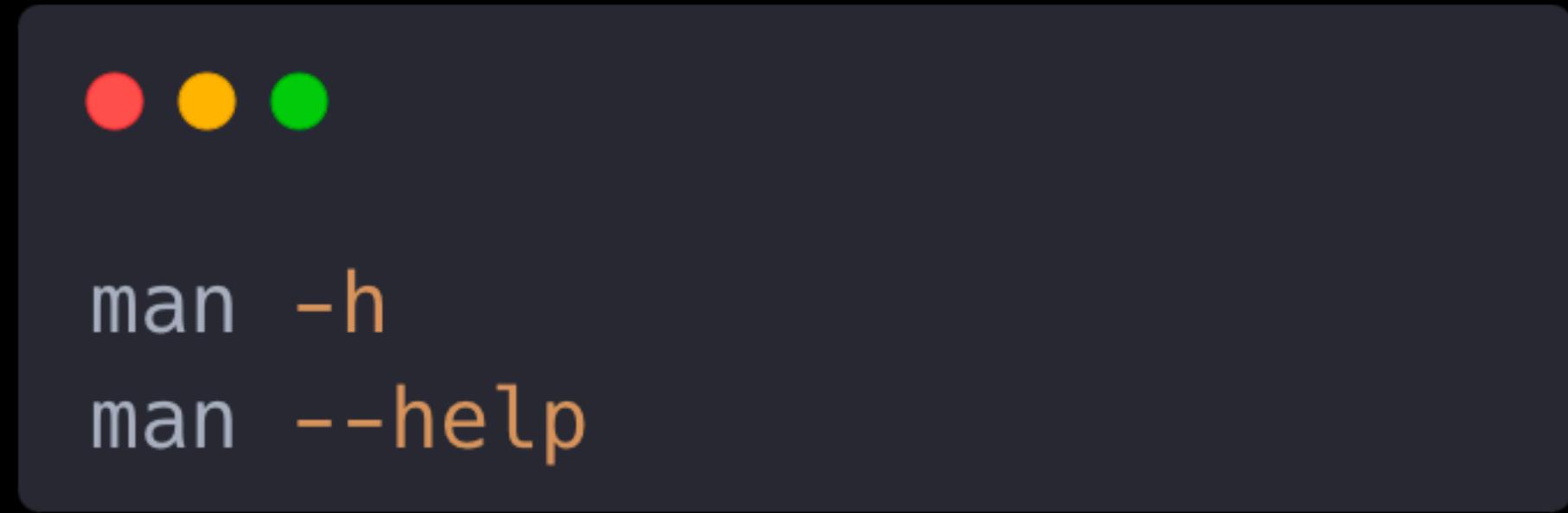
SYNOPSIS
    man [man options] [[section] page ...] ...
    man -k [apropos options] regexp ...
    man -K [man options] [section] term ...
    man -f [whatis options] page ...
    man -l [man options] file ...
    man -w|-W [man options] page ...

DESCRIPTION
    man is the system's manual pager. Each page argument given to man is normally the name
    of a program, utility or function. The manual page associated with each of these arguments
    is then found and displayed. A section, if provided, will direct man to look only
    in that section of the manual. The default action is to search in all of the available
    sections following a pre-defined order (see DEFAULTS), and to show only the first page
    found, even if page exists in several sections.

Manual page man(1) line 1 (press h for help or q to quit)
```

The terminal window has a dark background with white text. The title bar reads "ice1187@ice1187-lab: ~". The man page header is "MAN(1) Manual pager utils MAN(1)". The "NAME" section describes "man - an interface to the system reference manuals". The "SYNOPSIS" section lists various command-line options for "man". The "DESCRIPTION" section provides a detailed explanation of what "man" does, mentioning its role as the system's manual pager, how it finds manual pages, and its behavior regarding sections and multiple matches. At the bottom of the window, a status bar displays "Manual page man(1) line 1 (press h for help or q to quit)". Below the status bar, there is a decorative footer with various icons and metrics.

-h, --help



- 用途：印出指令內建的說明資訊
- 非內建指令沒有 man 說明頁面時很好用
- 此為開發慣例，並非所有指令都有 -h 與 --help

man

- man --help

The screenshot shows a terminal window with the following content:

```
ice1187@ice1187-lab:~$ man --help
Usage: man [OPTION...] [SECTION] PAGE... 指令格式

-C, --config-file=FILE      use this user configuration file
-d, --debug                 emit debugging messages
-D, --default                reset all options to their default values
--warnings [=WARNINGS]     enable warnings from groff

Main modes of operation:
-f, --whatis               equivalent to whatis
-k, --apropos              equivalent to apropos
-K, --global-apropos       search for text in all pages
-l, --local-file            interpret PAGE argument(s) as local filename(s)
-w, --where, --path, --location
                           print physical location of man page(s)
-W, --where-cat, --location-cat
                           print physical location of cat file(s)

-c, --catman                used by catman to reformat out of date cat pages
-R, --recode=ENCODING       output source page encoded in ENCODING

Finding manual pages:
```

A red box highlights the usage information and main modes of operation. A red arrow points from the text "指令參數簡介" to the right side of the highlighted area.

指令與參數



- **指令**：每個指令都是一個具有特定功能的程式 / 可執行檔
 - `man` 是一個顯示系統說明手冊的程式
 - `sleep` 是一個暫停執行 n 秒的程式

指令與參數



- 參數：用於提供**指令**資訊，沒有特定格式
 - `man ls`
 - `man --help`
 - `ls -al /home/user`

指令與參數

```
● ● ●  
grep [OPTION...] PATTERNS [FILE...]  
grep [OPTION...] -e PATTERNS ... [FILE...]
```

- 指令格式表達的通用寫法：
 - [OPTION...]：此參數可有可無 (optional)
 - [OPTION...]：此參數可有多個
 - PATTERNS：必要參數

Lab – Read the MANual

Read the MANual

100

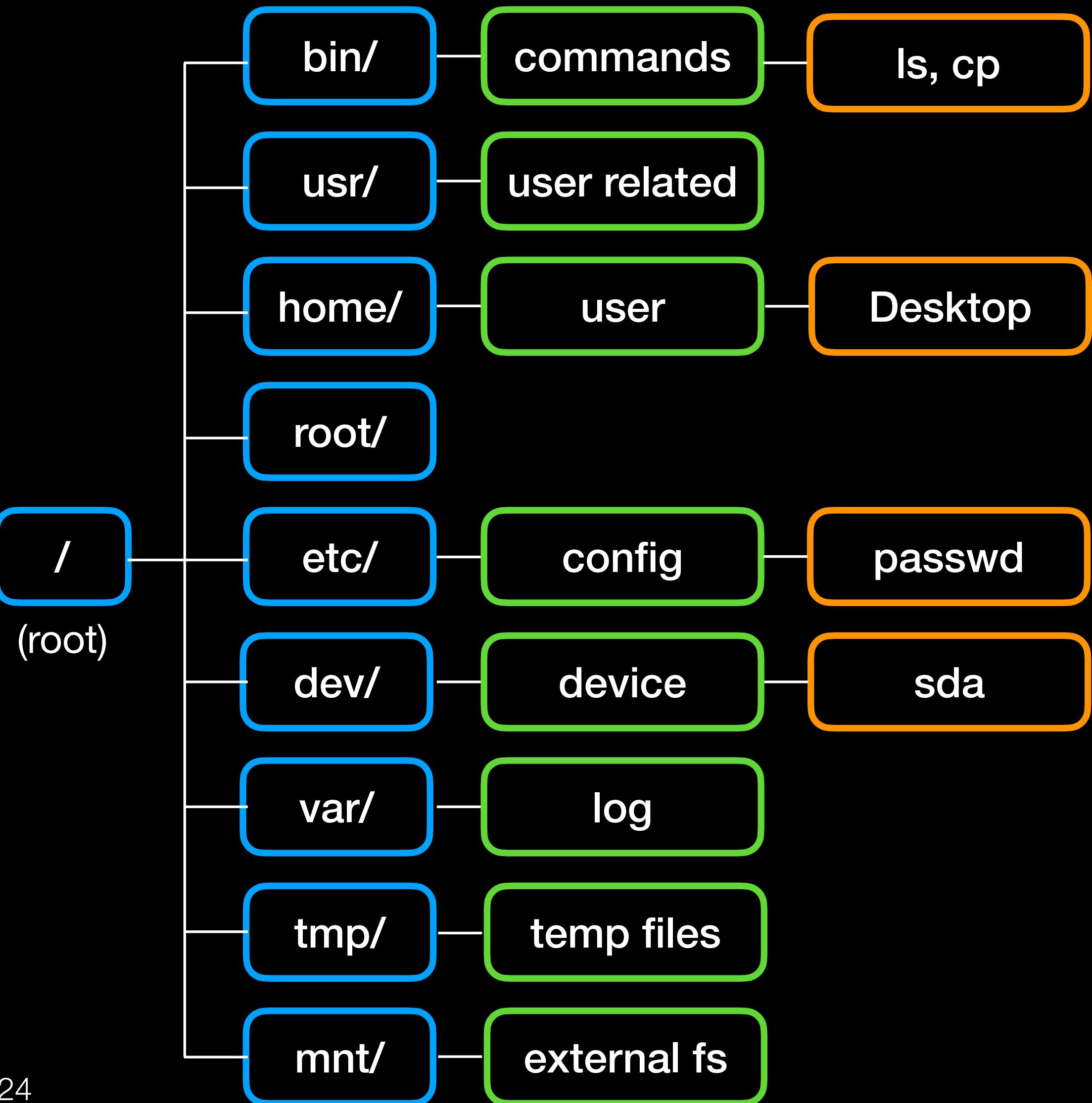
你知道如何查看 Linux 上的 system reference manuals 嗎？請找出 `ls` 指令的 `-a` 參數功能為何。

Flag 格式：`FLAG{description of -a option of ls command}`

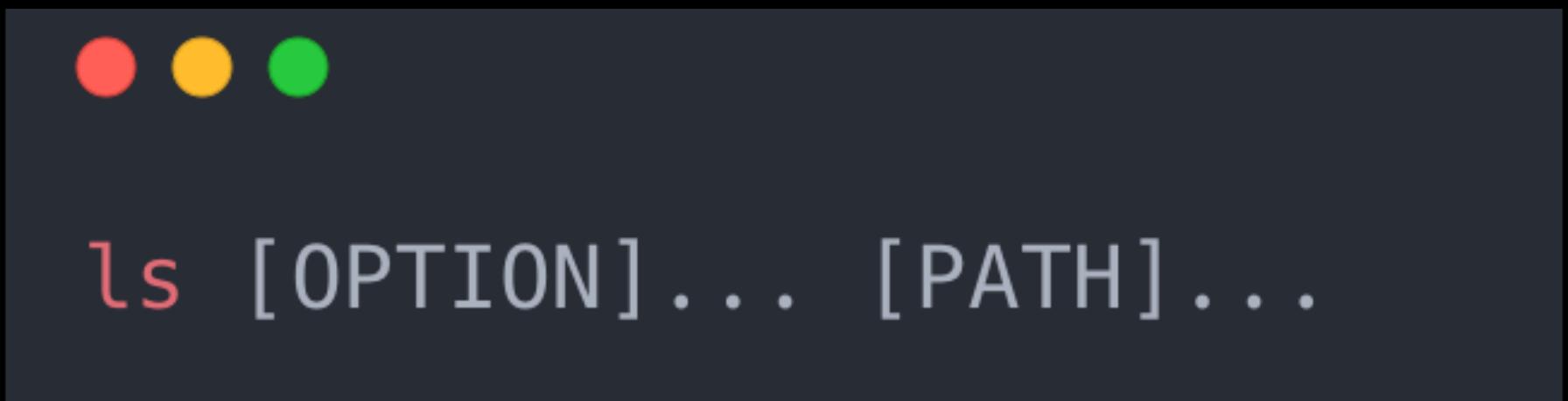
File System 檔案系統

Directory Hierarchy

- Linux 檔案系統的基本結構
- 只是慣例，非強制性
- "Everything is a file."
 - directory
 - device
 - socket
 - ...



ls



- 用途：列出當前資料夾 / 指定資料夾的檔案
- PATH：用於指定要列出的資料夾，預設為當前資料夾
- OPTION：使用 -al 列出完整資訊（時間、檔案權限、擁有者、隱藏檔案）

ls

```
└─(kali㉿ kali)-[~/Desktop]
```

```
└─$ ls
```

```
└─(kali㉿ kali)-[~/Desktop]
```

```
└─$ ls -al
```

```
total 8
```

```
drwxr-xr-x 2 kali kali 4096 Aug 31 01:44 .
```

```
drwxr-xr-x 15 kali kali 4096 Aug 31 02:04 ..
```

cd



- 用途：切換當前資料夾
- DIR：要前往的資料夾，預設為使用者的家目錄
- Tips：使用 - 回到來時的資料夾

cd

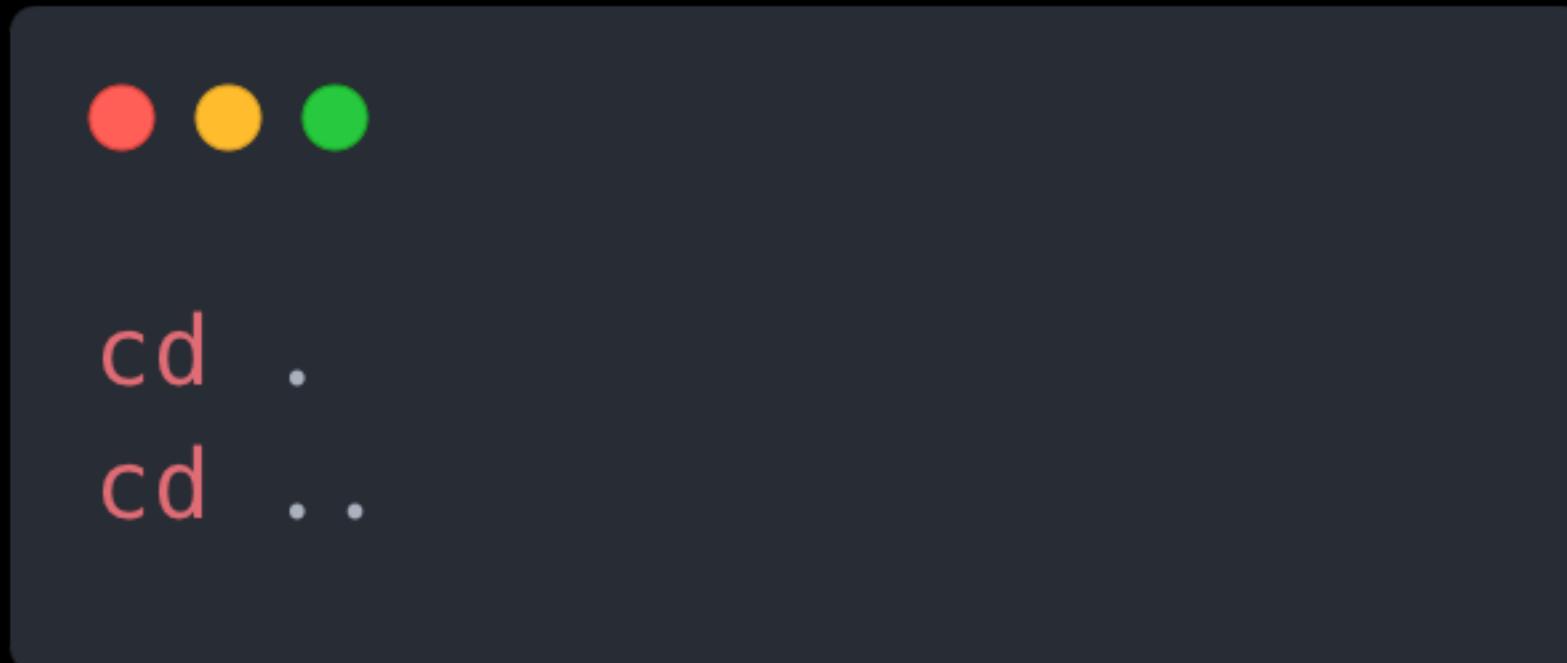
```
(kali㉿ kali)=[~/Desktop]
$ cd

(kali㉿ kali)=[~]
$ ls
Desktop Documents Downloads Music Pictures Public Templates Videos

(kali㉿ kali)=[~]
$ cd Desktop

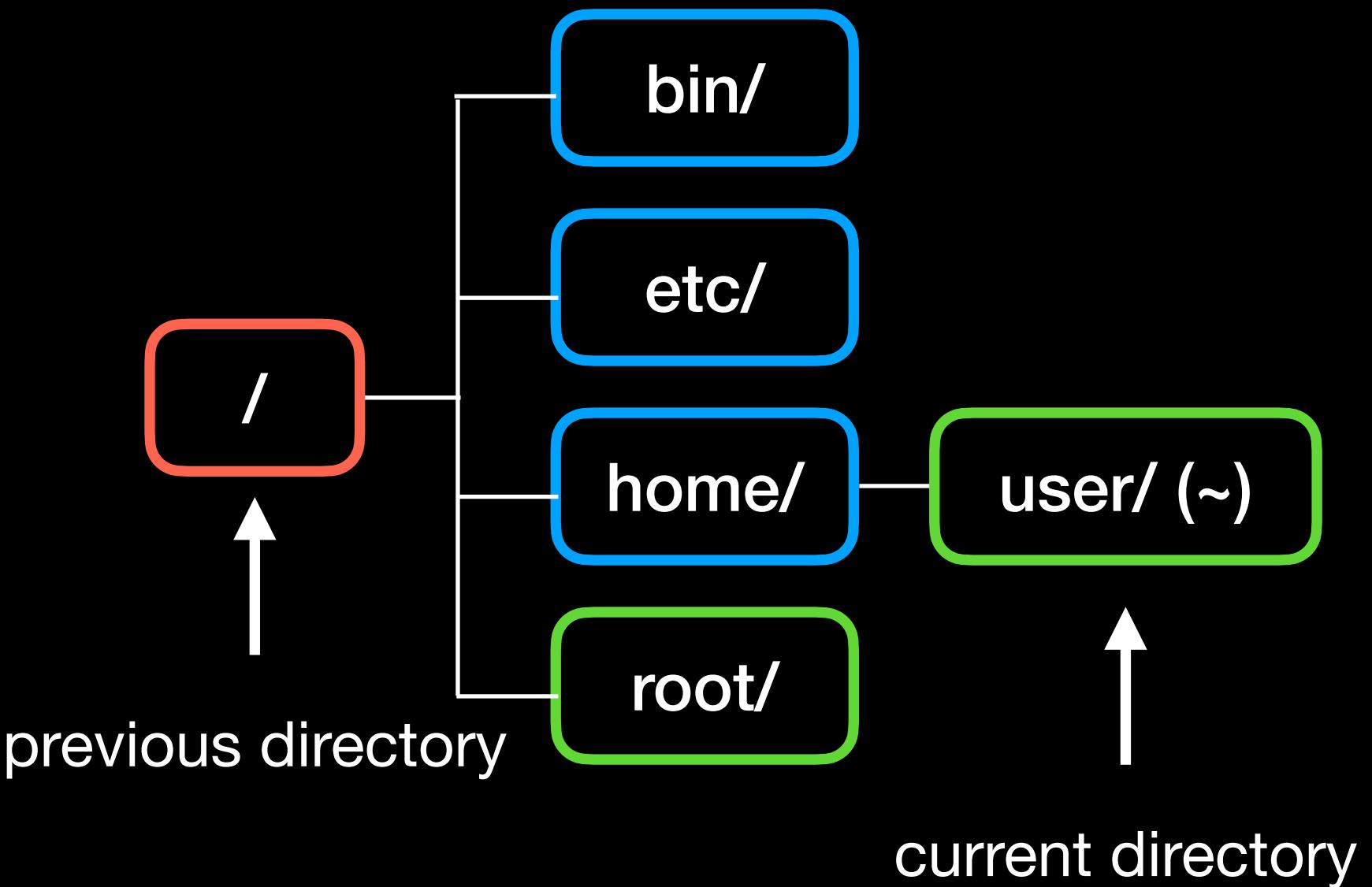
(kali㉿ kali)=[~/Desktop]
$ cd -
~
```

. & ..

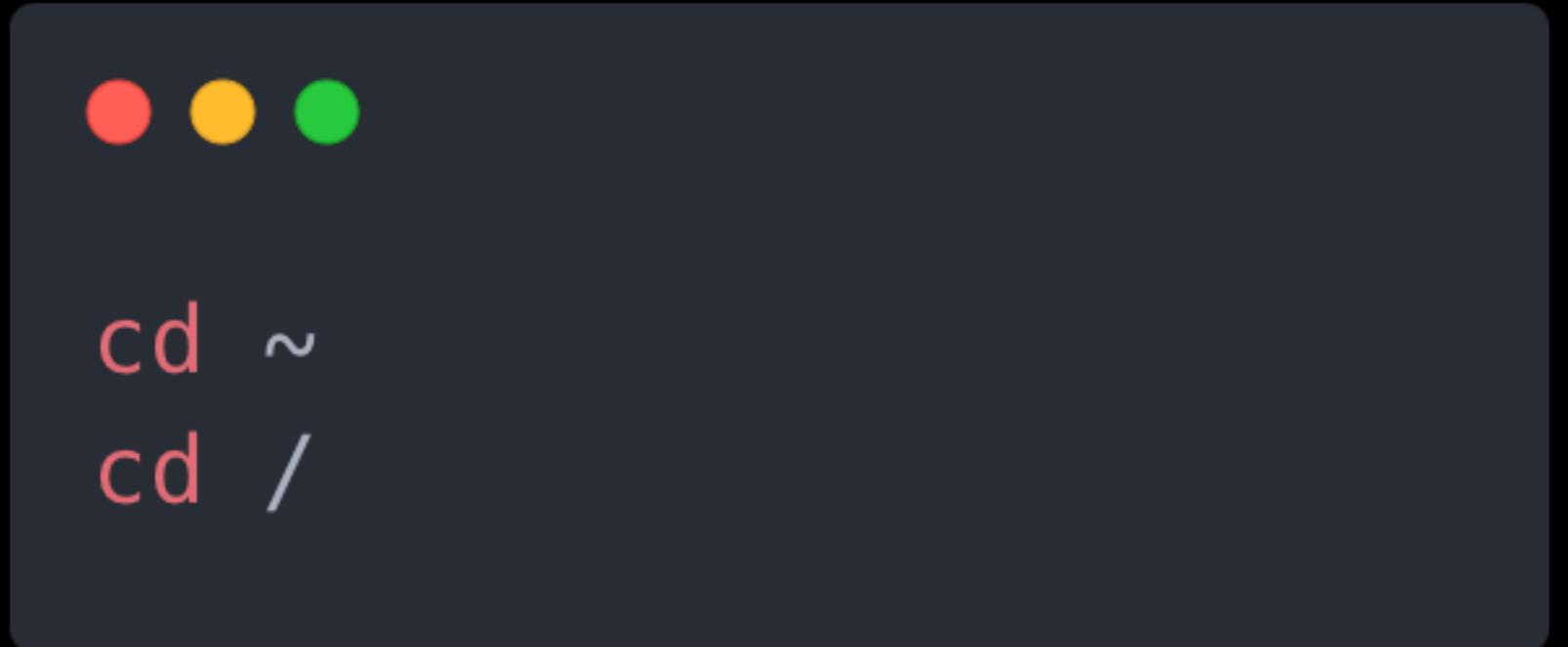


```
cd .
cd ..
```

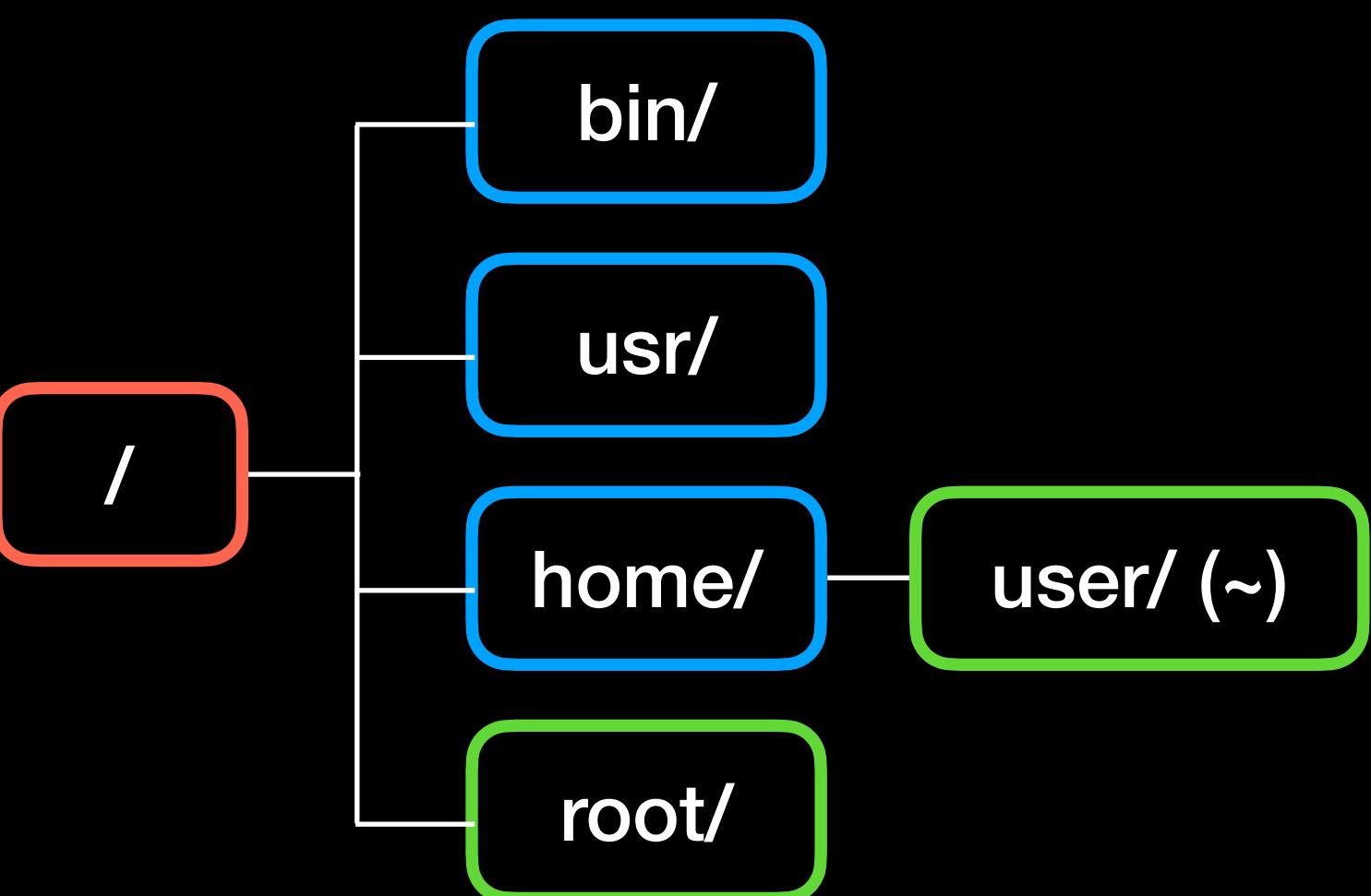
- 用途：`.`代表當前資料夾，`..`代表上一層資料夾
 - `cd ..`
 - `ls` 相同於 `ls .`



~ & /



- 用途：`~` 代表使用者的家目錄 (home)；`/` 代表根目錄 (root)
- `cd ~`
- `ls /`
- 名詞：目錄 = 資料夾



~ & /

```
└─(kali㉿kali)-[~/Desktop]
└─$ ls ~
Desktop Documents Downloads Music Pictures Public Templates Videos

└─(kali㉿kali)-[~/Desktop]
└─$ ls -l /
total 68
-rw-r--r-- 1 root root 0 Aug 31 01:26 0
lrwxrwxrwx 1 root root 7 Aug 31 01:21 bin -> usr/bin
drwxr-xr-x 3 root root 4096 Aug 31 01:41 boot
drwxr-xr-x 17 root root 3200 Aug 31 01:54 dev
drwxr-xr-x 160 root root 12288 Aug 31 01:43 etc
drwxr-xr-x 3 root root 4096 Aug 31 01:41 home
lrwxrwxrwx 1 root root 34 Aug 31 01:21 initrd.img -> boot/initrd.img-
lrwxrwxrwx 1 root root 34 Aug 31 01:21 initrd.img.old -> boot/initrd.
lrwxrwxrwx 1 root root 7 Aug 31 01:21 lib -> usr/lib
lrwxrwxrwx 1 root root 9 Aug 31 01:21 lib32 -> usr/lib32
lrwxrwxrwx 1 root root 9 Aug 31 01:21 lib64 -> usr/lib64
lrwxrwxrwx 1 root root 10 Aug 31 01:21 libx32 -> usr/libx32
drwx----- 2 root root 16384 Aug 31 01:21 lost+found
drwxr-xr-x 3 root root 4096 Aug 31 01:21 media
drwxr-xr-x 2 root root 4096 Aug 31 01:21 mnt
drwxr-xr-x 3 root root 4096 Aug 31 01:25 opt
dr-xr-xr-x 184 root root 0 Aug 31 01:43 proc
drwx----- 3 root root 4096 Aug 31 01:43 root
drwxr-xr-x 32 root root 840 Aug 31 02:18 run
```

pwd



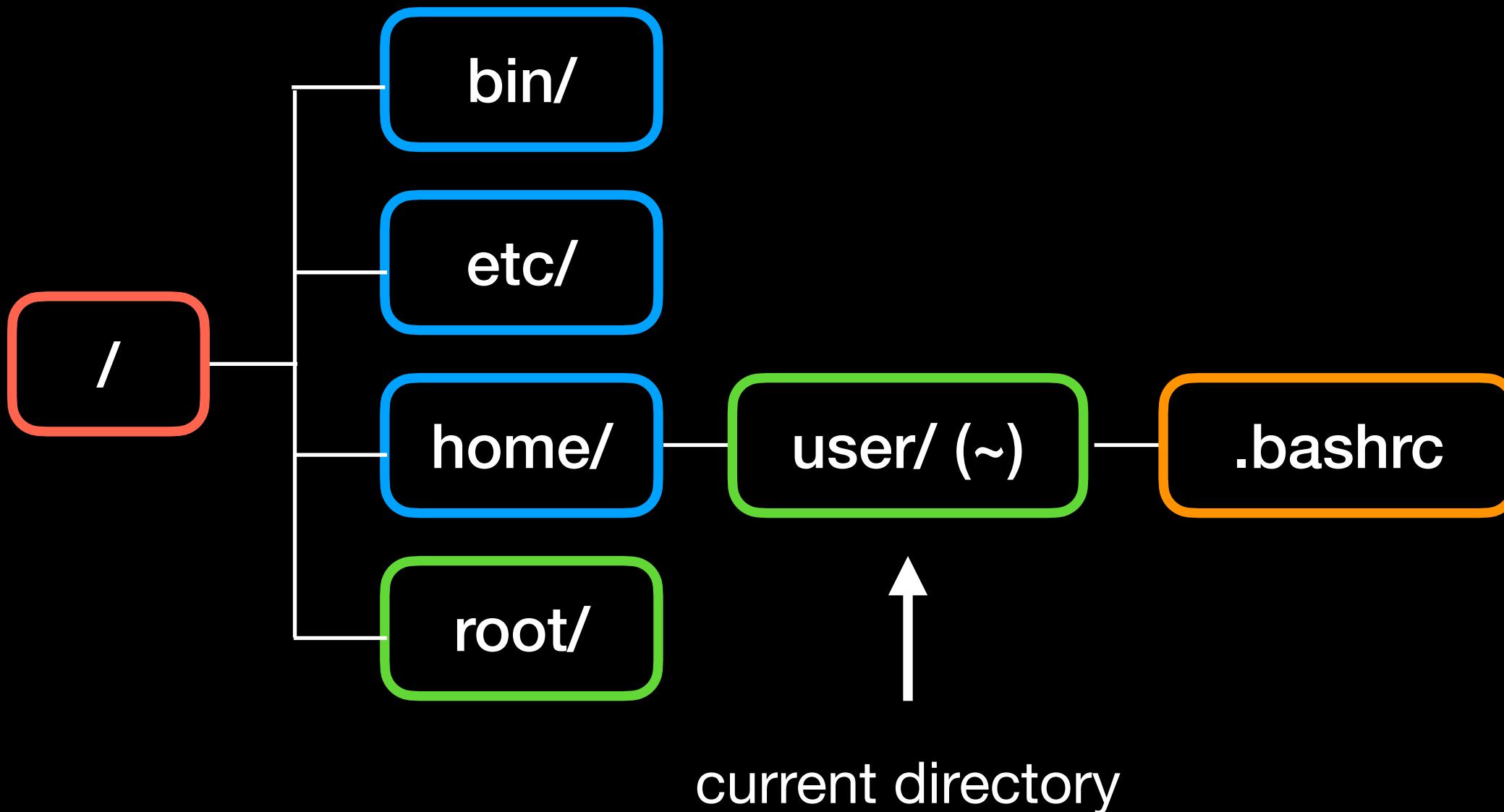
- 用途：顯示當前資料夾的路徑

pwd

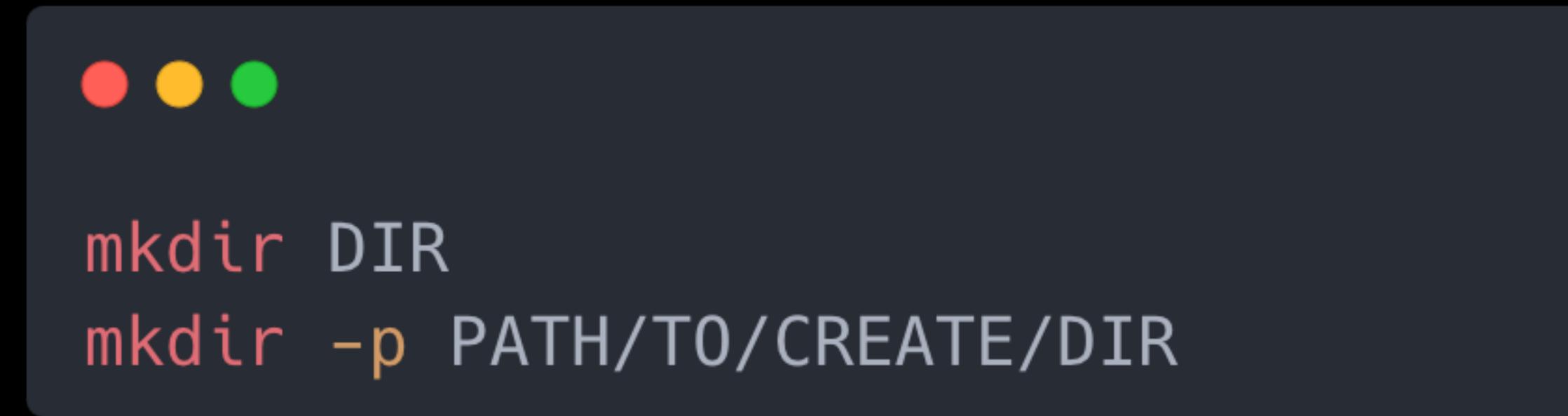
```
(kali㉿kali)-[~/Desktop]
$ pwd
/home/kali/Desktop
```

相對路徑 v.s. 絶對路徑

- 絶對路徑：從 **/** 開始指定的路徑，e.g.：**/home/user/.bashrc**、**/etc**
- 相對路徑：從當前資料夾開始指定的路徑，e.g.：**./.bashrc**、**../../etc**



mkdir



- 用途：建立 DIR 資料夾
- -p：若路徑中的資料夾不存在，則自動建立資料夾
- 如果 `mkdir -p /path/to/create/dir` 中的 `create/` 不存在，則自動建立 `create/`

```
(kali㉿kali)-[~]
$ ls
Desktop Documents Downloads Music Pictures Public Templates TobeExe Videos hello hello.c

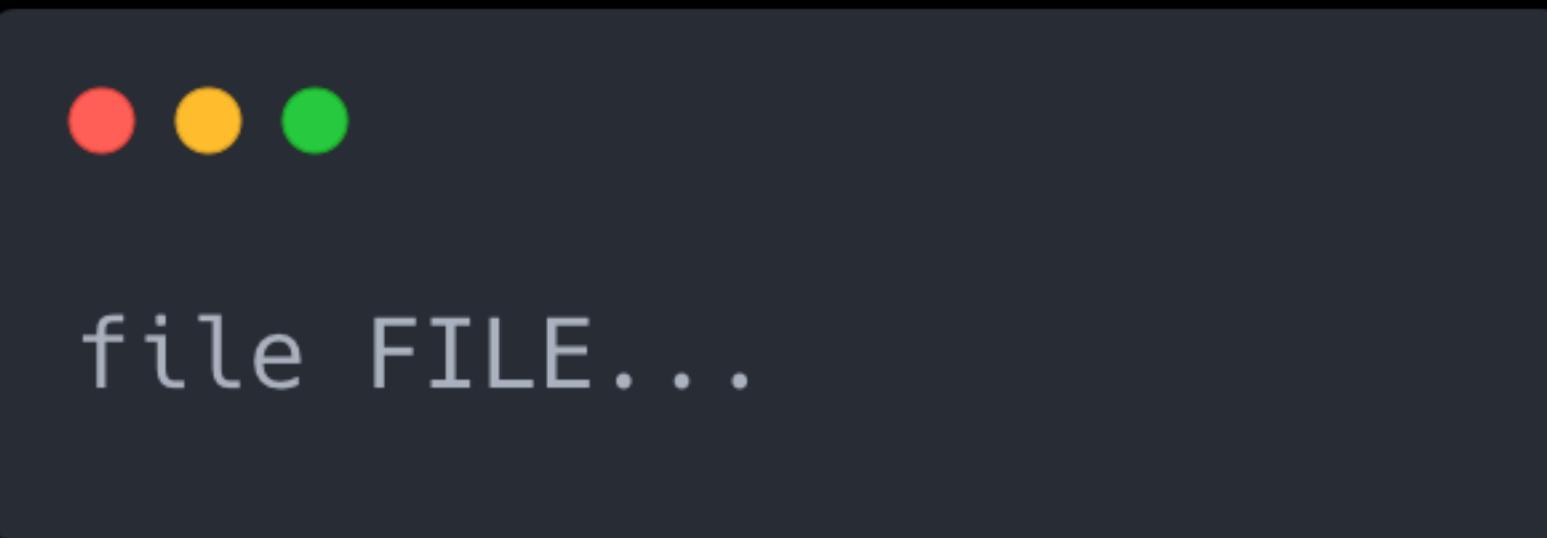
(kali㉿kali)-[~]
$ mkdir myDirectory

(kali㉿kali)-[~]
$ ls
Desktop Documents Downloads Music Pictures Public Templates TobeExe Videos hello hello.c myDirectory
```

Lab

- 練習熟悉一下～

file



- 用途：顯示 FILE 的檔案格式
- 注意：檔案格式與副檔名 (e.g. document.doc) 無關
- 判斷方式：系統資訊 → magic number → language test

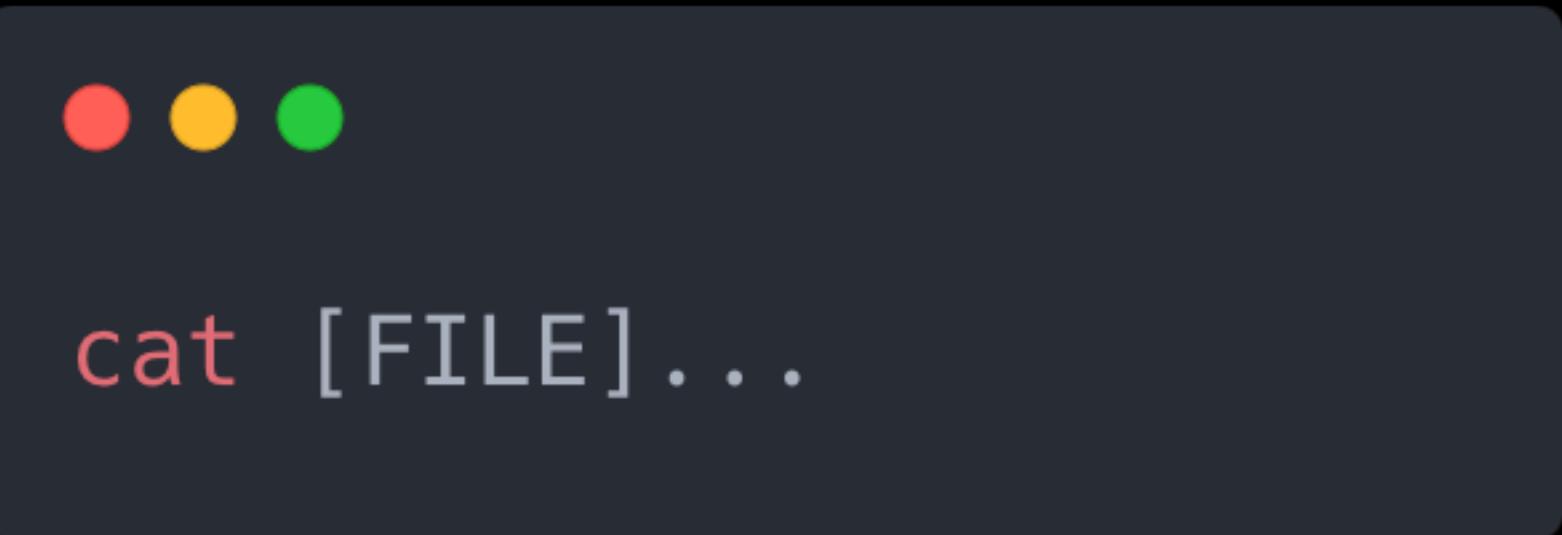
file

```
└──(kali㉿ kali)-[~]
└─$ file Desktop
Desktop: directory

└──(kali㉿ kali)-[~]
└─$ file .bashrc
.bashrc: Unicode text, UTF-8 text

└──(kali㉿ kali)-[~]
└─$ file hello
hello: ELF 64-bit LSB pie executable, x86-64, version 1 (SYSV), dynamically linked, 可執行檔
2ab9600f2096f833ebb04a985902f6db9, for GNU/Linux 3.2.0, not stripped
```

cat



- 用途：顯示檔案內容
- cat .bashrc

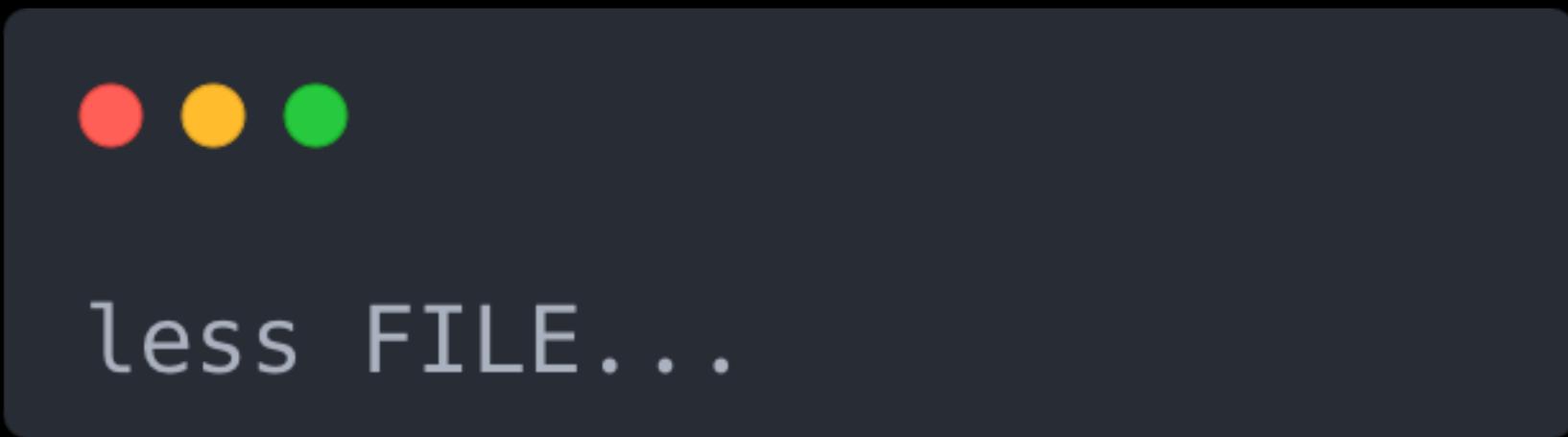
cat

```
(kali㉿kali)-[~]
$ cat .bashrc
# ~/.bashrc: executed by bash(1) for non-login shells.
# see /usr/share/doc/bash/examples/startup-files (in the package bash-doc)
# for examples

# If not running interactively, don't do anything
case $- in
  *i*) ;;
  *) return;;
esac

# don't put duplicate lines or lines starting with space in the history.
# See bash(1) for more options
HISTCONTROL=ignoreboth
```

less



- 用途：瀏覽檔案內容
- 當前 man 預設的瀏覽工具
- **j / k**：往下 / 上捲動一行
- **f / b**：往下 / 上捲動一頁
- **/pattern**：在檔案中往下搜尋 pattern
- **n / shift-n**：下 / 上一個搜尋結果
- **g**：回到檔案開頭
- **q**：離開

NAME

less – opposite of **more**

SYNOPSIS

```
less -?
less --help
less -V
less --version
less [-[+]aABcCdeEfFgGiIJKLMNOPQRSTUVWXYZ]
      [-b space] [-h lines] [-j line] [-k keyfile]
      [-{o0} logfile] [-p pattern] [-P prompt] [-t tag]
      [-T tagsfile] [-x tab,...] [-y lines] [-[z] lines]
      [-# shift] [+[-]cmd] [--] [filename]...
```

(See the OPTIONS section for alternate option syntax with long option names.)

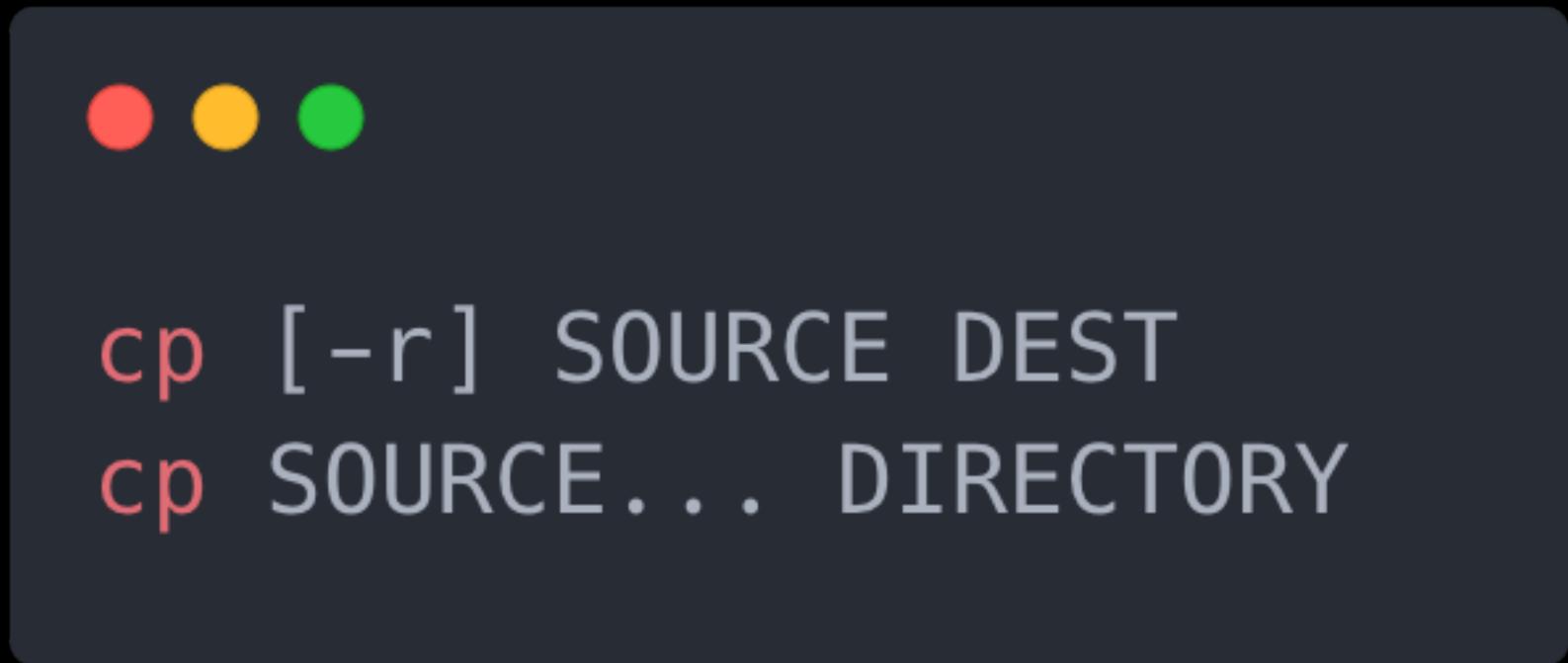
DESCRIPTION

Less is a program similar to **more**(1), but it has many more features. **Less** does not have to read the entire input file before starting, so with large input files it starts up faster than text editors like **vi**(1). **Less** uses termcap (or terminfo on some systems), so it can run on a variety of terminals. There is even limited support for hardcopy terminals. (On a hardcopy terminal, lines which should be printed at the top of the screen are prefixed with a caret.)

Commands are based on both **more** and **vi**. Commands may be preceded by a decimal number, called N in the descriptions below. The number is used by some commands, as indicated.

Manual page less(1) line 1 (press h for help or q to quit) █

cp



- 用途
 - 複製檔案 SOURCE 為檔案 DEST
 - 複製多個檔案到 DIRECTORY
- **-r** : 複製整個資料夾

```
└──(kali㉿kali)-[~/Lab]
└─$ ls
a
```

```
└──(kali㉿kali)-[~/Lab]
└─$ cat a
This is file 'a'.
```

```
└──(kali㉿kali)-[~/Lab]
└─$ cp a b
```

```
└──(kali㉿kali)-[~/Lab]
└─$ ls
a  b
```

```
└──(kali㉿kali)-[~/Lab]
└─$ cat b
This is file 'a'.
```

Copy file a to file b

```
└──(kali㉿kali)-[~/Lab]
└─$ ls
dir
```

```
└──(kali㉿kali)-[~/Lab]
└─$ ls dir
a
```

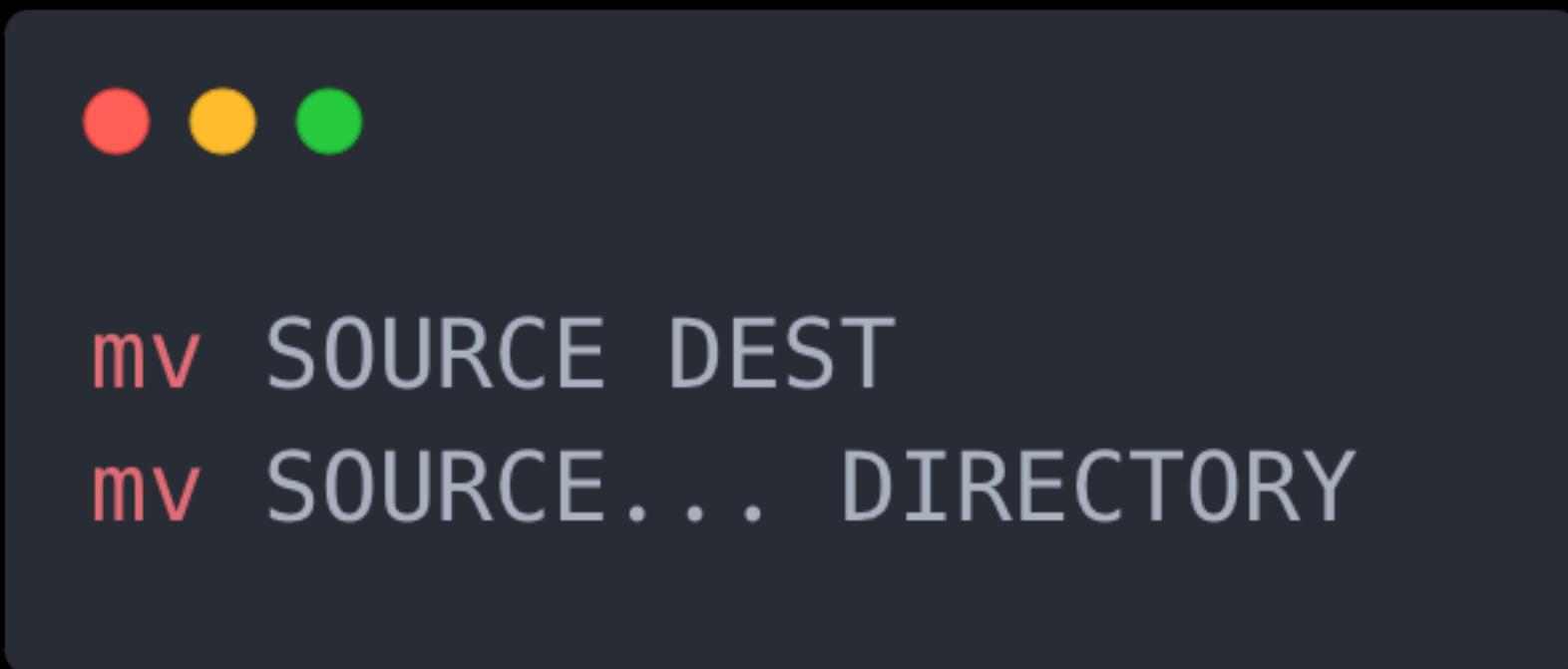
```
└──(kali㉿kali)-[~/Lab]
└─$ cp -r dir dir2
```

```
└──(kali㉿kali)-[~/Lab]
└─$ ls
dir  dir2
```

```
└──(kali㉿kali)-[~/Lab]
└─$ ls dir2
a
```

Copy directory dir to directory dir2

mv



- 用途：
 - 移動 SOURCE 到 DIRECTORY
 - 將 SOURCE 重新命名為 DEST

```
(kali㉿ kali)=[~/Lab]
└─$ ls
a dir

(kali㉿ kali)=[~/Lab]
└─$ ls dir

(kali㉿ kali)=[~/Lab]
└─$ mv a dir/
(kali㉿ kali)=[~/Lab]
└─$ ls
dir

(kali㉿ kali)=[~/Lab]
└─$ ls dir
a
```

Move file a into directory dir

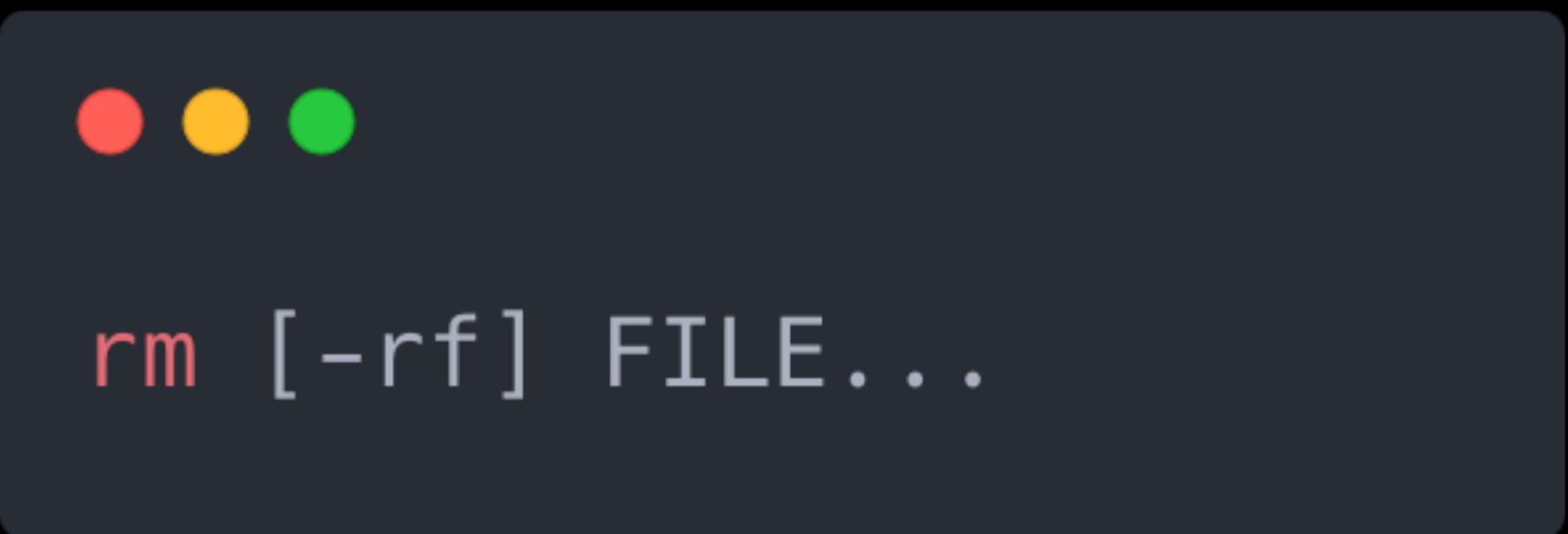
```
(kali㉿ kali)=[~/Lab]
└─$ ls
a

(kali㉿ kali)=[~/Lab]
└─$ mv a b

(kali㉿ kali)=[~/Lab]
└─$ ls
b
```

Rename file a to b

rm



- 用途：刪除檔案 FILE
- **-r**：遞迴刪除有含內容的資料夾
- **-f**：無視不存在檔案，不顯示警告直接刪除
- 千萬不要 **rm -rf /**

```
└─(kali㉿kali)-[~/lab]
└─$ ls
a  dir

└─(kali㉿kali)-[~/lab]
└─$ rm a

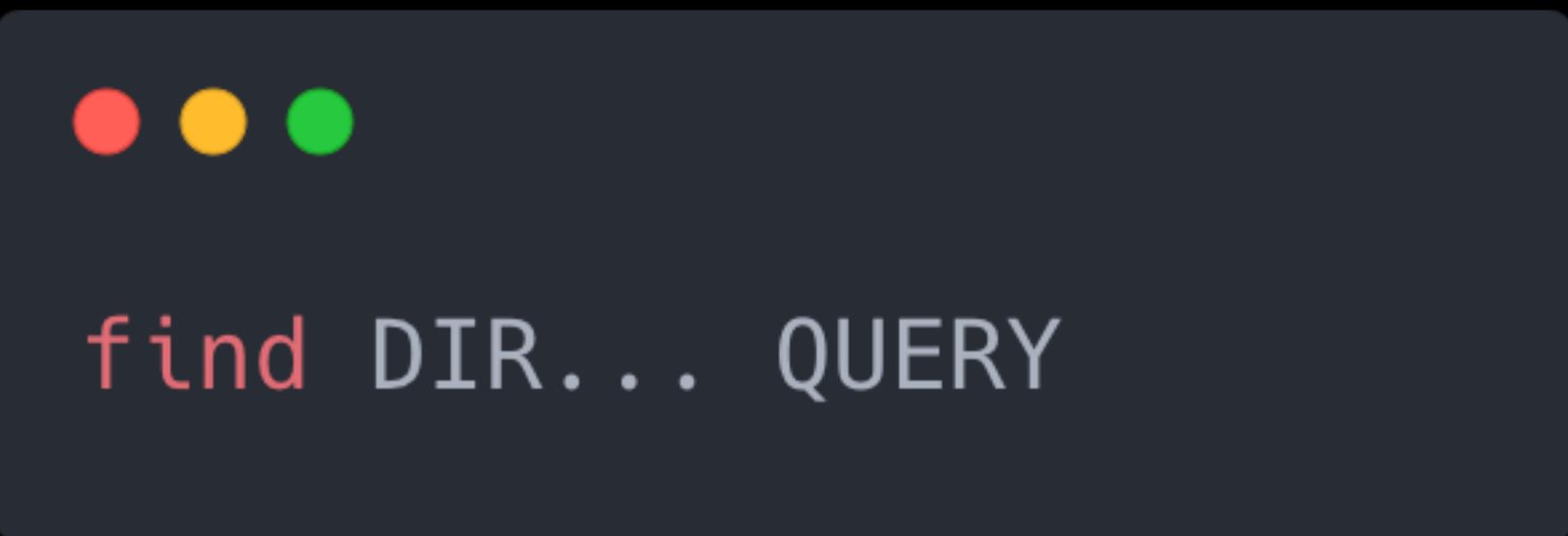
└─(kali㉿kali)-[~/lab]
└─$ ls
dir

└─(kali㉿kali)-[~/lab]
└─$ rm -r dir

└─(kali㉿kali)-[~/lab]
└─$ ls
```

Remove file a and directory dir

find



- 用途：在 DIR 資料夾下尋找符合 QUERY 的檔案
- QUERY：
 - **-name NAME**：檔案名稱
 - **-type TYPE**：檔案類型
- 詳細請參考 man find

find

```
(kali㉿ kali)~]$ find . -name "*rc"
./.dmrc
./.config/xfce4/desktop/icons.screen0-1008x717.rc
./.config/xfce4/desktop/icons.screen.latest.rc
./.config/xfce4/panel/cpugraph-13.rc
./.config/xfce4/panel/genmon-15.rc
./.zshrc
./.bashrc
```

grep



```
grep [-v] PATTERNS FILE...
grep -e PATTERN FILE...
grep -E PATTERN FILE...
```

- 用途：印出檔案 FILE 中符合 PATTERNS 的行
- **-v**：反向匹配，列出不符合 PATTERNS 的行
- **-e**：使用多次可指定多個可能的 PATTERNS，或是處理開頭為 - 的情況
- **-E**：將 PATTERNS 視為 extended regex

```
└─(kali㉿kali)-[~]
└─$ cat text
```

```
3742
-3742
1234
1423
```

```
└─(kali㉿kali)-[~]
└─$ grep 3742 text
3742
-3742
```

```
└─(kali㉿kali)-[~]
└─$ grep -v 3742 text
1234
1423
```

```
└─(kali㉿kali)-[~]
└─$ grep -e - text
-3742
```

```
└─(kali㉿kali)-[~]
└─$ grep -e 37 -e 42 text
3742
-3742
1423
```

```
└─(kali㉿kali)-[~]
└─$ grep -E "37|42" text
3742
-3742
1423
```

Lab – Grab the flag

- 下載檔案
 1. 右鍵 grab_the_flag 複製檔案連結
 2. 輸入 wget "檔案連結"

```
└─(kali㉿kali)-[~]
  $ wget http://210.70.138.222/files/b38d2dbd7d2954f8ba4bec9a44da8e0c/grab_the_flag
--2023-09-14 15:15:31--  http://210.70.138.222/files/b38d2dbd7d2954f8ba4bec9a44da8e0c/grab_the_flag
Connecting to 210.70.138.222:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2800028 (2.7M) [application/octet-stream]
Saving to: 'grab_the_flag'

grab_the_flag                                         100%[=====]  9.77 MB/s

2023-09-14 15:15:31 (9.77 MB/s) - 'grab_the_flag' saved [2800028/2800028]
```

Lab – Grab the flag

Grab the flag

100

你知道如何使用 `grep` 指令嗎？請從檔案 `grab_the_flag` 中找出開頭為 `???` 且結尾為 `!!!` 的 flag。

Flag 格式：`FLAG{???.something_in_between_!!!}`

`grab_the_flag`

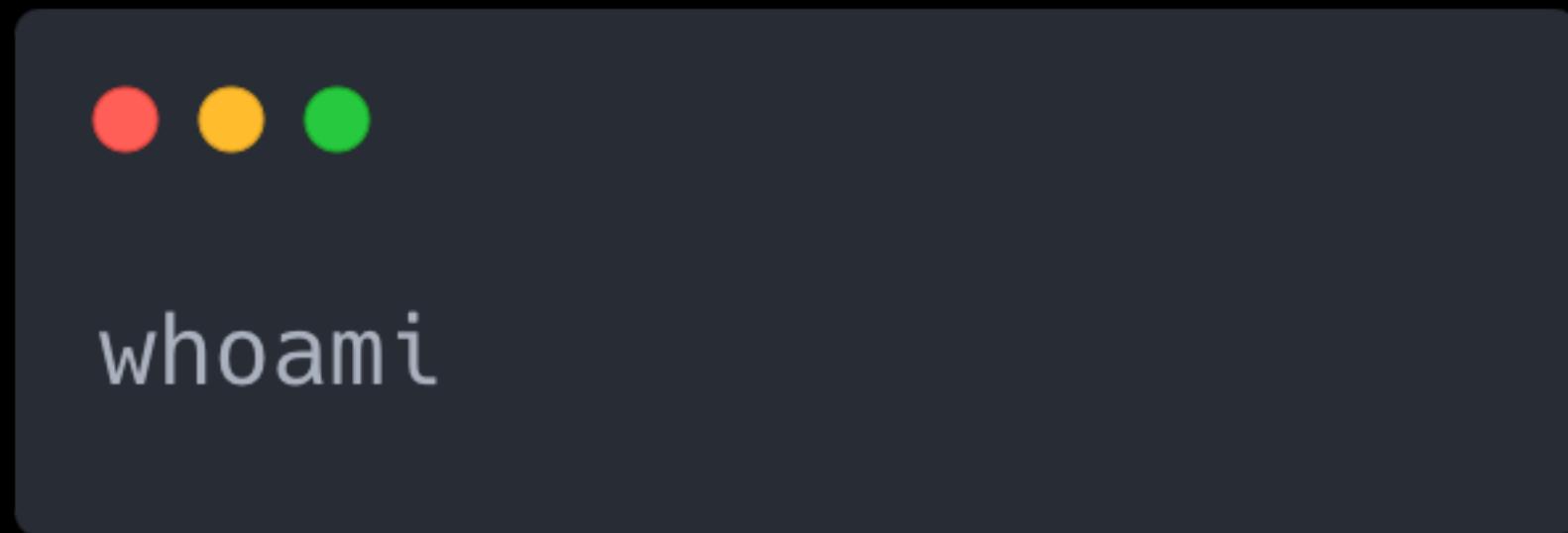
User & Group 使用者與群組

User 使用者

- 除了用戶是使用者，許多服務也會建立服務專屬的使用者
- 使用者擁有家目錄、群組等
- 使用者列表位於 /etc/passwd

```
(kali㉿kali)-[~]
$ cat /etc/passwd
root:x:0:0:root:/root:/usr/bin/zsh
daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
bin:x:2:2:bin:/bin:/usr/sbin/nologin
sys:x:3:3:sys:/dev:/usr/sbin/nologin
sync:x:4:65534:sync:/bin:/bin/sync
games:x:5:60:games:/usr/games:/usr/sbin/nologin
man:x:6:12:man:/var/cache/man:/usr/sbin/nologin
lp:x:7:7:lp:/var/spool/lpd:/usr/sbin/nologin
mail:x:8:8:mail:/var/mail:/usr/sbin/nologin
news:x:9:9:news:/var/spool/news:/usr/sbin/nologin
```

whoami



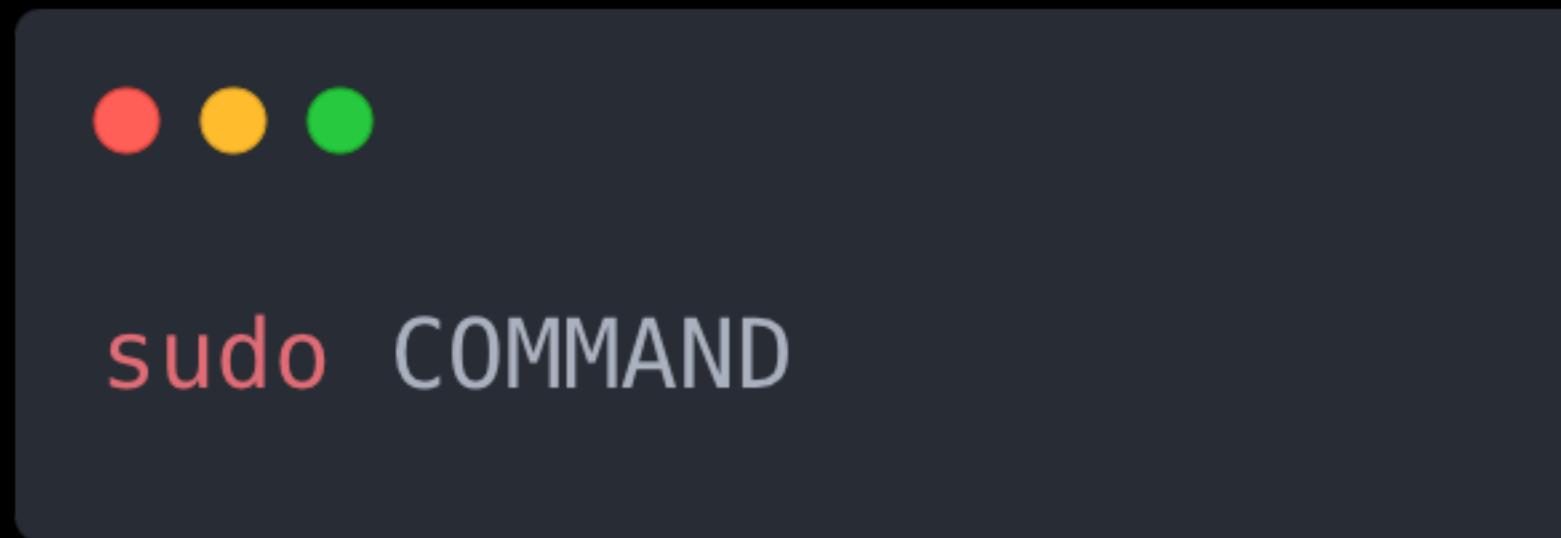
- 用途：顯示使用者名稱

```
(kali㉿kali)-[~]
$ whoami
kali
```

Root

- root 是最高權限使用者
- 所有系統操作皆需要 root 授權
 - 安裝程式
 - 開啟、關閉系統服務
 - 修改系統設定
- 雖然很方便，但大多數情況下不應該直接用 root 身份進行操作

sudo



- 用途：使用 root 權限執行指令 **COMMAND**
- 需輸入當前使用者的密碼
- 使用者須具有 root 權限才能使用 sudo，設定檔位於 /etc/sudoers

sudo

```
(kali㉿kali)-[~]
└─$ cat /etc/sudoers
cat: /etc/sudoers: Permission denied

(kali㉿kali)-[~]
└─$ sudo cat /etc/sudoers
#
# This file MUST be edited with the 'visudo' command as root.
#
# Please consider adding local content in /etc/sudoers.d/ instead of
# directly modifying this file.
```

SU



- 用途：切換至使用者 **USER**
- 需輸入該使用者的密碼

SU

```
└─(kali㉿ kali)-[~]
└$ whoami
kali

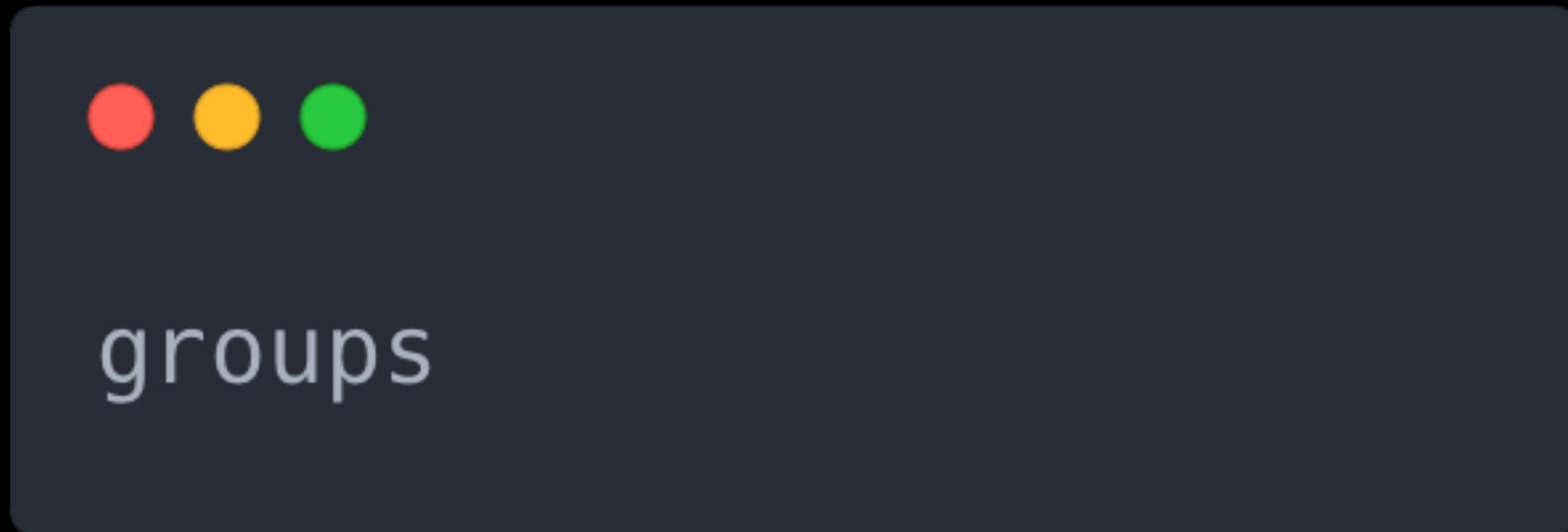
└─(kali㉿ kali)-[~]
└$ sudo su root
[sudo] password for kali:
└─(root㉿ kali)-[/home/kali]
└# whoami
root
```

Group 群組

- 每個使用者有自己獨立的群組
- 每個使用者可加入多個群組
- 用於管理權限，如：sudoers
- 群組列表位於 /etc/group

```
(kali㉿ kali)~]$ cat /etc/group
root:x:0:
daemon:x:1:
bin:x:2:
sys:x:3:
adm:x:4:kali
tty:x:5:
disk:x:6:
lp:x:7:
mail:x:8:
```

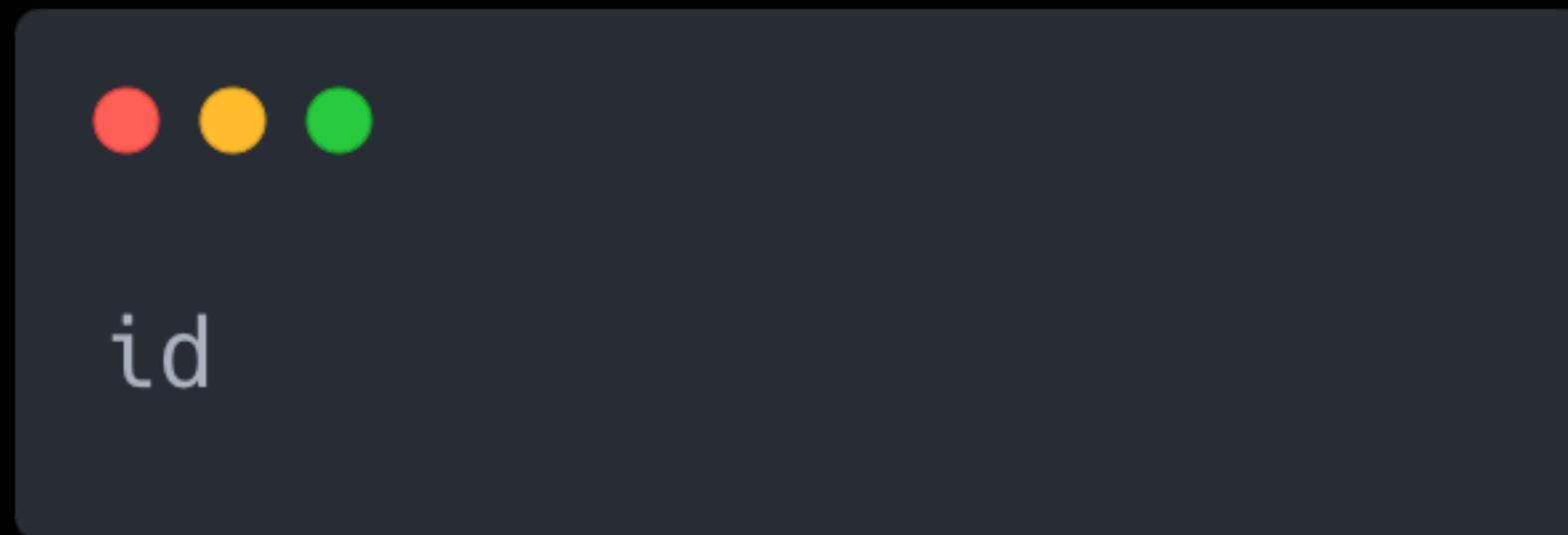
groups



- 用途：查看使用者所屬群組

```
|__ (kali㉿kali)-[~]
|__ $ groups
kali adm dialout cdrom floppy sudo audio dip video plugdev netdev wireshark bluetooth scanner kaboxer
```

id



- 用途：查看使用者的名稱、UID 和所屬群組

```
| (kali㉿kali)-[~]
| $ id
| uid=1000(kali) gid=1000(kali) groups=1000(kali),4(adm),20(dialout),24(cdrom),25(floppy),27(sudo),29(audio),30(dip),
| 44(video),46(plugdev),109(netdev),119(wireshark),121(bluetooth),137(scanner),141(kaboxer)
```

Lab – What can Super User DO

What can SUper DO

100

你知道遇到 Permission denied 的時候是出了什麼問題嗎？請找出檔案
`/etc/shadow` 的第一行內容為何。

Flag 格式：`FLAG{first line of /etc/shadow}`

File Permission 檔案權限

```
(kali㉿ kali)~]$ ls -al
total 132
drwxr-xr-x 15 kali kali 4096 Aug 31 05:41 .
drwxr-xr-x  3 root root 4096 Aug 31 01:41 ..
-rw-----  1 kali kali     0 Aug 31 01:44 .ICEauthority
-rw-----  1 kali kali    49 Aug 31 01:44 .Xauthority
-rw-r--r--  1 kali kali   220 Aug 31 01:41 .bash_logout
-rw-r--r--  1 kali kali  5551 Aug 31 01:41 .bashrc
-rw-r--r--  1 kali kali 3526 Aug 31 01:41 .bashrc.original
drwxr-xr-x  5 kali kali 4096 Aug 31 02:04 .cache
drwxr-xr-x 12 kali kali 4096 Aug 31 02:04 .config
-rw-r--r--  1 kali kali    35 Aug 31 02:03 .dmrc
-rw-r--r--  1 kali kali 11759 Aug 31 01:41 .face
lrwxrwxrwx  1 kali kali      5 Aug 31 01:41 .face.icon -> .face
drwx-----  3 kali kali 4096 Aug 31 01:44 .gnupg
drwxr-xr-x  3 kali kali 4096 Aug 31 01:41 .java
```

檔案權限

檔案擁有者

檔案所屬群組

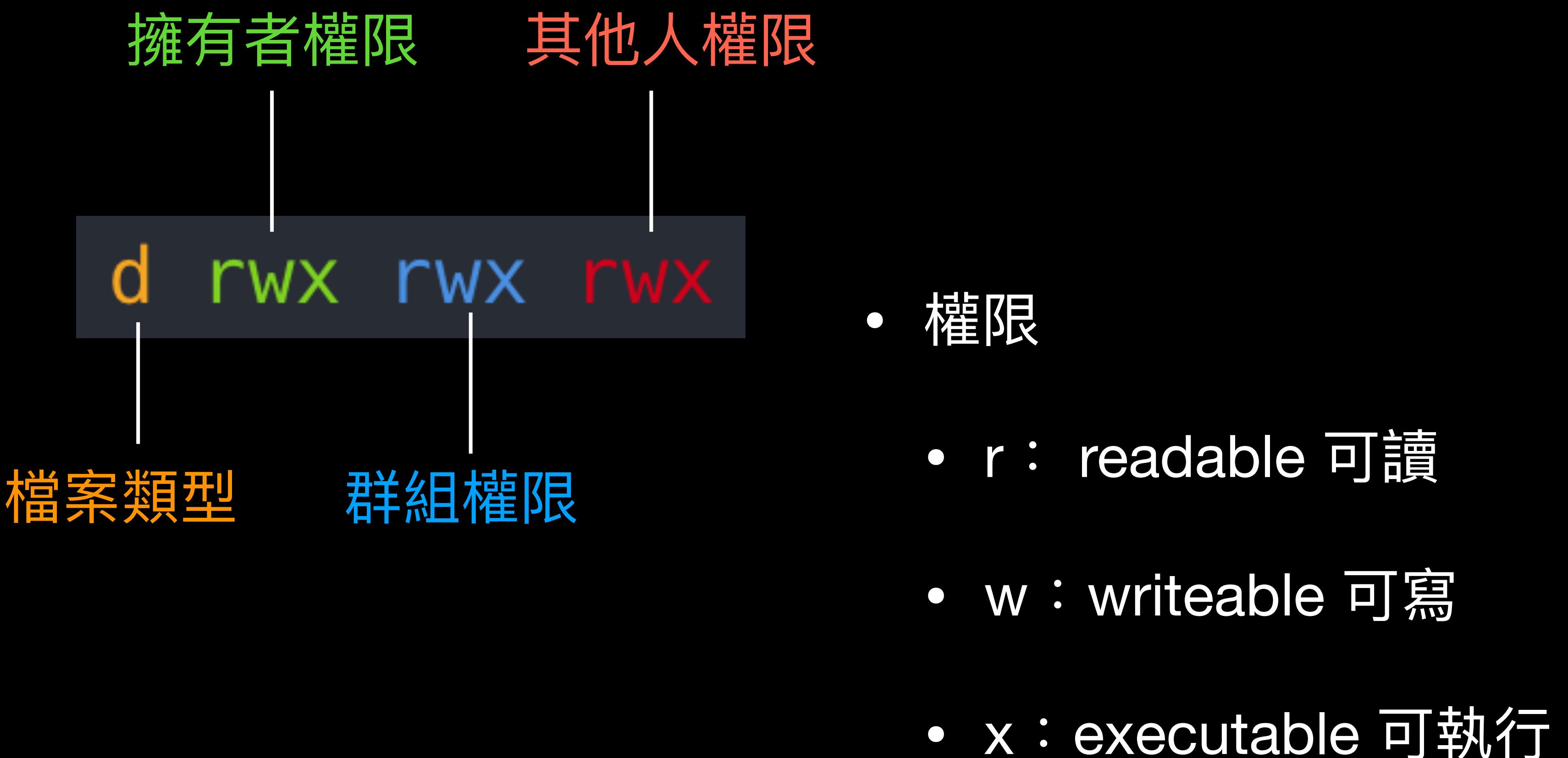
File Permission 檔案權限

- 檔案類型

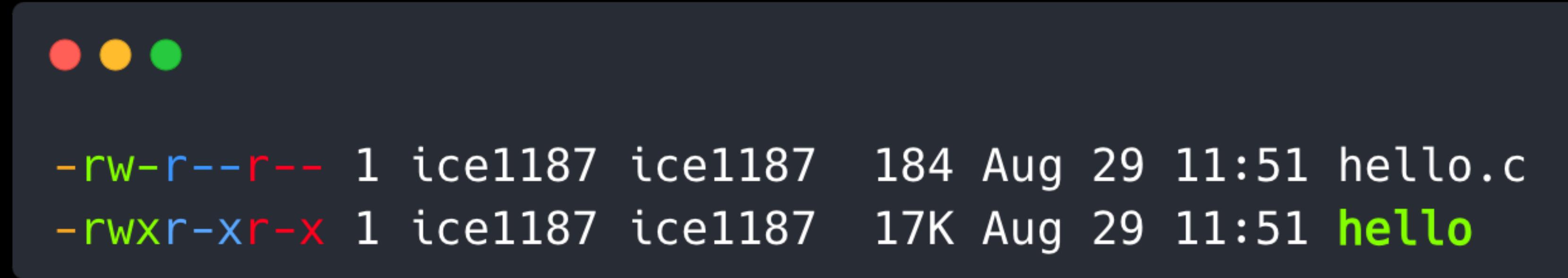
- - : 一般檔案

- d : 目錄

- l : 連結檔



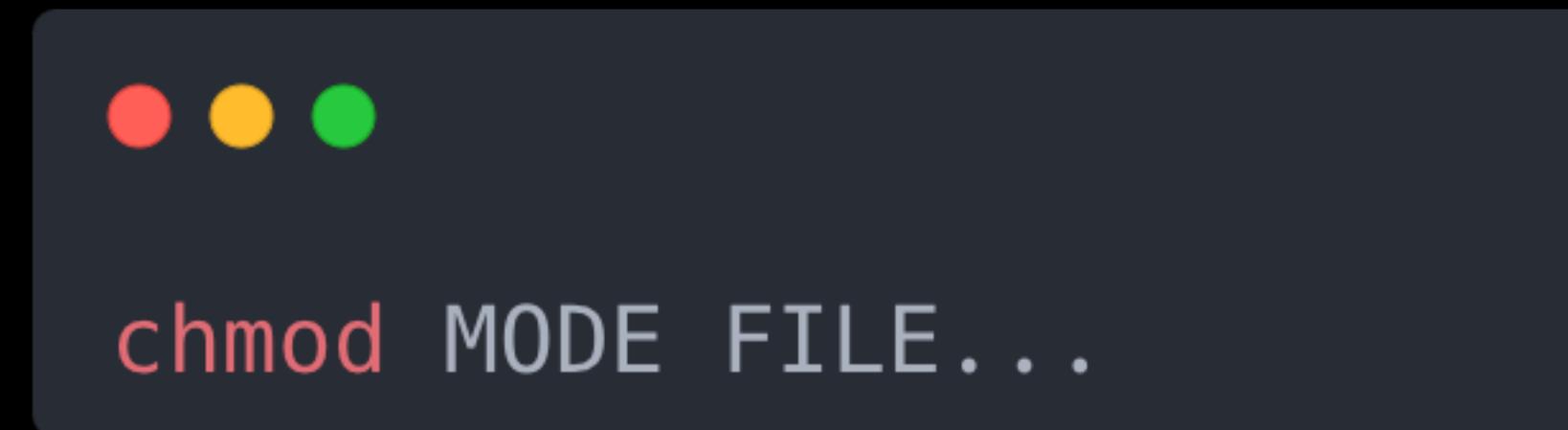
File Permission 檔案權限



```
-rw-r--r-- 1 ice1187 ice1187 184 Aug 29 11:51 hello.c
-rwxr-xr-x 1 ice1187 ice1187 17K Aug 29 11:51 hello
```

- 擁有者 `ice1187`：可讀 / 可寫 / 可執行
- 屬於 `ice1187` 群組的使用者：可讀 / 可執行
- 其他使用者：可讀 / 可執行
- 不同檔案格式，其預設的權限不同：
 - `hello.c` 原始碼不可執行；`hello` 執行檔可執行

chmod



- 用途：改變檔案 FILE 的檔案權限為 MODE
- MODE
 - 用數字表示： $r / w / x = 4 / 2 / 1$
 - $rwxr-x-r-x = 755$
 - $rwxrw-r-- = 764$
- 用 +- 增減權限：
 - 使用 +r / +w / +x 增加權限
 - 使用 -r / -w / -x 刪除權限

```
ice1187@ice1187-lab:/tmp$  
ice1187@ice1187-lab:/tmp$ ls hello  
-rwxr-xr-x 1 ice1187 ice1187 17K Aug 31 20:05 hello  
ice1187@ice1187-lab:/tmp$ chmod 764 hello  
ice1187@ice1187-lab:/tmp$ ls hello  
-rwxrw-r-- 1 ice1187 ice1187 17K Aug 31 20:05 hello
```

Change file permission from `rwxr-xr-x` (755) to `rwxrw-r--` (764)

```
ice1187@ice1187-lab:/tmp$ wget 127.0.0.1:8000/hello
--2023-08-31 20:06:03-- http://127.0.0.1:8000/hello
Connecting to 127.0.0.1:8000... connected.
HTTP request sent, awaiting response... 200 OK
Length: 16744 (16K) [application/octet-stream]
Saving to: 'hello'

hello          100%[=====] 16.35K --.-KB/s   in 0s

2023-08-31 20:06:03 (184 MB/s) - 'hello' saved [16744/16744]

ice1187@ice1187-lab:/tmp$ ls hello
-rw-r--r-- 1 ice1187 ice1187 17K Aug 31 20:05 hello
ice1187@ice1187-lab:/tmp$ chmod +x hello
ice1187@ice1187-lab:/tmp$ ls hello
-rwxr-xr-x 1 ice1187 ice1187 17K Aug 31 20:05 hello
```

Add executable permission (+x) to downloaded file

Lab – Give me flag

Give me flag

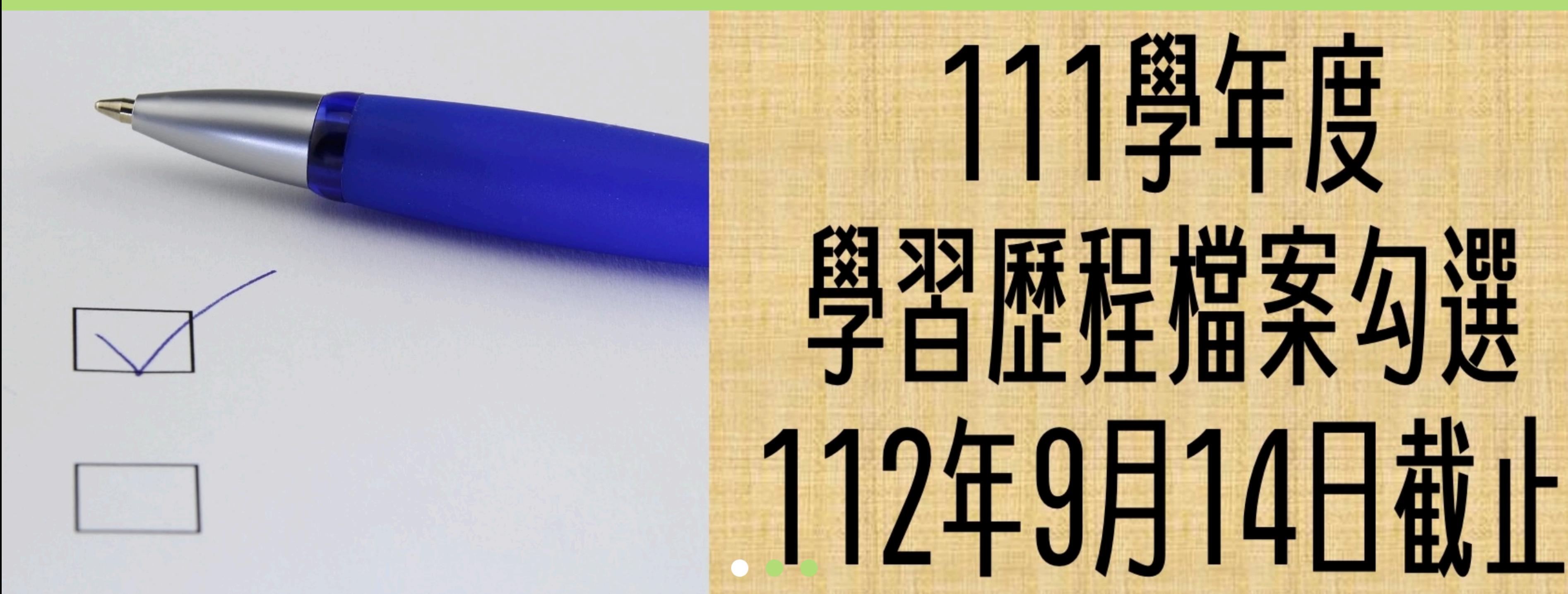
100

你知道如何執行一個下載來的檔案嗎？

Flag 格式：`FLAG{...}`

give_me_flag

Network 網路



111學年度
學習歷程檔案勾選
112年9月14日截止

學生訊息

教職員訊息

升學資訊

考試資訊

社團活動組

置頂

公告：9/14(四)-9/18(一)高一轉社辦理事宜

2023-09-14

生活輔導組

置頂

112年國家防災日地震避難掩護演練注意事項

2023-09-13

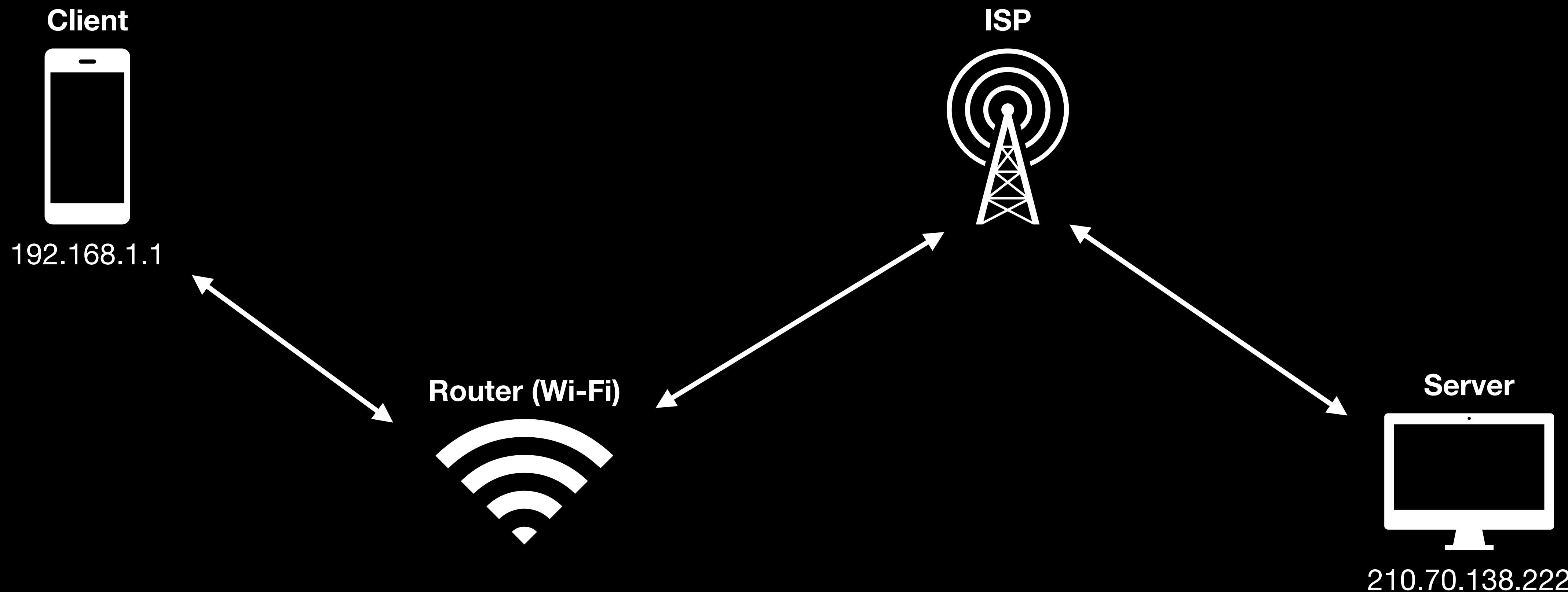
How Internet Works – IP

<https://www.tnfsh.tn.edu.tw/index.html>

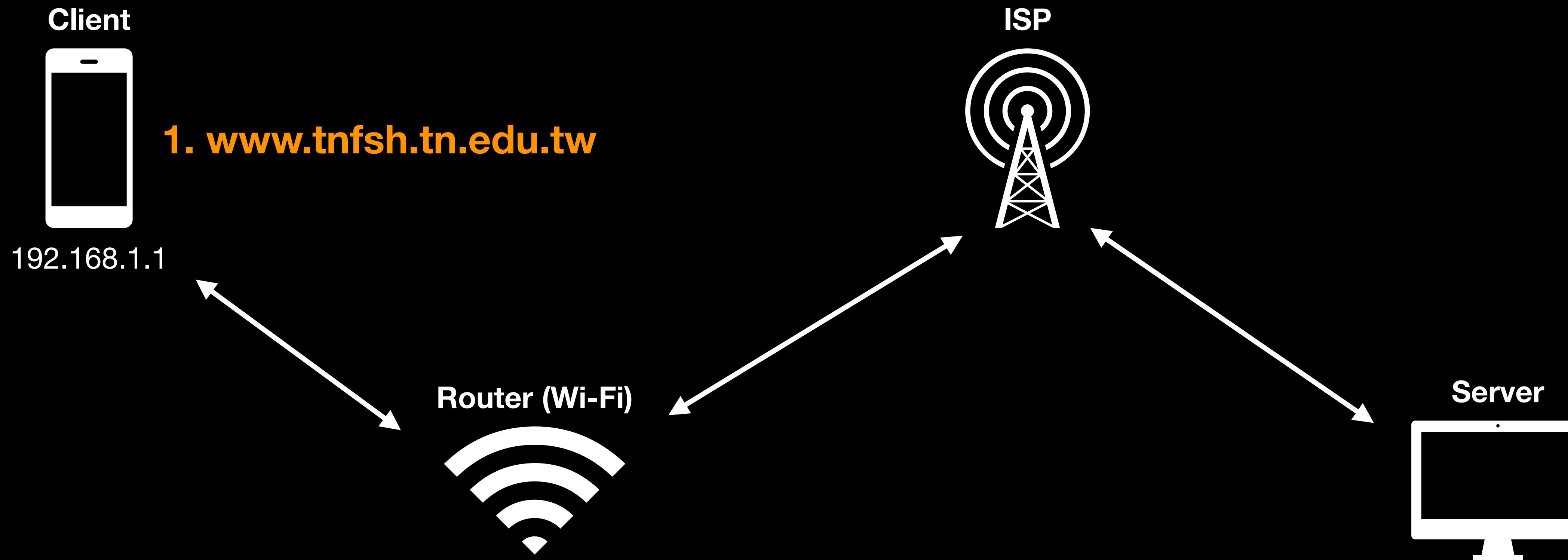


<https://www.tnfsh.tn.edu.tw:443/index.html>

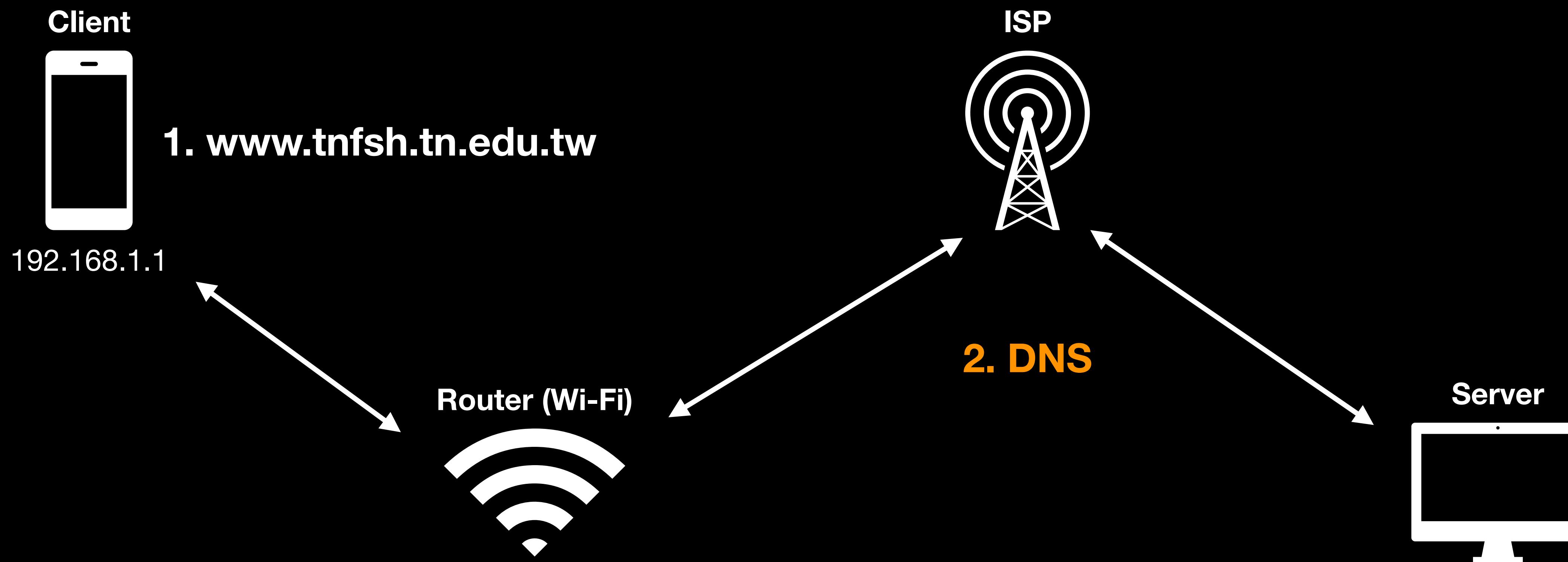
How Internet Works – IP



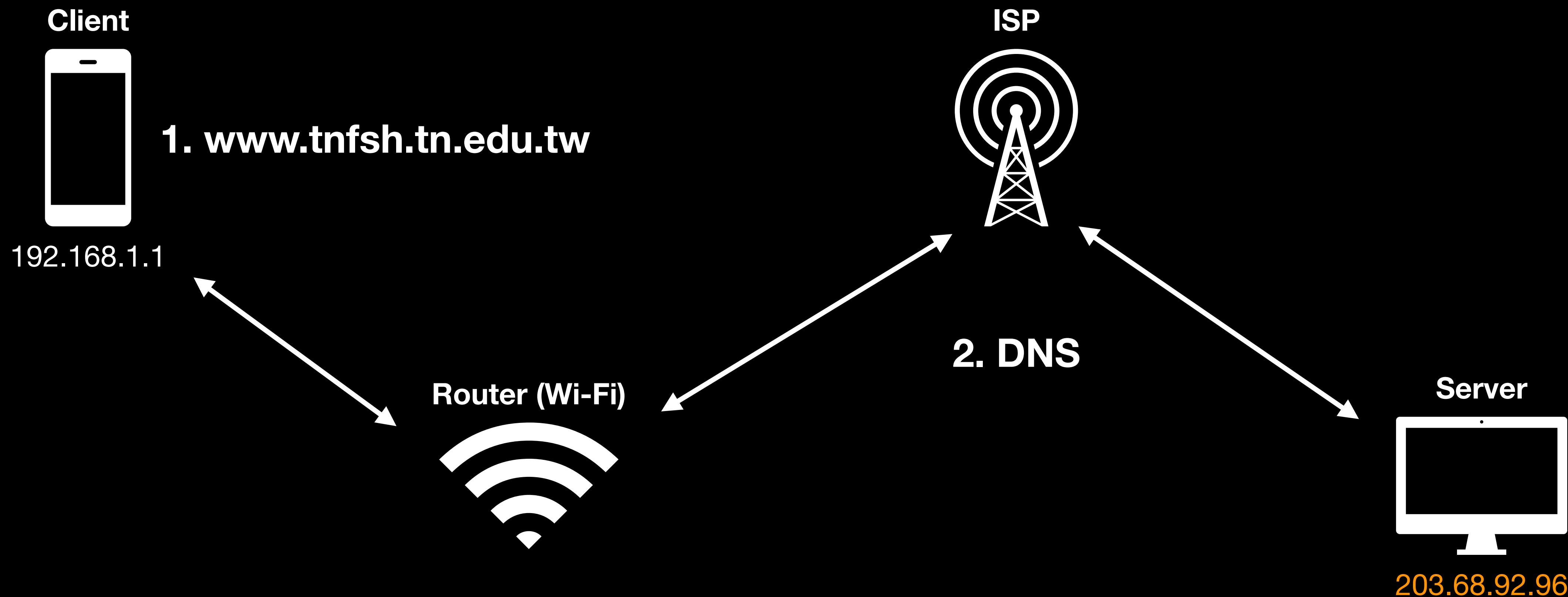
How Internet Works – IP



How Internet Works – IP



How Internet Works – IP



How Internet Works – Port

<https://www.tnfsh.tn.edu.tw/index.html>



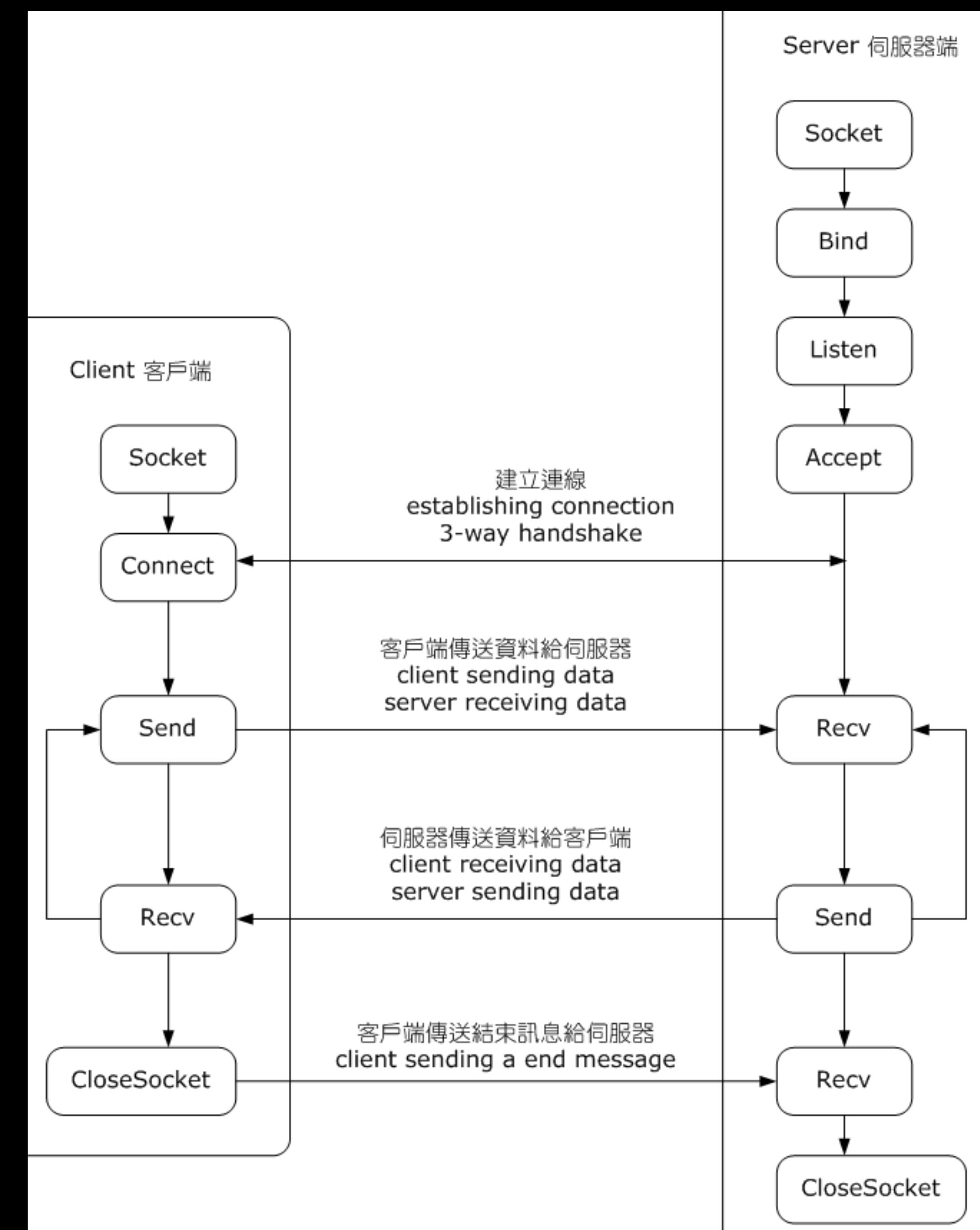
<https://www.tnfsh.tn.edu.tw:443/index.html>



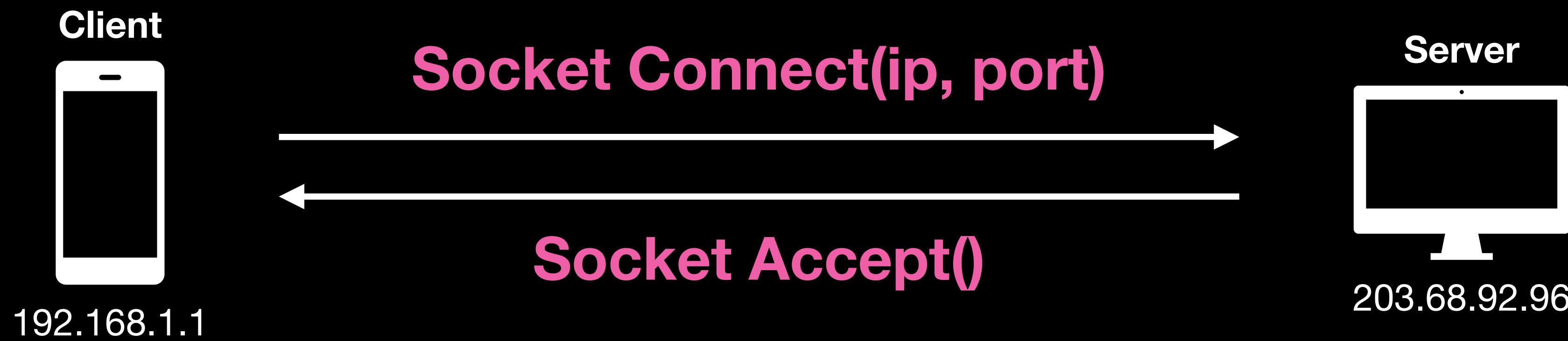
<https://203.68.92.96:443/index.html>

Socket & TCP

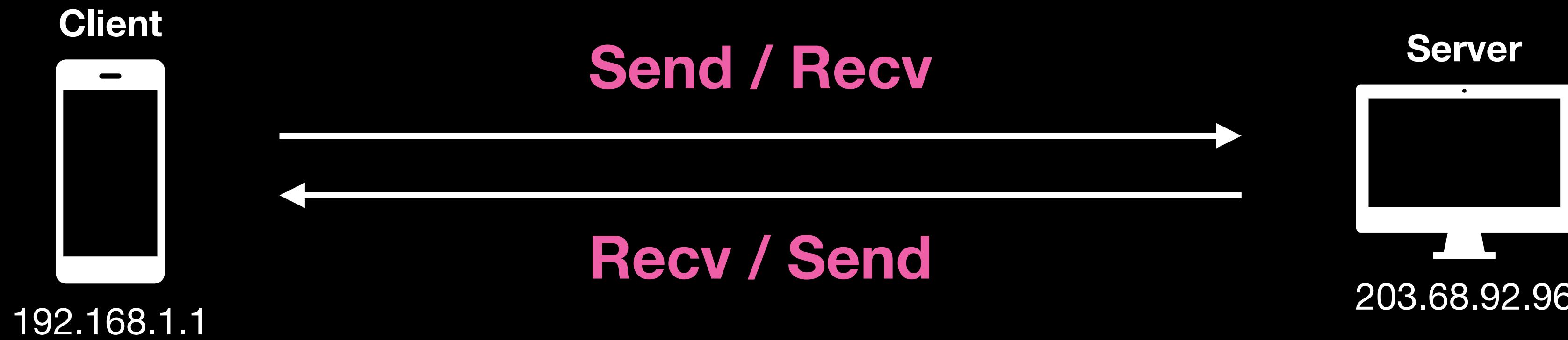
- Client
 - Connect : 嘗試建立連線
 - Send/Recv : 傳送/接收資料
- Server
 - Bind : 綁定 ip
 - Listen : 監聽 port
 - Accept : 接受建立連線



How Internet Works – Port



How Internet Works – Port



How Internet Works – Port

```
└─(kali㉿kali)-[~]
└─$ nc 127.0.0.1 11187
AAAAAAABBBBBBBB
Hello, World!
1234567890
```

```
└─(kali㉿kali)-[~]
└─$ nc -lvpn 11187
listening on [any] 11187 ...
connect to [127.0.0.1] from (UNKNOWN) [127.0.0.1] 49298
AAAAAAABBBBBBBB
Hello, World!
1234567890
```

How Internet Works – Content

<https://www.tnfsh.tn.edu.tw/index.html>

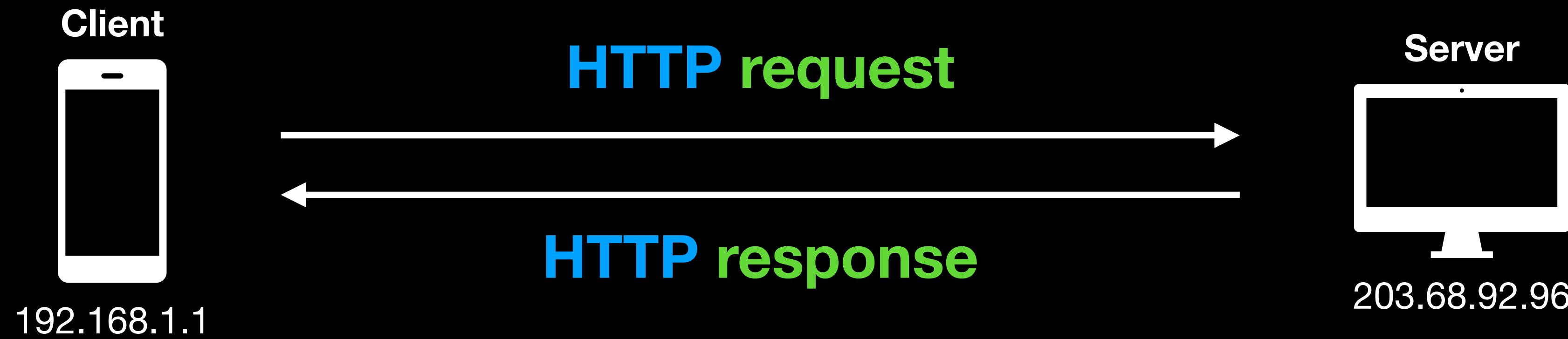


<https://www.tnfsh.tn.edu.tw:443/index.html>



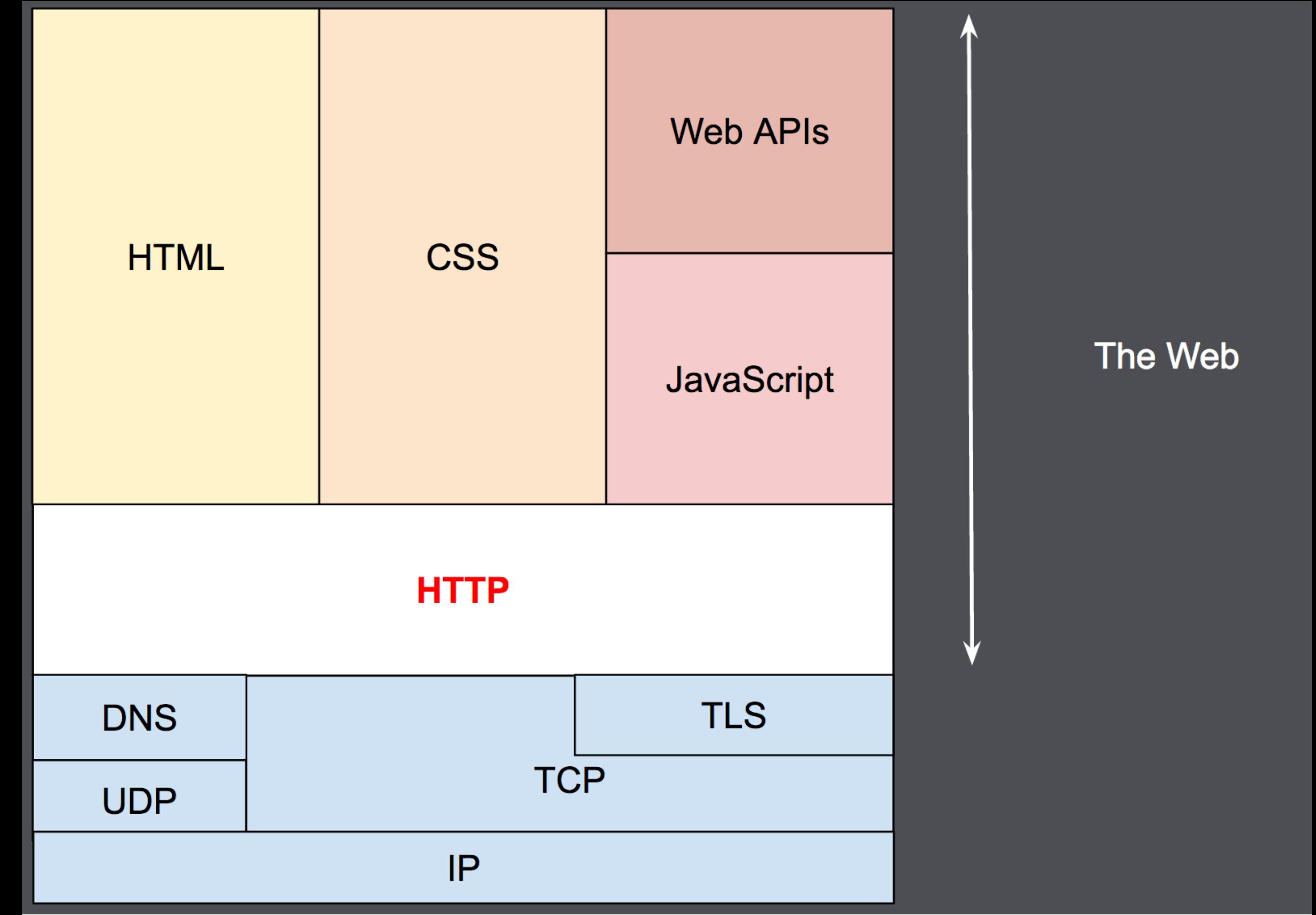
<https://203.68.92.96:443/index.html>

How Internet Works – Content



HTTP

- 一種網路傳輸協定 (protocol)



Img Src: <https://developer.mozilla.org/en-US/docs/Web/HTTP/Overview>

HTTP Request / Response

GET / HTTP/1.1

Host: developer.mozilla.org

Accept-Language: fr

HTTP/1.1 200 OK

Date: Sat, 09 Oct 2010 14:28:02 GMT

Server: Apache

Last-Modified: Tue, 01 Dec 2009 20:18:22 GMT

ETag: "51142bc1-7449-479b075b2891b"

Accept-Ranges: bytes

Content-Length: 29769

Content-Type: text/html

<!DOCTYPE html>... (here come the 29769 bytes of the requested web page)

Img Src: [MDN – An overview of HTTP](#)

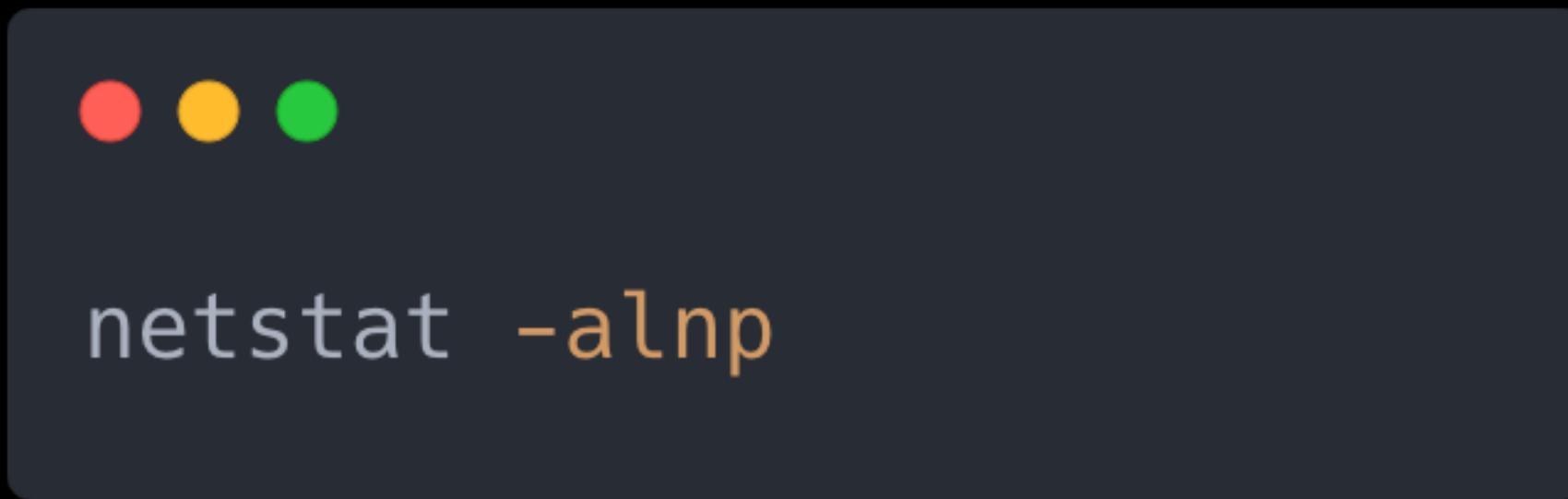
ip



- 用途：顯示網卡 address、設定網卡
- CTF 應用：基礎網路管理功能
- [ip Command Cheat Sheet by Red Hat](#)

```
(kali㉿kali)-[~]
$ ip addr
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host
            valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether be:ba:f6:f2:eb:0e brd ff:ff:ff:ff:ff:ff
        inet 192.168.10.54/24 brd 192.168.10.255 scope global dynamic noprefixroute eth0
            valid_lft 4142sec preferred_lft 4142sec
        inet6 fe80::bcba:f6ff:fef2:eb0e/64 scope link noprefixroute
            valid_lft forever preferred_lft forever
```

netstat



- 用途：查看 listen port 與運行 process / program
- 查看運行 process / program 需要 sudo
- CTF 應用：基礎網路管理功能、查看網路服務

```
(kali㉿kali)-[~]
$ netstat -alnp
(Not all processes could be identified, non-owned process info
 will not be shown, you would have to be root to see it all.)
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address          Foreign Address        State      PID/Program name
tcp      0      0 0.0.0.0:22              0.0.0.0:*              LISTEN     -
tcp      0      0 0.0.0.0:12345            0.0.0.0:*              LISTEN     -
tcp      0      0 0.0.0.0:8000             0.0.0.0:*              LISTEN     321725/python3
tcp      0      0 0.0.0.0:11187            0.0.0.0:*              LISTEN     321825/nc
tcp      0      932 192.168.10.54:22       192.168.2.2:55982    ESTABLISHED -
tcp6     0      0 :::22                  :::*                  LISTEN     -
udp      0      0 192.168.10.54:68       192.168.10.254:67    ESTABLISHED -
raw6     0      0 :::58                  :::*                  7          -
Active UNIX domain sockets (servers and established)
Proto RefCnt Flags       Type      State     I-Node      PID/Program name      Path
unix    2      [ ACC ]     STREAM    LISTENING  12665      -          /run/systemd/userdb/io.systemd.DynamicUser
unix    2      [ ACC ]     STREAM    LISTENING  12666      -          /run/systemd/io.system.Managed00M
unix    2      [ ]        DGRAM     LISTENING  12677      -          /run/systemd/journal/syslog
unix    2      [ ACC ]     STREAM    LISTENING  12679      -          /run/systemd/fsck.progress
unix   17      [ ]        DGRAM     CONNECTED 12683      -          /run/systemd/journal/dev-log
```

curl



```
curl --user user:pswd URL  
curl [--cookie COOKIE] --data DATA URL  
curl -X POST -H HEADER URL
```

- 用途：對 HTTP(S) 網站發 request
- 功能多元，詳見 man curl
- CTF 應用：Request 網頁內容、自動化腳本

```
└─(kali㉿kali)-[~]
└─$ curl https://www.tnfsh.tn.edu.tw/

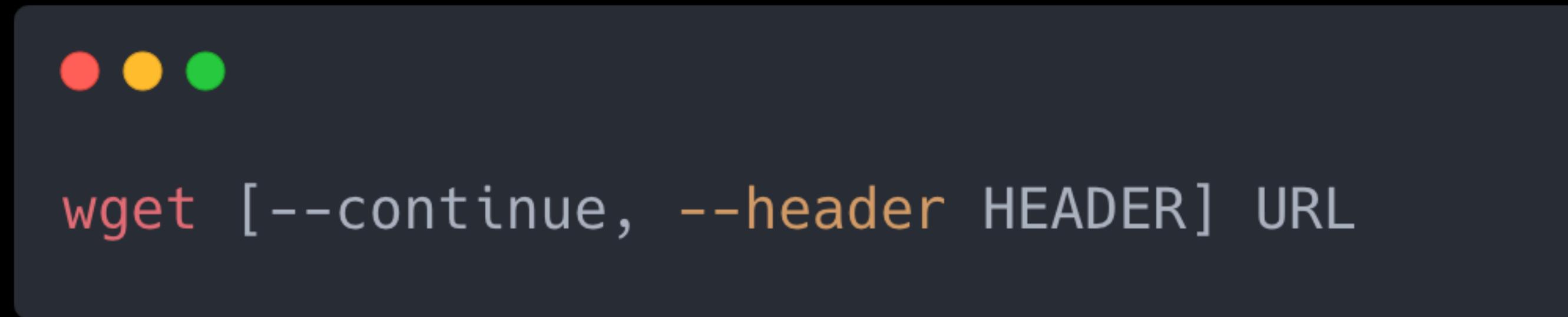
<!DOCTYPE html>
<html xmlns="http://www.w3.org/1999/xhtml" lang="zh-tw">

<head>

<meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
<meta name="viewport" content="width=device-width, initial-scale=1" />
<meta name="format-detection" content="telephone=no" />
<title>臺南第一高級中學</title>

<link href="css/bootstrap.css" rel="stylesheet" type="text/css" />
<link rel="stylesheet" href="Content/df_js/owlCarousel/owl.carousel.css" />
<link rel="stylesheet" href="Content/df_js/owlCarousel/owl.theme.default.css" />
<link rel="stylesheet" href="css/font-awesome.css" />
<link href="css/in_style.css" rel="stylesheet" type="text/css" />
<link href="css/in_rwd.css" rel="stylesheet" type="text/css" />
<link href="css/font-awesome.css" rel="stylesheet" />
<link rel="shortcut icon" href="favicon.ico" />
<link rel="icon" href="images/favicon.ico" type="image/x-icon" />
<link rel="shortcut icon" href="images/favicon.ico" type="image/x-icon" />
<meta property="og:site_name" content="臺南第一高級中學" />
<meta property="og:image" content="https://www.tnfsh.tn.edu.tw/images/og.jpg" />
<meta property="og:title" content="(臺南第一高級中學)" />
<meta property="og:description" content="臺南第一高級中學" />
```

wget



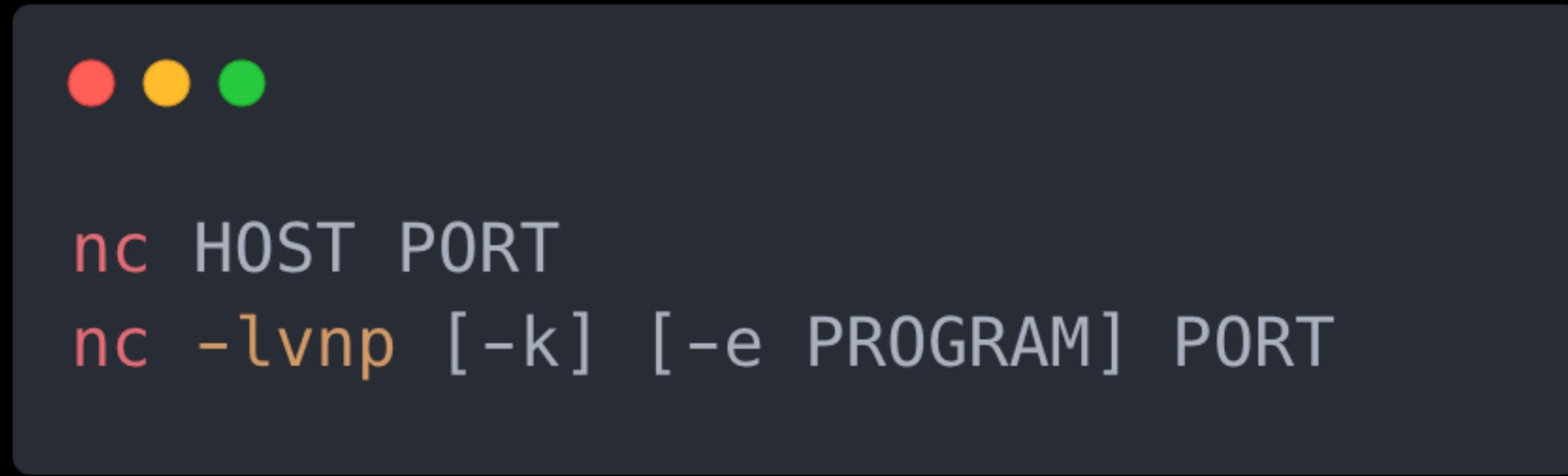
- 用途：從 HTTP(S) 網站下載檔案
- 有許多參數，詳見 `man wget`
- CTF 應用：下載 CTF 題目、下載檔案

```
└─( kali㉿kali )-[~]
└─$ wget http://120.114.62.217/TobeExe
--2023-09-01 00:06:03-- http://120.114.62.217/TobeExe
Connecting to 120.114.62.217:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 7348 (7.2K)
Saving to: 'TobeExe'
```

```
TobeExe                                         100%[=====]
2023-09-01 00:06:03 (1.42 GB/s) - 'TobeExe' saved [7348/7348]
```

```
└─( kali㉿kali )-[~]
└─$ ls
Desktop  Documents  Downloads  Music  Pictures  Public  Templates  TobeExe
```

nc



- 用途：對 TCP/UDP port 進行網路連線
- **-k**：持續保持 listen
- CTF 應用：與 pwn 題目互動、於 local 架設題目、彈 reverse shell
- 注意：nc 有兩個版本，其中一個沒有 -e，需要安裝 netcat 或 ncat 指令

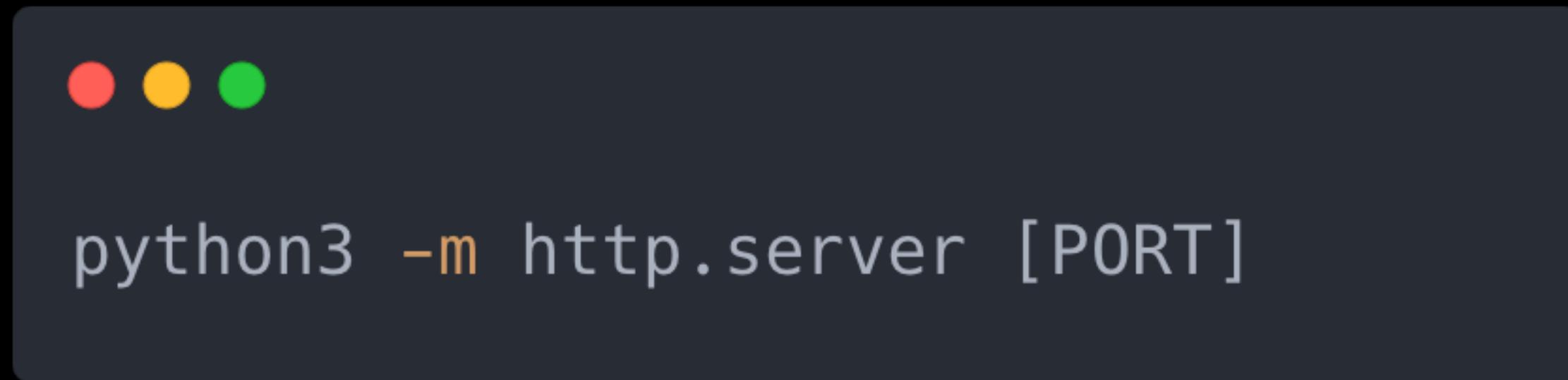
```
└─( kali㉿kali )-[~]
└─$ nc -lvpn 11187
listening on [any] 11187 ...
connect to [127.0.0.1] from (UNKNOWN) [127.0.0.1] 45698
0. Hello
1. Say Hi~~~~
```

```
└─( kali㉿kali )-[~]
└─$ nc 127.0.0.1 11187
0. Hello
1. Say Hi~~~~
```

```
└─(kali㉿kali)-[~]
└─$ nc -e ./hello -klvnp 11187
listening on [any] 11187 ...
connect to [127.0.0.1] from (UNKNOWN) [127.0.0.1] 44172
```

```
└─(kali㉿kali)-[~]
└─$ nc 127.0.0.1 11187
100
Hello, World!
Input is 100
```

Python HTTP Server



- 用途：架設臨時的 HTTP server
- PORT：指定 listen port，預設為 8000
- CTF 應用：接收 request、傳檔案（？）

```
└─(kali㉿kali)-[~]
$ python3 -m http.server 11187
Serving HTTP on 0.0.0.0 port 11187 (http://0.0.0.0:11187/) ...
127.0.0.1 - - [01/Sep/2023 02:13:12] "GET / HTTP/1.1" 200 -
127.0.0.1 - - [01/Sep/2023 02:13:49] code 404, message File not found
127.0.0.1 - - [01/Sep/2023 02:13:49] "GET /from_nc HTTP/1.1" 404 -
```

```
└─(kali㉿kali)-[~]
$ curl 127.0.0.1:11187
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
html4/strict.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html"
<title>Directory listing for /</title>
</head>
<body>
<h1>Directory listing for /</h1>
<hr>
<ul>
<li><a href=".bash_logout">.bash_logout</a></li>
<li><a href=".bashrc">.bashrc</a></li>
```

```
└─(kali㉿kali)-[~]
$ nc 127.0.0.1 11187
GET /from_nc HTTP/1.1
User-Agent: nc/ice1187
```

```
HTTP/1.0 404 File not found
Server: SimpleHTTP/0.6 Python/3.10.5
Date: Fri, 01 Sep 2023 06:13:49 GMT
Connection: close
Content-Type: text/html; charset=utf-8
Content-Length: 469
```

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN"
"http://www.w3.org/TR/html4/strict.dtd">
<html>
<head>
```

Lab – Tell me your (http) request

Tell me your request

100

你知道如何使用 `nc` 嗎？請跟以下檔案互動來找到 flag。

Flag 格式：`FLAG{....}`

`tell_me_your_...`

Tell me your HTTP request

100

你知道如何發出 http request 嗎？請跟以下檔案互動來找到 flag。

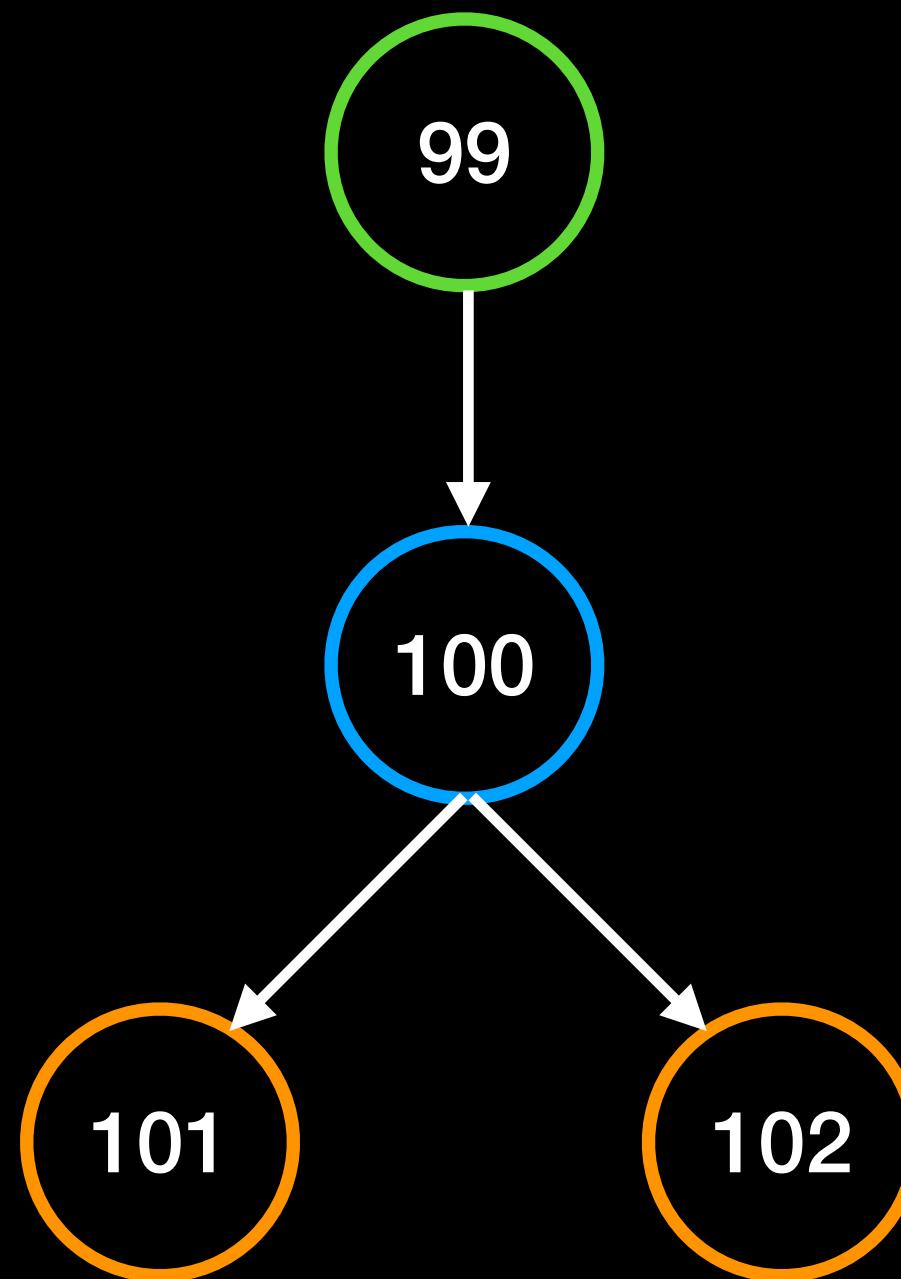
Flag 格式：`FLAG{....}`

`tell_me_your_...`

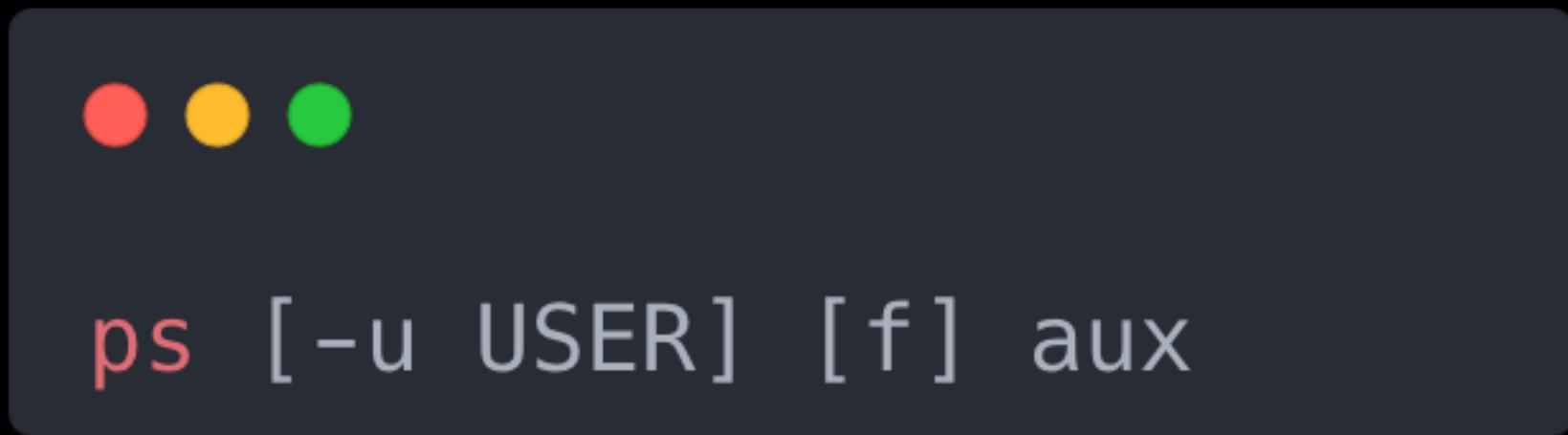
Process

Process

- 常見翻譯：進程、行程、程序
- 建議直接叫 process，較不易搞混
- 每個 process 都有唯一的 Process ID (PID)
- **Process / Parent Process / Child Process**



ps



- 用途：查看 process，類似 Windows 的工作管理員
- **-u**：指定 user
- **f**：以樹形顯示
- 參數繁雜，有無 dash 功能不一定相同，詳見 man ps

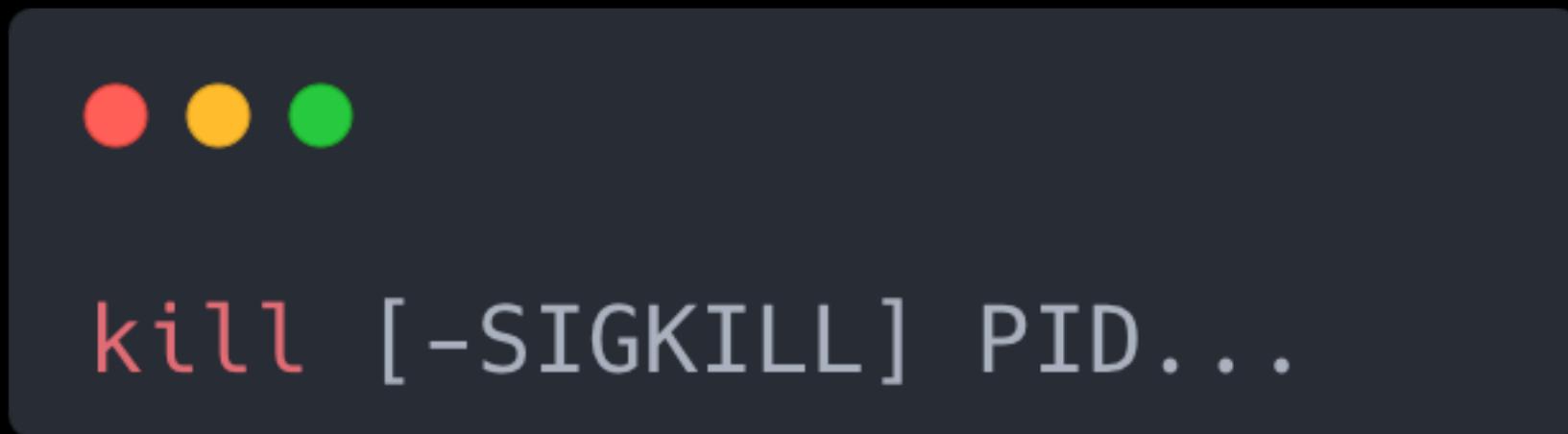
```
(kali㉿kali)-[~]
```

```
$ ps aux
```

USER	PID	%CPU	%MEM	VSZ	RSS	TTY	STAT	START	TIME	COMMAND
root	1	0.0	0.5	102544	12072	?	Ss	Aug31	0:01	/sbin/init splash
root	2	0.0	0.0	0	0	?	S	Aug31	0:00	[kthreadd]
root	3	0.0	0.0	0	0	?	I<	Aug31	0:00	[rcu_gp]
root	4	0.0	0.0	0	0	?	I<	Aug31	0:00	[rcu_par_gp]
root	5	0.0	0.0	0	0	?	I<	Aug31	0:00	[netns]
root	7	0.0	0.0	0	0	?	I<	Aug31	0:00	[kworker/0:0H-events_highpri]
root	9	0.0	0.0	0	0	?	I<	Aug31	0:01	[kworker/0:1H-events_highpri]
root	10	0.0	0.0	0	0	?	I<	Aug31	0:00	[mm_percpu_wq]
root	11	0.0	0.0	0	0	?	I	Aug31	0:00	[rcu_tasks_kthread]
root	12	0.0	0.0	0	0	?	I	Aug31	0:00	[rcu_tasks_rude_kthread]
root	13	0.0	0.0	0	0	?	I	Aug31	0:00	[rcu_tasks_trace_kthread]
root	14	0.0	0.0	0	0	?	S	Aug31	0:01	[ksoftirqd/0]
root	15	0.0	0.0	0	0	?	I	Aug31	0:09	[rcu_preempt]
root	16	0.0	0.0	0	0	?	S	Aug31	0:00	[migration/0]
root	18	0.0	0.0	0	0	?	S	Aug31	0:00	[cpuhp/0]
root	20	0.0	0.0	0	0	?	S	Aug31	0:00	[kdevtmpfs]
root	21	0.0	0.0	0	0	?	I<	Aug31	0:00	[inet_frag_wq]

```
(kali㉿kali)-[~]
$ ps -u kali fu
USER        PID %CPU %MEM    VSZ   RSS TTY      STAT START  TIME COMMAND
kali      741996  0.0  0.3 18696  7060 ?          S  04:24  0:00 sshd: kali@pts/1
kali      741997  0.0  0.3 10676  6332 pts/1       Ss  04:24  0:00  \_ -zsh
kali      744446  0.0  0.1 10116  3208 pts/1       R+  04:34  0:00      \_ ps -u kali fu
kali       608  0.0  1.3 268692 26812 ?          Ssl Aug31  0:00 xfce4-session
kali       665  0.0  0.0  8008   848 ?          Ss  Aug31  0:00  \_ /usr/bin/ssh-agent x-session-manager
kali       708  0.0  2.1 404884 43528 ?          Sl  Aug31  0:59  \_ xfwm4
kali       732  0.0  1.4 231548 29472 ?          Sl  Aug31  0:00  \_ xfsettingsd
kali       741  0.0  2.4 476120 48860 ?          Sl  Aug31  0:01  \_ xfce4-panel
kali       757  0.0  2.5 409632 52396 ?          Sl  Aug31  0:01 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       760  0.1  1.6 201936 33708 ?          Sl  Aug31  5:07 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       761  0.0  1.3 341168 26724 ?          Sl  Aug31  0:00 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       762  0.0  1.4 359084 29688 ?          Sl  Aug31  2:55 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       763  0.0  2.3 602088 47564 ?          Sl  Aug31  0:40 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       764  0.0  2.2 334144 44804 ?          Sl  Aug31  0:00 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       765  0.0  2.3 399868 46892 ?          Sl  Aug31  0:00 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       766  0.0  2.2 399708 44796 ?          Sl  Aug31  0:00 |  \_ /usr/lib/x86_64-linux-gnu/xfce4/p
kali       745  0.0  2.6 485636 54168 ?          Sl  Aug31  0:00 \_ Thunar --daemon
kali       754  0.0  2.8 475512 57144 ?          Sl  Aug31  0:01 \_ xfdesktop
kali       785  0.0  0.5 236892 10708 ?          Sl  Aug31  0:00 \_ xiccd
```

kill



- 用途：傳送 signal 到指定 process，通常用於強制結束 process
- 預設傳送 TERM (terminate) signal
- **-SIGKILL**：傳送 KILL signal
- TERM v.s. KILL：是否讓 process 執行必要的結束程序

```
[kali㉿kali)-[~]
$ sleep 100000 &
[1] 748156
```

```
[kali㉿kali)-[~]
$ ps u
USER          PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
kali        6025  0.0  0.3  14080  7336 pts/0    Ss+  Aug31   0:01 /usr/bin/zsh
kali      741997  0.1  0.3  10676  6400 pts/1    Ss   04:24   0:01 -zsh
kali      748156  0.0  0.0   5416   736 pts/1    SN   04:47   0:00 sleep 100000
kali      748168  0.0  0.1  9960  3236 pts/1    R+   04:47   0:00 ps u
```

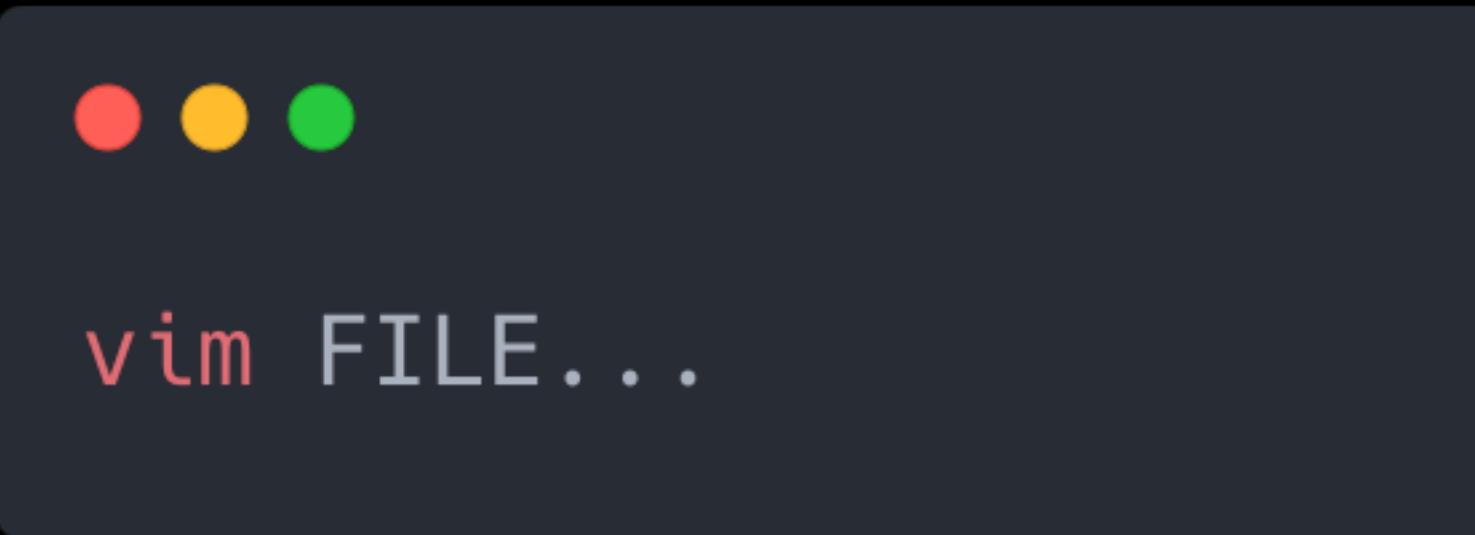
```
[kali㉿kali)-[~]
$ kill 748156
```

```
[1] + terminated  sleep 100000
```

```
[kali㉿kali)-[~]
$ ps u
USER          PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
kali        6025  0.0  0.3  14080  7336 pts/0    Ss+  Aug31   0:01 /usr/bin/zsh
kali      741997  0.1  0.3  10676  6400 pts/1    Ss   04:24   0:01 -zsh
kali      748228  0.0  0.1  9960  3276 pts/1    R+   04:47   0:00 ps u
```

Editor 編輯器

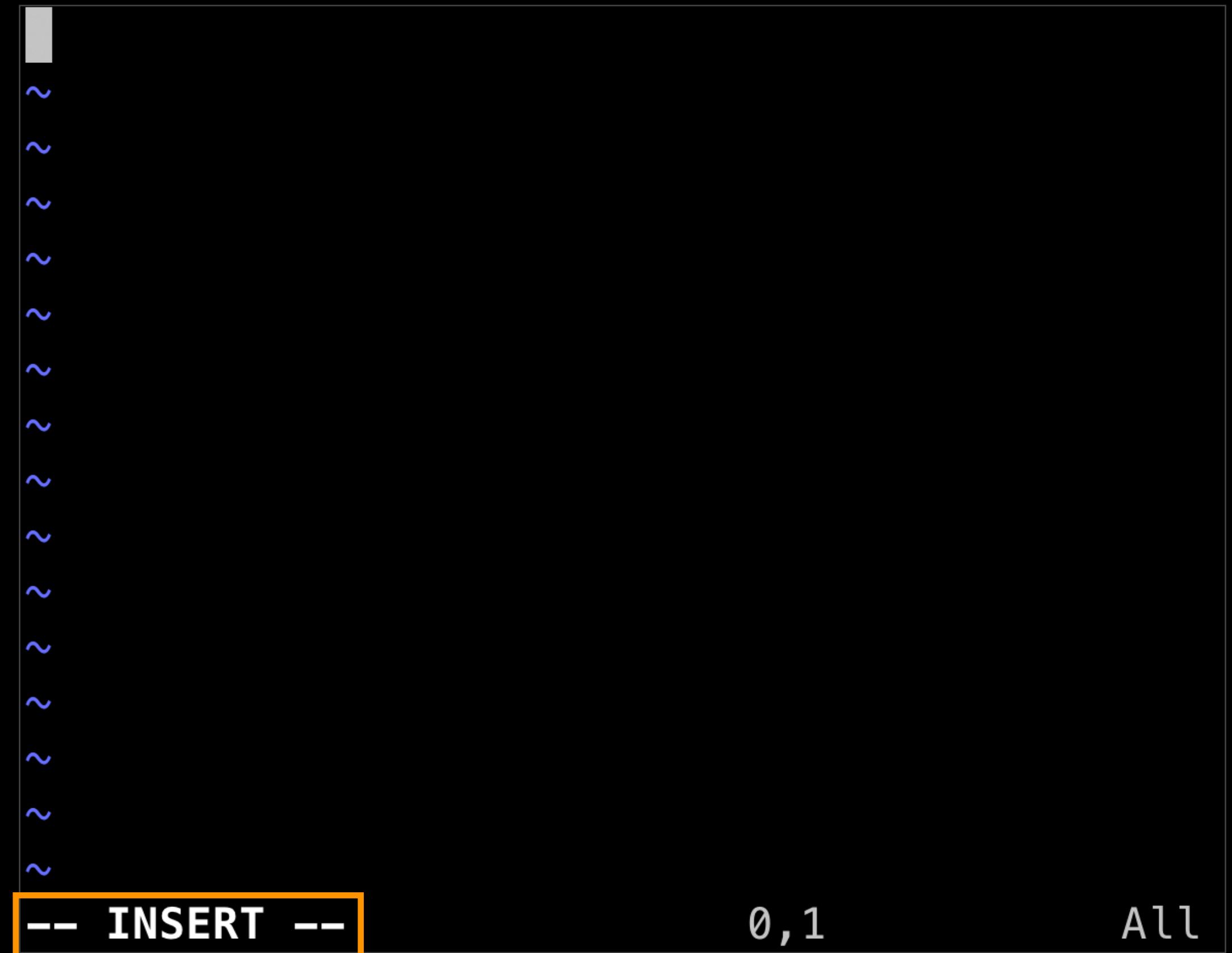
vim



- **最難最複雜、最快最好用的編輯器**
- 分成三種模式：指令模式、插入模式、可視模式
- 注意當前所在的模式！

插入模式

- 指令模式按 i 進入插入模式
- 左下角顯示 **INSERT** 表示為插入模式
- $\uparrow\downarrow\leftarrow\rightarrow$: 上下左右移動
- Esc : 回到指令模式



指令模式

- i : 進入插入模式
- h / j / k / l : 鼠標往左 / 下 / 上 / 右移動
- :: 輸入指令
 - w : 寫入存檔
 - q : 退出
- u / ctrl+r : undo / redo

█
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~

1,0-1

All

No write since last change

- 編輯後沒有存檔就退出
 - :wq 寫入並退出
 - :q! 放棄編輯並退出

~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~

E37: No write since last change (add ! to override)
Press ENTER or type command to continue

Found a swap file

E325: ATTENTION

Found a swap file by the name ".hello.c.swp"
owned by: kali dated: Sun Sep 03 03:08:29 2023
[cannot be read]
While opening file "hello.c"
dated: Sun Sep 03 03:07:17 2023

- .swp 是編輯暫存檔
- 刪除 .{filename}.swp
 - (1) Another program may be editing the same file. If this is the case, be careful not to end up with two different instances of the same file when making changes. Quit, or continue with caution.
 - (2) An edit session for this file crashed. If this is the case, use ":recover" or "vim -r hello.c" to recover the changes (see ":help recovery"). If you did this already, delete the swap file ".hello.c.swp" to avoid this message.

Swap file ".hello.c.swp" already exists!

[O]pen Read-Only, (E)dit anyway, (R)ecover, (D)elete it, (Q)uit, (A)bort:

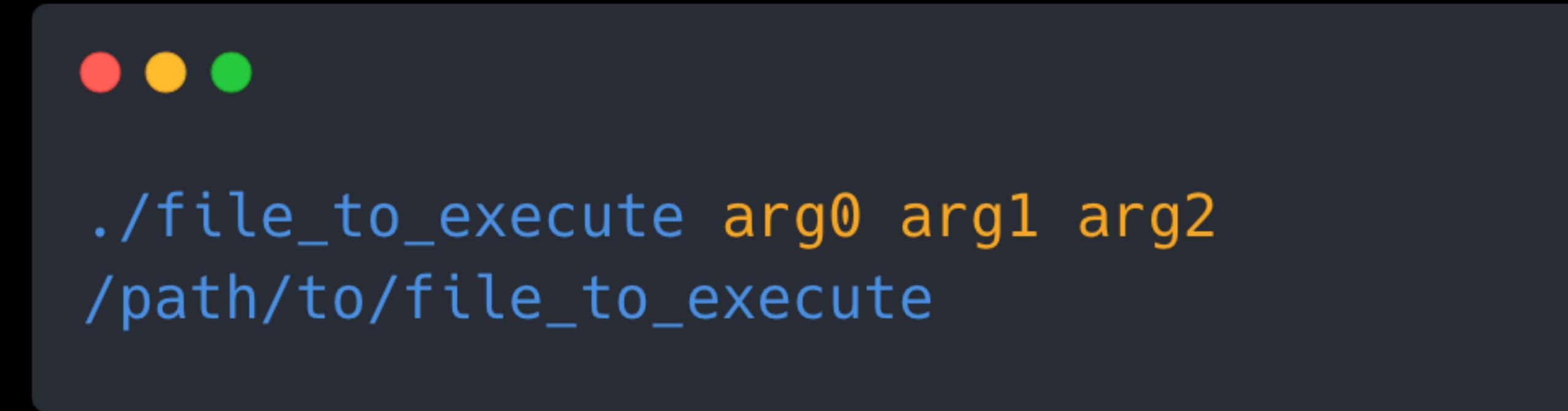
Compile & Execute 編譯與執行

Compile – gcc



- 用途：編譯程式
- CTF 應用：自學組語、編譯題目、寫腳本
- 如何關閉保護機制，請參考「[拜託別 Pwn 我啦！ - Protection 保護機制](#)」

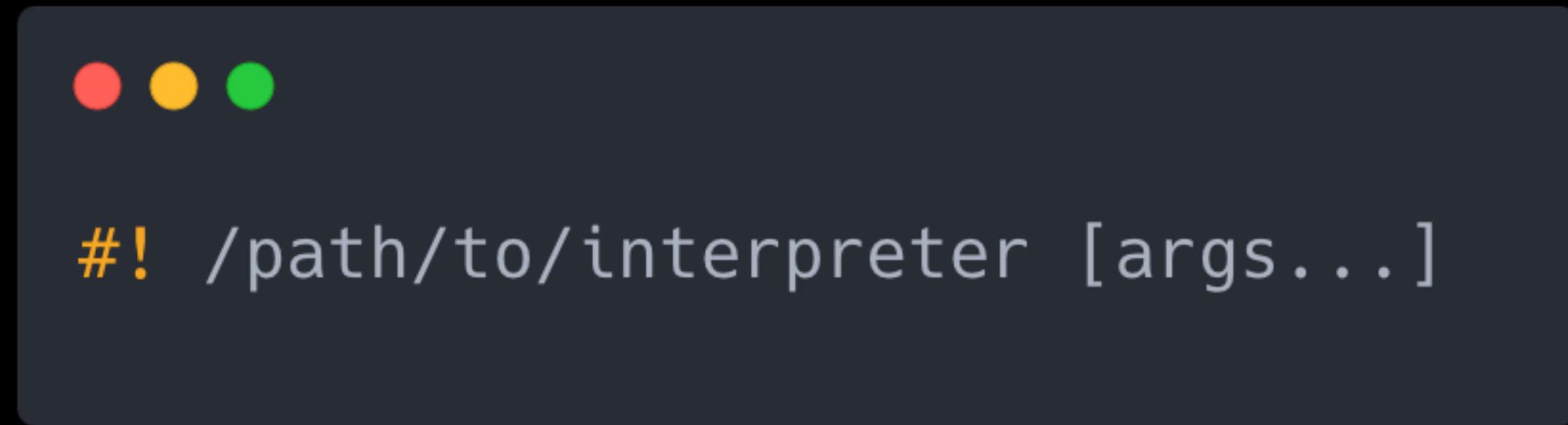
Execution 執行

A dark gray terminal window icon with three colored dots (red, yellow, green) in the top-left corner.

```
./file_to_execute arg0 arg1 arg2  
/path/to/file_to_execute
```

- 用途：執行檔案
- 注意：檔案需要有執行權限才能執行，下載的檔案有時需要先 chmod +x
- 任何檔案只要有執行權限皆可執行，例如：Python script、文字檔

Shebang #!



- 用途：指定執行該檔案 FILE 的 interpreter (直譯器)
- 實際執行指令：
 - `/path/to/interpreter [args...] FILE`

```
(kali㉿kali)-[~]
└─$ cat ls.ls
#!/usr/bin/ls /home/kali

(kali㉿kali)-[~]
└─$ ls -l ls.ls
-rwxr-xr-x 1 kali kali 26 Sep 10 03:50 ls.ls

(kali㉿kali)-[~]
└─$ ./ls.ls
./ls.ls

/home/kali:
Desktop Documents Downloads Music Pictures Public Templates TobeExe Videos err.sh
```

為什麼平常下的指令不用加 ./ 或用絕對路徑？

PATH 環境變數

- "The **search path for commands**. It is a colon-separated list of directories in which the shell looks for commands." – *man bash*
- PATH 環境變數中儲存了許多資料夾，shell 會從這些資料夾中找尋指令
- 範例：
 - PATH: /usr/local/sbin, /usr/local/bin, /usr/bin
 - CMD: ls
 - 從 /usr/local/sbin 依序搜尋 ls，直到找到 /usr/bin/ls

```
(kali㉿kali)-[~]
└─$ echo $PATH
/usr/local/sbin:/usr/sbin:/sbin:/usr/local/bin:/usr/bin:/bin:/usr/local/games:/usr/games

(kali㉿kali)-[~]
└─$ whereis ls
ls: /usr/bin/ls /usr/share/man/man1/ls.1.gz
```

Lab

- 練習用 vim 寫出 hello_world.c，並編譯和執行起來

```
#include <stdio.h>

int main(void) {
    printf("Hello, World!\n");
    return 0;
}
```

```
└─(kali㉿kali)-[~]
└─$ vim hello_world.c

└─(kali㉿kali)-[~]
└─$ gcc hello_world.c -o hello_world

└─(kali㉿kali)-[~]
└─$ ./hello_world
Hello, World!
```

Shell

What is Shell

- Shell 是人與作業系統互動的介面

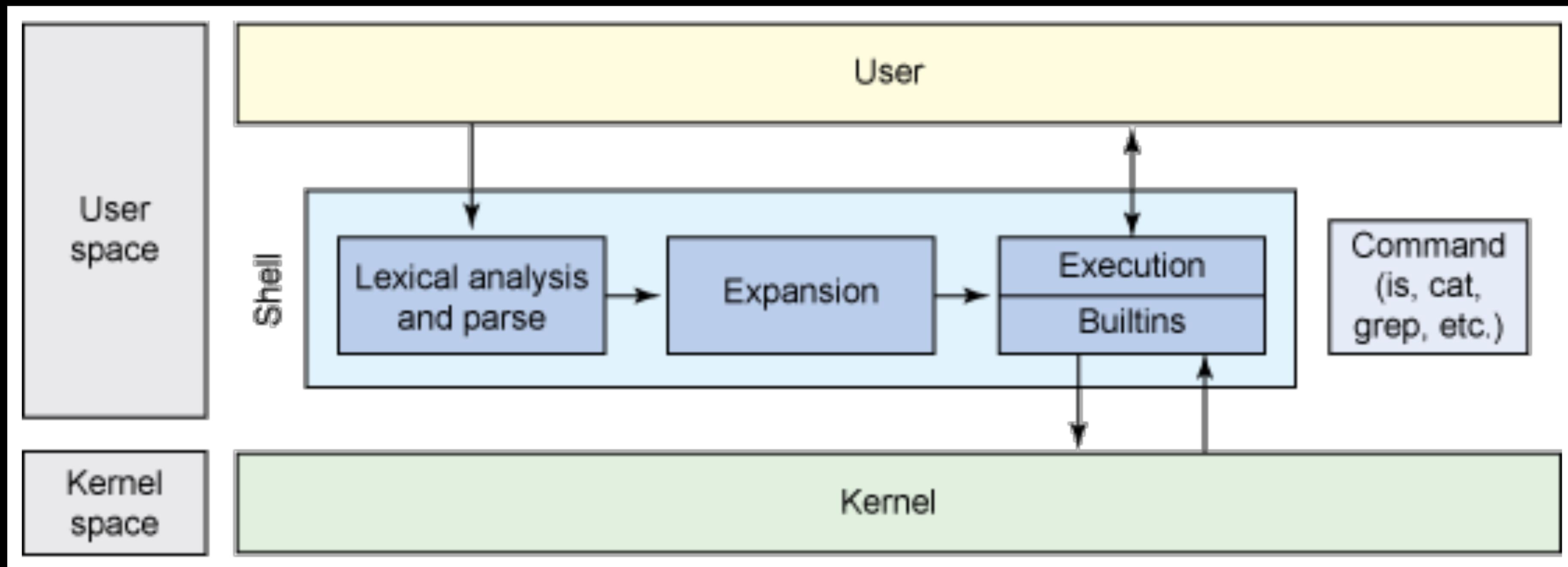
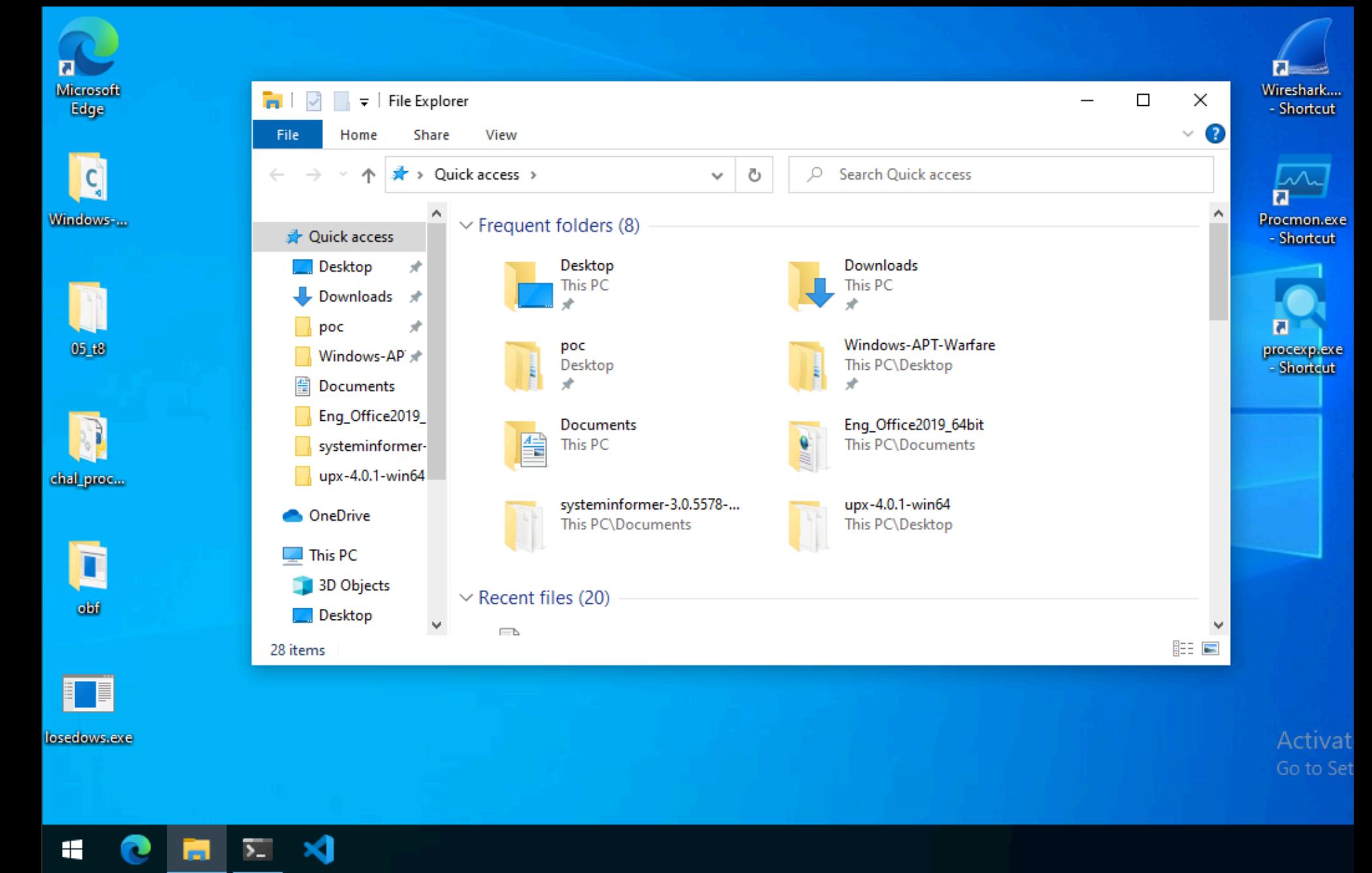


Image src: <https://developer.ibm.com/tutorials/l-linux-shells/>

What is Shell

- Shell 是人與作業系統互動的介面
 - 圖形化介面 – Windows Shell
 - 文字指令介面 – bash, zsh, fish

```
(kali㉿kali)-[~]
$ echo $SHELL
/usr/bin/zsh
```

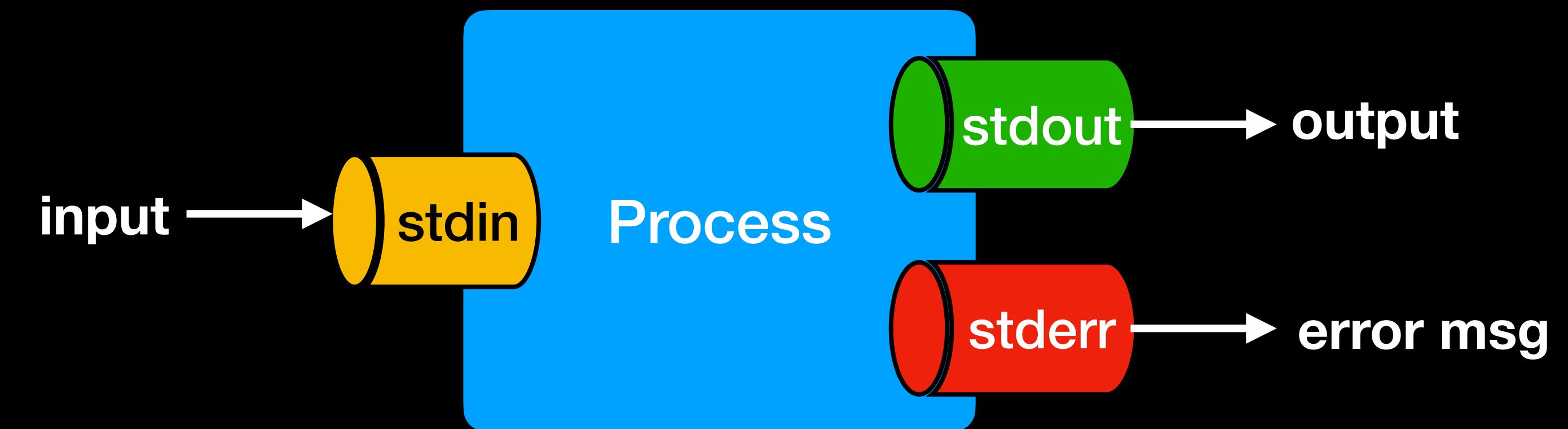


Shell

- Shell 有很多種，常見的預設為 bash, zsh
- Shell 的主要功能：
 - Command-line interpreter
 - execute program、pipe、redirect、substitution
 - Modify environment variable
 - Scripting

stdin, stdout, stderr

- Linux process 的三個標準輸入/輸出口
- stdin : 標準輸入
- stdout : 標準輸出
- stderr : 標準錯誤輸出



Pipe 管道



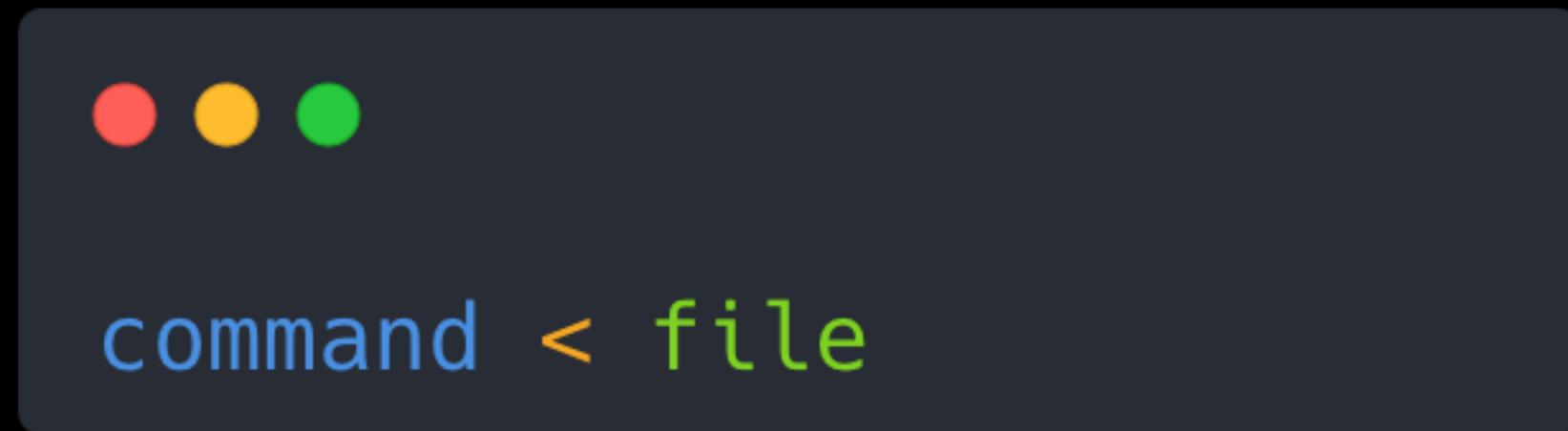
- 用途：將 command A 的 stdout 傳入 command B 的 stdin



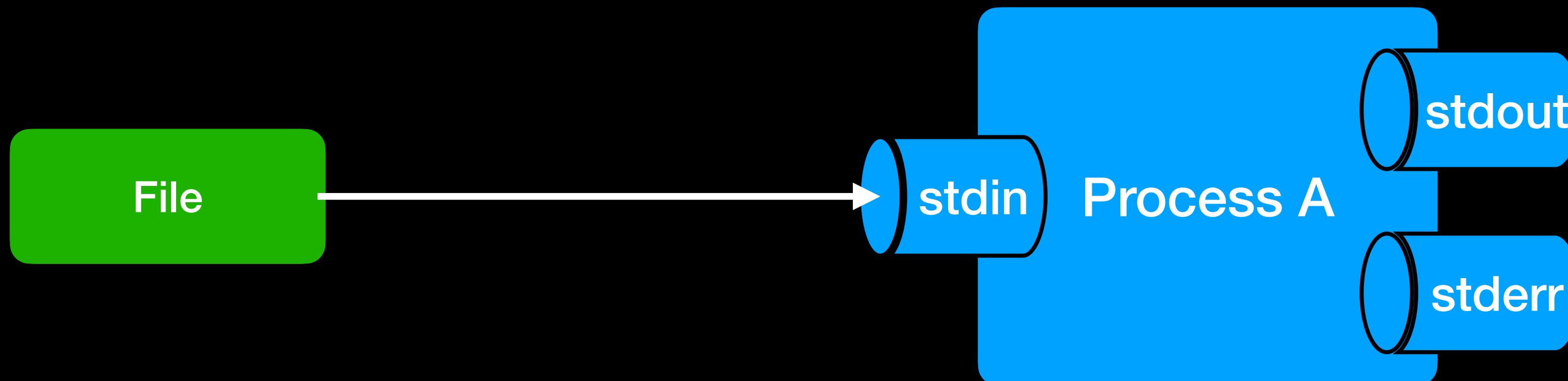
```
└─(kali㉿kali)-[~]
└─$ ./hello
Hello, World!
10
Input is 10
```

```
└─(kali㉿kali)-[~]
└─$ echo 30 | ./hello
Hello, World!
Input is 30
```

Redirect 重導向



- 用途：將 file 的內容傳入 command 的 stdin



```
(kali㉿ kali)~]$ cat < hello.c
#include <stdio.h>

int main(void) {
    int a;
    printf("Hello, World!\n");

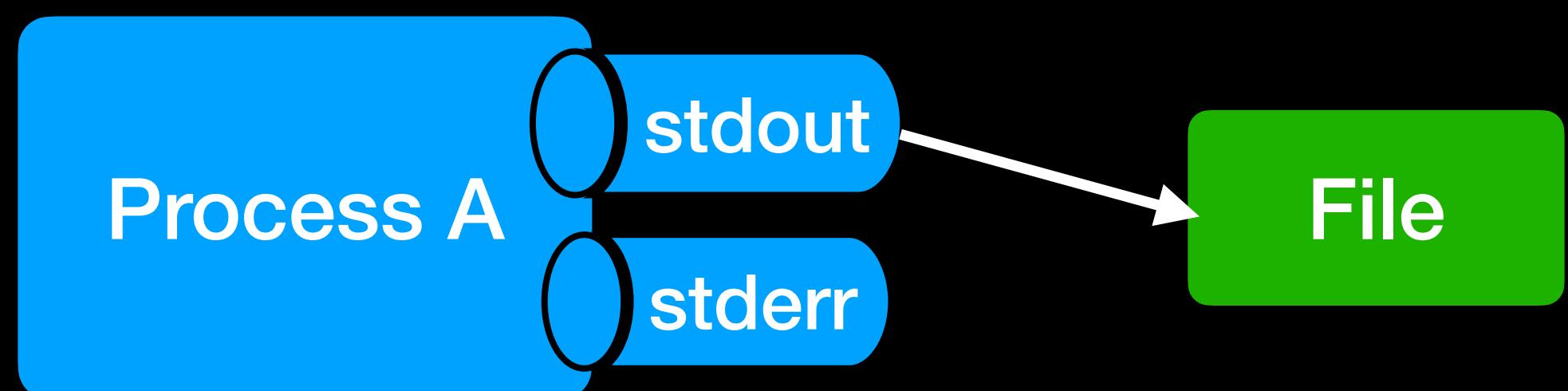
    scanf("%d", &a);
    printf("Input is %d\n", a);

    return 0;
}
```

Redirect 重導向

```
● ● ●  
command > file  
command 2> file  
command &> file
```

- 用途：將 `command` 的 `stdout/stderr` 傳入 `file`
 - `>` : `stdout` 傳入 `file`



> : stdout 傳入 file

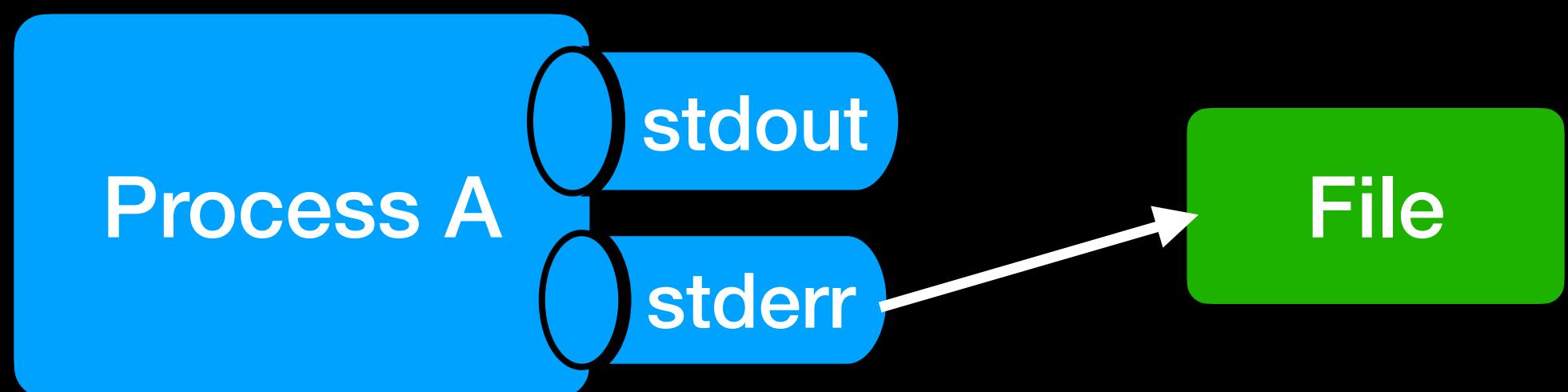
```
(kali㉿kali)-[~]
$ ls -l hello non_exist > a
ls: cannot access 'non_exist': No such file or directory

(kali㉿kali)-[~]
$ cat a
-rwxr-xr-x 1 kali kali 16208 Sep  1 02:00 hello
```

Redirect 重導向

```
● ● ●  
command > file  
command 2> file  
command &> file
```

- 用途：將 `command` 的 `stdout/stderr` 傳入 `file`
 - `>` : `stdout` 傳入 `file`
 - `2>` : `stderr` 傳入 `file`



2> : stderr 傳入 file

```
└─(kali㉿kali)-[~]
└$ ls -l hello non_exist 2> a
-rwxr-xr-x 1 kali kali 16208 Sep  1 02:00 hello

└─(kali㉿kali)-[~]
└$ cat a
ls: cannot access 'non_exist': No such file or directory
```

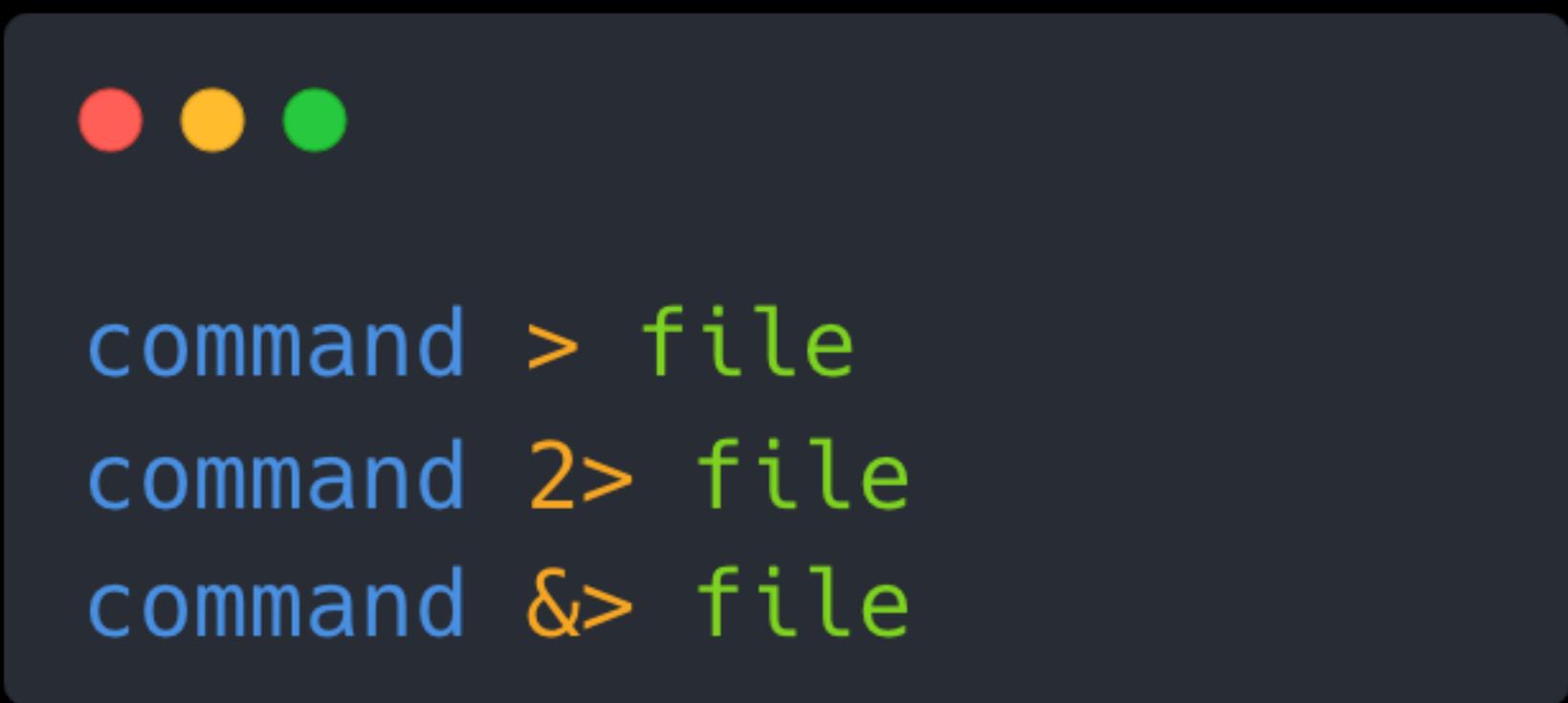
為什麼 `2>` 是 stderr ?

- "Everything is a file."
- `stdin`, `stdout`, `stderr` 被當作檔案來處理，對應的 file descriptor (fd)：
 - `stdin` : $fd = 0$
 - `stdout` : $fd = 1$
 - `stderr` : $fd = 2$

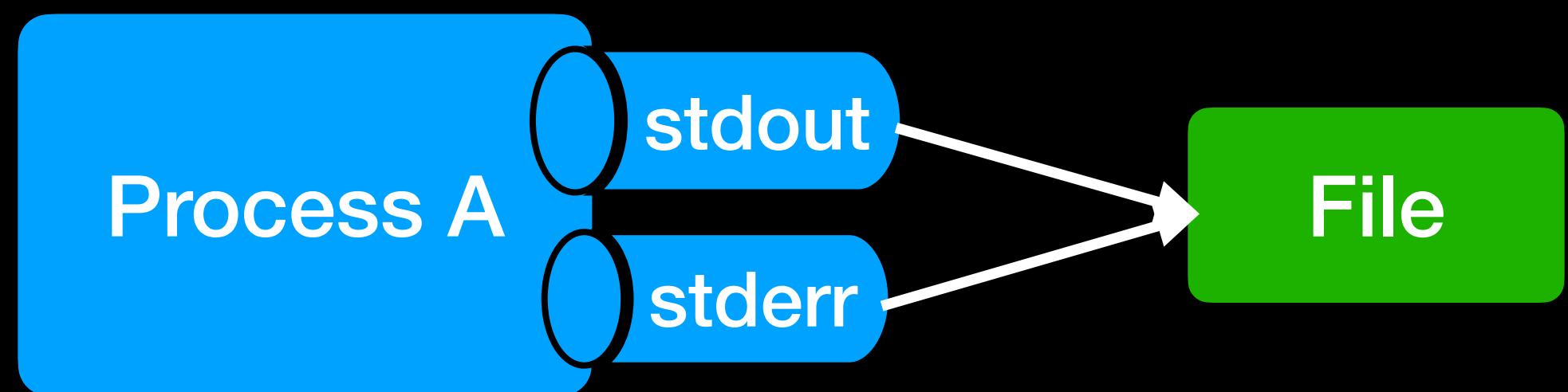
```
[kali㉿ kali) ~]  
$ sleep 10000  
Write to stdout of sleep
```

```
[kali㉿ kali) ~]  
$ ps -u | grep "sleep 1000"  
kali      3299410  0.0  0.0    5472   896 pts/3    S+   11:59   0:00 sleep 10000  
  
[kali㉿ kali) ~]  
$ ls /proc/3299410/fd  
0 1 2  
  
[kali㉿ kali) ~]  
$ echo "Write to stdout of sleep" > /proc/3299410/fd/1
```

Redirect 重導向



- 用途：將 `command` 的 `stdout/stderr` 傳入 `file`
 - `>` : `stdout` 傳入 `file`
 - `2>` : `stderr` 傳入 `file`
 - `&>` : `stdout` 與 `stderr` 傳入 `file`

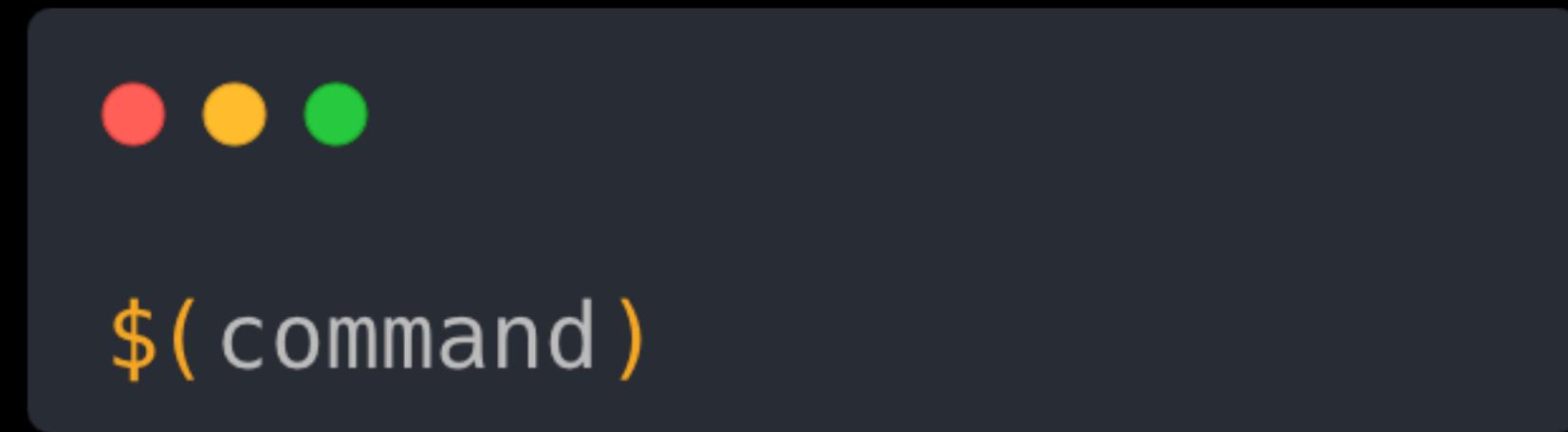


&> : std out 與 std err 傳入 file

```
(kali㉿kali)-[~]
$ ls -l hello non_exist &> a

(kali㉿kali)-[~]
$ cat a
ls: cannot access 'non_exist': No such file or directory
-rwxr-xr-x 1 kali kali 16208 Sep 1 02:00 hello
```

Command Substitution 指令替換



- 用途：將 command 的 output 作為指令的一部分
- 常見範例：\$(pwd)/file_A 快速取得當前檔案 file_A 的絕對路徑
- 以上 bash 功能的詳細介紹可參考：man bash

```
└─(kali㉿ kali)-[~]
└─$ cat a
100
```

```
└─(kali㉿ kali)-[~]
└─$ echo $(cat a) | ./hello
Hello, World!
Input is 100
```

```
└─(kali㉿ kali)-[~]
└─$ echo $(pwd)/hello
/home/kali/hello
```

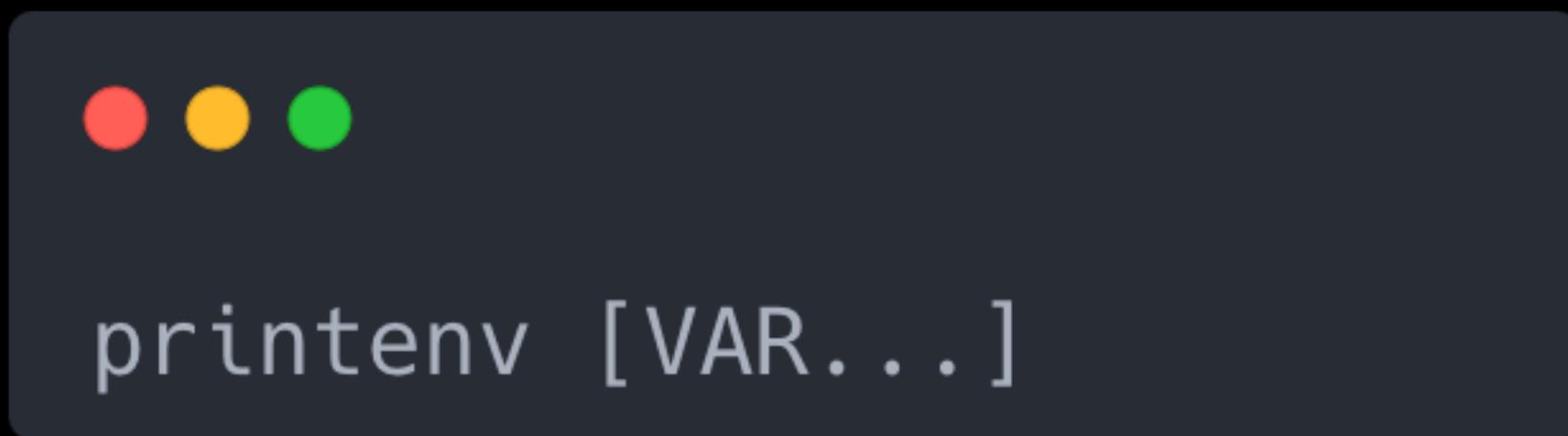
Environment Variable 環境變數

- 以 KEY=value 形式表示
- 另一組傳遞給程式的參數，類似於 argv
- 前述 PATH 即為其中一項環境變數

```
#include <unistd.h>

int execve(const char *pathname, char *const _Nullable argv[],
           char *const _Nullable envp[]);
```

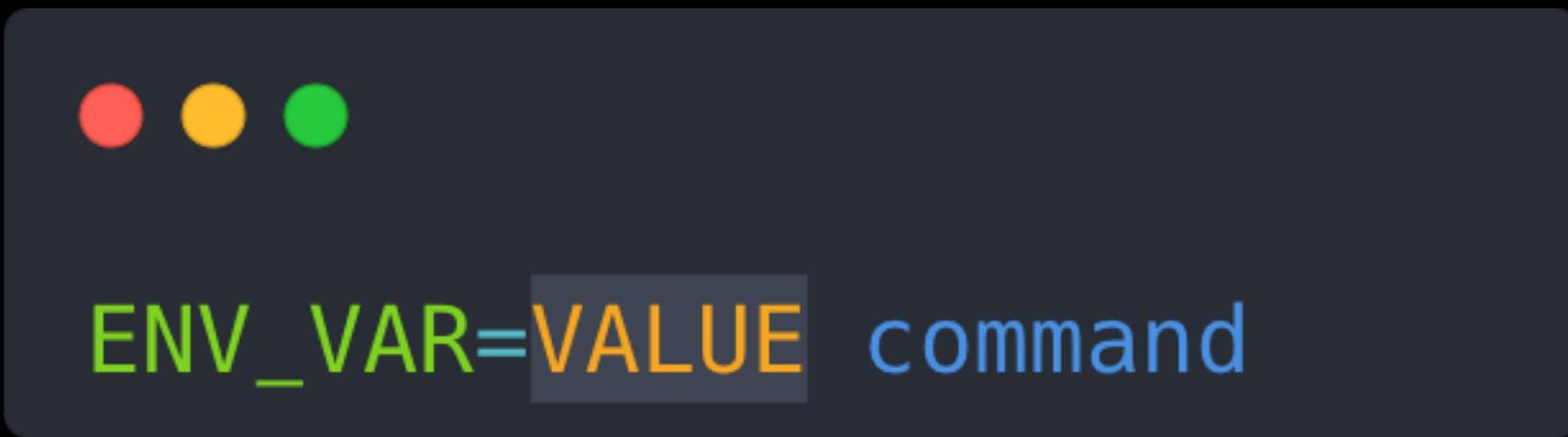
printenv



- 用途：列出環境變數
- VAR：指令要列出的環境變數，預設為所有

```
(kali㉿kali)-[~]
$ printenv
LC_TERMINAL_VERSION=3.4.20
LC_CTYPE=UTF-8
LC_TERMINAL=iTerm2
USER=kali
LOGNAME=kali
HOME=/home/kali
PATH=/usr/local/sbin:/usr/sbin:/sbin:/usr/local/bin:/usr/bin:/bin:/usr/local/games:/usr/games
SHELL=/usr/bin/zsh
TERM=xterm-256color
XDG_SESSION_ID=2237
XDG_RUNTIME_DIR=/run/user/1000
DBUS_SESSION_BUS_ADDRESS=unix:path=/run/user/1000/bus
XDG_SESSION_TYPE=tty
XDG_SESSION_CLASS=user
MOTD_SHOWN=pam
COMMAND_NOT_FOUND_INSTALL_PROMPT=1
POWERSHELL_UPDATECHECK=Off
POWERSHELL_TELEMETRY_OPTOUT=1
DOTNET_CLI_TELEMETRY_OPTOUT=1
LANG=en_US.UTF-8
SSH_CLIENT=192.168.2.2 61501 22
SSH_CONNECTION=192.168.2.2 61501 192.168.10.54 22
SSH_TTY=/dev/pts/1
SHLVL=1
PWD=/home/kali
```

修改環境變數



- 用途：將傳遞給 command 的環境變數 ENV_VAR 的值修改為 VALUE
- CTF 應用：使用 LD_PRELOAD 或 LD_LIBRARY_PATH 做 hook

```
(kali㉿kali)-[~]
$ PAGER=more man man
man: can't set the locale; make sure $LC_* and $LANG are correct
MAN(1)                               Manual pager utils                         MAN(1)
```

NAME

man – an interface to the system reference manuals

SYNOPSIS

```
man [man options] [[section] page ...] ...
man -k [apropos options] regexp ...
man -K [man options] [section] term ...
man -f [whatis options] page ...
man -l [man options] file ...
man -w|-W [man options] page ...
```

DESCRIPTION

man is the system's manual pager. Each page argument given to man is normally the name of a program, utility or function. The manual page associated with each of these arguments is then found and displayed. A section, if provided, will direct man to look only in that section of the manual. The default action is to search in all of the available sections following a pre-defined order (see DEFAULTS), and to show only the first page found, even if page exists in several sections.

The table below shows the section numbers of the manual followed

--More--

Change the pager of man to more

Bash Scripting

- Bash 有自己的 grammar，可以視做一種程式語言
- 常用於操作自動化
- 執行方式：
 - 將指令寫入 script.sh，然後以 bash script.sh 執行
 - shebang
- 語法請參考 [Bash Scripting Cheatsheet](#)

Lab – You know how to set env var!

You know how to set environment variables

100

你知道如何對單一 process 設定環境變數嗎？設置環境變數 `GIVE_ME_FLAG` 後執行附件程式來得到 flag !

Flag 格式：`FLAG{...}`

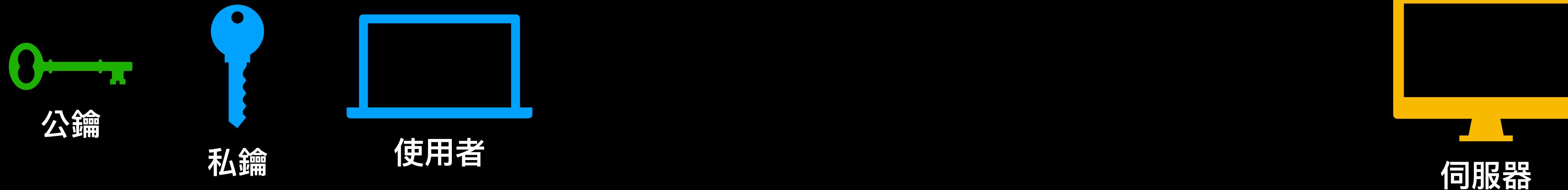
ssh 遠端管理

ssh

- 於非安全網路環境中建立安全連線的網路傳輸協定
- 常用於遠端管理、傳輸檔案等
- 支援密碼、非對稱式加密身份驗證

非對稱式加密

1. 使用者產生公鑰、私鑰



非對稱式加密



非對稱式加密



非對稱式加密



非對稱式加密

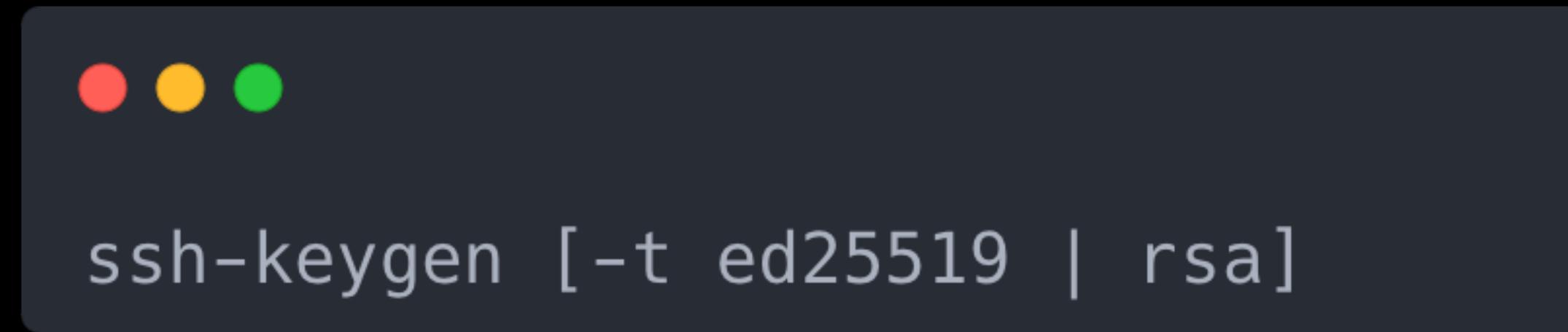
5. 檢查使用者回傳的驗證訊息是否正確



非對稱式加密

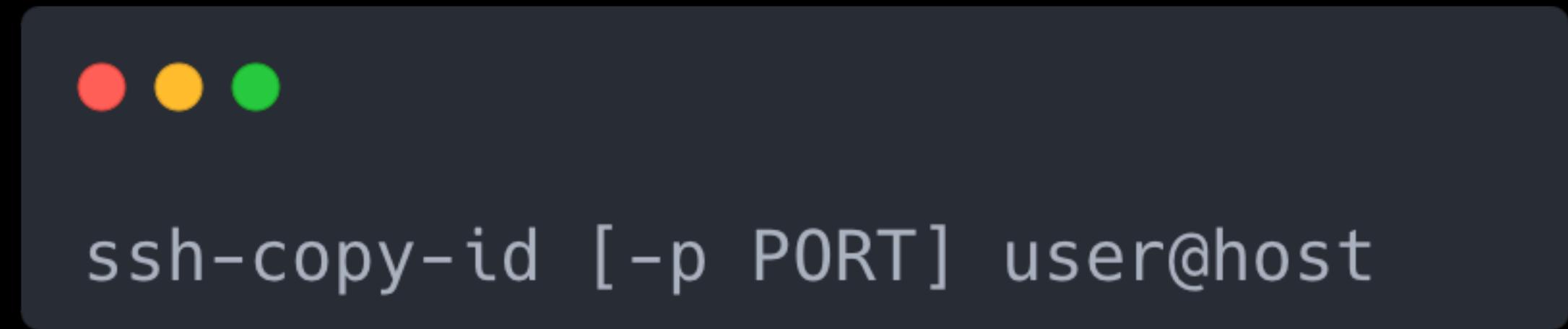


生成公私鑰 — ssh-keygen



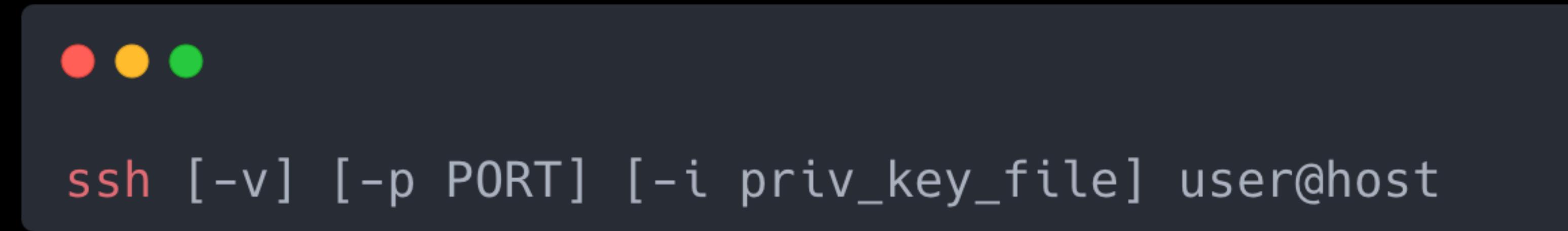
- 用途：產生一副公鑰、私鑰
- **-t**：選擇非對稱式加密演算法
 - 預設儲存位置：
 - 公鑰：`~/.ssh/id_{algo}.pub`
 - 私鑰：`~/.ssh/id_{algo}`

傳送公鑰 — ssh-copy-id



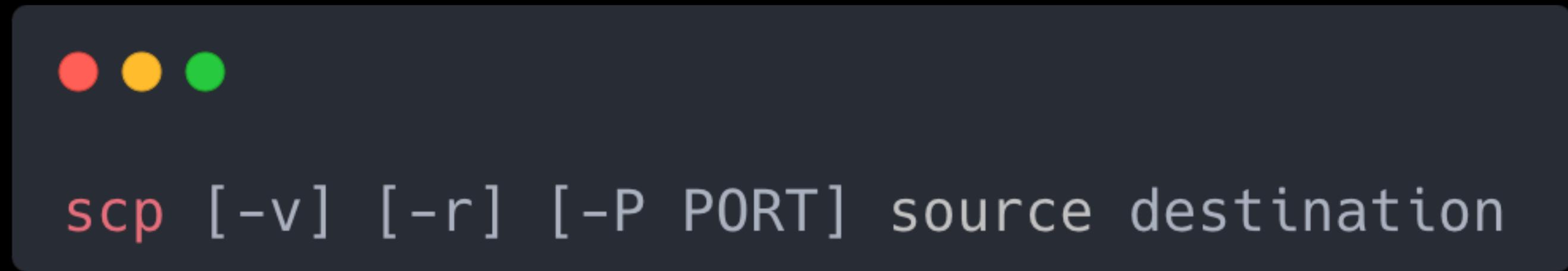
- 用途：將本地的公鑰複製到 host 伺服器的 user 使用者底下
- -p：指定 ssh 伺服器監聽的 port，預設為 22
- 公鑰儲存於伺服器該使用者的 ~/.ssh/authorized_keys 內，也可以手動複製

遠端連線 — ssh



- 用途：遠端連線至 host 伺服器的 user 使用者
- `-v`：印出連線時的 debug 資訊
- `-p`：指定 ssh 伺服器監聽的 port，預設為 22
- `-i`：指定身份驗證使用的私鑰

遠端傳送檔案 — scp



- 用途：在遠端與本地傳送檔案
 - -r : 複製整個資料夾
 - -P : 指定 ssh 監聽的 port
 - -v : 印出 debug 資訊
- 將檔案從 source 複製至 destination
- 本地檔案格式：相對路徑或絕對路徑
- 遠端檔案格式：user@host:[path/to/file]

Lab

- 嘗試使用 public key 驗證連線到某台有 ssh service 的機器

- ssh 遠端連線

- 輸入 ssh user@host

- 輸入 yes (第一次連線)

- 輸入密碼

```
ice1187@ice1187-lab:~$ ssh kali@192.168.10.54
The authenticity of host '192.168.10.54 (192.168.10.54)' can't be established.
ECDSA key fingerprint is SHA256:8zdkRD0LT+30xfnIPLP5E5Qlum0monS6DDQ0TATb5JU.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '192.168.10.54' (ECDSA) to the list of known hosts.
kali@192.168.10.54's password:
Linux kali 5.18.0-kali5-amd64 #1 SMP PREEMPT_DYNAMIC Debian 5.18.5-1kali6 (2022-07-07) x86_64
```

The programs included with the Kali GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*copyright.

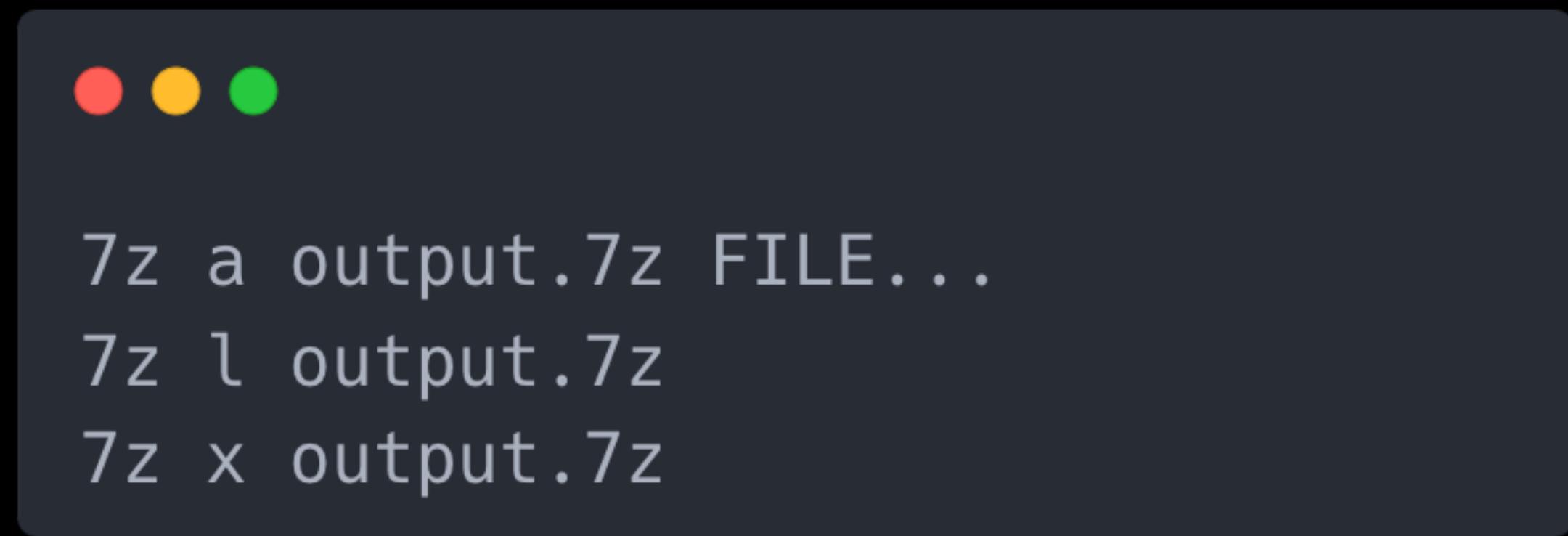
Kali GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.

Last login: Fri Sep 15 04:32:27 2023 from 192.168.2.2

```
[(kali㉿kali)-~]
$
```

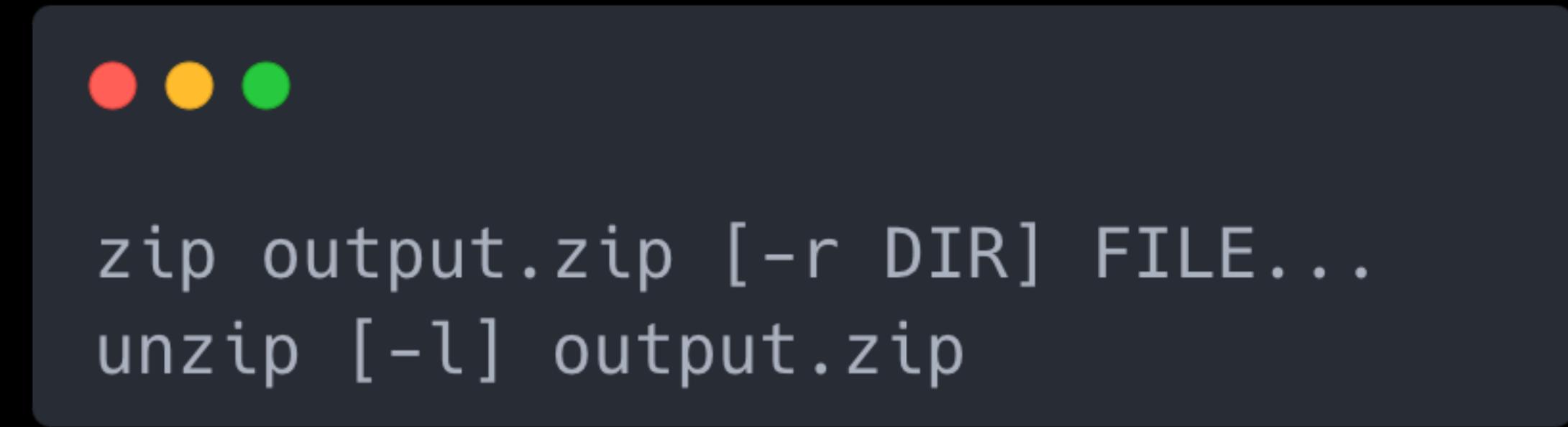
Compress 壓縮/解壓縮

7z



- 7z 支援多種壓縮演算法，多數壓縮檔都可用 7z 解開
- **a** : 壓縮 (archive)
- **l** : 列出壓縮檔內容 (list)
- **x** : 解壓縮

zip



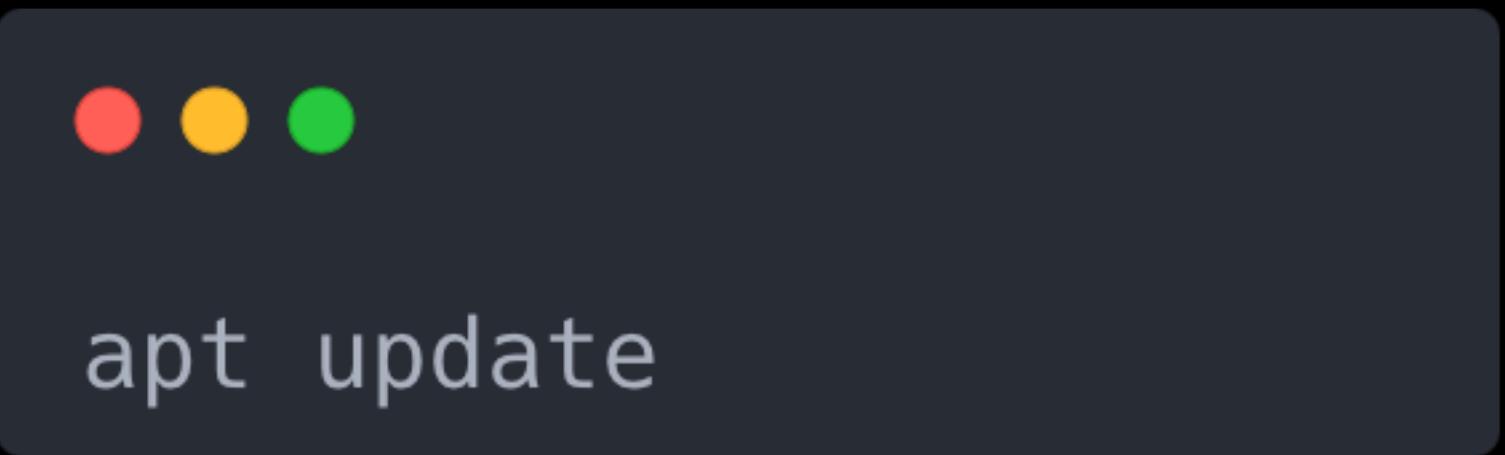
- output.zip 在 FILE... 前面
- **-r** : 惣縮整個資料夾
- **-l** : 列出慳縮檔內容
- 更多慳縮/解慳縮指令請參考「[GNU / Linux 各種慳縮與解慳縮指令](#)」

Package Manager 套件管理

Package Manager 套件管理

- 安裝、解除安裝、更新套件，並自動管理 dependency 和 conflict 等
- 程式語言的套件管理器：
 - Python – pip
 - Node.js – npm
- 作業系統也有套件管理器：pacman、yum、apt、dpkg

apt update

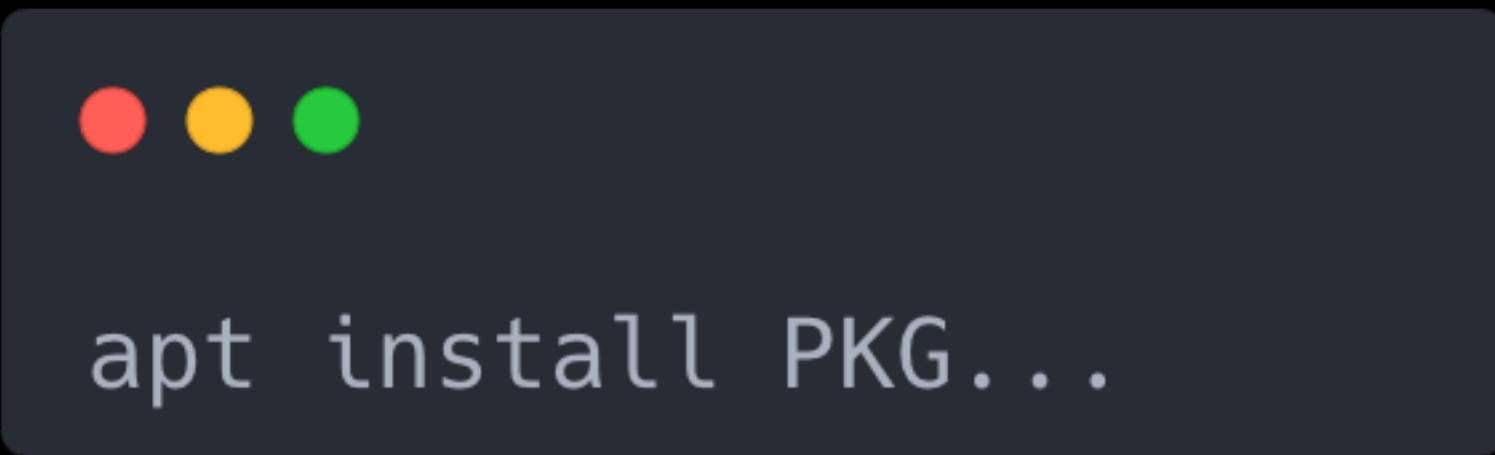


- 用途：從網路下載最新的套件資訊至本地套件資料庫 (a.k.a 更新套件資料庫)
- apt 多數功能皆仰賴套件資訊，無法安裝、升級時，可能需要先 update
- 套件管理屬於系統操作，需要加上 sudo

```
(kali㉿kali)-[~]
└─$ apt update
Reading package lists... Done
E: Could not open lock file /var/lib/apt/lists/lock - open (13: Permission denied)
E: Unable to lock directory /var/lib/apt/lists/
W: Problem unlinking the file /var/cache/apt/pkgcache.bin - RemoveCaches (13: Permission denied)
W: Problem unlinking the file /var/cache/apt/srcpkgcache.bin - RemoveCaches (13: Permission denied)

(kali㉿kali)-[~]
└─$ sudo apt update
[sudo] password for kali:
Get:1 http://kali.cs.nycu.edu.tw/kali kali-rolling InRelease [41.2 kB]
Get:2 http://kali.cs.nycu.edu.tw/kali kali-rolling/main amd64 Packages [19.4 MB]
Get:3 http://kali.cs.nycu.edu.tw/kali kali-rolling/main amd64 Contents (deb) [45.6 MB]
Get:4 http://kali.cs.nycu.edu.tw/kali kali-rolling/contrib amd64 Packages [115 kB]
Fetched 65.1 MB in 14s (4780 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
1834 packages can be upgraded. Run 'apt list --upgradable' to see them.
```

apt install



- 用途：安裝、更新套件
 - 安裝套件 PKG
 - 更新現有套件 PKG

```
(kali㉿kali)-[~]
```

```
$ docker
```

```
Command 'docker' not found, but can be installed with:
```

```
sudo apt install docker.io
```

```
sudo apt install podman-docker
```

```
(kali㉿kali)-[~]
```

```
$ sudo apt install docker.io
```

```
Reading package lists... Done
```

```
Building dependency tree... Done
```

```
Reading state information... Done
```

```
The following additional packages will be installed:
```

```
cgroupfs-mount containerd criu libapt-pkg-perl libcommon-sense-perl libcrypt-ssleay-perl libdbd-mariadb-  
liblist-moreutils-xs-perl liblocale-gettext-perl libmodule-find-perl libmodule-scandeps-perl libnet-dbus  
libsrt-naturally-perl libstring-crc32-perl libterm-readkey-perl libtext-charwidth-perl libtext-iconv-pe
```

```
Suggested packages:
```

```
containernetworking-plugins docker-doc aufs-tools btrfs-progs debootstrap rinse rootlesskit xfsprogs zfs  
libterm-readline-gnu-perl | libterm-readline-perl-perl libtap-harness-archive-perl
```

```
The following NEW packages will be installed:
```

```
cgroupfs-mount containerd criu docker.io libintl-perl libintl-xs-perl libmodule-find-perl libmodule-scar
```

```
The following packages will be upgraded:
```

```
libapt-pkg-perl libcommon-sense-perl libcrypt-ssleay-perl libdbd-mariadb-perl libdbi-perl libfcgi-perl 1  
libnet-dns-sec-perl libnet-libidn-perl libnet-ssleay-perl libsocket6-perl libstring-crc32-perl libterm-r
```

```
24 upgraded, 15 newly installed, 0 to remove and 1803 not upgraded.
```

```
Need to get 79.0 MB of archives.
```

```
After this operation, 320 MB of additional disk space will be used.
```

```
Do you want to continue? [Y/n] y
```

```
Get:1 http://http.kali.org/kali kali-rolling/main amd64 libapt-pkg-perl amd64 0.1.40+b2 [69.2 kB]
```

```
Get:2 http://kali.cs.nycu.edu.tw/kali kali-rolling/main amd64 libxml-parser-perl amd64 2.46-4 [201 kB]
```

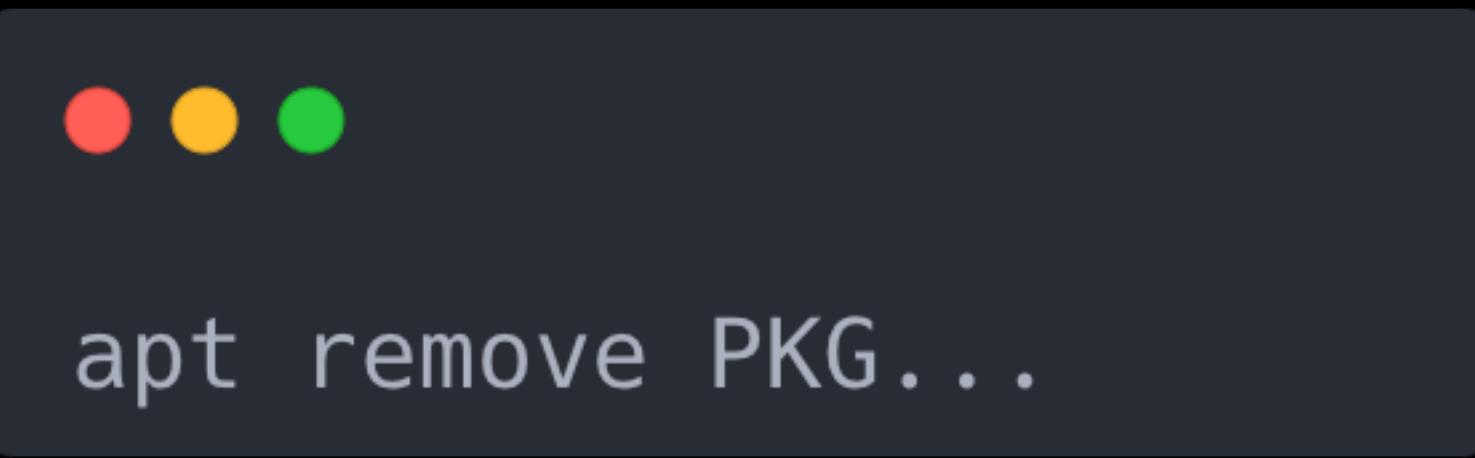
```
Get:3 http://http.kali.org/kali kali-rolling/main amd64 libunicode-linebreak-perl amd64 0.0.20190101-1+b5
```

```
└─(kali㉿kali)-[~]
└─$ apt list vim
Listing... Done
vim/kali-rolling 2:9.0.1672-1 amd64 [upgradable from: 2:8.2.4793-1]
N: There is 1 additional version. Please use the '-a' switch to see it
```

```
└─(kali㉿kali)-[~]
└─$ sudo apt install vim
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  vim-common vim-runtime vim-tiny xxd
```

```
└─(kali㉿kali)-[~]
└─$ apt list vim
Listing... Done
vim/kali-rolling,now 2:9.0.1672-1 amd64 [installed]
```

apt remove



- 用途：解除安裝套件（保留部分使用者設定）
- 使用 apt purge 移除使用者設定

Lab – Install Docker

- 練習安裝 Docker

```
(kali㉿kali)-[~]  
$ docker
```

Usage: docker [OPTIONS] COMMAND

A self-sufficient runtime for containers

Options:

--config string	Location of client config files (default "/home/kali/.docker")
-c, --context string	Name of the context to use to connect to the daemon (overrides DOCKER_HOST env)
-D, --debug	Enable debug mode
-H, --host list	Daemon socket(s) to connect to
-l, --log-level string	Set the logging level ("debug" "info" "warn" "error" "fatal") (default "info")
--tls	Use TLS; implied by --tlsverify
--tlscacert string	Trust certs signed only by this CA (default "/home/kali/.docker/ca.pem")
--tlscert string	Path to TLS certificate file (default "/home/kali/.docker/cert.pem")
--tlskey string	Path to TLS key file (default "/home/kali/.docker/key.pem")
--tlsverify	Use TLS and verify the remote
-v, --version	Print version information and quit

Encoding 編碼

ASCII

- 字母如何在電腦中被表示？

ASCII可顯示字元 (共95個)							
二進位	十進位	十六進位	圖形	二進位	十進位	十六進位	圖形
0010 0000	32	20	(space)	0100 0000	64	40	@
0010 0001	33	21	!	0100 0001	65	41	A
0010 0010	34	22	"	0100 0010	66	42	B
0010 0011	35	23	#	0100 0011	67	43	C
0010 0100	36	24	\$	0100 0100	68	44	D
0010 0101	37	25	%	0100 0101	69	45	E
0010 0110	38	26	&	0100 0110	70	46	F
0010 0111	39	27	'	0100 0111	71	47	G
0010 1000	40	28	(0100 1000	72	48	H
0010 1001	41	29)	0100 1001	73	49	I
0010 1010	42	2A	*	0100 1010	74	4A	J
							ˋ
							a
							b
							c
							d
							e
							f
							g
							h
							i
							j

Img Src: <https://zh.wikipedia.org/zh-tw/ASCII>

Hex & Binary

- Hex 十六進位

- 通常以 0x 開頭表示

- 0123456789abcdef

$$0x10 = 28 = 0b11100$$

- 每兩個數字剛好一個 byte

$$0x100 = 256 = 0b100000000$$

- Binary 二進位

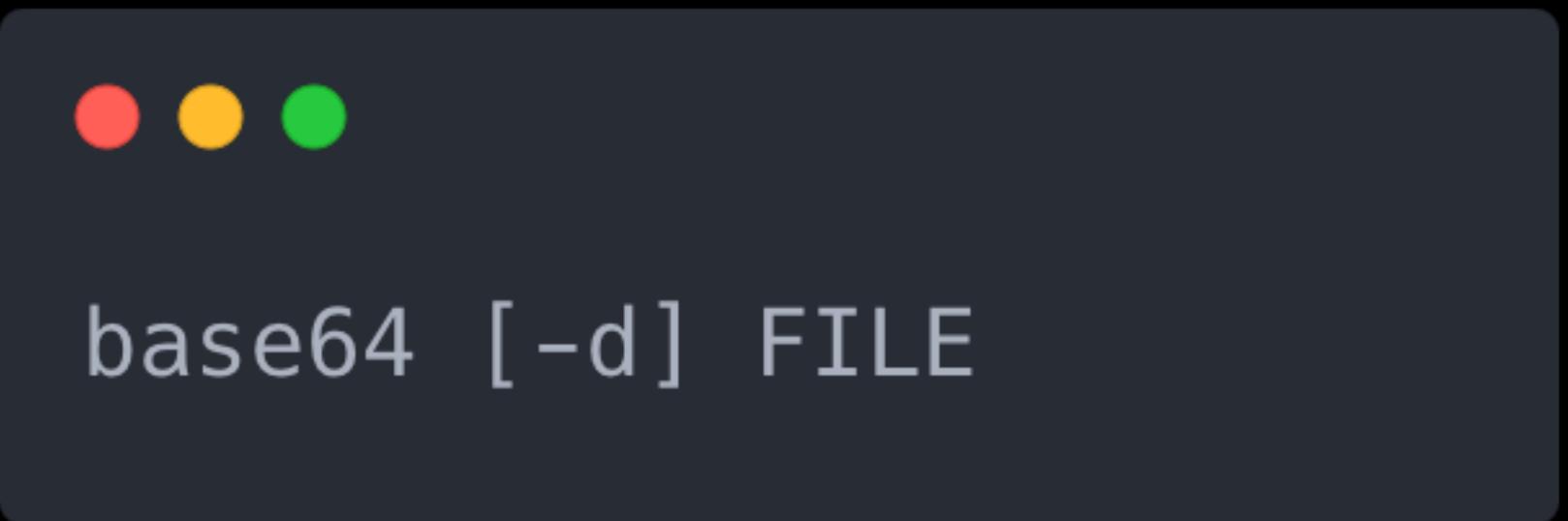
- 通常以 0b 開頭表示

Base64 編碼

- 一種由英文大小寫、數字和 `+/=` 組成 binary-to-text 編碼
 - 功能：使 binary 檔案 (圖片、執行檔) 得以在純文字管道中進行傳輸
 - 特徵：結尾為 `=` 或 `==`

Img Src: <https://en.wikipedia.org/wiki/Base64>

base64



- 用途：將檔案 FILE 做 base64 encoding
- **-d**：進行 decoding
- 注意：若要處理字串，需先寫入檔案，或用 pipe 傳入 stdin

```
(kali㉿kali)-[~]
└─$ echo Hello, World! | base64
SGVsbG8sIFdvcmxkIQo=
```

```
(kali㉿kali)-[~]
└─$ echo SGVsbG8sIFdvcmxkIQo= | base64 -d
Hello, World!
```

```
(kali㉿kali)-[~]
└─$ echo This is a b64 encodede file. | base64 > encode.b64
```

```
(kali㉿kali)-[~]
└─$ cat encode.b64
VGhpcyBpcyBhIGI2NCBlbmNvZGVkZSBmaWxllLgo=
```

```
(kali㉿kali)-[~]
└─$ base64 -d encode.b64
This is a b64 encodede file.
```

Number Converversion by Python

- number to string
 - int to bin : `hex(number)`
 - int to hex : `bin(number)`
- string to number
 - bin to int : `int('number string', 2)`
 - hex to int : `int('number string', 16)`

Base64 in Python

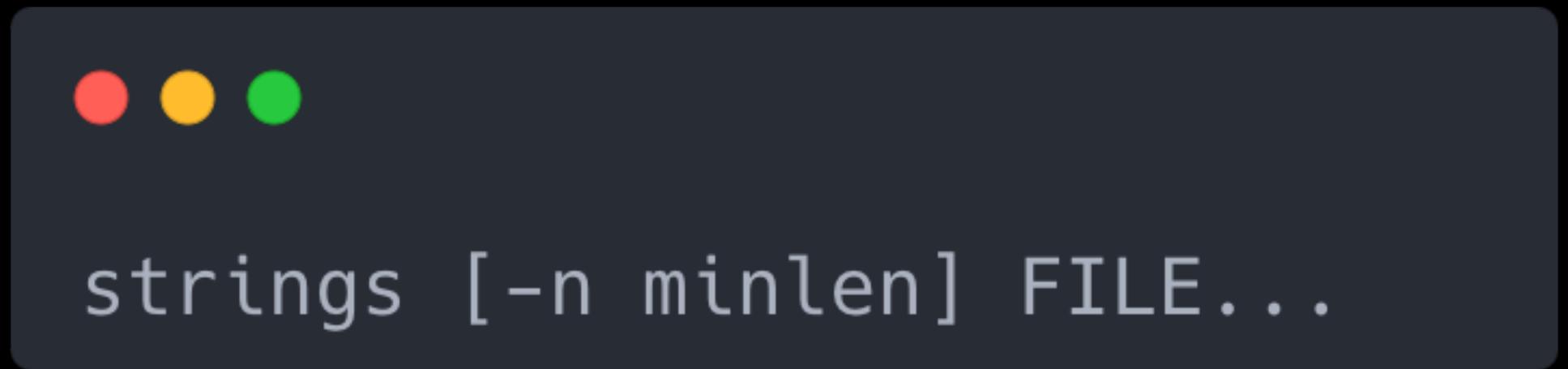
- from base64 import b64encode, b64decode
- b64encode(**b'base64 string'**)
- b64decode(**'base64 string'**)

```
> python3 try_b64.py
b'SGVsbG8sIFdvcmxkIQ=='
b'Hello, World!'
```

```
1 from base64 import b64encode, b64decode$  
2 $  
3 s = b'Hello, World!'$  
4 $  
5 b64_s = b64encode(s)$  
6 print(b64_s)$  
7 $  
8 ori_s = b64decode(b64_s)$  
9 print(ori_s)$
```

其他 CTF 常用指令

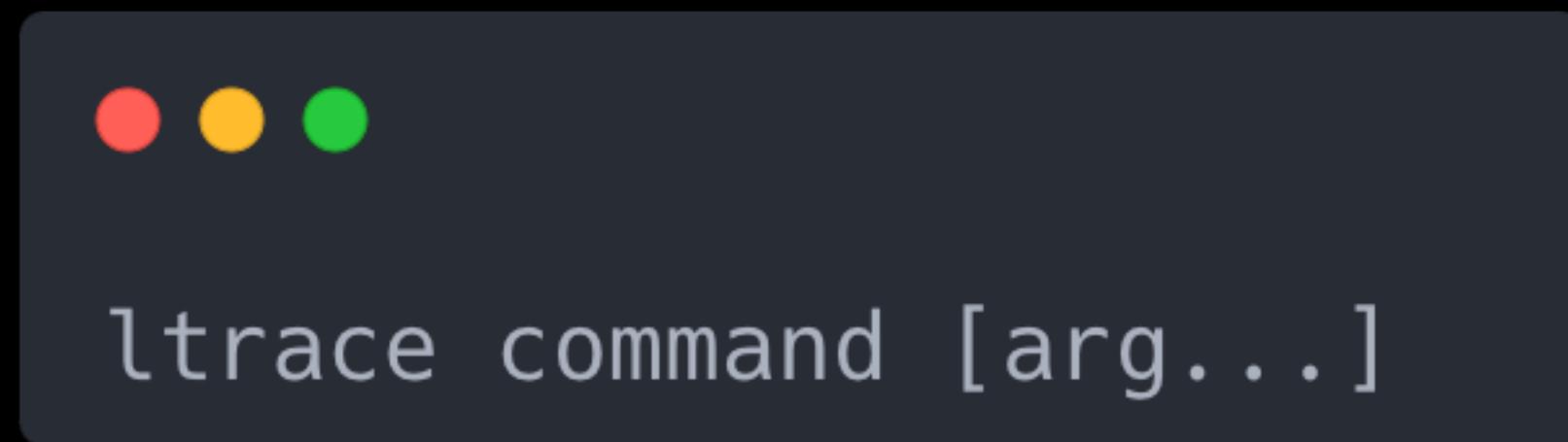
strings



- 用途：印出檔案 FILE 中所有連續數個可視字元組成的字串
- **-n**：指定字串至少要有連續 minlen 個可視字元，預設為 4
- CTF 應用：查看 binary 檔案中的字串

```
└─(kali㉿kali)-[~]
└─$ strings hello
/lib64/ld-linux-x86-64.so.2
__isoc99_scanf
puts
printf
__cxa_finalize
__libc_start_main
libc.so.6
GLIBC_2.7
GLIBC_2.2.5
__ITM_deregisterTMCloneTable
__gmon_start__
__ITM_registerTMCloneTable
u+UH
[]A\A]A^A_
Hello, World!
Input is %d
;*3$"
GCC: (Debian 11.3.0-5) 11.3.0
Scrt1.o
__abi_tag
crtstuff.c
deregister_tm_clones
__do_global_dtors_aux
```

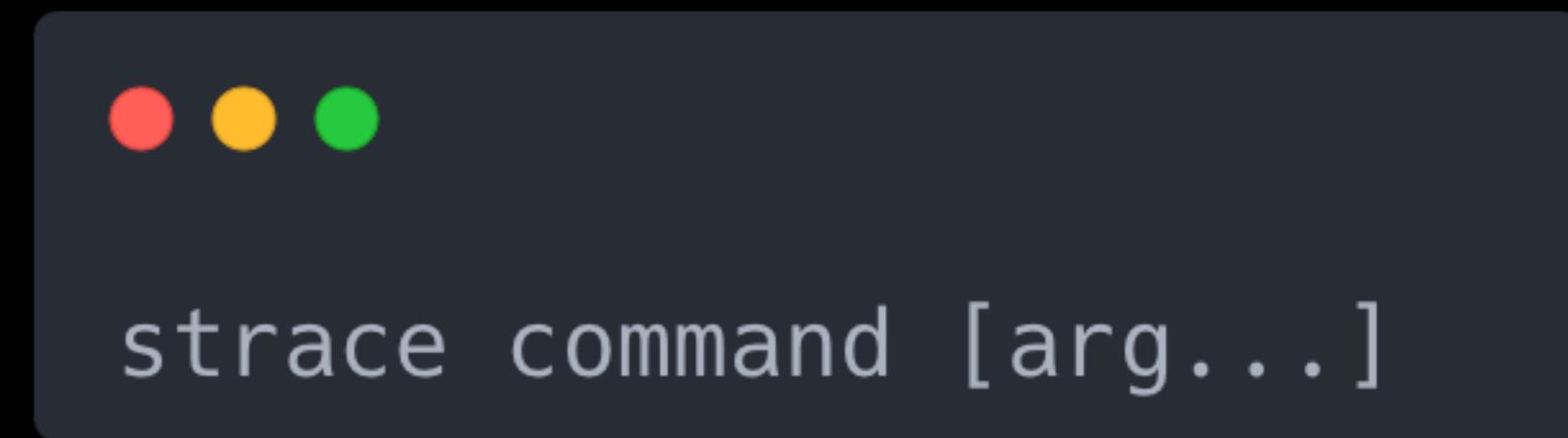
ltrace



- 用途：列出/紀錄 command 執行時所呼叫的 library call
- CTF 應用：查看程式執行時的 library call 和其參數

```
(kali㉿ kali)=[~]
$ ltrace ./hello
puts("Hello, World!"Hello, World!
)
__isoc99_scanf(0x55b1d5681012, 0x7ffe0a4563ec, 0, 0x7ff5cae4fad0100
)
printf("Input is %d\n", 100Input is 100
)
+++ exited (status 0) +++
```

strace



- 用途：列出/紀錄 command 執行時所呼叫的 system call 和接收的 signals
- CTF 應用：查看程式執行時的 system call 和其參數

```
write(1, "Hello, World!\n", 14Hello, World!
) = 14
newfstatat(0, "", {st_mode=S_IFCHR|0620, st_rdev=makedev(0x88, 0x1), ...}, AT_EMPTY_PATH) = 0
read(0, 100
"100\n", 1024) = 4
write(1, "Input is 100\n", 13Input is 100
) = 13
lseek(0, -1, SEEK_CUR) = -1 ESPIPE (Illegal seek)
exit_group(0) = ?
+++ exited with 0 +++
```

Lab – Can you see me?

Can you see me?

100

I am speeeeeed. Try to trace me.

strace

Lab – Trace down the flag

Trace down the flag

100

I forgot to print flag. But I do use it in some libc functions. Can you trace down the flag?

ltrace

Q & A