Good to the last drop
Writing robust Flask and Django Apps

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Who are we?

me:

Clara McCreery, software engineer @ r2c

MS in Computer Science from Stanford University

Previously: researcher at MIT Lincoln Laboratory

r2c:

We're a static analysis startup in San Francisco on a mission to profoundly improve software security and reliability

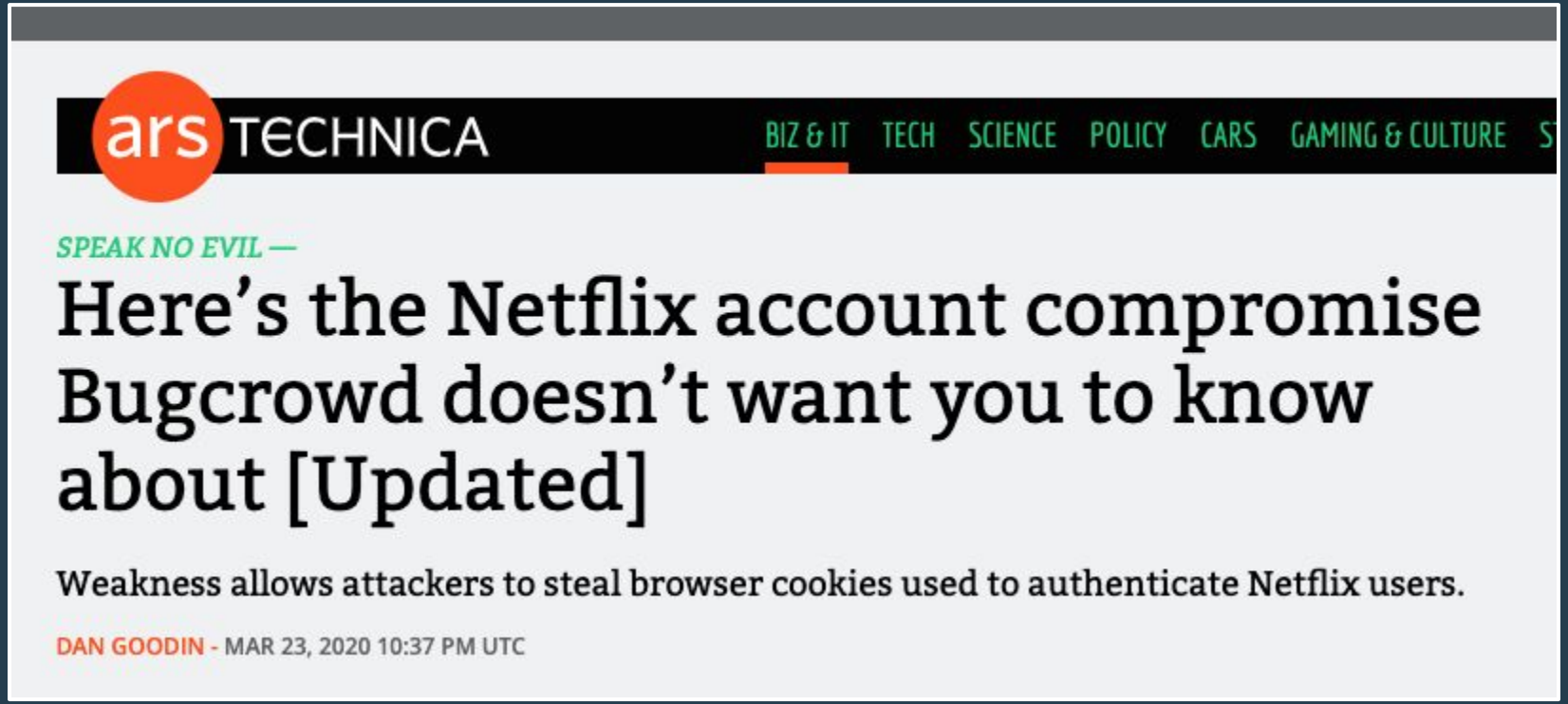
tl;dr

- Read docs for your framework & stay up to date (Flask Security Considerations or Django Security Docs)
- Favor secure-by-default frameworks (e.g. SQLAlchemy) and architectures (e.g. default True for TLS verification)
- **Check your code with code! In reality, you should automate this stuff and not have to be an expert.**

> **Note:** We'll use the open source tool Semgrep to explore security bugs during this talk. Search code with code that looks like it

Writing Secure Flask

1. **Have a Security Philosophy**
2. Flask Security Bugs (bug → mitigation → detection)
3. Scan Every Commit and Build

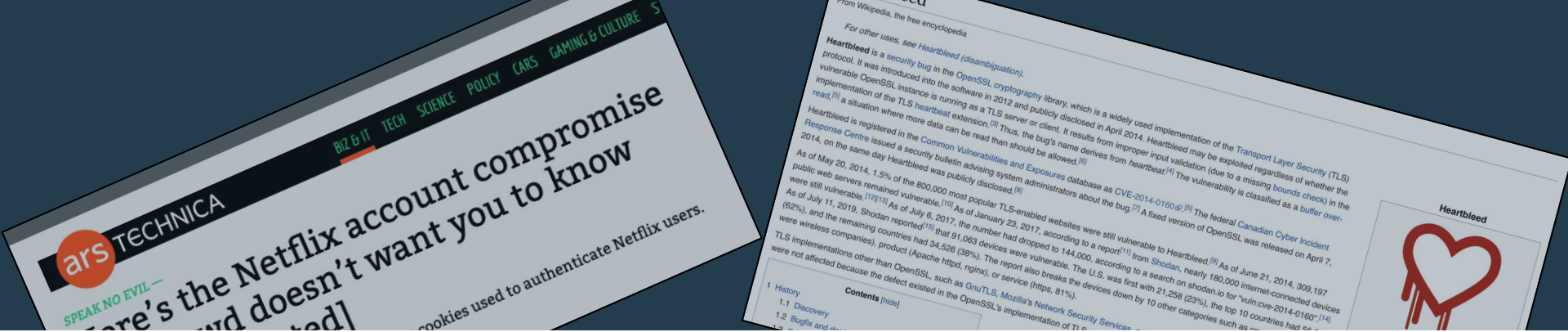


https://arstechnica.com/information-technology/2020/03/bugcrowd-tries-to-muzzle-hacker-who-found-netflix-account-compromise-weakness/

How Patreon got hacked - Publicly exposed Werkzeug Debugger

October 2, 2015

https://labs.detectify.com/2015/10/02/how-patreon-got-hacked-publicly-exposed-werkzeug-debugger/



What do they have in common?

Philosophy

Humans **will** make mistakes, eventually.

A short **complete** wall is better than an isolated tall gatehouse.

https://www.reddit.com/r/pics/comments/8sayj8/a_polite_but_useless_gate/

https://momentummag.com/tag/bike-lock/


TV LAND
YOU READY?

Writing Secure Flask

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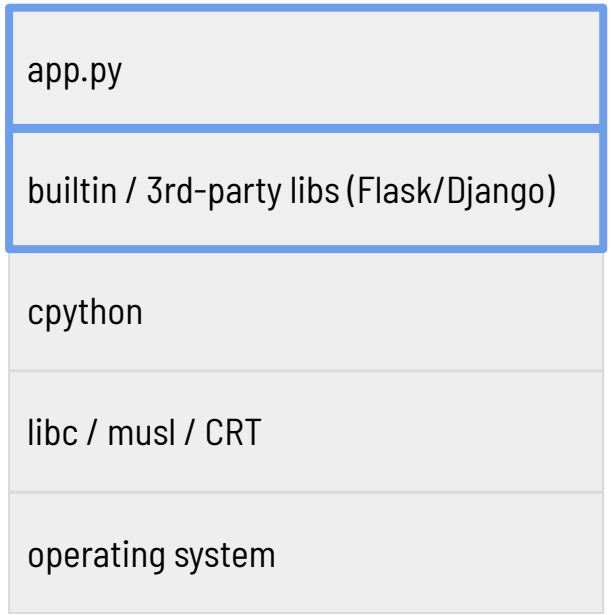
2. **Flask Security Bugs (bug → mitigation → detection)**
3. Scan Every Commit and Build

Stack/Security Overview



← your responsibility

Ontologies:

- Open Web Application Security Project (OWASP) Top 10
- MITRE CWE (extensive, used by governments, etc.)

Top 10 from Open Web Application Security Project

1. Injection
2. Broken authentication
3. Sensitive data exposure
4. XML XXE
5. Broken access control
6. Security misconfiguration
7. Cross-site scripting (XSS)
8. Insecure deserialization
9. Components with known vulnerabilities
10. Insufficient logging & monitoring

https://owasp.org/www-project-top-ten/

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#6: Security Misconfiguration

"Such flaws frequently give attackers unauthorized access to some system data or functionality. Occasionally, such flaws result in a complete system compromise." - OWASP Top 10

#6: Security Misconfiguration

```
from flask import Flask

if __name__ == "__main__":
    # ruleid:debug-enabled
    app.run("0.0.0.0", debug=True)
```

1. Ok to run this while developing
2. Opens up a debugging console on error

what's the problem?

How Patreon got hacked - Publicly exposed Werkzeug Debugger

October 2, 2015

https://labs.detectify.com/2015/10/02/how-patreon-got-hacked-pu

How do we audit for this issue?

https://semgrep.dev/s/7g6e/

Solution: https://semgrep.dev/s/ErgL/

#6: Security Misconfiguration

```
@app.route('/login', methods=['POST'])
def login():
    ...
    session.clear()
    session['user_id'] = user.id
    session.permanent = True
    ...
```

1. Cookie could be requested over HTTP connection, not HTTPS
2. Cross-site request forgery (CSRF)
3. Cookie could be read via Javascript (stealing user sessions if XSS happens)

what's the problem?

#6: Security Misconfiguration

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SPEAK NO EVIL —

Here's the Netflix accou Bugcrowd doesn't want about [Updated]

Weakness allows attackers to steal browser cookies used to authenticate Netflix users.

DAN GOODIN - MAR 23, 2020 10:37 PM UTC

https://arstechnica.com/information-technology/2020/03/bugcrowd-tries-to-muzzle-hacker-who-found-netflix-account-compromise-weakness/

Fix

1. Follow Flask session cookie recommendations:

```
app.config.update(
    SESSION_COOKIE_SECURE=True,
    SESSION_COOKIE_HTTPONLY=True,
    SESSION_COOKIE_SAMESITE='Lax',
)
```

2. Do this for all cookies you create:

```
resp.set_cookie('user', 'flask', secure=True, httponly=True, samesite='Lax')
```

3. Prevent merges to master with `secure` and `httponly` set to False

How do we audit for this issue?

https://semgrep.live/s/OZR

Solution: https://semgrep.live/s/vWX

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#1: Injection

"Injection can result in data loss, corruption, or disclosure to unauthorized parties, loss of accountability, or denial of access. Injection can sometimes lead to complete host takeover.

Injection vulnerabilities are often found in SQL, LDAP, XPath, or NoSQL queries, OS commands, XML parsers, SMTP headers, expression languages, and ORM queries." - OWASP Top 10

Types of injection:

- **SQL injection**
- Command injection
- Code injection
- Header injection
- Template injection

#1: Injection, SQL Injection

```
def search(request):
    user = request.GET['q']
    pw = request.GET['p']
    sql = f"SELECT * FROM users WHERE name='%{user}%' and password='%{pw}%';"

    cursor = db.cursor()
    cursor.execute(sql)
    ...
```

what's the problem?

#1: Injection, SQL Injection

```
def search(request):
    user = request.GET['q']
    pw = request.GET['p']
    sql = f"SELECT * FROM users WHERE name='%{user}%' and password='%{pw}%';"

    cursor = db.cursor()
    cursor.execute(sql)
    ...
```

user="' OR 1=1;"--"

Database sees:

"SELECT * FROM users WHERE name='' OR 1=1;"--"' and ...

#1: Injection, SQL Injection

```
def search(request):
    user = request.GET['q']
    pw = request.GET['p']
    sql = f"SELECT * FROM users WHERE name=

    cursor = db.cursor()
    cursor.execute(sql)
    ...
```

user="' OR 1=1;"--"

Database sees:

"SELECT * FROM users WHERE name='' OR 1=1;"

Fix

1. Don't use SQL (Use an ORM)

```
user = User.get(request.query['id'])
```

2. Maintain separation between code and data — parameterized queries

```
user = q.exec('SELECT * WHERE id=?', request.query['id'])
```

3. Sanitize all user input (hard to remember to do it *everywhere*) (DO NOT USE)

```
user = q.exec('SELECT * WHERE id=%s' % (strip_bad_chars(request.query['id'])))
```

4. Prevent merges to master that side-step any of the above (semgrep example).

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But wait, there's more!

OWASP Top 10 for *webapps*

1. Injection
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OWASP Top 10 for *APIs*

1. BOLA (Broken Object Level Authorization)
2. Broken Authentication
3. Excessive Data Exposure
4. Lack of Resources & Rate Limiting
5. BFLA (Broken Function Level Authorization)
6. Mass Assignment
7. Security Misconfiguration
8. Injection
9. Improper Assets Management
10. Insufficient Logging & Monitoring


GOTCHA
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GOTCHA


security

Writing Secure Flask

1. Have a Security Philosophy
2. Flask Security Bugs (bug → mitigation → detection)
3. **Scan Every Commit and Build**

What kinds of tools?

- **Secure-by-design languages and frameworks**
- **Static analysis**
- Formal methods
- Dynamic analysis (fuzzing, etc.)
- Let people poke it (bug bounties!)

Frameworks

Good frameworks and good defaults

- Avoid SQL injection: SQLAlchemy (not foolproof)
- Avoid XSS: React.js
- Avoiding XML vulnerabilities: defusedxml
- Avoid some CSRF with authentication via JWT (JSON Web Tokens) instead of cookies

Frameworks

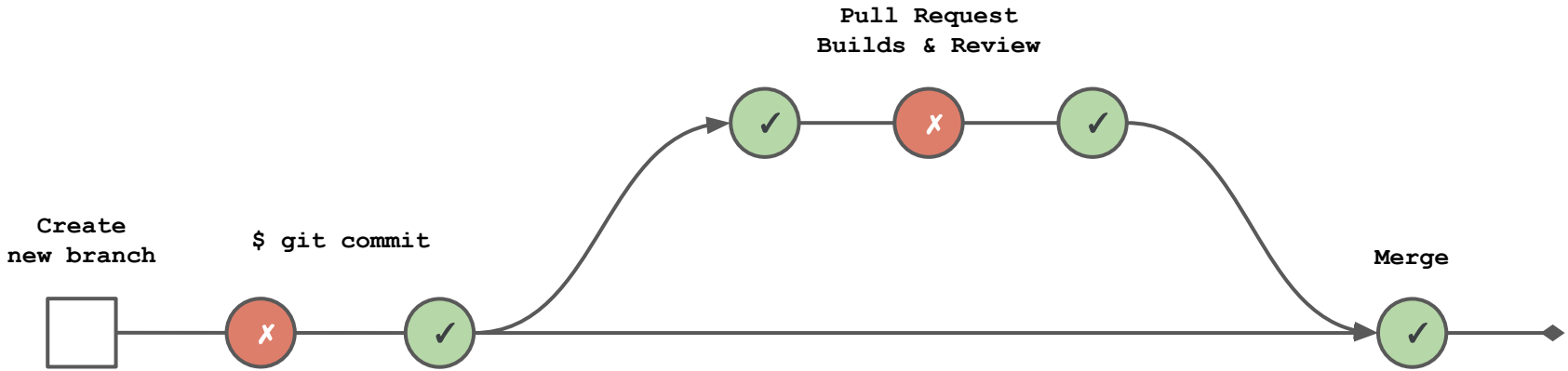
What makes some better than others?

OK: "Do not use this in a production environment"
BETTER: "Do not use this in a production environment, or you will get hacked"
BEST: "This is production-ready by default, but you are running with —DANGEROUS_ALLOW_ARBITRARY_CODE_FROM_USERS, so we're letting you do something scary, but don't you forget about it!"

Bad example: *render_template_string* vs *render_template* in Flask
Good example: *dangerouslySetInnerHTML* in React

Static Analysis Tools

- Free:
  - **grep** (!?)
  - **Bandit** (64 security rules) or **Dlint** (38 security rules, newer)
  - **Flake8** and associated plugins
  - **semgrep** has >150 security checks for python
    (it's free, open-source, and made by r2c!)
- Proprietary/closed license/SaaS:
  - SonarPython (36 security rules)
  - Commercial tools like Coverity, Fortify, Veracode, Checkmarx ($$$)


Pull Request
Builds & Review
Create
new branch
$ git commit
Merge

tl;dr

- Read docs for your framework & stay up to date (Flask Security Considerations)
- Favor secure-by-default frameworks (e.g. SQLAlchemy) and architectures (e.g. default True for TLS verification)
- Check your code with code!
  - Existing toolkits like Flake8, Bandit, Dlint
  - "Custom static analysis" with Semgrep

I'd love your feedback on this presentation! https://r2c.dev/survey

Want to learn more about Semgrep?

Learn how to write custom rules:

- Tutorial

See more rules and rulesets:

- Explore

Run on the command line:

- Docs

For more questions and to stay in touch, join our Community Slack!

Bonus content...

Top 10 from Open Web Application Security Project

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#7: Cross-Site Scripting (XSS)

"The impact of XSS is moderate for reflected and DOM XSS, and severe for stored XSS, with remote code execution on the victim's browser, such as stealing credentials, sessions, or delivering malware to the victim.

XSS is the second most prevalent issue in the OWASP Top 10, and is found in around two thirds of all applications." - OWASP Top 10

#7: Cross-Site Scripting (XSS)

```
<body>
  <h1>welcome to my website {{ app_name }}</h1>
  <li class="my-favorite-cities">
    {{ value }}
  </li>
</body>
```

what's the problem?

#7: Cross-Site Scripting (XSS)

```
<body>
  <h1>welcome to my website {{ app_name }}</h1>
  <li class="my-favorite-cities">
    {{ value }}
  </li>
</body>
```

value = "onmouseover=alert('xss:' + document.cookie)"

what's the problem?

#7: Cross-Site Scripting (XSS)

Straight from the docs:

Flask configures Jinja2 to automatically escape all values unless explicitly told otherwise. This should rule out all XSS problems caused in templates, but there are still other places where you have to be careful:

- generating HTML without the help of Jinja2
- calling Markup on data submitted by users
- sending out HTML from uploaded files, never do that, use the Content-Disposition: attachment header to prevent that problem.
- sending out textfiles from uploaded files. Some browsers are using content-type guessing based on the first few bytes so users could trick a browser to execute HTML.

Another thing that is very important are unquoted attributes.

#7: Cross-Site Scripting (XSS)

Flask is configured to autoescape most views.

Some gotchas:

- Template files must have the **.html** extension
- HTML attributes **must be quoted**
- Using template variables for **href** in anchor tags is **unsafe**

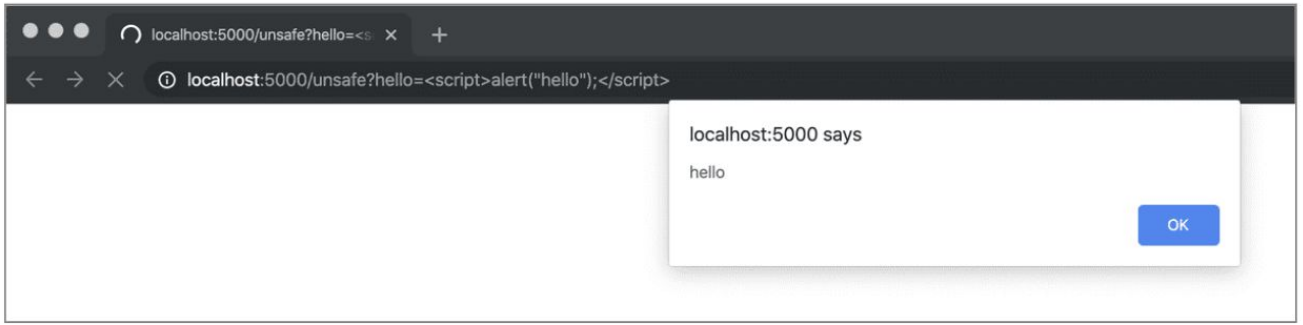
#7: Cross-Site Scripting (XSS)

Flask will autoescape in this case:

```
@app.route("/safe")
def safe():
    return render_template("safe.html", hello=request.args.get("hello"))
```

But, Flask will not autoescape in this case:

```
@app.route("/unsafe")
def unsafe():
    return render_template("unsafe.txt", hello=request.args.get("hello"))
```



Fix

1. Use a framework like React.js which is less vulnerable to XSS

```
<script src="https://unpkg.com/react@16/umd/react.development.js" crossorigin>
```

2. Always use .html extension for templates

```
render_template("index.html", context)
```

3. Set the Content Security Policy for your application

```
response.headers['Content-Security-Policy'] = "script-src https:"
```

4. Use Flask-Talisman by Google

```
from flask_talisman import Talisman; app = Flask(...); Talisman(app)
```

5. Prevent merges to master that violate any of the above.