# Information Disclosure

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# Information Disclosure

- What is the job of a web server?
  - Information dissemination
- Why information disclosure a problem?
  - Not all information should be public! Violates confidentiality
    - E.g. database passwords, usernames, debug info
    - Attackers often gather this information by maliciously interacting with server

- Say server tells its web server type/version, what is the big deal?
- Information may not be directly exploitable , but attacker can use it in an attack lifecycle
  - Attackers frequently use publicized security vulnerabilities
    - E.g. Zero-day vulnerabilities made public in the last 24 hours
    - zero-day vulnerability published → hackers scan web servers running the vulnerable software → Launch Attack
    - Web server should not leak software version and make itself a target!

# Point to Note

- Many web security attacks force web server to disclose some information and violate confidentiality
  - Access control, directory traversal attacks, SQL injection, XSS, CSRF etc (will be covered in detail)
- Here, we will cover some miscellaneous ways

# Outline

- What information is useful to attackers?
- How can such information leak?
- Impact of such leaks
- Common sources of such leaks
- Testing for such leaks
- Best Practices to defend against leaks

# Types of Information

- OS/Application Name and Version
  - Attacker can refer to publicly available database (CVE) to check for vulnerabilities
    - Results in a highly targeted and specific attack with a high chance of success
- Sensitive data leaks (also called data breaches)
  - E.g. personal information like names, addresses, pan card details, financial data
  - Attackers can sell such data in black market!
  - Explicitly protected under various legislative and regulatory measures (e.g. GDPR in Europe)
    - Can trigger significant financial penalties for an organisation

- Username Enumeration:
  - Helps attackers gain access to a user account → can act within authorised context of that user
    - This however needs password as well
    - But if able to enumerate valid usernames, job half-done!
- Server Configuration:
  - An inherent property of the server (e.g. Apache) or leak of a configuration file
  - Such leaks can reveal internal-only endpoints (e.g. IP), folder paths, software versions, database access credentials, API keys etc

- Application code:
  - Servers execute code and provide results (HTTP responses), details of code normally not exposed
  - But in some situations, code can leak
    - Server uses an interpreted language (e.g. PHP) but interpreter not enabled in configuration file
    - When a version control accidentally exposes source code
  - Attacker can get sensitive info like passwords/api keys from code or statistically analyse code for weaknesses

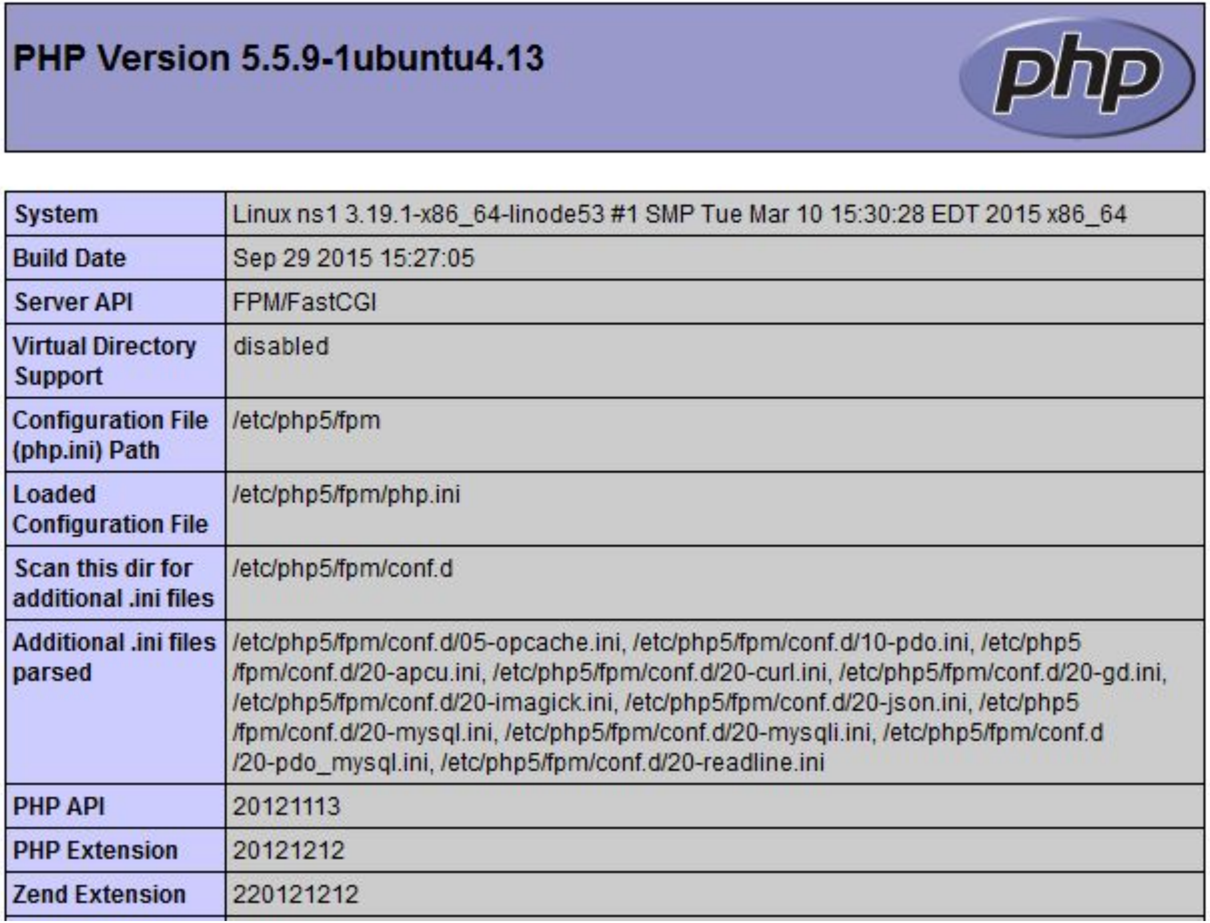
- Internal organisational data (not customer data)
  - E.g. employee data
  - Permits social engineering attacks (spear-phishing) to gain access to high-value accounts (e.g. admins)

# Why information leaks?

3 Main Reasons

- Sensitive content not removed from public content
  - Comments in Markup
  - Exposed metadata in git store
    - Git  stores metadata such as usernames, filenames, file paths, host IP addresses, detailed “diff” (source code snippets)
    - Git store can be accidentally uploaded as part of the CI/CD pipeline

- Insecure configuration
  - Not disabling debugging and diagnostic features
    - E.g. phpinfo() function is used on many web servers to test if PHP installation was successful
      - Exposes detailed information about PHP config as well as underlying system
      - phpinfo() as such should not be used in production environments!
  - Configuring incorrect MIME types (Multi-purpose Internet Mail Extensions)
    - E.g.  A web server determines the correct handling for a file based on MIME type (e.g .php)
    - Developer may create a backup (e.g. “file.php.bak”)
    - If MIME type not specified properly, the handler would not execute the file but return the code to the requester



# PHP Version 5.5.9-1ubuntu4.13

| | |
|---|---|
| **System** | Linux ns1 3.19.1-x86_64-linode53 #1 SMP Tue Mar 10 15:30:28 EDT 2015 x86_64 |
| **Build Date** | Sep 29 2015 15:27:05 |
| **Server API** | FPM/FastCGI |
| **Virtual Directory Support** | disabled |
| **Configuration File (php.ini) Path** | /etc/php5/fpm |
| **Loaded Configuration File** | /etc/php5/fpm/php.ini |
| **Scan this dir for additional .ini files** | /etc/php5/fpm/conf.d |
| **Additional .ini files parsed** | /etc/php5/fpm/conf.d/05-opcache.ini, /etc/php5/fpm/conf.d/10-pdo.ini, /etc/php5/fpm/conf.d/20-apcu.ini, /etc/php5/fpm/conf.d/20-curl.ini, /etc/php5/fpm/conf.d/20-gd.ini, /etc/php5/fpm/conf.d/20-imagick.ini, /etc/php5/fpm/conf.d/20-json.ini, /etc/php5/fpm/conf.d/20-mysql.ini, /etc/php5/fpm/conf.d/20-mysqli.ini, /etc/php5/fpm/conf.d/20-pdo_mysql.ini, /etc/php5/fpm/conf.d/20-readline.ini |
| **PHP API** | 20121113 |
| **PHP Extension** | 20121212 |
| **Zend Extension** | 220121212 |

- Over verbose Logs/error messages
    - When logging, can specify levels of reporting: “critical” or “detailed”
        - Detailed logs: function executed, received input, snippets of relevant code, call stack details etc
    - Logs helpful in development environments to help bugs but problematic when
        - Left in production systems
        - Collected logs inadvertent publishing to web root folder
        - Configuration setting where errors are returned to users as error messages
            - Differential error messages (sending different responses under different circumstances) particularly problematic
                - Can expose internal state

# Impact of Leaks

- Direct harm:  leaked information is inherently sensitive
  - Can cause financial or reputation damage
    - E.g. credit card data, financial data
  - Needs immediate attention
- Indirect harm: depends on what attacker can do with info
  - Latest patched version of software → no risk
  - Old version with vulnerability → high risk
- Focus on impact and exploitability of the leak, not just presence

# Outline

- ~~What information is useful to attackers?~~
- ~~How can such information leak?~~
- ~~Impact of such leaks~~
- Common sources of such leaks
- Testing for such leaks
- Best Practices to defend against leaks

# Some Common Sources of Leaks

- Files for web crawlers
- Directory listings
- Developer comments
- Error messages
- Debugging data
- User account pages
- Backup files
- Insecure configuration
- Version control history

# Example robots.txt

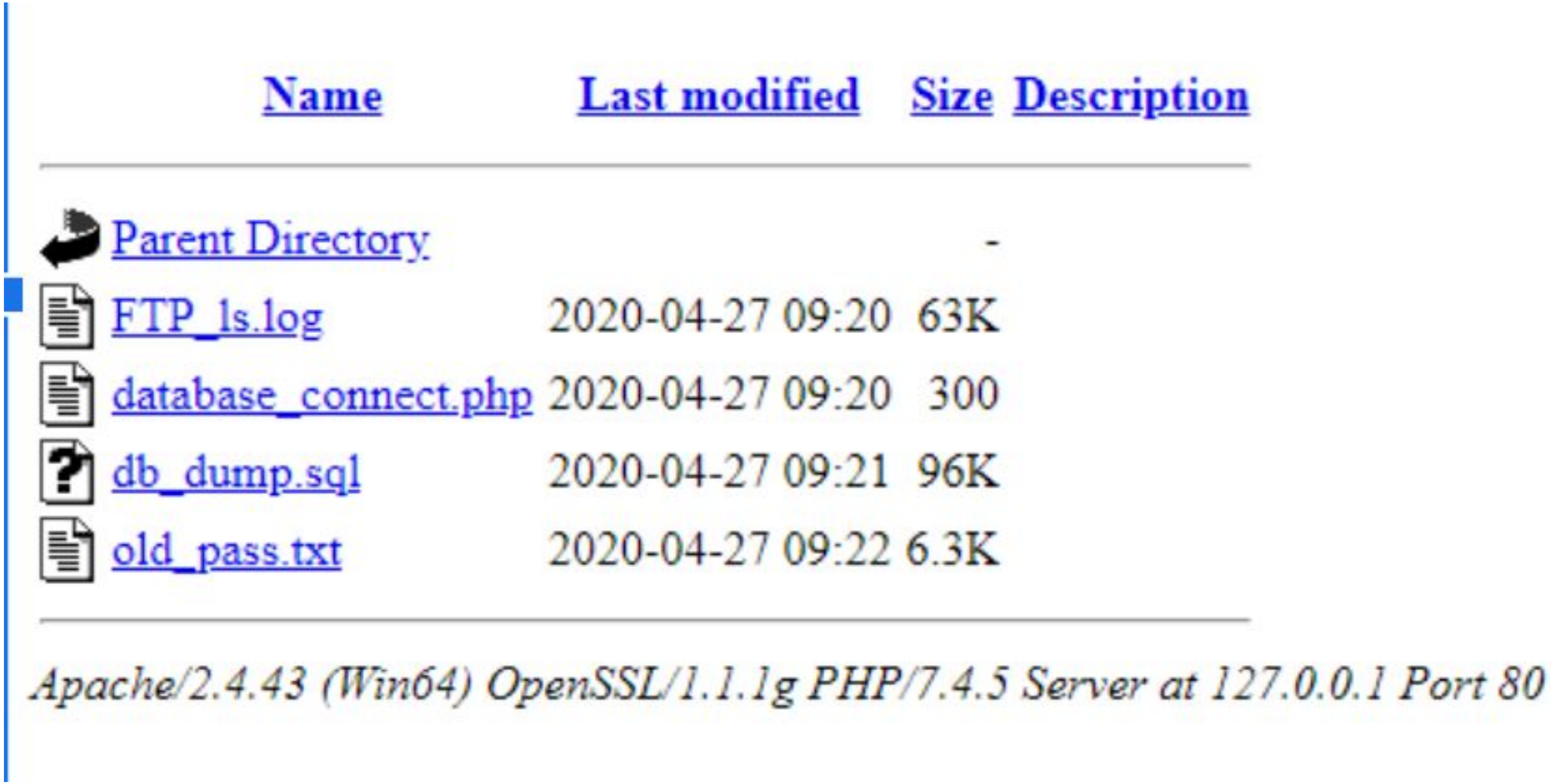
```
User-agent: Googlebot
Disallow: /admin/
Disallow: /includes/
Disallow: /content/plugins/
Disallow: /content/themes/
Crawl-delay: 50
Visit-time: 0400-0500
```

Google can crawl each page at a delay of 50 ms; specified URLs cannot be crawled, crawling can happen between 4-5 am only

- **Files used by web crawlers** (robots.txt and sitemap.xml)
  - robots.txt: controls and restrict web crawlers by specifying which parts they can and cannot access
  - sitemap.xml: lists all the pages of a website that should be indexed by search engines
  - Location: https://www.example.com/robots.txt  or https://www.example.com/sitemap.xml
  - Directories being asked to skip may contain sensitive information → worth exploring!

# Sample Apache Configuration

```
# Global configuration
ServerRoot "/etc/apache2"

# Listen on port 80
Listen 80

# Server-wide defaults
<Directory />
        Options FollowSymLinks
        AllowOverride None
        Require all denied
</Directory>

<Directory /var/www/>
        Options Indexes FollowSymLinks
        AllowOverride None
        Require all granted
</Directory>

# Logging
ErrorLog ${APACHE_LOG_DIR}/error.log
LogLevel warn
CustomLog ${APACHE_LOG_DIR}/access.log combined

# Include module configurations
IncludeOptional mods-enabled/*.load
IncludeOptional mods-enabled/*.conf

# Include additional directory configurations
IncludeOptional conf-enabled/*.conf

# Virtual hosts
IncludeOptional sites-enabled/*.conf
```



| Name | Last modified | Size | Description |
|---|---|---|---|
| Parent Directory | | - | |
| FTP_ls.log | 2020-04-27 09:20 | 63K | |
| database_connect.php | 2020-04-27 09:20 | 300 | |
| db_dump.sql | 2020-04-27 09:21 | 96K | |
| old_pass.txt | 2020-04-27 09:22 | 6.3K | |

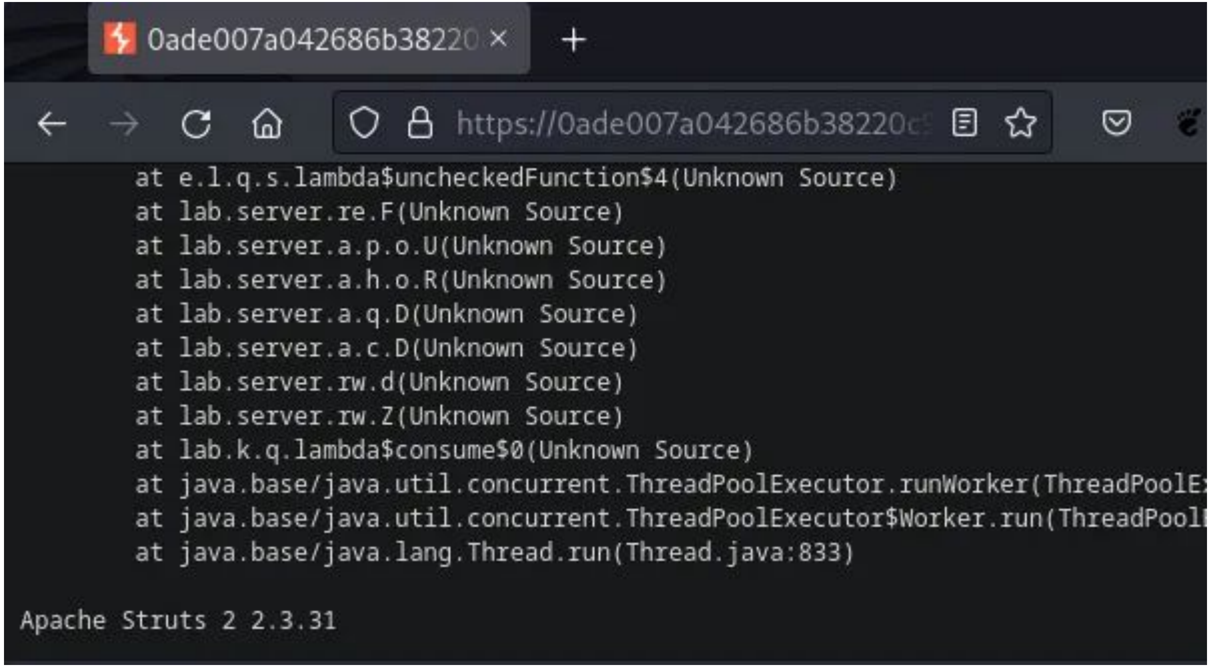
*Apache/2.4.43 (Win64) OpenSSL/1.1.1g PHP/7.4.5 Server at 127.0.0.1 Port 80*

- **Directory listings:** If configured, web servers can auto list contents of directories without index page
  - If index page “index.php or index.html” is say absent in root folder, server will show directory listing of root
  - Attackers can see temporary files or crash dumps available!

- **Developer comments**: in-line HTML comments added to markup
  - Should be stripped in production environment
  - But if forgotten or missed can help attackers
    - Hidden directories, hints about application logic etc

- **Error messages:** most common cause of information leakage
  - Can reveal information on input/data type → can identify exploitable parameters without wasting time
  - Provide information about different technologies being used
    - E.g. template engine, database type, or server version numbers
    - Can search for exploits against given technology
      - Can browse code of open-source frameworks and get even more info

https://example.com/product?productId=1 (valid)
https://example.com/product?productId=67 (invalid)



```
        at e.l.q.s.lambda$uncheckedFunction$4(Unknown Source)
        at lab.server.re.F(Unknown Source)
        at lab.server.a.p.o.U(Unknown Source)
        at lab.server.a.h.o.R(Unknown Source)
        at lab.server.a.q.D(Unknown Source)
        at lab.server.a.c.D(Unknown Source)
        at lab.server.rw.d(Unknown Source)
        at lab.server.rw.Z(Unknown Source)
        at lab.k.q.lambda$consume$0(Unknown Source)
        at java.base/java.util.concurrent.ThreadPoolExecutor.runWorker(ThreadPoolE
        at java.base/java.util.concurrent.ThreadPoolExecutor$Worker.run(ThreadPool
        at java.base/java.lang.Thread.run(Thread.java:833)

Apache Struts 2 2.3.31
```

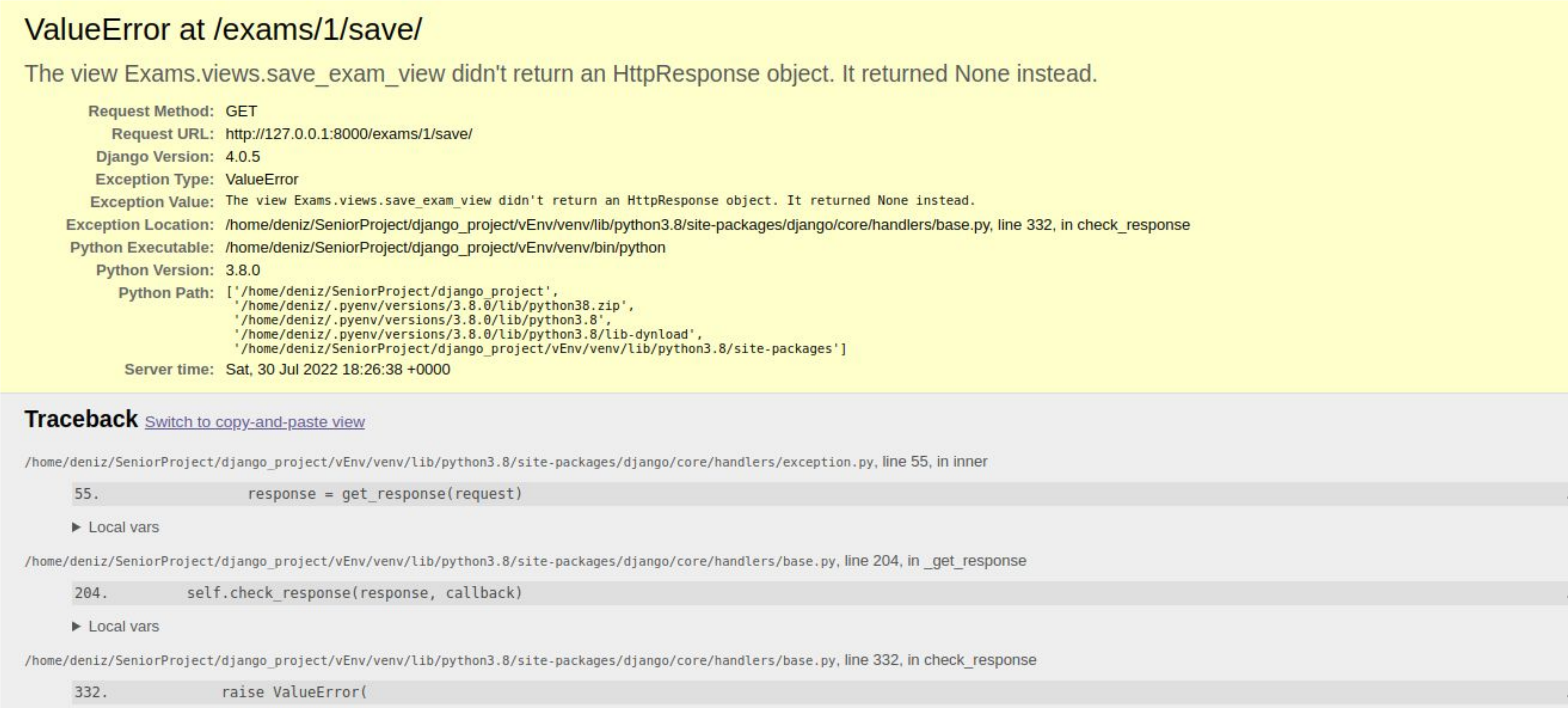
https://cyberw1ng.medium.com/6-1-lab-information-disclosure-in-error-messages-2023-40c410fec85e

- Differences between error messages can reveal application behavior
  - E.g. username enumeration
    - One of the guesses returns a different code from others → guess may be correct
- Should carefully audit all error messages

# Some Common Sources of Leaks

- ~~Files for web crawlers~~
- ~~Directory listings~~
- ~~Developer comments~~
- ~~Error messages~~
- Debugging data
- User account pages
- Backup files
- Insecure configuration
- Version control history

- **Debugging Data**: logs can contain large amounts of information about application's behavior
  - Can help understand application’s runtime state → can craft input to manipulate the application
  - Dangerous to expose in production environment
  - Examples:
    - Session variables (authentication tokens, personal data etc) expose sensitive information
    - Hostnames and credentials for back-end components
    - File and directory names on the server
    - Keys used to encrypt data



# ValueError at /exams/1/save/

The view Exams.views.save_exam_view didn't return an HttpResponse object. It returned None instead.

```
   Request Method: GET
      Request URL: http://127.0.0.1:8000/exams/1/save/
   Django Version: 4.0.5
   Exception Type: ValueError
  Exception Value: The view Exams.views.save_exam_view didn't return an HttpResponse object. It returned None instead.
Exception Location: /home/deniz/SeniorProject/django_project/vEnv/venv/lib/python3.8/site-packages/django/core/handlers/base.py, line 332, in check_response
Python Executable: /home/deniz/SeniorProject/django_project/vEnv/venv/bin/python
   Python Version: 3.8.0
      Python Path: ['/home/deniz/SeniorProject/django_project',
                    '/home/deniz/.pyenv/versions/3.8.0/lib/python38.zip',
                    '/home/deniz/.pyenv/versions/3.8.0/lib/python3.8',
                    '/home/deniz/.pyenv/versions/3.8.0/lib/python3.8/lib-dynload',
                    '/home/deniz/SeniorProject/django_project/vEnv/venv/lib/python3.8/site-packages']
      Server time: Sat, 30 Jul 2022 18:26:38 +0000
```

## Traceback

```
/home/deniz/SeniorProject/django_project/vEnv/venv/lib/python3.8/site-packages/django/core/handlers/exception.py, line 55, in inner

    55.                 response = get_response(request)

    ▶ Local vars

/home/deniz/SeniorProject/django_project/vEnv/venv/lib/python3.8/site-packages/django/core/handlers/base.py, line 204, in _get_response

    204.         self.check_response(response, callback)

    ▶ Local vars

/home/deniz/SeniorProject/django_project/vEnv/venv/lib/python3.8/site-packages/django/core/handlers/base.py, line 332, in check_response

    332.             raise ValueError(
```

https://forum.djangoproject.com/t/failed-to-load-resource-the-server-responded-with-a-status-of-500-internal-server-error/15105/2

- **User Accounts**: can contain sensitive information
  - Email address, phone number, API key etc
  - Is vulnerable if logic flaws allow attacker to view other user’s data
    - E.g. GET /user/info?user=ravi

- **Source code Leakage**: can reveal application logic as well as API keys and credentials for accessing back-end systems
  - Easy with open source systems (i.e. for logic)
  - Tough to normally get source code of website
    - Request source code (e.g. example.php) → server will execute it and send results
    - Requesting code file using a backup file extension (e.g ~ or .bak) may help
      - Robots.txt can help identify backup folders

- **Insecure Configuration**:
  - Forgot to disable debugging options
    - E.g. HTTP TRACE enabled on server
      - Echoes the exact request received → reveal any (authentication) headers appended to request by reverse proxies

- **Version Control**: Most websites use some version control for code (e.g. git)
  - Data stored in a folder called .git
  - If folder exposed, can download folder and explore
    - May not give access to full source code but can look at diffs
      - small snippets of code which can have sensitive hard-coded data

# Testing for Leaks

- Many commercial as well as open-source scanners
  - E.g. Burpe Suite, appcheck, qualys, acunetix, invicti etc
- Can detect known weaknesses published as CVEs

# Best Practices

- Use generic error messages as much as possible
- Ensure debugging or diagnostic features are disabled in the production environment
- Disable any features and settings that you don't need
- Do not upload any files that don’t need to be on the web root
- Ensure proper access controls and authorizations

- Train staff on what type of information is sensitive and how to securely handle it
- Audit code and configuration settings for potential information disclosure
  - Details about backend technology type, version, setup, builds
  - In code: hardcoded credentials, API keys, IP addresses
  - Configure the correct MIME types for all the different files being used
  - Can use automated tools for all this

# Web Server Settings

- Via web server configuration, disable any HTTP response headers that convey details about server
  - E.g. server technology, language, version etc
  - Browsers don’t use such information
- Avoid file suffixes in URLs that reveal details of technology (e.g .php, .asp, and .jsp)
- Name of the cookie to store session can also reveal server-side technology
  - Java web servers usually store session ID under a cookie named JSESSIONID

- Minify/obfuscate javascript files
  - Minifiers remove spaces, comments, replace code with shorter but semantically identical statements
  - Obfuscators make code less readable; replace function, variable names with tokens without changing code behaviour
  - E.g. UglifyJS does both of above for javascript
  - Developers normally use these for performance reasons, but it can help with security as well
    - Makes it harder for an attacker to casually inspect code and reverse engineers
    - Note: These do not offer foolproof protection against determined attackers, just raise the bar

- Keep upto date with security advisories
  - Attackers can use fingerprinting techniques still to glean information
    - E.g. corrupted HTTP requests or send requests with unusual HTTP verbs to see how server responds
    - Different server technologies may respond differently!
  - Following advisories regularly will keep you on top of the game

# Apache Config for MIME types

```
AddType text/html .html
AddType text/css .css
AddType application/javascript .js
AddType application/pdf .pdf
AddType image/jpeg .jpeg .jpg
AddType image/png .png
```

# Summary

- Attackers interested in a variety of information
  - Some to sell in black market (e.g. customer data), some to launch further attacks as part of kill chain (towards some attack goal)
- Information types: sensitive data, OS/app versions, user names, server configurations, app code etc
- Leaks mostly via insecure configuration, log/error messages, comments/metadata in files

# References

- https://portswigger.net/web-security/information-disclosure