

CyberSecurity: Principle and Practice

*BSc Degree in Computer Science
2024-2025*

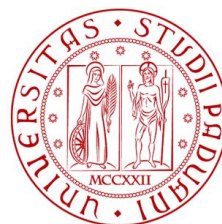
Lesson 10: Injection Attacks

Prof. Mauro Conti

Department of Mathematics
University of Padua
conti@math.unipd.it
<http://www.math.unipd.it/~conti/>

Teaching Assistants

Tommaso Bianchi
tommaso.bianchi@phd.unipd.it
Riccardo Preatoni
riccardo.preatoni@studenti.unipd.it



**UNIVERSITÀ
DEGLI STUDI
DI PADOVA**



SPRITZ
SECURITY & PRIVACY
RESEARCH GROUP



**DIPARTIMENTO
MATEMATICA**



- **Injection Attacks** are a class of attacks
- the attacker provides an untrusted input to our application
- the program processes the input and executes a function in an anomalous way
- it is considered the most dangerous class of attacks in web applications
- slides inspired by [link](#)



- The attacker injects application code written in the application language
- potential impact: full system compromised
- the attacker might try to run OS command with program privileges
- e.g., in the following example
 - (using “phpinfo()” in code)

```
/**
 * Get the code from a GET input
 * Example of Code Injection-
 * http://example.com/?code=phpinfo()
 */
$code = $_GET['code'];

/**
 * Unsafely evaluate the code
 * Example - phpinfo();
 */
eval("\$code;");
```

- Intro to CRLF:
 - a browser sends a request to a web server
 - the response of the web server contains
 - HTTP response header
 - a content (HTML page)
 - The two elements are separated with a combination of special characters
 - Carriage Return and a Line Feed (CRLF)
- the web server uses the CRLF to understand when new HTTP header begins and another one ends

- The attacker injects the CRLF characters into the input
- potential impact:
 - Injection of other attacks
 - information disclosure
- for example, a web server might collect logs
 - 123.123.123.123 - 08:15 - /index.php?page=home
- if an attacker can execute the CRLF attack, he can fake the log content
`/index.php?page=home&%0d%0a127.0.0.1 - 08:15 - /index.php?page=home&restricredredactio=edit`
- this attack will produce two entries in the log file
 1. 123.123.123.123 - 08:15 - /index.php?page=home
 2. 127.0.0.1 - 8:15 - /index.php?page,=home&restrictredaction=edit

- injection of custom scripts into a legitimate web server
 - usually JS codes
- this code is then executed in the victim's browser
 - occur when the victim visits the web application
- the web page is the vehicle of the attack
 - e.g., forums, message boards, and web pages that allow comments

- e.g., a browser might have a function that shows the last comment published, available in the database

```
print "<html>"  
print "<h1>Most recent comment</h1>"  
print database.latestComment  
print "</html>"
```

- the programmer assumption is that this should only contain text
- an attacker might inject the following:

```
<script>doSomethingEvil();</script>
```

- The server will provide the following HTML:

```
<html>  
<h1>Most recent comment</h1>  
<script>doSomethingEvil();</script>  
</html>
```

- when the victim loads the content, the script will be executed

Case 4: Email Header Injection



- Several web pages implement contact forms
- Most of the time, such contact forms set headers
- These headers are interpreted by the email library on the web server
 - turned into resulting SMTP commands
 - processed by the SMTP server
- A malicious user may be able to introduce additional headers into the message

A screenshot of a web contact form titled "Contact us". It contains three input fields: "Name", "Email", and "Message". Below the fields is a blue "SEND" button. The form is enclosed in a blue border.

Case 5: Host Header Injection



- Usually a web server hosts several web applications (a.k.a. virtual hosts)
 - i.e., several web app in the same IP
- The **host header** specifies which website or web application should process an incoming HTTP request
 - the host header will dispatch the request to the proper application
- Most web servers are configured to pass the unrecognized host header to the first virtual host in the list
- It is possible to send HTTP requests with arbitrary headers at the first virtual host

```
GET /example HTTP/1.1
```

```
Host: notvulnerable-website.com
```

- Host headers are common in PHP applications
- For example, an unsecure use is the following:
 - `<script src="http://<?php echo $_SERVER['HOST'] ?>/script.js">`
- An injection example is:
 - `<script src="http://attacker.com/script.js">`
- this will redirect the victim to a malicious web application

Case 6: OS command Injection



- Injection of OS commands that will run with application privileges
- For example, a PHP application might execute a ping to a given IP address

```
<?php
$address = $_GET["address"];
$output = shell_exec("ping -n 3 $address");
echo "<pre>$output</pre>";
?>
```

- The request is done via GET request
 - parameter name: address
- An attacker might request the following, displaying ping and list of files in the directory

<http://example.com/ping.php?address=8.8.8.8%26ls>

- Note that 26 -> &

- injection of SQL instructions
- for example, given a database with credentials

```
# Define POST variables
uname = request.POST['username']
passwd = request.POST['password']

# SQL query vulnerable to SQLi
sql = "SELECT id FROM users WHERE username='" + uname + "' AND
password='" + passwd + "'"

# Execute the SQL statement
database.execute(sql)
```
- The query returns always True if an attacker injects the following password:
 - password' OR 1=1



1. Welcome to fun with flags.
2. Because creating real pwn challs was to mainstream, we decided to focus on the development of our equation solver using OCR.
3. "I have been told that the best crackers in the world can do this under 60 minutes, but unfortunately I need someone who can do this under 60 seconds."
4. I know my contract number is stored somewhere on this interface, but I can't find it and this is the only available page!
Please have a look and get this info for me!

Questions? Feedback? Suggestions?



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

