Module 1 - Encoding and Filtering

Data Encoding Basics

Encoding Types

- URL encoding
- HTML encoding
- Base (32/64) encoding
- Unicode encoding

URL encoding

- contains characters in the range of the US-ASCII code char set.
- it's also called percent-encoding
- it replaces characters outside the allowed set with a % followed by the two hexadecimal digits representing the numeric value of the octet.

CLASSIFICATION	INCLUDED CHARACTERS	ENCODING REQUIRED?
Safe characters	Alphanumeric [0-9a-zA-Z], special characters $-_.+!*'(), and reserved characters used for their reserved purposes (e.g., question mark used to denote a query string)	NO
ASCII Control characters	Includes the ISO-8859-1 (ISO-Latin) character ranges 00-1F hex (0-31 decimal) and 7F (127 decimal.)	YES
Non-ASCII characters	Includes the entire "top half" of the ISO-Latin set 80-FF hex (128-255 decimal.)	YES
Reserved characters	$ & + , / : ; = ? @ (not including blank space)	YES*
Unsafe characters	Includes the blank/empty space and " < > # % { } | \ ^ ~ [ ] `	YES

Some commonly encoded chars

CHARACTER	PURPOSE IN URI	ENCODING
#	Separate anchors	%23
?	Separate query string	%3F
&	Separate query elements	%24
%	Indicates an encoded character	%25
/	Separate domain and directories	%2F
+	Indicates a space	%2B
<space>	Not recommended	%20 or +

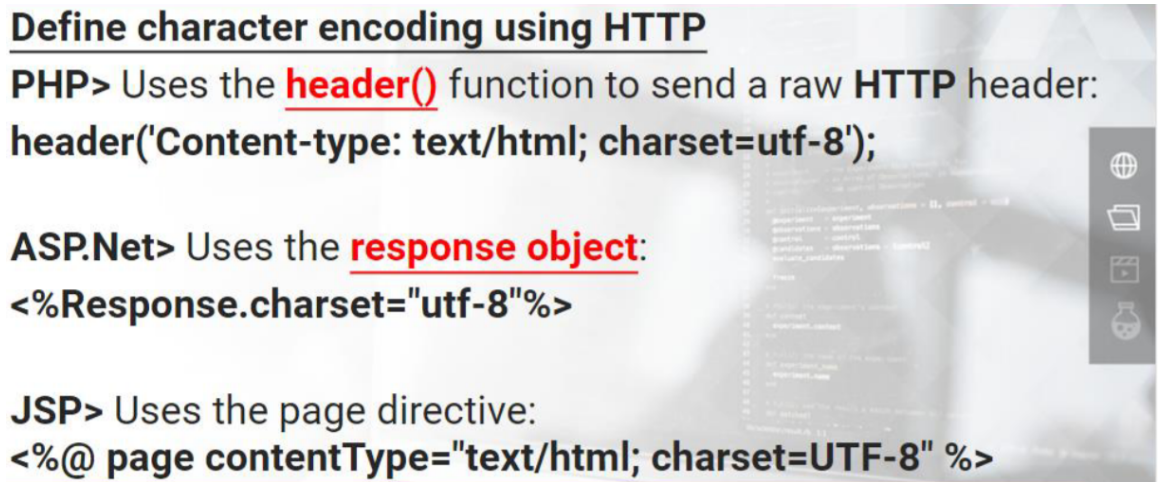
HTML encoding

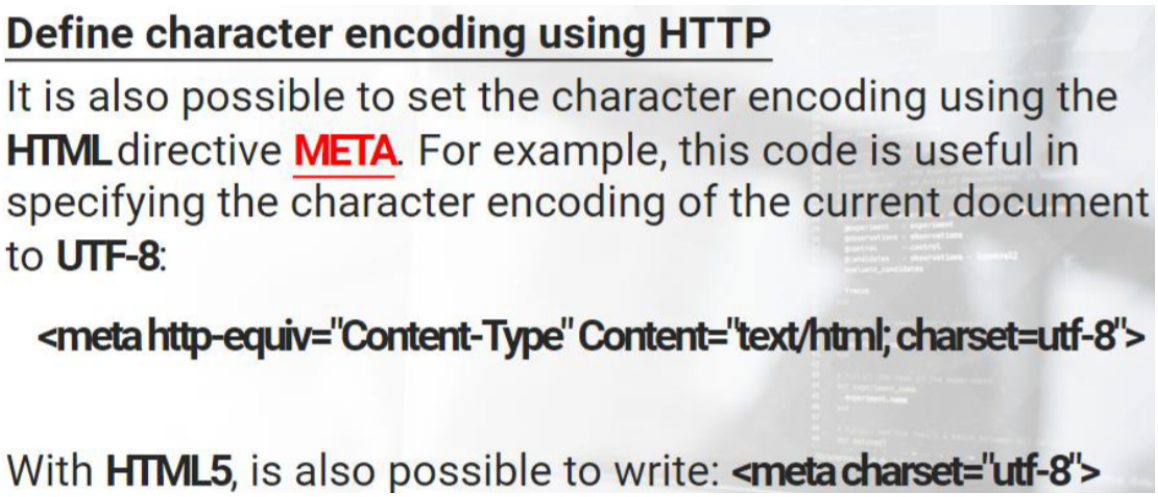
Document character encoding

Define char encoding using http :-

HTTP header → Content-Type:

- if this header is sent, we will see something like → Content-Type: text/html; charset=utf-8
- If this header is not defined, the RFC defines as the default charset the ISO-8859-1

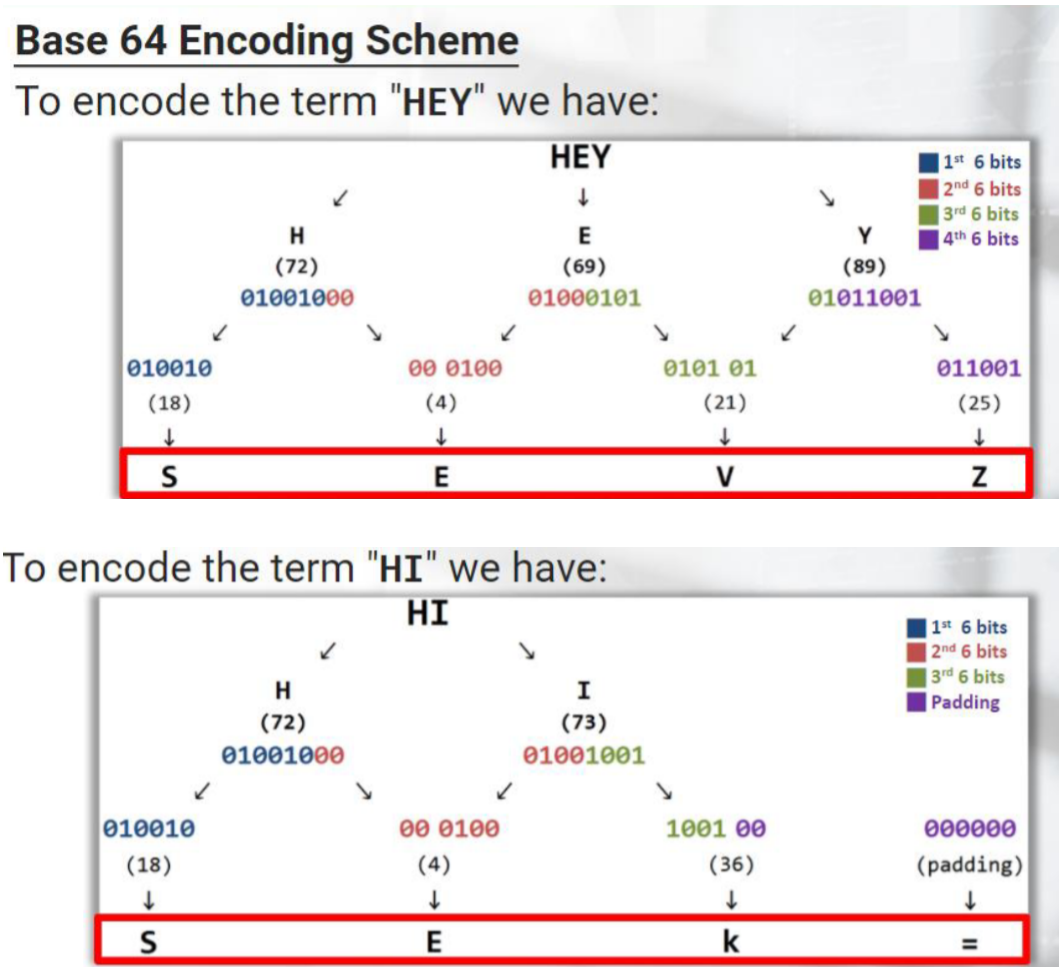


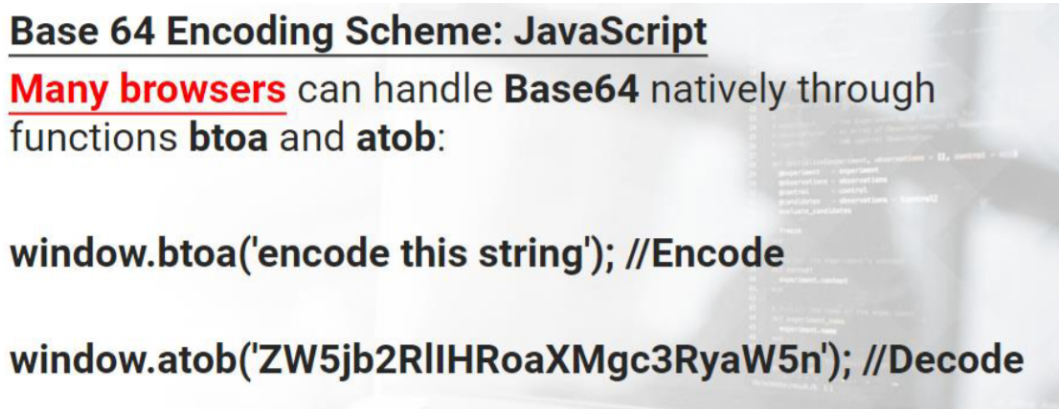


- HTML entities → https://www.freeformatter.com/html-entities.html
- ###Hexadecimal aka base16###

Base(36-64)

- base10 is case insensitive
- base36 is used in many real world scenarios





Unicode encoding

homoglyph/Visual spoofing attack generator

- https://www.irongeek.com/homoglyph-attack-generator.php

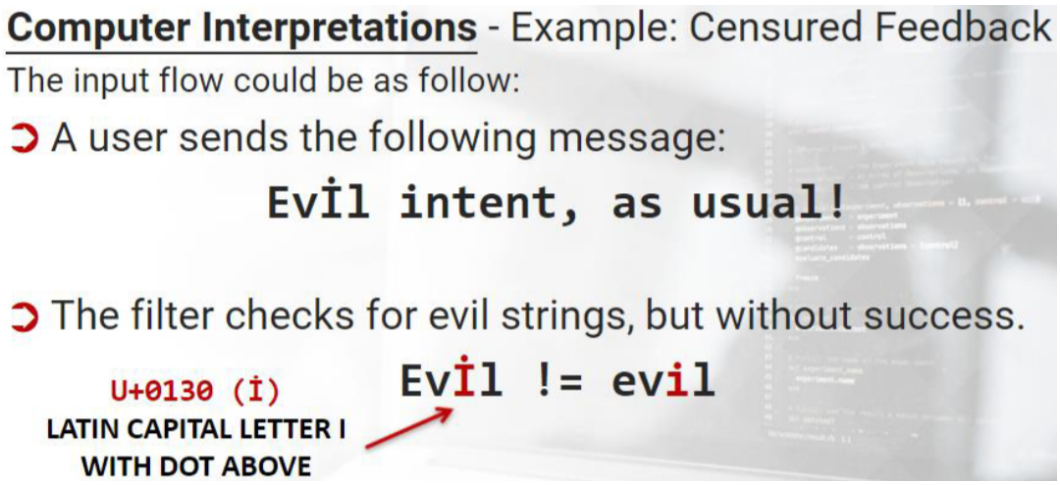
There 3 ways to map Unicode character points:

- UTF-8
- UTF-16
- UTF-32

UTF → Unicode Transformation Format

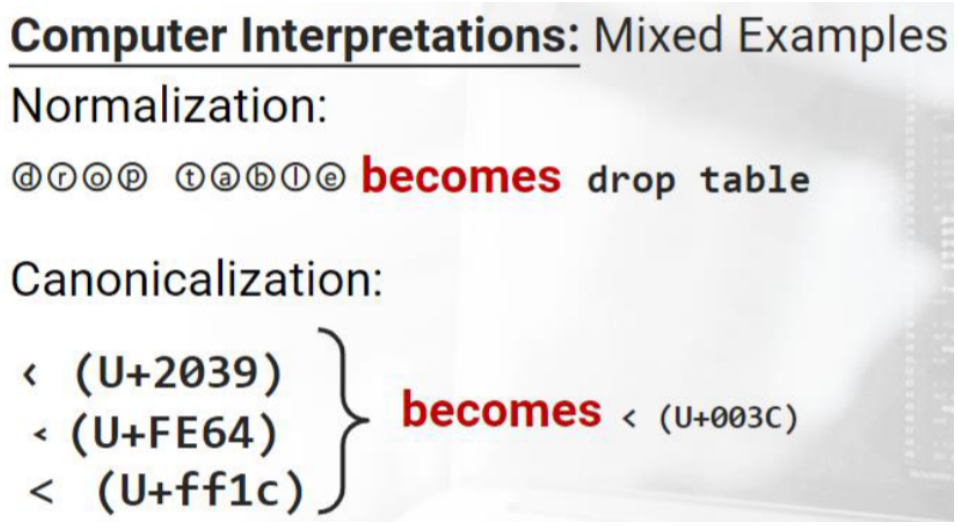
Punycode and Homoglyph attacks to obfuscate URLs for Phishing

https://www.irongeek.com/i.php?page=security/out-of-character-use-of-punycode-and-homoglyph-attacks-to-obfuscate-urls-for-phishing



Unicode Security Guide

- https://websec.github.io/unicode-security-guide/



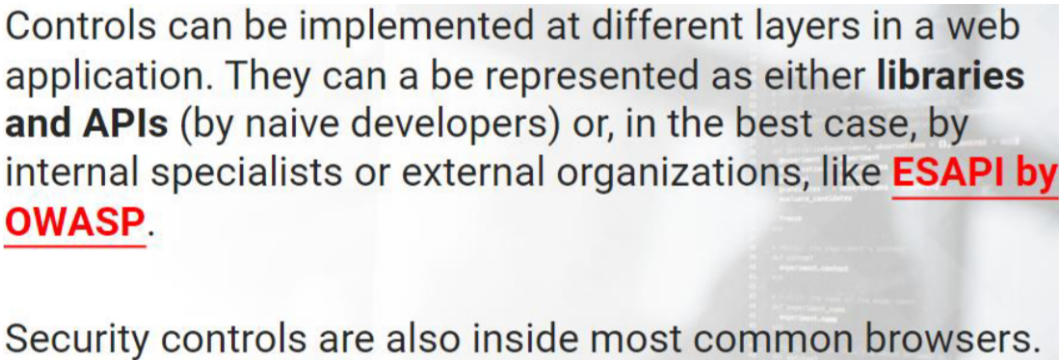
- https://codepoints.net/
- https://qaz.wtf/u/convert.cgi

Multiple (De|En) codings

Filtering Basics

Best Practice to Protect Web Apps

- **Input Filtering** and **Output Encoding** controls are crucial.



ESAPI by OWASP

- A free, open-source web application security control library that helps programmers write lower-risk applications.

- **Best Practice**: Use external solutions for web app protection, such as WAFs, instead of internal solutions like libraries or APIs.
- **Examples**: Paid and free open-source WAF software, such as **ModSecurity** (free WAF).

WAF

- Instructions on what a WAF or filter must block/allow are defined as **rules** (also referred to as **filters**).

RegEx

- **Two Main Types of Regex Engines**:
  - **DFA (Deterministic Finite Automaton)**: Faster due to its deterministic approach but lacks features like **lazy quantifiers** and **backreferences**.
  - **NFA (Nondeterministic Finite Automaton)**: More popular and supports additional regex features.
- https://en.wikipedia.org/wiki/Comparison_of_regular_expression_engines

ENGINE	PROGRAM
DFA	awk, egrep, MySQL, Procmail
NFA	.NET languages, Java, Perl, PHP, Python, Ruby, PCRE library, vi, grep, less, more

Metacharacters

Char	Name	Meaning
^	Caret	The position at the START of the line.
$	Dollar	The position at the END of the line.
()	Opening/Closing parenthesis	Start/close a characters group.
[]	Opening/Closing square bracket	Start/close a characters class.
?	Question mark	One or zero (optional) of the immediately-preceding item (char or group).
+	Plus	One or more of the immediately-preceding item (char or group).
*	Star or asterisk	Any number, including none, of the immediately-preceding item (char or group).
.	Period or dot	Shorthand for a character class that matches any character.
\	Backslash	Escape special characters.
|	Vertical bar or pipe	It means OR. Combines multiple expressions in one that matches any of single ones.
{}	Opening/Closing curly brace	Start/close repetitions of a characters class.

Shorthand Character Classes

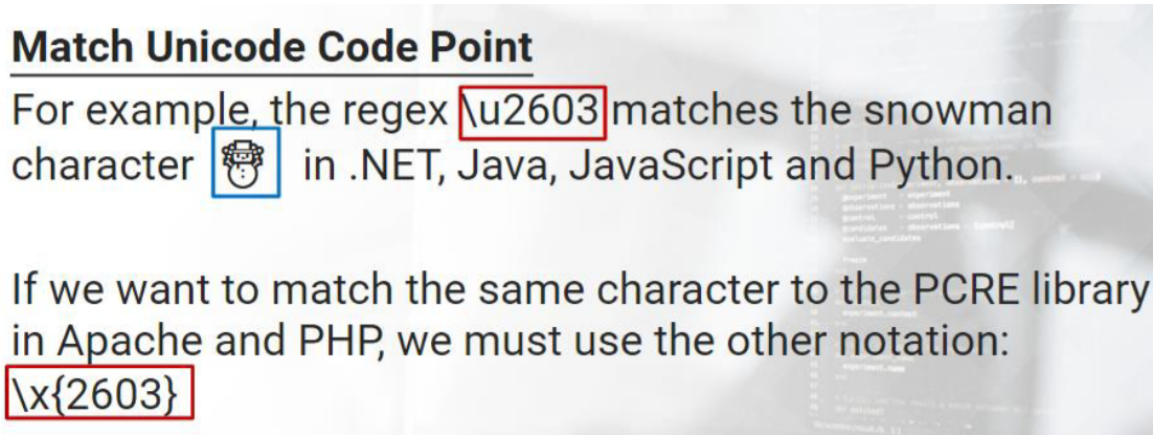
SHORTHAND	NAME	MEANING
^	Caret	If at the beginning of the character class, it means to reverse the matching for the class.
\d	Digit	Matches any digit character. The same as [0-9]
\D	Non-digit	The complement of \d. The same as [^\d]
\w	Part-of-word character	Matches any alphanumeric character or an underscore. The same as [a-zA-z0-9_] In some flavors the underscore is omitted.
\W	Non-word character	The complement of \w. The same as [^\w]
\s	Whitespace character	Matches any whitespace character. The same as [\f\n\r\t\v]
\S	Non-whitespace character	The complement of \s. The same as [^\s]

Non-Printing Characters

used for obfuscating the payload

SHORTHAND	NAME (Symbol, Unicode)	MEANING
\0	NUL (␀ U+0000)	NUL Byte, in many programming languages marks the end of a string.
\b	Backspace (␈ U+0008)	Within a character class represent the backspace character, while outside \b matches a word boundary.
\t	Horizontal tab (␉ U+0009)	Generated by the Tab key on a standard keyboard.
\n	Line feed (␊ U+000A)	New line.
\v	Vertical tab (␋ U+000B)	Vertical tabulation.
\f	Form feed (␌ U+000C)	Form feed.
\r	Carriage return (␍ U+000D)	In HTTP, the \r\n sequence is used as the end-of-line marker.
\e	Escape (␛ U+001B)	Escape character (Only for GNU Compiler Collection).

Unicode



CHARACTER QUALITY	DESCRIPTION
\p{L} or **\p{Letter}**	All the letters, from any language.
\p{Ll} or **\p{Lowercase_Letter}**	Lowercase letters that have the respective uppercase quality.
\p{Z} or **\p{Separator}**	Characters used to separate, but without visual representation.
\p{S} or **\p{Symbol}**	Currency symbols, math symbols, etc...
\p{N} or **\p{Number}**	All the numeric characters.
\p{Nd} or **\p{Decimal_Digit_Number}**	Numbers from zero to nine in multiple scripts except Chinese, Japanese, and Korean.
\p{P} or **\p{Punctuation}**	All the punctuation characters.

WAF - Web Application Firewall

- **Regex** is the main method to define how a WAF should behave.
- **Whitelisting mode** is the best solution to protect a web application.
  - **Customization**: Rules customization is challenging because it requires deep knowledge of both the application and the WAF solution.
  - **Drawback**: Whitelisting is prone to false positives, which is why WAFs are often deployed in **blacklisting mode** instead.

Blacklisting Mode

- Involves a collection of well-known attacks; WAF producers create a list of rules to protect against common vulnerabilities.

- **Drawback**: Multiple ways to achieve the same attack goal mean every small change in the attack payload must be added to the blacklist. Failure to do so can result in a **WAF bypass**.
- **Note**: **All WAFs can be bypassed!**

Simple Rules to Bypass WAFs

- **XSS**:
  - Instead of: `alert('xss')` or `alert(1)`
  - Use: `prompt('xss')`, `prompt(8)`, `confirm(8)`, `confirm('XSS')`, `alert(/xss/.source)`, `window`
  - Instead of: `alert(document.cookie)`
  - Use: `with(document)alert(cookie)`, `alert(document['cookie'])`, `alert(document[/cookie/.source])`, `alert(document[/coo/.source+/kie/.source])`
  - Instead of: `<img src=x onerror=alert(1);>`
  - Use: `<svg/onload=alert(1)>`, `<video src=x onerror=alert(1);>`, `<audio src=x onerror=alert(1);>`, `data:text/html;base64,PHNjcmlwdD5hbGVydCgnWFNTJyk8L3NjcmlwdD4=` (`<script>alert('xss')</script>`)
- **Blind-SQLi**:
  - Instead of: `' or 1=1`
  - Use: `' or 6=6`, `' or 0x47=0x47`, `or char(32)=''`, `or 6 is not null`
- **SQLi**:
  - Instead of: `UNION SELECT`
  - Use: `UNION ALL SELECT`
- **Directory Traversal**:
  - Instead of: `/etc/passwd`
  - Use: `/too/../etc/far/../passwd`, `/etc//passwd`, `/etc/ignore/../passwd`, `/etc/passwd.....`
- **Web Shell**:
  - Instead of: `c99.php`, `r57.php`, `shell.aspx`, `cmd.jsp`, `CmdAsp.asp`

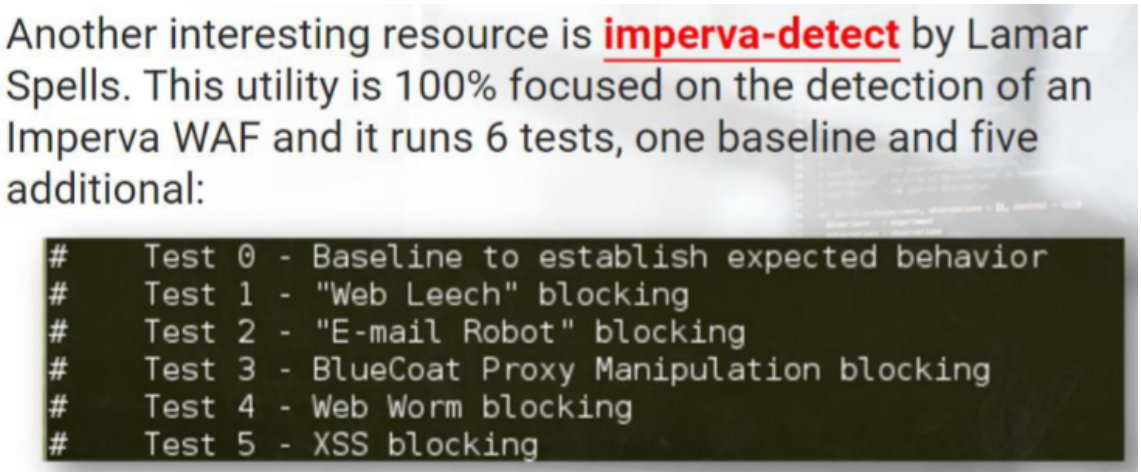
- Use: `augh.php`

WAF Detection and Fingerprinting

- WAFs usually operate in **passive** mode, **reactive** mode, or both.
  - **Passive Mode**: Reduces the number of false positives and avoids blocking the application.
  - **Reactive Mode**: Most WAFs in production are in this mode.

Before Testing a Web App, it's extremely useful to know if there is a WAF and its type.

- **Tools**:
  - **wafw00f** is the best tool for WAF detection.
  - **nmap**: Use the script `http-waf-fingerprint` for additional detection.



XSS Filter

XSS Filter (Internet Explorer):

XSS Filter is enabled by default in the Internet, Trusted, and Restricted security zones, but an interesting feature was introduced **to disable the filter**.

The main reason was because some sites may depend on the reflected values that the filter searches for.

X-XSS-Protection: 0

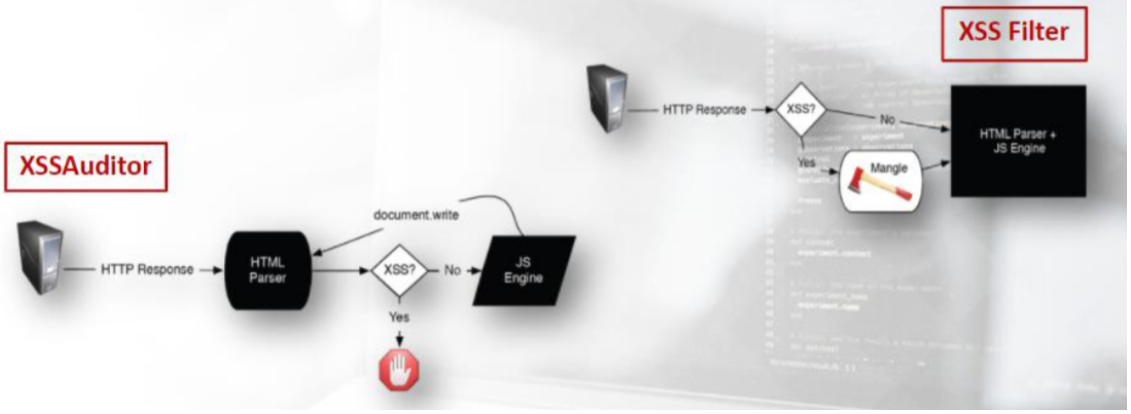
XSS Filter (Internet Explorer):

Later, the IE team added support to a new token in the `X-XSS-Protection` header:

```
X-XSS-Protection: 1; mode=block
```

With this token, if a potential reflected XSS attack is detected, the browser, rather than attempting to sanitize the page, will render a simple `#`. Here is a **simple test**.

XSSAuditor (WebKit/Blink): XSS Filter vs XSSAuditor



What is the best technique to evade XSS filters?

You can find more examples in the OWASP resource based on the XSS Cheat Sheet by RSnake.

- Using Character Encoding. ...
- Case Manipulation and Character Insertion. ...
- Fooling Regular Expressions. ...
- Using Atypical Event Handlers. ...
- Tricks with Tags and Attributes. ...
- Using Atypical Delimiters. ...
- Making Other Deliberate Mistakes.