

Web application security in Go

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The course provides a comprehensive exploration of secure coding principles and practices tailored specifically for Go developers. Starting off from the foundations of cybersecurity, you will understand the consequences of insecure code by examining threats through the lens of the CIA triad.

In the main part of the material, you will systematically walk through the various vulnerabilities outlined in the OWASP Top Ten. As you progress through the modules investigating the intricacies of authentication and authorization, through realizing the practical aspects of cryptography, to tackling injection attacks, you will gain a deep understanding of both theoretical concepts and practical skills for securing Java web applications. Further subjects are aligned to some common software security weakness types, such as error handling, code quality or denial of service.

These modules go beyond just the theory. Not only do they identify vulnerabilities, show their consequences, and detail the best practices, but – through hands-on labs and real-world case studies – they offer practical experience in identifying, exploiting, and mitigating these security risks within Java-based web applications.

So that you are prepared for the forces of the dark side.

So that nothing unexpected happens in your code.

Nothing.

Note: This course content is available as an e-learning subscription. We reserve a period of 3 months to digest the foundational material, after which we activate shorter learning units on a monthly basis. This gives secure coding efforts an initial boost, and builds up sustained readiness over time. These learning units are indicated in red in the table of contents below.

Cyber security skills and drills

Foundational material



25 LABS



25 CASE STUDIES

Monthly learning units



2-3 LABS



CASE STUDY

Audience

Go developers working on Web applications

Outline

- Cyber security basics
- The OWASP Top Ten
- A01 – Broken Access Control
- A02 – Security Misconfiguration
- A03 – Software Supply Chain Failures
- A04 – Cryptographic Failures
- A05 – Injection
- A06 – Insecure Design
- A07 – Authentication Failures
- A08 – Software or Data Integrity Failures
- A09 – Logging and Alerting Failures
- A10 – Mishandling of Exceptional Conditions
- X02 – Memory Management Failures
- Wrap up

Preparedness

General Go and Web development

Standards and references

OWASP, CWE and Fortify Taxonomy

What you'll have learned

- Getting familiar with essential cyber security concepts
- Identify Web application vulnerabilities and their consequences
- Learn the security best practices in Go
- Input validation approaches and principles
- Understanding Web application security issues
- Detailed analysis of the OWASP Top Ten elements
- Putting Web application security in the context of Go
- Going beyond the low hanging fruits

Table of contents

› Cyber security basics

Security basics

- What is security?
- Threat and risk
- [Cyber security threat types – the CIA triad](#)

Insecure software

- Consequences of insecure software
- Constraints and the market
- The dark side

› The OWASP Top Ten

Introduction

- OWASP and the Top 10
- Is it a standard?
- Methodology
- [The OWASP Top Ten 2025](#)

› A01 – Broken Access Control

Authorization

- Access control basics
- Access control types

 *Case study – Broken authz in FIFA platform during 2026 World Cup*

- Confused deputy

Failure to restrict URL access (Unit 5)

- Authorization in Angular

Insecure Direct Object Reference

- Insecure direct object reference (IDOR)
- Path traversal

 *Lab – Insecure Direct Object Reference*

- Path traversal best practices

Horizontal authorization

- Authorization bypass through user-controlled keys

 *Case study – Remote takeover of Nexx garage doors and alarms*

 *Lab – Horizontal authorization*

File upload

- Unrestricted file upload
- Good practices

 *Lab – Unrestricted file upload*

Cross-site Request Forgery (CSRF)

Cross-site Request Forgery (CSRF) best practices

- CSRF best practices
- CSRF defense in depth
- CSRF (XSRF) protection in Angular

SSRF

- Server-side Request Forgery (SSRF)

 *Case study – SSRF and the Capital One breach*

› A02 – Security Misconfiguration

Misconfiguration and XML parsing

- Configuration principles
- XML Entities
- DTD and the entities
- Entity expansion

XML External Entity (XXE)

- File inclusion with external entities
- Server-Side Request Forgery with external entities

 *Case study – XXE vulnerability in Ivanti products*

XXE best practices

Web security configuration issues

- Content Security Policy
- Resource control
- Fetch directives
- Source allowlisting
- Strict CSP: using nonces and hashes
- Navigation and reporting directives
- Document restrictions and sandboxing
- Browser support

- CSP best practices
- Cookie attributes

Secrets management

- Hard coded passwords
- Best practices

› **A03 – Software Supply Chain Failures**

Vulnerable components and dependencies

- Using vulnerable components
- Assessing the environment
- Hardening
- Untrusted functionality import
- Malicious Go packages
- Supply chain security and the Software Bill of Materials (SBOM)
- SBOM examples

 *Case study – The Polyfill.io supply chain attack*

Vulnerability management

- Patch management
- [Vulnerability management](#)
- Vulnerability databases
- Vulnerability rating – CVSS

 *Lab – Finding vulnerabilities in third-party components*

- Bug bounty programs

Build security

- [DevOps, the CI / CD build process and Software Composition Analysis](#)
- Dependency checking in Go

 *Lab – Detecting vulnerable components*

Dangerous and obsolete language elements

- Using dangerous language elements
- Using obsolete language elements

› **A04 – Cryptographic Failures**

Information exposure

- Exposure through extracted data and aggregation

 *Case study – Strava data exposure*

- Leaking system information

Cryptography for developers

- Cryptography basics
- Cryptography in Go

Hashing

- Hashing basics
- Common hashing mistakes
- Hashing in Go

 *Lab – Hashing in Go*

PRNG

- Random number generation
- Pseudo random number generators (PRNGs)
- Cryptographically secure PRNGs
- Using virtual random streams

 *Case study – Equifax credit account freeze*

A04 – Cryptographic Failures

- Weak PRNGs
- Using random numbers

 *Lab – Using random numbers in Go*

Encryption

- Confidentiality protection
- Symmetric encryption
- [Block ciphers](#)
- Modes of operation
- Modes of operation and IV – best practices

Encryption in Go

- Symmetric encryption in Go
- Handling IVs and block padding in Go

 *Lab – Symmetric encryption in Go*

Asymmetric encryption

- The RSA algorithm
- Using RSA – best practices
- RSA in Go

 *Case study – RSA attacks: Bleichenbacher, ROBOT, and Marvin*

- Combining symmetric and asymmetric algorithms

Key exchange and agreement

- Key exchange
- Diffie-Hellman key agreement algorithm
- Key exchange pitfalls and best practices

› A05 – Injection

Injection problems

- Injection principles
- Injection attacks

SQL injection

- SQL injection basics

 *Lab – SQL injection*

SQL injection attack techniques

- Attack techniques
- Content-based blind SQL injection
- Time-based blind SQL injection

SQL injection best practices

- Input validation
- Parameterized queries

 *Lab – Using prepared statements*

SQL injection additional considerations

- Database defense in depth

 *Case study – Hacking Fortnite accounts*

Beyond SQL injection – ORM and NoSQL (Unit 6)

- SQL injection protection and ORM
- NoSQL injection basics

Code injection

- OS command injection

 *Lab – Command injection*

OS command injection best practices

- Avoiding command injection with the right APIs

 *Lab – Command injection best practices*

 *Case study – Shellshock*

 *Lab – Shellshock*

 *Case study – Command injection in AVTECH IP cameras*

HTML injection – Cross-site scripting (XSS)

- [Cross-site scripting basics](#)
- Persistent cross-site scripting
- Reflected cross-site scripting
- Client-side (DOM-based) cross-site scripting

XSS attacks

 *Lab – Stored XSS*

 *Lab – Reflected XSS*

 *Case study – XSS in Fortnite accounts*

XSS best practices 1

- Protection principles – escaping
- Anti-XSS protection in Go

 *Lab – XSS fix / stored*

XSS best practices 2

 *Lab – XSS fix / reflected*

- Additional protection layers – defense in depth
- XSS protection in Angular

Template injection (Unit 6)

- Script injection
- Server-side template injection (SSTI)
- Client-side template injection (CSTI) in Angular

Input validation principles 1 (Unit 1)

- Input validation principles
- Denylists and allowlists
- Data validation techniques

Input validation principles 2 (Unit 1)

- What to validate – the attack surface
- Where to validate – defense in depth
- When to validate – validation vs transformations

Input validation principles 3 (Unit 1)

- Output sanitization
- Encoding challenges
- Unicode challenges
- Validation with regex

Path traversal and file validation (Unit 3)

- Path traversal
- Path traversal-related examples
- Additional challenges in Windows

Case study – File spoofing in WinRAR

- Virtual resources
- Path traversal best practices

› **A06 – Insecure Design**

Insecure design

- The STRIDE model of threats
- Secure design principles of Saltzer and Schroeder

Insecure design – Saltzer and Schroeder 1

- Economy of mechanism
- Fail-safe defaults
- Complete mediation
- Open design

Insecure design – Saltzer and Schroeder 2

- Separation of privilege
- Least privilege
- Least common mechanism
- Psychological acceptability

Client-side security (Unit 5)

- Same Origin Policy
- Simple request
- Preflight request
- Cross-Origin Resource Sharing (CORS)

Clickjacking

- Frame sandboxing
- Cross-Frame Scripting (XFS) attacks

Lab – Clickjacking

- Clickjacking beyond hijacking a click

Anti-clickjacking best practices

- Clickjacking protection best practices

Lab – Using CSP to prevent clickjacking

› A07 – Authentication Failures

Authentication

- Authentication basics
- Multi-factor authentication (MFA)
-  Case study – *The InfinityGauntlet attack*
- Authentication weaknesses

Session security

- Session management essentials
- Why do we protect session IDs – Session hijacking
- Session fixation
- Session invalidation
- Session ID best practices
- Session handling security considerations in single-page applications

Password management

- Storing account passwords
- Password in transit
-  Lab – *Is just hashing passwords enough?*

Password storage

- [Dictionary attacks and brute forcing](#)
- Salting
- Adaptive hash functions for password storage
-  Lab – *Using adaptive hash functions in Go*

Password policy

- [NIST authenticator requirements for memorized secrets](#)

Password storage – a case study

-  Case study – *The Ashley Madison data breach*
-  *The dictionary attack*
-  *The ultimate crack*
-  *Exploitation and the lessons learned*

Additional password management challenges

- Password database migration
- (Mis)handling null passwords

Password auditing (Unit 8)

- Using password cracking tools

- Password cracking in Windows

 *Lab – Password audit with John the Ripper*

- Password recovery issues
- Password recovery best practices

 *Case study – Facebook account takeover via recovery code*

 *Case study – GitLab account takeover*

Protecting secrets in memory (Unit 8)

- Challenges in protecting memory

 *Case study – Microsoft secret key theft via dump files*

› **A08 – Software or Data Integrity Failures**

Integrity protection and MAC

- Integrity protection
- Message Authentication Code (MAC)
- Calculating HMAC in Go

 *Lab – Calculating MAC in Go*

Digital signatures

- Digital signature
- Digital signature with RSA
- ECC basics
- Digital signature with ECC
- Digital signature in Go

 *Lab – Digital signature with ECDSA in Go*

Subresource integrity

- Importing JavaScript

 *Lab – Importing JavaScript*

- Subresource integrity in Angular

 *Case study – The British Airways data breach*

Insecure deserialization

- Serialization and deserialization challenges
- Integrity – deserializing untrusted streams
- Integrity – deserialization best practices

› A09 – Logging and Alerting Failures

Logging

- Logging and monitoring principles
- Insufficient logging
-  Case study – Plaintext passwords at Facebook
- Logging best practices

Log forging (Unit 7)

- Newline injection
- Log forging
- Web log forging
- Log forging – best practices

Monitoring (Unit 7)

- Monitoring best practices
- Firewalls and Web Application Firewalls (WAF)
- Intrusion detection and prevention
-  Case study – The Marriott Starwood data breach

› A10 – Mishandling of Exceptional Conditions

Principles

- Error and exception handling principles
- Information exposure through error reporting
- Information leakage via error pages
- Returning a misleading status code

Exception handling

- In the catch block. And now what?
- Empty catch block

Control flow and error handling

- Incorrect block delimitation
- Dead code
- Using if-then-else and switch defensively

› X01 – Lack of Application Resilience (Unit 9)

Denial of service

- Flooding
- Resource exhaustion

Sustained client engagement

- Infinite loop
- Economic Denial of Sustainability (EDoS)

Amplification

- Some amplification examples

Algorithmic complexity issues

- Regular expression denial of service (ReDoS)
- Dealing with ReDoS

› **X02 – Memory Management Failures**

Integer handling problems (Unit 2)

- Representing signed numbers
- Integer visualization
- Integer overflow

Race conditions (Unit 4)

- Time and state
- Race conditions
- Time of check to time of usage – TOCTTOU
- TOCTTOU attacks in practice

 *Case study – Arbitrary file deletion via TOCTTOU in N-Able Agent*

Locking and deadlocks (Unit 4)

- Mutual exclusion and locking
- Deadlocks
- Synchronization and thread safety

› **Wrap up**

Software security principles

- Principles of robust programming by Matt Bishop

Sources and further readings

- Software security sources and further reading
- Go resources