# Code responsibly with generative AI in C++ (CRWGAIC++)

**ID** CRWGAIC++ **Prix** CHF 2 250,– (Hors Taxe) **Durée** 3 jours

## A qui s'adresse cette formation

C/C++ developers using Copilot or other GenAI tools

## Pré-requis

General C++ and C development

## Objectifs

- Understanding the essentials of responsible AI
- Getting familiar with essential cyber security concepts
- Correctly implementing various security features
- Identify vulnerabilities and their consequences
- Learn the security best practices in C++
- Managing vulnerabilities in third party components
- Input validation approaches and principles
- All this put into the context of GitHub Copilot

**Wrap up**

- Secure coding principles
  - Principles of robust programming by Matt Bishop
  - Secure design principles of Saltzer and Schroeder
- And now what?
- Software security sources and further reading
  - C and C++ resources
  - Responsible AI principles in software development
  - Generative AI – Resources and additional guidance

## Contenu

**Day 1**

**Coding responsibly with GenAI**

- What is responsible AI?
- What is security?
- Threat and risk
- Cyber security threat types – the CIA triad
- Cyber security threat types – the STRIDE model
- Consequences of insecure software
- Security and responsible AI in software development
- GenAI tools in coding: Copilot, Codeium and others

**Memory management vulnerabilities**

- Assembly basics and calling conventions
  - x64 assembly essentials
  - Registers and addressing
  - Most common instructions
  - Calling conventions on x64
  - Calling convention – what it is all about
  - Calling convention on x64
- The stack frame
- Stacked function calls
- Buffer overflow
  - Memory management and security
  - Buffer security issues
  - Buffer overflow on the stack
  - Buffer overflow on the stack – stack smashing
  - Exploitation – Hijacking the control flow
  - Lab – Buffer overflow 101, code reuse
  - Exploitation – Arbitrary code execution
  - Injecting shellcode
  - Lab – Code injection, exploitation with shellcode
  - Case study – Stack BOF in FriendlyName handling of the Wemo Smart Plug
- Pointer manipulation
  - Modification of jump tables
  - Overwriting function pointers
  - Best practices and some typical mistakes
- Unsafe functions
  - Dealing with unsafe functions
  - Lab – Fixing buffer overflow (exploring with Copilot)
- Using std::string in C++
  - Manipulating C-style strings in C++
  - Malicious string termination
  - Lab – String termination confusion (exploring with Copilot)
  - String length calculation mistakes

**Day 2**

**Memory management hardening**

- Securing the toolchain
  - Securing the toolchain in C++
  - Using FORTIFY_SOURCE
  - Lab – Effects of FORTIFY
- AddressSanitizer (ASan)
  - Using AddressSanitizer (ASan)

    - Lab – Using AddressSanitizer
- Stack smashing protection
    - Detecting BoF with a stack canary
    - Argument cloning
    - Stack smashing protection on various platforms
    - SSP changes to the prologue and epilogue
    - Lab – Effects of stack smashing protection
- Runtime protections
    - Runtime instrumentation
    - Address Space Layout Randomization (ASLR)
        - ASLR on various platforms
        - Lab – Effects of ASLR
        - Circumventing ASLR – NOP sleds
        - Circumventing ASLR – memory leakage
- Non-executable memory areas
    - The NX bit
    - Write XOR Execute (W^X)
    - NX on various platforms
    - Lab – Effects of NX
    - NX circumvention – Code reuse attacks
    - Return-to-libc / arc injection
    - Return Oriented Programming (ROP)
    - Protection against ROP
- Case study – Systematic exploitation of a MediaTek buffer overflow

**Day 3**

**Common software security weaknesses**

- Security features
    - Authentication
    - Password management
        - Inbound password management
        - Storing account passwords
        - Password in transit
        - Lab – Is just hashing passwords enough?
        - Dictionary attacks and brute forcing
        - Salting
        - Adaptive hash functions for password storage
        - Password policy
        - NIST authenticator requirements for memorized secrets
        - Password database migration
- Code quality
    - Code quality and security
- Data handling
    - Type mismatch
    - Lab – Type mismatch (exploring with Copilot)
    - Initialization and cleanup
        - Constructors and destructors
        - Initialization of static objects
        - Lab – Initialization cycles (exploring with Copilot)
    - Unreleased resource
    - Array disposal in C++
    - Lab – Mixing delete and delete[] (exploring with Copilot)
- Object oriented programming pitfalls
    - Accessibility modifiers
    - Are accessibility modifiers a security feature?
    - Inheritance and object slicing
    - Implementing the copy operator
    - The copy operator and mutability
    - Mutability
    - Mutable predicate function objects
    - Lab – Mutable predicate function object

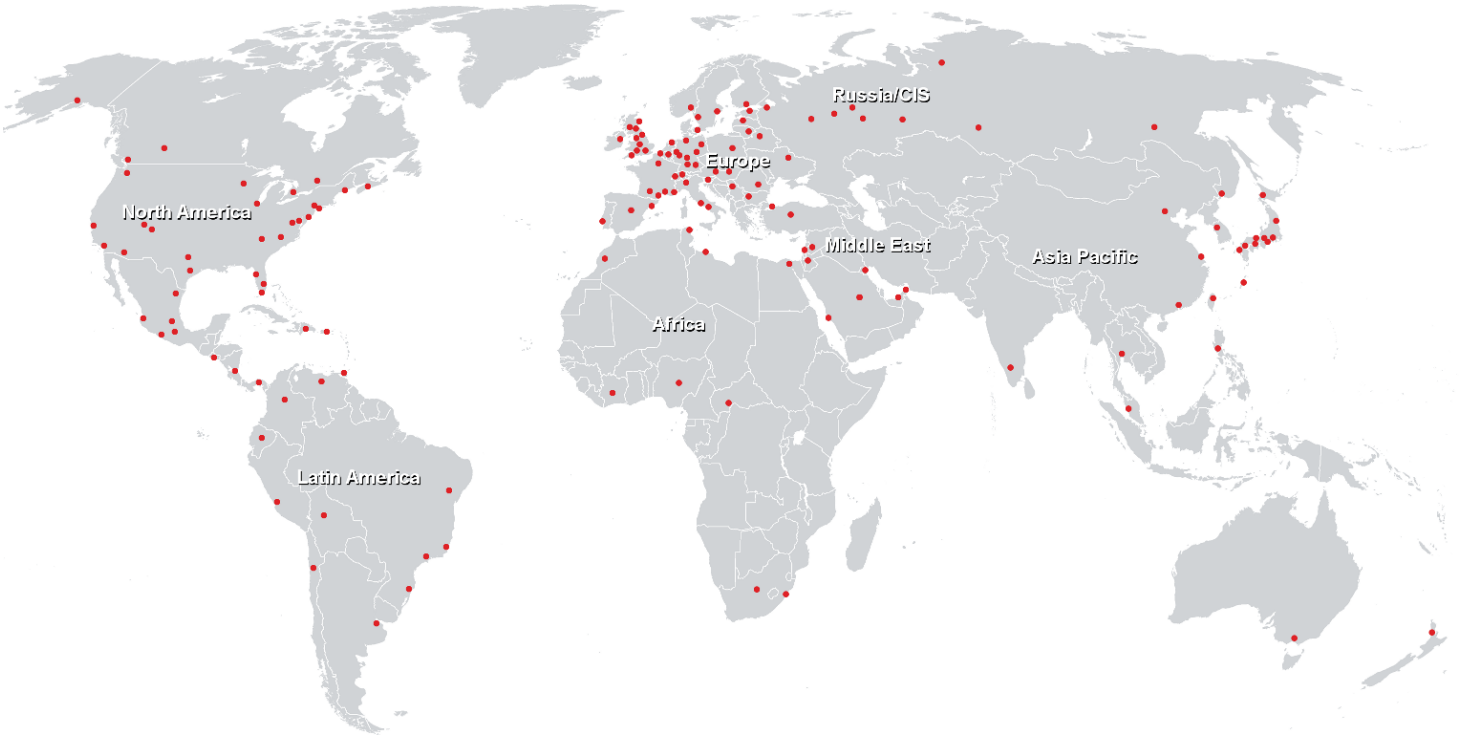
**Using vulnerable components**

- Security of AI generated code
- Practical attacks against code generation tools
- Dependency hallucination via generative AI
- Case study – A history of GitHub Copilot weaknesses (up to mid 2024)

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