

# Modern C++ 17 OOP and Windows Reverse Engineering Essentials

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- **Object Oriented Programming with C++ – 1671 Min**

- Introduction to Microsoft C++
  - i. Microsoft C++ Compiler
  - ii. Microsoft C++ Linker
  - iii. Visual Studio IDE
  - iv. Visual Studio Debugger
- Introduction to C++ and OOP
  - i. What is C++?
  - ii. What is a Multiparadigm Language?
    1. Inline
    2. Structural
    3. Object Oriented
    4. Functional
  - iii. C++ Programming Approaches
    1. Native C++ Programming
    2. Managed C++ Programming
    3. DotNet Framework and C++/CLI
  - iv. C++ Programs Type
    1. Graphical Programs – Win32 API
    2. Console Programs
- Fundamental and User Data Type
  - i. Fundamental Data Types
    1. Int
    2. Char
    3. Bool
    4. Float
    5. Double

- ii. Data Type Casting
  1. Roundoff Problem
  2. Losing Precisions
- iii. User Defined Data Types
  1. Classes
  2. Structure
  3. Enumerations

## — Classes and Objects

- i. Classes and Objects
- ii. Inheritance and Access Modifiers
  1. Public
  2. Private
  3. Protected
  4. Friend Classes and Functions
- iii. Namespaces and Enumerations

## — Conditions and Repeations

- i. If and Else
- ii. Switch Cases
- iii. For and While loop
- iv. Range based for loop
- v. Visual Studio Arguments Settings:
  1. Language Standard
  2. Intermediate File
  3. Output File
  4. Compile As

## — Memory Addressing

- i. What is a Pointer?
  1. Pointers Declaration
  2. Pointers Initialization
  3. Pointer Size in 32 Bit Systems
  4. Pointer Size in 64 Bit Systems
- ii. Pointers to Pointers
  1. Pointers Dereferencing
- iii. C++ References
  1. References vs Pointers
  2. Pass by References

- iv. Memory Analysis for References

- Translation Phases

- i. Preprocessing – Microsoft Preprocessor
- ii. Compiling – Microsoft C++ Compiler and Optimizer
- iii. Assembling – Microsoft Assembler / MASM
- iv. Linking – Microsoft Linker
- v. Visual Studio Project Settings
  1. Preprocessing Output – .i Files
  2. Compiling Output – .Asm Files
  3. Assembling Output – .Obj Files
  4. Linking Output – .Exe Files

- Preprocessing and Preprocessor

- i. What is Preprocessing?
- ii. Why Preprocessing is important?
- iii. Introduction to Translation Phase
- iv. Preprocessing Directives
  1. Include
  2. Pragma
  3. Define
  4. Undef
  5. Ifdef and ifndef
  6. Else

- Disassembler and Disassembling

- i. Reverse of Compilation Process
- ii. Disassemblers Tasks
- iii. Disassemblers Types
  1. Capstone Engine
  2. IDA Disassembler
  3. Radare2 Cutter

- Debugger and Debugging

- i. Visual Studio Builtin Debugger
- ii. Standalone Debuggers
  1. OllyDBG
  2. ImmDBG
  3. x64DBG

## — Overloading

- i. What is Overloading?
- ii. What is an Operator?
  - 1. Why is it Important?
  - 2. Function Overloading
  - 3. Class Member Overloading
  - 4. Operator Member Overloading

## — Templates

- i. What are Templates?
- ii. Why is it Important?
- iii. Standard Template Library
  - 1. Template in Action
    - a. Free Function Templates
    - b. Member Function Templates
    - c. Class Templates
    - d. Specialization Templates

## — Constants and const keyword

- i. What are Cons Qualifier?
- ii. Why is it Important?
  - 1. Const Keyword
  - 2. Const in Action
    - a. Constant Variables
    - b. Constant Pointers
    - c. Constant Pointers and Constant Locations
    - d. Pass Constant Arguments to Functions

## — Free Store or Heap Memory

- i. Free Store / Heap Memory
- ii. Dynamic Memory Allocation
  - 1. Struct Memory Management
  - 2. Class Memory Management
  - 3. Constructor and Destructor
  - 4. Free Store Keywords
    - a. New
    - b. Delete
    - c. Malloc
    - d. Free
- iii. Smart Pointers and Automatic Memory Management

1. Raw Pointers
2. Raw Pointers Memory Management Issues
  - a. Never Free
  - b. Double Free
  - c. Danling Pointers
  - d. Other Memory Leakage Issues
3. What are Smart Pointers?
  - a. Auto Deductions
  - b. Unique Pointers
  - c. Shared Pointers
  - d. Weak Pointers

## — Standard CPP Containers

### i. Std::Vectors

1. Push and Pop back
2. Begin and RBeign
3. End and REnd
4. Capacity and Size
5. At and []

### ii. Std:Deque

1. Push Back
2. Push Front
3. Emplace Back
4. Emplace Front
5. Advance and Erase

### iii. Std::List and std::forward\_list

1. Doubly Linked List
2. Push Back and Front
3. Emplace Back and Front
4. Advance and Erase
5. Merge and Sort
6. Unique and Remove

### iv. Std::Map and Std::Multimap

1. Keys and Values
2. Reverse Iterator
3. Iterator
4. Insert

### v. Std::Set and Std::Multiset

1. Keys and Values
2. Reverse Iterator

3. Iterator

4. Insert

#### vi. Std:Pair

1. Pair Concept

2. Make Pair

3. Pair Compare

#### vii. Std:Stack

1. Stack Structure

2. Push Back and Pop Back

3. Stack Empty

#### viii. Std:Queue

1. Queue

2. Priority Queues

3. Double Ended Queue

### — Static and Mutable Storage Class

#### i. Storage Classes

1. Static Storage Class

- a. Static Global Variable

- b. Static Global Function

- c. Static Local Variable

2. Mutable Storage Class

- a. Const Member Function

- b. Mutable Field

### — Polymorphism and Its Types

#### i. Compile-time Polymorphism

#### ii. Run-time Polymorphism

1. Virtual Functions

2. Overridden Functions

3. Pure Virtual Functions

4. Template-based Functions

#### iii. Coercion Polymorphism

#### iv. Ad-hoc Polymorphism

### — Lambda Expression

#### i. Lambda Calculus

#### ii. Lambda Expression

1. Capture Clause

2. Parameter List

3. Return Type
4. Algorithm Header
  - a. for\_each
  - b. find\_if
5. Functional Header
  - a. std::function

## — Exception Handling

- i. Different Model of Handling
  1. C-Style
  2. C++-Style
  3. COM Model
  4. Posix Model
- ii. C++ Exception Handling
  1. Try
  2. Catch
  3. Multiple Catch
- iii. Runtime Exceptions
  1. invalid\_argument
  2. out\_of\_range
  3. exception
- iv. Stack Unwinding
- v. Structured Exception Handler
- vi. Assert and Static Assert

## — Modern CPP Standard Coding

- i. Linux Environment
  1. Clang++
  2. Github Commands
  3. Makefile
- ii. CPP Code Refactoring
- iii. Template Deduction

## — Input and Output File Stream

- i. File Systems
- ii. C++ Streams
- iii. Output File Stream
  1. File Creation
  2. File Opening
  3. Ofstream Flags

- 4. Writing Data to File
- iv. Input File Stream
  - 1. Reading Data
  - 2. Parsing Data
  - 3. Showing Data in Terminal

## — C++ Technical Concepts

- i. Binding
  - 1. Static Binding
  - 2. Dynamic Binding
  - 3. Virtual Pointer Table
- ii. Callbacks
  - 1. Why Callbacks?
  - 2. Overview of Callbacks
  - 3. Function Pointers
  - 4. Function Objects / Functors
- iii. Problem Solving with Polymorphism
  - 1. Compile-time polymorphism with Templates
  - 2. Runtime polymorphism with Inheritance
  - 3. Overloading
- iv. Translation Unit Testing
  - 1. Integration Test
  - 2. Acceptance Test
  - 3. Performance Test
    - a. Instrumentation
    - b. Test Case Analysis
  - 4. Unit Test Frameworks
    - a. GoogleTest Framework
      - Configuring in VS17
      - Test a Project
    - b. BoostTest Framework
      - Installation with by VCPKG
      - Configuring in VS17
      - Test a Project
    - c. Microsoft Native Unit Testing
      - Configuring in VS17
      - Test a Project
    - d. Runtime Speed Execution Performance Test
      - Using Chrono for Measurement
      - Using GoogleBenchmark for Measurement



## v. Introduction to Iterators

### 1. STL Components

#### a. Algorithms

- Sort
- Search
- Merge

#### b. Containers

- Sequence containers
- Associative containers
- Container adaptors

#### c. Iterators

- Why we need Iterators?
- Iterators Categories
  1. Input Iterators
  2. Output Iterators
  3. Forward Iterators
  4. Bidirectional Iterators
  5. Random-Access Iterators
- Auxiliary Iterator Functions
  1. `std::advance`
  2. `std::distance`
  3. `std::next`
  4. `std::prev`

## vi. Introduction to Algorithms

### 1. What is an Algorithm?

### 2. Algorithm Characteristics

#### a. Complexity

- Constant
- Logarithmic
- Linear
- Quasilinear
- Polynomial

#### b. Execution Policy

- Sequential
- Parallelism

#### c. Vectorized Algorithms

#### d. Non-Vectorized Algorithms

### 3. Algorithm Standard Members

#### a. All of

#### b. Any of

#### c. For each

#### d. Find if

#### e. ...

## vii. Concurrency and Parallelism

### 1. What is an Concurrency?

2. What is an Parallelism?
3. Concurrent Programming
  - a. Asynchronous Tasks
    - `std::launch::async`
    - `std::launch::deferred`
    - `std::future`
    - `std::future_status`
  - b. Sharing and Coordinating
    - `std::mutex`
    - `std::shared_mutex`
    - `std::lock_guard`
    - `std::shared_lock`
    - `Atomics`
    - `Condition Variables`
  - c. Low-Level Concurrency Facilities
    - `std::this_thread::yield`
    - `std::this_thread::get_id`
    - `std::this_thread::sleep_for`
    - `td::this_thread::sleep_until`
4. Parallel Algorithms
  - a. `std::execution::seq`
  - b. `std::execution::par`
  - c. `std::execution::par_unseq`

## viii. C++17 Language Changes

1. Type Inference
  - a. `auto`
  - b. `decltype`
2. Fold Expressions
  - a. `Parameters Packs`
  - b. `Foldable Operators`
  - c. `Functions Overloads`
3. Expression Type
  - a. `Left Value`
  - b. `Right Value`
  - c. `eXpiring Value`
4. Advanced Semantics
  - a. `Value-Based References`
    - `Left Value Reference`
    - `Right Value Reference`
  - b. `Traditional Constructors`
    - `Deep Copy`
    - `Shallow Copy`
    - `Special Methods`
    - `Copy Constructors`

- Assignment Constructors
- Delegated-based Constructors
- c.** Move Semantics
  - std::move
  - Move Assignment
  - Move Constructors
  - std::remove\_reference
- d.** Template Specialization
- e.** Tag Dispatching
- f.** Subsituarion Failure is Not An Error
  - Domain Name Lookup
  - Type Argument Deduction
  - Type Substitution
  - Type SubstitutionFailure
  - Function Overload Sets
- g.** Scope Resolution
  - Type Aliasing
  - Using Declarations
  - Namespace Resolution
- 5.** Conditional Return Value
- 6.** Compile-Time Rational Arithmetic
- 7.** Pseudo-Random Number Generator
  - a.** Deterministic
  - b.** Non-Deterministic
  - c.** Sources of Entropy
    - Low Entropy Sources
    - High Entropy Sources
  - d.** Random Number Engine
    - Mersenne Twister
    - Random Device
    - C Randomness
  - e.** Randomness Application
    - Game Engine
    - VS ASLR Mechanism
      1. Image Base Randomization
      2. Address of Entry Point
      3. Code Injection
      4. PE Modifying
    - Cryptographic-Key Generation
  - f.** Random Number Distributions
    - Uniform
    - Normal
    - Poisson
  - g.** Entropy and Randomness Measurement
- 8.** Filesystem Support

- a.** Introduction to File System
- b.** Operating System File Managers
  - Windows File Explorer
  - Linux Gnome Project
  - Linux KDE Project
  - Macintosh Finder
- c.** File System Header
  - filesystem::path
    - 1. Windows-Based Path
    - 2. Linux-Based Path
    - 3. Raw String Path
  - filesystem::path.empty()
  - filesystem::path.filename()
  - filesystem::path.extension()
  - filesystem::path.make\_preferred()
  - filesystem::directory\_iterator
  - filesystem::recursive\_directory\_iterator
  - ...
- d.** PE Signature Checker Software

## ix. Boost Library Features

- 1.** Boost Library Utilities
  - a.** Any
  - b.** Variant
  - c.** Optional
  - d.** PropertyTree
    - Tree Structure
    - Key and Value Pair
    - XML-JSON Parsing with PT
  - e.** Tribool Logic
    - Boolean Logic
    - Triple Value Logic
    - Tribool Decision Making
- 2.** Boost Networking
  - a.** Introduction to Networking
    - IP Addresses
    - Port Numbers
    - Port Numbers Relation with Services
    - Analogy of IP and Logical Ports
    - Packet Inspection with Wireshark
    - Communication Architecture
      - 1. Client/Server Architecture
      - 2. One-way (C&C) Architecture
  - b.** ASIO Network Programming Model
    - The Internet Protocol Suite
    - Hostname Resolution
    - Connecting

- Buffers
- Reading and Writing Data with Buffers
- c.** The Hypertext Transfer Protocol (HTTP)
  - Implementing a Simple HTTP Client
  - Asynchronous Reading and Writing
  - Serving
- d.** Multithreading Boost Asio