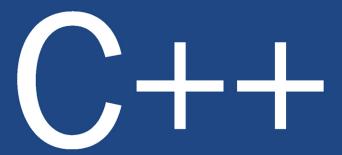
Siddhartha Rao



# Sams Teach Yourself



# in One Hour a Day P

# Sams Teach Yourself C++ in One Hour a Day

PART I: The Basics						
Getting Started	2 The Anatomy of a C++ Program	3 Using Variables, Declaring Constants	4 Managing Arrays and Strings	Working with Expressions, Statements, and Operators	<b>6</b> Controlling Program Flow	7 Organizing Code with Functions
	PART II: Fundamen	damentals of Object-Oriented C++ Programming	inted C++ Program	ming		
8 Pointers and Explained References	9 Classes and Objects	<b>10</b> Implementing Inheritance	<b>11</b> Polymorphism	12 Operator Types and Operator Overloading	<b>L3</b> Casting Operators	14 An Introduction to Macros and Templates
PART III: Learning the Standard		Template Library (STL)				PART IV:
An Introduction to the The Standard Template Library	<b>16</b> The String Class	<b>17</b> STL Dynamic Array Classes	<b>18</b> STL list and forward_list	<b>19</b> STL set and multiset	<b>20</b> STL map and multimap	<b>21</b> Understanding Function Objects
Lambda Expressions and STL A	ons and STL Algorithms	smi		PART V: Advanced C++ Concepts	Concepts	
<b>22</b> Lambda Expressions	<b>23</b> STL Algorithms	24 Adaptive Containers: Stack and Queue	<b>25</b> Working with Bit Flags Using the STL	<b>26</b> Understanding Smart Pointers	Using Streams for Input and Output	<b>28</b> Exception Handling
C++20 Concepts, Ranges, Views, and Adaptors	<b>30</b> C++ Threads	31 C++20 Modules and C++23				

# Sams Teach Yourself C++ in One Hour a Day

# **Table of Contents**

Cover

Title

Copyright

Dedication

Contents at a Glance

Table of Contents

Introduction

PART I: The Basics

**LESSON 1: Getting Started** 

A Brief History of C++

Connection to C

Advantages of C++

Evolution of the C++ Standard

Who Uses Programs Written in C++?

Programming a C++ Application

Steps in Building an Executable

Analyzing Errors and Debugging

Integrated Development Environments

Programming Your First C++ Application

Building and Executing Your First C++ Application

**Understanding Compiler Errors** 

Whats New in C++20?

Summary



Q&A

Workshop

Quiz

Exercises

# LESSON 2: The Anatomy of a C++ Program

Parts of the Hello World Program

Preprocessor Directive #include

The Body of Your Program: main()

Returning a Value

The Concept of Namespaces

Comments in C++ Code

Functions in C++

Basic Input Using std::cin and Output Using std::cout

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 3: Using Variables, Declaring Constants

#### What Is a Variable?

Memory and Addressing in Brief

Declaring Variables to Access and Use Memory

Declaring and Initializing Multiple Variables of a Type

Understanding the Scope of a Variable

Global Variables

Naming Conventions

# Common Compiler-Supported C++ Variable Types

Using Type bool to Store Boolean Values

Using Type char to Store Character Values

The Concept of Signed and Unsigned Integers

Signed Integer Types short, int, long, and long long



Unsigned Integer Types unsigned short, unsigned int, unsigned long, and unsigned long long

Avoiding Overflow Errors by Selecting Correct Data Types

Floating-Point Types float and double

Determining the Size of a Variable by Using sizeof()

Avoid Narrowing Conversion Errors by Using List Initialization

Automatic Type Inference Using auto

Using typedef to Substitute a Variables Type

What Is a Constant?

Literal Constants

Declaring Variables as Constants Using const

Constant Expressions Using constexpr

C++20 Immediate Functions Using consteval

**Enumerations** 

Scoped Enumerations

Defining Constants by Using #define

Keywords You Cannot Use as Variable or Constant Names

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 4: Managing Arrays and Strings

# What Is an Array?

The Need for Arrays

Declaring and Initializing Static Arrays

How Data Is Stored in an Array

Accessing Data Stored in an Array

Modifying Data Stored in an Array

## Multidimensional Arrays

Declaring and Initializing Multidimensional Arrays

Accessing Elements in a Multidimensional Array



```
Dynamic Arrays
     C-Style Character Strings
     C++ Strings: Using std::string
     Summary
     Q&A
     Workshop
          Quiz
          Exercises
LESSON 5: Working with Expressions, Statements, and Operators
     Statements
     Compound Statements, or Blocks
     Using Operators
          The Assignment Operator (=)
          Understanding I-Values and r-Values
          Operators to Add (+), Subtract (-), Multiply (*), Divide (/), and Modulo Divide (%)
          Operators to Increment (++) and Decrement (--)
          To Postfix or to Prefix?
          Equality Operators (== and !=)
          Relational Operators
          C++20 Three-Way Comparison Operator (<=>)
          Logical Operations NOT, AND, OR, and XOR
          Using C++ Logical Operators NOT (!), AND (&&), and OR (||)
          Bitwise NOT (~), AND (&), OR (|), and XOR (^) Operators
          Bitwise Right Shift (>>) and Left Shift (<<) Operators
          Compound Assignment Operators
          Using the sizeof() Operator to Determine the Memory Occupied by a Variable
          Operator Precedence and Associativity
     Summary
     Q&A
     Workshop
          Quiz
          Exercises
```



# LESSON 6: Controlling Program Flow

# Conditional Execution Using if else

Conditional Programming Using if else

Conditional Execution of Statements Within a Block

Nested if Statements

Conditional Processing Using switch-case

Conditional Execution Using the ?: Operator

# Getting Code to Execute in Loops

A Rudimentary Loop Using goto

The while Loop

The do while Loop

The for Loop

The Range-Based for Loop

### Modifying Loop Behavior Using continue and break

Loops That Dont End: Infinite Loops

Controlling Infinite Loops

# **Programming Nested Loops**

Using Nested Loops to Walk a Multidimensional Array

Using Nested Loops to Calculate Fibonacci Numbers

#### Summary

Q&A

#### Workshop

Quiz

Exercises

# **LESSON 7: Organizing Code with Functions**

#### The Need for Functions

What Is a Function Prototype?

What Is a Function Definition?

What Is a Function Call, and What Are Arguments?

Programming a Function with Multiple Parameters

Programming Functions with No Parameters or No Return Values

Function Parameters with Default Values



Recursion: Functions That Invoke Themselves

Functions with Multiple Return Statements

# Using Functions to Work with Different Forms of Data

Overloading Functions

Passing an Array of Values to a Function

Passing Arguments by Reference

# How Function Calls Are Handled by the Microprocessor

Inline Functions

Automatic Return Type Deduction

Lambda Functions

### Summary

Q&A

# Workshop

Quiz

Exercises

# LESSON 8: Pointers and References Explained

#### What Is a Pointer?

Declaring a Pointer

Determining the Address of a Variable by Using the Reference Operator (&)

Using Pointers to Store Addresses

Accessing Pointed Data Using the Dereference Operator (\*)

What Is the Size of a Pointer?

#### Dynamic Memory Allocation

Using the Operators new and delete to Allocate and Release Memory Dynamically

Effects of the Increment (++) and Decrement (--) Operators on Pointers

Using the const Keyword on Pointers

Passing Pointers to Functions

Similarities Between Arrays and Pointers

# Common Programming Mistakes When Using Pointers

Memory Leaks

Pointers Pointing to Invalid Memory Locations

Dangling Pointers (Also Called Stray or Wild Pointers)



Checking Whether an Allocation Request Using new Succeeded

# Pointer Programming Best Practices

#### What Is a Reference?

What Makes References Useful?

Using the Keyword const on References

Passing Arguments by Reference to Functions

# Summary

Q&A

Workshop

Quiz

Exercises

# PART II: Fundamentals of Object-Oriented C++ Programming

# LESSON 9: Classes and Objects

# The Concept of Classes and Objects

Declaring a Class

An Object as an Instance of a Class

Accessing Members by Using the Dot Operator (.)

Accessing Members by Using the Pointer Operator (->)

#### The Keywords public and private

Abstraction of Data via the Keyword private

#### Constructors

Declaring and Implementing a Constructor

When and How to Use Constructors

Overloading Constructors

A Class Without a Default Constructor

Constructor Parameters with Default Values

Constructors with Initialization Lists

#### Destructor

Declaring and Implementing a Destructor

When and How to Use a Destructor

The Copy Constructor



Shallow Copying and Associated Problems

Ensuring a Deep Copy Using a Copy Constructor

Using Move Constructors to Improve Performance

#### Different Uses of Constructors and the Destructor

A Class That Does Not Permit Copying

A Singleton Class That Permits a Single Instance

A Class That Prohibits Instantiation on the Stack

Using Constructors to Convert Types

The this Pointer

Using sizeof() with a Class

The Keyword struct and Its Differences from class

Declaring a friend of a class

Union: A Special Data Storage Mechanism

Declaring a Union

Where Would You Use a Union?

# Using Aggregate Initialization on Classes and structs

constexpr with Classes and Objects

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 10: Implementing Inheritance

#### Basics of Inheritance

Inheritance and Derivation

C++ Syntax of Derivation

The Access Specifier Keyword protected

Base Class Initialization: Passing Parameters to the Base Class

A Derived Class Overriding the Base Classs Methods

Invoking Overridden Methods of a Base Class

Invoking Methods of a Base Class in a Derived Class

A Derived Class Hiding the Base Classs Methods



Order of Construction

Order of Destruction

Private Inheritance

Protected Inheritance

The Problem of Slicing

Multiple Inheritance

Avoiding Inheritance Using final

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 11: Polymorphism

# Basics of Polymorphism

Need for Polymorphic Behavior

Polymorphic Behavior Implemented Using Virtual Functions

Need for Virtual Destructors

How Do Virtual Functions Work? Understanding the Virtual Function Table

Abstract Base Classes and Pure Virtual Functions

Using Virtual Inheritance to Solve the Diamond Problem

Using the Specifier override to Indicate the Intention to Override

Using final to Prevent Function Overriding

Virtual Copy Constructors?

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 12: Operator Types and Operator Overloading

What Are Operators in C++?

**Unary Operators** 



Unary Increment (++) and Decrement (--) Operators **Conversion Operators** The Dereference Operator (\*) and Member Selection Operator (->) **Binary Operators** The Binary Addition (a+b) and Subtraction (a-b) Operators The Addition Assignment (+=) and Subtraction Assignment (-=) Operators The Equality (==) and Inequality (!=) Operators The <, >, <=, and >= Operators The C++20 Three-Way Comparison Operator (<=>) The Copy Assignment Operator (=) The Subscript Operator ([]) The Function Operator (()) The Move Constructor and Move Assignment Operator for High-Performance Programming The Problem of Unwanted Copy Steps Declaring a Move Constructor and Move Assignment Operator **User-Defined Literals** Operators That Cannot Be Overloaded Summary Q&A Workshop Quiz Exercises **LESSON 13: Casting Operators** The Need for Casting Why C-Style Casts Are Not Popular with Some C++ Programmers The C++ Casting Operators Using static\_cast Using dynamic\_cast and Runtime Type Identification Using reinterpret\_cast Using const\_cast Problems with the C++ Casting Operators



Summary

-	٦	О	٨
ı	.,	ж.	н

Workshop

Quiz

Exercises

# LESSON 14: An Introduction to Macros and Templates

The Preprocessor and the Compiler

Using the Macro #define to Define Constants

Using Macros for Protection Against Multiple Inclusion

# Using #define to Write Macro Functions

Why All the Parentheses?

Using the assert Macro to Validate Expressions

Advantages and Disadvantages of Using Macro Functions

# An Introduction to Templates

Template Declaration Syntax

The Different Types of Template Declarations

**Template Functions** 

Templates and Type Safety

Template Classes

Declaring Templates with Multiple Parameters

Declaring Templates with Default Parameters

Sample Template Class: HoldsPair

Template Instantiation and Specialization

Template Classes and static Members

Variable Templates

Using static\_assert to Perform Compile-Time Checks

Using Templates in Practical C++ Programming

#### Summary

Q&A

Workshop

Quiz

Exercises

PART III: Learning the Standard Template Library (STL)



# LESSON 15: An Introduction to the Standard Template Library

STL Containers

Sequential Containers

**Associative Containers** 

**Container Adapters** 

STL Iterators

STL Algorithms

Interaction Between Containers and Algorithms Using Iterators

Using the Keyword auto to Let a Compiler Define Type

Choosing the Right Container

STL String Classes

Summary

Q&A

Workshop

Quiz

# LESSON 16: The STL String Class

The Need for String Manipulation Classes

Working with the STL string Class

Instantiating the STL string Class and Making Copies

Accessing Character Contents of std::string

Concatenating One String to Another

Finding a Character or Substring in a String

Truncating an STL String

String Reversal

String Case Conversion

Template-Based Implementation of an STL String

operator ""s in std::string

Using std::string\_view (Amended in C++20)

Summary

Q&A

Workshop



Quiz

Exercises

# LESSON 17: STL Dynamic Array Classes

The Characteristics of std::vector

# **Typical Vector Operations**

Instantiating a Vector

Inserting Elements at the End of a Vector by Using push\_back()

List Initialization

Inserting Elements at a Given Position by Using insert()

Accessing Elements in a Vector by Using Array Semantics

Accessing Elements in a Vector by Using Pointer Semantics

Removing Elements from a Vector

Understanding the Concepts of Size and Capacity

The STL deque Class

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 18: STL list and forward\_list

The Characteristics of std::list

## **Basic list Operations**

Instantiating a std::list Object

Inserting Elements at the Front or Back of a List

Inserting Elements in the Middle of a List

Erasing Elements from a List

# Reversing and Sorting Elements in a List

Reversing Elements by Using list::reverse()

Sorting Elements

Sorting and Removing Elements from a List That Contains Instances of a Class

std::forward list

Summary



Q&A

Workshop

Quiz

Exercises

# LESSON 19: STL set and multiset

An Introduction to STL Set Classes

Basic STL set and multiset Operations

Instantiating a std::set Object

Inserting Elements in a Set or Multiset

Finding Elements in an STL set or multiset Container

Erasing Elements in an STL set or multiset Container

Pros and Cons of Using STL set and multiset

STL Hash Set Implementation: std::unordered\_set and

std::unordered\_multiset

Q&A

Workshop

Summary

Quiz

Exercises

# LESSON 20: STL map and multimap

An Introduction to STL Map Classes

Basic std::map and std::multimap Operations

Instantiating std::map or std::multimap

Inserting Elements in an STL Map or Multimap

Finding Elements in an STL map Container

Finding Elements in an STL multimap Container

Erasing Elements from an STL map or multimap Container

Supplying a Custom Sort Predicate

STLs Hash TableBased Key/Value Container

How Hash Tables Work

Using unordered map and unordered multimap



```
Summary
        Q&A
        Workshop
            Quiz
            Exercises
PART IV: Lambda Expressions and STL Algorithms
    LESSON 21: Understanding Function Objects
        Function Objects and Predicates
        Typical Applications of Function Objects
            Unary Functions
            Unary Predicates
            Binary Functions
            Binary Predicates
        Summary
        Q&A
        Workshop
            Quiz
            Exercises
   LESSON 22: Lambda Expressions
        What Is a Lambda Expression?
        How to Define a Lambda Expression
            Capturing Variables
            Parameters
            Return Types
        A Lambda Expression for a Unary Function
        A Lambda Expression for a Unary Predicate
        A Lambda Expression with State via Capture Lists ([])
        A Lambda Expression for a Binary Function
        A Lambda Expression for a Binary Predicate
        Summary
```



Q&A

Workshop

Quiz

Exercises

# LESSON 23: STL Algorithms

What Are STL Algorithms?

Classification of STL Algorithms

Non-mutating Algorithms

Mutating Algorithms

# Usage of STL Algorithms

Finding Elements, Given a Value or a Condition

Counting Elements Given a Value or a Condition

Searching for an Element or a Range in a Collection

Initializing Elements in a Container to a Specific Value

Using std::generate() to Initialize Elements to a Value Generated at Runtime

Processing Elements in a Range by Using for\_each()

Performing Transformations on a Range by Using std::transform()

Copy and Remove Operations

Replacing Values and Replacing Elements Given a Condition

Sorting and Searching in a Sorted Collection and Erasing Duplicates

Partitioning a Range

Inserting Elements in a Sorted Collection

Performing Fold Operations Using std::accumulate() in C++20

#### C++20 Constrained Algorithms

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 24: Adaptive Containers: Stack and Queue

The Behavioral Characteristics of Stacks and Queues

Stacks



#### Queues

# Using the STL stack Class

Instantiating a Stack

Stack Member Functions

Insertion and Removal at the Top, Using push() and pop()

# Using the STL queue Class

Instantiating a Queue

Member Functions of the queue Class

Insertion at the End and Removal at the Beginning of a Queue via push() and pop()

# Using the STL Priority Queue

Instantiating the priority\_queue Class

Member Functions of priority\_queue

Insertion at the End and Removal at the Beginning of a Priority Queue via push() and pop()

## Summary

Q&A

# Workshop

Quiz

Exercises

# LESSON 25: Working with Bit Flags Using the STL

#### The bitset Class

Instantiating std::bitset

## Using std::bitset and Its Members

Useful Operators in std::bitset

std::bitset Member Methods

#### The vector<bool> Class

Instantiating vector<bool>

vector<bool> Functions and Operators

#### Summary

Q&A

#### Workshop

Quiz



Exercises

# PART V: Advanced C++ Concepts

# LESSON 26: Understanding Smart Pointers

What Are Smart Pointers?

The Problem with Using Conventional (Raw) Pointers

How Do Smart Pointers Help?

How Are Smart Pointers Implemented?

Types of Smart Pointers

Deep Copy

Copy on Write

Reference-Counted Smart Pointers

Reference-Linked Smart Pointers

**Destructive Copy** 

Using std::unique\_ptr

Popular Smart Pointer Libraries

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 27: Using Streams for Input and Output

The Concept of Streams

Important C++ Stream Classes and Objects

Using std::cout for Writing Formatted Data to the Console

Changing the Display Number Format by Using std::cout

Aligning Text and Setting Field Width by Using std::cout

Using std::cin for Input

Using std::cin for Input into a Plain Old Data Type

Using std::cin::get for Input into the char\* Buffer

Using std::cin for Input into std::string

Using std::fstream for File Handling



Opening and Closing a File Using open() and close()

Creating and Writing a Text File by Using open() and the Operator <<

Reading a Text File by Using open() and the Operator >>

Writing to and Reading from a Binary File

Using std::stringstream for String Conversions

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 28: Exception Handling

What Is an Exception?

What Causes Exceptions?

Implementing Exception Safety via try and catch

Using catch() to Handle All Exceptions

Catching Exceptions of a Type

Throwing Exceptions of a Type by Using throw

How Exception Handling Works

Class std::exception

A Custom Exception Class Derived from std::exception

Summary

Q&A

Workshop

Quiz

Exercises

# LESSON 29: C++20 Concepts, Ranges, Views, and Adaptors

#### Concepts

Using Concepts Provided by the Standard Library

Defining Custom Concepts by Using the Keyword requires

Using Concepts with Classes and Objects

The Ranges Library, Views, and Adaptors



Views and Adaptors Adaptors Provided by the Ranges Library Combining Multiple Adaptors Summary Q&A Workshop Quiz Exercises LESSON 30: C++20 Threads Multithreading What Is a Thread? Why Program Multithreaded Applications? Using the C++20 Thread Library How Can Threads Transact Data? Using Mutexes and Semaphores to Synchronize Threads Summary Q&A Workshop Exercise LESSON 31: C++20 Modules and C++23 Modules The Problem with #include<header> C++20 Modules Programming a Module Consuming a Module Why import Module; Is Superior to the Preprocessor #include<header> C++23 Expected Features Learning C++ Doesnt Stop Here!



Online Documentation

Summary

Communities for Guidance and Help

Q&A

Workshop

Exercise

PART VI: Appendixes

APPENDIX A: Working with Numbers: Binary and Hexadecimal

APPENDIX B: C++ Keywords

APPENDIX C: Writing Great C++ Code

APPENDIX D: ASCII Codes

**APPENDIX E: Answers** 

Index

