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## Rust for Python Programmers

### Class Duration

- 5 days of comprehensive training
- Structured pathway for Python developers

### Target Audience

- Proficiency in Python programming
- Basic understanding of programming concepts such as variables, expressions, functions, and control flow

### Description

Transitioning from Python to Rust? This course offers Python developers a structured pathway to understand and master the Rust programming language. We delve deep into Rust's memory safety guarantees, its concurrency model, and how it contrasts with Python's dynamic nature. By the end of the course, you'll be equipped to build efficient, safe, and concurrent applications in Rust, all while leveraging your Python expertise.

### Learning Objectives

- Understand the Rust Philosophy
- Set Up and Navigate the Rust Environment
- Explore Rust within the context of Python
- Grasp Basic Rust Syntax and Semantics
- Learn Control Flow and Logic
- Learn Ownership and Borrowing Concepts
- Utilize Tuples, Enums, Structs, and Vectors
- Employ Pattern Matching
- Harness Rust's Concurrency Model
- Create Custom Macros
- Write Rust Tests
- Create Documentation with Rustdoc

### Training Materials

All students receive comprehensive courseware covering all topics in the course. Courseware is distributed via GitHub in the form of documentation



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and extensive code samples. Students practice the topics covered through challenging hands-on lab exercises.

## Software Requirements

Students will need a free, personal GitHub account to access the courseware. Student will need permission to install Rust, Python, and Visual Studio Code on their computers. Also, students will need permission to install Rust Crates, Python Packages, and Visual Studio Extensions. If students are unable to configure a local environment, a cloud-based environment can be provided.

## Training Topics

### Introduction

- What is Rust?
- Rust's Philosophy and Goals
- History and motivation
- Rust vs Python
- Rust Community
- The Rust Playground

### Install Rust

- Script
- macOS Homebrew
- Platform Installers

### Rust Editors

- VSCode with Extensions
- Rust Rover
- Debug Rust in VSCode
- GitHub Copilot

### Hello World

- Create a new Project
- Main Function
- Print to the Console
- Comments

### Cargo

- What is Cargo?



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- How does Cargo compare to Pip and Conda?
- Rust Crates compared to Python Packages
- Run Command
- Build Command
- Build Release Command
- Install Third-Party Crates

### Popular Cargo Crates

- Serde
- Tokio
- Request
- SQLx
- Anyhow

### Rust and Python Differences

- Static Typing vs Dynamic Typing
- Memory Management
- Error Handling
- Sequence, Selection, and Iteration
- Structs vs Classes
- Traits vs Protocols
- Generics
- Concurrency

### Scalar Types and Data

- Rust Types vs Python Types
- Constants
- Immutable Variables
- Mutable Variables

### Code Logic

- If Statement
- Loop with Break
- While Loop

### Functions

- Define a Function
- Call a Function



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- Parameter Types
- Return Types
- Closure Functions

### Modules

- Import Modules from Standard Library
- Import Modules from Third-Party Crates
- Define Custom Modules
- Import Custom Modules

### Built-In Macros

- `print!` and `println!`
- `format!`
- `vec!`
- `include_str!` and `include_bytes!`
- `cfg!` and `env!`
- `panic!`

### Memory Management

- Problems with Manual Management
- Problems with Garbage Collection
- Ownership & Borrowing
- Rust vs Python
- References
- Immutable vs Mutable
- Lifetimes
- Heap Allocation with `Box` and `Rc`
- `Drop` Trait

### Strings

- String Slices
- String Objects
- Convert Between Slices and Strings
- Parse Number from String
- Trim String
- Print Strings with Interpolation



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## Tuples

- What is a Tuple?
- Heterogeneous Elements
- Access Elements
- Destructuring
- Immutable

## Enums

- What is an Enum?
- Define an Enum
- Using Enums
- Enum Variants
- Enum Methods
- Enums and Pattern Matching
- Result Enum
- Option Enum
- Enums vs Structs

## Structs

- What is a Struct?
- Create Instance
- Field Init Shorthand
- Struct Update Syntax
- Tuple Structs
- Unit-Like Structs
- Ownership of Struct Data
- Function Implementation
- Associated Functions
- Struct Methods
- Constructor Pattern

## Vectors

- What is a Vector?
- Create a Vector
- Add and Remove Elements
- Access Elements
- Iterate over Elements



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- Slicing, Length, and Capacity
- Common Vector Operations
- Understand Memory Management
- Ownership and Borrowing Rules

### Collections and Iterators

- Vectors, arrays, and slices
- HashMaps and hash sets
- Iteration and iterators

### Traits

- What is a trait?
- How does a trait related to traditional OOP interfaces?
- Defining a trait
- Implementing a trait
- Default implementations
- Traits as parameters
- Traits as return types
- Traits as bounds

### Generics

- What is a generic?
- How does a generic related to traditional OOP generics?
- Defining a generic
- Implementing a generic
- Generic bounds
- Multiple generic types
- Where clauses

### Pattern Matching

- What is Pattern Matching?
- Match Statement
- If Let Statement
- While Let Statement
- Destructuring Structs and Tuples
- Pattern Matching with Enums
- Pattern Matching with Functions
- Pattern Matching and Ownership



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- Refutability and Irrefutability

### Concurrent Programming

- What is Concurrent Programming?
- Using Multiple Threads
- Mutex, RwLock, and Arc
- Message Passing with Channels
- Sync and Send Traits
- Futures and Async/Await

### Unsafe Rust

- What is Unsafe Rust?
- Raw Pointers
- Dereferencing Raw Pointers
- Calling Unsafe Functions
- Creating Safe Abstractions
- Unsafe Traits
- Unsafe Blocks
- Unsafe Superpowers

### Macros and Metaprogramming

- What is a Macro?
- Define a Macro with `macro_rules!`
- Using Pattern Matching
- Define Expansion
- Use the Custom Macro

### Tests

- What is a Test?
- Test Functions
- Test Organization
- Test Attributes
- Test Coverage
- `assert!`, `assert_eq!`, and `assert_ne!`

### Documentation with Rustdoc

- What is Rustdoc?
- Add Documentation to Rust Code



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- Triple-Slash Comments and the `#[doc]` Attribute
- Generate Documentation
- Linking and Cross-Referencing Documentation

#### Python Extension written in Rust (overview)

- Why write Python Extensions in Rust?
- Create a New Extensions
- Compile, Run, and Debug a Rust Extension
- Run Parallel Code outside of the GIL
- GIL and Rust Lifetimes
- Create Python Classes in Rust

#### Conclusion

- Course wrap-up and next steps