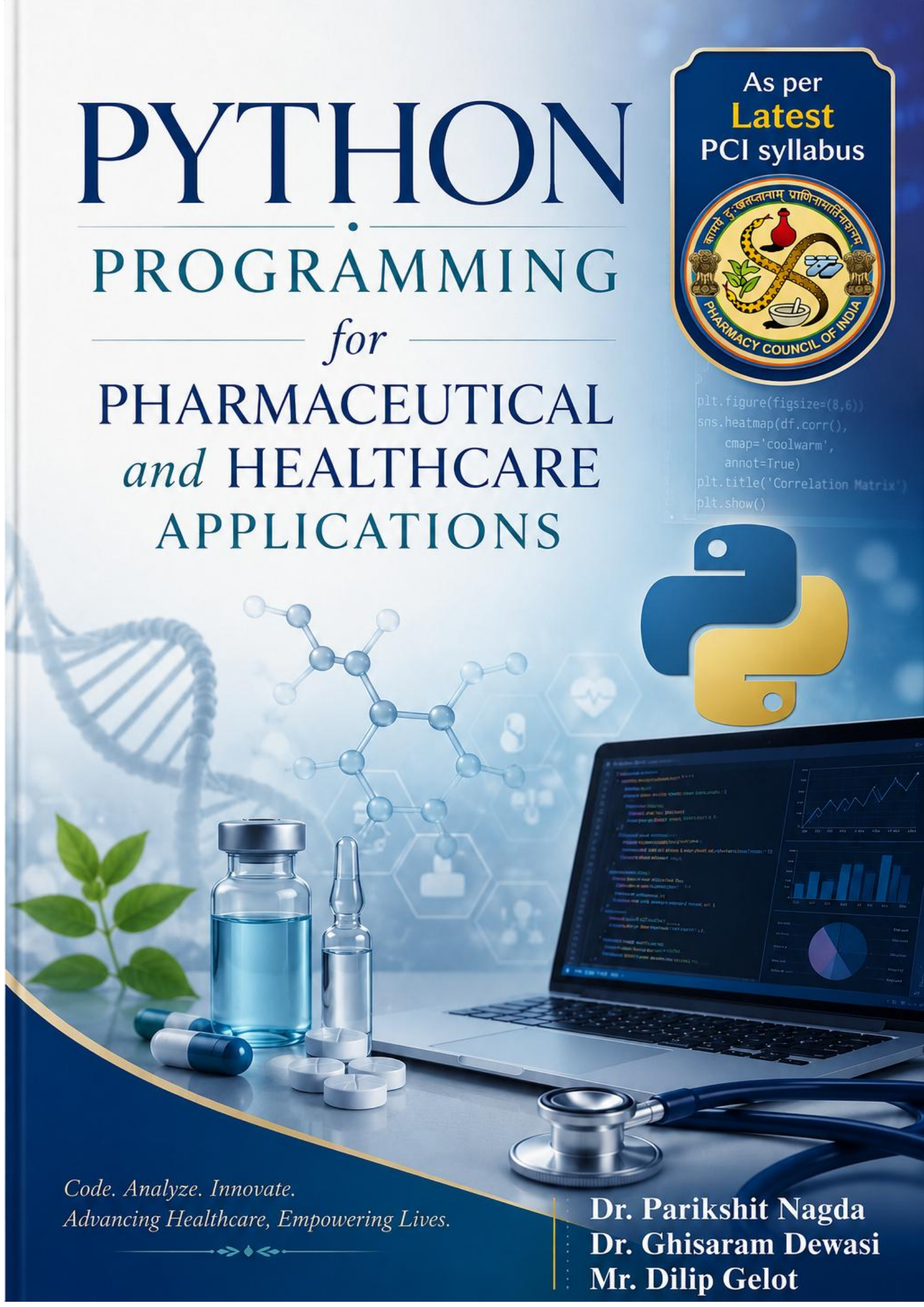
# PYTHON

## PROGRAMMING *for* PHARMACEUTICAL *and* HEALTHCARE APPLICATIONS

As per **Latest** PCI syllabus

PHARMACY COUNCIL OF INDIA

```
plt.figure(figsize=(8,6))
sns.heatmap(df.corr(),
    cmap='coolwarm',
    annot=True)
plt.title('Correlation Matrix')
plt.show()
```



*Code. Analyze. Innovate.*
*Advancing Healthcare, Empowering Lives.*

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Book: **PYTHON PROGRAMMING FOR PHARMACEUTICAL AND HEALTHCARE APPLICATIONS**

**A Comprehensive Textbook for B.Pharm Students**

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# PREFACE

The intersection of computer science and pharmaceutical sciences represents one of the most promising frontiers in modern healthcare education. As pharmacy practice evolves to embrace digital transformation, the need for programming literacy among pharmacy professionals has become increasingly evident. This textbook, "Python Programming for Pharmaceutical and Healthcare Applications," has been crafted specifically to address this educational need for Bachelor of Pharmacy (B.Pharm) students who are beginning their journey into computational thinking and programming.

Python, with its intuitive syntax and extensive library ecosystem, serves as an ideal first programming language for students from healthcare backgrounds. Unlike traditional programming languages that require extensive syntax memorization, Python emphasizes readability and logical flow, making it accessible to learners without prior coding experience. This textbook leverages Python's approachable nature while demonstrating its powerful applications in pharmaceutical and healthcare contexts.

The pharmaceutical industry generates enormous volumes of data daily, from clinical trial results and pharmacovigilance reports to patient records and drug formulation data. Modern pharmacy professionals must be equipped with skills to organize, analyze, and interpret this data effectively. Python provides the tools necessary for these tasks, ranging from simple data organization to complex statistical analysis and visualization.

This textbook follows a carefully designed pedagogical approach that prioritizes conceptual understanding over technical complexity. Each chapter builds upon foundational concepts, gradually introducing students to more sophisticated programming techniques while consistently relating these concepts to pharmaceutical applications. The emphasis remains on developing analytical thinking and problem-solving skills that will serve students throughout their professional careers.

We acknowledge the rapidly evolving nature of both programming technologies and healthcare informatics. While specific tools and libraries may evolve, the fundamental principles of computational thinking, data management, and analytical reasoning presented in this textbook will remain relevant. Students who master these foundational concepts will be

well-prepared to adapt to future technological developments in the pharmaceutical industry.

This book is intended primarily for B.Pharm students undertaking their first formal exposure to programming. No prior coding experience is assumed. The content has been aligned with pharmacy education standards and designed to meet the requirements of pharmaceutical science curricula across educational institutions.

# ACKNOWLEDGEMENT

The creation of this textbook represents the collaborative efforts of numerous individuals whose contributions have shaped its final form. We extend our sincere gratitude to the faculty members of pharmaceutical sciences departments who provided valuable feedback during the manuscript review process. Their insights into pedagogical requirements and industry expectations have significantly enhanced the educational value of this work.

We acknowledge the broader scientific community whose research in pharmaceutical informatics and healthcare data science has provided the foundation upon which this textbook is built. The works of computing educators and scientific programmers have inspired our approach to presenting programming concepts in an accessible and relevant manner.

Our thanks are due to the students who participated in pilot testing the material. Their responses, questions, and suggestions have helped refine explanations and identify areas requiring additional clarity. Educational material improves through iteration, and student feedback has been invaluable in this process.

Finally, we express our appreciation to our families and colleagues whose support and encouragement made the completion of this project possible.

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# CHAPTER 1: INTRODUCTION TO PYTHON PROGRAMMING

## 1.1 Overview of Computer Programming

Computer programming represents the process of creating instructions that tell computers how to perform specific tasks. These instructions, written in programming languages, enable computers to process data, perform calculations, make decisions, and automate complex processes. Programming forms the foundation of all software applications, from simple mobile applications to sophisticated healthcare management systems.

The concept of programming emerged alongside the first mechanical computers in the nineteenth century. However, modern programming as we understand it today began with the development of high-level programming languages in the mid-twentieth century. These languages allowed programmers to write instructions using more human-readable syntax, abstracting away the complex binary machine code that computers actually process.

Programming languages can be categorized into several types based on their abstraction level and purpose. Machine languages represent the lowest level, consisting of binary instructions that computers execute directly. Assembly languages provide minimal abstraction, using symbolic code to represent machine instructions. High-level languages, including Python, offer substantial abstraction, allowing programmers to express logic in formats closer to natural language.

The evolution of programming languages has consistently moved toward greater abstraction and improved programmer productivity. Early programmers needed extensive knowledge of computer hardware architecture. Modern programmers can focus more on problem-solving and algorithm design, leaving the technical details of machine execution to the programming language and its supporting tools.

## 1.2 Evolution of Programming Languages

The history of programming languages reflects the continuous effort to make computers more accessible and programming more efficient. FORTRAN, developed in the 1950s, was among the first high-level

languages designed specifically for scientific and engineering calculations. Its mathematical focus made it valuable for early scientific computing applications.

The 1970s and 1980s witnessed the emergence of structured programming languages such as C and Pascal. These languages introduced systematic approaches to code organization, emphasizing clear program structure and modular design. C proved particularly influential, serving as the foundation for many operating systems and applications.

Object-oriented programming paradigms gained prominence in the 1990s with languages like C++ and Java. These languages introduced concepts of objects and classes, enabling programmers to model real-world entities more naturally in code. The pharmaceutical industry's adoption of computer systems during this period aligned with these technological developments.

Python emerged in the early 1990s, created by Guido van Rossum at the National Research Institute for Mathematics and Computer Science in the Netherlands. Python was designed with emphasis on code readability and programmer productivity. Its syntax allowed developers to express concepts in fewer lines of code compared to languages like C++ or Java.

The language gained significant traction in scientific computing and data analysis communities during the 2000s and 2010s. The development of scientific libraries such as NumPy, SciPy, and later Pandas transformed Python into a powerful tool for research and data science. Healthcare and pharmaceutical applications increasingly adopted Python for data analysis, visualization, and automation tasks.

## 1.3 Introduction to Python

Python is a high-level, interpreted programming language known for its clear syntax and excellent readability. The language design philosophy, encapsulated in the document known as "The Zen of Python," emphasizes principles such as readability counts, simplicity over complexity, and explicit over implicit behavior. These design principles make Python particularly suitable for beginners learning programming concepts.

Python supports multiple programming paradigms, including procedural, object-oriented, and functional programming styles. This flexibility allows programmers to choose the most appropriate approach for their specific

problems. For pharmaceutical applications, this means students can begin with simple procedural scripts and gradually incorporate more sophisticated programming techniques as their skills develop.

The Python interpreter executes code line by line, which simplifies debugging and allows for interactive development. Programmers can test individual code segments quickly, making the development process more iterative and exploratory. This feature is particularly valuable in educational settings where students benefit from immediate feedback.

Python's standard library provides extensive functionality for common programming tasks. The library includes modules for file operations, mathematical functions, string processing, networking, and numerous other purposes. This comprehensive standard library means programmers often find built-in solutions for common problems, reducing the need to implement basic functionality from scratch.

The Python ecosystem extends far beyond the standard library through third-party packages available from the Python Package Index (PyPI). These packages address specialized domains including scientific computing, data analysis, machine learning, web development, and many other areas. For pharmaceutical applications, packages such as NumPy,

Pandas, and Matplotlib provide essential functionality for data analysis and visualization.

## 1.4 Features and Advantages of Python

Python offers numerous features that contribute to its popularity and suitability for healthcare applications. The language's simplicity represents one of its most significant advantages. Python syntax uses English-like keywords and clear structure, allowing new programmers to focus on understanding programming concepts rather than memorizing complex syntax rules.

Readability represents a core design principle of Python. The language uses indentation to define code blocks, a convention that promotes consistent formatting across all Python programs. This approach produces code that is not only easier to read but also easier to review and maintain over time. In pharmaceutical settings, where code review and regulatory compliance are important, readable code offers significant advantages.

Dynamic typing in Python allows variables to hold different types of data without explicit type declarations. This feature simplifies code writing and reduces the overhead of variable management. Programmers can focus on the data values and operations rather than type specifications, making the programming process more intuitive for beginners.

Python's cross-platform compatibility means programs written in Python can run on various operating systems including Windows, macOS, and Linux. This flexibility is valuable in healthcare environments where different systems and platforms may be in use. Python code developed on one platform can typically run on others with minimal or no modification.

The extensive community support surrounding Python provides abundant resources for learning and problem-solving. Online documentation, tutorials, forums, and community-contributed code libraries offer assistance for programmers at all skill levels. For students learning Python, this community support makes troubleshooting and skill development more accessible.

## 1.5 Importance of Python in Healthcare

Healthcare organizations increasingly rely on data-driven decision-making processes. Python's capabilities for data analysis, visualization, and automation align well with healthcare needs. From analyzing patient records to monitoring drug safety signals, Python provides tools that healthcare professionals can use to derive meaningful insights from complex data.

Clinical research generates substantial data requiring careful analysis and interpretation. Python's statistical and scientific computing libraries enable researchers to process clinical trial data, perform pharmacokinetic analysis, and generate publication-quality visualizations. The language's integration with data formats commonly used in healthcare research facilitates seamless data handling workflows.

Pharmacovigilance, the science of detecting, assessing, and preventing adverse drug reactions, relies heavily on data analysis. Python can process large volumes of adverse event reports, identify patterns, and generate reports for regulatory submission. Automated pharmacovigilance workflows using Python improve efficiency and consistency in drug safety monitoring.

Hospital information systems and pharmacy management software benefit from Python's capabilities for data processing and integration. Python scripts can automate routine data management tasks, generate reports, and facilitate data exchange between different healthcare systems. These applications improve operational efficiency in pharmacy settings.

The rise of artificial intelligence and machine learning in healthcare creates additional opportunities for Python applications. Python serves as the primary language for many machine learning frameworks used in medical image analysis, disease diagnosis, drug discovery, and personalized medicine. Healthcare professionals with Python skills will be better positioned to engage with these emerging technologies.

## 1.6 Installing Python

Python installation involves downloading the Python interpreter and associated tools from the official Python website at python.org. The website provides installers for Windows, macOS, and Linux operating systems. Students should download the latest stable version of Python 3, as Python 2 reached end-of-life and is no longer supported.

The installation process for Windows involves running the downloaded installer and following the on-screen instructions. During installation, students should ensure the option to add Python to the system PATH is selected. This configuration allows Python to be invoked from the command prompt regardless of the current directory.

macOS users may find Python pre-installed on their systems, though this version may be outdated. The official Python installer provides the most current version. Homebrew, a package manager for macOS, offers an alternative installation method through the command line.

Linux distributions typically include Python in their software repositories. Users can install Python through package management systems such as apt (Debian and Ubuntu) or yum (Red Hat and Fedora). The installation process varies slightly between distributions but generally follows similar principles.

After installation, students should verify that Python is correctly installed by opening a terminal or command prompt and typing "python --version" or "python3 --version". Successful installation displays the installed Python version number.

## 1.7 Integrated Development Environments

Integrated Development Environments (IDEs) provide comprehensive software environments for writing, testing, and debugging code. IDEs combine text editing capabilities with development tools including syntax highlighting, code completion, error detection, and debugging interfaces. Using an IDE significantly improves programming productivity compared to basic text editors.

Jupyter Notebook represents a popular environment for Python development, particularly in scientific and educational contexts. Jupyter provides an interactive interface where code is organized into cells that can be executed individually. This cell-based structure allows programmers to run code segments incrementally and view results immediately.

The ability to combine code, text, equations, and visualizations in a single document makes Jupyter particularly valuable for data analysis and exploratory programming. Healthcare professionals often use Jupyter Notebooks for analyzing clinical data, documenting analytical workflows, and sharing research findings. Jupyter Notebook is included with

Anaconda, a Python distribution that also includes many scientific computing packages.

PyCharm is a professional IDE developed specifically for Python programming. The Community Edition is freely available and includes features such as intelligent code editing, debugging, testing support, and version control integration. PyCharm's comprehensive development environment supports larger software projects with multiple files and complex dependencies.

Visual Studio Code (VS Code) provides a lightweight but powerful code editor that supports Python through extensions. Students can install the Python extension for VS Code to gain features such as syntax highlighting, code navigation, and debugging capabilities. VS Code's flexibility and customization options make it popular among developers.

## 1.8 Variables and Data Types

Variables serve as named containers for storing data values in programs. A variable's name identifies the data it contains, allowing programmers to reference and manipulate data through meaningful labels. In healthcare

applications, variable names might represent patient identifiers, drug names, dosage values, or measurement results.

Python variable names follow specific rules. Names must begin with a letter or underscore character and can contain letters, numbers, and underscores. Python is case-sensitive, meaning "PatientID" and "patientid" represent different variables. Descriptive variable names improve code readability and maintainability.

Data types define the kind of data a variable can hold and the operations that can be performed on that data. Python includes several fundamental data types including integers, floating-point numbers, strings, and boolean values. Understanding data types is essential for proper data handling in pharmaceutical applications.

Integers represent whole numbers without decimal components. In pharmacy contexts, integers might represent patient counts, tablet quantities, or prescription numbers. Floating-point numbers represent decimal values and are used for measurements such as dosages in milligrams, drug concentrations, or body weight in kilograms.

Strings represent sequences of characters and are used for text data such as patient names, medication names, and address information. String operations allow programmers to manipulate text data, extract information, and format output for reports and displays.

Boolean values represent logical true or false conditions and are fundamental to decision-making in programs. Boolean data types are used extensively in conditional logic for dose verification, eligibility checking, and other clinical decision support functions.

## 1.9 Type Casting

Type casting, also known as type conversion, transforms data from one type to another. Python provides functions for converting between different data types including int(), float(), str(), and bool(). Understanding type conversion is important because different operations require specific data types.

Converting floating-point numbers to integers truncates the decimal portion, resulting in the whole number component only. This conversion is useful when discrete counts are needed from continuous measurements.

However, programmers must be aware that precision may be lost in such conversions.

Converting strings to numeric types enables mathematical operations on text-based numerical data. Patient records often store numerical values as strings, requiring conversion before calculations can be performed. Invalid conversion attempts, such as converting the string "Aspirin" to a number, result in errors.

Converting numeric values to strings creates text representations of numbers. This conversion is necessary when combining numerical data with text in output messages or when preparing data for storage in text-based file formats.

Boolean conversion treats certain values as logically true or false. In Python, values such as zero, empty strings, and None are considered false, while non-zero numbers and non-empty strings are considered true. Understanding these conventions is important for writing correct conditional logic.

## 1.10 Operators

Operators perform operations on values and variables. Python includes several categories of operators for different types of operations including arithmetic, comparison, logical, and assignment operations.

Arithmetic operators perform mathematical calculations. The basic operators include addition (+), subtraction (-), multiplication (*), and division (/). Additional operators include floor division (//) which returns the integer portion of division, modulo (%) which returns the remainder, and exponentiation (**) which raises a number to a power.

Comparison operators evaluate relationships between values and return boolean results. These operators include equal to (==), not equal to (!=), greater than (>), less than (<), greater than or equal to (>=), and less than or equal to (<=). Comparison operations are essential for conditional logic in healthcare applications such as dose range checking.

Logical operators combine boolean conditions. The "and" operator returns true only when both conditions are true. The "or" operator returns true when either condition is true. The "not" operator reverses the logical value. These operators enable complex decision-making logic in programs.

Assignment operators assign values to variables. The basic assignment operator (=) stores a value in a variable. Compound assignment operators combine assignment with arithmetic operations, such as "+=" which adds and assigns in a single operation.

## 1.11 Input and Output Operations

Input and output operations enable programs to interact with users and external data sources. The print() function displays output to the console, allowing programs to communicate results to users. Output formatting enables clear presentation of pharmaceutical data.

The input() function requests data from users during program execution. When input() is called, program execution pauses until the user enters data and presses Enter. The entered data is returned as a string value. Healthcare applications frequently use input operations for patient data entry in pharmacy management systems.

Formatted output presents data in organized, readable formats. The format() method and f-strings (formatted string literals) enable precise control over how numerical and text data appears in output. Properly

formatted output is essential for generating clinical reports and documentation.

File input and output operations allow programs to read data from files and write results to files. Healthcare applications often need to read patient records from files, process the data, and write results to output files for storage or transmission.

**Example Code:**

python

```
# Patient Registration System Example

patient_name = input("Enter patient name: ")

age = int(input("Enter patient age: "))

weight = float(input("Enter weight (kg): "))

print(f"Patient: {patient_name}, Age: {age}, Weight: {weight} kg")
```

## 1.12 Standard and Third-Party Libraries

Python's standard library provides extensive functionality without requiring additional installations. The library includes modules for

mathematical operations (math), date and time handling (datetime), file operations (os, shutil), and many other common programming tasks. Healthcare applications frequently use datetime for scheduling and timestamping patient activities.

Third-party libraries extend Python's capabilities beyond the standard library. These libraries are developed and maintained by the Python community and are available through the Python Package Index (PyPI). Package managers such as pip install third-party libraries and manage their dependencies.

NumPy provides fundamental numerical computing capabilities including efficient array operations and mathematical functions. Pandas builds upon NumPy to offer data manipulation and analysis tools particularly suited for tabular data. Matplotlib enables data visualization through various chart types. These three libraries form the core of scientific computing in Python.

Installing third-party libraries is straightforward using pip, Python's package installer. The command "pip install package_name" downloads and installs the specified package. Healthcare students should install

NumPy, Pandas, and Matplotlib as foundational tools for their coursework.

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## Chapter 1 Summary

Python programming offers valuable skills for pharmaceutical and healthcare professionals. This chapter introduced fundamental concepts including programming basics, Python history and features, variable and data type concepts, operators, and input/output operations. The healthcare examples demonstrated practical applications in patient registration and pharmacy management contexts.

**Key Points:**

- Python is a high-level, interpreted programming language designed for readability and productivity
- Variables store data values using meaningful names following Python naming conventions
- Fundamental data types include integers, floating-point numbers, strings, and booleans

- Operators perform arithmetic, comparison, and logical operations on data
- Input/output operations enable user interaction and data display
- IDEs such as Jupyter Notebook, PyCharm, and VS Code support Python development
- Third-party libraries extend Python for specialized healthcare applications

# Chapter 1 Review Questions

## Multiple Choice Questions:

1.Which feature of Python makes it particularly suitable for beginners?

a) Complex syntax

b) Readable and simple syntax

c) Requires compilation

d) Uses pointers extensively

2.What is the correct data type for a patient's body temperature

(37.5°C)?

a) Integer

b) String

c) Float

d) Boolean

3.Which operator checks if two values are equal?

a) =

b) ==

c) !=

d) >=

4.Which library is commonly used for data manipulation in Python?

a) NumPy only

b) Pandas

c) Matplotlib

d) Os

5.What does the input() function return?

a) Integer

b) Float

c) String

d) Boolean

**Viva Questions:**

1.Explain the differences between high-level and low-level programming languages.

2.Why is Python considered suitable for healthcare data analysis?

3.Describe the purpose of variables in programming with healthcare examples.

4.Explain type casting and its importance in pharmaceutical applications.

5.Discuss the role of libraries in extending Python's capabilities.

**Practical Exercises:**

1.Write a Python script to calculate the Body Mass Index (BMI) given height in meters and weight in kilograms.

2.Create a program that accepts a drug name, dosage, and unit, then displays this information in a formatted output.

3.Write a script to convert temperature from Fahrenheit to Celsius, commonly used in pharmaceutical stability testing.

# CHAPTER 2: CONTROL STRUCTURES AND FUNCTIONS

## 2.1 Introduction to Control Structures

Control structures determine the flow of program execution. By default, Python executes statements sequentially, meaning each statement runs after the previous one completes. However, programs frequently need to deviate from sequential execution based on certain conditions or repeat operations multiple times. Control structures provide this capability through conditional branching and loops.

The ability to make decisions based on conditions is fundamental to programming. Healthcare applications require decision-making logic constantly. A pharmacy system might need to check whether a prescribed dose falls within safe limits, whether a patient meets certain criteria for a medication, or whether drug interactions exist between prescribed medications.

Loop structures enable programs to repeat operations efficiently. Instead of writing the same code multiple times, programmers can define a loop that executes a block of code repeatedly. This capability is essential for

processing multiple patient records, calculating statistics across datasets, or performing repeated calculations in pharmacokinetic analysis.

Understanding control structures is essential for developing functional healthcare software. From simple dosage verification to complex clinical decision support systems, control structures provide the logical foundation for programmatic decision-making in pharmacy applications.

## 2.2 Conditional Statements

Conditional statements execute different code blocks based on specified conditions. The if statement represents the simplest form of conditional execution, executing a code block only when a condition evaluates to true. This basic structure forms the foundation of decision-making in Python programs.

The syntax of an if statement involves the if keyword followed by a condition and a colon. The code block to execute when the condition is true appears indented below the if statement. In pharmacy applications, this structure might check whether a patient's age exceeds a minimum threshold for a particular medication.

The else clause provides an alternative code block that executes when the if condition is false. This structure enables programs to handle both positive and negative cases of a condition. A pharmacy system might display one message when a drug is in stock and a different message when it is not.

The elif clause, short for "else if," allows checking multiple conditions in sequence. When the first condition is false, the program evaluates the elif condition. This chain can continue with multiple elif statements, each checked in order until a true condition is found or the else clause is reached.

**Example Code:**

python

```
# Dosage Verification

dose = 500

max_dose = 1000

min_dose = 100
```

```
if dose > max_dose:
    print("Warning: Dose exceeds maximum safe limit")
elif dose < min_dose:
    print("Warning: Dose below minimum effective level")
else:
    print("Dose is within acceptable range")
```

## 2.3 Decision-Making in Healthcare Programming

Healthcare applications require sophisticated decision-making logic that accounts for various clinical factors. Programming decisions in pharmacy contexts must consider dosage ranges, patient characteristics, drug interactions, contraindications, and regulatory requirements.

Dose-range checking represents a fundamental decision-making requirement in pharmacy systems. Programs must verify that prescribed doses fall between minimum effective doses and maximum safe doses. These thresholds vary by drug and patient characteristics, requiring flexible conditional logic that adapts to specific clinical scenarios.

Age-based prescribing represents another common decision-making pattern. Certain medications have age-specific dosing guidelines or may be contraindicated in particular age groups. Pharmacy systems can use conditional logic to flag prescriptions that require additional review based on patient age.

Weight-based dosing calculations require both decision-making and mathematical operations. Many pediatric medications and some adult medications are dosed based on patient weight. Programs must determine whether weight-based dosing is required, calculate the appropriate dose, and verify the calculated dose falls within acceptable limits.

Renal and hepatic function may affect drug dosing and eligibility. Healthcare systems often incorporate decision logic that adjusts dosing recommendations or flags contraindications based on organ function indicators. These decisions require careful conditional logic that considers multiple clinical parameters.

## 2.4 Nested Conditions

Nested conditions involve placing conditional statements within other conditional statements. This nesting enables complex decision trees where one decision depends on the outcome of another. While nested conditions are powerful, excessive nesting can make code difficult to read and maintain.

In pharmacy contexts, nested conditions might evaluate multiple criteria in sequence. A program might first check whether a patient is allergic to a drug class, and if not, then check whether the patient has contraindications, and if those are clear, then verify the dose is appropriate. Each level of nesting adds another dimension to the decision logic.

Medical eligibility determination frequently requires nested conditional logic. Insurance coverage decisions might depend on diagnosis codes, treatment history, and patient demographics. Pharmacy benefit systems use nested conditions to determine coverage, patient responsibility, and prior authorization requirements.

However, programmers should use nesting judiciously. Deeply nested code becomes difficult to understand and debug. Alternative approaches such as combining conditions with logical operators or refactoring into

separate functions can often simplify complex decision logic while maintaining the same functionality.

## 2.5 For Loops

For loops iterate over sequences of items, executing a code block for each item in the sequence. Python's for loop is particularly flexible, able to iterate over lists, strings, ranges, and other iterable objects. This flexibility makes for loops versatile tools for processing collections of healthcare data.

The range() function generates sequences of numbers commonly used with for loops. range(start, stop) generates numbers from start to stop-1, while range(stop) generates numbers from 0 to stop-1. range(start, stop, step) generates numbers with a specified increment. These variations support various iteration patterns.

Processing multiple patient records efficiently demonstrates the practical value of loops. Instead of writing separate code for each patient, a for loop can process each record in a patient database systematically. This

approach is scalable and maintainable, as the same loop logic handles any number of records.

**Example Code:**

python

```
# Processing Patient Records

patient_ids = ["P001", "P002", "P003", "P004", "P005"]



for patient_id in patient_ids:

    print(f"Processing record for patient: {patient_id}")



# Using range for numerical iteration

for i in range(1, 6):

    print(f"Processing dosage record {i}")
```

## 2.6 While Loops

While loops execute repeatedly as long as a condition remains true. Unlike for loops that iterate over known sequences, while loops continue based on dynamic conditions that may change during loop execution. This makes while loops suitable for scenarios where the number of iterations is not predetermined.

Healthcare monitoring applications often use while loops for continuous monitoring scenarios. A program might monitor vital signs until values stabilize, until a timeout occurs, or until manual intervention stops the monitoring process. While loops enable this type of indefinite iteration with built-in termination conditions.

Loop control statements modify loop execution behavior. The break statement terminates the loop immediately, transferring control to the code following the loop. The continue statement skips the remaining statements in the current iteration and proceeds to the next iteration.

Infinite loops, where the condition never becomes false, represent a common programming error. Programmers must ensure loop conditions will eventually become false or include break statements that can terminate the loop. Healthcare applications should include timeout mechanisms and safety checks to prevent runaway loops.

**Example Code:**

python

```
# Patient Monitoring Simulation

patient_stable = False

iteration = 0



while not patient_stable:

    iteration += 1

    print(f"Checking patient status - Iteration {iteration}")



    if iteration >= 5:

        print("Patient monitoring completed")

        break
```

## 2.7 Introduction to Functions

Functions represent reusable blocks of code that perform specific tasks. Rather than repeating the same code in multiple places, programmers define functions once and call them as needed throughout the program. This approach reduces code duplication, improves organization, and makes programs easier to maintain.

Functions accept input through parameters and may produce output through return values. Parameters define the data the function expects to receive when called. Return values represent the data the function produces and provides back to the calling code. This input-output interface makes functions flexible and reusable.

Modular programming through functions supports good software design principles. Complex healthcare systems can be broken down into functions that each handle specific tasks. A prescription processing system might include separate functions for dose verification, interaction checking, and inventory management, with a main function coordinating these components.

Functions improve code testing by allowing individual functions to be tested in isolation. When functions are small and focused on single tasks, identifying and fixing errors becomes more straightforward. Healthcare

applications benefit from this reliability, as software errors can have serious consequences.

## 2.8 Function Definition and Parameters

Defining a function requires specifying its name, parameters, and the code it contains. The def keyword begins a function definition, followed by the function name, parameter list in parentheses, and a colon. The function body, containing the code to execute, is indented below the function definition.

Parameter definitions specify the data the function expects to receive. Parameters function as variable names within the function scope, receiving their values from the arguments provided during the function call. Parameters enable functions to operate on different data values each time they are called.

Default parameter values allow functions to be called with fewer arguments. When defining a function, parameters can be assigned default values using the assignment operator. If the calling code does not provide values for these parameters, the defaults are used. This feature adds flexibility to function interfaces.

**Example Code:**

python

```
# BMI Calculation Function

def calculate_bmi(weight_kg, height_m):

    """Calculate Body Mass Index from weight and height"""

    bmi = weight_kg / (height_m ** 2)

    return bmi



def categorize_bmi(bmi, age):

    """Categorize BMI based on value and age"""

    if age < 18:

        return "Pediatric assessment required"

    elif bmi < 18.5:

        return "Underweight"

    elif bmi < 25:

        return "Normal weight"
```

```
    elif bmi < 30:
        return "Overweight"
    else:
        return "Obese"


# Usage
patient_weight = 70  # kilograms
patient_height = 1.75  # meters
patient_bmi = calculate_bmi(patient_weight, patient_height)
category = categorize_bmi(patient_bmi, 30)
print(f"Patient BMI: {patient_bmi:.2f}")
print(f"Category: {category}")
```

## 2.9 Return Values and Scope

Return values provide output from functions to the calling code. The return statement specifies the value to return when the function

completes. Functions may return a single value, multiple values as a tuple, or no value at all (returning None implicitly).

Multiple return values enable functions to provide several pieces of information efficiently. A drug information function might return both the drug name and its therapeutic class. The calling code can receive these values and use them appropriately.

Variable scope determines where variables can be accessed within a program. Variables defined inside a function are local to that function and cannot be accessed from outside. This encapsulation prevents unintended interactions between different parts of a program.

Global variables, defined outside functions, can be accessed from anywhere in the program. However, modifying global variables from within functions can lead to confusion and errors. Healthcare applications should generally avoid global variables, preferring to pass data through function parameters and return values.

## 2.10 Automation Concepts in Pharmacy

Automation in pharmacy involves using software to perform tasks that would otherwise require manual effort. Python's ability to process data, make decisions, and interact with files makes it suitable for automating various pharmacy tasks including inventory management, report generation, and data processing.

Prescription processing workflows can be partially automated using Python. After receiving prescription data, a Python script can verify dosing, check for interactions, update inventory records, and generate dispensing labels. Automation reduces processing time and human error while ensuring consistent application of rules.

Report generation represents a common automation opportunity in pharmacy settings. Daily, weekly, or monthly reports on prescription volumes, inventory levels, or clinical metrics can be generated automatically using Python. Scheduled Python scripts can produce these reports without manual intervention.

Data validation and cleaning benefit from programmatic automation. Healthcare data often contains inconsistencies, missing values, or format variations. Python scripts can identify and correct common data quality issues, preparing data for analysis or reporting.

## Chapter 2 Summary

Control structures and functions form the structural foundation of Python programming. Conditional statements enable programs to make decisions based on conditions. Loops allow efficient repetition of operations. Functions organize code into reusable modules with clear inputs and outputs. These concepts are essential for developing healthcare applications that process patient data, make clinical decisions, and automate pharmacy workflows.

**Key Points:**

- Conditional statements (if, elif, else) enable decision-making based on conditions
- For loops iterate over sequences, while loops continue based on conditions
- Loop control statements (break, continue) modify loop execution behavior
- Functions encapsulate reusable code with parameters and return values

- Nested conditions enable complex decision trees but should be used carefully
- Automation concepts support pharmacy workflow efficiency

# Chapter 2 Review Questions

## Multiple Choice Questions:

1.Which statement is used to check multiple sequential conditions?

a) if only

b) elif

c) for

d) switch

2.What does the break statement do in a loop?

a) Skips current iteration

b) Continues to next iteration

c) Terminates the loop

d) Restarts the loop

3.What is the purpose of parameters in a function?

a) Store permanent data

b) Define input data the function receives

c) Create new variables

d) Return values

4.Which loop is best when the number of iterations is known?

a) While loop

b) For loop

c) Infinite loop

d) Nested loop

5.What does a function return by default if no return statement is present?

a) Zero

b) Empty string

c) None

d) False

**Viva Questions:**

1.Explain the difference between if, elif, and else clauses with a healthcare example.

2.Describe how nested conditions are used in medical eligibility determination.

3.Discuss the importance of functions in healthcare software development.

4.Explain the difference between while and for loops. When would you use each?

5.How can automation improve pharmacy workflow efficiency?

**Practical Exercises:**

1.Write a function that determines whether a patient is eligible for a medication based on age (must be between 18 and 65) and weight (must be above 50 kg).

2.Create a function that categorizes blood pressure readings into normal, elevated, and high categories.

3.Write a program using a loop to calculate and display the total cost of multiple prescribed medications.

# CHAPTER 3: DATA STRUCTURES AND FILE HANDLING

## 3.1 Understanding Data Structures

Data structures organize and store collections of data in ways that enable efficient access and manipulation. Different data structures offer different advantages for particular use cases. Understanding data structures is essential for effectively managing healthcare data, which often includes multiple related pieces of information for each patient, prescription, or clinical event.

The choice of data structure affects program efficiency and maintainability. Some operations are faster with certain data structures while slower with others. Healthcare programmers must select appropriate data structures based on the operations their applications need to perform.

Python provides several built-in data structures including lists, tuples, dictionaries, and sets. Each has distinct characteristics that make it suitable for different purposes. Pharmaceutical applications typically use lists for ordered collections, dictionaries for labeled data, and tuples for fixed collections of related values.

## 3.2 Lists

Lists represent ordered, mutable collections of items. List items are enclosed in square brackets and separated by commas. Lists can contain items of different types, though in practice healthcare applications typically store items of the same type together for consistency.

List indexing accesses individual items by their position. Python uses zero-based indexing, meaning the first item has index 0, the second has index 1, and so on. Negative indices access items from the end of the list, with -1 representing the last item.

Slicing extracts portions of a list using start and end index specifications. list[start:end] returns items from start index up to but not including end index. Slicing is useful for extracting specific portions of patient records or dividing datasets into segments.

**Example Code:**

python

```
# Patient Medication List

medications = ["Metformin", "Lisinopril", "Aspirin", "Atorvastatin"]

print(f"Total medications: {len(medications)}")
```

```
print(f"First medication: {medications[0]}")

print(f"Last medication: {medications[-1]}")


# Adding a new medication

medications.append("Omeprazole")

print(f"Updated list: {medications}")
```

### 3.3 List Operations and Methods

Python lists support various operations for adding, removing, and modifying items. The append() method adds an item to the end of a list. The insert() method adds an item at a specified position. The remove() method removes the first occurrence of a specified value.

The pop() method removes and returns an item at a specified position, or the last item if no position is specified. The clear() method removes all items from a list. These methods enable dynamic list manipulation as programs process healthcare data.

Sorting arranges list items in order. The sort() method sorts lists in place, while the sorted() function returns a new sorted list without modifying the original. Sorting is useful for organizing patient records alphabetically or arranging numerical data in order.

List comprehension provides a concise way to create lists based on existing lists. The syntax [expression for item in iterable if condition] creates a new list by applying an expression to each item that satisfies a condition. List comprehensions can simplify code for filtering and transforming healthcare data.

## 3.4 Tuples

Tuples resemble lists but are immutable, meaning their contents cannot be modified after creation. Tuple items are enclosed in parentheses rather than square brackets. The immutability of tuples makes them suitable for representing fixed collections of related data.

In healthcare contexts, tuples can represent patient data records where certain fields should not change. A patient record tuple might contain

identifier, name, date of birth, and blood type—values that are established once and should remain constant.

Tuple unpacking assigns tuple items to separate variables in a single operation. This feature simplifies extracting multiple values from functions that return tuples. A function returning patient measurements might return a tuple containing multiple values that can be unpacked into individual variables.

The count() method returns the number of occurrences of a specified value in a tuple. The index() method returns the position of the first occurrence. These methods enable searching operations within fixed data collections.

## 3.5 Dictionaries

Dictionaries store data as key-value pairs, providing fast lookup by key rather than by position. Dictionary items are enclosed in curly braces with keys and values separated by colons. Each key must be unique within a dictionary, though values may be duplicated.

Healthcare applications frequently use dictionaries to store patient records where field names serve as keys. A patient dictionary might have keys for "name", "age", "weight", and "conditions", with corresponding values storing the actual data. This labeled structure makes accessing specific fields intuitive.

**Example Code:**

python

```
# Patient Record Dictionary
patient = {
    "id": "P001",
    "name": "John Smith",
    "age": 45,
    "weight_kg": 82.5,
    "conditions": ["Hypertension", "Type 2 Diabetes"]
}


# Accessing dictionary values
```

```
print(f"Patient Name: {patient['name']}")

print(f"Age: {patient['age']} years")


# Adding new information

patient["blood_type"] = "O+"

patient["allergies"] = ["Penicillin"]


print(f"All patient data: {patient}")
```

### 3.6 Dictionary Operations

Dictionary keys provide access to corresponding values using bracket notation. Attempting to access a non-existent key raises a KeyError, so programs should either check for key existence or use the get() method which returns None or a default value if the key is not found.

The update() method merges another dictionary into an existing dictionary, adding new keys or updating existing ones. This method is

useful for consolidating patient information from multiple sources or applying updates to records.

Iteration over dictionaries can access keys, values, or both. The keys(), values(), and items() methods return views of dictionary keys, values, or key-value pairs respectively. Looping over items enables processing all patient record fields systematically.

Dictionary comprehension, similar to list comprehension, creates dictionaries from iterables using a compact syntax. This feature can simplify creating dictionaries from patient data collections.

## 3.7 Introduction to NumPy

NumPy (Numerical Python) is a fundamental library for scientific computing in Python. It provides efficient array operations and mathematical functions that form the foundation for many other scientific libraries. Healthcare applications use NumPy for numerical calculations, statistical analysis, and data processing.

NumPy's core data structure is the array, which stores homogeneous data in a multidimensional format. Arrays offer significant performance

advantages over Python lists for numerical operations because NumPy's underlying implementation uses optimized compiled code.

The np.array() function creates arrays from Python lists. Once created, arrays support mathematical operations that operate element-wise, meaning the operation is applied to each array element individually. This vectorized approach simplifies code and improves performance.

### 3.8 NumPy Arrays and Operations

NumPy arrays can be one-dimensional (vectors), two-dimensional (matrices), or higher-dimensional structures. The shape attribute reports the dimensions of an array. Healthcare data often uses two-dimensional arrays where rows represent observations (patients) and columns represent variables (measurements).

**Example Code:**

python

```
import numpy as np
```

```
# Creating arrays for patient data

dosages = np.array([100, 200, 150, 300, 250])

weights = np.array([60.5, 75.2, 68.0, 82.3, 70.8])



# Element-wise operations

weight_kg = weights

weight_lb = weights * 2.205

print(f"Weight in kg: {weight_kg}")

print(f"Weight in lb: {weight_lb}")



# Statistical calculations

mean_dose = np.mean(dosages)

max_dose = np.max(dosages)

min_dose = np.min(dosages)

print(f"Mean dosage: {mean_dose}")

print(f"Range: {min_dose} to {max_dose}")
```

## 3.9 Arithmetic Operations with NumPy

NumPy supports comprehensive arithmetic operations including addition, subtraction, multiplication, division, and exponentiation. These operations work element-wise when both operands are arrays of the same shape, or broadcast appropriately when shapes differ in specific ways.

Universal functions (ufuncs) provide fast element-wise operations including trigonometric functions, logarithms, and exponentials. These functions operate efficiently on entire arrays, eliminating the need for explicit loops in many cases.

NumPy's mathematical functions include sum(), mean(), std() (standard deviation), var() (variance), min(), max(), and numerous others. These aggregate functions are essential for calculating statistics across patient populations or experimental datasets.

Array reshaping transforms arrays between different dimensional configurations. A one-dimensional array of 12 elements can be reshaped into a 3x4 two-dimensional array. This flexibility supports various data organization patterns in healthcare applications.

## 3.10 File Handling in Python

File handling enables programs to read data from files and write results to files for persistent storage. Healthcare applications frequently need to process patient records stored in files, load configuration data, and export reports. Python's file handling capabilities support these requirements.

The open() function opens a file and returns a file object. The first argument specifies the file path, while the second argument specifies the mode: 'r' for reading, 'w' for writing (overwriting existing content), 'a' for appending, and 'rb' or 'wb' for binary modes.

Reading from files can be done using read(), readline(), or readlines() methods. The read() method reads the entire file content as a string, readline() reads a single line, and readlines() returns a list of all lines. For large files, reading line by line is often more memory-efficient.

Writing to files uses the write() method for strings or writelines() for lists of strings. Programs should close files after use to ensure all data is properly saved and system resources are released. The with statement provides automatic file closing, ensuring proper cleanup even if errors occur.

## 3.11 Healthcare Dataset Structures

Healthcare datasets typically organize patient information in tabular formats with rows representing individual patients or records and columns representing variables. Each column contains a specific type of information such as patient identifier, diagnosis code, medication, or measurement value.

Pharmacokinetic studies generate datasets with time-series measurements of drug concentrations. These datasets typically include columns for patient identifier, time point, concentration measurement, and dosing information. Analyzing such data requires understanding both the data structure and the clinical context.

Adverse drug reaction reports contain structured information including patient demographics, drug information, reaction descriptions, and outcome data. This information is often organized in standardized formats that facilitate analysis and regulatory reporting.

Prescription records include information about prescriber, patient, medication, dosage, and dispensing details. These records support

inventory management, regulatory compliance, and clinical research activities.

**Example Code:**

python

```
# Simple Patient Data Storage

patient_records = [

    {"id": "P001", "name": "Alice Johnson", "medication": "Metformin", "dosage": 500},

    {"id": "P002", "name": "Bob Williams", "medication": "Lisinopril", "dosage": 10},

    {"id": "P003", "name": "Carol Davis", "medication": "Aspirin", "dosage": 75}

]



# Writing patient records to file

with open("patient_data.txt", "w") as file:

    for patient in patient_records:
```

```
    line =
f"{patient['id']},{patient['name']},{patient['medication']},{patient['dosag
e']}\n"
    file.write(line)

print("Patient records saved to file")
```

### 3.12 CSV File Handling

CSV (Comma-Separated Values) files represent tabular data in text format where values are separated by commas. CSV is a standard format for healthcare data exchange, recognized by spreadsheet applications, databases, and analytical software. Python's csv module provides functions for reading and writing CSV files.

The csv.reader() function creates a reader object that iterates over rows in a CSV file. Each row is returned as a list of values. The csv.writer() function creates a writer object for creating CSV files.

Reading CSV files typically involves opening the file, creating a reader, and processing each row. For healthcare applications, each row might

represent a patient record, prescription, or laboratory result. Processing involves parsing values, validating data, and performing required calculations or transformations.

Writing CSV files requires organizing data into rows that will be written to the file. Headers should be written first to label each column, followed by data rows. Proper CSV formatting ensures compatibility with other healthcare systems and analytical tools.

---

## Chapter 3 Summary

Data structures and file handling provide essential capabilities for managing healthcare information. Lists and dictionaries organize data in ways that support efficient access and manipulation. NumPy arrays enable efficient numerical computation for statistical analysis. File handling allows persistent storage of patient records and healthcare data. Understanding these concepts prepares students for data management tasks in pharmaceutical and clinical settings.

**Key Points:**

- Lists store ordered, mutable collections; tuples store ordered, immutable collections
- Dictionaries store key-value pairs enabling fast lookup by label
- NumPy provides efficient array operations and mathematical functions
- File handling enables persistent storage and retrieval of healthcare data
- CSV files provide a standard format for healthcare data exchange

# Chapter 3 Review Questions

## Multiple Choice Questions:

1.Which data structure uses key-value pairs for data storage?

a) List

b) Tuple

c) Dictionary

d) Set

2.What is the index of the first element in a Python list?

a) 1

b) 0

c) -1

d) First

3.What makes NumPy arrays efficient for numerical operations?

a) They use Python lists

b) They use optimized compiled code

c) They store strings

d) They are immutable

4.Which file mode should be used to read an existing file?

a) 'w'

b) 'a'

c) 'r'

d) 'rb'

5.What does tuple immutability mean?

a) Can grow and shrink

b) Cannot be modified after creation

c) Contains only numbers

d) Is always sorted

**Viva Questions:**

1.Explain when you would use a list versus a dictionary for storing patient data.

2.Describe the advantages of NumPy arrays over Python lists for numerical computation.

3.How does CSV format support healthcare data exchange?

4.Explain the concept of list indexing and slicing with examples.

5.Discuss the importance of file handling in pharmacy management systems.

**Practical Exercises:**

1.Create a dictionary to store and display information for five patients including ID, name, age, and blood type.

2.Use NumPy to calculate the mean, standard deviation, and range of a list of drug concentrations [2.5, 3.0, 2.8, 3.5, 2.9, 3.2].

3.Write a Python script to read patient data from a CSV file and display the total number of records.

# CHAPTER 4: DATA HANDLING WITH PANDAS

## 4.1 Introduction to Pandas

Pandas is a powerful library built on NumPy that provides high-level data manipulation and analysis capabilities. The name "Pandas" derives from "panel data," reflecting its origin in econometric applications involving multidimensional data structures. Today, Pandas is a standard tool for data analysis across many domains including healthcare and pharmaceutical sciences.

Pandas introduces two primary data structures: Series and DataFrame. Series represents a one-dimensional labeled array, similar to a column in a spreadsheet. DataFrame represents a two-dimensional labeled data structure with rows and columns, similar to an entire spreadsheet or database table. These abstractions align well with healthcare data organization patterns.

The library excels at handling data that comes from various sources including CSV files, Excel spreadsheets, databases, and web APIs. Pandas provides functions to read data from these sources, process and analyze

the data, and export results in various formats. This end-to-end capability makes Pandas particularly valuable for healthcare data workflows.

## 4.2 Series and DataFrames

Series objects store one-dimensional data with associated labels called the index. When creating a Series from a list or array, an integer index is automatically generated. However, custom indexes can be specified to label data points meaningfully. For time-series healthcare data, dates often serve as meaningful indexes.

**Example Code:**

python

```
import pandas as pd


# Creating a Series for patient temperatures
temperatures = pd.Series([37.2, 37.5, 38.1, 36.9, 37.0],
                         index=['Mon', 'Tue', 'Wed', 'Thu', 'Fri'])
print(temperatures)
```

```
print(f"Mean temperature: {temperatures.mean():.2f}")
```

DataFrame objects store two-dimensional data with both row and column labels. Each column in a DataFrame is essentially a Series, sharing the same index. This columnar structure enables operations on individual variables while maintaining alignment across the entire dataset.

Creating DataFrames can be done from dictionaries, where keys become column names and values become column data. Lists of dictionaries, arrays, or other DataFrames can also create new DataFrames. For healthcare applications, dictionaries naturally map to patient records with named fields.

## 4.3 Reading CSV and Excel Files

Pandas provides the read_csv() function for reading comma-separated values files. This function automatically parses the file, identifies headers, infers data types, and handles various formatting variations. For healthcare datasets stored in CSV format, read_csv() offers a quick way to load data into DataFrames.

The read_excel() function reads data from Excel spreadsheet files (.xlsx format). This capability is valuable because Excel is commonly used for data collection and sharing in healthcare settings. Multiple sheets within an Excel workbook can be accessed using the sheet_name parameter.

**Example Code:**

python

```
import pandas as pd


# Reading a CSV file containing patient data
# df = pd.read_csv("patient_records.csv")


# For demonstration, creating sample data
data = {
    'patient_id': ['P001', 'P002', 'P003', 'P004', 'P005'],
    'age': [45, 62, 38, 55, 71],
    'weight_kg': [72.5, 85.3, 68.0, 79.8, 90.2],
```

```
    'blood_pressure': ['130/85', '145/92', '118/75', '135/88', '158/98']
}


df = pd.DataFrame(data)
print(df)
print(f"\nDataset shape: {df.shape}")
```

4.4 Dataset Inspection

After loading data, initial inspection helps understand the dataset's structure and content. The head() method displays the first few rows, providing a preview of the data. The tail() method shows the last few rows. These methods are useful for quickly verifying data loading and understanding data organization.

The info() method provides a summary of the DataFrame including the number of rows and columns, column names and data types, and memory usage. This overview helps identify data type issues or missing values that may require attention.

The describe() method generates descriptive statistics for numerical columns including count, mean, standard deviation, minimum, maximum, and quartile values. For healthcare data, these statistics provide initial insights into patient populations or measurement distributions.

The columns attribute returns the column names. The dtypes attribute returns data types for each column. The shape attribute returns the dimensions as a tuple (rows, columns). These attributes provide quick access to structural information about the dataset.

## 4.5 Data Cleaning

Data cleaning addresses quality issues that could affect analysis accuracy. Missing values represent a common data quality problem in healthcare datasets. The isnull() method identifies missing values, returning a boolean DataFrame indicating which cells contain missing data.

Handling missing values requires decisions based on the context. The dropna() method removes rows or columns containing missing values. The fillna() method replaces missing values with specified values such as zero, the mean, or forward-filled values from previous observations.

**Example Code:**

python

```
import pandas as pd

import numpy as np


# Sample data with missing values

data = {

    'patient_id': ['P001', 'P002', 'P003', 'P004', 'P005'],

    'age': [45, 62, np.nan, 55, 71],

    'dosage_mg': [100, 200, 150, np.nan, 250]

}


df = pd.DataFrame(data)

print("Original data:")

print(df)
```

```
print("\nMissing values per column:")

print(df.isnull().sum())


# Filling missing values with column means

df_filled = df.fillna(df.mean())

print("\nAfter filling missing values:")

print(df_filled)
```

Duplicate records represent another data quality concern. The duplicated() method identifies duplicate rows. The drop_duplicates() method removes duplicate rows, keeping either the first or last occurrence of each unique record.

## 4.6 Data Filtering

Data filtering selects subsets of data based on specified conditions. Boolean indexing uses conditions to create masks that identify rows meeting specific criteria. These masks can be combined using logical

operators (& for AND, | for OR, ~ for NOT) to create complex selection conditions.

Filtering patient records based on clinical criteria is a common operation in healthcare data analysis. Examples include selecting patients within a certain age range, identifying those taking specific medications, or filtering records with certain diagnosis codes.

The query() method provides an alternative syntax for filtering using string expressions. This method can make complex filtering conditions more readable. The loc[] and iloc[] indexers provide precise control over row and column selection.

**Example Code:**

python

```
import pandas as pd


# Patient data
data = {
    'patient_id': ['P001', 'P002', 'P003', 'P004', 'P005'],
```

```
    'age': [45, 62, 38, 55, 71],
    'dosage_mg': [100, 200, 150, 300, 250],
    'department': ['Cardiology', 'General', 'Cardiology', 'ICU', 'General']
}

df = pd.DataFrame(data)

# Filter patients over 50 years old
elderly = df[df['age'] > 50]
print("Patients over 50:")
print(elderly)

# Filter cardiology patients with dosage above 100
cardiology_high = df[(df['department'] == 'Cardiology') & (df['dosage_mg'] > 100)]
print("\nCardiology patients with high dosage:")
```

```
print(cardiology_high)
```

## 4.7 Grouping and Aggregation

Grouping combines data based on categorical variables, enabling aggregate calculations within groups. The groupby() method creates group objects that can then have aggregation functions applied. Common aggregations include sum, mean, count, min, and max.

In pharmacovigilance analysis, grouping adverse event reports by drug name enables calculation of event frequencies per medication. In clinical research, grouping patients by treatment arm enables comparison of outcomes between groups.

The agg() method applies multiple aggregation functions simultaneously, providing comprehensive summaries. Named aggregation using the agg dictionary allows different functions for different columns. These capabilities support sophisticated analytical requirements.

**Example Code:**

python

```
import pandas as pd
```

```
# Prescription data
data = {
    'medication': ['Metformin', 'Metformin', 'Lisinopril', 'Lisinopril', 'Aspirin', 'Aspirin'],
    'month': ['Jan', 'Feb', 'Jan', 'Feb', 'Jan', 'Feb'],
    'prescriptions': [150, 165, 120, 135, 200, 210],
    'revenue': [1500, 1650, 1200, 1350, 1000, 1050]
}

df = pd.DataFrame(data)

# Group by medication
print("Prescription summary by medication:")
summary = df.groupby('medication').agg({
    'prescriptions': 'sum',
```

```
    'revenue': 'mean'
})
print(summary)


# Group by multiple columns
print("\nMonthly summary:")
monthly = df.groupby(['month', 'medication'])['prescriptions'].sum()
print(monthly)
```

## 4.8 Pharmacokinetic Data Analysis

Pharmacokinetic (PK) studies analyze how drugs move through the body, including absorption, distribution, metabolism, and elimination. PK data typically includes drug concentration measurements at various time points following administration. Pandas facilitates organization and analysis of this time-series data.

Concentration-time data can be loaded into DataFrames with columns for patient ID, time point, concentration, and dosing information. Filtering

by patient enables individual PK profile analysis. Grouping by time point across patients enables population-level analysis.

Area Under the Curve (AUC) calculations, fundamental to bioavailability assessment, can be performed using Pandas operations. The trapezoidal rule approximates AUC from concentration-time data. Comparing AUC values between formulations or administration routes supports bioequivalence determinations.

Maximum concentration (Cmax) and time to maximum concentration (Tmax) are key PK parameters that can be extracted from concentration-time data using Pandas' max() and idxmax() methods. These parameters characterize drug absorption profiles.

## 4.9 Adverse Drug Reaction Analysis

Pharmacovigilance relies on systematic collection and analysis of adverse drug reaction (ADR) reports. ADR datasets typically include patient demographics, suspected drugs, adverse events, outcomes, and report sources. Pandas enables efficient analysis of these reports to identify safety signals.

Grouping ADR reports by drug enables calculation of event frequencies. Sorting by frequency identifies drugs with the most reported events. Filtering for serious events focuses attention on the most concerning safety issues.

**Example Code:**

python

```
import pandas as pd


# ADR Report Data
adr_data = {
    'report_id': ['A001', 'A002', 'A003', 'A004', 'A005', 'A006'],
    'drug': ['DrugA', 'DrugA', 'DrugB', 'DrugB', 'DrugB', 'DrugC'],
    'reaction': ['Nausea', 'Headache', 'Rash', 'Dizziness', 'Nausea', 'Headache'],
    'severity': ['Mild', 'Moderate', 'Mild', 'Severe', 'Moderate', 'Mild']
}
```

```
adr_df = pd.DataFrame(adr_data)


# Count reports per drug

print("ADR reports per drug:")

drug_counts = adr_df['drug'].value_counts()

print(drug_counts)


# Filter for severe reactions

severe = adr_df[adr_df['severity'] == 'Severe']

print("\nSevere adverse reactions:")

print(severe)


# Cross-tabulation of drugs and reactions

print("\nDrug-Reaction matrix:")

cross_tab = pd.crosstab(adr_df['drug'], adr_df['reaction'])

print(cross_tab)
```

## 4.10 Clinical Data Interpretation

Clinical data interpretation requires understanding both statistical measures and clinical significance. Pandas calculations provide numerical summaries, but interpreting these summaries in clinical context requires domain knowledge. Statistical significance does not always imply clinical importance.

Descriptive statistics for patient populations support clinical interpretation. Age distributions, gender proportions, and comorbidity patterns characterize the population being studied. These population characteristics influence expected outcomes and limit generalizability.

Comparative analyses between treatment groups require appropriate statistical methods beyond basic Pandas functionality. However, Pandas can prepare data for statistical testing, calculate summary statistics by group, and format results for presentation. Integration with statistical libraries extends Pandas' analytical capabilities.

---

## Chapter 4 Summary

Pandas provides comprehensive capabilities for healthcare data manipulation and analysis. Series and DataFrame structures align with healthcare data organization patterns. Data cleaning addresses common quality issues. Filtering enables selection of relevant subsets. Grouping and aggregation support summary calculations. These capabilities are essential for pharmacovigilance, pharmacokinetics, and clinical data analysis in pharmaceutical settings.

**Key Points:**

- Pandas Series stores one-dimensional labeled data; DataFrame stores two-dimensional labeled data
- read_csv() and read_excel() functions load data from common file formats
- Data cleaning handles missing values and duplicates
- Boolean filtering selects data subsets based on conditions
- groupby() enables aggregate calculations within categories

# Chapter 4 Review Questions

## Multiple Choice Questions:

1.What is the primary two-dimensional data structure in Pandas?

a) Series

b) Array

c) DataFrame

d) Matrix

2.Which method identifies missing values in a DataFrame?

a) isempty()

b) missing()

c) isnull()

d) hasna()

3.What does the groupby() method create?

a) A new DataFrame

b) A GroupBy object

c) A Series

d) A list

4.Which function reads data from CSV files?

a) read.excel()

b) read.csv()

c) read_csv()

d) load_csv()

5.What does the describe() method return for numerical columns?

a) Data types

b) Column names

c) Descriptive statistics

d) Missing values

**Viva Questions:**

1.Explain the difference between Pandas Series and DataFrame structures.

2.Describe strategies for handling missing data in healthcare datasets.

3.How can filtering operations support pharmacovigilance analysis?

4.Explain how grouping enables aggregate calculations in patient data.

5.Discuss the role of Pandas in pharmacokinetic data analysis.

**Practical Exercises:**

1.Load a CSV file containing patient data and display the first ten rows along with basic statistics.

2.Filter a patient dataset to find all patients above a specified age threshold with specific medication.

3.Create a summary showing the count and average dosage of medications grouped by department.

# CHAPTER 5: DATA VISUALIZATION WITH MATPLOTLIB

## 5.1 Introduction to Data Visualization

Data visualization represents information graphically to facilitate understanding, interpretation, and communication. Visual representations of data often reveal patterns, trends, and relationships that might not be apparent in raw numerical data. In pharmaceutical and healthcare contexts, effective visualization is essential for data analysis, research communication, and clinical decision-making.

The importance of visualization extends beyond analysis to include regulatory compliance and scientific publication. Regulatory agencies require graphical presentations of clinical trial data. Scientific journals expect publication-quality figures. Healthcare professionals communicate findings through dashboards and visual reports.

Python's Matplotlib library provides comprehensive visualization capabilities that support these requirements. Matplotlib can produce a wide variety of plots including line plots, scatter plots, bar charts, histograms, and box plots. Customization options enable precise control over appearance and formatting.

## 5.2 Importance of Visualization in Pharmaceutical Sciences

Pharmaceutical sciences rely heavily on graphical analysis across drug development stages. Preclinical studies use concentration-time plots to characterize pharmacokinetics. Clinical trials use various plots to present safety and efficacy results. Formulation scientists use dissolution profiles and stability data visualizations.

Drug release patterns from various formulations are compared visually using release profiles. Regulatory guidelines often specify graphical presentation formats for these comparisons. Proper visualization supports both development decisions and regulatory submissions.

Pharmacodynamic relationships between drug concentrations and effects are often presented graphically. Dose-response curves characterize drug potency and efficacy. These visualizations inform dosing recommendations and therapeutic monitoring.

Quality control in pharmaceutical manufacturing uses control charts and other statistical process control visualizations. These tools identify processes that may be drifting out of specification, enabling timely corrective actions.

## 5.3 Introduction to Matplotlib

Matplotlib is a comprehensive 2D plotting library that produces publication-quality figures. The library follows the MATLAB plotting model, providing familiar commands for those with MATLAB experience while offering Python's programming advantages.

The pyplot module within Matplotlib provides a procedural interface for creating figures and plots. Functions in pyplot create figures, define plots, set properties, and display results. This stateful interface simplifies common plotting tasks.

Creating basic plots involves importing matplotlib.pyplot, preparing data, calling a plotting function (such as plot(), scatter(), or bar()), and optionally customizing appearance. The show() function displays the completed figure. In Jupyter environments, figures display automatically without explicit show() calls.

**Example Code:**

python

```
import matplotlib.pyplot as plt

import numpy as np
```

```
# Simple line plot

x = np.array([0, 1, 2, 3, 4, 5])

y = np.array([0, 2, 4, 6, 8, 10])


plt.figure(figsize=(8, 5))

plt.plot(x, y)

plt.xlabel('Time (hours)')

plt.ylabel('Concentration (mg/L)')

plt.title('Drug Concentration Over Time')

plt.grid(True)

plt.show()
```

## 5.4 Line Plots

Line plots connect data points with straight lines, making them ideal for showing trends over time or continuous variables. Healthcare applications

include displaying concentration-time profiles, vital sign trends, and laboratory value progressions.

Multiple data series can be plotted on the same axes for comparison. Different line styles, colors, and markers distinguish series visually. Legends identify each series. This capability supports comparison between treatment groups or formulation types.

The plot() function accepts parameters for line style (linestyle), line width (linewidth), marker style (marker), marker size (markersize), and color (color). These parameters enable customization to meet publication standards or organizational style guidelines.

**Example Code:**

python

```
import matplotlib.pyplot as plt
import numpy as np


# Concentration-time profiles for two formulations
time = np.array([0, 1, 2, 4, 6, 8, 12])
```

```
# Formulation A (oral)

conc_a = np.array([0, 2.5, 4.2, 5.8, 4.1, 2.3, 0.8])


# Formulation B (enhanced absorption)

conc_b = np.array([0, 3.8, 6.2, 7.5, 5.2, 3.0, 1.2])


plt.figure(figsize=(10, 6))

plt.plot(time, conc_a, 'b-o', label='Formulation A', linewidth=2)

plt.plot(time, conc_b, 'r-s', label='Formulation B', linewidth=2)

plt.xlabel('Time (hours)', fontsize=12)

plt.ylabel('Concentration (mg/L)', fontsize=12)

plt.title('Pharmacokinetic Comparison: Formulation A vs B', fontsize=14)

plt.legend(fontsize=10)

plt.grid(True, alpha=0.3)

plt.show()
```

## 5.5 Histograms

Histograms display the distribution of numerical data by dividing values into bins and showing the count or frequency in each bin. Histograms reveal data distribution characteristics including central tendency, spread, and shape.

Clinical measurement distributions are often examined using histograms. Patient age distributions, laboratory value distributions, and dosing distributions can all be visualized effectively with histograms. Outliers and unusual patterns become visible in histogram presentations.

The hist() function creates histograms with parameters for number of bins (bins), whether to normalize (density), and visual styling options. Choosing appropriate bin counts requires consideration of sample size and the level of detail needed in the visualization.

**Example Code:**

python

```
import matplotlib.pyplot as plt

import numpy as np
```

```
# Simulated patient age data

np.random.seed(42)

patient_ages = np.random.normal(55, 15, 200)

patient_ages = np.clip(patient_ages, 18, 90)  # Reasonable age limits



plt.figure(figsize=(10, 6))

plt.hist(patient_ages, bins=15, edgecolor='black', alpha=0.7)

plt.xlabel('Age (years)', fontsize=12)

plt.ylabel('Number of Patients', fontsize=12)

plt.title('Distribution of Patient Ages', fontsize=14)

plt.axvline(x=np.mean(patient_ages), color='red', linestyle='--',

        label=f'Mean: {np.mean(patient_ages):.1f}')

plt.legend()

plt.grid(True, alpha=0.3)

plt.show()
```

## 5.6 Scatter Plots

Scatter plots display the relationship between two numerical variables as points in a two-dimensional space. Each point represents one observation with its position determined by the values of the two variables. Scatter plots reveal correlations, clusters, and outliers.

Pharmacokinetic data analysis uses scatter plots to examine concentration-response relationships. The relationship between drug dose and response, or between drug concentration and effect, can be visualized effectively. Separate scatter plots for different groups enable group comparisons.

The scatter() function creates scatter plots with parameters for marker style (marker), marker size (s), and color (c). Color can be varied based on a third variable, creating a three-dimensional effect in two dimensions.

**Example Code:**

python

```
import matplotlib.pyplot as plt

import numpy as np
```

```
# Relationship between weight and dosage requirement

np.random.seed(42)

n_patients = 50

weights = np.random.normal(70, 15, n_patients)

optimal_doses = weights * 1.5 + np.random.normal(0, 10, n_patients)



plt.figure(figsize=(10, 6))

plt.scatter(weights, optimal_doses, alpha=0.6, s=50)

plt.xlabel('Body Weight (kg)', fontsize=12)

plt.ylabel('Optimal Dose (mg)', fontsize=12)

plt.title('Weight vs Optimal Dose Relationship', fontsize=14)

plt.grid(True, alpha=0.3)



# Add trend line

z = np.polyfit(weights, optimal_doses, 1)

p = np.poly1d(z)
```

```
plt.plot(weights, p(weights), 'r--', alpha=0.8, label='Trend line')

plt.legend()

plt.show()
```

## 5.7 Box Plots

Box plots, also called box-and-whisker plots, display data distribution through quartiles. The box represents the interquartile range (IQR) containing the middle 50% of data. The line inside the box marks the median. Whiskers extend to minimum and maximum values within 1.5 times the IQR. Points beyond whiskers represent outliers.

Comparing distributions across groups is a primary application of box plots. Treatment group outcomes, facility performance metrics, and regional variations can all be compared visually using side-by-side box plots. This comparison format supports identification of differences and outliers.

The boxplot() function creates box plots with parameters for notch styling (notch), outlier styling (sym), and orientation (vert). Multiple boxes can be created by passing a list of data arrays.

**Example Code:**

python

```
import matplotlib.pyplot as plt

import numpy as np


# Response times (minutes) for different hospital departments

np.random.seed(42)

emergency = np.random.normal(15, 5, 50)

outpatient = np.random.normal(25, 8, 50)

pharmacy = np.random.normal(8, 3, 50)


plt.figure(figsize=(10, 6))

data = [emergency, outpatient, pharmacy]

labels = ['Emergency', 'Outpatient', 'Pharmacy']


plt.boxplot(data, labels=labels, patch_artist=True)
```

```
plt.ylabel('Response Time (minutes)', fontsize=12)

plt.title('Response Time Distribution by Department', fontsize=14)

plt.grid(True, alpha=0.3, axis='y')

plt.show()
```

## 5.8 Labels, Legends, and Annotations

Clear labeling is essential for interpretable visualizations. Axis labels identify variables and units. Title labels identify the overall figure content. These elements should be descriptive without being excessively long.

Legends identify multiple data series within a plot. The legend() function adds legends with parameters for location (loc) and styling. Legends should be placed where they do not obscure data, typically in corners or outside plot areas.

Annotations add text or arrows to highlight specific features in plots. The annotate() function creates annotations with parameters for text, arrow properties, and positioning. Annotations can identify peaks, valleys, or important data points.

**Example Code:**

python

```
import matplotlib.pyplot as plt

import numpy as np



x = np.linspace(0, 10, 100)

y = np.sin(x)



plt.figure(figsize=(10, 6))

plt.plot(x, y, 'b-', linewidth=2)

plt.xlabel('Time (hours)', fontsize=12)

plt.ylabel('Drug Effect (%)', fontsize=12)

plt.title('Drug Effect Over Time', fontsize=14)

plt.grid(True, alpha=0.3)



# Annotate peak
```

```
peak_x = x[np.argmax(y)]

peak_y = np.max(y)

plt.annotate(f'Peak Effect: {peak_y:.2f}',

        xy=(peak_x, peak_y),

        xytext=(peak_x + 1.5, peak_y + 0.1),

        arrowprops=dict(arrowstyle='->', color='red'),

        fontsize=10, color='red')


plt.show()
```

## 5.9 Scientific Interpretation of Graphs

Interpreting pharmaceutical graphs requires understanding both the visual representation and the underlying scientific context. Concentration-time curves in pharmacokinetics indicate absorption, distribution, and elimination processes. Curve shapes provide qualitative information about drug properties.

AUC (Area Under the Curve) represents total drug exposure over time. Visually, AUC is the area between the concentration-time curve and the x-axis. Larger AUC indicates greater overall exposure. Comparing AUCs between treatments supports bioequivalence assessments.

Cmax (maximum concentration) appears as the highest point on a concentration-time curve. Tmax (time to maximum concentration) indicates when this peak occurs. These parameters characterize absorption rate and extent.

Dissolution profiles show drug release from formulations over time. USP apparatus and testing conditions are standardized. Profile comparison using similarity factors (f2) determines whether formulations are considered similar.

## 5.10 Creating Publication-Quality Figures

Publication-quality figures meet standards for clarity, completeness, and aesthetic presentation. Required elements include clear titles, labeled axes with units, legends when multiple series are present, and appropriate figure captions.

Font sizes should be legible when figures are reduced to publication dimensions. Line widths should be thick enough to remain visible after reduction. Color choices should provide sufficient contrast and should be distinguishable when printed in grayscale.

Figure formats should match journal requirements. Vector formats (PDF, EPS) are preferred for publications as they scale without quality loss. Raster formats (PNG, JPEG) are appropriate for web content or when file size is a concern.

The savefig() function exports figures in various formats with quality control parameters. dpi (dots per inch) controls resolution, and bbox_inches='tight' trims excess white space.

---

## Chapter 5 Summary

Data visualization transforms raw data into interpretable visual representations. Matplotlib provides comprehensive capabilities for creating various plot types including line plots, histograms, scatter plots, and box plots. Effective visualization is essential for pharmaceutical research, clinical data analysis, and regulatory communication.

Understanding both the technical implementation and scientific interpretation of visualizations prepares students for pharmaceutical data analysis roles.

**Key Points:**

- Line plots show trends over time; histograms show distributions
- Scatter plots reveal relationships between variables
- Box plots compare distributions across groups
- Clear labels, legends, and annotations enhance interpretability
- Publication-quality figures meet specific technical standards

# Chapter 5 Review Questions

## Multiple Choice Questions:

1.Which plot type is best for showing trends over time?

a) Histogram

b) Scatter plot

c) Line plot

d) Box plot

2.What does a box in a box plot represent?

a) Mean value

b) Interquartile range

c) Outliers

d) Whisker range

3.Which Matplotlib function creates scatter plots?

a) plot()

b) bar()

c) scatter()

d) hist()

4.What does AUC represent in pharmacokinetic curves?

a) Maximum concentration

b) Total drug exposure

c) Time to peak

d) Elimination rate

5.What format is preferred for publication-quality figures?

a) JPEG

b) PNG

c) PDF

d) GIF

**Viva Questions:**

1.Explain when you would use a histogram versus a box plot for analyzing patient data.

2.Describe the key parameters (AUC, Cmax, Tmax) derived from concentration-time curves.

3.What makes a figure suitable for publication in scientific journals?

4.How do scatter plots support pharmacokinetic data interpretation?

5.Discuss the importance of visualization in regulatory submissions.

**Practical Exercises:**

1.Create a line plot showing drug concentration over 24 hours with appropriate labels and title.

2.Generate a histogram of simulated blood pressure readings and interpret the distribution.

3.Create a box plot comparing response times across three different pharmacy locations.

# CHAPTER 6: FUTURE PERSPECTIVES AND CAREER OPPORTUNITIES

## 6.1 The Future of Python in Pharmacy

The role of programming and data science in pharmaceutical sciences continues to expand rapidly. Python's position as a leading language for data analysis, machine learning, and automation suggests its importance will continue growing in healthcare and pharmacy settings.

Digital transformation in healthcare creates increasing demand for professionals who understand both clinical domain knowledge and computational skills. Pharmacy graduates with programming abilities will be better positioned for emerging roles that combine these competencies.

Clinical decision support systems, personalized medicine applications, and telehealth platforms all require software development and data analysis capabilities. Python's versatility makes it suitable for developing and maintaining these systems.

## 6.2 Artificial Intelligence in Healthcare

Artificial intelligence (AI) and machine learning applications are transforming healthcare delivery and pharmaceutical development. Python serves as the primary language for most machine learning frameworks including TensorFlow, PyTorch, and scikit-learn.

AI applications in pharmacy include drug discovery, where machine learning models predict molecular properties and identify candidate compounds. Clinical decision support uses AI to assist with diagnosis, treatment recommendations, and risk stratification. Image analysis AI helps with medical imaging interpretation.

Pharmacists may increasingly work with AI systems as these technologies become integrated into clinical practice. Understanding AI capabilities and limitations, interpreting AI-generated recommendations, and maintaining AI systems will require foundational knowledge that programming skills support.

## 6.3 Data Science Opportunities

Data science combines statistical analysis, programming, and domain expertise to extract insights from data. Healthcare generates enormous

volumes of data from electronic health records, laboratory systems, pharmacy records, and research studies. Data science methods enable systematic analysis of this information.

Pharmaceutical data science applications include clinical trial optimization, where data analysis improves trial design and execution. Pharmacovigilance uses data science methods to detect adverse event signals. Real-world evidence analysis examines data from routine clinical practice to support regulatory and clinical decisions.

Career opportunities in pharmaceutical data science span pharmaceutical companies, healthcare organizations, research institutions, and regulatory agencies. These roles typically require strong analytical skills, programming abilities, and domain knowledge in pharmaceutical or healthcare sciences.

## 6.4 Industry Applications

Pharmaceutical companies apply Python and data science across the drug development continuum. Discovery research uses computational methods to identify and optimize drug candidates. Clinical development

uses statistical analysis for trial design and regulatory submissions. Manufacturing applies process analytics for quality control and optimization.

Regulatory agencies including the FDA and EMA increasingly expect data-driven approaches in submissions. Knowledge of programming and data analysis supports compliance with these expectations. Regulatory professionals benefit from understanding how data underlying submissions is generated and analyzed.

Healthcare technology companies develop software used in pharmacies and healthcare facilities. These organizations value professionals who understand both the technical implementation and clinical context of their products.

## 6.5 Research Applications

Academic and industrial research relies heavily on computational methods. Laboratory automation generates data requiring programmatic analysis. High-throughput screening produces large datasets needing

systematic processing. omics research (genomics, proteomics, metabolomics) requires sophisticated computational approaches.

Research skill development should include study design, statistical methods, data management, and result interpretation. Programming abilities enable researchers to implement custom analyses and develop novel methodologies.

Collaboration between pharmaceutical scientists and computational experts increasingly drives innovation. Professionals who can bridge these domains are particularly valuable in research environments.

## 6.6 Educational Recommendations

Students pursuing pharmaceutical careers should develop programming skills progressively. Beginning with Python fundamentals provides a foundation that transfers to other programming contexts. Building proficiency in data analysis with Pandas and NumPy addresses common workplace requirements.

Practical projects applying programming to healthcare scenarios reinforce learning and build portfolios demonstrating capability. Analyzing publicly

available healthcare datasets, creating visualizations of pharmaceutical data, and developing simple healthcare applications provide valuable experience.

Continued learning is essential as technologies evolve. Online courses, documentation study, and participation in professional communities support ongoing skill development. The Python ecosystem continues expanding with new libraries and capabilities.

# REFERENCES

1.Weiss, C.J., 2017. Scientific Computing for Chemists with Python. Available at: https://weisscharlesj.github.io/SciCompforChemists/notebooks/introduction/intro.html

2.Perkovic, L., 2015. Introduction to Computing Using Python: An Application Development Focus. 2nd ed. Wiley.

3.Sweigart, A., 2025. Automate the Boring Stuff with Python. 3rd ed. Available at: https://automatetheboringstuff.com/

4.W3Schools. Python Tutorial. Available at: https://www.w3schools.com/python/

5.Educational dataset sources include Kaggle healthcare datasets, WHO data repositories, data.gov.in, healthdata.gov, Clinical Trials Registry India (CTRI), and clinicaltrials.gov.

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In his editorial capacity, he serves as a Managing Editor for Current Trends in Medicine and Clinical Research, overseeing peer reviews and journal layouts. His work at ICMR further underscores his commitment to advancing research-driven healthcare solutions through statistical rigor and innovative visualization.

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