Before proceeding, complete software installation by following **Software Installation.pdf**.

1. Introduction to Python Programming

Book 1 Think Python, Chapter 1 The way of the program

1. Basic Concepts

1.1 Program

A program is a sequence of instructions that specifies how to perform a computation. Basic instructions of programming languages include the following.

- Input
  Get data from the keyboard, a file, the network, or some other device.
- Output
  Display data on the screen, save it in a file, send it over the network, etc.
- Math
  Perform basic mathematical operations like addition and multiplication.
- Conditional execution
  Check for certain conditions and run the appropriate code.
- Repetition
  Perform some action repeatedly, usually with some variation.

1.2 Variables

A **variable** is a named location used to store data in the computer memory. Think it as a container that holds data that can be changed later in the program. Or for simplicity, typically we think a variable as a name that refers to a value. Sample variable names are number, grade, email, firstName, cardNumber, shipping_address, employee_id, etc.

1.3 Comments

A **comment** is a piece of text that the computer ignores but provides useful documentation to programmers. In Python, the text after a pound sign, #, is a comment.

In lecture notes, comments are in blue, and code output is also shown in blue.

1.4 Data types

A data type tells the compiler or interpreter how the programmer intends to use the data.

Four basic data types in Python

- **Boolean**: True or False
- **int** and **float** are numeric data types**:** They represent numbers
- **str** is a string type: its value is wrapped by single or double quotes

Data Type	Type of Data	Examples
Boolean	Boolean values	True, False
int	Integers	−5, -2, 0, 1, 7
float	Real numbers	−0.25, .3333, 3.14, 6.5
str	Character strings	"Hi there", "", "16", 'hello', 'A B C', ' '

The Python's **type()** function returns the type of the object, for example

```
type(5) # int
type('A') # str
type('2.5') # str
```

1.5 Assignment Statements

In programming, the equal sign, **=**, makes an assignment. An assignment statement creates a new variable and gives it a value. The value on the right side of equal sign is assigned to the variable on the left side of the equal sign.

```
num = 5 # assign an integer value to a variable, num, without declaring the data type of num.
num = 1.2 # the value of num is changed from 5 to 1.2 and its data type is changed to float.
num = 'Good morning' # the variable's value is updated and its data type is changed to str.
```

1.6 Dynamically vs. statically typed

Dynamically typed: A variable and its data type do not need to be declared before execution.
Statically typed: A variable and its data type must be declared at compile time.

Python is dynamically typed	**Java is statically typed**

// don't specify a data type before assigning a value
age = 18
type(age) // the output is int
	// need to declare a data type for
	// a variable before assigning a value
	int age = 18;

1.7 Weakly vs. strongly typed

Weakly typed: After declaring a data type for a variable, the data type can be changed.
Strongly typed: After declaring a data type for a variable, the data type cannot be changed.

Python is weakly typed	**Java is strongly typed**

age = 18
type(age) // int
age = "100 Main St."
type(age) // str
	int age = 18;
	double age = 18.0; // a compilation error
	String age = "hello"; // a compilation error

1.8 Algorithm

Algorithm is a finite sequence of well-defined, computer-implementable instructions, typically to solve a class of problems or to perform a computation.

The following is a sample algorithm for finding the maximum number from a list of numbers.

Algorithm description: This algorithm iterates through a list of numbers and keeps track of the largest number found so far.

Specific steps:

[1] Start by assuming the first number in the list is the largest.
[2] Compare this number with each subsequent number in the list.
[3] If a number is greater than the current largest number, update the largest number.
[4] Repeat until all numbers in the list have been checked.
[5] Return the largest number.

2. Python

- Python was invented at early 1990s by Guido van Rossum
- Python is a high-level, general-purpose programming language. It is an **interpreted** language – this means that a Python program is not compiled into a compiled program before execution. A **compiler** is a program that reads a program written in the high-level language and converts it into the machine or low-level language, and reports the errors if they are present in the program.
- When a Python program is executed, the Python interpreter first translates it into byte code, and then the byte code is sent to Python Virtual Machine for further interpretation and execution.
- Python program files use .**py** extension.
- Python files created in Jupyter Notebook has **.ipynb** extension that can be converted to a .py program.

3. Program Development Environment

Programmers usually write high-level language statements/programs in a text editor. In this class, we use Jupyter Notebook as development environment. Refers to Software Installation.pdf for software installation and introduction to Jupyter Notebook.

Jupyter Notebook is an interactive development environment (IDE) for IPython (interactive Python) to write programs and display images, and it runs in a web browser (Internet connection is not required). It combines software code, computational output, explanatory text, and multimedia resources.

4. Python vs. Java

Python and Java are two of the most popular and robust programming languages. The following table lists their main differences.

	Python	**Java**
Compilation	No compilation for Python programs. Python is a scripting language which can be **interpreted** by an interpreter and does not need to be compiled before execution.	Java programs are compiled before execution. As a programming language Java requires a compiler to compile the source code into compiled code which can be later executed.
Dynamically or statically typed	Python is dynamically typed. age = 18	Java is statically typed. int age = 18;

Weakly or strongly typed	Python is weakly typed.
	n = 1
	n = 'hello world'
	n = 2.5
		Java is strongly typed.
		int n = 1;
		n = "hello world"; // compilation error
		n = 2.5; // compilation error

Learning curve	Low	Medium
Best use for	Mainly in the field of data science	Very broad for enterprise software development, such as embed systems, web applications, and mobile applications.

5. The Software Development Process

- Software development is the process of conceiving, specifying, designing, programming, documenting, testing, and bug fixing involved in creating and maintaining software programs.
- Waterfall model is a basic software development approach
- Common phases in the waterfall model:
  - Customer request
  - Analysis: identify requirements
  - Design: identify what programs/classes are needed, what each of the classes does and their relationships
  - Implementation: software development
  - Integration
  - Maintenance

- Modern software development is usually **incremental** and **iterative**
  - Analysis and design may produce a prototype of a system, code the prototype, testing, and then back up to earlier phases to fill in more details.

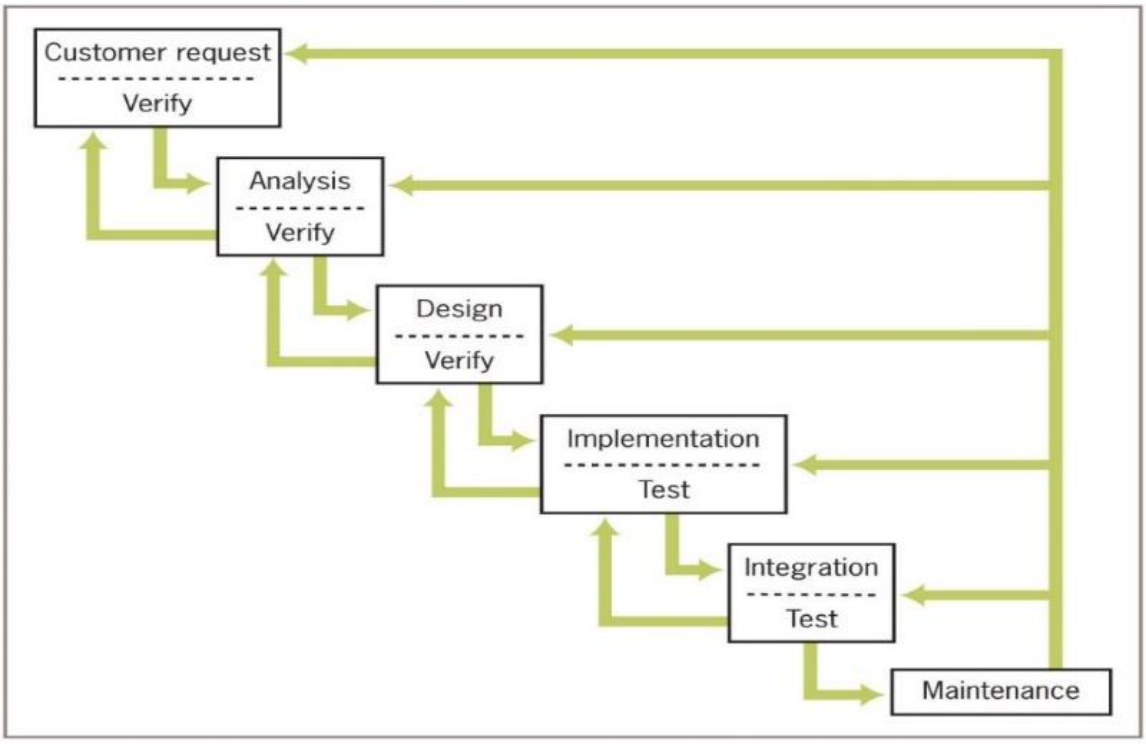


Figure 2-1 The waterfall model of the software development process

- Programs rarely work as hoped the first time they are run
  - Must perform extensive and careful testing
  - The cost of developing software is not spread equally over the phases

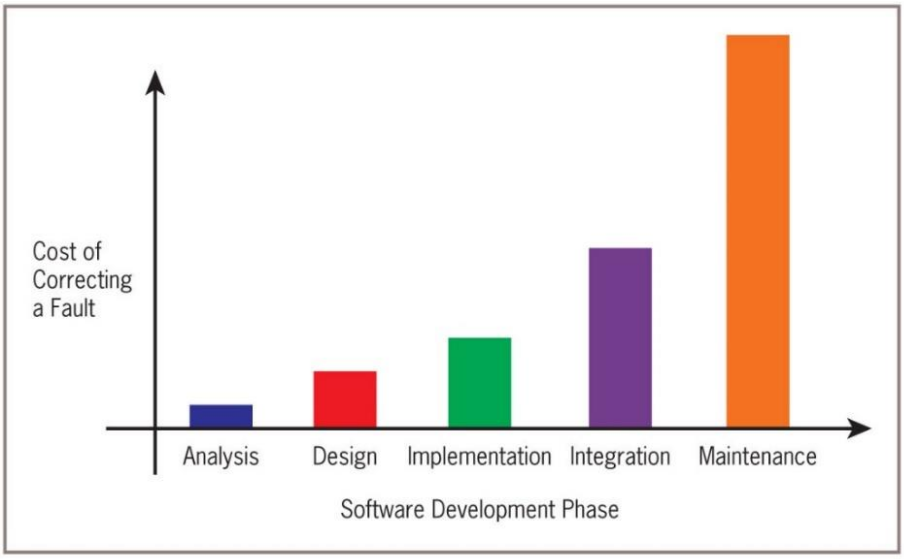
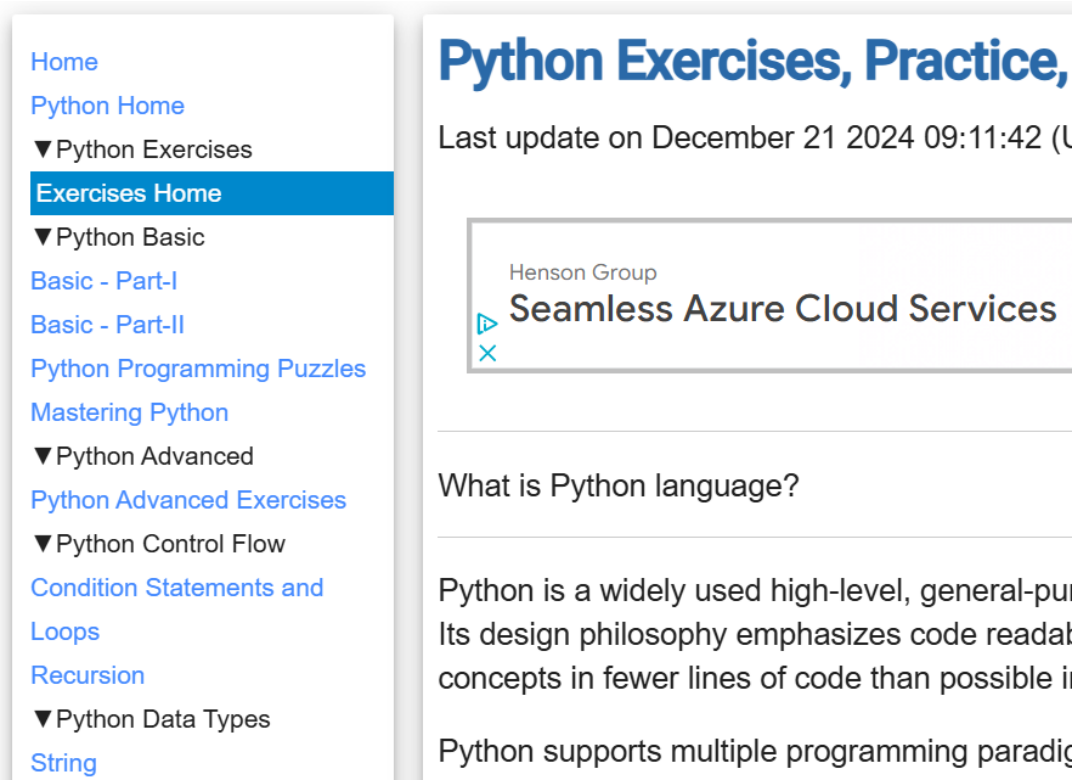


Figure 2-2 Relative costs of repairing mistakes that are found in different phases

6. How to Study This Class

The best way to learn programming is to **practice**.
Thus, you are encouraged to do more exercises in addition to class assignments and project.
A great source for Python exercises is at https://www.w3resource.com/python-exercises/.



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