Introduction to
Computers and Programming

Topics

- Introduction
- Hardware and Software
- How Computers Store Data
- How a Program Works
- Using Python

Introduction

- Computers can be programmed
  - Designed to do any job that a program tells them to
- Program: set of instructions that a computer follows to perform a task
  - Commonly referred to as *Software*
- Programmer: person who can design, create, and test computer programs
  - Also known as software developer

Hardware and Software

- Hardware: The physical devices that make up a computer
  - Computer is a system composed of several components that all work together
- Typical major components:
  - Central processing unit
  - Main memory
  - Secondary storage devices
  - Input and output devices

The CPU

- Central processing unit (CPU): the part of the computer that actually runs programs
  - Most important component
  - Without it, cannot run software
  - Used to be a huge device
- Microprocessors: CPUs located on small chips

Main Memory

- Main memory: where computer stores a program while program is running, and data used by the program
- Known as *Random Access Memory* or *RAM*
  - CPU is able to quickly access data in RAM
  - Volatile memory used for temporary storage while program is running
  - Contents are erased when computer is off

Secondary Storage Devices

- Secondary storage: can hold data for long periods of time
  - Programs normally stored here and loaded to main memory when needed
- Types of secondary memory
  - Disk drive: magnetically encodes data onto a spinning circular disk
  - Solid state drive: faster than disk drive, no moving parts, stores data in solid state memory
  - Flash memory: portable, no physical disk

Input Devices

- Input: data the computer collects from people and other devices
- Input device: component that collects the data
  - Examples: keyboard, mouse, touchscreen, scanner, camera
  - Disk drives can be considered input devices because they load programs into the main memory

Output Devices

- Output: data produced by the computer for other people or devices
  - Can be text, image, audio, or bit stream
- Output device: formats and presents output
  - Examples: video display, printer
  - Disk drives and USB drives can be considered output devices because data is sent to them to be saved

Software (1 of 2)

- Everything the computer does is controlled by software
  - General categories:
    - Application software
    - System software
- Application software: programs that make computer useful for every day tasks
  - Examples: word processing, email, games, and Web browsers

Software (2 of 2)

- System software: programs that control and manage basic operations of a computer
  - Operating system: controls operations of hardware components
  - Utility Program: performs specific task to enhance computer operation or safeguard data
  - Software development tools: used to create, modify, and test software programs

How Computers Store Data

- All data in a computer is stored in sequences of 0s and 1s
- Byte: just enough memory to store letter or small number
  - Divided into eight bits
  - Bit: electrical component that can hold positive or negative charge, like on/off switch
  - The on/off pattern of bits in a byte represents data stored in the byte

Storing Numbers

- Bit represents two values, 0 and 1
- Computers use binary numbering system
  - Position of digit `j` is assigned the value 2^{j-1}
  - To determine value of binary number sum position values of the 1s
- Byte size limits are 0 and 255
  - 0 = all bits off; 255 = all bits on
  - To store larger number, use several bytes

Storing Characters

- Data stored in computer must be stored as binary number
- Characters are converted to numeric code, numeric code stored in memory
  - Most important coding scheme is ASCII
    - ASCII is limited: defines codes for only 128 characters
  - Unicode coding scheme becoming standard
    - Compatible with ASCII
    - Can represent characters for other languages

Advanced Number Storage

- To store negative numbers and real numbers, computers use binary numbering and encoding schemes
  - Negative numbers encoded using two's complement
  - Real numbers encoded using floating-point notation

Other Types of Data

- Digital: describes any device that stores data as binary numbers
- Digital images are composed of pixels
  - To store images, each pixel is converted to a binary number representing the pixel's color
- Digital music is composed of sections called samples
  - To store music, each sample is converted to a binary number

How a Program Works (1 of 3)

- CPU designed to perform simple operations on pieces of data
  - Examples: reading data, adding, subtracting, multiplying, and dividing numbers
  - Understands instructions written in machine language and included in its instruction set
    - Each brand of CPU has its own instruction set
- To carry out meaningful calculation, CPU must perform many operations

How a Program Works (2 of 3)

- Program must be copied from secondary memory to RAM each time CPU executes it
- CPU executes program in cycle:
  - Fetch: read the next instruction from memory into CPU
  - Decode: CPU decodes fetched instruction to determine which operation to perform
  - Execute: perform the operation

How a Program Works (3 of 3)

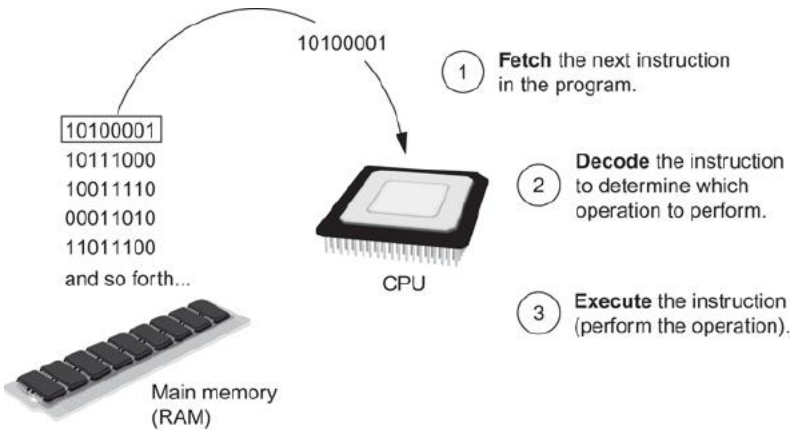

10100001
1 Fetch the next instruction in the program.
10100001
10111000
10011110
00011010
11011100
and so forth...
CPU
2 Decode the instruction to determine which operation to perform.
3 Execute the instruction (perform the operation).
Main memory (RAM)

Figure 1-16 The fetch-decode-execute cycle

From Machine Language to Assembly Language

- Impractical for people to write in machine language
- Assembly language: uses short words (mnemonics) for instructions instead of binary numbers
  - Easier for programmers to work with
- Assembler: translates assembly language to machine language for execution by CPU

High-Level Languages

- Low-level language: close in nature to machine language
  - Example: assembly language
- High-Level language: allows simple creation of powerful and complex programs
  - No need to know how CPU works or write large number of instructions
  - More intuitive to understand

Keywords, Operators, and Syntax: an Overview

- Keywords: predefined words used to write program in high-level language
  - Each keyword has specific meaning
- Operators: perform operations on data
  - Example: math operators to perform arithmetic
- Syntax: set of rules to be followed when writing program
- Statement: individual instruction used in high-level language

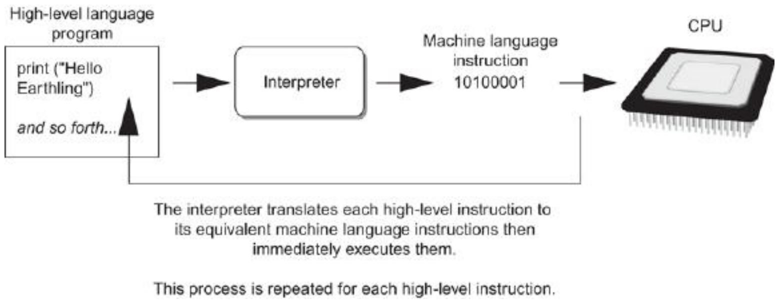
Compilers and Interpreters (1 of 3)

- Programs written in high-level languages must be translated into machine language to be executed
- Compiler: translates high-level language program into separate machine language program
  - Machine language program can be executed at any time

Compilers and Interpreters (2 of 3)

- Interpreter: translates and executes instructions in high-level language program
  - Used by Python language
  - Interprets one instruction at a time
  - No separate machine language program
- Source code: statements written by programmer
  - Syntax error: prevents code from being translated

Compilers and Interpreters (3 of 3)


High-level language program
print ("Hello Earthling")
and so forth...
Interpreter
Machine language instruction
10100001
CPU

The interpreter translates each high-level instruction to its equivalent machine language instructions then immediately executes them.

This process is repeated for each high-level instruction.

Figure 1-19 Executing a high-level program with an interpreter

Using Python

- Python must be installed and configured prior to use
  - One of the items installed is the Python interpreter
- Python interpreter can be used in two modes:
  - Interactive mode: enter statements on keyboard
  - Script mode: save statements in Python script

Interactive Mode

- When you start Python in interactive mode, you will see a prompt
  - Indicates the interpreter is waiting for a Python statement to be typed
  - Prompt reappears after previous statement is executed
  - Error message displayed If you incorrectly type a statement
- Good way to learn new parts of Python

Writing Python Programs and Running Them in Script Mode

- Statements entered in interactive mode are not saved as a program
- To have a program use script mode
  - Save a set of Python statements in a file
  - The filename should have the `.py` extension
  - To run the file, or script, type

    ```
    python filename
    ```

    at the operating system command line

The IDLE Programming Environment

- IDLE (Integrated Development Program): single program that provides tools to write, execute and test a program
  - Automatically installed when Python language is installed
  - Runs in interactive mode
  - Has built-in text editor with features designed to help write Python programs

Summary

- This chapter covered:
  - Main hardware components of the computer
  - Types of software
  - How data is stored in a computer
  - Basic CPU operations and machine language
  - Fetch-decode-execute cycle
  - Complex languages and their translation to machine code
  - Installing Python and the Python interpreter modes

Introduction to
Python Programming Language

Topics (1 of 2)

- Designing a Program
- Input, Processing, and Output
- Displaying Output with `print` Function
- Comments
- Variables
- Reading Input from the Keyboard
- Performing Calculations
- String Concatenation

Topics (2 of 2)

- More About The `print` Function
- Displaying Formatted Output
- Named Constants
- Introduction to Turtle Graphics

Designing a Program (1 of 3)

- Programs must be designed before they are written
- Program development cycle:
  - Design the program
  - Write the code
  - Correct syntax errors
  - Test the program
  - Correct logic errors

Designing a Program (2 of 3)

- Design is the most important part of the program development cycle
- Understand the task that the program is to perform
  - Work with customer to get a sense what the program is supposed to do
  - Ask questions about program details
  - Create one or more software requirements

Designing a Program (3 of 3)

- Determine the steps that must be taken to perform the task
  - Break down required task into a series of steps
  - Create an algorithm, listing logical steps that must be taken
- Algorithm: set of well-defined logical steps that must be taken to perform a task

Pseudocode

- Pseudocode: fake code
  - Informal language that has no syntax rule
  - Not meant to be compiled or executed
  - Used to create model program
    - No need to worry about syntax errors, can focus on program's design
    - Can be translated directly into actual code in any programming language

Flowcharts (1 of 2)

- Flowchart: diagram that graphically depicts the steps in a program
  - Ovals are terminal symbols
  - Parallelograms are input and output symbols
  - Rectangles are processing symbols
  - Symbols are connected by arrows that represent the flow of the program

Flowcharts (2 of 2)

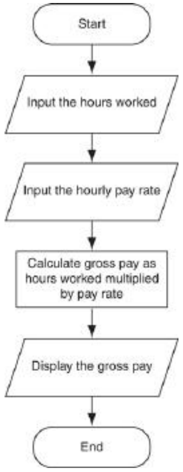

Start
Input the hours worked
Input the hourly pay rate
Calculate gross pay as hours worked multiplied by pay rate
Display the gross pay
End

Figure 2-2 The program development cycle

Input, Processing, and Output

- Typically, computer performs three-step process
  - Receive input
    - Input: any data that the program receives while it is running
  - Perform some process on the input
    - Example: mathematical calculation
  - Produce output

Displaying Output with the `print` Function

- Function: piece of prewritten code that performs an operation
- `print` function: displays output on the screen
- Argument: data given to a function
  - Example: data that is printed to screen
- Statements in a program execute in the order that they appear
  - From top to bottom

Strings and String Literals

- String: sequence of characters that is used as data
- String literal: string that appears in actual code of a program
  - Must be enclosed in single (') or double (") quote marks
  - String literal can be enclosed in triple quotes (''' or `"""`)
    - Enclosed string can contain both single and double quotes and can have multiple lines

Comments

- Comments: notes of explanation within a program
  - Ignored by Python interpreter
    - Intended for a person reading the program's code
  - Begin with a # character
- End-line comment: appears at the end of a line of code
  - Typically explains the purpose of that line

Variables

- Variable: name that represents a value stored in the computer memory
  - Used to access and manipulate data stored in memory
  - A variable references the value it represents
- Assignment statement: used to create a variable and make it reference data
  - General format is `variable = expression`
    - Example: `age = 29`
    - Assignment operator: the equal sign (=)

Variables (cont’d.)

- In assignment statement, variable receiving value must be on left side
- A variable can be passed as an argument to a function
  - Variable name should not be enclosed in quote marks
- You can only use a variable if a value is assigned to it

Variable Naming Rules

- Rules for naming variables in Python:
  - Variable name cannot be a Python key word
  - Variable name cannot contain spaces
  - First character must be a letter or an underscore
  - After first character may use letters, digits, or underscores
  - Variable names are case sensitive
- Variable name should reflect its use

Displaying Multiple Items with the `print` Function

- Python allows one to display multiple items with a single call to `print`
  - Items are separated by commas when passed as arguments
  - Arguments displayed in the order they are passed to the function
  - Items are automatically separated by a space when displayed on screen

Variable Reassignment

- Variables can reference different values while program is running
- Garbage collection: removal of values that are no longer referenced by variables
  - Carried out by Python interpreter
- A variable can refer to item of any type
  - Variable that has been assigned to one type can be reassigned to another type

Numeric Data Types, Literals, and the `str` Data Type

- Data types: categorize value in memory
  - e.g., int for integer, float for real number, str used for storing strings in memory
- Numeric literal: number written in a program
  - No decimal point considered int, otherwise, considered float
- Some operations behave differently depending on data type

Reassigning a Variable to a Different Type

- A variable in Python can refer to items of any type

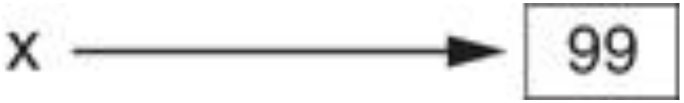


Figure 2-7 The variable x references an integer

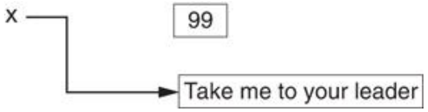


Figure 2-8 The variable x references a string

Reading Input from the Keyboard

- Most programs need to read input from the user
- Built-in `input` function reads input from keyboard
  - Returns the data as a string
  - Format: *`variable`* `= input(`*`prompt`*`)`
    - `prompt` is typically a string instructing user to enter a value
  - Does not automatically display a space after the prompt

Reading Numbers with the `input` Function

- `input` function always returns a string
- Built-in functions convert between data types
  - `int(`*`item`*`)` converts *`item`* to an `int`
  - `float(`*`item`*`)` converts *`item`* to a `float`
  - Nested function call: general format: *`function1`*`(`*`function2`*`(`*`argument`*`))`
    - value returned by function2 is passed to function1
  - Type conversion only works if item is valid numeric value, otherwise, throws exception

Performing Calculations

- Math expression: performs calculation and gives a value
  - Math operator: tool for performing calculation
  - Operands: values surrounding operator
    - Variables can be used as operands
  - Resulting value typically assigned to variable
- Two types of division:
  - `/` operator performs floating point division
  - `//` operator performs integer division
    - Positive results truncated, negative rounded away from zero

Operator Precedence and Grouping with Parentheses

- Python operator precedence:
  1. Operations enclosed in parentheses
     - Forces operations to be performed before others
  2. Exponentiation (**)
  3. Multiplication (*), division (/ and //), and remainder (%)
  4. Addition (+) and subtraction (-)
- Higher precedence performed first
  - Same precedence operators execute from left to right

The Exponent Operator and the Remainder Operator

- Exponent operator (`**`): Raises a number to a power
  - `x ** y =` x^y
- Remainder operator (%): Performs division and returns the remainder
  - a.k.a. modulus operator
  - e.g., `4%2=0, 5%2=1`
  - Typically used to convert times and distances, and to detect odd or even numbers

Converting Math Formulas to Programming Statements

- Operator required for any mathematical operation
- When converting mathematical expression to programming statement:
  - May need to add multiplication operators
  - May need to insert parentheses

Mixed-Type Expressions and Data Type Conversion

- Data type resulting from math operation depends on data types of operands
  - Two `int` values: result is an `int`
  - Two `float` values: result is a `float`
  - `int` and `float`: `int` temporarily converted to `float`, result of the operation is a `float`
    - Mixed-type expression
  - Type conversion of `float` to `int` causes truncation of fractional part

Breaking Long Statements into Multiple Lines (1 of 2)

- Long statements cannot be viewed on screen without scrolling and cannot be printed without cutting off
- Multiline continuation character (\): Allows to break a statement into multiple lines

```
result = var1 * 2 + var2 * 3 + \
         var3 * 4 + var4 * 5
```

Breaking Long Statements into Multiple Lines (2 of 2)

- Any part of a statement that is enclosed in parentheses can be broken without the line continuation character.

```
print("Monday's sales are", monday,
      "and Tuesday's sales are", tuesday,
      "and Wednesday's sales are", Wednesday)

total = (value1 + value2 +
         value3 + value4 +
         value5 + value6)
```

String Concatenation (1 of 2)

- To append one string to the end of another string
- Use the + operator to concatenate strings

```
>>> message = 'Hello ' + 'world'
>>> print(message)
Hello world
>>>
```

String Concatenation (2 of 2)

- You can use string concatenation to break up a long string literal

```
print('Enter the amount of ' +
      'sales for each day and ' +
      'press Enter.')
```

This statement will display the following:

```
Enter the amount of sales for each day and press Enter.
```

Implicit String Literal Concatenation (1 of 2)

- Two or more string literals written adjacent to each other are implicitly concatenated into a single string

```
>>> my_str = 'one' 'two' 'three'
>>> print(my_str)
onetwothree
```

Implicit String Literal Concatenation (2 of 2)

```
print('Enter the amount of '
      'sales for each day and '
      'press Enter.')
```

This statement will display the following:

```
Enter the amount of sales for each day and press Enter.
```

More About The `print` Function (1 of 2)

- `print` function displays line of output
  - Newline character at end of printed data
  - Special argument `end='`*`delimiter`*`'` causes `print` to place *`delimiter`* at end of data instead of newline character
- `print` function uses space as item separator
  - Special argument `sep='`*`delimiter`*`'` causes `print` to use *`delimiter`* as item separator

More About The `print` Function (2 of 2)

- Special characters appearing in string literal
  - Preceded by backslash (`\`)
    - Examples: newline (`\n`), horizontal tab (`\t`)
  - Treated as commands embedded in string

Displaying Formatted Output with F-strings (1 of 8)

- An f-string is a special type of string literal that is prefixed with the letter `f`

```
>>> print(f'Hello world')
Hello world
```

- F-strings support placeholders for variables

```
>>> name = 'Johnny'
>>> print(f'Hello {name}.')
Hello Johnny.
```

Displaying Formatted Output with F-strings (2 of 8)

- Placeholders can also be expressions that are evaluated

```
>>> print(f'The value is {10 + 2}.')
The value is 12.


>>> val = 10
>>> print(f'The value is {val + 2}.')
The value is 12.
```

Displaying Formatted Output with F-strings (3 of 8)

- Format specifiers can be used with placeholders

```
>> num = 123.456789
>> print(f'{num:.2f}')
123.46
>>>
```

- `.2f` means:
  - round the value to 2 decimal places
  - display the value as a floating-point number

Displaying Formatted Output with F-strings (4 of 8)

- Other examples:

```
>> num = 1000000.00
>> print(f'{num:,.2f}')
1,000,000.00


>>> discount = 0.5
>>> print(f'{discount:.0%}')
50%
```

Displaying Formatted Output with F-strings (5 of 8)

- Other examples:

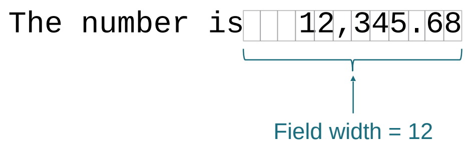
```
>> num = 123456789
>> print(f'{num:,d}')
123,456,789


>>> num = 12345.6789
>>> print(f'{num:.2e}')
1.23e+04
```

Displaying Formatted Output with F-strings (6 of 8)

- Specifying a minimum field width:

```
>>> num = 12345.6789
>>> print(f'The number is {num:12,.2f}')
The number is   12,345.68
```

Field width = 12



Displaying Formatted Output with F-strings (7 of 8)

- Aligning values within a field
  - Use < for left alignment
  - Use > for right alignment
  - Use ^ for center alignment

- Examples:
  - `print(f'{num:<20.2f}')`
  - `print(f'{num:>20.2f}')`
  - `print(f'{num:^20.2f}')`

Displaying Formatted Output with F-strings (8 of 8)

- The order of designators in a format specifier
  - When using multiple designators in a format specifier, write them in this order:

```
[alignment][width][,][.precision][type]
```

- Example:
  - `print(f'{number:^10,.2f}')`

Magic Numbers

- A magic number is an unexplained numeric value that appears in a program’s code. Example:

```
amount = balance * 0.069
```

- What is the value 0.069? An interest rate? A fee percentage? Only the person who wrote the code knows for sure.

The Problem with Magic Numbers

- It can be difficult to determine the purpose of the number.
- If the magic number is used in multiple places in the program, it can take a lot of effort to change the number in each location, should the need arise.
- You take the risk of making a mistake each time you type the magic number in the program’s code.
  - For example, suppose you intend to type 0.069, but you accidentally type .0069. This mistake will cause mathematical errors that can be difficult to find.

Named Constants

- You should use named constants instead of magic numbers.
- A named constant is a name that represents a value that does not change during the program's execution.
- Example:

```
INTEREST_RATE = 0.069
```

- This creates a named constant named `INTEREST_RATE`, assigned the value 0.069. It can be used instead of the magic number:

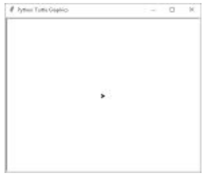
```
amount = balance * INTEREST_RATE
```

Advantages of Using Named Constants

- Named constants make code self-explanatory (self-documenting)
- Named constants make code easier to maintain (change the value assigned to the constant, and the new value takes effect everywhere the constant is used)
- Named constants help prevent typographical errors that are common when using magic numbers

Introduction to Turtle Graphics (1 of 2)

- Python's turtle graphics system displays a small cursor known as a *turtle*.



- You can use Python statements to move the turtle around the screen, drawing lines and shapes.

Introduction to Turtle Graphics (2 of 2)

- To use the turtle graphics system, you must import the turtle module with this statement:

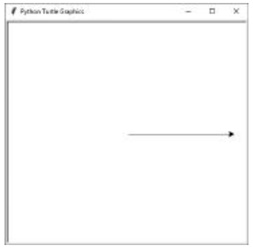
  ```
  import turtle
  ```

  This loads the turtle module into memory

Moving the Turtle Forward

- Use the `turtle.forward(`*n*`)` statement to move the turtle forward *n* pixels.

```
>>> import turtle
>>> turtle.forward(100)
>>>
```

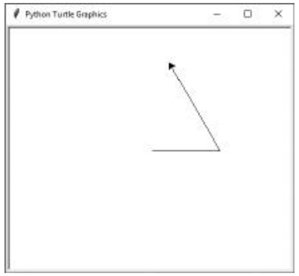


Turning the Turtle (1 of 3)

- The turtle's initial heading is 0 degrees (east)
- Use the `turtle.right(`*`angle`*`)` statement to turn the turtle right by *`angle`* degrees.
- Use the `turtle.left(`*`angle`*`)` statement to turn the turtle left by *`angle`* degrees.

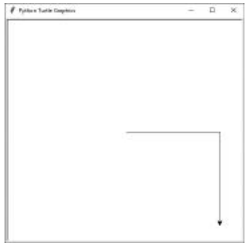
Turning the Turtle (2 of 3)

```
>>> import turtle
>>> turtle.forward(100)
>>> turtle.left(90)
>>> turtle.forward(100)
>>>
```



Turning the Turtle (3 of 3)

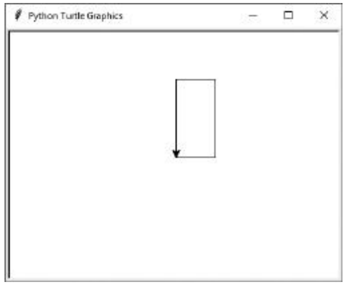
```
>>> import turtle
>>> turtle.forward(100)
>>> turtle.right(45)
>>> turtle.forward(100)
>>>
```



Setting the Turtle's Heading

- Use the `turtle.setheading(`*`angle`*`)` statement to set the turtle's heading to a specific angle.

```
>>> import turtle
>>> turtle.forward(50)
>>> turtle.setheading(90)
>>> turtle.forward(100)
>>> turtle.setheading(180)
>>> turtle.forward(50)
>>> turtle.setheading(270)
>>> turtle.forward(100)
>>>
```

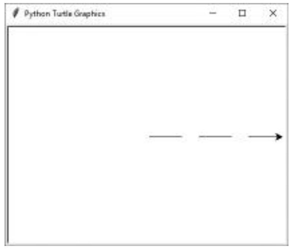


Setting the Pen Up or Down (1 of 2)

- When the turtle's pen is down, the turtle draws a line as it moves. By default, the pen is down.
- When the turtle's pen is up, the turtle does not draw as it moves.
- Use the `turtle.penup()` statement to raise the pen.
- Use the `turtle.pendown()` statement to lower the pen.

Setting the Pen Up or Down (2 of 2)

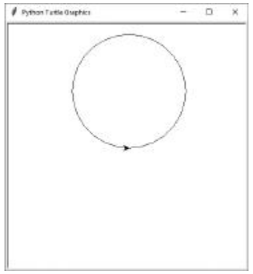
```
>>> import turtle
>>> turtle.forward(50)
>>> turtle.penup()
>>> turtle.forward(25)
>>> turtle.pendown()
>>> turtle.forward(50)
>>> turtle.penup()
>>> turtle.forward(25)
>>> turtle.pendown()
>>> turtle.forward(50)
>>>
```



Drawing Circles

- Use the `turtle.circle(`*`radius`*`)` statement to draw a circle with a specified radius.

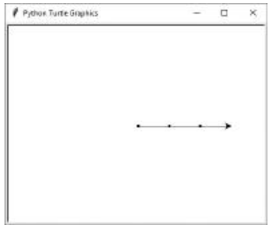
```
>>> import turtle
>>> turtle.circle(100)
>>>
```



Drawing Dots

- Use the `turtle.dot()` statement to draw a simple dot at the turtle's current location.

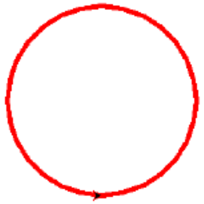
```
>>> import turtle
>>> turtle.dot()
>>> turtle.forward(50)
>>> turtle.dot()
>>> turtle.forward(50)
>>> turtle.dot()
>>> turtle.forward(50)
>>>
```



Changing the Pen Size and Drawing Color

- Use the `turtle.pensize(`*`width`*`)` statement to change the width of the turtle's pen, in pixels.
- Use the `turtle.pencolor(`*`color`*`)` statement to change the turtle's drawing color.
  - *See Appendix D in your textbook for a complete list of colors.*

```
>>> import turtle
>>> turtle.pensize(5)
>>> turtle.pencolor('red')
>>> turtle.circle(100)
>>>
```



Working with the Turtle's Window

- Use the `turtle.bgcolor(`*`color`*`)` statement to set the window's background color.
  - *See Appendix D in your textbook for a complete list of colors.*
- Use the `turtle.setup(`*`width`*`,`*`height`*`)`statement to set the size of the turtle's window, in pixels.
  - The *`width`* and *`height`* arguments are the width and height, in pixels.
  - For example, the following interactive session creates a graphics window that is 640 pixels wide and 480 pixels high:

```
>>> import turtle
>>> turtle.setup(640, 480)
>>>
```

Resetting the Turtle’s Window (1 of 3)

- The `turtle.reset()` statement:
  - Erases all drawings that currently appear in the graphics window.
  - Resets the drawing color to black.
  - Resets the turtle to its original position in the center of the screen.
  - Does *not* reset the graphics window’s background color.

Resetting the Turtle’s Window (2 of 3)

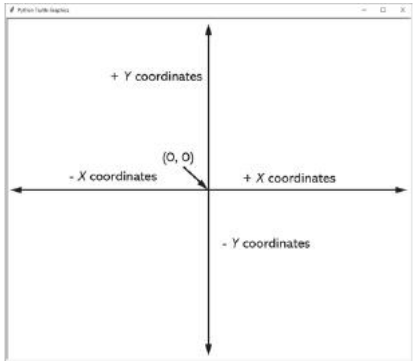
- The `turtle.clear()` statement:
  - Erases all drawings that currently appear in the graphics window.
  - Does *not* change the turtle's position.
  - Does *not* change the drawing color.
  - Does *not* change the graphics window’s background color.

Resetting the Turtle’s Window (3 of 3)

- The `turtle.clearscreen()` statement:
  - Erases all drawings that currently appear in the graphics window.
  - Resets the drawing color to black.
  - Resets the turtle to its original position in the center of the screen.
  - Resets the graphics window’s background color to white.

Working with Coordinates

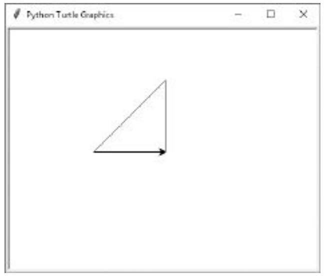
- The turtle uses Cartesian Coordinates



Moving the Turtle to a Specific Location

- Use the `turtle.goto(`*`x, y`*`)` statement to move the turtle to a specific location.

```
>>> import turtle
>>> turtle.goto(0, 100)
>>> turtle.goto(−100, 0)
>>> turtle.goto(0, 0)
>>>
```



- The `turtle.pos()` statement displays the turtle's current *X*,*Y* coordinates.
- The `turtle.xcor()` statement displays the turtle's current *X* coordinate and the `turtle.ycor()` statement displays the turtle's current *Y* coordinate.

Animation Speed

- Use the `turtle.speed(speed)` command to change the speed at which the turtle moves.
  - The *speed* argument is a number in the range of 0 through 10.
  - If you specify 0, then the turtle will make all of its moves instantly (animation is disabled).

Hiding and Displaying the Turtle

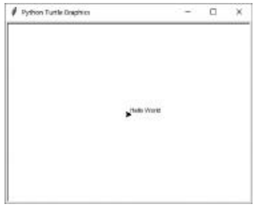
- Use the `turtle.hideturtle()` command to hide the turtle.
  - This command does not change the way graphics are drawn, it simply hides the turtle icon.
- Use the `turtle.showturtle()` command to display the turtle.

Displaying Text (1 of 2)

- Use the `turtle.write(`*`text`*`)` statement to display text in the turtle's graphics window.
  - The *`text`* argument is a string that you want to display.
  - The lower-left corner of the first character will be positioned at the turtle’s *X* and *Y* coordinates.

Displaying Text (2 of 2)

```
>>> import turtle
>>> turtle.write('Hello World')
>>>
```



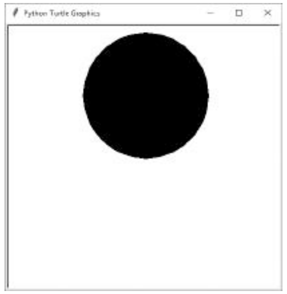
Hello World

Filling Shapes (1 of 2)

- To fill a shape with a color:
  - Use the `turtle.begin_fill()` command before drawing the shape
  - Then use the `turtle.end_fill()` command after the shape is drawn.
  - When the `turtle.end_fill()` command executes, the shape will be filled with the current fill color

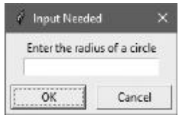
Filling Shapes (2 of 2)

```
>>> import turtle
>>> turtle.hideturtle()
>>> turtle.fillcolor('red')
>>> turtle.begin_fill()
>>> turtle.circle(100)
>>> turtle.end_fill()
>>>
```



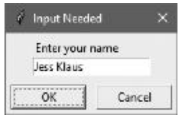
Getting Input With a Dialog Box (1 of 2)

```
>>> import turtle
>>> age = turtle.numinput('Input', 'Enter your age')
```



Enter the radius of a circle

```
>>> import turtle
>>> name = turtle.textinput('Input', 'Enter your name')
```



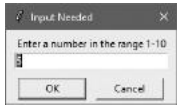
Enter your name

Jess Klaus

Getting Input With a Dialog Box (2 of 2)

- Specifying a default value, minimum value, and maximum value with `turtle.numinput`:

```
>>> import turtle
>>> num = turtle.numinput('Input', 'Enter a number',
          default=10, minval=0, maxval=100)
```

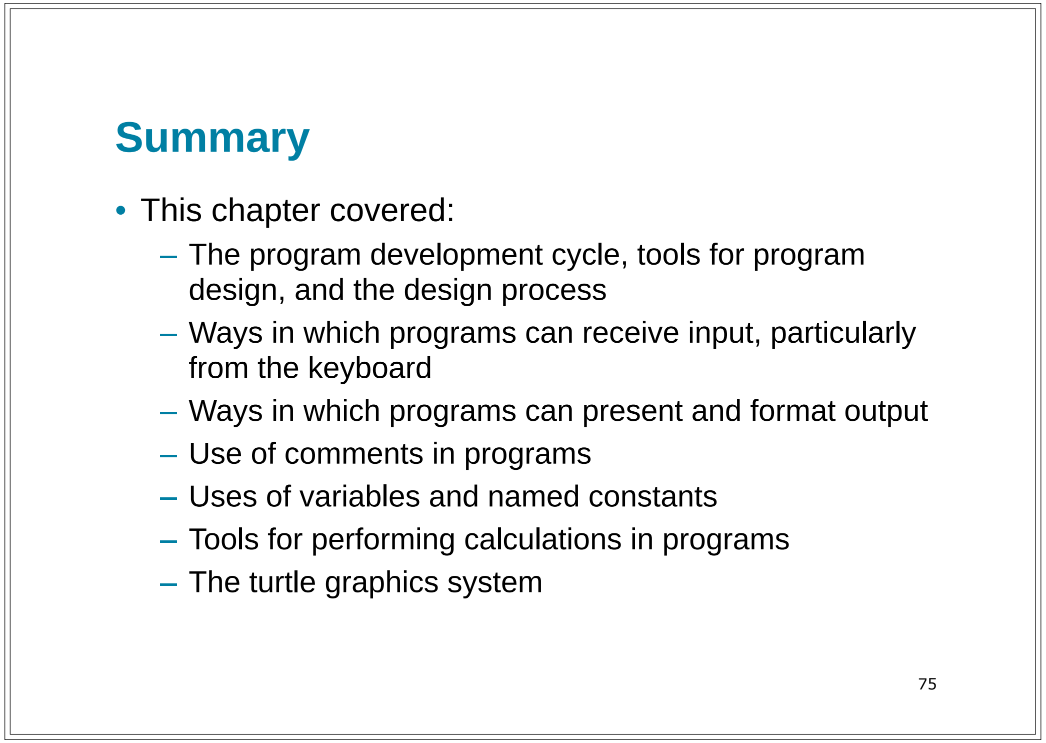


Enter a number in the range 1-10

- An error message will be displayed if the input is less than `minval` or greater than `maxval`

Keeping the Graphics Window Open

- When running a turtle graphics program outside IDLE, the graphics window closes immediately when the program is done.
- To prevent this, add the `turtle.done()` statement to the very end of your turtle graphics programs.
  - This will cause the graphics window to remain open, so you can see its contents after the program finishes executing.



Summary

- This chapter covered:
  - The program development cycle, tools for program design, and the design process
  - Ways in which programs can receive input, particularly from the keyboard
  - Ways in which programs can present and format output
  - Use of comments in programs
  - Uses of variables and named constants
  - Tools for performing calculations in programs
  - The turtle graphics system