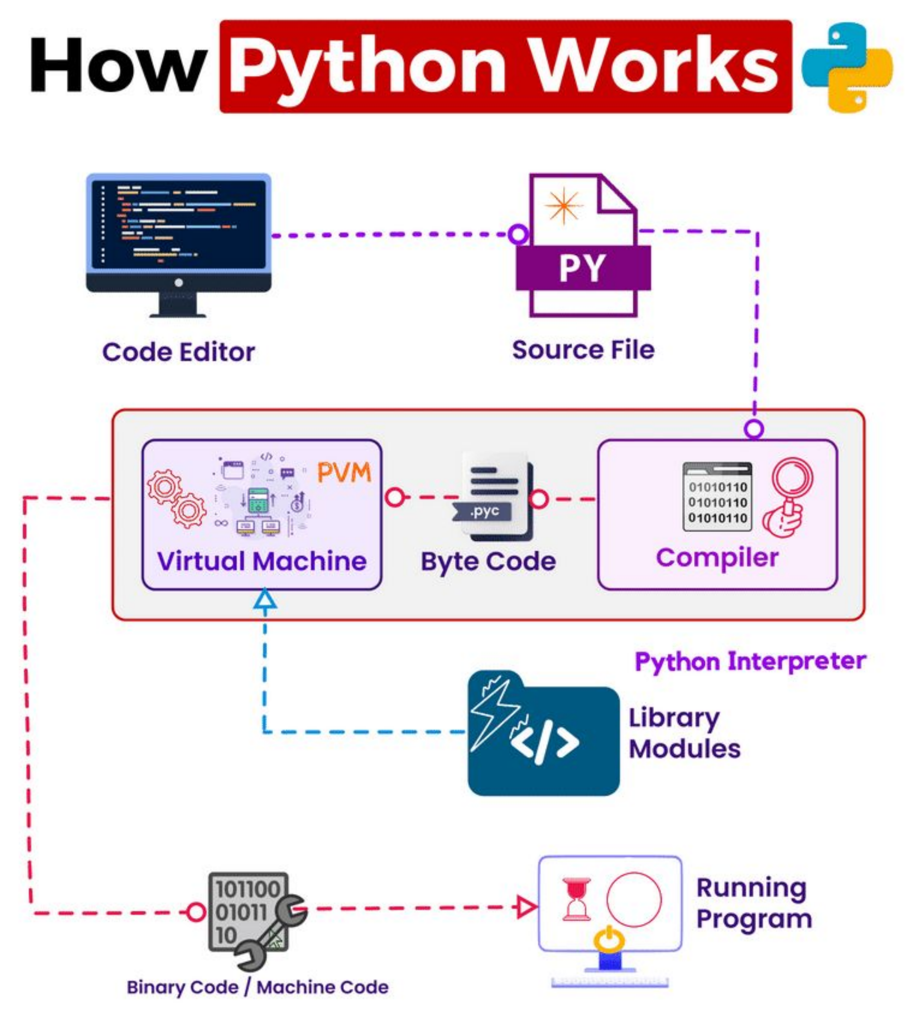
COMP110

Objects, Data Types, & Expressions

Announcements

- Want help installing software, setting up your workspace, or practicing today’s content?
  - Visit our in-person Office Hours today from 1-3pm in Sitterson Hall, room 008!
- Today’s homework:
  - **LS02: Objects and Data Types** due tonight at 11:59pm
  - **LS03: Expressions** due tonight at 11:59pm
  - **EX00: Hello World!** due tomorrow (Friday) at 11:59pm

First… how does our code turn into output?



Some lines of code exist exclusively for human readability!

Docstrings

- A string written at the top of every file to describe its purpose
  - Written for humans, not for the computer to evaluate
- Denoted with three quotations “““ ”””

Comments

- Lines that start with # are ignored by the interpreter
  - Written for humans, not for the computer to evaluate
- Best practice to comment your code to explain what it’s doing (if it isn’t obvious!)

Objects and Built-In Types

An **object** is *typed* unit of data in memory.

The object's **type** classifies it to help the computer know how it should be interpreted and represented.

Programming languages offer many built-in data types for you to work with, typically including:

- numerical
  - integers
  - decimal numbers
  - complex numbers
- textual
- logical
- collections of many objects
  - sequences
  - sets
  - dictionaries

Numerical Built-In Types

- Integers
  - `int`
  - Zero, *or* non-zero digit followed by zero or more integers
  - 100 is an int, but 0100 is not
  - 3 is, but 3.08 is not
  - -2000 is, but -2000.1 is not

- Floating-point “decimal” numbers
  - `float`
  - Examples: 3.02, 4008.0, -16.99999
  - Not the *only* way to represent decimal numbers, but a very precise way

Boolean Built-In Type

- `bool`
- Evaluates to **`True`** or **`False`**
- Important: these should *always* have a capital T or F!
  - **`True`** is a boolean value
    - **`TRUE`** and **`true`** are not
  - **`False`** is a boolean value
    - **`FALSE`** and **`false`** are not

Textual Built-In Type

- Strings
  - `str`
  - A sequence (or *string*) of characters
  - Can be denoted using “ ”
  - Examples:
    - A word: “hello”
    - A phrase: “Hope we get some snow!”
    - A single character: “A”, “ “, “🎉”
    - A number *in quotes*: “23”, “110”, “12.5”
    - An empty string: “”

Indexing

- **Subscription** syntax uses square brackets and allows you to access an item in a sequence
- **Index numbering starts from 0 (in Python)**

Example:

The string, “`happy`”

Indexing

- **Subscription** syntax uses square brackets and allows you to access an item in a sequence
- **Index numbering starts from 0 (in Python)**

Example:

The string, “`happy`”

Characters:	h	a	p	p	y
Indices:	0	1	2	3	4

“`happy`” `[0]` would give us what letter?

In English: “happy at index 0”

Indexing

- **Subscription** syntax uses square brackets and allows you to access an item in a sequence
- **Index numbering starts from 0 (in Python)**

Example:

The string, “happy”

Characters:	h	a	p	p	y
Indices:	0	1	2	3	4

“happy”[0]? “h”

Your turn: “happy”[4]? “y”

In English: “happy at index 0”

Check an Object’s Type

- `type()`
    - `type(3)`
    - `type(“hi”)`
    - `type(True)`

Change (Cast) an Object’s Type

- `float()`
- `str()`
- `int()`

Review: Data Types

Discuss these questions with your neighbor and jot the answers down.

1. What is the difference between `int` and `float`?

2. Is there a difference between the following? What *type* of **literal** is each an example of?
    a. `“True”`
    b. `True`
    c. `TRUE`

3. What role do **types** play for data in Python?

Review: `str` is a *Sequence* Type

Discuss these questions with your neighbor and jot the answers down.

1. What does the `len()` function evaluate to when applied to a `str` value? What will the expression `len(“cold”)` evaluate to?

2. Is there a difference between `“True”` and `‘True’`? What *type* of **literal** is each an example of?

3. What are the **square brackets** called in the following *expression*? What does the following expression evaluate to? `“The Bear”[4]`

4. Can a string be a number in Python? Explain.

Expressions

- Fundamental building block in programs
- 2 main ideas behind expressions:
  - An expression *evaluates* to a *typed* value at runtime
  - An object’s *type* tells you what you can do with it
    An *expression* is an intent to do something
- Computer evaluates each expression in your program one step at a time
- Examples
  - 1 + 2 * 3
  - 1
  - 1.0 * 2.0
  - “Hello” + “ World!”
  - 1 > 3

Numerical Operators

Symbol	Operator Name	Example
**	Exponentiation	2 ** 8 equivalent to 2^8
*	Multiplication	10 * 3
/	Division	7 / 5 result is 1.4
//	Integer Division	7 // 5 result is 1
%	Remainder “modulo”	7 % 5 result is 2
+	Addition	1 + 1
-	Subtraction	111 - 1
-	Negation	-(1 + 1) result is -2

Order Of Operations

- P ()
- E **
- MD * / %
- AS + -
- Tie? Evaluate *Left to Right*

Addition +

- If numerical objects, add the values together
  - 1 + 1 “evaluates to” 2
  - 1.0 + 2.0 ⟶ 3.0
  - 1 + 2.0 ⟶ 3.0
- If strings, concatenate them
  - “Comp” + “110” ⟶ “Comp110”
- The result type depends on the operands
  - float + float ⟶ float
  - int + int ⟶ int
  - float + int ⟶ float
  - int + float ⟶ float
  - str + str ⟶ str

Addition +

- If numerical objects, add the values together
  - 1 + 1 → 2
  - 1.0 + 2.0 → 3.0
  - 1 + 2.0 → 3.0
- If strings, concatenate them
  - “Comp” + “110” → “Comp110”
- The result type depends on the operands
  - float + float → float
  - int + int → int
  - float + int → float
  - int + float → float
  - str + str → str

Question: What happens when you try to add incompatible types?

Subtraction/Negation -

- Meant strictly for numerical types
  - 3 - 2 → 1
  - 4.0 - 2.0 → 2.0
  - 4.0 - 2 → 2.0
  - - (1 + 1) → -2
- The result type depends on the operands
  - float - float → float
  - int - int → int
  - float - int → float
  - int - float → float

Multiplication *

- If numerical objects, multiply the values
  - 1 * 1 → 1
  - 1.0 * 2.0 → 2.0
  - 1.0 * 2 → 2.0
- If string and int, repeat the string int’s number of times
  - “Hello” * 3 → “HelloHelloHello”
- The result type depends on the operands
  - float * float → float
  - int * int → int
  - float * int → float
  - int * float → float
  - str * int → str

Question: What happens when you try `str * float`?

Division /

- Meant strictly for numerical types
  - 3 / 2 → 1.5
  - 4.0 / 2.0 → 2.0
  - 4 / 2 → 2.0
- Division results in a float
  - float / float → float
  - int / int → float
  - float / int → float
  - int / float → float
- For integer division // , the result type depends on the operands
  - int // int → int
  - float // float → float
  - float // int → float
  - int // float → float

Remainder “modulo”

- Calculates the *remainder* when you divide two numbers
- Meant strictly for numerical types
  - 5 % 2 ⟶ 1
  - 6 % 3 ⟶ 0
- The result type depends on the operands
  - int % int ⟶ int
  - float % float ⟶ float
  - float % int ⟶ float
  - int % float ⟶ float
- Note:
  - If x is even, x % 2 ⟶ 0
  - If x is odd, x % 2 ⟶ 1

Exponentiation **

- Meant strictly for numerical types
  - 2 ** 2 → 4
  - 2.0 ** 2.0 → 4.0
- The result type depends on the operands
  - float ** float → float
  - int ** int → int
  - float ** int → float
  - int ** float → float

Order Of Operations

- P ()
- E **
- MD * / %
- AS + -
- Tie? Evaluate *Left to Right*

Relational Operators

- Always result in a bool (True or False) value
- Equals (==) and Not Equal (!=)
  - ! is commonly used in programming languages to represent the word “not”
  - Can be used for all primitive types we’ve learned so far! (bool, int, float, str)
- Greater than (>), at least (>=), less than (<), at most (<=)
  - Just use on floats and ints
  - (Can *technically* use on all primitive types, but it might not evaluate in ways you’d expect!)

Relational Operators

Operator Symbol	Verbalization	`True` Ex.	`False` Ex.
`==`	Is equal to?	`1 == 1`	`1 == 2`
`!=`	Is NOT equal to?	`1 != 2`	`1 != 1`
`>`	Is greater than?	`1 > 0`	`0 > 1`
`>=`	Is at least?	`1 >= 0` or `1 >= 1`	`0 >= 1`
`<`	Is less than?	`0 < 1`	`1 < 0`
`<=`	Is at most?	`0 <= 1` or `1 <= 1`	`1 <= 0`

Practice: Operators and Expressions

Discuss these questions with your neighbor and jot the answers down.

1. What is the result of evaluating `10 % 3`? What about `10 // 3`? `10 ** 3`?

2. Is there an error in the expression, `“CAMP” + 110`? If so, how would you fix it such that the `+` symbol is evaluated to be **concatenation**?

3. What is the evaluation of the expression `10 / 4`? What types are the operands (`10` and `4`), what type does the expression evaluate to?

4. What is the evaluation of the expression `2 - 6 / 3 + 4 * 5`?

Practice! Simplify and Type

- 2 + 4 / 2 * 2

- 220 >= int((“1” + “1” + “0”) * 2)

Simplify: 2 + 4 / 2 * 2

(Reminder: P E M D A S)

Simplify: 2 + 4 / 2 * 2

What type is 2 + 4 / 2 * 2?

Simplify:

```
220 >= int((“1” + “1” + “0”) * 2)
```

Mods Practice! Simplify

- 7 % 2
- 8 % 4
- 7 % 4
- Any even number % 2
- Any odd number % 2