香港中文大學(深圳)
The Chinese University of Hong Kong, Shenzhen

Introduction to Computer Science: Programming Methodology

Lecture 2 Python Basics

Prof. Yunming XIAO

School of Data Science

Parselmouth

Parseltongue is the language of serpents and those who can converse with them. An individual who can speak Parseltongue is known as a Parselmouth. It is very uncommon skill, and may be hereditary. Nearly all known Parselmouths are descended from Salazar Slytherin.

https://harrypotter.wikia.com/wiki/Parseltongue

Pythonista

Python is the language of Python interpreter and those who can converse with them. An individual who can speak Python is known as a Pythonista. It is very uncommon skill, and may be hereditary. Nearly all known Pythonistas use software initially developed by Guido van Rossum

Most popular programming language

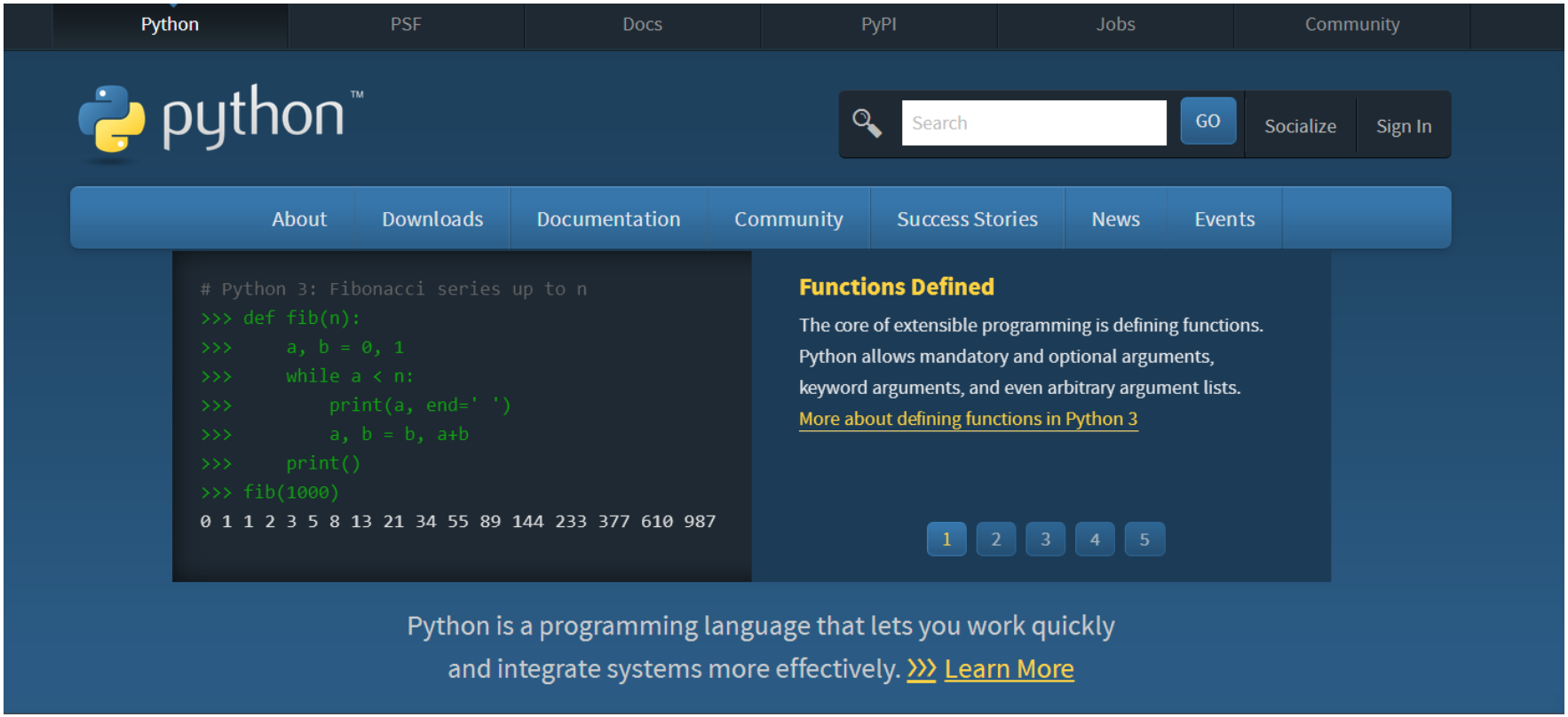
Aug 2025	Aug 2024	Change	Programming Language	Ratings	Change
1	1		Python	26.14%	+8.10%
2	2		C++	9.18%	-0.86%
3	3		C	9.03%	-0.15%
4	4		Java	8.59%	-0.58%
5	5		C#	5.52%	-0.87%
6	6		JavaScript	3.15%	-0.76%
7	8	↑	Visual Basic	2.33%	+0.15%
8	9	↑	Go	2.11%	+0.08%
9	25	⇈	Perl	2.08%	+1.17%
10	12	↑	Delphi/Object Pascal	1.82%	+0.19%

https://www.tiobe.com/tiobe-index/

Early learners: syntax error

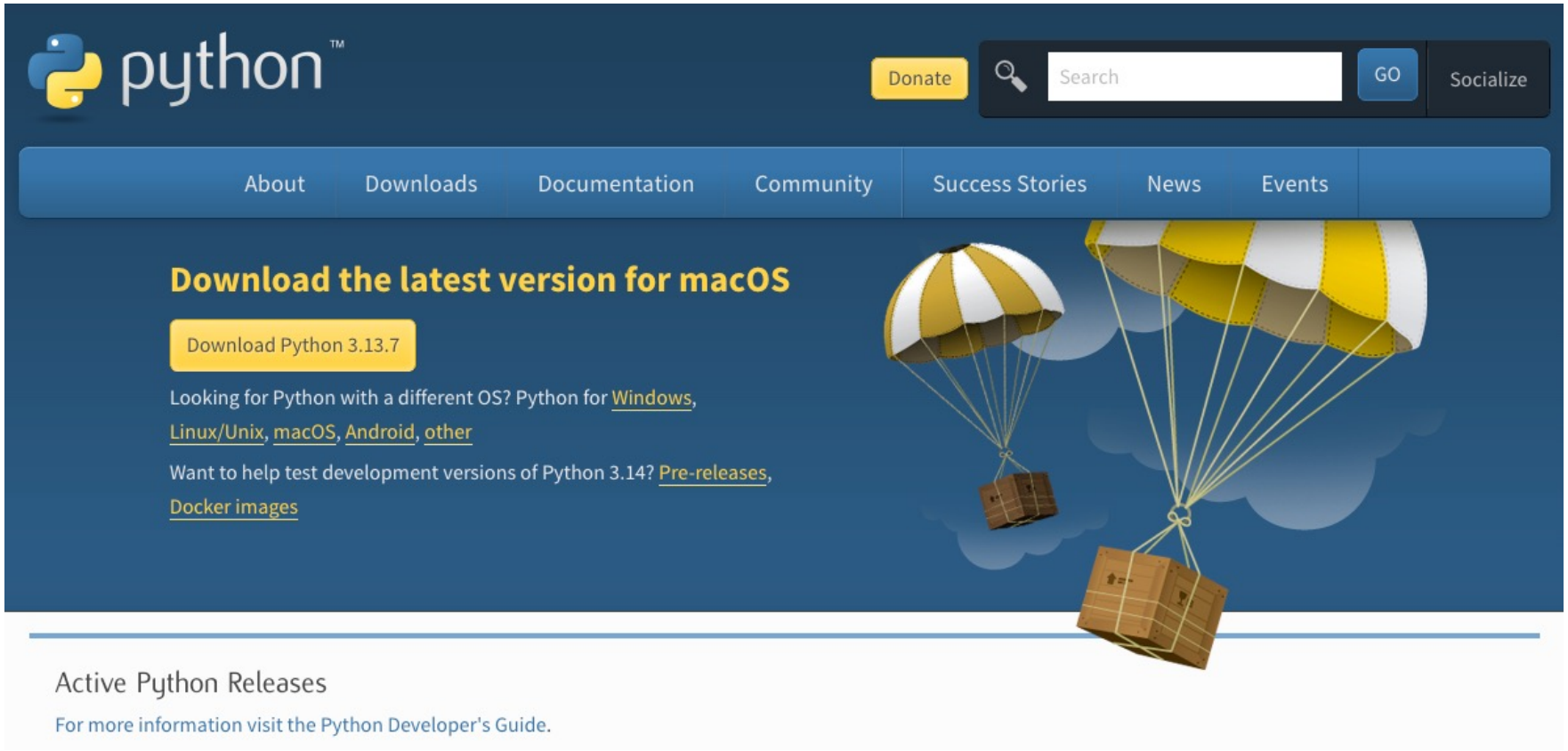
- We need to learn the Python language so we can communicate our instructions to Python. In the beginning we will make lots of mistakes and speak gibberish like small children
- When you make a mistake, the computer does not think you are "cute". It says "syntax error" – given that it "knows" the language and you are just learning it. It seems like Python is cruel and unfeeling
- You must remember that you are intelligent and can learn, while the computer is simple and very fast – but cannot learn (without AI)
- It is easier for you to learn Python than for the computer to learn human language

Installing Python



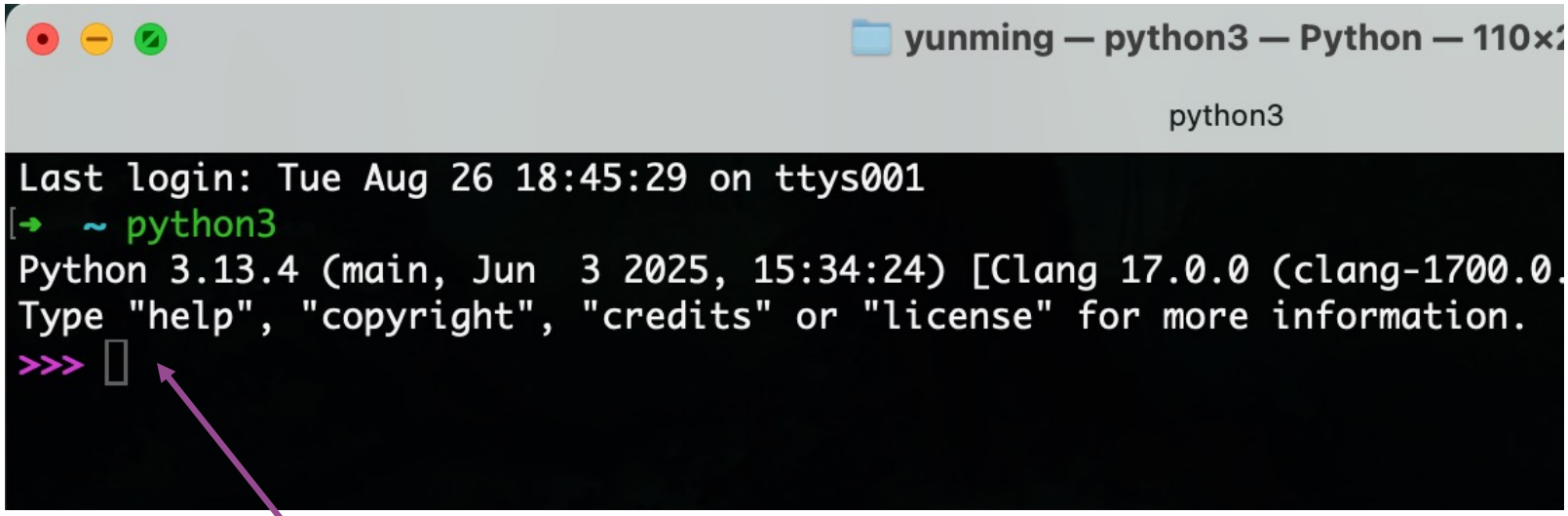
https://www.python.org

Installing Python



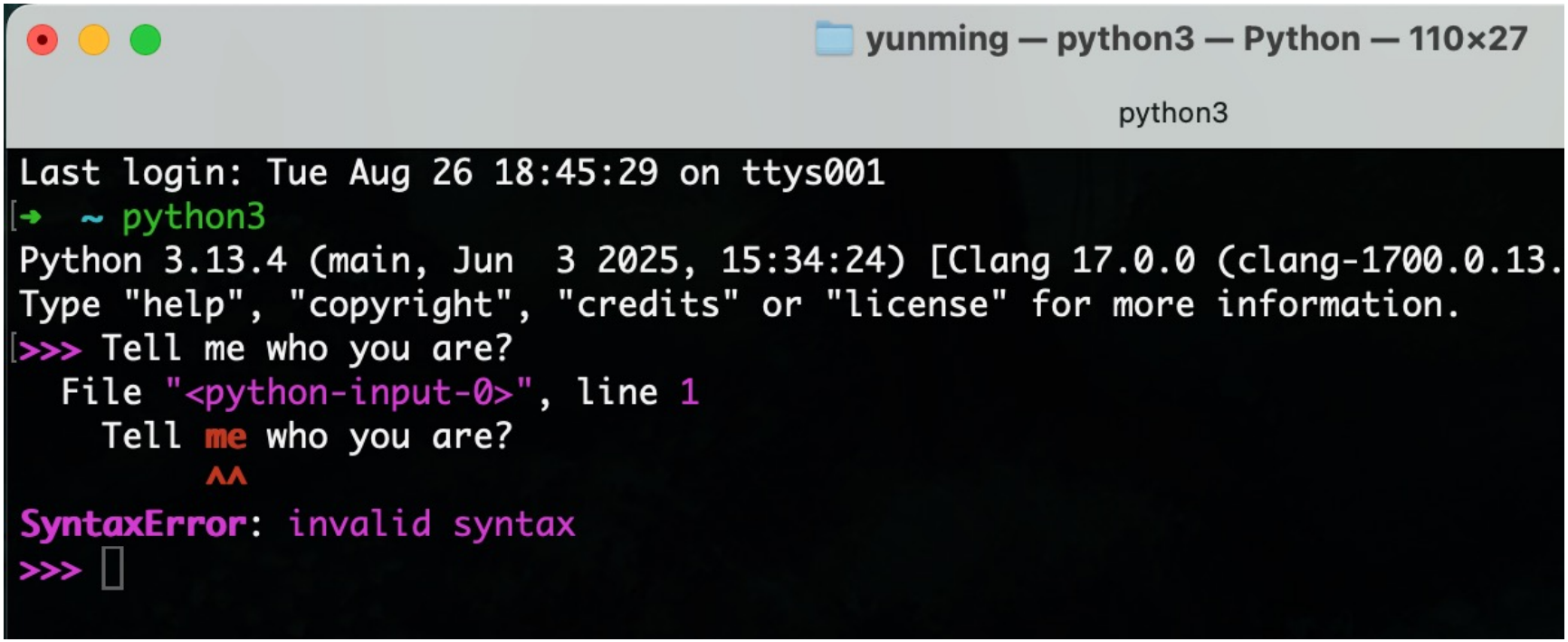
https://www.python.org/download

Python shell

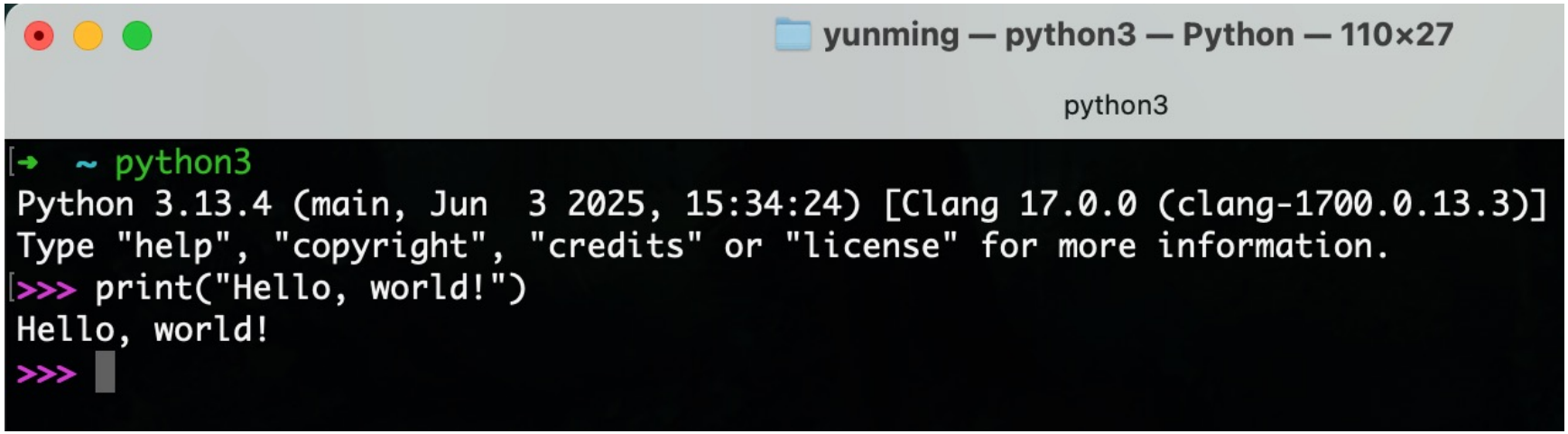


What is next?

Syntax error



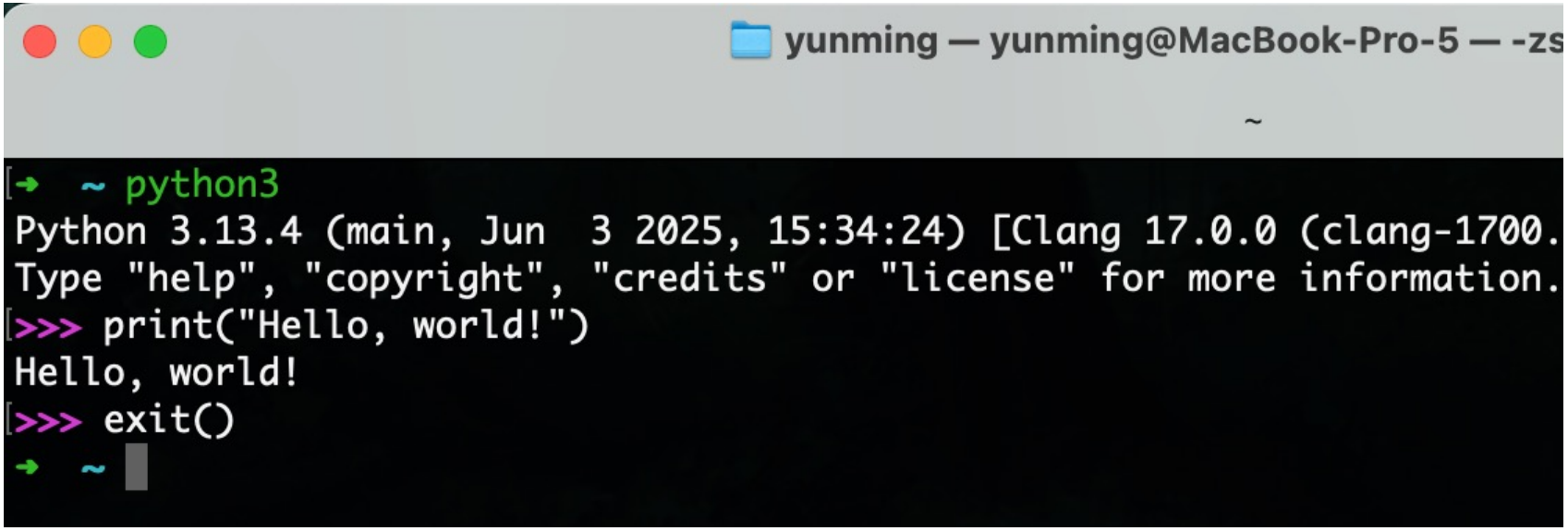
Hello, world!



- You must say something that Python interpreter can understand!!

- Print() is a function in Python

Exit()

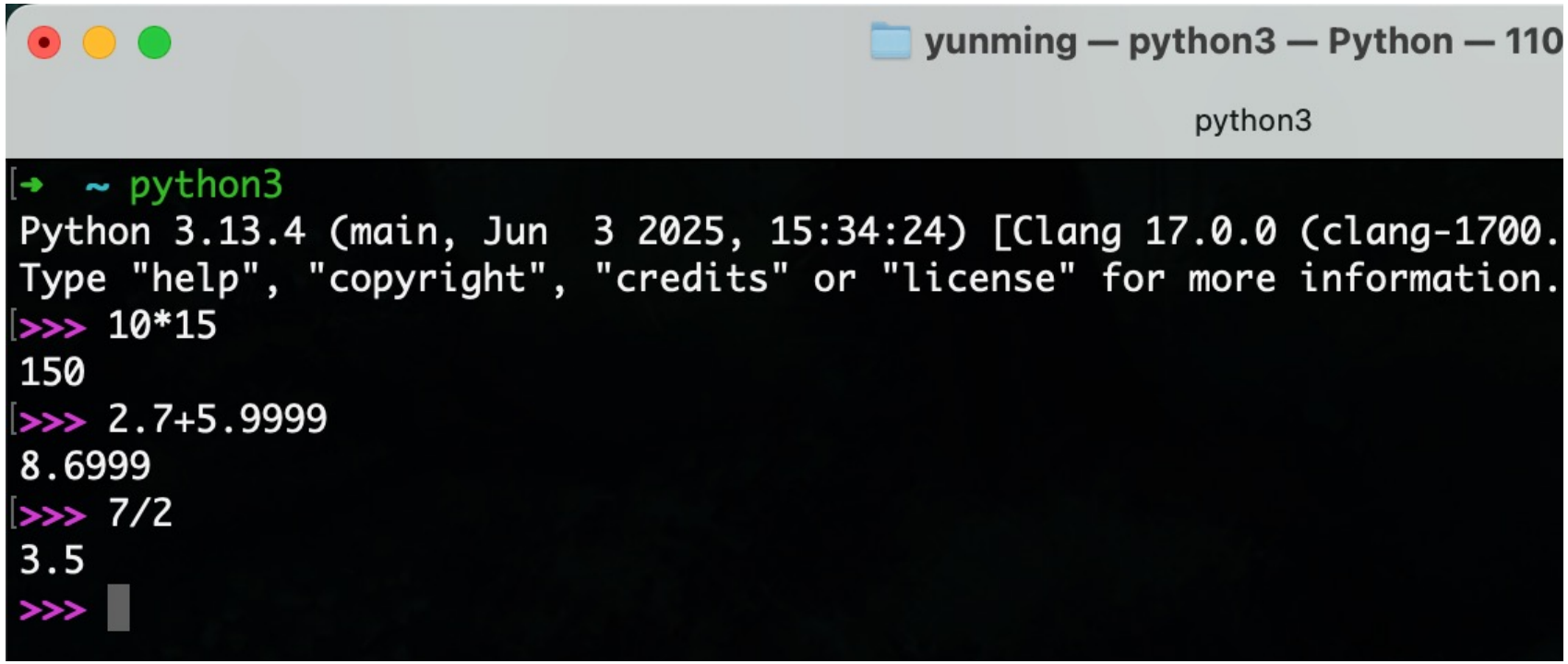

yunming — yunming@MacBook-Pro-5 — -zs
~
➜ ~ python3
Python 3.13.4 (main, Jun 3 2025, 15:34:24) [Clang 17.0.0 (clang-1700.
Type "help", "copyright", "credits" or "license" for more information.
>>> print("Hello, world!")
Hello, world!
>>> exit()
➜ ~

What should we say to Python?

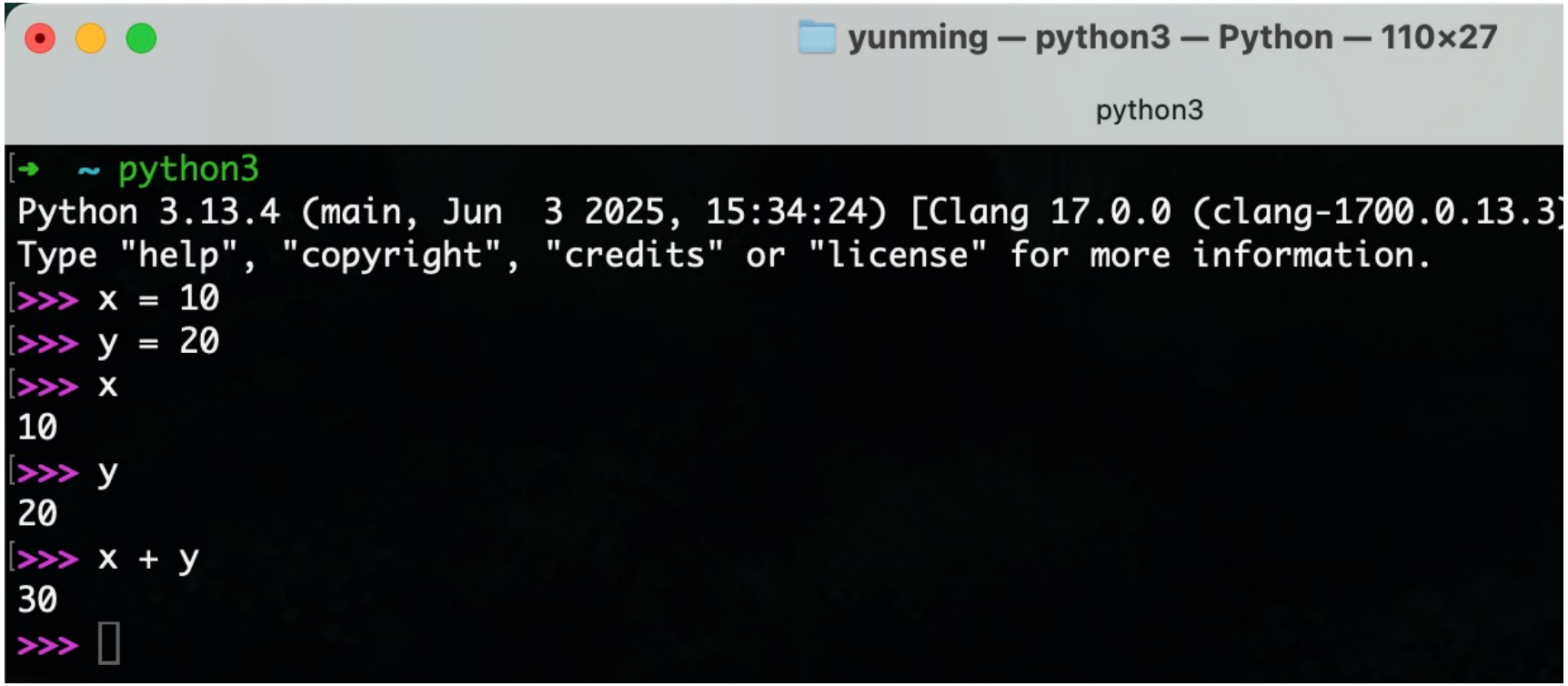
Elements of Python language

- Vocabulary/words – Variables and Reserved words
- Sentence structure – valid syntax patterns
- Story structure – constructing a meaningful program for some purposes

Use Python as a calculator



Variables

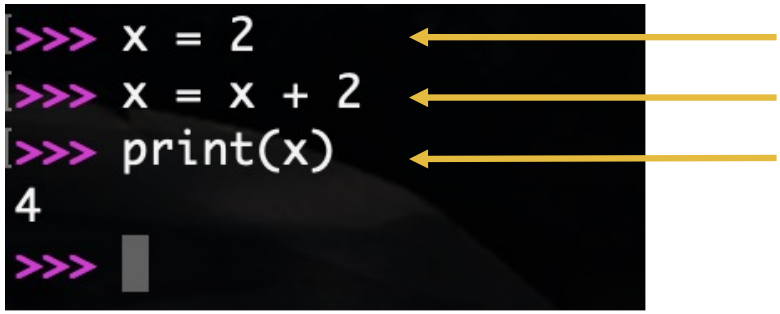

yunming — python3 — Python — 110×27
python3
~ python3
Python 3.13.4 (main, Jun 3 2025, 15:34:24) [Clang 17.0.0 (clang-1700.0.13.3]
Type "help", "copyright", "credits" or "license" for more information.
>>> x = 10
>>> y = 20
>>> x
10
>>> y
20
>>> x + y
30
>>>

Reserved words

- You cannot use the following words as variables

```
False    None     True     and      as       assert   break
class    continue def      del      elif     else     except
finally  for      from     global   if       import   in
is       lambda   nonlocal not      or       pass     raise
return   try      while    with     yield
```

Sentences or lines



Assignment statement
Assignment with expressions
Print statement (output statement)

Programming scripts

- Interactive Python is good for experiments and programs of 3-4 lines long
- Most programs are much longer, so we need to type them in a file and execute them all together
- In this sense, we are giving Python a script
- As convention, ".py" is added as the suffix on the end of these files

Interactive vs. script

- Interactive

✓ You type directly to Python one line at a time and it responds

- Script

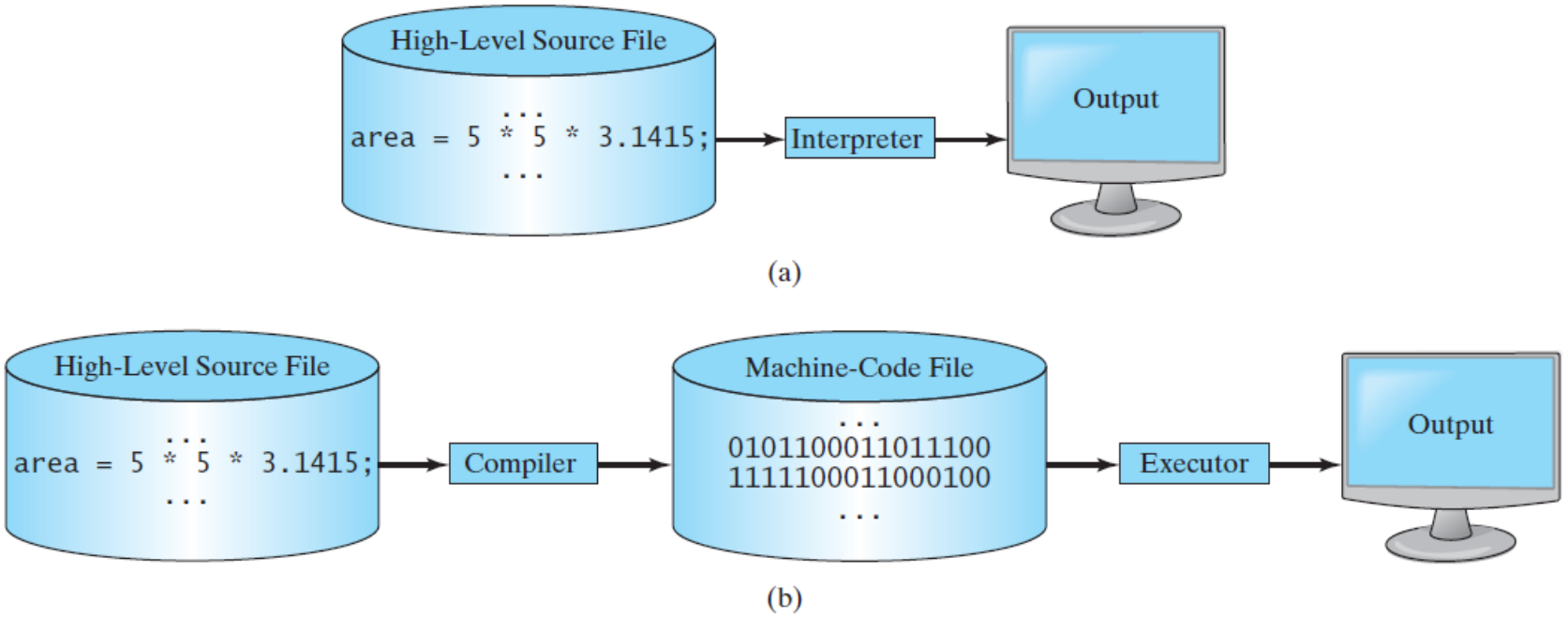
✓ You enter a sequence of statements (lines) into a file using a text editor and tell Python to execute the file

Interpreter vs. compiler

- Interpreter (解释器) is a computer program that directly executes, i.e. performs, instructions written in a programming or scripting language, without compiling them into a machine language program beforehand

- A compiler (编译器) is a computer program (or a set of programs) that transforms source code written in a programming language (the source language) into another computer language (the target language), with the latter often having a binary form known as object code

Interpreter vs. compiler



Example of compiler

- For C programs, they need to be compiled first using `gcc` before execution

```
➜  code ls lecture2-compiler.c
lecture2-compiler.c
➜  code gcc -o lecture2-compiler lecture2-compiler.c
➜  code ls
lecture2-compiler           lecture2-conditional-flow.py
lecture2-compiler.c         lecture2-divmod.py
lecture2-compiler.cpp       lecture2-floor-division.py
➜  code ./lecture2-compiler
Hello, World!
➜  code
```

Example of interpreter

- For Python programs, they don't need to be compiled first before execution
- By calling `python3`, it will execute the program with an interpreter

```
[➜  code ls lecture2-hello-world.py
lecture2-hello-world.py
[➜  code cat lecture2-hello-world.py
print("Hello, World!")
[➜  code python3 lecture2-hello-world.py
Hello, World!
➜  code
```

Does Python use interpreter or compiler?

- By default, Python programs are executed by an interpreter
- But it is possible to compile Python programs
  - (numba, cython, etc)

What's the difference?

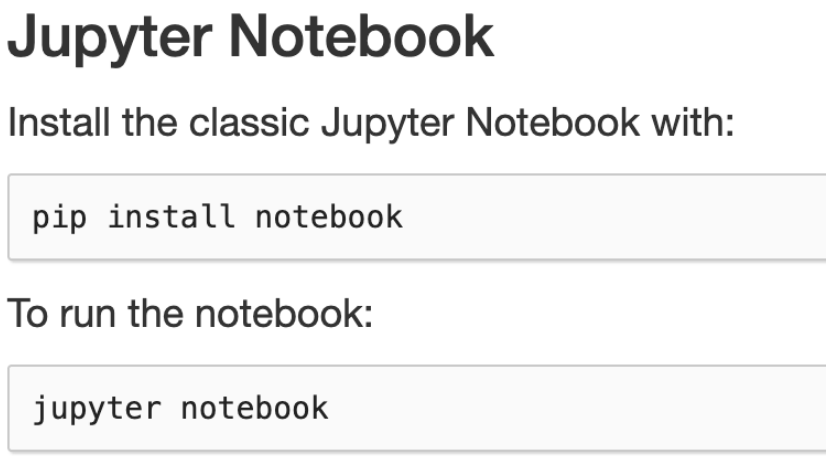
- Compiling first allows the program to run more efficiently, i.e., faster

```
(venv) ➜  code python3 lecture2-hardwork.py
Computing sum of squares for N=3000000
Result: 8999995500000500000
Time elapsed: 0.160 seconds
```

```
(venv) ➜  code gcc -o lecture2-hardwork-c lecture2-hardwork-c.c
(venv) ➜  code ./lecture2-hardwork-c
C result: 8999995500000500000
Time: 0.010057 s
(venv) ➜  code
```

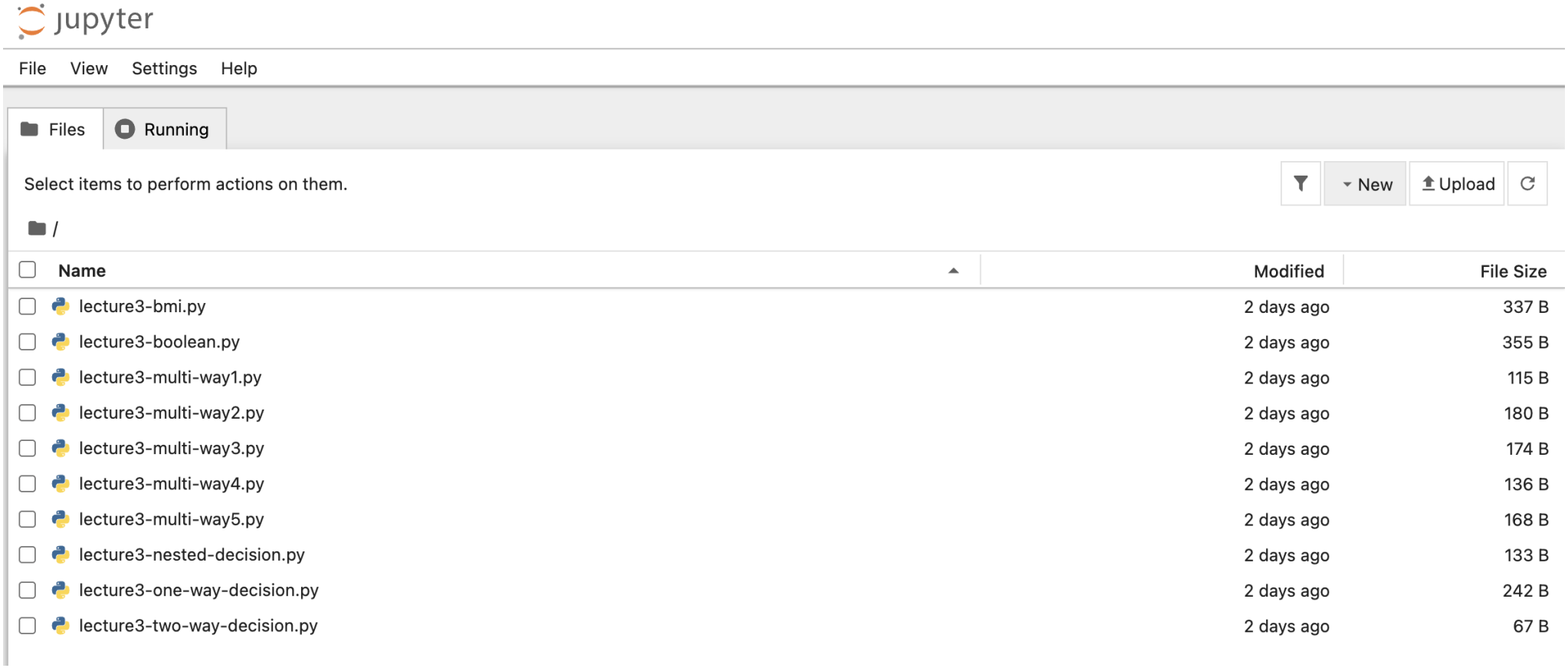
A new interactive interface of Python

- Jupyter notebook allows you to easily store and replicate all commands used in the interactive mode
- Widely used in AI and many research communities to allow others to easily replicate what they've done
- How to install? -> https://jupyter.org/install



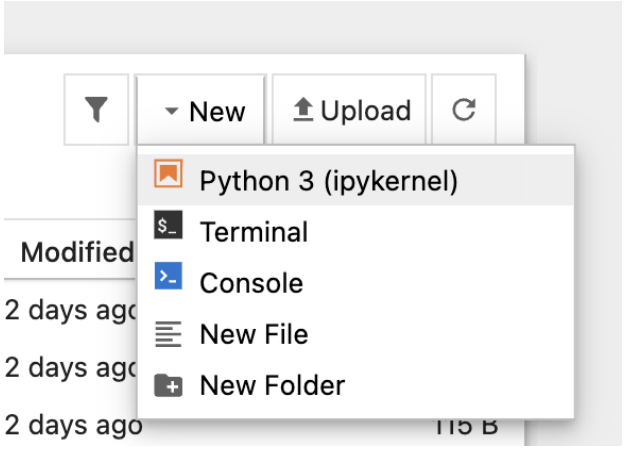
Usage

- Type `jupyter notebook` in the command line/Terminal



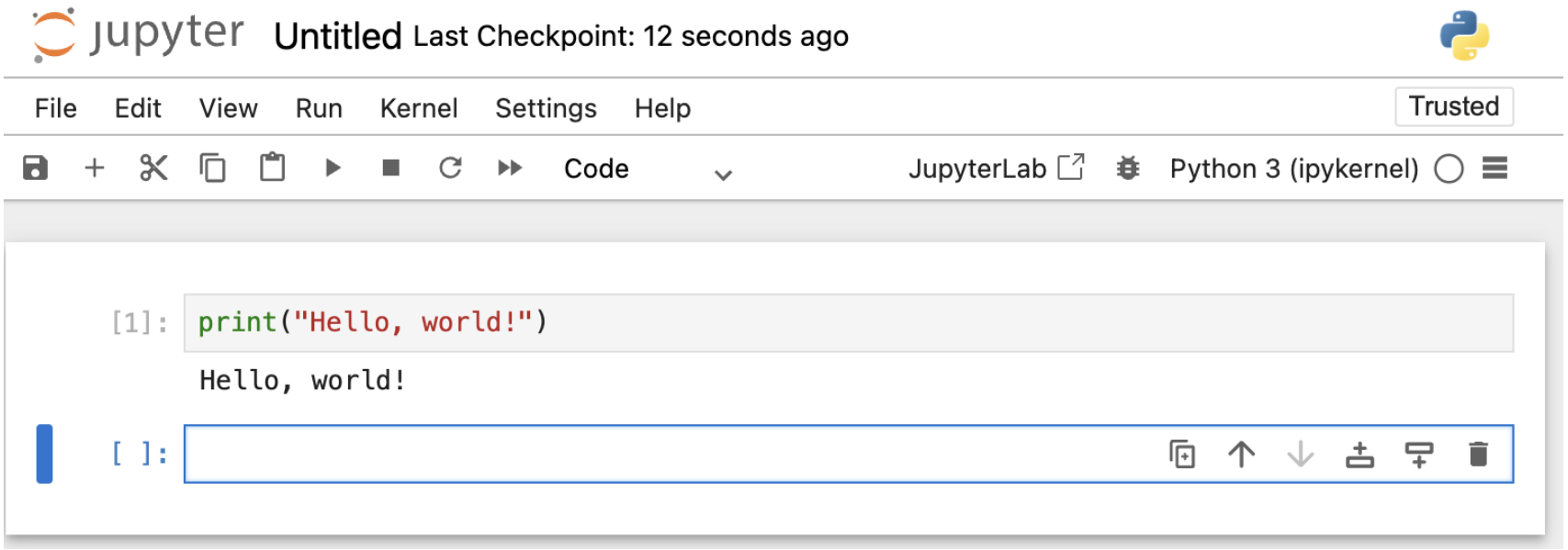
Usage

- Create a new interactive notebook, or open any existing notebooks/scripts



Interactive notebook

- Execute code block by block, and in each block, you can
  - Put in multiple lines that serve the same purpose
  - Try multiple times until the output is expected!



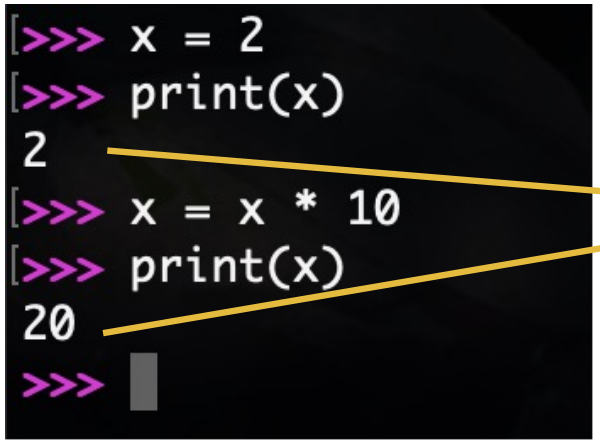
The real class starts from here

Program steps or program flow

- Like a recipe, a program is a sequence of steps to be done in pre-determined order
- Some steps are conditional, i.e. they may be skipped
- Sometimes, we will repeat some steps
- Sometimes, we store a set of steps to be used over and over again in future as needed

Sequential flow

Execute sequentially



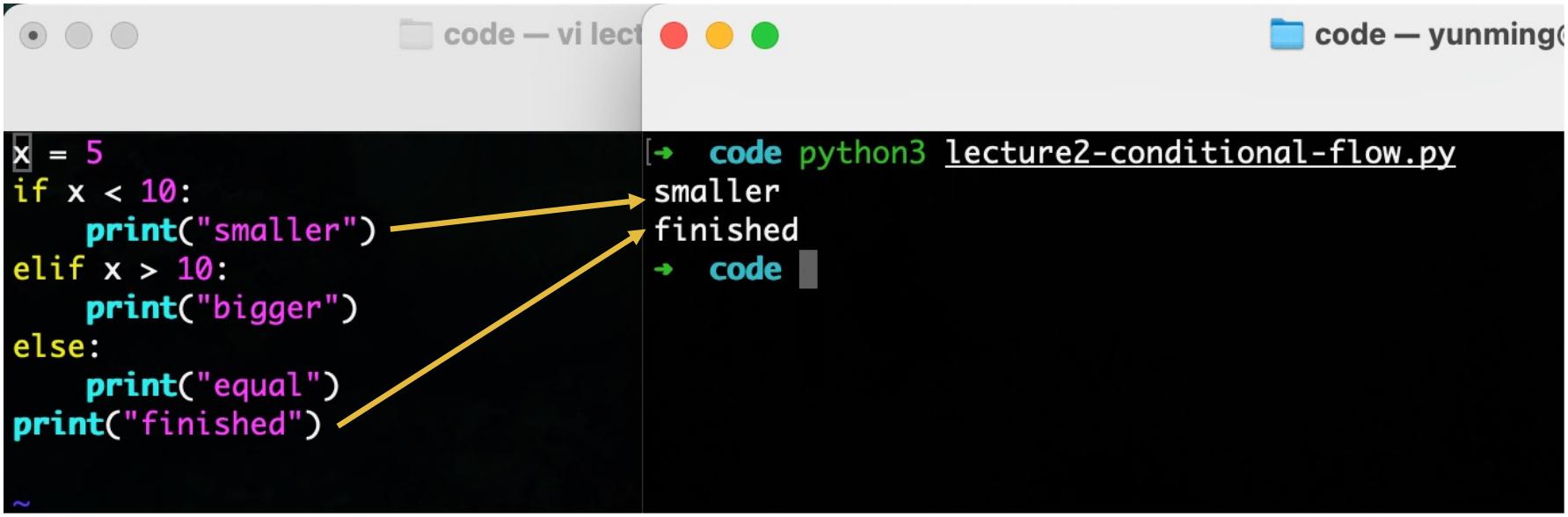
Outputs

- When a program is running, it flows from one step to the next
- We as programmers, set up "paths" for the program to follow

Conditional flow

Program

Outputs



Repeated flow

Program

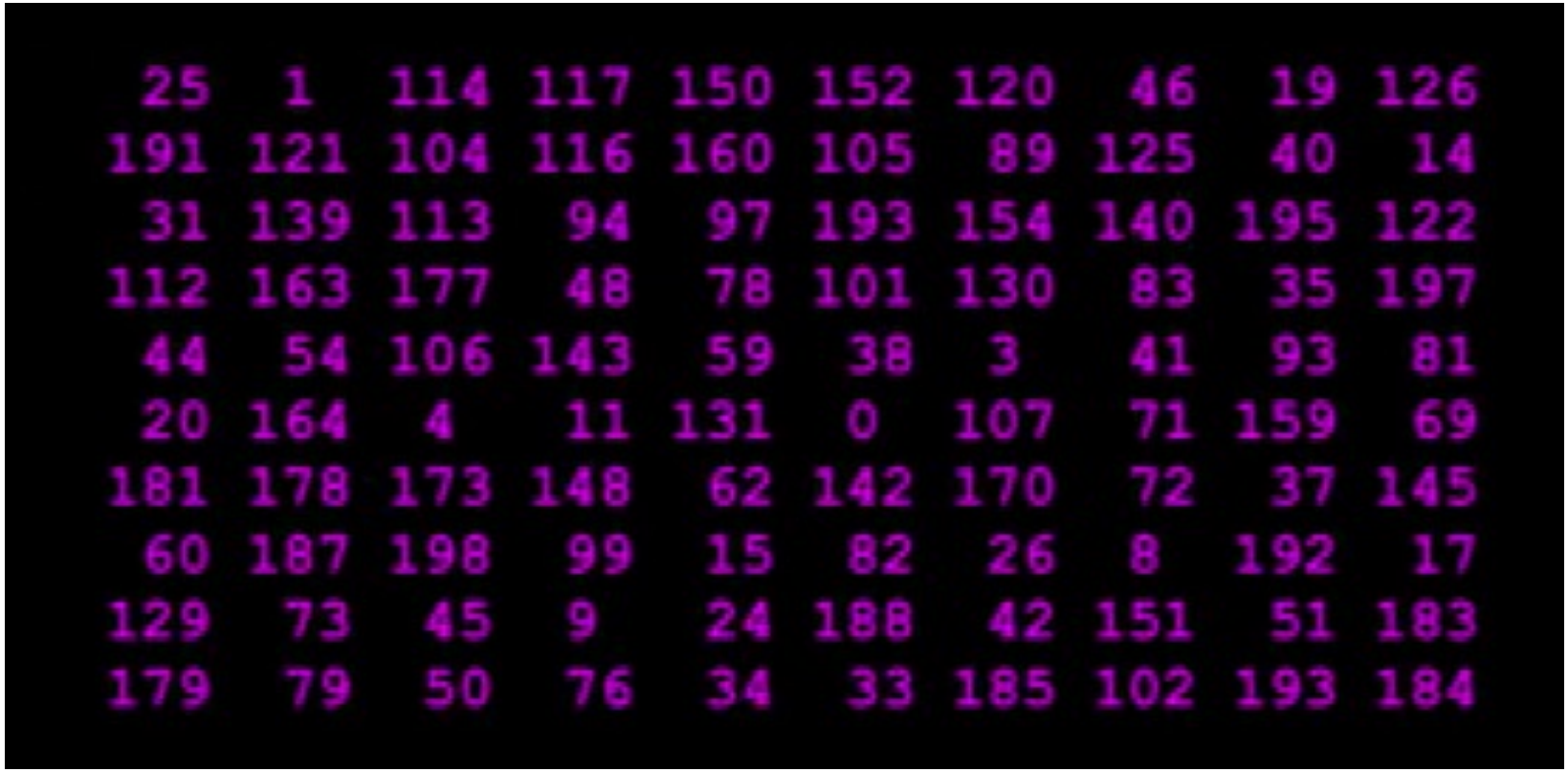
```
n = 5
while n > 0:
    print(n)
    n = n - 1
print("finished")
```

Outputs

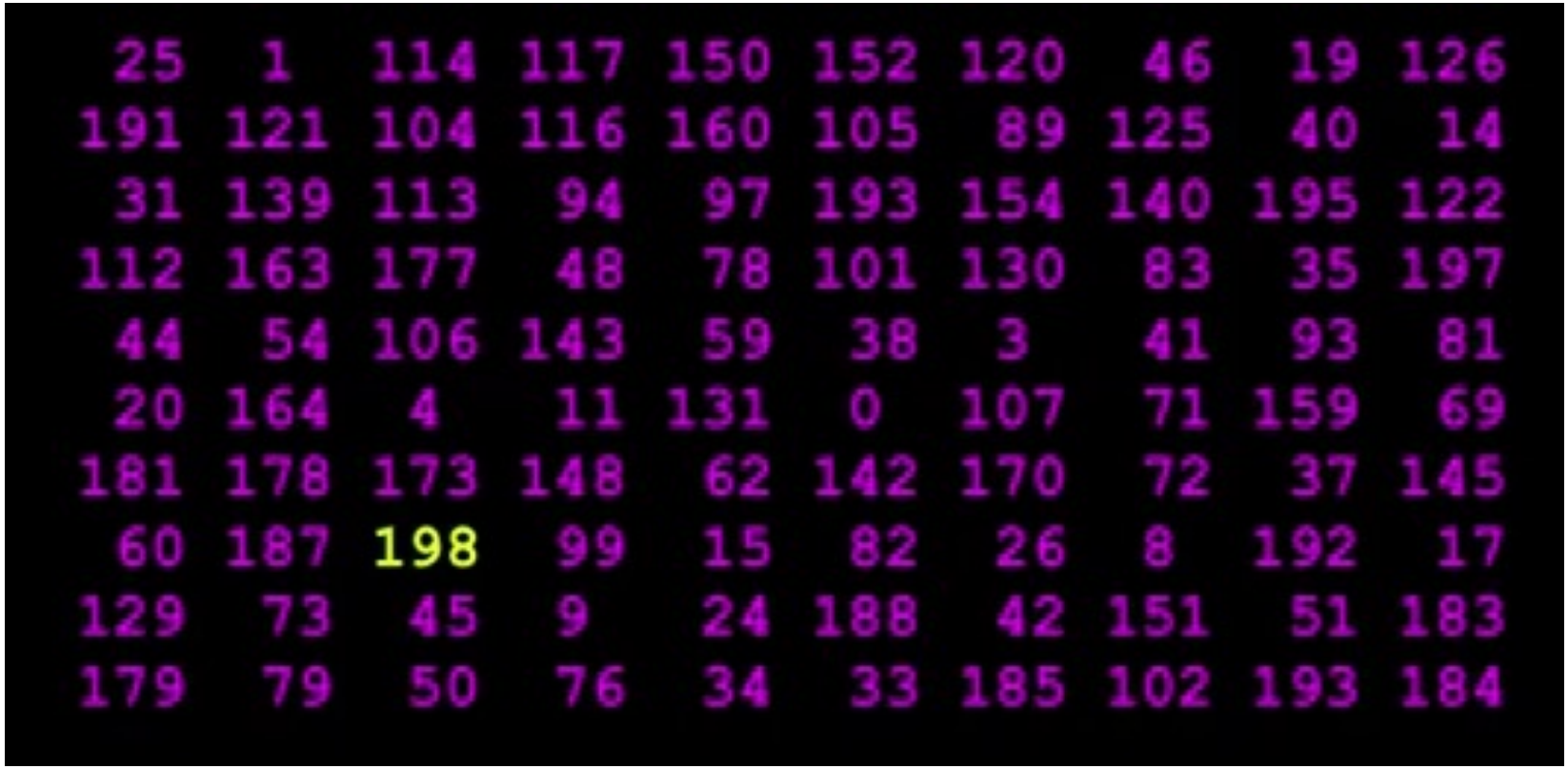
```
code python3 lecture2-repeated-flow.py
5
4
3
2
1
finished
code
```

- Loops (repeated steps) have iterative variables that change each time through a loop
- Often these iterative variables go through a sequence of numbers

What is the largest number?



What is the largest number?



Constants

- Fixed values such as numbers and letters are called constants, since their values won't change

- String constants use single-quotes (') or double-quotes (")

Variable

- A variable is a named space in the memory where a programmer can store data and later retrieve the data using the variable name
- Variable names are determined by programmers
- The value of a variable can be changed later in a program

Rules for naming variables in Python

- Must start with a letter or underscore _
- Can only contain letters, numbers and underscore
- Case sensitive
- Good: apple, car, myNumber123, _light
- Bad: 456aaa, #ab, var.12
- Different: apple, Apple, APPLE

Most common naming methods

- Use meaningful words as variable names

- Camel case
  - Start with a lower-case letter
  - Capitalize the first letter of each word
  - Example: bankAccountID, numOfCards, …

- Snake case
  - Use lower-case letters in most cases
  - Use underscores to connect the words
  - Example: bank_account_id/bank_account_ID, num_cards, …

Bad example: what is this code doing?

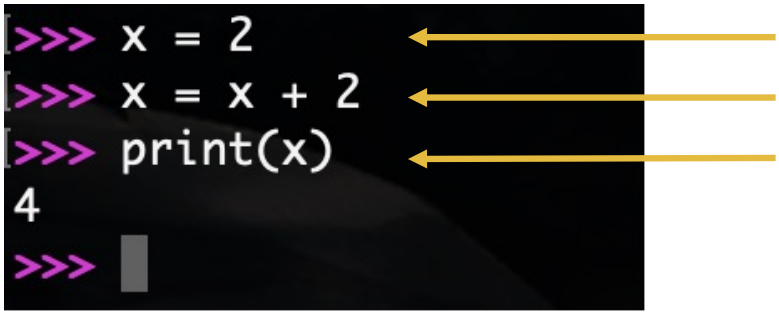
```
x1q3z9ocd = 35.0
x1q3z9afd = 12.50
x1q3p9afd = x1q3z9ocd * x1q3z9afd
print x1q3p9afd
```

Reserved words

- You cannot use the following words as variables

```
False    None     True     and      as       assert   break
class    continue def      del      elif     else     except
finally  for      from     global   if       import   in
is       lambda   nonlocal not      or       pass     raise
return   try      while    with     yield
```

Identify different elements in the code



Assignment statement
Assignment with expressions
Print statement (output statement)

Variable	Operator	Constant	Reserved words
x	= +	2	print

Assignment statement

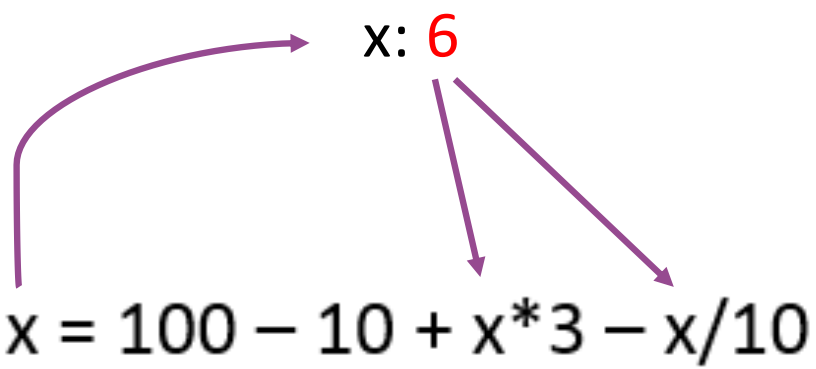
- We assign a value to a variable using the assignment operator (=)

- An assignment statement consists of an expression on the right-hand side, and a variable to store the result

Example: x = 100 – 10 + x*3 – x/10

Assignment statement

- There is a location in the memory for x
- Whenever the value of x is needed, it can be retrieved from the memory
- After the expression is evaluated, the result will be put back into x



Cascaded assignment

- We can set multiple variables into the same value using a single assignment statement

Example

```
>>> z = y = x = 2 + 7 + 2
>>> x, y, z
(11, 11, 11)
>>>
```

Simultaneous assignment

- The values of two variables can be exchanged using simultaneous assignment

  (not applicable in many other languages)

Example

```
>>> current_pwd = "deep_secret"    # Set current password
>>> old_pwd = "you'll never know"  # Set old password
>>> current_pwd, old_pwd
('deep_secret', "you'll never know")
>>> current_pwd, old_pwd = old_pwd, current_pwd  # Exchange the passwords
>>> current_pwd, old_pwd
("you'll never know", 'deep_secret')
```

Practice

- Write a program to exchange the values of two variables without using simultaneous assignment

Bad use of simultaneous assignment

```
# A bad use of simultaneous assignment
x, y = (45 + 34) / (21 - 4), 56 * 57 * 58 * 59
print(x, y)

# A better way of setting the values of x and y
x = (45 + 34) / (21 - 4)
y = 56 * 57 * 58 * 59
print(x, y)
```

Break

Order evaluation

- When we put operators together, Python needs to know which one to do first
- This is called “operator precedence”
- Which operator “takes precedence” over the others

Example: x = 1 + 2*3 – 4 / 5 ** 6

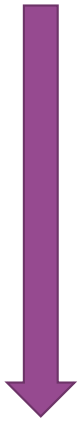
Numerical expression and operators

- We use some keys we have on the keyboard to denote the classic math operators
- Asterisk (*) is the multiplication operator
- Double asterisk (**) is used to denote Exponentiation (raise to a power)

Operator	Operation
+	Addition
-	Subtraction
*	Multiplication
/	Division
**	Power
%	Remainder

Operator precedence rules

- **Highest to lowest precedence rule**
  - Parenthesis are always with highest priority
  - Power
  - Multiplication, division and remainder
  - Addition and subtraction
  - Left to right



Operator precedence rules

Example: x = 1 + 2*(3 + 2) – 4 / 5 ** 6

Floor division

```
time = 257              # Time in seconds
minutes = time // 60  # Number of complete minutes in time
print("There are ", minutes, "complete minutes in", time, "seconds.")

print(143 // 25)
print(143.4 // 25)
print(9 // 2.5)

~
```

code — yunming@MacBook-Pro-5 — -zsh —

..1-25fall/code

```
➜  code python3 lecture2-floor-division.py
There are  4 complete minutes in 257 seconds.
5
5.0
3.0
➜  code
```

Floor division

```
time = 257         # Initialize time
SEC_PER_MIN = 60  # Use a "named constant" for 60
divmod(time, SEC_PER_MIN) # See what divmod() returns

# Use simulataneous assigment to obtain minutes and seconds
minutes, seconds = divmod(time, SEC_PER_MIN)

# Attempt to display the minutes and seconds in "standard" form
print(minutes, ":", seconds)

# Successfully attempt to display time in "standard" form
print(minutes, ":", seconds, sep="")

# Obtain number of quarters and leftover change in 143 pennies
quarters, cents = divmod(143, 25)
print(quarters, cents)
~
```

code — yunming@MacBook-Pro-5

..1-25fall/code

```
➜  code python3 lecture2-divmod.py
4 : 17
4:17
5 18
```

Floor division

- The general form of argument assignment looks like

<lvalue> <op>= <expression>

Example

```
>>> x = 22
>>> x += 7  # Equivalent to "x = x + 7"
>>> x
29
>>> x -= 2 * 7  # Equivalent to "x = x - (2 * 7)
>>> x
15
>>>
```

Personal tips

- Use parenthesis
- Keep mathematical expressions simple so that they are easy to understand
- Break up long series of math expressions to make them easy to understand

Integer division in Python

- In Python 2, Integer division truncates
- Integer division produces floating point numbers in Python 3
- The conversion between integer and floating-point numbers is done automatically in Python 3
- Things change between Python 2 and Python 3

Data type

- In Python, variables and constants have an associated "type"
- Python knows the difference between a number and a string
- Example:

```
>>> a = 100 + 200
>>> print(a)
300
>>> print(type(a))
<class 'int'>
>>>
>>> b = "100" + "200"
>>> print(b)
100200
>>> print(type(b))
<class 'str'>
>>>
```

Type matters

- Python knows what type everything is
- Some operations are prohibited on certain types
- You cannot “add 1” to a string
- We can check the type of something using function type()

Type of numbers

- Numbers in Python generally have two types:
  - Integers: 1, 2, 100, -20394209
  - Floating point numbers: 2.5, 3.7, 11.32309, -30.999

- There are other number types, which are variations on float and integer

Type can change

- The type of a variable can be dynamically changed
- A variable's type is determined by the value that is last assigned to the variable

```
>>> x = 7 * 3 * 2
>>> y = "is the answer to the ultimate question of life"
>>> print(x, y)
42 is the answer to the ultimate question of life
>>> x, y
(42, 'is the answer to the ultimate question of life')
>>> type(x), type(y)
(<class 'int'>, <class 'str'>)
>>>
>>> # Set x and y to new values
>>> x = x + 3.14159
>>> y = 123123321 * 987654321
>>> print(x, y)
45.14159 121603280001520041
>>> type(x), type(y)
(<class 'float'>, <class 'int'>)
>>>
```

Type conversion

- When an expression contains both integer and float, integers will be converted into float implicitly

- You can control this using functions int() and float()

```
>>> print(float(99)/100)
0.99
>>> i = 42
>>> type(i)
<class 'int'>
>>> f = float(i)
>>> print(f)
42.0
>>> type(f)
<class 'float'>
>>> print(1+2*float(3)/4-5)
-2.5
>>> print(int(1+2*float(3)/4-5))
-2
>>>
```

String conversion

- We can convert numbers into string using function str()

```
>>> str(5)              # Convert int to a string
'5'
>>> str(1 + 10 + 100)   # Convert int expression to a string
'111'
>>> str(-12.34)         # Convert float to a string
'-12.34'
>>> str("Hello World") # str() accepts string argument
'Hello World'
>>> str(divmod(14, 9)) # Convert tuple to a string
'(1, 5)'
>>> x = 42
>>> str(x)              # Convert int variable to a string
'42'
>>>
```

User input

- We can instruct Python to stop and take user inputs using function input()

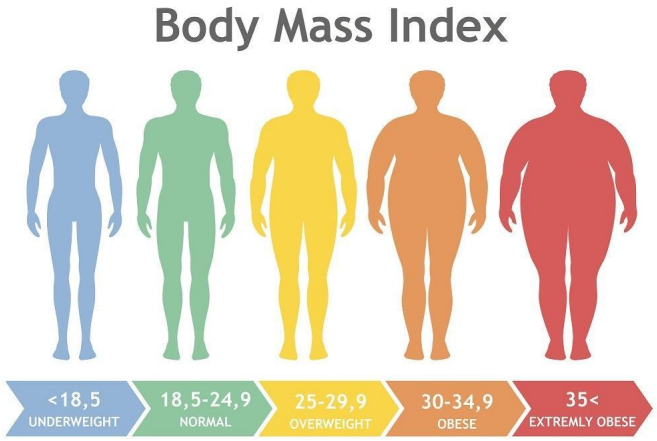
- The input() function returns a string

Type conversion

- The BMI (body mass index) of a human can be calculated using the following equation:

  BMI = weight (kg) ÷ height ^ 2 (m)

- Write a program to input a user's weight and height, and then output his BMI



Converting user input

- If we want to read a number using input(), we must then convert the input into a number using int() or float()

- Later we will deal with bad input data

Comments

- Anything after a “#” is ignored by Python

- Why comment?
  - Describe what is going to happen in a sequence of code
  - Document who wrote the code and other important information
  - Turn off a line of code – usually temporarily

String operations

- Some operators apply to strings
  - “+”: concatenation
  - “*”: multiple concatenation

- Python knows whether it is dealing with a number or a string

Practice

- Write a program to instruct the user to input two of his friends' names, and then output a sentence "I am the friend of XX and XX."

Output using print()

```
>>> print(42, "42")  # An int and a str that looks like an int
42 42
>>> print("3.14")    # A str that looks like a float
3.14
>>> print(3.14)      # A float
3.14
>>>
```

More details on print()

- We can learn more about a function, such as print(), using function help()

```
>>> help(print)
Help on built-in function print in module builtins:

print(*args, sep=' ', end='\n', file=None, flush=False)
    Prints the values to a stream, or to sys.stdout by default.

    sep
      string inserted between values, default a space.
    end
      string appended after the last value, default a newline.
    file
      a file-like object (stream); defaults to the current sys.stdout.
    flush
      whether to forcibly flush the stream.
Help on print line 1/13 (END) (press h for help or q to quit)
```

Examples

```
>>> print("I", "am", "Yunming Xiao")
I am Yunming Xiao
>>> print("I", "am", "Yunming Xiao", sep="")
IamYunming Xiao
>>> print("I", "am", "Yunming Xiao", sep=",")
I,am,Yunming Xiao
>>>
```

Examples

```
print("Test line 1")
print("Test line 2")

print("Test line 1", end="")
print("Test line 2")

print("Test line 1", end="---")
print("Test line 2")
```

```
[➜  code python3 lecture2-print.py
Test line 1
Test line 2
Test line 1Test line 2
Test line 1---Test line 2
```

A powerful function – eval()

- The eval() function takes a string argument and evaluates that string as a Python expression, i.e., just as if the programmer had directly entered the expression as code
- The function returns the result of that expression
- Eval() gives the programmers the flexibility to determine what to execute at run-time
- one should be cautious about using it in situations where users could potentially cause problems with “inappropriate” input

Example

```
>>> string = "5 + 12"  # Create a string
>>> print(string)      # Print the string
5 + 12
>>> eval(string)       # Evaluate the string
17
>>> print(string, "=", eval(string))
5 + 12 = 17
>>> eval("print('Hello World!')")  # We can call functions from eval()
Hello World!
>>> # Using eval() we can accept all kinds of input
>>> age = eval(input("Enter your age: "))
Enter your age: 28
>>> age
28
>>> age = eval(input("Enter your age: "))
Enter your age: 20 + 8 + 0.5
>>> age
28.5
>>>
```

Example

```
>>> eval("10, 32")   # String with comma-separated values
(10, 32)
>>> x, y = eval("10, 20 + 12") # Use simultaneous assignment
>>> x, y
(10, 32)
>>> x, y = eval(input("Enter x and y: "))
Enter x and y: 5 * 2, 32
>>> x, y
(10, 32)
>>>
```

Please help to make this class better!

https://forms.cloud.microsoft/r/euzTPwjksR

Thanks