CSIT110

Fundamental Programming with Python

Input Output

Basic Data Types

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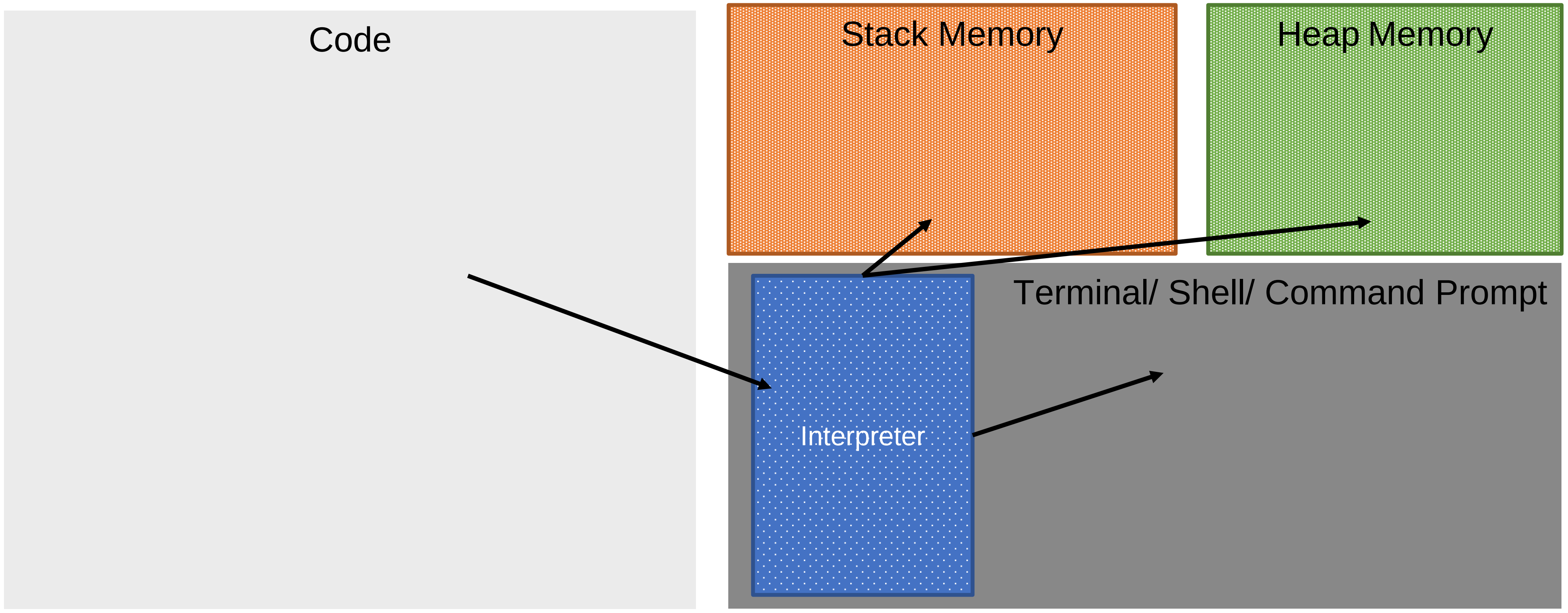
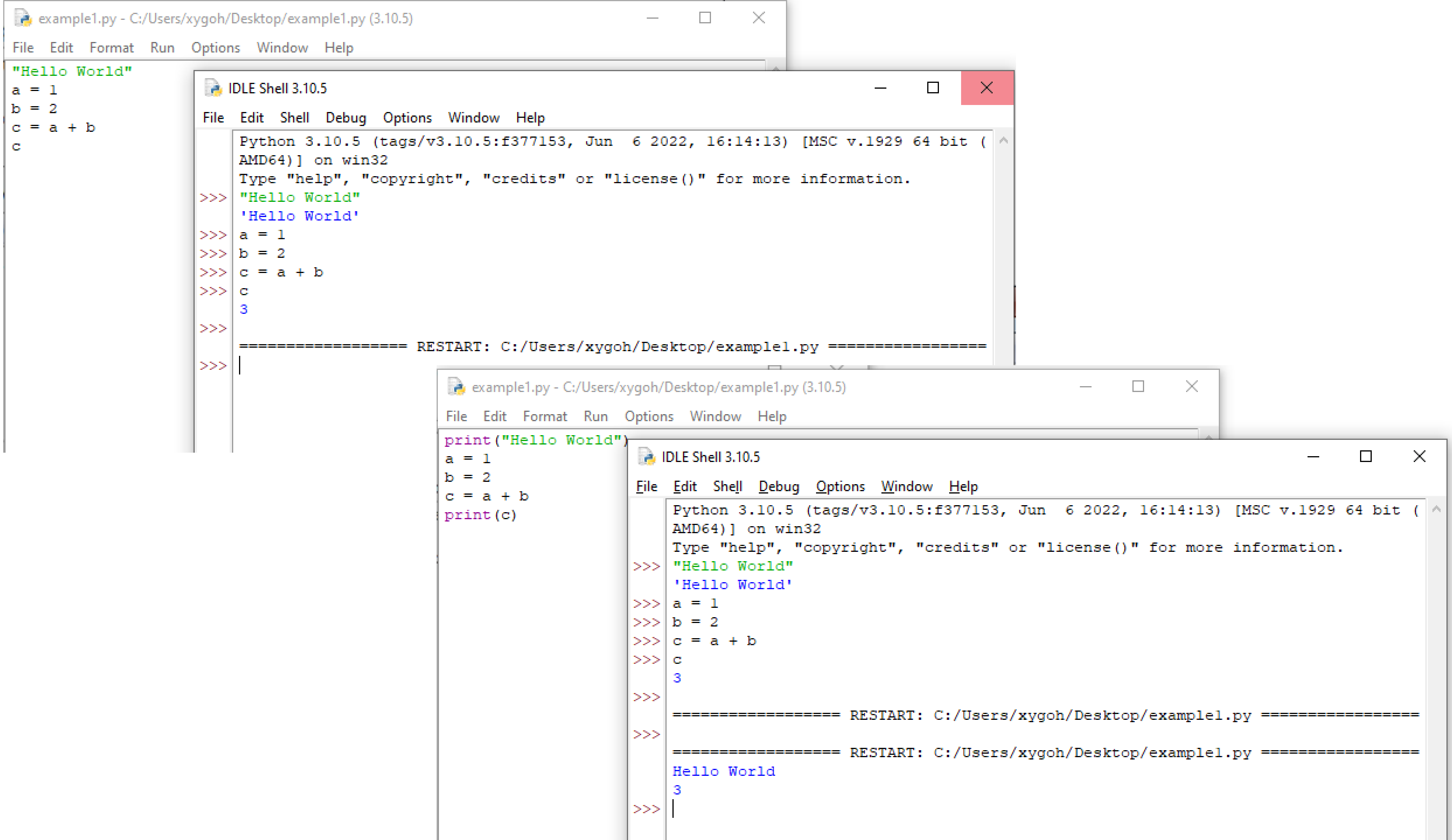
In this lecture

- `id()` function
- Display to console
  - `print()` function
- Variables & Data types
- Convert between data types
- Input
  - `input()` function
- More terminologies

Recall


Code
Stack Memory
Heap Memory
Terminal/ Shell/ Command Prompt
Interpreter


example1.py - C:/Users/xygoh/Desktop/example1.py (3.10.5)
File Edit Format Run Options Window Help

```
"Hello World"
a = 1
b = 2
c = a + b
c
```

IDLE Shell 3.10.5
File Edit Shell Debug Options Window Help

```
Python 3.10.5 (tags/v3.10.5:f377153, Jun  6 2022, 16:14:13) [MSC v.1929 64 bit (
AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> "Hello World"
'Hello World'
>>> a = 1
>>> b = 2
>>> c = a + b
>>> c
3
>>> 
================== RESTART: C:/Users/xygoh/Desktop/example1.py =================
>>> 
```

example1.py - C:/Users/xygoh/Desktop/example1.py (3.10.5)
File Edit Format Run Options Window Help

```
print("Hello World")
a = 1
b = 2
c = a + b
print(c)
```

IDLE Shell 3.10.5
File Edit Shell Debug Options Window Help

```
Python 3.10.5 (tags/v3.10.5:f377153, Jun  6 2022, 16:14:13) [MSC v.1929 64 bit (
AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> "Hello World"
'Hello World'
>>> a = 1
>>> b = 2
>>> c = a + b
>>> c
3
>>> 
================== RESTART: C:/Users/xygoh/Desktop/example1.py =================
>>> 
================== RESTART: C:/Users/xygoh/Desktop/example1.py =================
Hello World
3
>>> 
```

print()

Output to console:

```
print(...variable_name...)
```

Code example in the terminal

```
>>>x = 1 + 2
>>>x
3
>>> x + 3
6
```

Code example in a .py file

```
x = 1 + 2
print(x)
print(x+3)
```

```
3
6
```

Variables

ALWAYS use variables with **meaningful names** and **correct data types**

```
first_name = "John"
last_name = "Smith"
age = 20
```

NEVER use variable like a, b, c, x, y, z, or blah...

```
n1 = "John"
n2 = "Smith"
a = 20
```

Data Types

Each object has a data type.

Basic Data Types

- Numeric
  - Integer e.g. 1,2,3,4
  - Float e.g. 1.234
  - Complex Number 12+34j
- String
- Boolean
- Date
- NoneType

type()

Checking data type:

```
type(...variable_name...)
```

Data Types – Integer [int]

Integer: whole numbers

```python
age = 20
temperature = -5
credit_point = 6
type(age)
print(type(temperature))
print(type(credit_point))
```

```
<class 'int'>
<class 'int'>
```

Data Types – Float [`float`]

Float: decimal numbers

```
price = 30.5
interest_rate = 3.18
print(type(price))
print(type(interest_rate))
```

```
<class 'float'>
```

Data Types – Complex [`complex`]

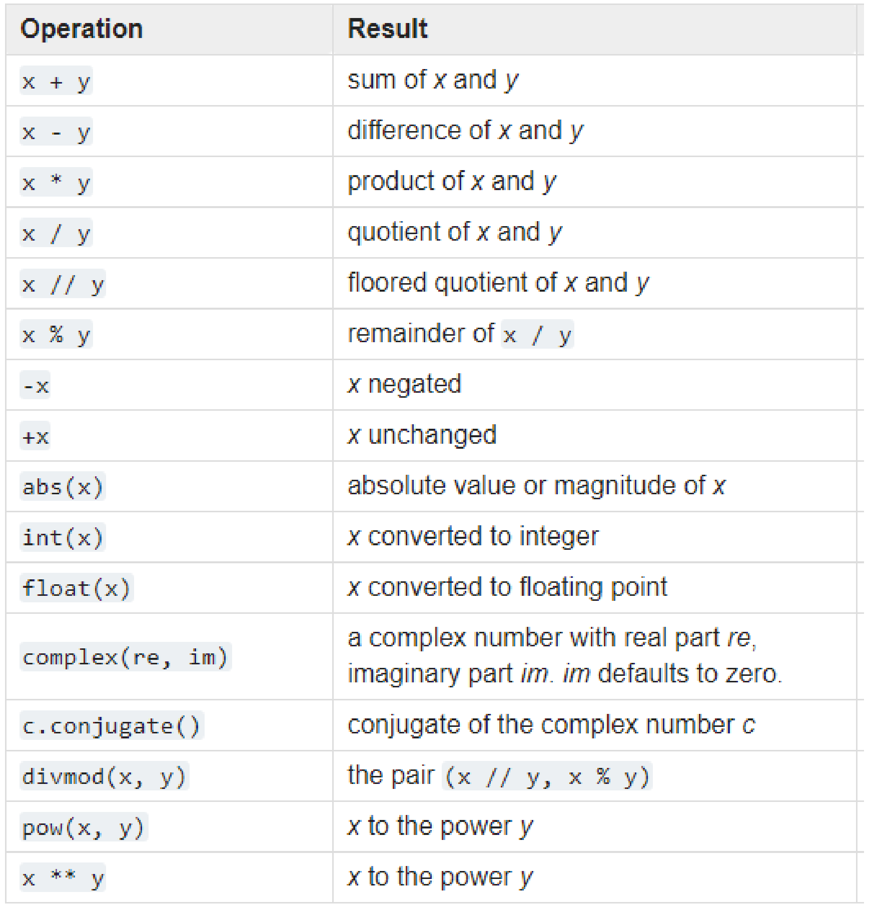
```
>>>impedance = 1+0.5j
>>>impedance.real
1.0
>>> impedance.imag
0.5
```

Supports mathematical operations

- Addition
- Subtraction
- Multiplication and division e.g. `j*j = -1`

Numeric Data Type

All numeric types (except complex) support the following operations



Operation	Result
`x + y`	sum of *x* and *y*
`x - y`	difference of *x* and *y*
`x * y`	product of *x* and *y*
`x / y`	quotient of *x* and *y*
`x // y`	floored quotient of *x* and *y*
`x % y`	remainder of `x / y`
`-x`	*x* negated
`+x`	*x* unchanged
`abs(x)`	absolute value or magnitude of *x*
`int(x)`	*x* converted to integer
`float(x)`	*x* converted to floating point
`complex(re, im)`	a complex number with real part *re*, imaginary part *im*. *im* defaults to zero.
`c.conjugate()`	conjugate of the complex number *c*
`divmod(x, y)`	the pair `(x // y, x % y)`
`pow(x, y)`	*x* to the power *y*
`x ** y`	*x* to the power *y*

Rounded to -inf

```
   1 //   2   >>>  0
(-1)//   2   >>> -1
   1 //(-2)  >>> -1
(-1)//(-2)  >>>  0
```

Note: the order of operator precedence >> docs

Numeric Data Type

Constructors: `int(), float(), complex()`

You can use the constructor to create or convert data types

```
>>>int(3.7)
3

>>>float(3)
3.0

>>>complex(1,2)
(1+2j)
```

Arithmetic operators

Arithmetic operators

`+`	Addition	`3 + 5 = 8`
		`3 + 5.0 = 8.0`
		`1.2 + 3.4 = 4.6`

`-`	Subtraction	`5 - 2 = 3`
		`5 - 2.0 = 3.0`
		`6.5 - 1.2 = 5.3`

`*`	Multiplication	`5 * 2 = 10`
		`5 * 2.0 = 10.0`
		`6.5 * 1.3 = 8.45`

Arithmetic operators

/	Division	10/2 = 5.0 10/4 = 2.5 10/2.0 = 5.0 10.0/1.2 = 8.3333
//	Floor division	10//2 = 5 10//4 = 2 10//2.0 = 5.0 10.0//1.2 = 8.0

What is the difference between Division and Floor division?

Arithmetic operators

`/`	`Division`	`10/2 = 5.0`
		`10/4 = 2.5`
		`10/2.0 = 5.0`
		`10.0/1.2 = 8.3333`

`//`	`Floor division`	`10//2 = 5`
		`10//4 = 2`
		`10//2.0 = 5.0`
		`10.0//1.2 = 8.0`

Note that division of **two** integers give a decimal number

```
10/2 = 5.0
```

So if we want integer result, we should use Floor division

```
10//2 = 5
```

Arithmetic operators

`**`	Exponent	`10**2 = 100`
		`10**4 = 10000`
		`1.1**2 = 1.21`
		
		`16**0.5 = 4.0`
		`36**0.5 = 6.0`

```
16**0.5    square root of 16
```

Arithmetic operators

`%`	`Modulus`	`15%2 = 1`
		`124%10 = 4`
		`28%2 = 0`
		`37%5 = 2`
		`-15%2 = 1`

when `x` is an odd number: `x%2 = 1`
when `x` is an even number: `x%2 = 0`

to find the last digit of positive integers:

```
124%10 = 4
23%10 = 3
```

Other types of operators

Assignment operators

Assignment operators

`+=`	`x += 2 is the same as x = x + 2`
`-=`	`x -= 2 is the same as x = x - 2`
`*=`	`x *= 2 is the same as x = x * 2`
`/=`	`x /= 2 is the same as x = x / 2`
`//=`	`x //= 2 is the same as x = x // 2`
`**=`	`x **= 2 is the same as x = x ** 2`
`%=`	`x %= 2 is the same as x = x % 2`

Data Types – Boolean (bool)

bool()

True or False

```
virus_scan_completed = True
virus_found = False
print(type(virus_scan_completed))
print(type(virus_found))
temperature = -5
temp_is_negative = temperature < 0
print(temp_is_negative)
temp_is_positive = temperature > 0
print(temp_is_positive)
```

```
<class 'bool'>
<class 'bool'>
```

```
True
```

```
False
```

Data Types – Boolean

bool()

`True` or `False`

```
print(bool(0))
print(bool(1))
print(bool(0.2))
print(bool(-1))
```

```
False
True
True
True
```

Data Types – String [`str`]

Str: Text
using either double quote or single quote

```
first_name = "John"
last_name = 'Snow'
```

String literals

Single quotes
Double quotes
Triple quotes

```
e.g. string1 = 'allows embedded "double" quotes'
e.g. string2 = "allows embedded 'single' quotes"
e.g. string3 = """Three double quotes
     Can span multiple lines"""
e.g. string4 = ''' three single quotes
 works too '''
```

Data Types – String

Splicing a string:

```
sentence = "Python is cool!"
sub_sentence1 = sentence[1:4]
# "yth"
```

[i:j] gives substring from index i up to index (j-1), so altogether, there are (j-i) characters

```
sub_sentence2 = sentence[1:]
# "ython is cool!"
```

[i:] gives substring from index i up to the end

```
sub_sentence3 = sentence[:4]
# "Pyth"
```

[:j] is the same as [0:j] gives substring from index 0 up to index (j-1), so altogether, there are j characters

Data Types – String

- Concatenation with the ‘+’ sign

```
# name details
first_name = "John"
last_name = "Snow"
# use string addition to formulate the full name
full_name = first_name + " " + last_name
# display the full name
print("My name is " + full_name + ".")
```

```
My name is John Snow.
```

Data Types – String

- Multiplication with an integer

```
# display some silly strings
silly1 = "frog" * 7
silly2 = 5 * "I am Sam"
print(silly1)
print(silly2)
```

```
frogfrogfrogfrogfrogfrogfrog

I am SamI am SamI am SamI am SamI am Sam
```

Our first Python program

```python
# My first Python program
print("PPP Y Y TTTTT H  H  OO  N   N")
print("P P Y Y   T   H  H O  O NN  N")
print("PPP  Y    T   HHHH O  O N N N")
print("P    Y    T   H  H O  O N  NN")
print("P    Y    T   H  H  OO  N   N")
# print blank lines
print()
print()
# print greetings
print("Welcome to Python - Class of 2020!")
```

What do you think this program will do?

Write this python code and run it.
See what the code produces.

Our first Python program

```
# print hello and greeting
print("Hello World!")
print('Welcome to Python!')
```

```
# print hello and greeting and silly stuff :-)
print("Hello World!", end="frog")
print("Welcome to Python!", end="cat")
print("How are you?")
```

What is the purpose of

```
print("...")
print('...')
print("...", end="...")
print()
```

What is wrong with this code?

```
print(Hello World!)
```

Getting input from the user

When we want to ask the user some information, use the `input()` function.

In the `input()` function, we can specify the **prompt**. i.e. `input(`**prompt**`)`

The information that the user has entered will be returned as a **str**.

```
# ask the user to enter some information
variable_here = input("Put the prompt here: ")
```

Getting input from the user

Example 1:

```
# ask the user to enter first name and last name
first_name = input("Enter your first name: ")
last_name = input("Enter your last name: ")
# use string addition to formulate the full name
full_name = first_name + " " + last_name
# display the full name
print("My name is " + full_name + ".")
```

```
Enter your first name: Frodo
Enter your last name: Baggins
My name is Frodo Baggins.
```

Getting input from the user

Example 2:

```
# Ask the user to enter 3 subjects
print("You must choose 3 subjects.\n")
subject1 = input("Enter the 1st subject: ")
subject2 = input("Enter the 2nd subject: ")
subject3 = input("Enter the 3rd subject: ")
# Display subjects
print("\nYou have chosen: " + subject1 + ", " + subject2 + ", " +
subject3 + ".")
```

```
You must choose 3 subjects.

Enter the 1st subject: ISIT111
Enter the 2nd subject: MATH101
Enter the 3rd subject: ACCY113

You have chosen: ISIT111, MATH101, ACCY113.
```

Getting input from the user

Example 2:

```
# Ask the user to enter 3 subjects
print("You must choose 3 subjects.\n\n")
subject1 = input("Enter the 1st subject: ")
subject2 = input("Enter the 2nd subject: ")
subject3 = input("Enter the 3rd subject: ")
# Display subjects
print("\nYou have chosen: "
      + subject1 + ", "
      + subject2 + ", "
      + subject3 + ".")
```

Rewrite the code to make it clearer.

When we have a lot of string additions, write it this way make the code clearer!

Convert number into string

```
# A program to display a favourite number

# favourite number
fav_number = 7

# display favourite number
print("My favourite number is " + fav_number)
```

Copy this python code and run it.

You will see that the code cannot run because there is an error.

What is wrong with this code?

Convert number into string

```
# A program to display a favourite number

# favourite number
fav_number = 7

# display favourite number
print("My favourite number is " + fav_number)
```

this is a string

this is a number

Python cannot add a string to a number

(some other programming languages can)

Convert number into string

```
# A program to display a favourite number

# favourite number
fav_number = 7

# display favourite number
print("My favourite number is " + fav_number)
```

1. Convert a number to a str

```
fav_number                     7

str(fav_number)  ──────────▶  "7"
```

2. now we can do string addition

```
"My favorite number is " + "7"
```

```
My favorite number is 7
```

Convert number into string

```python
# A program to display a favourite number

# favourite number
fav_number = 7

# display favourite number
print("My favourite number is " + str(fav_number))
```

```
My favorite number is 7
```

Convert a string to number

```python
# Ask the user to enter 2 integers and display the sum
number1 = input("Enter the 1st integer: ")
number2 = input("Enter the 2nd integer: ")
# calculate the sum
number_sum = number1 + number2 # display the sum
print("The sum is " + number_sum)
```

```
Enter the 1st integer: 100
Enter the 2nd integer: 50
The sum is 10050
```

why the output is like this

Convert a string to number

```
# Ask the user to enter 2 integers and display the sum
number1 = input("Enter the 1st integer: ")
number2 = input("Enter the 2nd integer: ")
# calculate the sum
number_sum = number1 + number2 # display the sum
print("The sum is " + number_sum)
```

```
Enter the 1st integer: 100
Enter the 2nd integer: 50
The sum is 10050
```

When we ask the user to enter an input, the input returns a **str**.

```
number1 is a str "100"
number2 is a str "50"
string addition means
number_sum is a str "10050"
```

Convert a string to number

```python
# Ask the user to enter 2 integers and display the sum
user_input1 = input("Enter the 1st integer: ")
number1 = int(user_input1)
user_input2 = input("Enter the 2nd integer: ")
number2 = int(user_input2)

# calculate the sum
number_sum = number1 + number2
# display the sum
print("The sum is " + str(number_sum))
```

```
Enter the 1st integer: 100
Enter the 2nd integer: 50
The sum is 150
```

What did we change?

Convert a string to number

```python
# Ask the user to enter 2 integers and display the sum
user_input1 = input("Enter the 1st integer: ")
number1 = int(user_input1)
user_input2 = input("Enter the 2nd integer: ")
number2 = int(user_input2)

# calculate the sum
number_sum = number1 + number2
# display the sum
print("The sum is " + str(number_sum))
```

user_input1 is a **str** "100"
number1 is an **int**

user_input2 is a **str** "50"
number2 is an **int**

number addition means number_sum is a **number** 150

```
Enter the 1st integer: 100
Enter the 2nd integer: 50
The sum is 150
```

Convert a string to number

```
# Ask the user to enter 2 integers and display the sum
user_input = input("Enter the 1st integer: ")
number1 = int(user_input)
user_input = input("Enter the 2nd integer: ")
number2 = int(user_input)

# calculate the sum
number_sum = number1 + number2

# display the sum
print("The sum of "
  + str(number1)
  + " and "
  + str(number2)
  + " is "
  + str(number_sum)
)
```

```
Enter the 1st integer: 100
Enter the 2nd integer: 50
The sum of 100 and 50 is 150
```

We can use just one variable `user_input` to save memory space

Convert a string to a decimal number

```python
# Ask the user to enter 2 decimal numbers and display the sum
user_input = input("Enter the 1st number: ")
number1 = float(user_input)

user_input = input("Enter the 2nd number: ")
number2 = float(user_input)

# calculate the sum
number_sum = number1 + number2

# display the sum
print("The sum of "
  + str(number1)
  + " and "
  + str(number2)
  + " is "
  + str(number_sum)
)
```

We use `number1 = float(user_input)` to convert the string `user_input` into a decimal number `number1`

```
Enter the 1st number: 2.5
Enter the 2nd number: 3.1
The sum of 2.5 and 3.1 is 5.6
```

Convert between data types

Convert to a string: `str(...variable_name...)`

```
fav_number                    7

str(fav_number)              "7"
```

! str() can be used to convert other data types into string, such as boolean, list, dictionary, etc.

Convert to an integer: `int(...variable_name...)`

```
user_input = input("Enter an integer: ")
number = int(user_input)
```

$$\begin{tikzcd}\texttt{user\_input} \arrow[r] & \texttt{"50"} \\ \texttt{int(user\_input)} \arrow[r] & \texttt{50}\end{tikzcd}$$

Convert between data types

Convert to a decimal number: `float(...variable_name...)`

$$\begin{tikzcd} \texttt{input1} \arrow[r] & \texttt{"2.3"} \\ \texttt{float(input1)} \arrow[r] & \texttt{2.3} \end{tikzcd}$$

We can also convert integer to float, float to integer, etc...

Comments

```
# print blank lines
print()
print()
# print greetings
print("Welcome to Python - Class of 2020!")
```

comment

comment

We can put comments anywhere in the program:

- to **make the program clearer** for people to read and maintain
- to **help people understand** our program better, especially, if our program has a special logic that needs explanation
- comments are not code, so they will NOT be executed

Important programming rules

ALWAYS write comments first, then code.

NEVER write code first, then insert comments.

ALWAYS use variables with **meaningful names**

NEVER use variable like a, b, c, x, y, z, or blah...

Important programming rules

Variable contains data information only

Bad example:

```
subject = "MATH111: Abstract Algebra"
```

The colon (:) is not part of the information and should not be stored in variable.
What if we want to display like this:

```
MATH111 - Abstract Algebra
```

or this:

```
Abstract Algebra (MATH111)
```

Good example:

```
subject_code = "MATH111"
subject_title = "Abstract Algebra"

print(subject_code + ' - ' + subject_title)
print(subject_title + '(' + subject_code + ')')
```

Important programming rules

Variable must be in correct data type

Bad example:

```
unit_price = "$10.50"
```

Unit price should be a number, not a string.

Good example:

```
unit_price = 10.50
quantity = 12
cost = unit_price * quantity
```

Important programming rules

Variable must be in correct data type

```python
mobile_number = 1231231234
student_number = 1234567
```

Mobile number should be a string, not a number.
Student number should be a string, not a number.

```python
mobile_number = "0980980987"
student_number = "0043210"
```

- Prevents data loss
- Stores leading zeros or symbols

Naming Convention

```
first_name = "John"
last_name = "Smith"
full_name = first_name + " " + last_name
fav_number = 7
subject1 = "ISIT111"
subject2 = "MATH101"
subject3 = "ACCY113"
SECOND_PER_MINUTE = 60
minute = 5
second = minute * SECOND_PER_MINUTE
```

ALWAYS use variables with **meaningful names**

`lower_case_with_underscores` for normal variables

`UPPER_CASE_WITH_UNDERSCORES` for constants

Keywords

The following list shows the Python keywords. These are reserved words and we **CANNOT** use them as constant or variable or any other identifier names.

and	elif	if	print
as	else	import	raise
assert	except	in	retur n
break	exec	is	try
class	finally	lambd a	while
continue	for	not	with
def	from	or	yield
del	global	pass	

Terminology

Code

Variable

Comments are not code: `# Comments start with a hash sign`

Syntax

Debug

Runtime

Source file: .py

Instantiate

Any questions?