CITY UNIVERSITY
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Introduction to programming using Python

Session 2

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Objectives

- Review what we have seen in the previous session:
  - Variables
  - Data types
  - Functions
- Controlling the flow of our programs

Variables 1: dynamic typing

- Python has strong dynamic typing
  - No need to declare the type of the variable
  - Python recognises the type according to the value of the variable

```
my_variable = 100
print(type(my_variable))  # will print <class 'int'>
my_variable="100"  # notice the quote for a string data type
print(type(my_variable))  # will print <class 'str'>
```

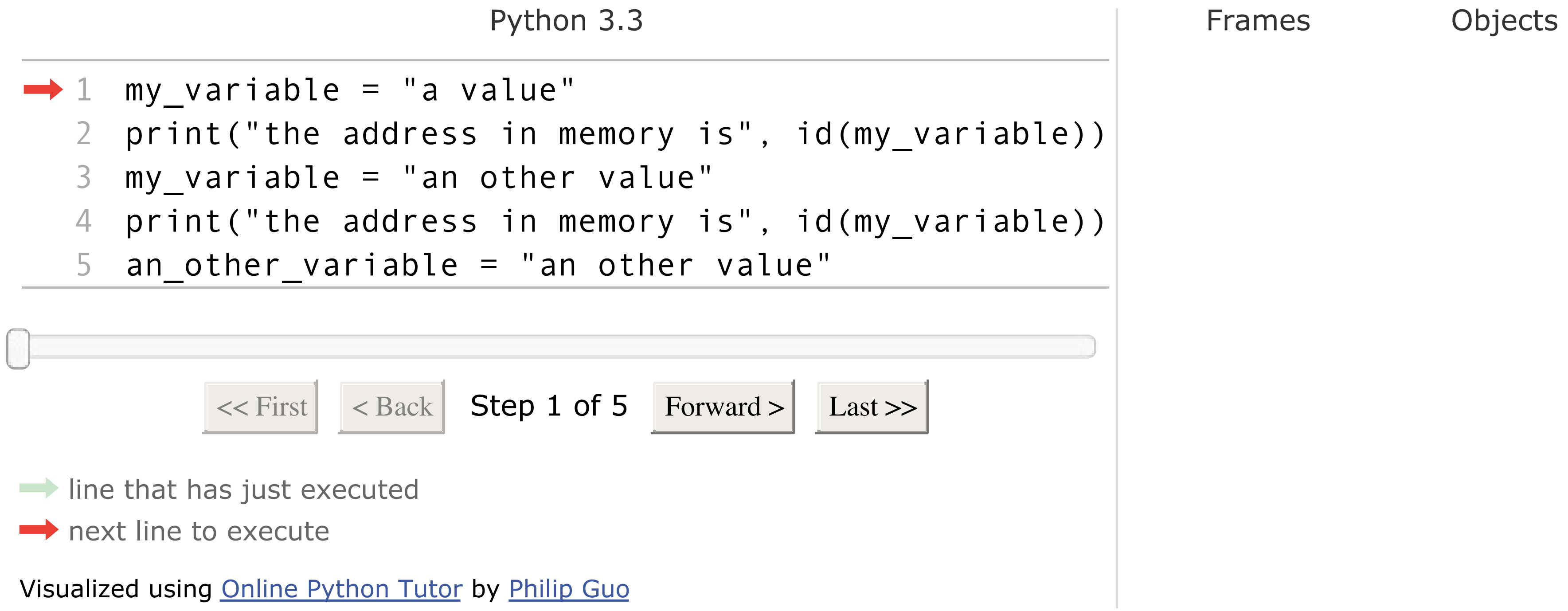
Variables 2: case sensitive

- Python is case sensitive

```
My_variable = 100
print(id(My_variable))
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'my_variable' is not defined
```

Variables 3: where it is stored

- A variable has an address in memory



```
my_variable = "a value"
print("the address in memory is", id(my_variable))
my_variable = "an other value"
print("the address in memory is", id(my_variable))
an_other_variable = "an other value"
```

🟩 line that has just executed

🟥 next line to execute

Visualized using Online Python Tutor by Philip Guo

Variables 4: scope

- A variable has a **scope**: only accessible from where it is defined.
- A variable is wiped out from memory once it stops being used. We say that is it **garbage collected**

We define *variable_a* in *program_a.py*

```
#program_a.py
variable_a = 42
```

We try to use *variable_a* in *program_b.py*. What is wrong?

```
#program_b.py
print(variable_a)
```

Variables 5: naming rules

- A variable name is a non-empty sequence of characters of any length with:
  - The start character can be the underscore "_" or a capital or lower case letter.
  - Python keywords are not allowed as identifier names!

Keywords (to not use as variable name)

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

Exercise 1: From algorithm to Python code

- Translate the following algorithm into Python code:
  - Step 1: Use a variable named *miles* with initial value 100 .
  - Step 2: Multiply *miles* by 1.609 and assign it to a variable named kilometers
  - Step 3: Display the value of kilometers with the function print()

👁 Show solution

Exercise 2.1: Area of a squared room

- The *length* and *width* are hardcoded variables for now.
- Use variables (for length, width and area)
- The multiply operator in Python is the sign*
- Formulae of the area of a square: length * width
- Use the **print()** function to display the result

👁 Show solution

Exercise 2.2: Dynamic Area

- The *length* and *width* are dynamic variables now.
- Use the **input()** function for taking the values from the user.
- Convert the input received into a number with the function **float()**

👁 Show solution

Common Data Types: definition

- Numeric types:
  - **Integer**: whole number

```
type(1)  # <class 'int'>
```

  - **Float**: number with decimal

```
type(1.0)  # <class 'float'>
```

- **String**

```
type("1.0")  # <class 'str'>
```

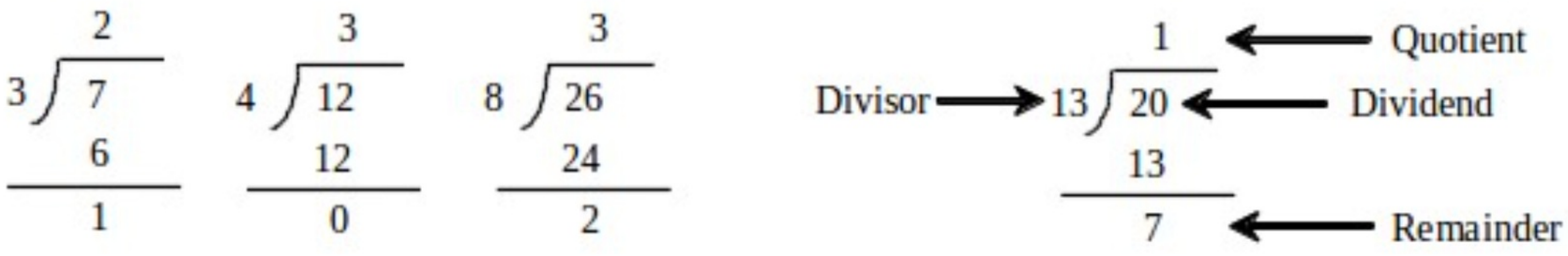
Common Data Types: Examples

Data type	Examples
Integers	-2, -1, 0, 1, 2, 3, 4, 5
Floats	-1.25, -1.0, --0.5, 0.0, 0.5, 1.0, 1.25
Strings	'a', 'aa', 'aaa', 'Hello!', '11 cats'

Numeric Operators

Name	**Meaning**	**Example**	**Result**
+	Addition	34 + 1	35
-	Substraction	34.0 - 0.1	33.9
*	Multiplication	300 * 30	9000
/	Float division	1 / 2	0.5
//	**Integer Division**	1 // 2	0
**	**Exponentiation**	4 ** 0.5	2.0
%	**Remainder**	20 % 3	2

The % (modulo or remainder) operator (1/2)



The % (modulo or remainder) operator (2/2)

Remainder or Modulo is very useful in programming. For example, an even number % 2 is always 0 and an odd number % 2 is always 1. So you can use this property to determine whether a number is even or odd.

Arithmetic expressions

$$\frac{3+4x}{5}-\frac{10(y-5)(a+b+c)}{x}+9\left(\frac{4}{x}+\frac{9+x}{y}\right)$$

...is translated to:

```
(3 + 4 * x) / 5 – 10 * (y - 5) * (a + b + c) / x +\
    9 * (4 / x + (9 + x) / y)
```

NB: the sign \ is an "escaped" character, to break a line for readability

Exercise: Computing Loan Payments

Let the user enter the interest rate, number of years, and loan amount, and computes monthly payment and total payment.

- Use input()
- Translate the following arithmetic expression in Python:

$$monthlyPayment = \frac{loanAmount \times monthlyInterestRate}{1 - \frac{1}{(1 + monthlyInterestRate)^{numberOfYears \times 12}}}$$

Solution: Computing Loan Payments

👁 Show solution

Operations on the String Type (1/2)

Concatenation

The expression concatenating a string returns a new string:

```
first_string = "abra"
second_string = "cada"
third_string = "bra"
concatenated_string = first_string + second_string \
    + third_string
print("first_string is", first_string,
    "second_string is", second_string,
    "third_string is ", third_string,
    "concatenated_string is ", concatenated_string)
```

Operations on the String Type (2/2)

Slicing

Remember that the string is a **sequence** of characters

The items of a sequence can be accessed through indexes

Items (characters)	a	b	r	a	c	a	d	a	b	r	a
Indexes	0	1	2	3	4	5	6	7	8	9	10

Get the first element of the sequence:

```
first_elem = abracadabra[0]
```

Built in functions seen so far

- Input/Ouput
  - input()
  - print()
- Conversion type:
  - int()
  - float()
  - str()
- Introspection:
  - type()
  - dir()
  - help()
  - id()

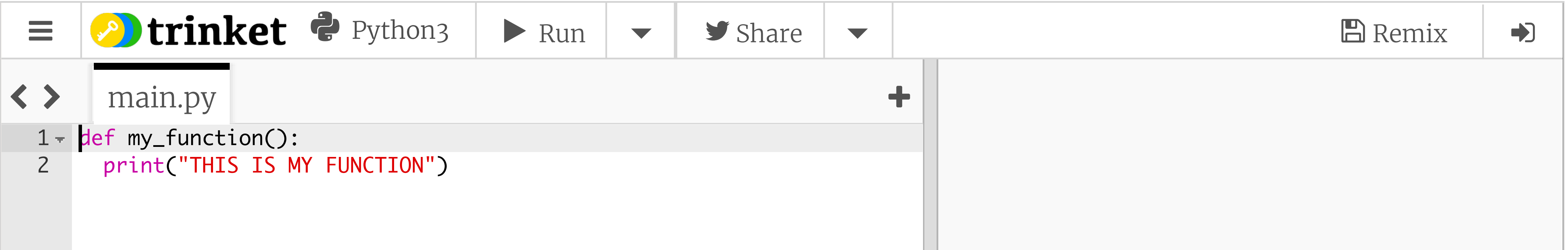
Defining our own function

To define a function, we use the keyword **def**, the name of the function, the brackets, and the colon

Then the body of the function needs to be indented

```
def name_of_the_function():
    # body of the function
```

When we define a function, we just make python see that the function exist but it is not executed



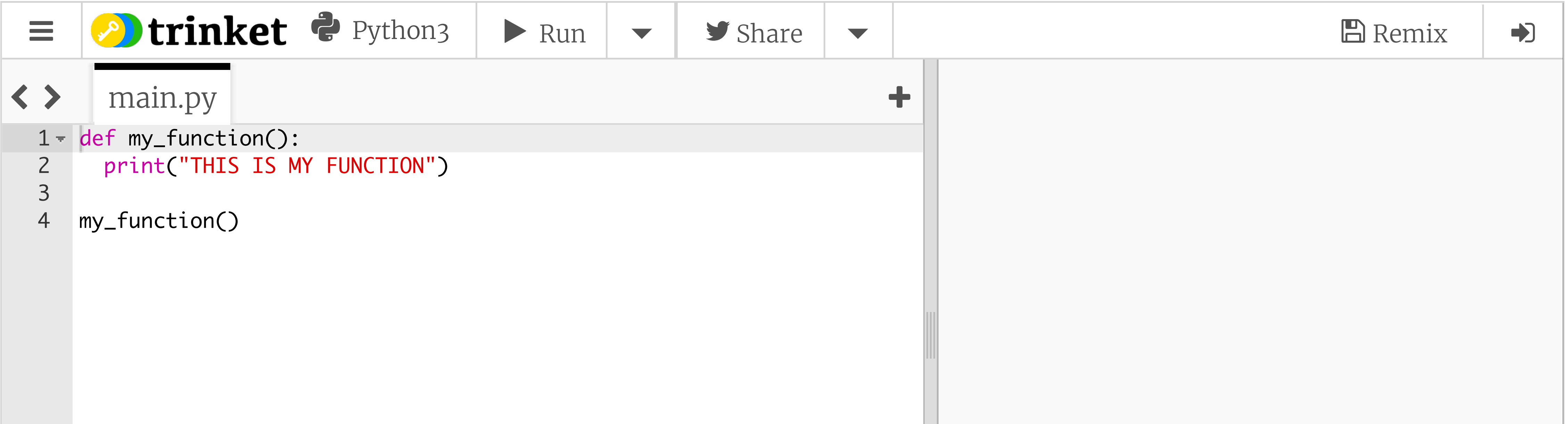
```
def my_function():
  print("THIS IS MY FUNCTION")
```

Calling our own function

To call or execute or run a function, we use the name of the function AND the brackets, without the brackets, the function is not called.

```
name_of_the_function()
```

Notice the difference between defining and calling a function

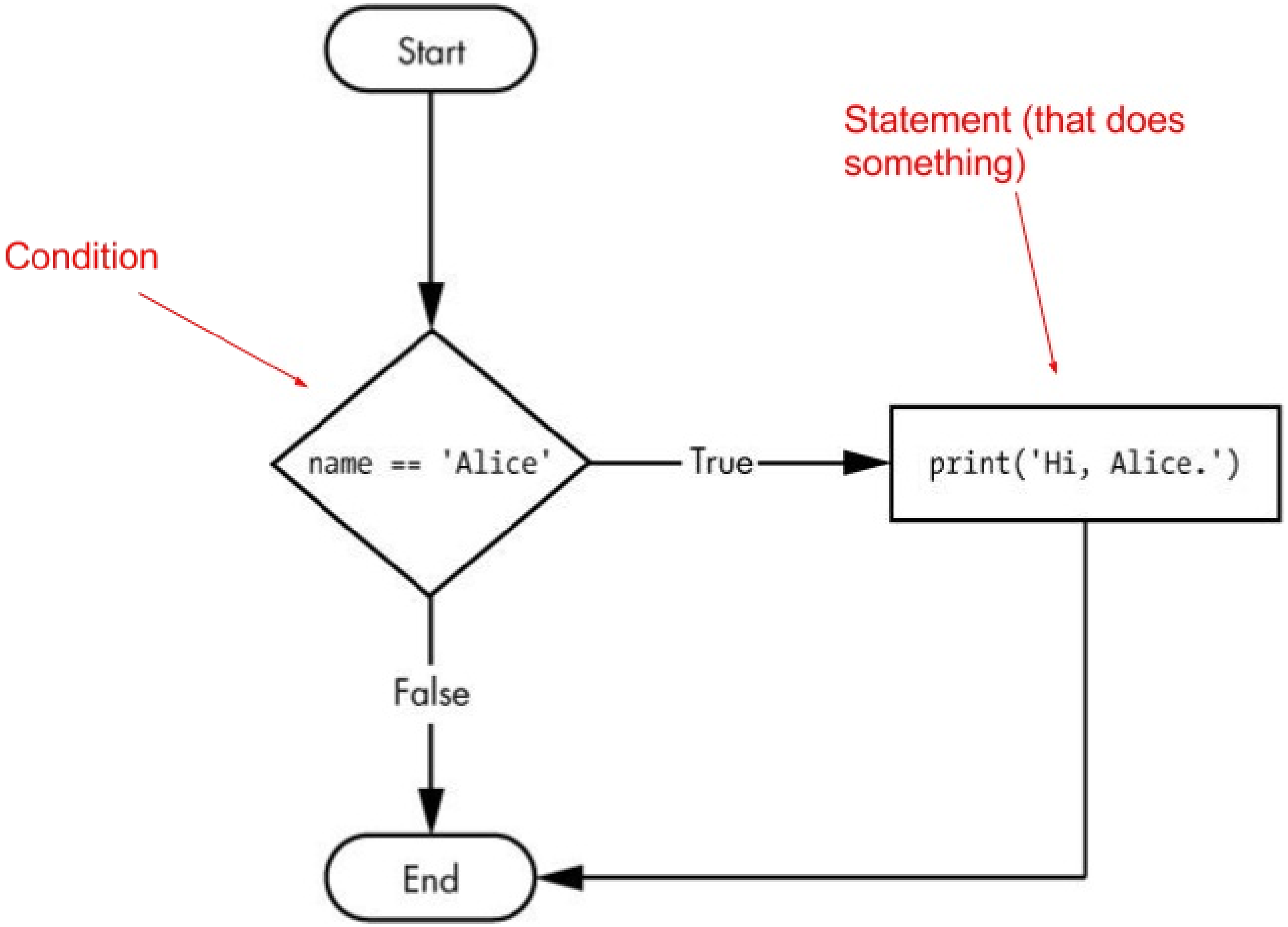


```
def my_function():
  print("THIS IS MY FUNCTION")

my_function()
```

Controlling the flow of our programs

We can represent the flow of execution with a flow chart



Condition

Statement (that does something)

Structure of a simple if statement

Pseudo code:

```
if condition:
    # statement (mind the indentation)
```

Example, representation of the flow chart example in python code:

```
if name=='Alice':
    print('Hi Alice')
```

The two-way if statement

Pseudo code:

```
if condition:
    # statement (mind the indentation)
else:
    # statement executed when the condition is False
```

Example, representation of the flow chart example in python code with an else statement:

```
if name=='Alice':
    print('Hi Alice')
else:
    print('Hi')
```

Multiple Alternative if Statements

The naive way

```
if condition:
    # statement (mind the indentation)
else:
    if:
        # statement executed when
        # the previous condition is False
    else:
        # statement executed when none of
        # the previous condition is verified
```

Multiple Alternative if Statements

The better way, the pythonc way

```
if condition:
    # statement (mind the indentation)
elif:
    # statement executed when
    # the previous condition is False
elif:
    # statement executed when none of
    # the previous condition is verified
else:
    # executed when all conditions are False
```

Value of the condition

The program will execute statement only if the condition is verified. Only if the condition is True.

The condition is actually a **boolean**.

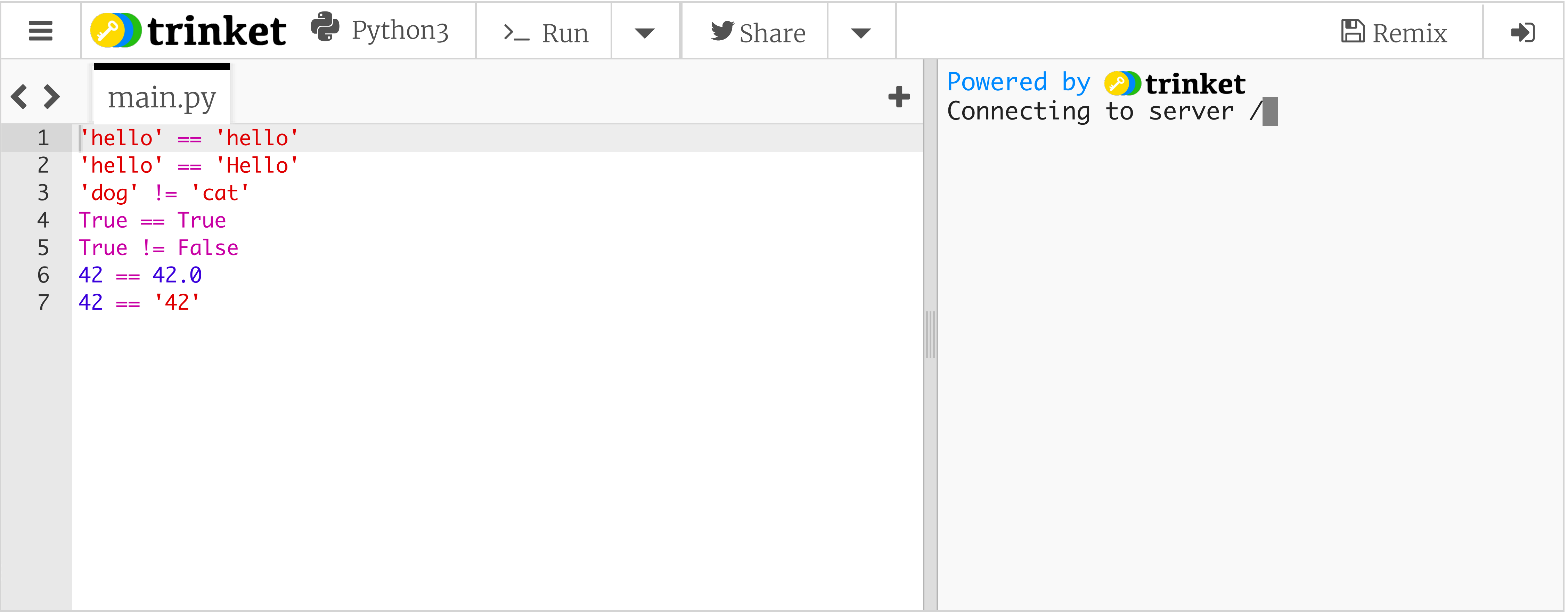
The Boolean Type

- It has only 2 possible values: **True** or **False**. Notice that they are both capitalized, which is important because Python is case sensitive
- It is often obtained as a result of a comparison expression.

The Comparison Operators

Operator	Meaning
<	less than
<=	less than or equal
>	greater than
>=	greater than or equal
==	equal to
!=	not equal to

Examples



```
'hello' == 'hello'
'hello' == 'Hello'
'dog' != 'cat'
True == True
True != False
42 == 42.0
42 == '42'
```

```
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Connecting to server /
```

Difference between ’==’ and ’=’

- The sign **=** is the sign of **assignment**, it is used for assigning a value to a variable
- The sign **==** is the sign of **comparison**, it compares 2 values and return a boolean (True or False)

Exercise: password

Create a program that ask the user for a password.

- Have the password defined in "clear" in your program, in a variable called "PASSWORD"
- Use input() to receive the password entered by the user
- If the word entered by the user matches the password, display "Access Granted", else, "Forbidden"

Solution: password

👁 Show solution

Truth tables

Show every possible result of a Boolean operator.

The **and** Operator's Truth Table

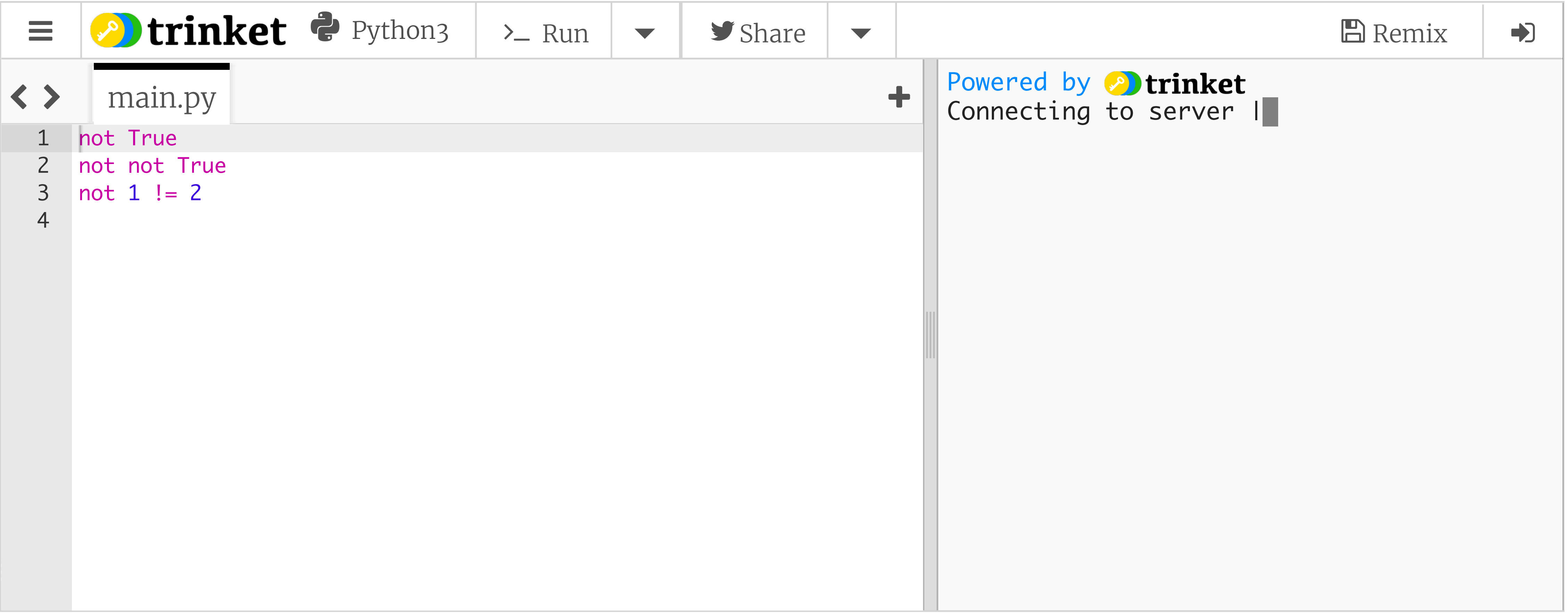
Expression	**Evaluates to...**
True and True	True
True and False	False
False and True	False
False and False	False

The **or** Operator's Truth Table

Expression	**Evaluates to...**
True or True	True
True or False	True
False or True	True
False or False	False

The **not** Operator

It operates on only one Boolean value (or expression). The not operator simply evaluates to the opposite Boolean value.



```
not True
not not True
not 1 != 2
```

```
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```

Exercise: password and login

Create a program that ask the user for a login and password.

- Have the password "PASSWORD" AND login "LOGIN" defined in "clear" in your program, in variables
- Use input() to receive the password and login entered by the user
- If login and password match the values of your PASSWORD and LOGIN, display "Access Granted", else, "Forbidden"

Solution: password and login

👁 Show solution

Exercise: check number divisor

Write a program that prompts the user to enter an integer. If the number is a multiple of 5, print HiFive. If the number is divisible by 2, print HiEven.

- Use input() take the user input
- Use int() to convert the value return by input into an integer
- Use % to see if a number x is divisible by an other number y, if x%y returns 0, then x is divisible by y
- Use print()

Solution: control flow

👁 Show solution

Exercise: grading students

Write a program that is going to give the grade of a student according to the score obtained.

- Display 'A' if the score is greater than 90
- Display 'B' if the score is between 80 and 90
- Display 'C' if the score is between 70 and 80
- Display 'D' if the score is between 60 and 70
- Display 'F' if the score is lower than 60

Solution: grading students

👁 Show solution

Exercise: determining a leap year

This program first prompts the user to enter a year as an int value and checks if it is a leap year.

A year is a leap year if it is divisible by 4 but not by 100, or it is divisible by 400.

- Use input() to take the user input (the year, i.e. 2016) and convert it with int()
- Use % to see if a number x is divisible by an other number y, if x%y returns 0, then x is divisible by y
- Check if the year is divisible by 4 AND not divisible by 100
- OR check if the year is divisible by 400.
- Use print()

Solution: determining a leap year

- 👁 Complete solution

Solution optimized: determining a leap year

- Condition to use
- Complete solution

Exercise: Chinese Zodiac sign

Now let us write a program to find out the Chinese Zodiac sign for a given year. The Chinese Zodiac sign is based on a **12-year cycle**, each year being represented by an animal: rat, ox, tiger, rabbit, dragon, snake, horse, sheep, monkey, rooster, dog, and pig, in this cycle

👁 Hint 1

👁 Hint 2

Exercise: Chinese Zodiac sign

Year	Zodiac sign
0	monkey
1	rooster
2	dog
3	pig
4	rat
5	ox
6	tiger
7	rabbit
8	dragon
9	snake
10	horse
11	sheep