COMPSCI 101

Principles of Programming

Lecture 4 –The type() function, strings, objects, the len() function, string slicing

Learning outcomes

At the end of this lecture, you will know that:

- a variable stores a reference to the object
- a string object is a sequence of characters within single or double quotes

At the end of this lecture, you will know how to:

- use the len() function to calculate how many characters are in a string object
- obtain a single character from a string
- obtain a slice of a string
- concatenate string objects to obtain a new string object

Recap

From lecture 3:

Developing a program in steps

```
import math

side1 = 4
side2 = 7
side3 = 9

part1 = math.pow(side1, 2) * math.pow(side2, 2)
part1 = part1 + math.pow(side1, 2) * math.pow(side3, 2)
part1 = part1 + math.pow(side2, 2) * math.pow(side3, 2)
part1 = part1 * 4

part2 = math.pow(side1, 2) + math.pow(side2, 2)
part2 = part2 + math.pow(side3, 2)
part2 = math.pow(part2, 2)

part3 = math.sqrt(part1 - part2)


area = math.floor(1 / 4 * part3)
print("Length of sides: ", side1, ', ', side2, ' and ',
                                        side3, sep = "")
print("Area:", area)
```

```
Length of sides: 4, 7 and 9
Area: 13
```

Program execution

The statements in a Python program are executed in sequence.

```
"""Calculates the radius of a circle.
Author: Adriana Ferraro
"""
import math

area = 221.67
radius = math.sqrt(area / math.pi)
print("Radius of circle with area ", area, "is", radius)
```

```
Radius of circle with area  221.67 is 8.399985266079987
```

Variables can only store one value, i.e. assigning a new value to a variable means that you lose access to the old value.

```
number = 34
number = 56
number = number - 10
print("Finally", number)
```

```
Finally 46
```

Exercise

Give the output.

```
num1 = 7
num2 = 3
num3 = 2
num4 = 4

num5 = num1
num1 = num2 * num1 + 4
num2 = num5 + num2
num5 = num3
num3 = num4 - num3 + 1
num4 = num5

print(num1, num2, num3, num4, num5)
```

Another Python type - strings

Strings are any sequence of characters enclosed inside single quotes ('…') or double quotes ("…"). We have already seen string objects when we needed to print a message to the standard output, e.g.

```
print("Area of circle")
```

Examples of strings:

- `"A"`
- `'A longer string'`
- `"45.78"`
- `" "`
- `""`

Another Python type - `strings`

Strings can be assigned (using the assignment operator, **=**) to variables in order to store them in the program memory. Strings can be printed using the `print()` function.

For example:

```
word1 = "Bellissima"
word2 = "Bravissima"
word3 = word1

print(word2, word3, word1)
```

```
Bravissima Bellissima Bellissima
```

The Python `len()` function

Python has a built-in function, **`len()`**, which can be used to determine the number of characters in a string.

```
1 word1 = "Fantastico"
2 length1 = len(word1)
3 length2 = len("012 3 4")
4 print(length1, length2)
```

In the example code above there are two **calls** to the `len()` function (on the right hand side of lines 2 and 3).

The **`len()`** function is said to **return** the number of characters in the string passed to the function (inside the parentheses).

```
10 7
```

The Python `len()` function

```
1 word1 = "Fantastico"
2 length1 = len(word1)
3 length2 = len("012 3 4")
4 print(length1, length2)
```

```
10 7
```

Functions use round brackets (parentheses).

On line 2 of the code, the string, `word1`, **is passed to** the `len()` function. On line 3 of the code, the string, `"012 3 4"`, **is passed to** the `len()` function.

The `len()` function **returns** the number of characters in the string (passed to the function inside the parentheses).

Remember: firstly the right hand side of the assignment operator is evaluated and then the resulting value is passed to the variable on the left of the assignment operator.

In Python everything is an object

The world is made up of real world objects e.g. students, dogs, cars, cats, books, words, numbers. Objects are the things our programs deal with and in our programs we want to represent these objects.

So far, in our programs, we have used the following Python types:

- **Integer** objects which represent whole numbers,
- **Floating point** objects which represent decimal numbers,

and,

- **String** objects which represent sequences of characters.

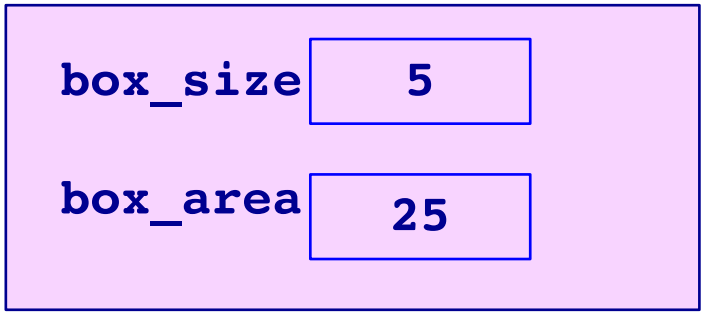
We have used variables to store these objects in the program memory.

In Python everything is an object

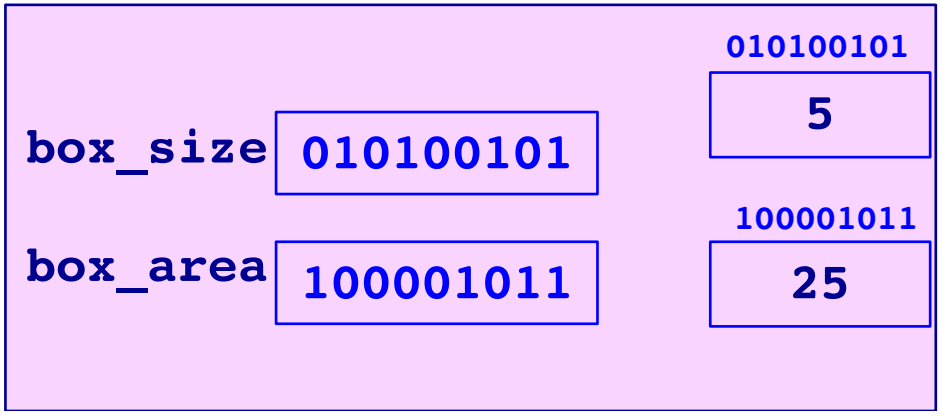
We often visualise variables as being a box containing a value (the last value assigned to the variable). Given the code:

```
box_size = 5
box_area = box_size * box_size
```

we visualise the two variables:



In fact, every variable in Python stores a reference (the memory address) of the value assigned to it:

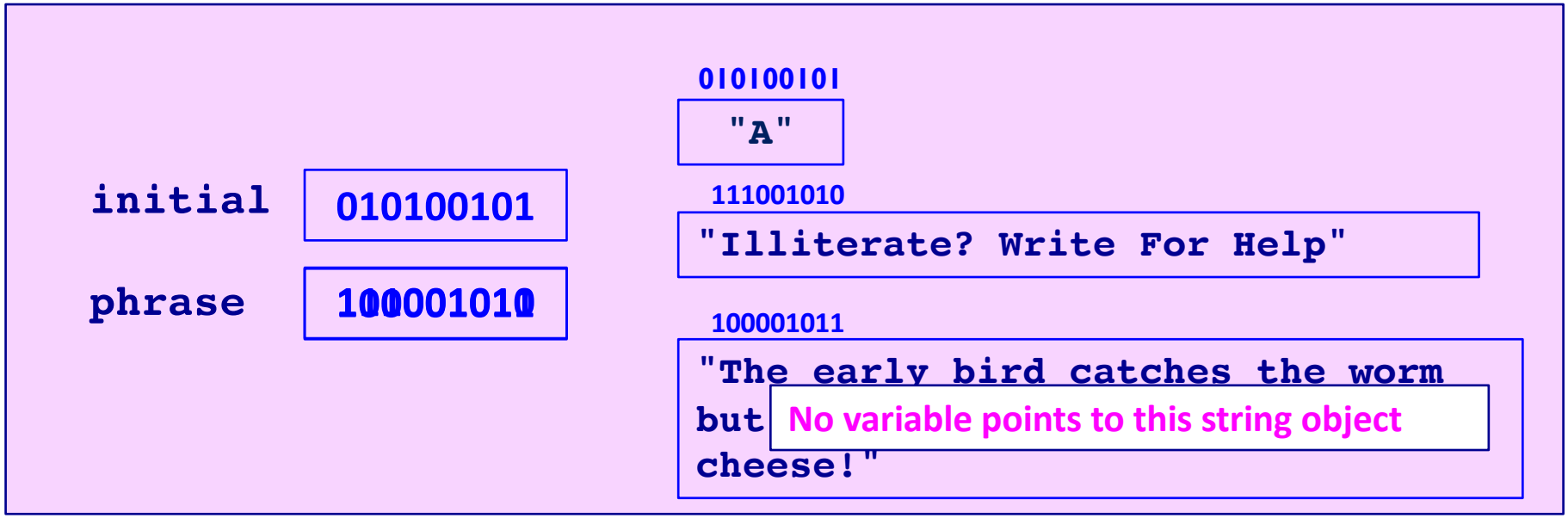


In Python everything is an object

Storing the reference (the memory address) of the value assigned to to a variable makes sense:

```
initial = "A"
phrase = "The early bird catches the worm but the second
                                        mouse gets the cheese!"
phrase = "Illiterate? Write For Help"
```

because the information in an object can have different sizes.



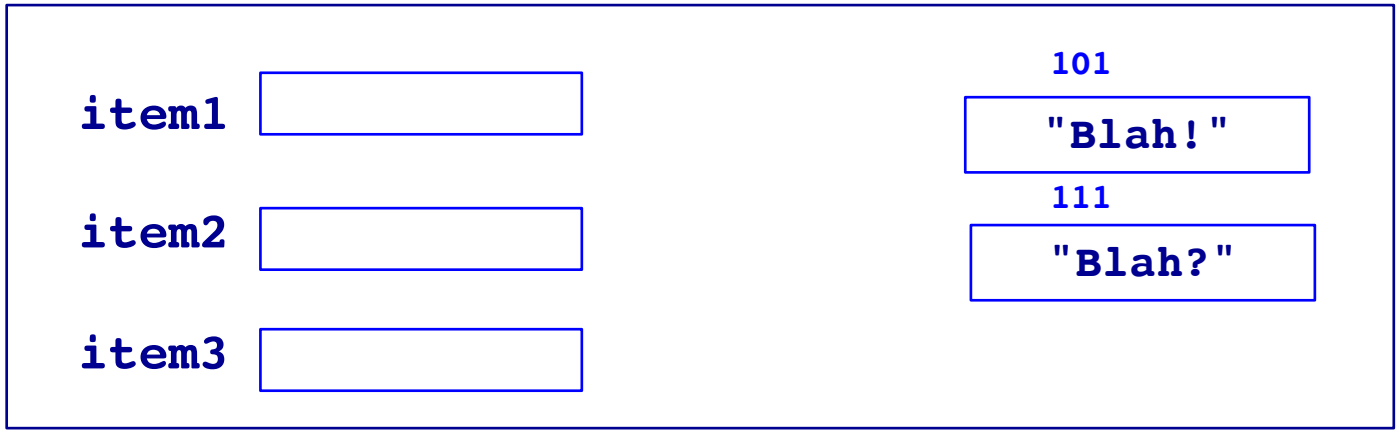
Exercise

Given the following code:

```
item1 = "Blah!"
item2 = "Blah?"
item3 = item2
item2 = item1
```

how many string objects are there in memory?

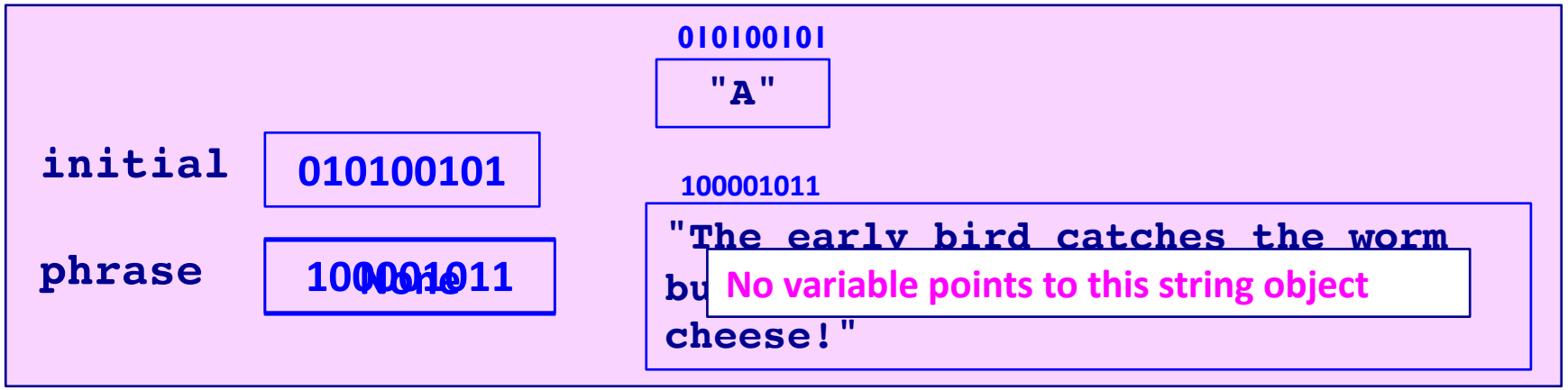
Given the memory diagram below, i.e. fill in the variable addresses:



None

None is a special value which can be assigned to a variable and it means that the variable is not referencing (pointing to) any object.

```
initial = "A"
phrase = "The early bird catches the worm but the
                              second mouse gets the cheese!"
phrase = None
```



A variable which contains the value None can be printed:

```
phrase = None
print(phrase)
```

```
None
```

The inbuilt `type()` function

Every Python object has a specific type. The type of any Python object can be obtained by using the **`type()`** inbuild function. Printing the result of applying this function, prints the type of the object, e.g.

```
num1 = 7
num2 = 26.7
word = "numero"

print(type(num1))
print(type(num2))
print(type(word))
```

```
<class 'int'>
<class 'float'>
<class 'str'>
```

The output, `<class 'int'>` means that there is the definition of this type of object in a file named `int.py` (inside the Python libraries)

Special characters in a string

Some characters perform operations such as inserting a new line or a tab space into the string. To insert a new line into a string we use the escape sequence '\n' within the string. A tab can be inserted into a string by using the escape sequence '\t'.

```
shopping = "Carrots, \npumpkin,\nchocolate"
print(shopping)
```

```
Carrots,
pumpkin,
chocolate
```

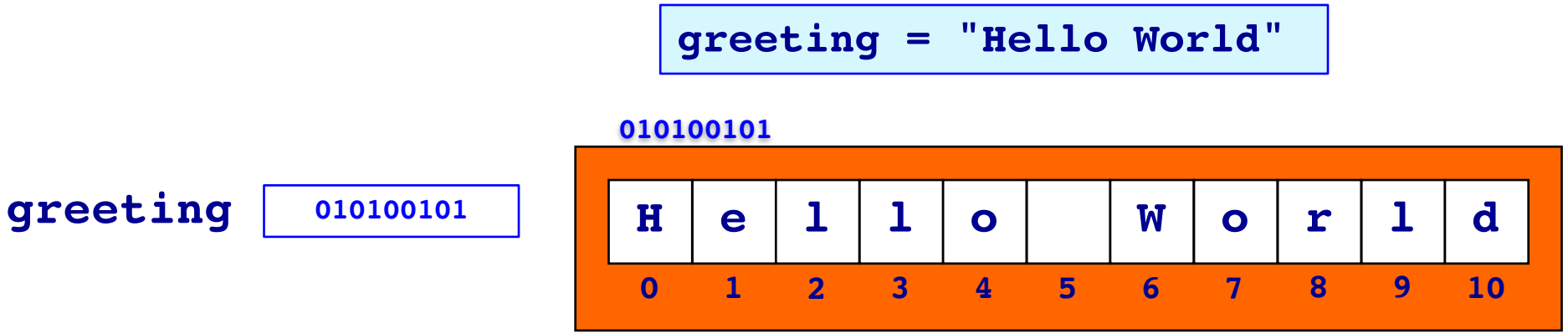
To insert a double quote into the output (if your string is enclosed inside double quotes), use the escape sequence "\"", and to insert a single quote into the output, (if your string is enclosed inside single quotes), use the escape sequence '\''.

```
print(1, "\"Super\" Man")
print(2, '\'Super\' Man')
print(3, '"Super" Man')
print(4, "Super Ma\\n")
```

```
1 "Super" Man
2 'Super' Man
3 "Super" Man
4 Super Ma\n
```

More about strings

A string is a sequence of characters and every character in a string has an index, i.e. its position in the string. The index starts from position 0. For example:

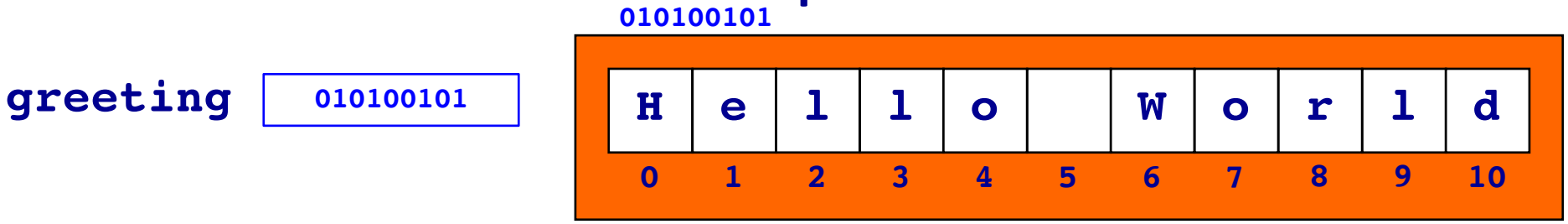


Every character in the string can be accessed using the variable name, square brackets and the index value:

```
greeting = "Hello World"
first_letter = greeting[0]
last_position = len(greeting) - 1
last_letter = greeting[last_position]
print(first_letter, last_letter)
```

```
H d
```

Ooops!



What is the problem with the following code?

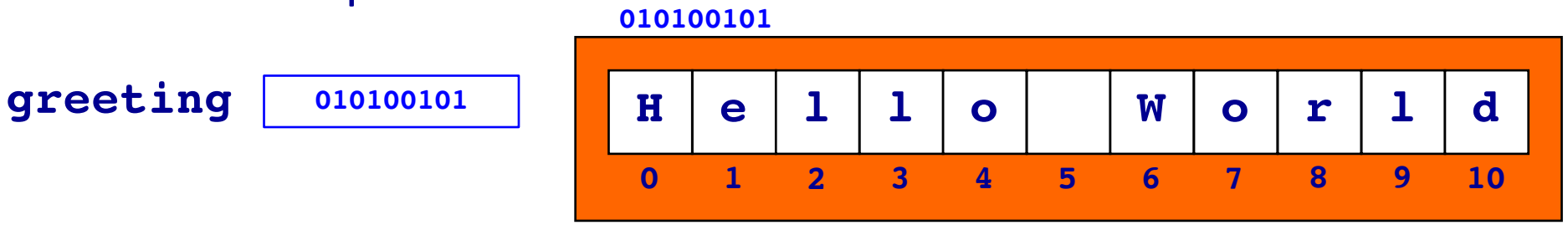
```
…
4  greeting = "Hello World"
5  last_letter = greeting[len(greeting)]
```

```
Traceback (most recent call last):
  File "LectureCode.py", line 5, in <module>
    last_letter = greeting[len(greeting)]
IndexError: string index out of range
```

An IndexError occurs if you try to access a position in the string which doesn't exist

Strings – negative index

To access a character from the end of the string, a negative index can be used. For example




```
greeting = "Hello World"
last_letter = greeting[-1]
second_to_last = greeting[-2]
print(last_letter, second_to_last)
```

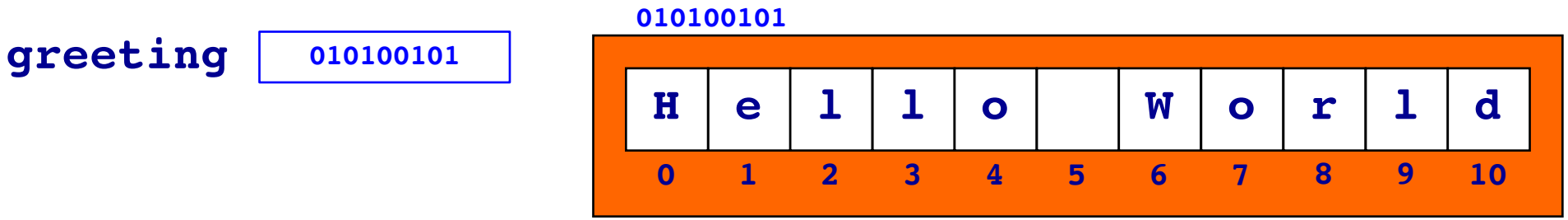
```
d l
```

Does the following code cause a problem?

```
greeting = "Hello World"
a_letter = greeting[-len(greeting)]
```

Getting a slice from a string

As well as obtaining a single character from a string, whole sections of the string can be obtained. This is called **slicing**.



To get a section of a string we use square brackets, the index of the first character in the section we want, a colon followed by the index of the character **after** the end of the required section.

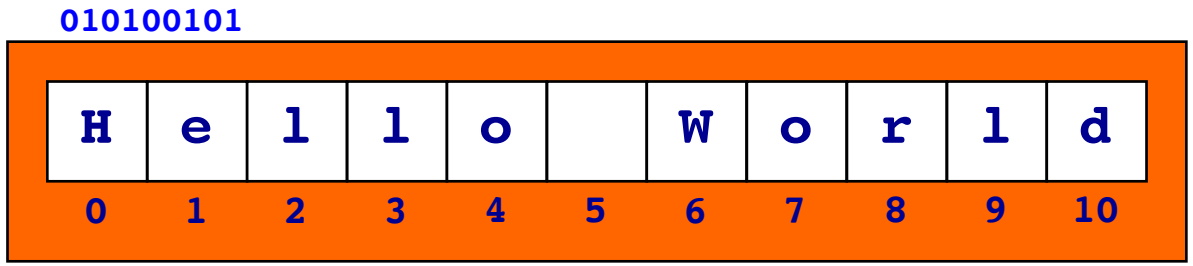
```
greeting = "Hello World"
first_part = greeting[0:5]
second_part = greeting[6:11]

print(second_part, first_part)
```

```
World Hello
```

Getting a slice from a string

When slicing a string, if the start of the slice is omitted, the slice starts from the first character in the string. When slicing a string, if the end of the slice is omitted, the slice goes to the end of the string.

greeting 010100101



For example,

```
greeting = "Hello World"
first_part = greeting[:5]
second_part = greeting[6:]

print(second_part, first_part)
```

```
World Hello
```

Concatenation - joining strings

The + operator can be used to join two strings, e.g.,

```
first_name = "Li"
last_name = "Po"
full_name = first_name + " " + last_name
print("***", full_name , "***")
```

```
*** Li Po ***
```

How does the Python interpreter know if the + operator is adding two numbers or concatenating two strings?

```
first = "4"
second = "5"
sum = 4 + 5
number = first + second
print(sum, number)
```

```
9 45
```

Chuang Tzu in dream became a butterfly, …

The repeat operator – repeat strings

The * operator can be used to create **a new string object** with characters of a string repeated two or more times, e.g.,

```
praise = "good!"
lots_of_praise = praise * 4
print(praise)
print(lots_of_praise)
```

```
good!
good!good!good!good!
```


What is the meaning of the words "to create a **new**" string object in the statement above?

Complete the output

Complete the output.

```
s = "Dogs have masters. Cats have staff."
print("1.", s[1: 6])
print("2.", s[:2] * 3)
print("3.", s[-3])
print("4.", s[4] + s[1])
print("5.", s[-4:])
```

```
1.
2.
3.
4.
5.
```

Exercise

Complete the following program so that it prints the name between two rows of stars. The output has three spaces on each side of the name. Your code should work for names of any length.

```
name = "Philomena Evangeline"
num_spaces = 3
```

```
**************************
   Philomena Evangeline
**************************
```

Summary

In Python :

- variables store a reference to the object
- string objects are a sequence of characters
- the len() function is used to calculate how many characters are in a string
- we use the index number to obtain a single character from a string
- we can slice strings
- use the '+' operator to concatenate strings

Examples of Python features used in this lecture

```
words = " Prince Charming "
length = len(words)

letter1 = words[3]
letter2 = words[-5]
letter3 = words[len(words) - 2]

letters1 = words[3:6]
letters2 = words[:6]
letters3 = words[6:]
letters4 = words[len(words) - 3:]

word2 = letter1 + letter2
phrase = word2 + " " + letter3
print(letters1, letters2, letters3, letters4, phrase)
```