

**COMPSCI 101**
Principles of Programming

Lecture 19 - Tuples

### Learning outcomes

At the end of this lecture, students should be able to:

- understand the tuple type
- create tuples
- manipulate code which contains tuples
- return tuples
- know the differences between tuples and lists

Also

- We will be looking at Slides 19, 20 and 21 from Lecture 16
- We will be looking at the last two questions of Assignment 3

### Recap

From lecture 17
- Understand various operators on lists
- Understand various list methods
- Lists are mutable

```python
def main():
    numbers = [1206, 1216, 475, 1038, 1481, 135]
    search_numbers = [1038, 1367, 1206, 740, 1281, 1216]
    index_list = get_index_list(numbers, search_numbers)
    print("indices of the numbers found", index_list)

def get_index_list(number_list, numbers_to_look_for):
    a_list = list()
    for number in numbers_to_look_for:
        if number in number_list:
            index = number_list.index(number)
            a_list.append(index)
    a_list.sort()
    return a_list

main()
```

**indices of the numbers found [0, 1, 3]**

### Creating Tuples

- The items of a tuple are enclosed inside a pair of parentheses, separated by commas even if there is only one item in the tuple
- A tuple is an ordered sequence of items of any types
- Tuples are sequences - the elements of a tuple have an order.

Create Tuples

- an empty tuple `tuple1 = ()` or `tuple1 = tuple()`
- Other tuple creation examples:

```python
tuple1 = (4, True, "Test", 34.8)
tuple2 = ("red", "blue")
tuple3 = (1, 2, "jim")
tuple4 = (3,
```

Needs the comma if only one element in the tuple
Creating Tuples with a single element

Create Tuples

If the tuple contains a single element, a comma is added after the element. This is required as, otherwise, there would be confusion between a tuple and a parenthesised object, e.g., (5) is the same as the integer 5.

```python
tuple1 = (5,)
```

```python
print(type((5,)))  #(5,) is a tuple
print(type(5))     #(5) is an int (with parentheses around it)
```

Note that `tuple` is a built-in type and it should not be used as a variable name.

Printing tuples

Printing the elements of tuples

Use the `print()` function to print the elements of the tuple.

```python
tuple1 = (3, 6, 8)
print(tuple1)
tuple2 = ("abcdef", "ghij", "klmno")
print(tuple2)
```

```python
(3, 6, 8)
('abcdef', 'ghij', 'klmno')
```

Accessing the elements of a tuple

Accessing tuple elements

- Each element in a tuple can be accessed using the index value (starting from index 0) and square brackets.
- The elements of a tuple can be accessed from the end of the tuple backwards using a negative index.
- `for` ... in loop can be used to visit each element of a tuple (iterate through the tuple).

```python
tuple1 = (3, 6, 8)
print("1.", tuple1[1], tuple1[2], tuple1[0])
print("2.", tuple1[-2], tuple1[-3])
tuple2 = (tuple1[1], tuple1[2], tuple1[0], 1, 7)
print("3.", tuple2)
print()
```

```python
for element in tuple2:
    if element > 3:
        print(element)
```

```python
1. 6 8 3
2. 6 3
3. (6, 8, 3, 1, 7)
```

Note that tuples use round brackets.

+, *, and in operators and tuples

Operators + (concatenate), * (repeat), and in (membership) can be used with tuples. The result of the + and * operators is a new tuple object.

```python
tuple1 = (3, 6, 8)
tuple2 = (5, 1, 0, 4)
tuple3 = tuple2 + tuple1
tuple4 = tuple1 * 3
```

```python
print(0 in tuple1)
print(0 in tuple2)
```

```python
print("1.", tuple1)
print("2.", tuple2)
print("3.", tuple3)
print("4.", tuple4)
```

False
True
1. (3, 6, 8)
2. (5, 1, 0, 4)
3. (5, 1, 0, 4, 3, 6, 8)
4. (3, 6, 8, 3, 6, 8, 3, 6, 8)
Slicing tuples

Tuples can be sliced in the same way as strings and lists are sliced. The result is a new tuple.

tuple1 = (3, 6, 8, 0, 1, 2, 7)
print("1.", tuple1[0:6:2])
print("2.", tuple1[2:7:3])
print("3.", tuple1[5:1:-1])

1. (3, 8, 1)
2. (8, 2)
3. (2, 1, 0, 8)

Complete the output

```python
def fiddle_tuples(t1, t2):
    t3 = (t1[1], t2[0])
    t1 = (t3[1], t2[0])
    t2 = t1
    return t3

def main():
    t1 = (3, 5)
    t2 = (4, 7)
    t3 = fiddle_tuples(t1, t2)
    print("t1:", t1, "t2:", t2, "t3:", t3)
main()
```

t1:        t2:        t3:

Tuples are immutable

Tuples are "immutable", i.e., the elements of a tuple object cannot be changed.

tuple1 = (3, 6, 8)
tuple2 = tuple1
tuple3 = (tuple2[0], tuple2[1], tuple2[2])
print("1.", tuple1 is tuple2)
tuple1 = tuple1 + (5,)
print("2.", tuple1)
print("3.", tuple2)

print("4.", tuple1 is tuple2)
print("5.", tuple2 == tuple3)
print("6.", tuple2 is tuple3)

1. True
2. (3, 6, 8, 5)
3. (3, 6, 8)
4. False
5. True
6. False

Converting tuples into lists

The shortcut way of creating an empty list is:

```
a_list = []
```

The alternative way of creating an empty list is:

```
a_list = list()
```

A tuple can be converted into a list by enclosing the tuple inside `list(...)`, i.e., passing the tuple as an argument. For example,

tuple1 = (3, 6, 8)
a_list = list(tuple1)
tuple1 = (3, 6, 8, 9, 5)
a_list = list(tuple1)
a_list.sort()

print("1.", tuple1)
print("2.", a_list)

1. (3, 6, 8, 9, 5)
2. [3, 5, 6, 8, 9]
Converting lists into tuples
The shortcut way of creating an empty tuple is:  
\[ \text{a_tuple = ()} \]
The alternative way to create an empty tuple is:  
\[ \text{a_tuple = tuple()} \]
A list can be converted into a tuple by enclosing the list inside `tuple(...)`, i.e., passing the list as an argument.  
```
a_list = [3, 6, 8]
a_tuple = tuple(a_list)
tuple1 = (3, 6, 8, 2, 5)
a_list = list(tuple1)
a_list.sort()
a_tuple = tuple(a_list)
```
```
print("1.", a_list)  
print("2.", tuple1)  
print("3.", a_tuple)
```
```
1. [2, 3, 5, 6, 8]  
2. (3, 6, 8, 2, 5)  
3. (2, 3, 5, 6, 8)
```

Returning more than one value
Functions can return a tuple of values.
```
def get_a_date():
    months = ("January", "February", ..., "November", "December")
    days_in_month = (31, 28, 31, 30, 31, ..., 30, 31, 30, 31)
    days = ("Sunday", "Monday", ..., "Saturday")
    day_number = random.randrange(0, len(days))
    month_number = random.randrange(0, len(months))
    date = random.randrange(1, days_in_month[month_number] + 1)
    return (days[day_number], months[month_number], date)

def main():
    date = get_a_date()
    print("Your best day next year is a", date[0], "around", date[1], date[2])
    date = get_a_date()
    print("Next year be careful on a", date[0], "around", date[1], date[2])
main()
```
```
Your best day next year is a Wednesday around February 14
Next year be careful on a Sunday around November 10
```

Multiple assignment
Assignment to more than one variable can be done on ONE line.
```
scores = (56, 78, 91)
(test1, test2, test3) = scores  
name1, name2, name3 = "Bob", "Jane", "Jill"
name2 = name2 + "-marie"
```
```
print("1.", test2, test1, test3)  
print("2.", name3, name1, name2)
```
```
1. 78 56 91
2. Jill Bob Jane-marie
```

A tuple method
`index(x)` returns the index of the first element from the left in the tuple with a value equal to x.
Python throws an error if there is no such value in the list. Because of this, `index(x)` is usually preceded by a check for that element using the `in` operator.
```
tuple1 = (10, 20, 30, 40, 50, 55)
if 40 in tuple1:  #check first
    index = tuple1.index(40)
    print("40 is in position ", index, " in the tuple")
else:
    print("40 is not in the tuple")
```
```
tuple1 = (10, 20, 30, 40, 50, 55)
if 40 in tuple1:  #check first
    index = tuple1.index(40)
    print("40 is in position ", index, " in the tuple")
else:
    print("40 is not in the tuple")
```
```
40 is in position 3 in the tuple
```
Exercise

Complete the get_uniques_tuple() function which returns a tuple made up of all the unique values in the parameter tuple, a_tuple. You may find that you need to work with a list, and, finally, convert the list to a tuple.

```python
def get_uniques_tuple(a_tuple):
    # Your implementation here

def main():
    a_tuple = get_uniques_tuple((3, 4, 5, 6, 3, 2, 9, 4, 5, 6, 2, 9))
    print("Without duplicates", a_tuple)
main()
```

Without duplicates (3, 4, 5, 6, 2, 9)

Exercise

Complete the carry_out_transactions() function which is passed an initial balance and a tuple of transactions (positive and negative amounts). The function returns a tuple made up of three values: the final balance, the sum of all the deposits and the sum of all the withdrawals.

```python
def carry_out_transactions(balance, transactions_tuple):
    # Your implementation here

def main():
    results = carry_out_transactions(5400, (100, -400, 500, -800, 600, -100, -200, 50, 0, -200))
    print("Balance $", results[0], ", deposits $", results[1], ", withdrawals $", results[2], sep="")
main()
```

Balance $4950, deposits $1250, withdrawals $1700

Why tuples?

Tuples cannot be inadvertently changed (remember they are immutable). They are a useful tool if you want to use read-only information.

Tuples are immutable and can be used where only immutable objects can be used (this becomes important later in course).

Processing tuples is faster than processing lists.

Assignment to multiple variables (packed inside a tuple) can be done on the same line of code.

A function can return multiple values (packed inside a tuple).

Tuples are processed more quickly than lists. If you are not going to change the elements of a series of objects, use a tuple rather than a list.

A tuple stores data as a sequence

- The operators: +, * and in can be used with tuples
- We use a for ... in ... to iterate through the contents of a tuple
- len() returns the number of elements in a tuple
- min() returns the minimum of the elements in a tuple
- max() returns the maximum of the elements in a tuple
- sum() returns the sum of the elements in a tuple
- Each element of the tuple can be accessed using the index operator. The index can be negative (starting from the end of the tuple)
- Slices of tuple can be obtained by using [slice_start: slice_end: step]
- Tuples are immutable and therefore the elements of a tuple can be accessed but not changed

- Tuples can be converted into lists and vice versa
- Assignment to multiple variables (packed inside a tuple) can be done on the same line of code.
- A function can return multiple values (packed inside a tuple).
Python features used in this lecture

tuple1 = (5, 7, 2, 6, 4, 3, 9)
tuple2 = (6, )
for element in tuple1:
...

number_of_elements = len(tuple1)
min_value = min(tuple1)
max_value = max(tuple1)
total = sum(tuple1)
element_from_end = tuple1[-2]
tuple2 = tuple1[1:5:2]
position = tuple1.index(3)
tuple3 = tuple([8, 4, 9])
list1 = list(tuple1)
(a, b, c) = ("ant", "bee", "cat")

def get_results():
    return (56, 23, 91)