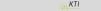# Using Functions

Informatics 1 for Biomedical Engineers
Tutor Session 3

KTI, Knowledge Technologies Institute

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Today's Topics

1. What are functions?

2. Defining Python functions

   - Syntax
   - Function arguments - input parameters - keyword arguments
   - Return values
   - Lambda functions

3. Using your own functions

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Student Goals

- Be able to define your own functions in Python
- Get a feeling about how much functionality to put into one function
- Use (self defined) Python functions in a small program

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What are functions?

- Reuse code snippets
- Quick changing of code throughout the program without copy/paste
- Less typing - less mistakes (potentially)
- Prettier (better readable) and reusable code

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Defining Python functions

```python
1  # Syntax of Python functions: always the same
2  def function_name(arg1, arg2, ..., argN):
3      # do something
4      return something # remember: this is optional!
```

- Syntax

  - input arguments (0 - n) and keyword arguments - optional
  - return values (0 - n) - optional
  - indentation (think of control structures)

Defining Python functions

- Note: Python functions are per definition void()-type functions - return value or function type definition not necessary

- Common: return a tuple and assign return values to several variables simultaneously

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Defining Python functions

```python
1   # Defining our first function
2   def a_simple_function():
3       print("Good morning, starshine!")
4
5   # Defining another function
6   def simple_calculus(input_argument):
7       result = input_argument + 365
8       return result
```

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Keyword arguments

- Declared when defining a function
- Optional when calling the function - default value is used
- When specified, the new value is passed into the function for the keyword

Keyword arguments

```
1   # Implementing some mathematical function
2   def math_function(number, exponent = 2):
3       result = number ** exponent
4       return result
5
6   # Calling the function
7   math_function(5)
8   math_function(5, 6)
9   math_function(number = 5, exponent = 8)
10
11  # Non-default arguments before keyword arguments!
```

How to work with functions

- Using the return value
- Assigning the result of a function to some variable(s)
- Multiple assignment using Tuples

Using the return value

```python
1   # Function returning a tuple
2   def statistic_measures(mean, variance):
3       stand_dev = variance ** 0.5
4       conf_upper = mean + 1.96 * stand_dev
5       return (stand_dev, conf_upper)
6
7   # Assigning the result to several variables at once
8   standard_dev, confidence_up = statistic_measures(3, 1.59)
9   standard_dev = statistic_measures(3, 1.59)[0]
10  confidence_up = statistic_measures(3, 1.59)[1]
11  # "throwing away" a variable:
12  _, confidence_up = statistic_measures(3, 1.59)
```

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Anonymous functions

- Lambda expressions
- Created at point of use with lambda keyword
- e.g. as an argument of a function

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Lambda expressions

```python
1   # Lambda expression as input for the .sort() method
2   # Sorting a list of tuples by name
3   grade_list = [('Alex', 3), ('Michi', 5), ('Sasha', 3)]
4   grade_list.sort(key=lambda name: name[0])
5
6   # Sorting the list by grades
7   grade_list.sort(key=lambda name: name[1])
```

Lambda expressions

```python
def my_filter_fct(obj):
    """
    This function takes an object (which should be a two elemented
    tuple) and returns the second element of the obj
    """
    return obj[1]

grade_list.sort(key=my_filter_fct)

# With lambda, we don't need to declare separate functions
```

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Separating functionality

- How many tasks in one function?

```
1   # Example: triangle information
2   def triangle_circumfer_area(param_a, param_b, param_c, height):
3       circumference = param_a + param_b + param_c
4       area = (param_a * height) / 2
5       return circumference, area
6
7   # We can return both with one function, but it
8   # would be better to split this function
9   # for clarity and usability
```

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Complex example

Task: function for solving a quadratic equation

- $x^2 + px + q = 0$
- $x_1, x_2 = -(p/2) +- (p^2/4 - q) \, \hat{} \, 0.5$
- Input: parameter p and q from the equation
- Return: x_1 and x_2

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Complex Task: Sample Solution

```python
1    # Sample solution
2    def solve_quadr_equation(param_p, param_q):
3        #x1,2 = -(p/2) +- sqrt((p**2/4)-q)
4        main_term = -(param_p / 2)
5        root_pos = ((param_p ** 2)/4 - param_q) ** 0.5
6        root_neg = root_pos * (-1)
7        x_1 = (main_term + root_pos)
8        x_2 = (main_term + root_neg)
9        return (x_1, x_2)
```

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Student Task

Task: Write a function to calculate the median

- Get the list of input data from pickle file
- Write a function to calculate the median of the given data list

  - Bring elements in correct order
  - Get the element(s) in the middle of the list
  - Calculate and return the median

Student Task: Sample Solution

```python
def calc_median(elem_list):
    elem_list.sort()
    length = len(elem_list)
    half_length = int(length / 2)

    if length % 2 == 0: # Even number of elements
        first = elem_list[half_length - 1]
        second = elem_list[half_length]
        median = (first + second) / 2

    else: # Odd number of elements
        median = elem_list[half_length - 1]

    return median
```