

# Programming

## Functions, debugging, functional programming and lazy evaluation

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***Functions***

***Debugging***

***Functional  
programming***

***Lazy  
evaluation***

# Functions

```
def «functionName» ( «parameterName1»,  
«parameterName2», ... ):  
    «statement»  
    return «statement»
```

▲ Mind the indentation!

*gray = optional*

# Variable Scope

## ***Functions have a separate variable scope!***

- ❖ internal variables are not accessible from outside
- ❖ calling global functions and variables is possible
  - ❖ Reading global variables is discouraged
- ❖ Changing global variables requires

«`global` variableName»

statement inside function (highly discouraged)

# Functions—a simple example

```
1 def myFirstFunction():  
2     print('this is my first function')  
3  
4 # call function  
5 myFirstFunction()  
6  
7 # save return value in variable  
8 hereComesNothing = myFirstFunction()
```

## Functions—example of code reuse

```
1 def findSubstringInStrings(stringCollection, pattern):
2     occ = list()
3     for i, s in enumerate(stringCollection):
4         j = s.find(pattern)
5         while j != -1:
6             occ.append((i, j))
7             j = s.find(pattern, j+1)
8     return occ
9
10 myStringList = ['the_rain_in_spain', 'ain\t_no_sunshine',
11                'she_was_greeted_with_disdain']
12
13 occOfAin = findSubstringInStrings(myStringList, 'ain')
```

# Quiz

Have you ever seen a function calling itself? Consider the following:

```
1 def fun(x):  
2     if len(x) > 1:  
3         return fun(x[1:])  
4     return x
```

What does the function call `fun([1,2,3,4])` return?

# Quiz

Have you ever seen a function calling itself? Consider the following:

```
1 def fun(x):  
2     if len(x) > 1:  
3         return fun(x[1:])  
4     return x
```

What does the function call `fun([1,2,3,4])` return?

[4]



***Functions***

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# Programming errors

Recognizing different types of errors:

- ❖ **Syntactic:** spelling & grammar mistakes
  - ❖ e.g.  $avg = (x\ y)/2$
- ❖ **Semantic:** mistakes in meaning, context, or program flow
  - ❖ e.g.  $avg = x + y/2$  or  $avg = (x + z)/0$

Distinction between

- ❖ Compile-time errors (syntactic, semantic)
- ❖ Runtime errors (semantic)

# RuntimeError

## Changing the size of my\_dict in loop

```
1 # dictionary filled with arbitrary elements
2 my_dict = {'key': 'value', 1: 'text', (1, 2)
3           : 'text'}
4
5 # for-loop over keys of my_dict with control
6   variable 'key'
7
8 for key in my_dict:
9     my_dict[(key, 1, 2, 3)] = 'new_element'
```

# Catching exceptions

Controlled treatment of anticipated exceptions:

```
1 while True:
2     try:
3         x = int(input("Please enter a number: "))
4         break
5     except ValueError:
6         print("Oops! That was no valid number. Try again...")
```

# Raising exceptions

Use **raise** keyword to throw exceptions:

```
1 def myFunction(collection):  
2  
3     if len(collection) == 0:  
4         raise RuntimeError("Invalid input: empty collection")  
5         # do something ..  
6         return  
7  
8 myFunction(list())
```

## Raising exceptions

Check properties of input parameters using the assert statement:

```
1 def myFunction(collection):  
2  
3     assert len(collection) > 0, "Invalid input: empty collection"  
4  
5     # do something ..  
6     return  
7  
8 myFunction(list())
```

Failed assertions result in an AssertionError

# Debugging

## PDB—the Python debugger

- ❖ Enables step-by-step proceeding of statements in Python programs
- ❖ Interaction with Python program at runtime
- ❖ Debugger is invoked by *breakpoints*
- ❖ Set breakpoint in arbitrary location of your code by
  - ❖ calling builtin “`breakpoint()`” function (Python version  $\geq 3.7$ )
  - ❖ statement “`import pdb; pdb.set_trace()`”

## Python debugger—example

```
1 # dictionary filled with arbitrary elements
2 my_dict = {'key': 'value', 1: 'text', (1, 2)
3           : 'text'}
4
5 # invoke Python debugger
6 breakpoint()
7
8 # for-loop over keys of my_dict with control
9   variable 'key'
10 for key in my_dict:
11     my_dict[(key, 1, 2, 3)] = 'new_element'
```



# Quiz

- ❖ Is improper indentation a syntactic or semantic error?
- ❖ Consider the following code:

```
1 def str2int(x):  
2     try:  
3         return int(x)  
4         _____ ValueError:  
5         return -1
```

What keyword should be used here?

`except`

`raise`

`else`

`Exception`

source: <https://quizizz.com/>

# Quiz

- Is improper indentation a syntactic or semantic error? syntactic
- Consider the following code:

```
1 def str2int(x):  
2     try:  
3         return int(x)  
4         _____ ValueError:  
5         return -1
```

What keyword should be used here?

`except` ✓

`raise`

`else`

`Exception`

source: <https://quizizz.com/>

***Functions***

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evaluation***

# *Functional programming*

See Jupyter Notebook!

- ❖ Declarative programming paradigm
- ❖ Result constructed by applying and composing functions

***Functions***

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# *Lazy evaluation*

See Jupyter Notebook!

- ❖ Concept in functional programming
- ❖ Refers to how function arguments are processed **only** when an expression is being evaluated

# *Recap*

# Summary

- ❖ Code reuse through functions
- ❖ Compile-time and runtime errors
- ❖ Python debugger, a tool for hunting runtime errors (bugs)
- ❖ Declarative paradigm: functional programming
- ❖ Lazy evaluation and implicit Boolean conversion



# What comes next?

- ❖ Write your first function
- ❖ Familiarize yourself with the Python Debugger
- ❖ Due date for this week's exercises is **Wednesday, November 13, 2pm, 2024.**

*Next lecture: Object-oriented programming ... ..*