

빅 데이터 혁신 공유 대학

# 파이썬으로 배우는 데이터 구조

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# Data Structures in Python

## Chapter 1 - 2

- Object-Oriented Programming
- OOP in Python
- OOP - Fraction Example
- OOP - Classes
- OOP - In-Place Operators
- **Exceptions**
- Exception Clauses

# Agenda

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- Topics: Python Review
  - Exception Handling
- Learning outcomes
  - Understand the flow of control that occurs with exceptions.
    - **try, except, finally**
  - Use exceptions to handle unexpected runtime errors gracefully.
    - **Catch** an exception of the appropriate type.
    - **Throw** an exception.
    - **Raise** exceptions when appropriate.
- Resources
  - Errors and Exceptions — Python 3.9.6 documentation
    - <https://docs.python.org/3/tutorial/errors.html>
  - Python3 Tutorial: Exception Handling
    - [https://www.python-course.eu/python3\\_exception\\_handling.php](https://www.python-course.eu/python3_exception_handling.php)

# Introduction

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- **Errors occur in software programs.**
  - However, if you handle errors properly, you will greatly improve your program's **readability, reliability and maintainability**.
  - Python uses exceptions for error handling.
- Exception examples:
  - Attempt to divide by ZERO
  - Couldn't find the specific file to read
- The run-time system will attempt to handle the exception (default exception handler), usually by displaying an error message and terminating the program.

# Divide by zero error

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- Check for valid input first
  - Only accept input where the divisor is non-zero

```
def divide(a, b):  
    if b == 0:  
        result = 'Error: cannot divide by zero'  
    else:  
        result = a / b  
    return result
```

# Divide by zero error

- Check for valid input first
  - Only accept input where the divisor is non-zero

```
def divide(a, b):  
    if b == 0:  
        result = 'Error: cannot divide by zero'  
    else:  
        result = a / b  
    return result
```

- What if “b” is not a number

```
def divide(a, b):  
    if (type(b) is not int and type(b) is not float):  
        result = "Error: divisor is not a number"  
    elif b == 0:  
        result = 'Error: cannot divide by zero'  
    ...
```

# Handling input error

- Check for valid input first
  - What if “a” is not a number?

```
def divide(a, b):  
    if (type(b) is not int and type(b) is not float or  
        type(a) is not int and type(a) is not float):  
        result = ('Error: one or more operands' +  
                  ' is not a number')  
  
    elif b == 0:  
        result = 'Error: cannot divide by zero'  
    else:  
        result = a / b  
    return result  
  
x = divide(5, 'hello')  
print(x)
```

# What is an Exception?

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- An exception is **an event** that occurs during the execution of a program that **disrupts** the normal flow of instructions during the execution of a program.
- When an error occurs within a method, the method creates an **exception object** and hands it off to the runtime system.
- The **exception object** contains
  - **information** about the error, including its type and the state of the program when the error occurred.
- Creating an exception object and handing it to the runtime system is called **throwing an exception**.



# Handling exceptions

- Code that might create a runtime error is enclosed in a **try** block.
  - Statements are executed sequentially as normal.
  - If an error occurs then the remainder of the code is **skipped**.
  - The code **starts executing** again at the **except** clause.
    - The exception is "caught".

```
try:  
    statement block  
    statement block  
except:  
    exception handling statements  
    exception handling statements
```

- Advantages of catching exceptions:
  - It allows you to fix the error.
  - It prevents the program from automatically terminating.

# Handling exceptions - Case 1

```
def divide(a, b):  
    try:  
        result = a / b  
        ➡ print ("try-block")  
    except:  
        result = 'Error in input data'  
        print ("except-block")  
    return result
```

- Case 1: No error
  - divide(5, 5)

➡  
➡

```
x = divide(5, 5)  
print ("Program continues here...")  
print(x)
```

try-block  
Program continue here...  
1.0

## Handling exceptions - Case 2

```
def divide(a, b):  
    try:  
        result = a / b ✗  
        print ("try-block")  
    except:  
        result = 'Error in input data'  
        print ("except-block")  
    return result
```

- Case 2: Invalid input

- divide(5, 0)
- divide(5, 'Hello')

```
➡ x = divide(5, 0)  
➡ print ("Program continues here...")  
➡ print(x)
```

```
except-block  
Program continues here...  
Error in input data
```

- But what is the error in each situation?

1.  $5/0 \rightarrow \text{ZeroDivisionError: division by zero}$
2.  $5/\text{'hello'} \rightarrow \text{TypeError: unsupported operand type(s) for /: 'int' and 'str'}$

## Exercise 1

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- What is the output of the following?

```
def divide(dividend, divisor):  
    try:  
        quotient = dividend / divisor  
    except:  
        quotient = 'Error in input data'  
    return quotient  
  
x = divide(5, 0)  
print(x)  
x = divide('hello', 'world')  
print(x)  
x = divide(5, 5)  
print(x)
```

# Exercise 1

- What is the output of the following?

```
def divide(dividend, divisor):  
    try:  
        quotient = dividend / divisor  
    except:  
        quotient = 'Error in input data'  
    return quotient
```

```
x = divide(5, 0)  
print(x)  
x = divide('hello', 'world')  
print(x)  
x = divide(5, 5)  
print(x)
```

Error in input data

Error in input data

1.0

# Danger in catching all exceptions

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- The general **except** clause catching **all** runtime errors.
  - Sometimes that can hide problems.
- You can put **two or more** except clauses, each except block is an exception handler and handles the type of exception indicated by its argument in a program.
  - The runtime system invokes the exception handler when the handler is the **FIRST ONE** matches the **type** of the exception thrown.
    - It executes the statement inside the matched except block, the other except blocks are bypassed and continues after the try-except block.

# Specifying the exceptions

```
def divide(a, b):  
    try:  
        ➡ result = a / b  
    except TypeError:  
        result = 'Type of operands is incorrect'  
    except ZeroDivisionError:  
        result = 'Divided by zero'  
    return result
```

- Case 1:

- No error

```
➡ x = divide(5, 5)  
  print(x) 1.0
```

# Specifying the exceptions

```
def divide(a, b):  
    try:  
        result = a / b  
    except TypeError:  
        result = 'Type of operands is incorrect'  
    except ZeroDivisionError:  
        result = 'Divided by zero'  
    return result
```

- Case 2:
  - is not a number

```
➡ x = divide('hello', 5)  
   print(x)
```

Type of operands is incorrect



# Specifying the exceptions

```
def divide(a, b):  
    try:  
        result = a / b  
    except TypeError:  
        result = 'Type of operands is incorrect'  
    ➡ except ZeroDivisionError:  
        result = 'Divided by zero'  
    return result
```

- Case 3:
  - is not a number

➡ `x = divide(5, 0)`  
`print(x)`

Divided by zero

## Specifying the exceptions - Exception not Matched

- If no matching except block is found, the run-time system will attempt to handle the exception, by terminating the program.

```
def divide(a, b):  
    try:  
        result = a / b ✖  
    except IndexError:  
        result = 'Type of operands is incorrect'  
    ➡ except ZeroDivisionError:  
        result = 'Divided by zero'  
    return result
```

- Case 4:
  - Exception not matched

➡ `x = divide('abc', 0)`  
`print(x)`

```
TypeError                                Traceback (most recent call last):  
<ipython-input-2-da1852461651> in <module>  
----> 1 x = divide('abc', 0)  
      2 print(x)result = a / b TypeError: unsupported operand  
<ipython-input-1-5faae4bc1dfe> in divide(a, b)  
      1 def divide(a, b):  
      2     try:  
----> 3         result = a / b  
TypeError: unsupported operand type(s) for /: 'str' and 'int'
```

# Specifying the exceptions - Order of except clauses

- Specific exception block must come **before** any of their general exception block.

```
def divide(a, b):  
    try:  
        result = a / b  
    except: ← general exception block  
        result = 'Type of operands is incorrect'  
    except ZeroDivisionError:  
        result = 'Divided by zero'  
    return result
```

This code will **never** catch ZeroDivisionError exception.

```
def divide(a, b):  
    try:  
        result = a / b  
    except ZeroDivisionError:  
        result = 'Divided by zero'  
    except:  
        # handle all other exceptions  
        result = ...  
    ...
```

# Exceptions

- Any kind of built-in error can be caught
  - Check the Python documentation for the complete list
  - Some popular errors:
    - `ArithmeticError`: various arithmetic errors
    - `ZeroDivisionError`: dividing by 0
    - `IndexError`: a sequence subscript is out of range
    - `TypeError`: inappropriate type
    - `ValueError`: has the right type but an inappropriate value
    - `IOError`: Raised when an I/O operation
    - `EOFError`: hits an end-of-file condition (EOF) without reading any data
    - ...
- Resources: Built-in Exceptions:
  - <https://docs.python.org/3/library/exceptions.html>
  - <https://docs.python.org/3/library/exceptions.html#exception-hierarchy>

```
BaseException
+-- SystemExit
+-- KeyboardInterrupt
+-- GeneratorExit
+-- Exception
    +-- StopIteration
    +-- StopAsyncIteration
    +-- ArithmeticError
    |   +-- FloatingPointError
    |   +-- OverflowError
    |   +-- ZeroDivisionError
    +-- AssertionError
    +-- AttributeError
    +-- BufferError
    +-- EOFError
    +-- ImportError
    |   +-- ModuleNotFoundError
    +-- LookupError
    |   +-- IndexError
    |   +-- KeyError
    +-- MemoryError
    +-- NameError
    |   +-- UnboundLocalError
    +-- OSError
    |   +-- BlockingIOError
    |   +-- ChildProcessError
    |   +-- ConnectionError
    |       +-- BrokenPipeError
    |       +--
    +-- ConnectionAbortedError
    |   +--
    +-- ConnectionRefusedError
    |   +-- ConnectionResetError
    |   +-- FileExistsError
    |   +-- FileNotFoundError
```

## Exercise 2

- Consider the following code:

```
my_list = [1, 2, 3]
num = int(input('Enter an index: '))
print(my_list[num])
```

- Sample Run:

Enter an index: 1

2

Enter an index: 6

...

IndexError: list index out of range

- Rewrite it using try-except block to handle the general error.

- Sample Run:

Enter an index: 1

2

Enter an index: 6

DSpy joyful error: list index out of range

your own message

system's error message

## Exercise 2 - solution

```
my_list = [1, 2, 3]
num = int(input('Enter an index: '))
try:
    print(my_list[num])
except Exception as e:
    print('DSpy joyful error: ' + str(e))
```

- Rewrite it using try-except block to handle the general error.
  - Sample Run:

Enter an index: 1

2

Enter an index: 6 DSpy joyful error: list index out of range

your own message

system's error message

## Exercise 3

- Consider the following code:

```
rgb = {'red': 1, 'green': 2, 'blue': 3 }  
num = input('Enter a key: ')  
print(rgb[num])
```

- Sample Run:

Enter a key: red

1

Enter a key: orange

...

KeyError: 'orange'

- Rewrite it using try-except block to handle the **KeyError**.

- Sample Run:

Enter a key: red

2

Enter a key: orange

DSpy joyful error: Invalid key!

your own message

system's error message

## Exercise 3 - solution

```
rgb = {'red': 1, 'green': 2, 'blue': 3 }
num = input('Enter a key: ')

try:
    print(rgb[num])
except KeyError:
    print('DSpy joyful error: ' + 'Invalid Key!')
except Exception as e:
    print('DSpy joyful error: ' + str(e))
```

- Rewrite it using try-except block to handle the **KeyError**.

- Sample Run:

Enter a key: red

2

Enter a key: orange DSpy joyful error: Invalid key!

your own message

your own message



# Data Structures in Python

## Chapter 1 - 2

- Object-Oriented Programming
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- OOP - Fraction Example
- OOP - Classes
- OOP - In-Place Operators
- **Exceptions**
- Exception Clauses