

O Object O Oriented P Programming

S1 = Python with Bianca

S2 = Java with Bryan

DT228(TU856)/DT282(TU858) - 2



**COMPUTER
SCIENCE**

Exception Handling and Files

Objectives

- Discuss the need for exceptions
- Apply and use exceptions
- Write your own exceptions
- Interact with files

Syntax, Runtime and Logical Errors

```
if message == first_name  
    print("oh no")
```

Syntax errors are the easy ones. Here a colon is missing.

```
"/Volumes/GoogleDrive/My Drive/Vorlesu
```

```
File "/Volumes/GoogleDrive/My Dr
```

```
if message == first_name
```

```
SyntaxError: invalid syntax
```

```
Process finished with exit code 1
```

```
a = 45
```

```
b = 0
```

```
print(a/b)
```

```
"/Volumes/GoogleDrive/My Drive/Vorlesu
```

```
Traceback (most recent call last):
```

```
File "/Volumes/GoogleDrive/My Drive/V
```

```
print(a/b)
```

```
ZeroDivisionError: division by zero
```

Runtime errors are the next best ones. Here a division by 0. Start fixing by going to the line pointed out, then move up.

```
a = 45
```

```
b = 4
```

```
if a < b:
```

```
    print(a, ' is greater than ', b)
```

Logical errors are the hardest to track down.

```
Process finished with exit code 1
```

Why we need Exceptions

- In the old days we would rigorously check inputs for all possible values and try to avoid bad inputs/outputs
- Methods would have special return values to indicate an error had occurred
 - Example: return a negative value if a positive value could not be calculated
 - Different numbers indicate different errors
- Every code that is using this method would have to explicitly check for these error numbers
 - This is tedious so it rarely happened, so programs just crashed

What are Exceptions

- Allow us to deal with errors only if they come up
- They handle recovery, so programs crash less
- Are used as part of your code's flow control
 - If we encounter a specific exception and have checked if this case occurs, we can then control what the program is to do next, which avoids programs just hanging or crashing

Build in Errors/Exceptions

- ValueError
- ZeroDivisionError
- IOError
- ImportError
- IndexError
- KeyError
- NameError
- TypeError

Check Python documentation for more!

<https://docs.python.org/3/library/exceptions.html>

exception **Exception** ¶

All built-in, non-system-exiting exceptions are derived from this class. All user-defined exceptions should also be derived from this class.

exception **ArithmeticError**

The base class for those built-in exceptions that are raised for various arithmetic errors: `OverflowError`, `ZeroDivisionError`, `FloatingPointError`.

exception **BufferError**

Raised when a `buffer` related operation cannot be performed.

exception **LookupError**

The base class for the exceptions that are raised when a key or index used on a mapping or sequence is invalid: `IndexError`, `KeyError`. This can be raised directly by `codecs.lookup()`.

Example of Causing an Exception to be Fired

```
names = ["Bianca", "Bryan", "Susan"]  
print(names[5])
```

Position index 5 does not exist!!
In the example the list's highest position index is 2.

```
/Users/bianca.schoenphelan/Documents/OOP_Class/Code/venv/bin/python /Users/bianca.schoenphelan/Doc  
Traceback (most recent call last):  
  File "/Users/bianca.schoenphelan/Documents/OOP_Class/Code/tutorial.py", line 2, in <module>  
    print(names[5])  
IndexError: list index out of range  
  
Process finished with exit code 1
```


Try, Except

- How to manage errors in your program
- Structure:

Try do something:

Except: do something else in case of an error

```
try:
    result = 4 / 0
    print(result)
except:
    print('An error occurred.')
```

```
try:
    result = 4 / 0
    print(result)
except ZeroDivisionError:
    print('cannot divide by zero.')
except Exception as e:
    print("Unknown error.")
```

Try Except for the List Error in Previous Slide

```
names = ["Bianca", "Bryan", "Susan"]
try:
    print(names[5])
except IndexError as ie:
    print("This index position does not exist."
          "Caused error: \n", ie)
except Exception as e:
    print("Unexpected error occurred: \n", e)
print("still here. We haven't crashed.")
```

as denotes that the name after is an alias for what's before. This is often used for shorthand of long names. Exceptions names can get very long.

```
/Users/bianca.schoenphelan/Documents/OOP_Class/Code
This index position does not exist.Caused error:
  list index out of range
still here. We haven't crashed.

Process finished with exit code 0
```

Logical Errors

- Unit testing is very useful in this context
 - We will talk about testing in teaching week 10
- Look at the **traceback**
- Re-read your code and look at the documentation
- Search online
- Ask for help
- Take a break

[3]

Python prints a so called “traceback” if an exception is raised. The traceback is supposed to help you identify the cause of the error. Other names are stack trace, back trace. Main thing to remember, is that we read a traceback bottom to top.

[3]

The Components of a Traceback

Read exceptions from bottom to top line.

```
names = ["Bianca", "Bryan", "Susan"]  
print(names[5])
```

```
/Users/bianca.schoenphelan/Documents/OOP_Class/Code/venv/bin/python /Users/bianca.schoenphelan/  
Traceback (most recent call last):  
  File "/Users/bianca.schoenphelan/Documents/OOP_Class/Code/tutorial.py", line 2, in <module>  
    print(names[5])  
IndexError: list index out of range  
  
Process finished with exit code 1
```

The name of the function call that caused the exception.

Last line of traceback contains the exception's name, here `IndexError`, and then the exception's message, here "list index out of range".

Common Exceptions

```
1 print "hello World"
```

```
print "hello World"  
^  
SyntaxError: Missing parentheses in call to 'print'. Did you mean print("hello World")?  
Process finished with exit code 1
```

This particular error happens a lot for programmers switching from Python2 to Python3, because `print`, although a valid instruction, is now a method!

Common Exceptions cont'd

```
a = 10/0
```

```
a = 10/0  
ZeroDivisionError: division by zero  
Process finished with exit code 1
```

Common Exceptions cont'd

```
myList = [1,2,4]  
print(myList[3])
```

```
print(myList[3])  
IndexError: list index out of range
```

Common Exceptions cont'd

```
myList = [1,2,4]  
myList + 2
```

```
myList + 2  
TypeError: can only concatenate list (not "int") to list
```



Common Exceptions cont'd

```
myList = [1,2,4]  
myList.add
```

```
myList.add  
AttributeError: 'list' object has no attribute 'add'
```

Common Exceptions cont'd

```
myDictionary = {'a': 'hello world'}  
myDictionary['b']
```



```
myDictionary['b']  
KeyError: 'b'
```

Common Exceptions cont'd

```
print(my_misspelled_variable)
```

```
print(my_misspelled_variable)  
NameError: name 'my_misspelled_variable' is not defined
```

Common Exceptions Summary

- Not always 'wrong' input as such, sometimes intentional, for example zero division error
- All exceptions end on Error

You can use the same mechanisms Python uses to check for inputs.

In Python we use the words error and exceptions mostly interchangeably.

Use in your own code

```
class EvenOnly(list):
    def append(self, integer):
        if not isinstance(integer, int):
            raise TypeError("Only integers can be added")
        if integer % 2:
            raise ValueError("Only even numbers can be added")
        super().append(integer)
```

```
even = EvenOnly()
even.append("hello world")
```

`even.append(3)`

`raise ValueError("Only even numbers can be
ValueError: Only even numbers can be added")`

```
Traceback (most recent call last):
  File "/Users/bianca.schoenphelan/PycharmProjects/Te
    even.append("hello world")
  File "/Users/bianca.schoenphelan/PycharmProjects/Te
    raise TypeError("Only integers can be added")
TypeError: Only integers can be added

Process finished with exit code 1
```

How to Raise and Exception

- It's just an object
 - Like everything in Python!
- Many different classes are available to raise exceptions
- They all inherit from a built in class called `BaseException`

If an exception occurs, everything that was supposed to happen in your program, now doesn't happen.

Exception Handling

- When an exception occurs the program appears to stop immediately
- None of the code after the exception is executed
- Unless the exception is dealt with, the program will terminate with an error message
- Even if your method calls another method that raises an exception, nothing beyond the 2nd method call will be executed once the exception has been raised.

Exceptions

- What would happen in case of an exception?

```
try:  
    call_demo()  
except:  
    print("I caught the exception")  
  
print('We\'re now outside the exception.')
```

```
call_demo starts here...  
I am about to raise an exception  
I caught the exception  
We're now outside the exception.
```

- Recover and continue!!

Handling different Scenarios

```
def my_divisions2(myNumber):  
    try:  
        return 100 / myNumber  
    except (ZeroDivisionError, TypeError):  
        return "Enter a number that is not zero!"  
  
for value in ('0', 50.0, 'hello', 13):  
    print('Testing {}: '.format(value), end=" ")  
    print(my_divisions2(value))
```

We can catch several different exceptions and handle them with the same code.

```
Testing 0: Enter a number that is not zero!  
Testing 50.0: 2.0  
Testing hello: Enter a number that is not zero!  
Testing 13: 7.6923076923076925
```

[1]

Handling different Scenarios cont'd

- We can stack exceptions
- Only first one will be executed that fits, even if more fit

```
def my_divisions3(myNumber):
    try:
        if myNumber == 13:
            raise ValueError("13 is an unlucky number")
        return 100 / myNumber
    except ZeroDivisionError:
        return "Enter a number other than zero"
    except TypeError:
        return "Enter a numerical value"
    except ValueError:
        print("No, No, not 13!")
        raise

for value in (0, "hello", 50.0, 13):
    print("Testing %s:" % value, end=" ")
    print(my_divisions3(value))
```

```
Testing 0: Enter a number other than zero
Traceback (most recent call last):
Testing hello: Enter a numerical value
Testing 50.0: 2.0
  File "/Users/bianca.schoenphelan/PycharmProje
    print(funny_division3(val))
Testing 13: No, No, not 13!
  File "/Users/bianca.schoenphelan/PycharmProje
    raise ValueError("13 is an unlucky number")
ValueError: 13 is an unlucky number

Process finished with exit code 1
```

Handling different Scenarios cont'd

- Allows us to enter our own text

```
def testingArguments():  
    try:  
        raise ValueError("this is a test argument")  
    except ValueError as e:  
        print("The exception arguments are: ", e.args)  
  
testingArguments()
```

Still missing something

- Execute code regardless of whether or not an exception has occurred
- Specify which code should be executed only if an exception does not occur
- Solution: **finally ... else**

Finally...else

```
some_exceptions = [ValueError, TypeError, IndexError, None]

try:
    choice = some_exceptions[3] #change values here from 0 to 3
    print("raising {}".format(choice))

except ValueError:
    print("Caught a ValueError")
except TypeError:
    print("Caught a TypeError")
except Exception as e:
    print("Caught some other error: %s" % e.__class__.__name__)
else:
    print("This code called if there is no exception")
finally:
    print("This cleanup code is always called")
```

```
ExceptionExamples x
/Users/bianca.schoenphelan/PycharmPro
raising <class 'IndexError'>
Caught some other error: IndexError
This cleanup code is always called

Process finished with exit code 0
```

- IndexError will be handled in the Exception as e clause
- Print in the finally clause is always executed, no matter what happens, examples:
- Cleaning up database connection
- Closing an open file
- Send closing handshake over network
- Return statements in case of an error
- In case of no exception both else and finally are executed!

Hierarchy

- After a `try` any of `except`, `else` or `finally` are optional and can be omitted
 - `else` by itself is invalid though
- If use more than one, then the `except` must come first, then the `else`, then the `finally`
- Order of exceptions themselves usually go from most specific to most general

Define your own

- Name of the class should communicate what went wrong
- Inherit from Exception
- We can define arguments too
- We haven't talked about inheritance and objects yet, so this is content to go back to when we have covered this material.

Your own Exception

- You need to inherit from Exception
- That's it
- Can use any argument type, string probably most commonly used.

```
class InvalidStudentEnrollment(Exception):  
    pass
```

```
raise InvalidStudentEnrollment("Not a valid student for this programme.")
```

```
Traceback (most recent call last):
```

```
  File "/Users/bianca.schoenphelan/PycharmProjects/TestProject1/ExceptionEx:  
    raise InvalidStudentEnrollment("Not a valid student for this programme."  
__main__.InvalidStudentEnrollment: Not a valid student for this programme.
```

```
Process finished with exit code 1
```

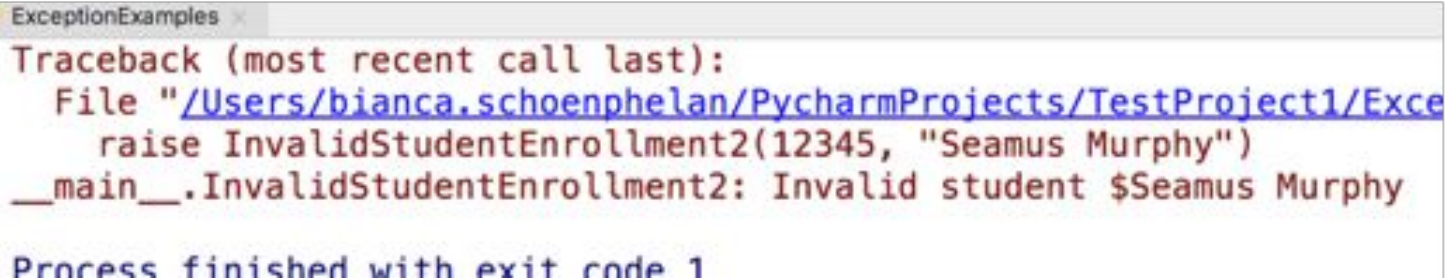

Your own Exception cont'd

You can include any amount of arguments.

```
class InvalidStudentEnrollment2(Exception):
    def __init__(self, studentID, name):
        super().__init__("Invalid student ${}".format(name))
        self.studentID = studentID
        self.name = name

    def auditInvalidStudent(self):
        return self.name + ' ' + self.studentID

raise InvalidStudentEnrollment2(12345, "Seamus Murphy")
```



ExceptionExamples

```
Traceback (most recent call last):
  File "/Users/bianca.schoenphelan/PycharmProjects/TestProject1/Exce
    raise InvalidStudentEnrollment2(12345, "Seamus Murphy")
__main__.InvalidStudentEnrollment2: Invalid student $Seamus Murphy

Process finished with exit code 1
```

Files

Files

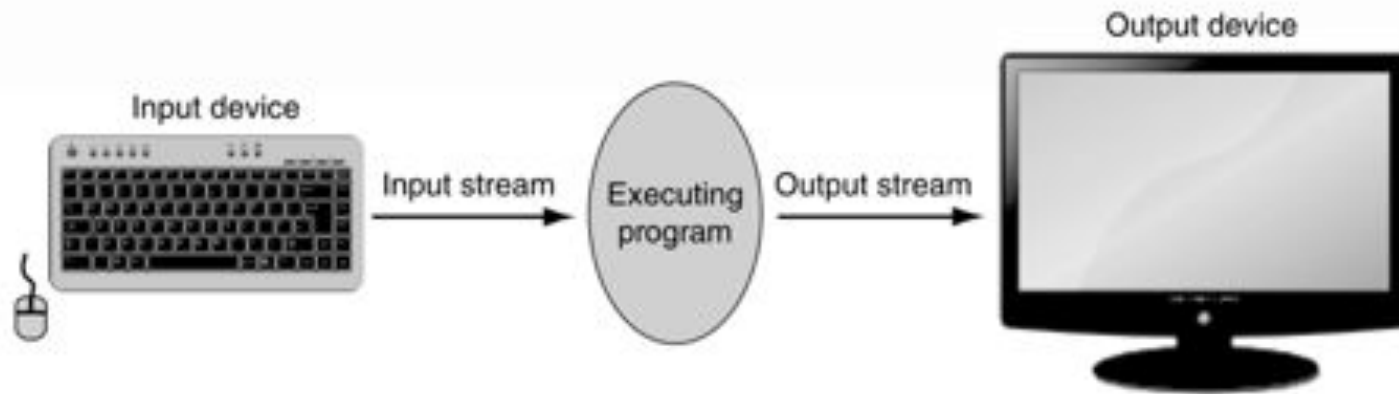
- A file is a set of data stored on secondary storage such as a usb drive
- Accessing a file means establishing the connection to a file.
- Two types:
 - Text file
 - Human readable
 - Control characters, such as `\n` are typically interpreted
 - Binary file
 - Not human readable
 - Contains non-readable information
 - All information is directly translated

Open a File

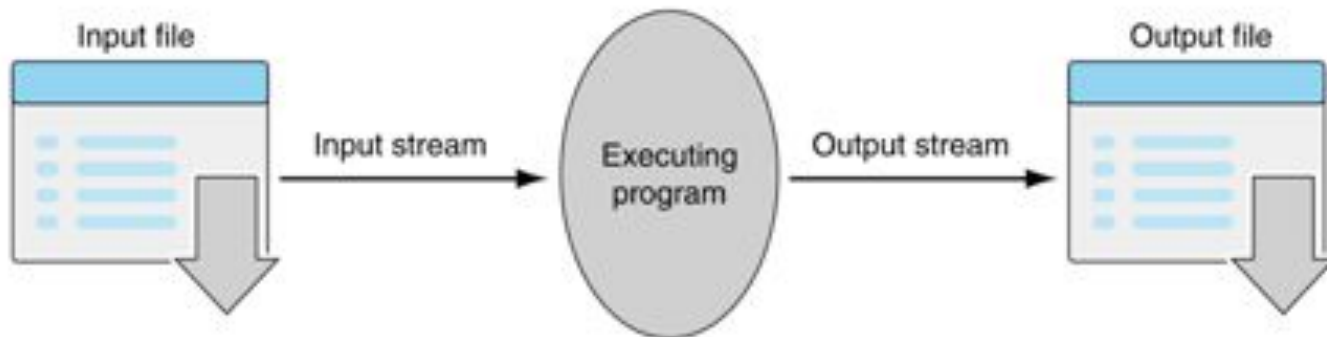
- You open a stream or a file object stream
 - That's the connection between any disk and your programme
 - Stream contains a buffer of the data from the file and provides that data to the program

Input/Output Stream

[2]



a) Standard input and output



b) File input and output

FIGURE 5.1 Input-output streams.

Buffering

[2]

- Reading from a disk is typically very slow
- Latency and throughput
- Computer reads a lot in the hope that you might need further data later
- The copy of the data in the computer is in the cache

Making a File Object

- `myFile` is a file object
 - Contains the buffer of information
- `open` function creates the connection
 - First parameter is the file name
 - Second is the mode to open, here `r`



A screenshot of a Python IDE window. The title bar shows three tabs: 'optionexamples.py', 'FileExamples.py', and 'mytextfile.txt'. The main editor area displays the code: `myFile = open('mytextfile.txt', 'r')`. The string 'mytextfile.txt' is underlined with a green wavy line, indicating it is a recognized file object.

- Two different forms possible for the name:
- Relative: `"mytextfile.txt"`
- Absolute: `"C:\MyDocs\mytextfile.txt"`

File Open Options

Mode	Meaning	If File Exists	If File Doesn't Exist
'r'	Read-only	File is opened	Error message
'w'	Write-only	Clears file contents	Creates and opens a new file
'a'	Write-only	Existing content left in tact and new content appended	Creates and opens a new file
'r+'	Read and write	Reads and overwrites from the file's beginning	Error message
'w+'	Read and write	Clears the file contents	Creates and opens a new file
'a+'	Read and write	Existing content left in tact and read and write content appended	Creates and opens a new file

Text Files

- Everything is a string
 - Everything read is a string
 - Everything written must be a string
- Once opened, print can be used to write to a file

Writing to a File

```
F = open("myFile.txt", "w")  
print(F)  
F.write('first line \n')  
F.write("second line")  
F.close()
```

`write()` by itself does not add a
newline character.

Reading from a File

```
F = open("myFile.txt", "r")  
print(F.read())  
F.close()
```

```
F = open("myFile.txt", "r")  
print(F.read(5))  
F.close()
```

```
F = open("myFile.txt", "r")  
print(F.readline())  
F.close()
```

```
F = open("myFile.txt", "r")  
print(F.readlines())  
F.close()
```

`readline()` reads a string and automatically adds newline character apart from the last line

Looping through a File

```
F = open("myFile.txt", "r")
for line in F:
    print(line)
F.close()
```

```
F = open("myFile.txt", "r")
for line in F:
    word = line.split()
    print(word)
F.close()
```

```
['first', 'line']
['second', 'line']
```

Why do we close()

- Flush the buffer contents from the computer to the file
- Stop the connection to the file

All open files should be closed, if you don't, you won't see any immediate effects but over time might get interesting memory effects.

- For an automatic close use with

```
with open("myFile.txt", "a") as file_obj:  
    file_obj.write("hello")
```

Summary

- ★ **Built-in exceptions**
- ★ **Build your own exceptions**
- ★ **Handle files**



References

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2. The Practice of Computing Using Python, Punch, Enbody , 2013 Pearson Addison-Wesley.
3. Understanding traceback messages, Real Python, Chad Hanson, <https://realpython.com/python-traceback/>, accessed Oct 2020.