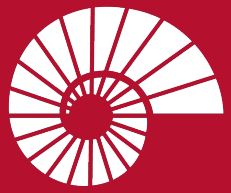

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11 – Exceptions

COMP 125 Programming with Python

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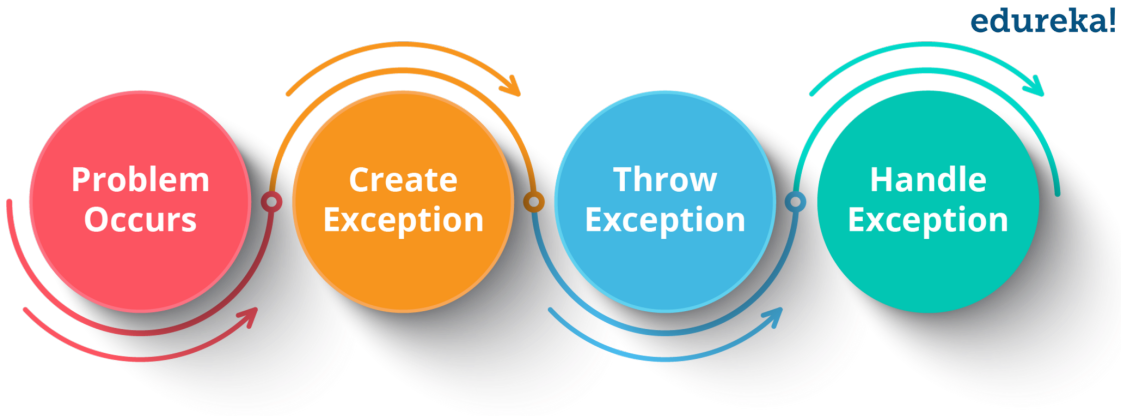
Exceptions and exception handling

- Lots of things can go wrong in computer programs
- For example, you may try to
  - Convert a string with non-digit characters to an integer
  - Call a non-existent function of a class
  - Import a non-existent module
  - Open a non-existent file
  - Modify an immutable object

These are examples of exceptions



Should our programs stop or handle these exceptions?

Exceptions

- Indication of a “special event”, usually an error, during program execution
- Exceptions cause the program to abruptly halt, unless handled
- **Traceback:**
  - Occurs when an exception is encountered
  - Error messages give information regarding the line numbers that caused the exception
  - Indicates the type of exception and brief description of the error that caused exception to be raised

```
1   def divide(num1, num2):
2       result = num1 / num2
3       return result
4
5   def foo(a, b):
6       D = divide(a, b)
7       print(D)
8
9   def main():
10      x = 10
11      y = 0
12      foo(x, y)
13
14  main()
```

```
In [1]: runfile('/Users/cigdem/Desktop/exception_example.py', wdir='/Users/
Traceback (most recent call last):

  File "/Users/cigdem/Desktop/exception_example.py", line 14, in <module>
    main()

  File "/Users/cigdem/Desktop/exception_example.py", line 12, in main
    foo(x, y)

  File "/Users/cigdem/Desktop/exception_example.py", line 6, in foo
    D = divide(a, b)

  File "/Users/cigdem/Desktop/exception_example.py", line 2, in divide
    result = num1 / num2

ZeroDivisionError: division by zero
```

Exceptions

- Many exceptions can be prevented by careful coding
  - For example, in order to avoid an error of converting a non-numeric string to an integer, you may first check if the string is made up of digits

- However, some exceptions cannot be avoided
- Hence, we need to handle them

Exception handling

- We must first “anticipate” an exception (including its type), then write code to “catch” it, and handle it

- The **try-except** statement

```
try:
        statements_that_may_cause an exception
except ExceptionType:
        statements_to_handle_the_exception
```

- The code in the except part is called the exception handler

Exception handling

```
try:
    statements_that_may_cause an exception
except ExceptionType:
    statements_to_handle_the_exception
```

- If the statement within the try block raises an exception
  - If this is an exception specified in except clause
    - Handler, immediately following the except clause, executes
    - Continue program after the try-except statement
  - Other exceptions:
    - Program halts with a traceback error message
- If no exception is raised, handlers (statements in the except block) are skipped

Example

```
1   def divide(num1, num2):
2       result = num1 / num2
3       return result
4
5   def foo(a, b):
6       D = divide(a, b)
7       print(D)
8
9   def main():
10      x = 10
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13
14  main()
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In [1]: runfile('/Users/cigdem/Desktop/exception_example.py', wdir='/Users/
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    main()

  File "/Users/cigdem/Desktop/exception_example.py", line 12, in main
    foo(x, y)

  File "/Users/cigdem/Desktop/exception_example.py", line 6, in foo
    D = divide(a, b)

  File "/Users/cigdem/Desktop/exception_example.py", line 2, in divide
    result = num1 / num2

ZeroDivisionError: division by zero
```

Example

```
def divide(num1, num2):
    try:
        result = num1 / num2
        return result
    except ZeroDivisionError:
        return 0

def foo(a, b):
    D = divide(a, b)
    print(D)

def main():
    x = 10
    y = 0
    foo(x, y)

main()
```

```
In [1]: runfil
wdir='/Users/c
0
```

Exception handling

- Code in the try block may throw more than one type of exception

- Need to write an except block (handler) for each type of the exception that needs to be handled
  - Can specify multiple except blocks
  - Some exceptions may be handled together, just write them as a tuple

- An except clause that does not list a specific exception will handle any exception that is raised in the try block
  - Should always be last in a series of except clauses

Example

```
no = 100
while True:
    try:
        divisor = int(input('Enter an integer: '))
        result = no / divisor
        print('Result:',  format(result,'.2f'))
        break

    except ZeroDivisionError:
        print('Attempted to divide by zero')

    except ValueError:
        print('You must enter an integer')
```

```
In [1]: runfile('/Users/cigdem/De

Enter an integer: 124.5
You must enter an integer

Enter an integer: 0
Attempted to divide by zero

Enter an integer: comp 125
You must enter an integer

Enter an integer: 13
Result: 7.69
```

Can specify multiple except blocks

Compare it with the previous example

```
no = 100
while True:
    try:
        divisor = int(input('Enter an integer: '))
        result = no / divisor
        print('Result:',  format(result,'.2f'))
        break

    except (ZeroDivisionError, ValueError):
        print('Invalid divisor')
```

```
In [2]: runfile('/Users/cigdem/De

Enter an integer: 124.5
Invalid divisor

Enter an integer: 0
Invalid divisor

Enter an integer: comp 125
Invalid divisor

Enter an integer: 13
Result: 7.69
```

Some exceptions may be handled together, just write them as a tuple

Compare it with the previous examples

```
no = 100
while True:
    try:
        divisor = int(input('Enter an integer: '))
        result = no / divisor
        print('Result:',  format(result,'.2f'))
        break

    except ZeroDivisionError:
        print('Attempted to divide by zero')

    except:
        print('Other exception')
```

```
In [1]: runfile('/Users/cigdem/Des

Enter an integer: 124.5
Other exception

Enter an integer: 0
Attempted to divide by zero

Enter an integer: comp 125
Other exception

Enter an integer: 13
Result: 7.69
```

An except clause that does not list a specific exception will handle any exception that is raised in the try block (should always be the last in a series of except clauses)

Exception's error message

- Exceptions usually come with error messages to help debug the problem
- When an exception is thrown, an exception object (variable) is created, which contains the message
- Can assign the exception object to a variable in an except clause

```
except ValueError as err:
```

- Can pass exception object variable to print function to **display the default error message**

```
print(err)
```

Example

```
no = 100
while True:
    try:
        divisor = int(input('Enter an integer: '))
        result = no / divisor
        print('Result:',  format(result,'.2f'))
        break

    except ZeroDivisionError as err1:
        print(err1)

    except ValueError as err2:
        print(err2)
```

```
In [2]: runfile('/Users/cigdem/Desktop/example1.py'

Enter an integer: 124.5
invalid literal for int() with base 10: '124.5'

Enter an integer: 0
division by zero

Enter an integer: comp 125
invalid literal for int() with base 10: 'comp 125'

Enter an integer: 13
Result: 7.69
```

Using `else` with `try-except`

- `try/except` statement may include an optional `else` clause
  - It should be aligned with the try and except clauses and
  - It should appear after all the except clauses

- The code within the else block is run when there are no exceptions raised within the except block

- If exception was raised, the `else` block is skipped

Example

```
no = 100
while True:
    try:
        divisor = int(input('Enter an integer: '))
        result = no / divisor

    except ZeroDivisionError as err1:
        print(err1)

    except ValueError as err2:
        print(err2)

    else:
        print('Result:',  format(result,'.2f'))
        break
```

```
In [4]: runfile('/Users/cigdem/Desktop/example1.py

Enter an integer: 124.5
invalid literal for int() with base 10: '124.5'

Enter an integer: 0
division by zero

Enter an integer: comp 125
invalid literal for int() with base 10: 'comp 125'

Enter an integer: 13
Result: 7.69
```

`finally` clause

- `try/except` statement may include an optional `finally` clause
  - It should be aligned with the try and except clauses and
  - It should appear after all the except clauses

- The code within the finally block is executed whether an exception occurs or not

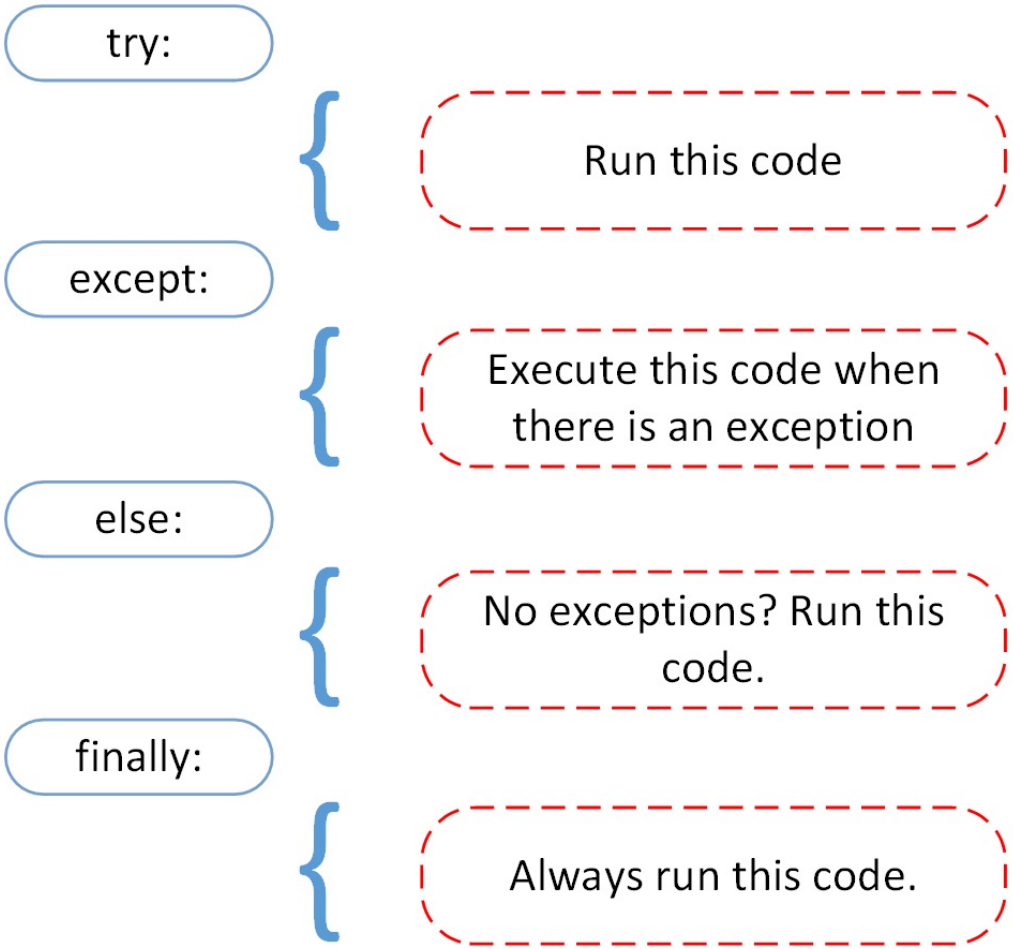
- Purpose is to perform cleanup

Example

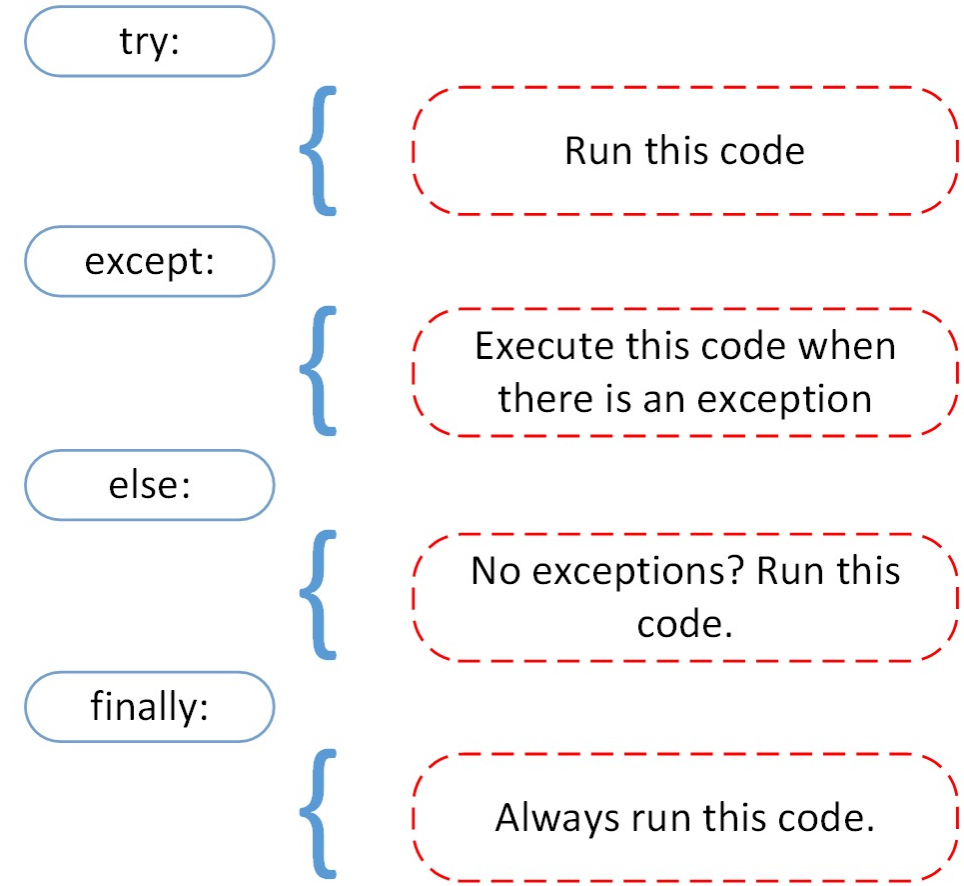
```
no = 100
trial_no = 0
while True:
    trial_no += 1
    try:
        divisor = int(input('Enter an integer: '))
        result = no / divisor

    except ZeroDivisionError as err1:
        print(err1)

    except ValueError as err2:
        print(err2)

    else:
        print('Result:',  format(result,'.2f'))
        break

    finally:
        print('Trial no:', trial_no)
```

```
In [6]: runfile('/Users/cigdem/Desktop/example1.py'

Enter an integer: 124.5
invalid literal for int() with base 10: '124.5'
Trial no: 1

Enter an integer: 0
division by zero
Trial no: 2

Enter an integer: comp 125
invalid literal for int() with base 10: 'comp 125'
Trial no: 3

Enter an integer: 13
Result: 7.69
Trial no: 4
```

Summary


try:
Run this code
except:
Execute this code when there is an exception
else:
No exceptions? Run this code.
finally:
Always run this code.

Summary



Source: Real Python

- Can have multiple except clauses
- Can handle multiple exceptions in a single except block
- Can get the exception object with as
- A lonely except catches “everything”

What happens if an exception is not handled?

- Two ways for exception to go unhandled
  - No except clause specifying the exception of the right type
  - Exception raised outside a try clause
- In both cases, exception will cause the program to halt (and a traceback)
- Python documentation provides information about exceptions that can be raised by different functions
  https://docs.python.org/3/library/exceptions.html#exception-hierarchy

Raising an exception

- You may want to raise your own exception, especially if you are writing a module/library

```
raise ExceptionType(message)
```

- A simple example

```
if row1 != row2:
    raise ValueError("Number of rows do not match")
```

- The parent of each exception type is the **`Exception`**. If unsure, just throw this

```
if a == 0:
    raise Exception("Number cannot be zero.")
```

Example

```
def square_root(n):
    if n < 0:
        raise Exception('Negative number')
    else:
        return n ** 0.5

def main():
    try:
        number = input('Enter a number: ')
        number = float(number)
        res = square_root(number)

    except ValueError:
        print('Enter a float')

    except:
        print('Enter a positive float')

    else:
        print('Result: ', res)

main()
```

```
In [1]: runfile('/Users/ci

Enter a number: comp125
Enter a float

In [2]: runfile('/Users/ci

Enter a number: -64
Enter a positive float

In [3]: runfile('/Users/ci

Enter a number: 65
Result:  8.06225774829855
```

Example

```
def square_root(n):
    if n < 0:
        raise Exception('Negative number')
    else:
        return n ** 0.5

def main():
    try:
        number = input('Enter a number: ')
        number = float(number)
        res = square_root(number)

    except Exception as err:
        print(err)

    else:
        print('Result: ', res)

main()
```

```
In [1]: runfile('/Users/cig

Enter a number: comp125
could not convert string to

In [2]: runfile('/Users/cig

Enter a number: -64
Negative number

In [3]: runfile('/Users/cig

Enter a number: 65
Result:  8.06225774829855
```