Lecture 04: Exceptions & Unit Testing
IN710: Object-Oriented Systems Development
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Lecture 03: Object-Oriented Analysis & Design Recap

- Object-oriented paradigm
- Object-oriented analysis, design & modeling
- KISS
- DRY
- YAGNI
- SOLID

Lecture 04: Exceptions & Automation Testing Topics

- Syntax errors
- Exceptions
- Automation testing
  - Unit testing
  - Integration testing
  - End-end testing
  - User acceptance testing
- Software development testing practices
  - Test-driven development
  - Continuous integration

Syntax Errors

- Parsing errors

```
while True print('John Doe')

  File "<ipython-input-1-2b688bc740d7>", line 1
    while True print('John Doe')
               ^
SyntaxError: invalid syntax
```

Exceptions

- Errors detected during execution
- Most exceptions aren't handled by the programmer

IndexError

- Raised when a sequence index is out of range

```
nums = (1, 2, 3, 4, 5)
nums(5)
```

```
---------------------------------------------------------------------------
IndexError                                Traceback (most recent call last)
<ipython-input-16-725b0b18bdb2> in <module>
      1 nums = (1, 2, 3, 4, 5)
----> 2 nums(5)

IndexError: list index out of range
```

KeyError

- Raised when a dictionary key isn't found in the set of existing keys

```
person = { 'first_name': 'John', 'last_name': 'Doe' }
person('first')
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
<ipython-input-18-c227410ba879> in <module>
      1 person = { 'first_name': 'John', 'last_name': 'Doe' }
----> 2 person('first')

KeyError: 'first'
```

NameError

- Raised when a local or global name isn't found

```
x
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-11-6fcf9dfbd479> in <module>
----> 1 x

NameError: name 'x' is not defined
```

TypeError

- Raised when an operation or function is applied to an object isn't supported

```
'1' + 1
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-12-cc892b1f57d5> in <module>
----> 1 '1' + 1

TypeError: can only concatenate str (not "int") to str
```

ZeroDivisionError

- Raised when the second argument of a division or modulo operation is zero

```
10/0
```

```
---------------------------------------------------------------------------
ZeroDivisionError                         Traceback (most recent call last)
<ipython-input-13-e574edb36883> in <module>
----> 1 10/0

ZeroDivisionError: division by zero
```

Raising Exceptions

- Allows the programmer to force a specified exception to occur
- The sole argument to raise must be either an exception instance or exception class

```
raise NameError

---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-1-42b67b2fc75d> in <module>
----> 1 raise NameError

NameError:
```

Handling Exceptions

- Try
- Except

```
while True:
    try:
        x = int(input('Please␣enter␣a␣number:␣'))
        break
    except ValueError:
        print('Oops!␣That␣was␣an␣invalid␣number.␣Please␣try␣again...')
```

```
Please enter a number: !
Oops! That was an invalid number. Please try again...
Please enter a number: 1
```

Clean-Up Actions

- Finally

```
try:
    raise KeyboardInterrupt
finally:
    print('exit(0)')

exit(0)
```

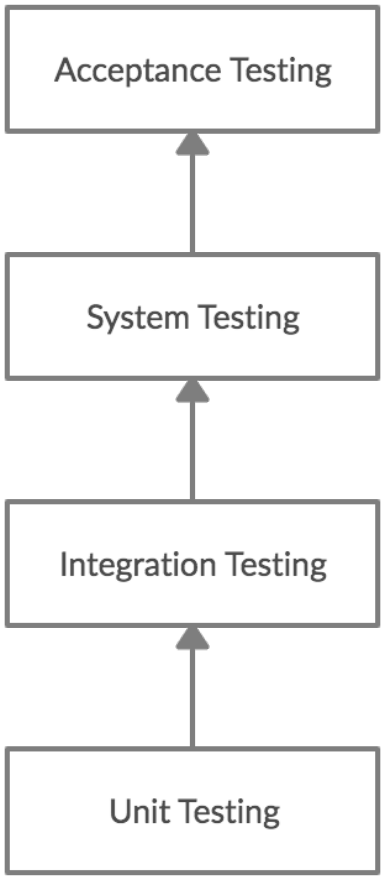
```
KeyboardInterrupt                         Traceback (most recent call last)
<ipython-input-1-cf37e4784c69> in <module>
      1 try:
----> 2     raise KeyboardInterrupt
      3 finally:
      4     print('exit(0)')

KeyboardInterrupt:
```

Automation Testing

- Technique used to test & compare the actual outcome with the expected outcome
- Writing test scripts or using automation testing tools
- Use of software to control the execution of tests
- Automate tasks which are difficult to perform manually

Levels Of Testing

- Four levels of testing



Unit Testing

- Individual units/components are tested
- Smallest testable part of any software
- One or two inputs & one output
  - In OOP, the smallest unit is a method
- Each unit performs as designed
- unittest module
  - Originally inspired by JUnit

Unit Testing

```
from unittest import TestCase, main

class Person:
    def __init__(self, first_name, last_name, age):
        self.first_name = first_name
        self.last_name = last_name
        self.age = age

    def is_legal(self):
        return True if self.age >= 18 else False

class TestPerson(TestCase):
    def setUp(self):
        self.person_1 = Person('John', 'Doe', 25)
        self.person_2 = Person('Jane', 'Doe', 5)

    def test_is_legal(self):
        self.assertEqual(True, self.person_1.is_legal())

    def test_is_not_legal(self):
        self.assertEqual(False, self.person_2.is_legal())

    def tearDown(self):
        self.person_1 = None
        self.person_2 = None

if __name__ == '__main__':
    main(argv=(''), verbosity=2, exit=False)
```

Unit Testing: Test Suite

- A collection of test cases

```
from unittest import TestCase, TestSuite, TextTestRunner, main

class Person:
    def __init__(self, first_name, last_name, age):
        self.first_name = first_name
        self.last_name = last_name
        self.age = age

    def is_legal(self):
        return True if self.age >= 18 else False

class TestPerson(TestCase):
    def setUp(self):
        self.person_1 = Person('John', 'Doe', 25)
        self.person_2 = Person('Jane', 'Doe', 5)

    def test_is_legal(self):
        self.assertEqual(True, self.person_1.is_legal())

    def test_is_not_legal(self):
        self.assertEqual(False, self.person_2.is_legal())

    def tearDown(self):
        self.person_1 = None
        self.person_2 = None

def suite():
    test_suite = TestSuite()
    test_suite.addTest(TestPerson('test_is_legal'))
    return test_suite

if __name__ == '__main__':
    runner = TextTestRunner(stream=None, descriptions=True, verbosity=2)
    runner.run(suite())
```

Integration Testing

- Group of individual units/components are tested
- Expose defects in the interaction between integrated units

Integration Testing

```python
from unittest import TestCase, main
from requests import get

class TestAPI(TestCase):
    def setUp(self):
        self.base_url = 'https://oosd-flask-api.herokuapp.com'
        self.api_url = '/api/videogames/'

    def test_url_is_ok(self):
        req = get(self.base_url)
        self.assertEqual(req.status_code, 200)

    def test_developer_is_atari(self):
        req = get(f'{self.base_url}{self.api_url}?id=0')
        self.assertEqual(req.json()[0].get('developer'), 'Atari')

    def test_title_is_donkey_kong(self):
        req = get(f'{self.base_url}{self.api_url}?id=1')
        self.assertEqual(req.json()[0].get('title'), 'Donkey_Kong')

    def test_year_release_is_1972(self):
        req = get(f'{self.base_url}{self.api_url}?id=2')
        self.assertEqual(req.json()[0].get('year_release'), 1972)

    def tearDown(self):
        self.base_url = None
        self.api_url = None

if __name__ == '__main__':
    main(argv=(''), verbosity=2, exit=False)
```

End-To-End Testing

- User interface or browser testing
- Testing the flow of an application from start to end
- Simulates a real user scenario
- Validates a system or systems under test & its components for integration & data integrity

End-To-End Testing: Selenium WebDriver

- A collection of open source APIs
- Supports the automation of web browsers

End-To-End Testing

```
from unittest import TestCase, main
from selenium import webdriver

class TestGoogleSearch(TestCase):
    def setUp(self):
        self.driver = webdriver.Chrome(
            '../chromedriver/chromedriver_mac')
        self.driver.get('https://google.com/')

    def test_search_in_google(self):
        self.assertEqual(True, 'Google' in self.driver.title)
        search_input = self.driver.find_element_by_xpath(
            '//*(@id="tsf")/div(2)/div(1)/div(1)/div/div(2)/input')
        search_input.send_keys('Larry Page')
        search_btn = self.driver.find_element_by_xpath(
            '//*(@id="tsf")/div(2)/div(1)/div(3)/center/input(1)')
        search_btn.click()
        self.assertEqual(
            True, 'Larry Page - Wikipedia' in self.driver.page_source)

    def tearDown(self):
        self.driver.close()

if __name__ == '__main__':
    main(argv=(''), verbosity=2, exit=False)
```

Learning Activity: Test Scenario - Creating & Sending An Email (15 minutes)

- In groups of two or three, create a test case for creating & sending an email in Outlook

User Acceptance Testing

- Beta or end-user testing
- System is tested for acceptability
- Evaluating the system's compliance with the business requirements
- Assessing whether the system is acceptable for delivery

Regression Testing

- Ensures that changes to the application haven't adversely affected it
- New test cases aren't created
- Previously created test cases are re-executed

Test-Driven Development

- Relies on the repetition of a short development cycle
- Requirements are turned into specific test cases
- The software is improved so that the tests pass

Test-Driven Development Cycle

- Add a new test - each new feature begins with writing a test
- Run the tests & see if the new test fails
- Write the code
- Run the tests & see if the new test passes
- Refactored the code
- Repeat

Continuous Integration

- Merging changes back to the master branch as often as possible
- Validated by creating a build & running automated tests against the build
- Avoid integration hell

Practical

- Series of tasks covering today's lecture
- Worth 1% of your final mark for the Object-Oriented Systems Development course
- Deadline: Tuesday, 10 March at 5pm

Exam 01

- Series of tasks covering lectures 01-04
- Worth 6% of your final mark for the Object-Oriented Systems Development course
- Deadline: Thursday, 5 March at 5pm

Lecture 05: Strategy Pattern Topics

- Design pattern 01: strategy pattern
  - Definition
  - Problem & solution
  - Real world analogy
  - UML & implementation
  - Open-closed principle
  - Pros & cons
  - Relationship with other design patterns