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Do you trust your software?

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CSC301

Quote(s) of the Week

“Software testers always go to heaven; they’ve already had their fair share of hell.”

– Anonymous

“If you don’t like unit testing your product, most likely your customers won’t like to test it either.” – Anonymous

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What is software quality? Why is it important?

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How do we ensure quality and minimize bugs?

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Warm-up Activity

Think of tests for moving a file called “z.zip” from Folder A to Folder B

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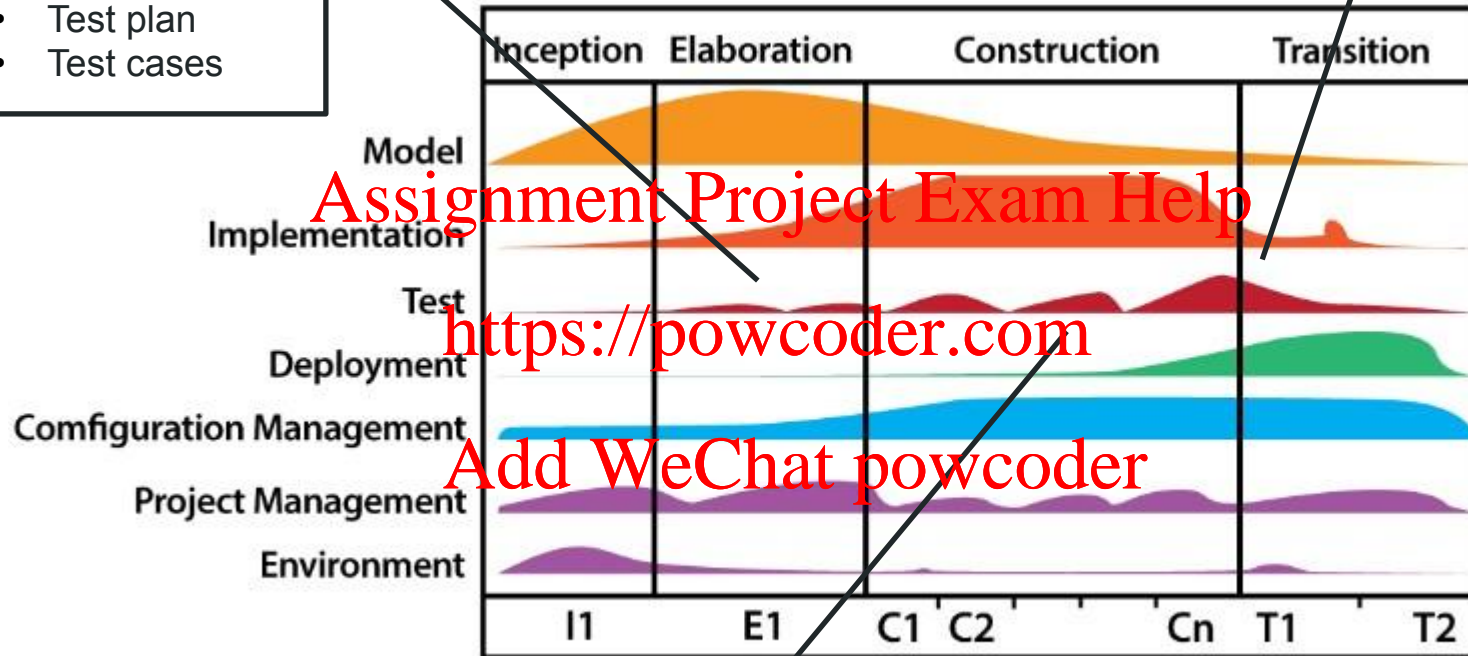
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The Traditional QA Lifecycle

QA documentation

- Test strategy
- Test plan
- Test cases

Big bang execution of performance, regression, and integration tests



QA Execution

- QA executes tests against completed code
- Dev context switches between new code and fixing code they may not have worked on for months...

Possible solutions

- No Testing
 - User will find and report bugs
- Manual Testing
 - Developers
 - Testers
- **Automated Testing**
 - Unit Testing
 - Service/Integration/Component Testing
 - UI Testing (e.g., Selenium)

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Running Tests

- Who likes running manual tests?
- When do we run tests?
- When should we write tests?
- What do you think the combination of tests will look like for a real application? Why?

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Why Automated Tests?

- Catching bugs before deployment to production
 - Confidence in releases (and changes)
 - Confidence in changing the code/refactoring (did we break it?)
 - No impact to customers' data and experience
 - No reactive/urgent fixes
- Exponential growth of
 - Time needed to test
 - Complexity of applications

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The Rising Cost of Bugs

Design and architecture	Implementation	Integration testing	Customer beta test	Postproduct release
1X*	5X	10X	15X	30X

*X is a normalized unit of cost and can be expressed in terms of person hours, dollars, etc.
Source: National Institute of Standards and Technology (NIST)†

This measure does not quantify reputational risk and other difficult to measure qualities like brand loyalty/affinity. Social media has amplified such risks in recent years

The Productivity Impact of Product Quality

“Studies indicate that **40-50 percent** of the cost of software development is devoted to testing, with the percentage for testing critical software being even higher”

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- Cost gets WORSE over time without significant effort
- Every dollar spent on QA is a dollar not spent on functionality or technical debt

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Who does QA?

How many of you aspire to have a career in quality assurance?

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QA has historically been (incorrectly) viewed as a “second fiddle” job in IT. Note that this is not the case at large tech firms. DevOps practices also changing the view of QA as a part of one’s career

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Test Automation <https://powcoder.com>

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Testing Pyramid



Unit Tests

- Testing a single unit of code (e.g., a small method) without dependencies
- Done fast (milliseconds)
- 80-90%

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Integration Tests

- Testing how multiple parts of code integrate
- Include dependencies
- Takes longer (seconds or minutes)
- 10-15%

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UI Testing

- Takes much longer
- Tend to break faster than others
- 5-10%

Activity 2

How would you write unit tests for a login function?

What tests would you write?

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`public Boolean authorize(String username, String password){}`

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Unit Testing in Python - Structure

```
helloworld/
├── bin/
├── docs/
│   ├── hello.md
│   └── world.md
├── helloworld/
│   ├── __init__.py
│   ├── runner.py
│   └── hello/
│       ├── __init__.py
│       ├── hello.py
│       └── helpers.py
│   └── world/
│       ├── __init__.py
│       ├── helpers.py
│       └── world.py
├── data/
│   ├── input.csv
│   └── output.xlsx
├── tests/
│   ├── hello
│   │   ├── helpers_tests.py
│   │   └── hello_tests.py
│   └── world/
│       ├── helpers_tests.py
│       └── world_tests.py
├── .gitignore
├── LICENSE
└── README.md
```

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Your application code goes here
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Tests go under tests.

Folder structure mirrors application folder structure
foo.py has corresponding foo_test.py

Unit Testing in Python – Test File

```
import unittest
```

```
class TestStringMethods(unittest.TestCase):
```

```
    def test_upper(self):  
        self.assertEqual('foo'.upper(), 'FOO')
```

```
    def test_isupper(self):  
        self.assertTrue('FOO'.isupper())  
        self.assertFalse('Foo'.isupper())
```

```
    def test_split(self):  
        s = 'hello world'  
        self.assertEqual(s.split(), ['hello', 'world'])  
        # check that s.split fails when the separator is not a string  
        with self.assertRaises(TypeError):  
            s.split(2)
```

```
if __name__ == '__main__':  
    unittest.main()
```

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Unit Testing in Python – Test Fixture

```
import unittest
```

```
class WidgetTestCase(unittest.TestCase):
```

```
    def setUp(self):
```

```
        self.widget = Widget('The widget')
```

```
    def test_default_widget_size(self):
```

```
        self.assertEqual(self.widget.size(), (50, 10),  
                           'incorrect default size')
```

```
    def test_widget_resize(self):
```

```
        self.widget.resize(100, 150)
```

```
        self.assertEqual(self.widget.size(), (100, 150),  
                           'wrong size after resize')
```

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```
import unittest
```

```
class WidgetTestCase(unittest.TestCase):
```

```
    def setUp(self):
```

```
        self.widget = Widget('The widget')
```

```
    def tearDown(self):
```

```
        self.widget.dispose()
```

Unit Testing in Python – Class & Module Fixtures

```
import unittest

class Test(unittest.TestCase):
    @classmethod
    def setUpClass(cls):
        cls.connection = createExpensiveConnectionObject()
    @classmethod
    def tearDownClass(cls):
        cls.connection.destroy()
```

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```
def setUpModule():
    createConnection()

def tearDownModule():
    closeConnection()
```

Naming Tests

- Choose a naming convention and stick to it
- **WhenXThenY**
 - WhenUserDepositsMoneyThenIncreaseTheirBalance
- **when_x_then_y**
 - when_user_deposits_money_then_increase_their_balance
- **Given_x_when_y_then_z**
 - Given_user_is_authenticated_when_they_deposit_money_then_increase_their_balance
- And many other ways

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Assertions

- Common assertions

- assertTrue

- assertFalse

- assertNull

- assertNotNull

- assertEquals

- assertNotEqual

- Examples

- assertEquals(obj1,obj2);

- assertNotNull(string1);

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Activity 3

Take the test(s) from the previous tests and write pseudocode with assertions

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Unit Testing in Python - Example

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Test Automation Approaches

- Regular test automation
 - Writing tests after feature implementation
- Test-Driven Development (TDD)
 - Development method introduced in the 90s
- Behavioral-Driven Development (BDD)
 - Simplifies communication among all stakeholders

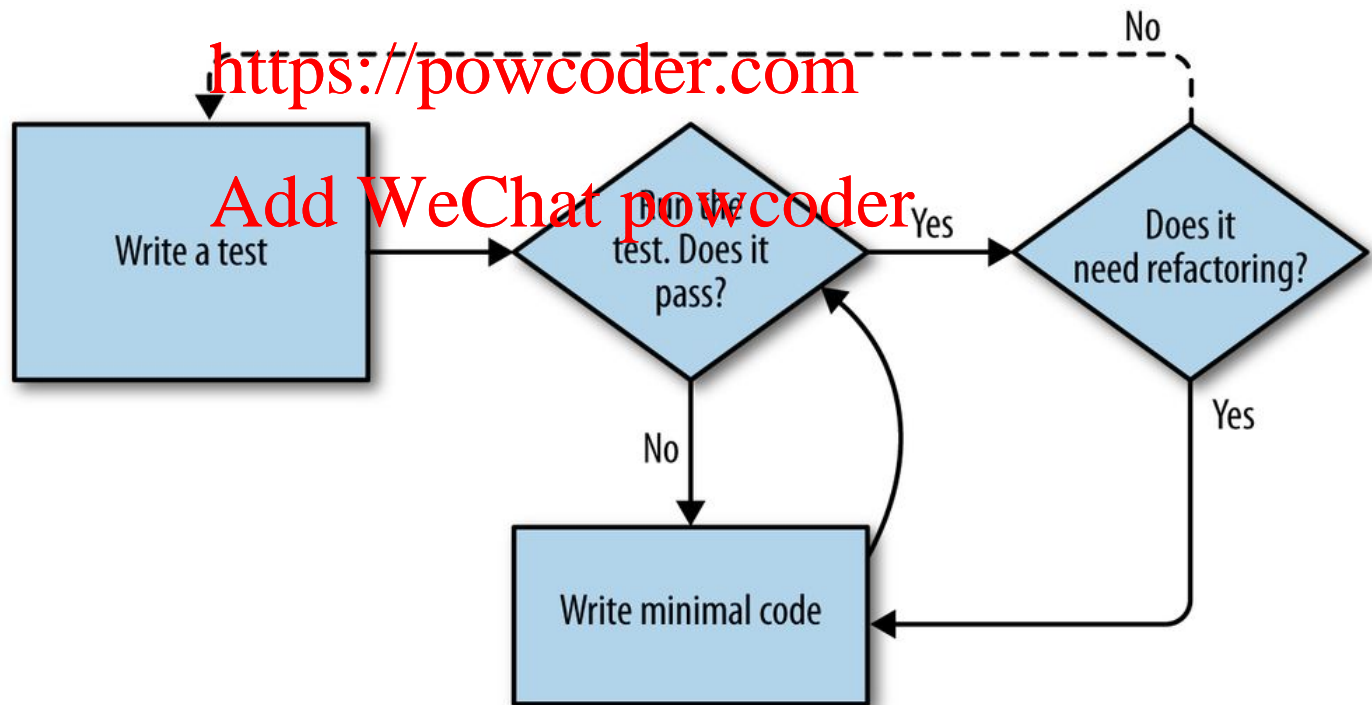
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Test Driven Development

- Write your test before writing the code
- Write the code to pass the test
- Repeat the cycle to add more tests or refactor earlier code



[Image from here](#)

Test Driven Development Pros

- Helps with automating tests and enables CI/CD
- Helps focus the development efforts (on the important features).
- Thinking about <https://powcoder.com> how the code will be used, before writing it, leads to better design.
- Tests serve as clear specifications.
- Increases confidence in functionality and minimizes technical debt increase

Test Driven Development Cons

- Not always cost-effective - Testing infrastructure/scaffolding can be very expensive and/or complex to build.
- Too many unit tests, not enough system tests.
- Writing tests takes more time *initially*

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TDD Walkthrough

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Walk through TDD with powcoder.com

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Behavioral-Driven Development (BDD)

- Starts from a user story
- Goes to specifics in **business language**
 - Context
 - Action
 - Expected Result

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BDD Language

- User story: as a registered user, I want to be able to login to the system so I can see my profile
- Language **Assignment Project Exam Help**
 - Given, When, Then
 - Given the user is on the login page and not logged in when the user provides the correct credentials Then log them in and take them to home page
 - When, If, Then
 - When the user is on the login page and not logged in if the user provides the correct credentials Then log them in and take them to home page

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How does BDD help?(1)

- Requirements gathering
 - No BDD
 - I'll implement the login feature
 - BDD
 - When the user is on the login page, if they provide the right credentials, then we'll log them in and open "home" page
- New releases
 - No BDD
 - Users catch errors and unintended changes
 - Manual tests
 - Anxiety or worry
 - BDD
 - Testing fails when you break a feature
 - Everyone speaks the same language. Communication becomes easier

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How does BDD help?(2)

- Testing

- No BDD

- You have to come up with tests as you are writing code

- BDD

- Your spec serves as your test cases confirmed by your user.
 - Improved readability
 - Essentially contains your acceptance criteria
 - Tests serve as documentation

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Testability – Design for Ease of QA

- SOLID principles & OO “best practices” promote modifiability. They have an equally profound impact on testability
 - Single Responsibility Principle – what’s easier to test, 5 lines of `calculateAbsoluteValue(number)` or 1000 lines of `doSomething(httpRequest)?`
 - Large parameter lists cause a combinatorial explosion in unit testing complexity
 - Encapsulation – limiting exposure of internal state limits how the outside world can break you

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Test Doubles - Design Patterns For Testing

- Term coined by Gerard Meszaros in the book “xUnit Test Patterns”, Addison-Wesley, 2007
- The idea is simple: During testing, **replace an object with a test double** (like a stunt double for a movie)
 - An object that “looks the same” (i.e., implements the same interface(s))
 - But gives us **more inspection/monitoring capabilities**

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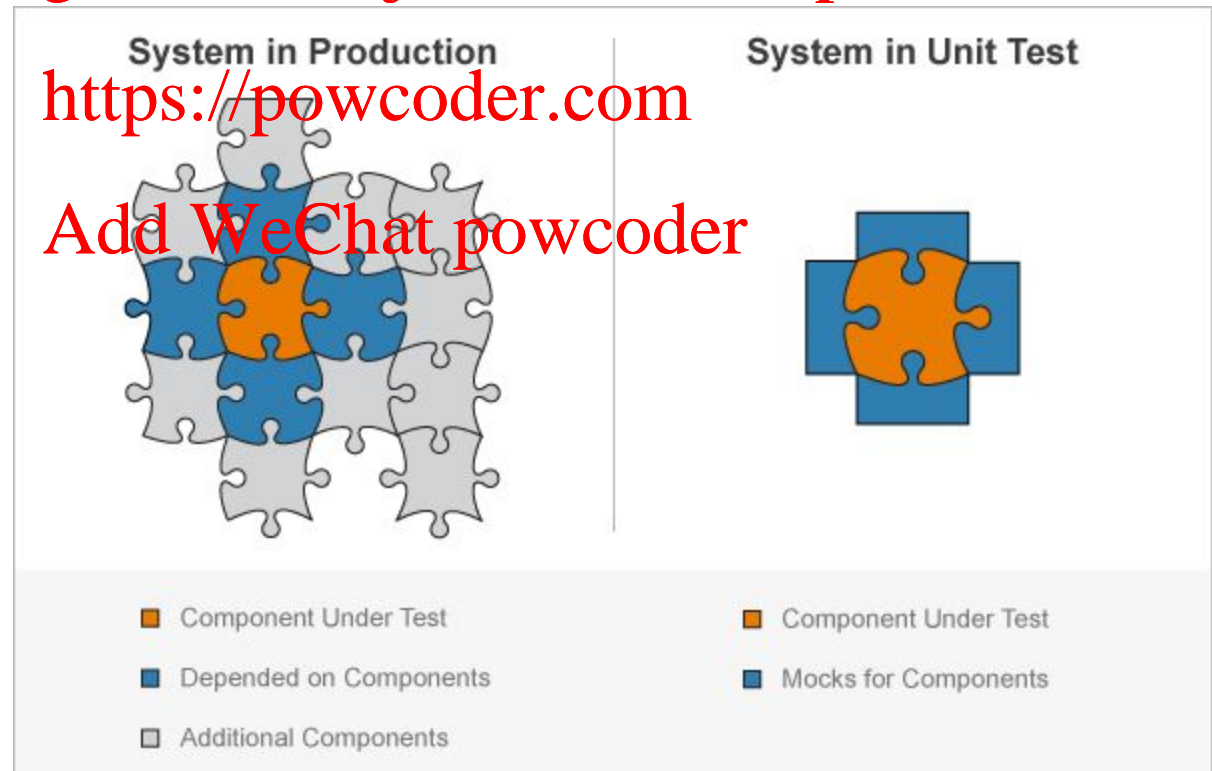
Mocks (Test Doubles)

- Primarily used for unit testing
- Allows writing tests without dependencies
- Technically mocks are a subset of test doubles but many people use mocks to mean fakes, stubs, etc.
- [Image from here](#)

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Test Doubles (Mocks)

- Test double is a general name for various patterns:
 - **Dummy** - No implementation, passed around, but not used - usually just to fill parameter requirements
 - **Fake** - has a working implementation, but not suitable for production use (e.g., in-memory test database)
 - **Stub** - Somewhat similar to Fake, but only behaviour needed for testing is implemented (i.e., has no logic, returns pre-programmed answers for testing)
 - **Spy** - A stub that also records information about how it was called
 - **Mock** - A spy that expects to be used a certain way, can be used to test object interactions
 - E.g., can throw an exception if it receives a call it doesn't expect and is checked during verification to ensure it got all the calls it was expecting

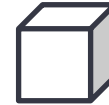
Types of Unit Tests

Black Box



- Tests are designed and executed **without** knowledge of implementation details
- You of course know your implementation, so perhaps black box testing involves
 - Testing against the method signature
 - Testing against the method documentation

White Box



- Tests are designed and executed **with** knowledge of implementation details
- Why isn't black box enough?
 - BB does not guarantee 100% code coverage
 - Certain parameter combinations may have unique behaviours
 - Not everything is documented

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Test Frameworks

- There are hundreds
 - JUnit [Assignment Project Exam Help](#)
 - PyUnit <https://powcoder.com>
 - PHPUnit [Add WeChat powcoder](#)
 - Jasmine
 - Mocha
 - Selenium

Next Steps

- [A step-by-step guide to mock in Python](#)
- [Mocking HTTP requests in Node](#)

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What's on your mind when you are deploying your product?

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Why is that?

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“Argh! Tests are failing” Should this make you happy or upset?

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Mobile Development Options

MOBILE DEVELOPMENT TIERS

