Test-Driven Development

Course of
Software Engineering II
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Contents at Glance

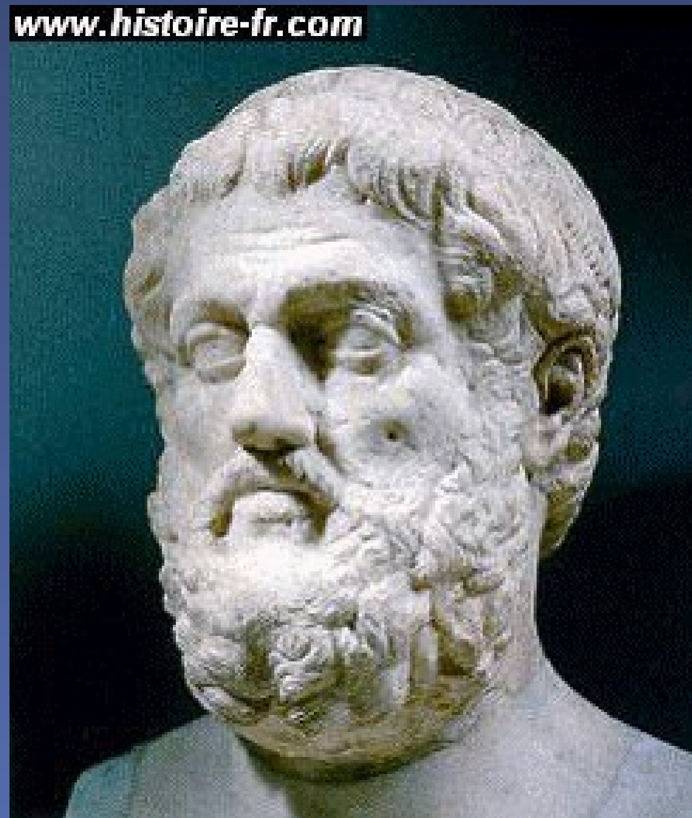
- What is TDD ?
- TDD and XP
- TDD *Mantra*
- TDD Principles and Patterns

1. Example Scenario

Software Development as a Learning Process

- *One must learn by doing the thing; for though you think you know it, you have no certainty until you try*

Sofocle

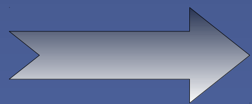


Software Development as a Learning Process

- Almost all projects attempts *something* new
- *Something* refers to
  - People involved
  - Technology involved
  - Application Domain
  - … (most likely) a combination of these
- For Customers and End-Users ?
  - Experience is worse!

Software Development as a Learning Process

- Every one involved has to learn as the projects progresses
  - Resolve misunderstanding along the way
- There will be changes!!



Anticipate unanticipated changes

Feedback is a fundamental tool

- Team needs cycle of activities
  - Add new feature
  - Gets feedback about quality and quantity of work already done!
- Time Boxes
- Incremental and Iterative Development
  - Incremental : Dev. *feature by feature*
  - Iterative: improvement of features in response to feedback

Practices that support changes

1. Constant testing to catch regression errors
   a. Add new feature without *fear*
   b. Frequent manual testing is infeasible!!
2. Keep the code as simple as possible
   a. More time spent in reading code than writing it
3. *Simplicity* takes effort so...
   a. REFACTOR!

2. Test Driven Development

Test Driven Development

- We write tests *before* we write the code
- Testing as a *Design Activity*
- Testing to clarify ideas about *what* we want the code to do!

What is TDD ?

- Test-Driven Development
- Test-First Programming
- Test-Driven Design

What is TDD ?

- Iterative and incremental software development
- TDD objective is to DESIGN CODE and not to VALIDATE Code
  - *Design to fail* principle

TDD and Agile

- TDD concepts combines
  - Test First Programming
  - Refactoring
- TDD is an *agile practice*
- XP is an *agile methodology*

TDD and XP

- Core of XP
- No needs of others XP practices

- Avoid *software regression*
  - *Anticipate changes*

- *Product code smarter that works better*

- Reduce the presence of bugs and errors
  - *“You have nothing to lose but your bugs”*

3. TDD and Unit Testing

Unit test

- *“ Unit tests run fast. If they don't run fast they're not unit tests. ”*

- A test is not a *unit test* if:
  - communicate with DB
  - communicate with networking services
  - cannot be executed in parallel with other unit tests

Unit Test and TDD

- Testing code is released together with production code
- A feature is released only if
  - Has at least a Unit test
  - All of its unit tests pass
- Do changes without *fear*
  - *Refactoring*
- Reduce debugging

Unit Test and TDD

- Unit Tests overcome dependencies
  - How ?
  - Stubs and Mock Objects
- www.mockobjects.com
- Mocks simulate interactions with real objects
  - Unit tests can continue to run fast...
  - ... but ?
- Too many setup operations are bad!

Example

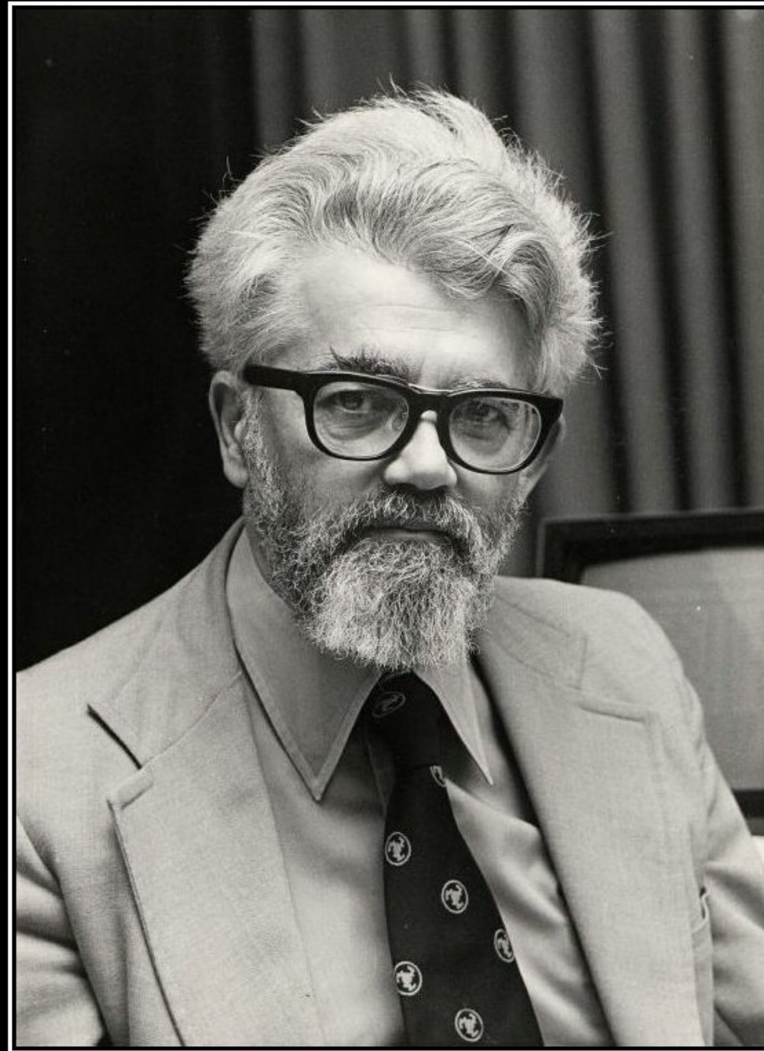
DBConnection.java

```java
public interface DBConnection
{
    void connect();
    void close();
}
```

FakeDBConnection.java

```java
public class FakeDBConnection implements DBConnection
{
    private boolean connected = false;
    private boolean closed = false;
    public void connect() {connected = true;}
    public void close() {closed = true;}
    public boolean validate(){return connected && closed;}
}
```

4. TDD Mantra



TDD Mantra

First step

Think : step by step

Think about what we want the code to do

TDD Mantra

Example

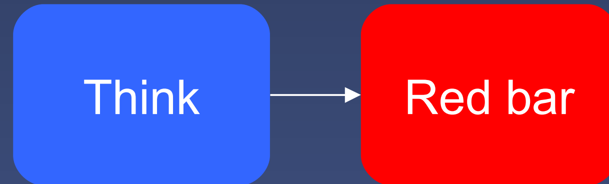
Think

"We want do develop an innovative arithmetic library that handles only non negative numbers"

aritLib.py

TDD Mantra

Second Step

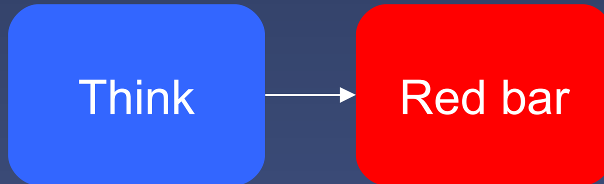


Red Bar : Writing tests

Think about the behavior of the class and its public interface

TDD Mantra

Second step

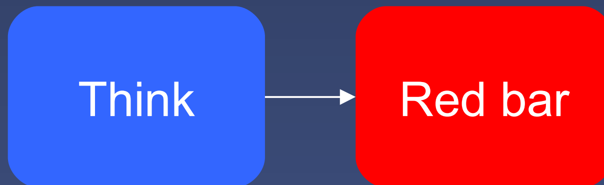



```
import aritLib
import unittest

class AritLibTest(unittest.TestCase):
    knownValues = ((0,0,0),(1,1,2),(2,3,5),(-1,-1,-1),(-10,10,-1),(10,-5,-1),)
    def testSum(self):
        for x, y, sum in self.knownValues:
            result = aritLib.add(x, y)
            self.assertEquals(sum, result)
```

TDD Mantra

Second step

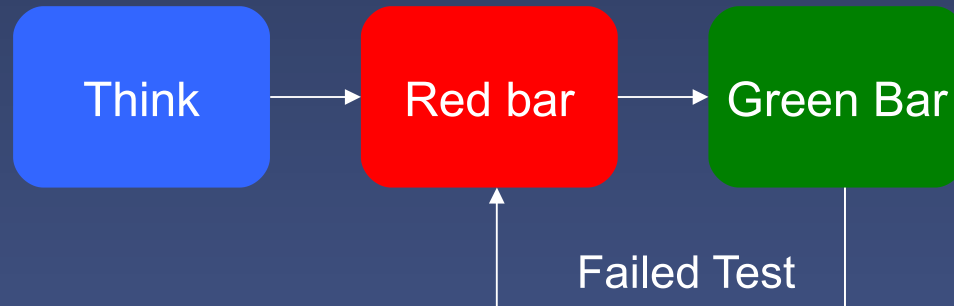


TEST FAILS BECAUSE THE FUNCTION STILL NOT EXISTS

```
class AritLibTest(unittest.TestCase):
    knownValues = ((0,0,0),(1,1,2),(2,3,5),(-1,-1,-1),(-10,10,-1),(10,-5,-1),)
    def testSum(self):
        for x, y, sum in self.knownValues:
            result = aritLib.add(x, y)
            self.assertEquals(sum, result)
```

```
ERROR: testAdd (__main__.AritLibTest)
----------------------------------------------------------------------
Traceback (most recent call last):
File “AritLibTest.py”, line 11, in testAdd
result = aritLib.add(x,y)
AttributeError: 'module' object has no attribute 'add'
----------------------------------------------------------------------
Ran 1 test in 0.000s
FAILED (errors=1)
```

TDD Mantra

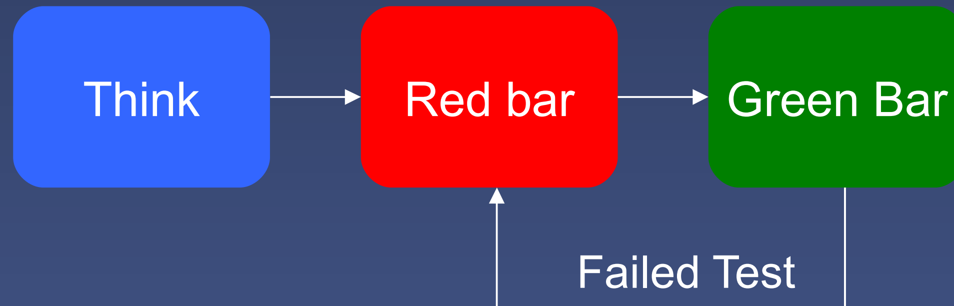


Green Bar : writing production code.

Write **ONLY** production code to pass previous test

TDD Mantra

Third step

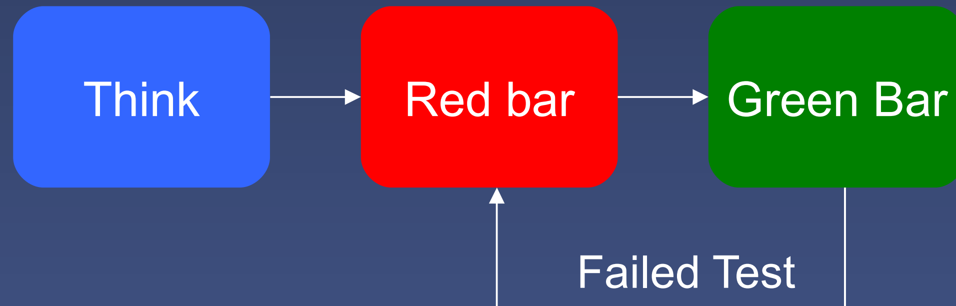


Green Bar : writing production code.

aritLib.py

```python
def add(x, y):
    if x < 0:
        return -1
    if y < 0:
        return -1
    return x+y
```

TDD Mantra



Green Bar : writing production code.

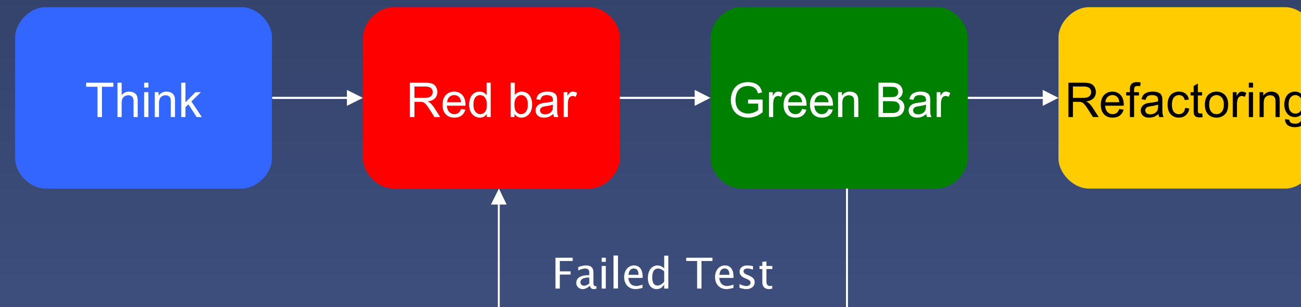
aritLib.py

```
def add(x, y):
    if x < 0:
        return -1
    if y < 0:
        return -1
    return x+y
```

```
----------------------------------------------------------------------
Ran 1 test in 0.000 s
----------------------------------------------------------------------
OK
```

Run previous tests without modifications

TDD Mantra

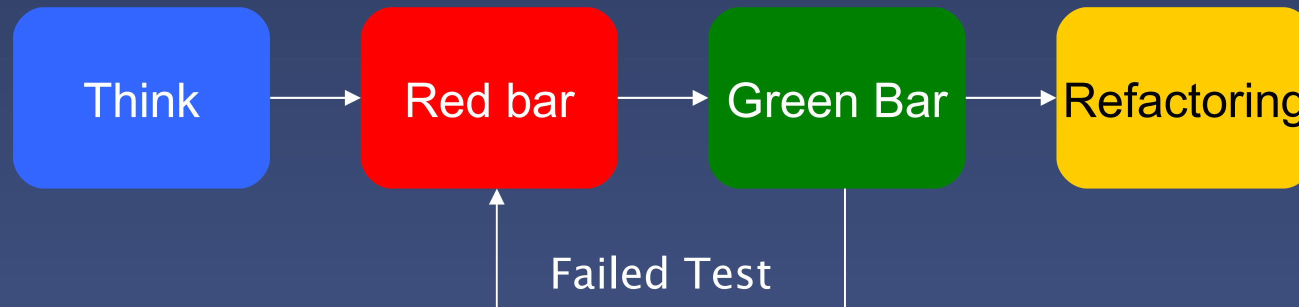


Refactoring: refactor developed feature

During refactoring we DO NOT have to modify semantic of developed feature!!

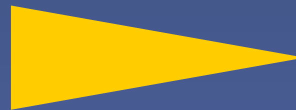
TDD Mantra

Fouth step



Before

```python
def add(x, y):
    if x < 0:
        return -1
    if y < 0:
        return -1
    return x+y
```

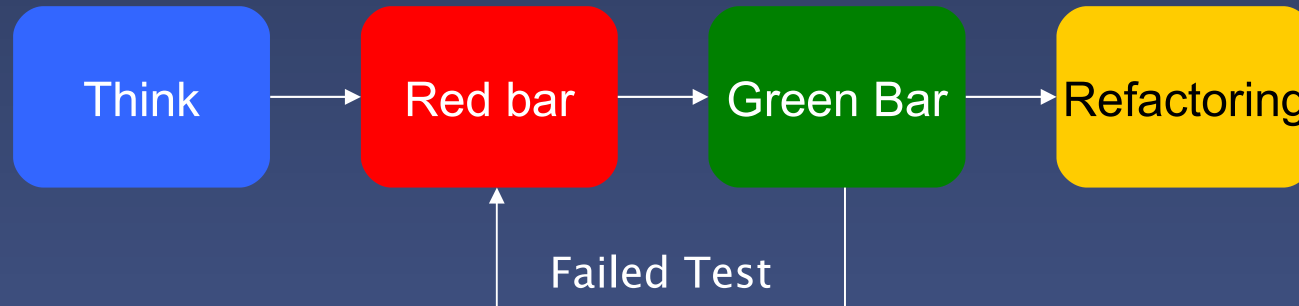


After

```python
def add(x, y):
    if x < 0 or y < 0:
        return -1
    return x+y
```

TDD Mantra

Fouth step



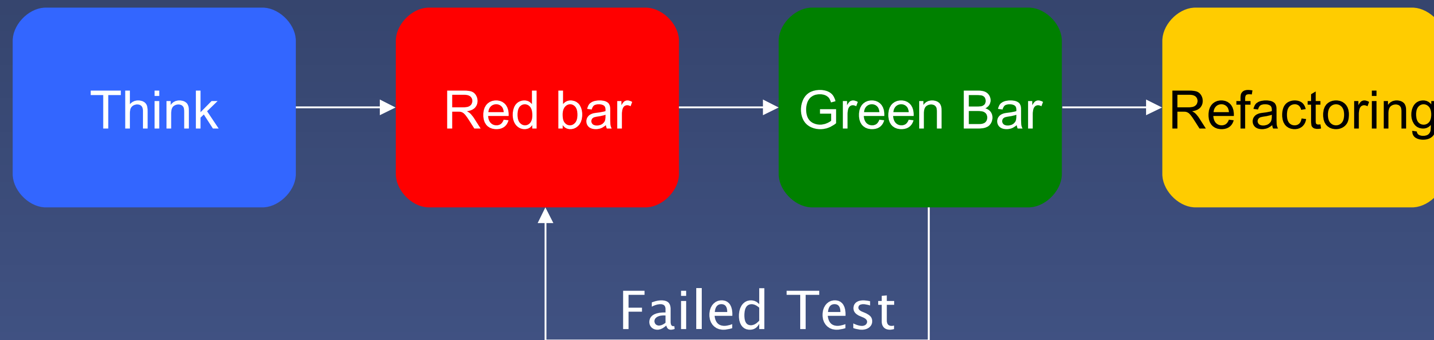
After

```
def add(x, y):
    if x < 0 or y < 0:
        return -1
    return x+y
```

```
----------------------------------------------------------------------
Ran 1 test in 0.000 s
----------------------------------------------------------------------
OK
```

Run previous tests without modifications

Principles



- Code once, test twice
- Clean code that works

- KISS: Keep It Short & Simple
- YAGNI: You Ain’t Gonna Need It
- DRY: Don't repeat yourself

Banana Spelling ?

- *“ I can spell banana but I never know when to stop”*

  WHEN TO STOP ?
- When code works
- When all tests are done
- When there's no duplicated code

Bad smells ...

There's something wrong when:

- It is necessary to test *private* and/or *protected* methods.

- We need *white box testing*.
- We need to configure system before run tests.
- Tests run intermittently.
- Tests run slowly.

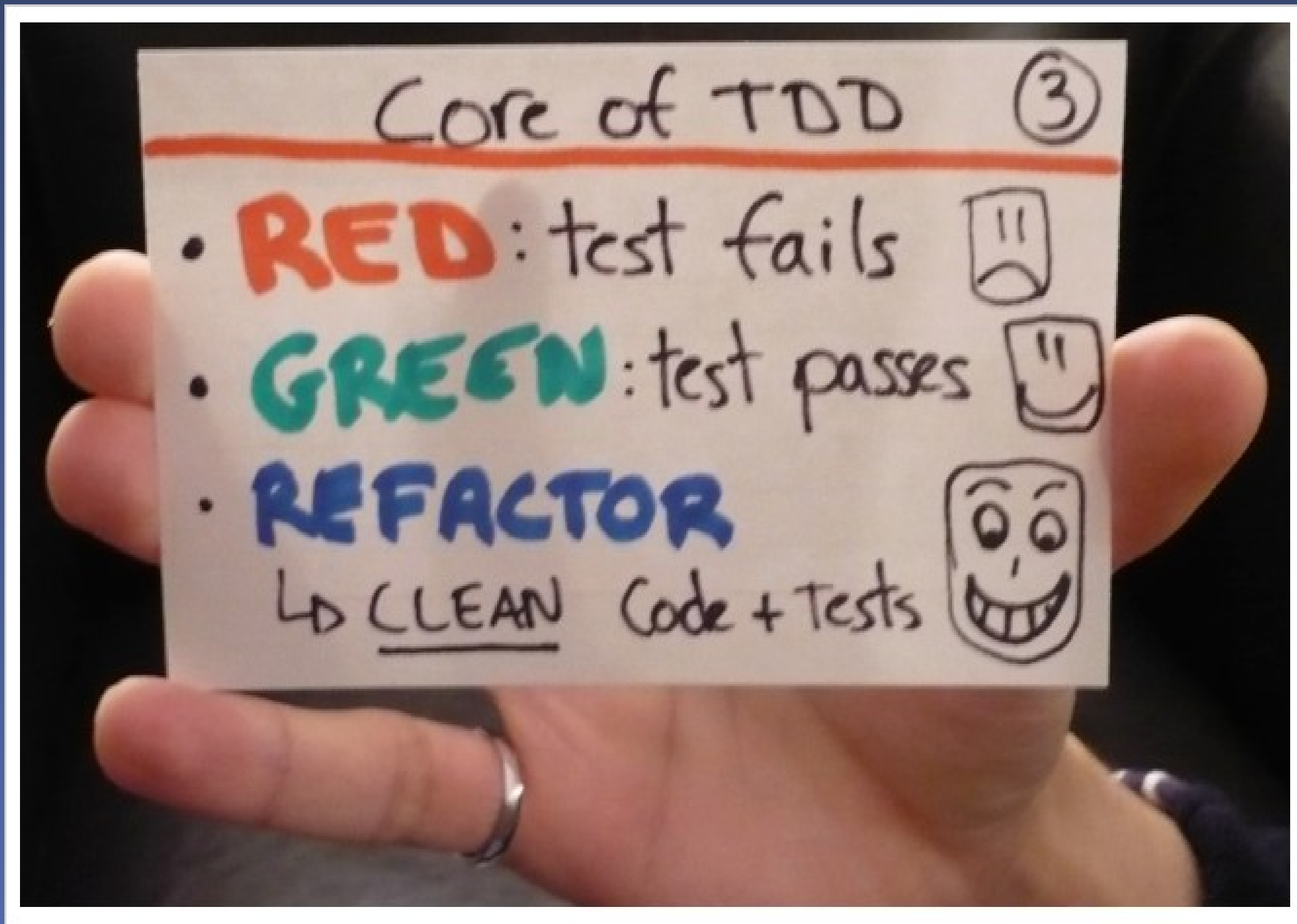
Speed

"Unit tests run fast. If they don't run fast, they aren't unit tests."

Testing Speed is important because:

- If the tests were not fast then they would be a distraction.
- If the tests were not fast then it would not run with high frequency
  - Benefit of the TDD ?

5. TDD Patterns



TDD Patterns

Red Bar patterns:

- Begin with a simple test.
- If you have a new idea
  - add it to the test list
  - stay on what you're doing.
- Add a test for any faults found.
- If you can not go on **throw it all away and change it.**

TDD Patterns

Testing patterns:

- If the test takes too long to work then divide it into simpler parts.
- If tests need some complex objects then use mock objects.
- Store execution log of tests
- If you work alone leave the last test of the day **broken**
- If you work in a team leave **ever** tests running.

TDD Patterns

Green Bar patterns:

- Writing the easier code to pass the test.
- Write the simpler implementation to pass current test
- If an operation has to work on collections
  - write the first implementation on a single object
  - then generalizes.

Test Readability

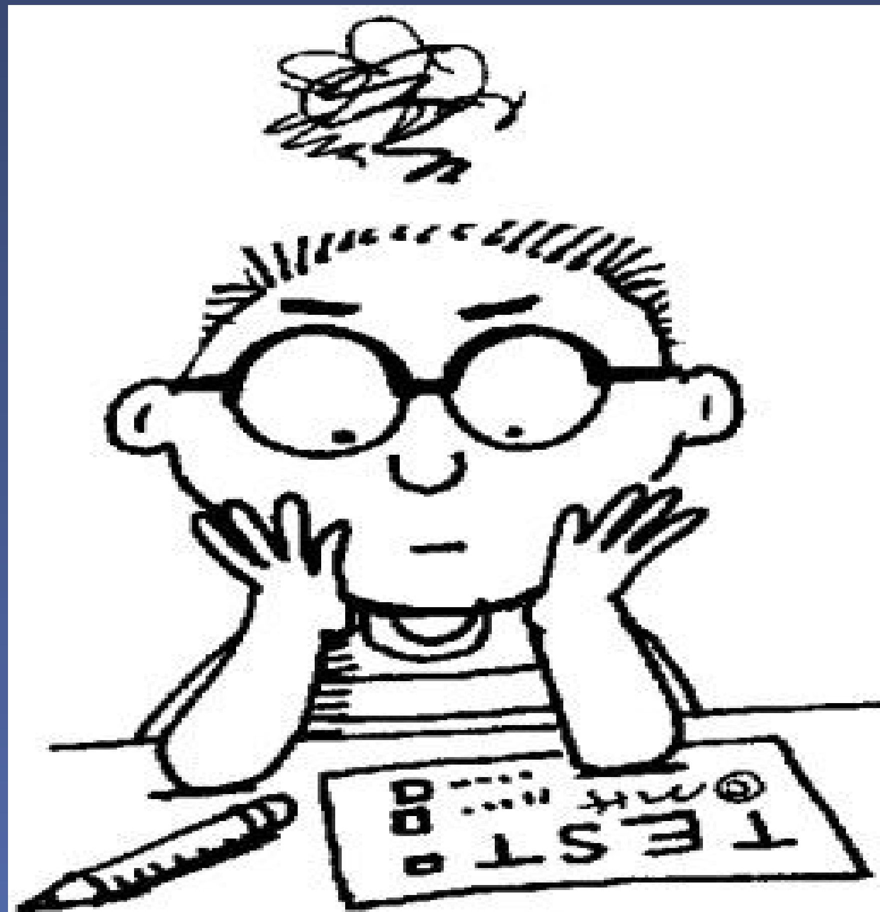
- Test names describe features

```
public class TargetObjectTest
{
    @Test public void test1() { [...]
    @Test public void test2() { [...]
    @Test public void test3() { [...]
}
```

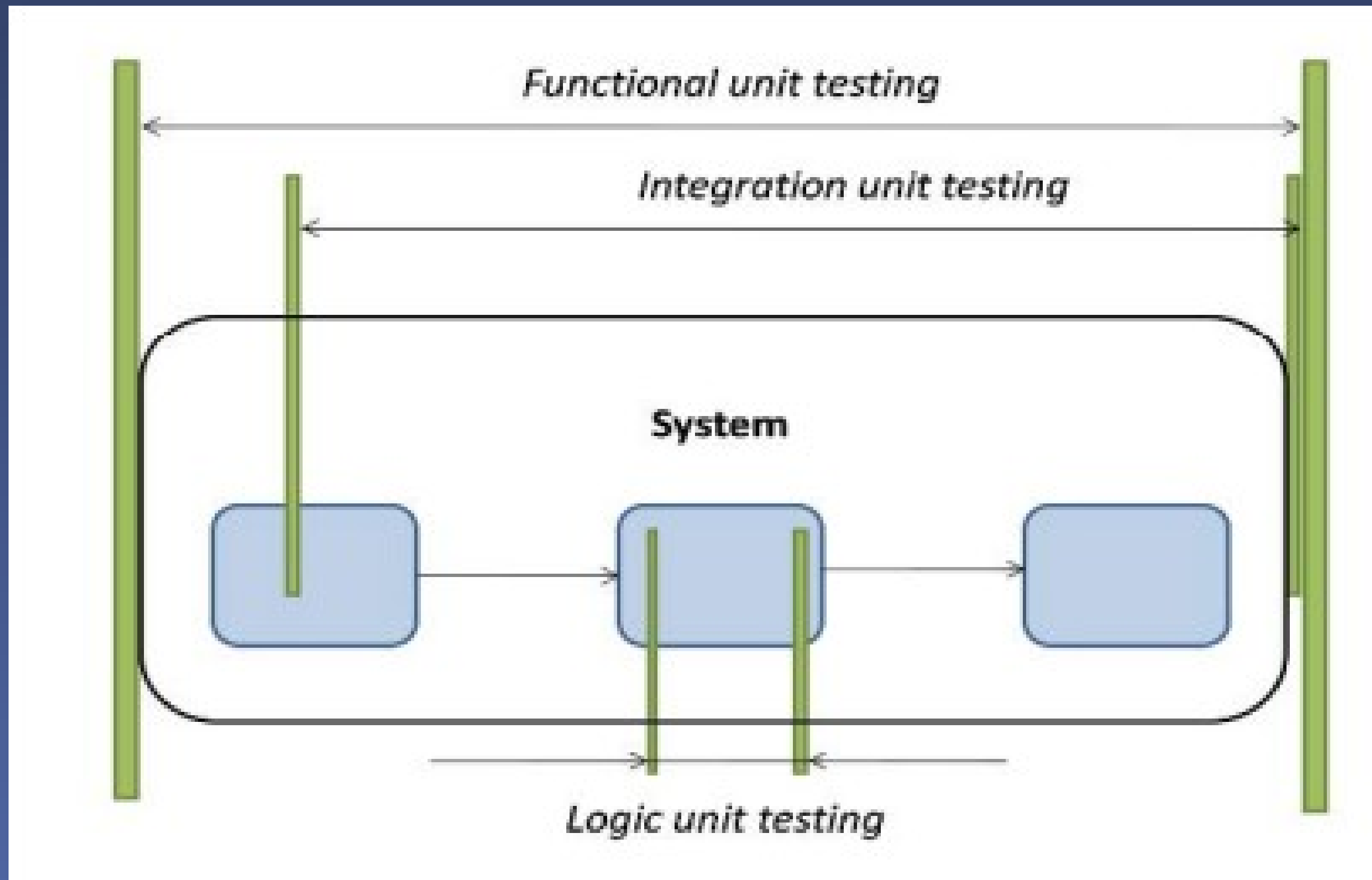
```
public class TargetObjectTest
{
    @Test public boolean isReady() { [...]
    @Test public void choose(Picker picker) { [...]

}
```

6. *Focused Integration Testing* and *eEnd2End Testing*



Three types of unit tests



Focused integration testing

A focused integration test is focused on testing:

- communication with the database
- network communication
- communication with the filesystem
- communication with external objects

Focused integration testing (2)

- If you need a lot of integration tests then there's something wrong.
- Ex. If all the business objects speak directly with the database then the code have not a good design!
- The code that talks too much with the outside world is neither very cohesive nor well coupled.

End–to–end Testing

Used to test the whole system:

Test of whole stories using the system, the GUI user to the database ...

Cons:

- Difficult to accomplish.
- Difficult to set.
- Difficult to detect errors.
- Very slow.
- Not automated.

Execution speed of tests

- Unit tests
  - one hundred per second.
- Focused integration tests
  - ten per second.
- End-to-end tests
  - several seconds for each test.

7. TDD and Legacy Code

Legacy Code

"Legacy code is code without tests"

Problems:

- Lack of documentation
- Difficult to understand in depth
- It is not designed thinking of "testability"

Legacy Code (2)

Steps to address the legacy code:

- Start typing tests to see if the legacy code (a part of) was well understood.
- Fit the test until it works well.

- What code has been tested ?
- What areas need testing ?
- What are the risks of the code ?

8. Conclusions

Social Implications

- TDD handles “the *fears*” during software development
- Fears has a lot of negative aspects:
  - makes it uncertain
  - removes the desire to communicate
  - makes it wary of the feedback
  - makes nervous

Social Implications (2)

- TDD handles the "fears" during development:
  - New (small) release only if the code has exceeded 100% of the test set.
  - The design goes hand in hand with development.
  - TDD allows programmers to perfectly know the code.

TDD Benefits

- It keeps the code simple
- Rapid development
- The tests are both design and documentation
- Easy to understand code
- Bugs found early in development
- Less debugging
- Low cost of change

TDD Limits

- High learning curve
- Managers are reluctant to apply
- Requires great discipline
- Difficult to implement the GUI
- Difficult to apply to Legacy Code