# Test-Driven

### Development

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Lecture #13 out of 16 80 minutes

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The Psychology of Testing

Test Driven Development (TDD)

Unit vs. Integration Tests

Test Coverage

**Automated Performance Testing** 

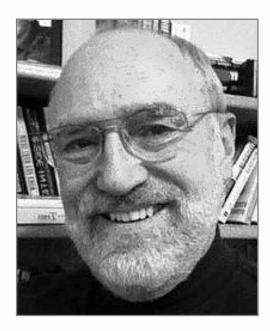
Behavior Driven Development (BDD)

Testing vs. QA

Books, Venues, Call-to-Action

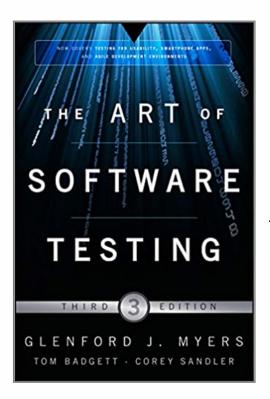
Chapter #1:

The Psychology of Testing



"One of the primary causes of poor application testing is the fact that most programmers begin with a false definition of the term. They might say: 'Testing is the process of demonstrating that errors are not present."

— Glenford J. Myers, *The Art of Software Testing* 



"Don't test a program to show that it works; rather, start with the assumption that the program contains errors. Testing is the process of executing a program with the intent of finding errors."

— The Art of Software Testing, Glenford J. Myers et al.

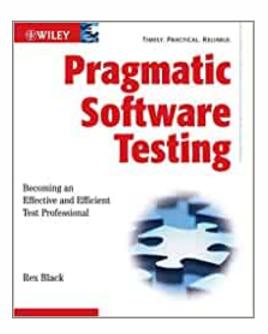
"If something is to be delivered, then it is the testers who make the final <u>decision</u> as to whether or not that something is delivered into the live environment." —Nick Sewell, *How to Test a System That Is Never Finished*, 2009

"Testing is an essential activity in software engineering. In the simplest terms, it amounts to observing the execution of a software system to validate whether it behaves as intended ..."—Antonia Bertolino, Software testing research: Achievements, challenges, dreams, 2007

"Software testing is the process of executing a software system to determine whether it matches its specification and executes in its intended environment."

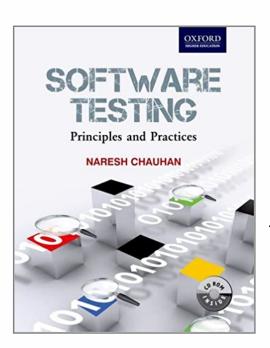
—James A. Whittaker, What Is Software Testing? And Why Is It So Hard?, 2000

"We distinguish the four major testing models... One model says we test to demonstrate that some version of the software satisfies its specification, two models say we test to detect faults, and the fourth says we test to prevent faults. These three goals need not conflict and, in fact, are all present in the prevention model." —David Gelperin, *The growth of software testing*, 1988



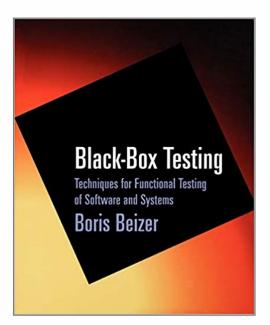
"Software testing is not about proving conclusively that the software is free from any defects, or even about discovering <u>all</u> the defects. Such a mission for a test team is truly impossible to achieve."

 Rex Black, Pragmatic Software Testing: Becoming Effective and Efficient Test Professional



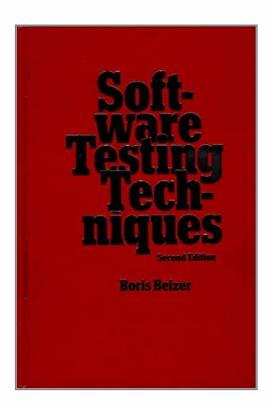
"The immediate goal of testing is to find errors at any stage of software development. More the bugs discovered at an early stage, better will be the success rate of software testing."

— Naresh Chauhan, *Software Testing: Principles and Practices* 



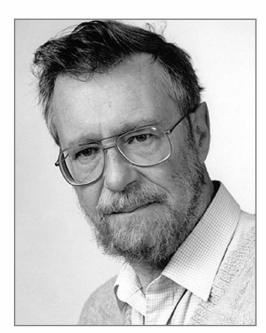
"Anything written by people has bugs. Not testing something is equivalent to asserting that it's bug-free. Programmers can't think of everything especially of all the possible interactions between features and between different pieces of software. We try to break software because that's the only practical way we know of to be confident about the product's fitness for use."

— Boris Beizer, *Black-Box Testing: Techniques for Functional Testing of Software and Systems* 



"The probability of showing that the software works decreases as testing increases; that is, the more you test, the likelier you are to find a bug. Therefore, if your objective is to demonstrate a high probability of working, that objective is best achieved by not testing at all!"

— Beizer, Boris, *Software Testing Techniques* 



"Program testing can be used to show the presence of bugs, but never to show their absence!"

Edsger W. Dijkstra, *Notes on Structured Programming*,1970

Software Testing Philosophy
Bee Mobile Meetup
Moscow, Russia, 7 November 2018



Testing and Testers
TestCon
Moscow, Russia, 16 September 2020



Software Testing Pitfalls
JPoint
Moscow, Russia, 5 April 2019



Quality Assurance vs. Testing
QA Fest
Kyiv, Ukraine, 20 September 2019



Chapter #2:

Test Driven Development (TDD)

```
(test one)
(is (= 1 (f 1)))
(test two)
(is (= 1 (f 2))))
(test fifteen)
(is (= 610 (f 15))))
```

Can you put some code here?

```
(test one
(is (= 1 (f 1))))
(test two
(is (= 1 (f 2))))
(test fifteen
(is (= 610 (f 15))))
```



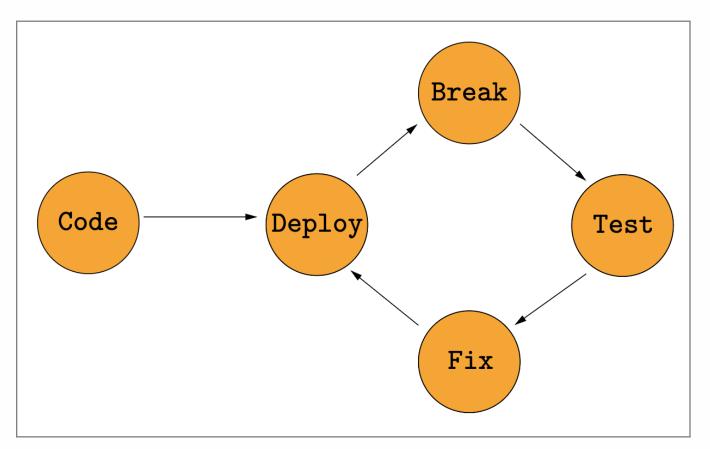
"Test-first fundamentalism is like abstinence-only sex ed: An unrealistic, ineffective morality campaign for self-loathing and shaming."

David Heinemeier Hansson, <u>TDD is dead. Long live</u> testing



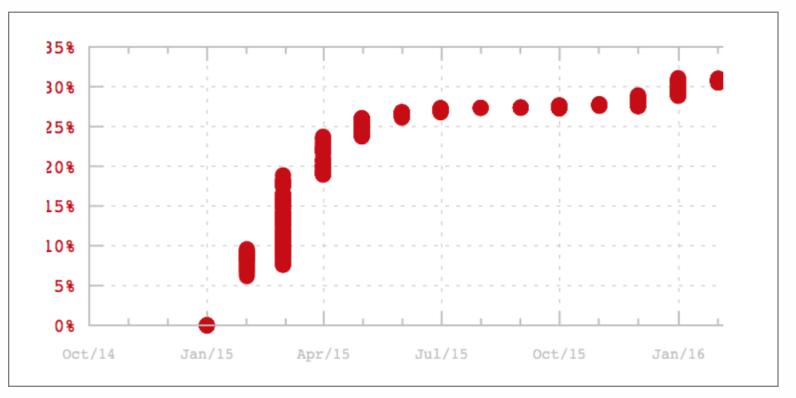
"It would not surprise me if, one day, TDD had the force of law behind it."

Robert Martin, <u>Professionalism and TDD (Reprise)</u>



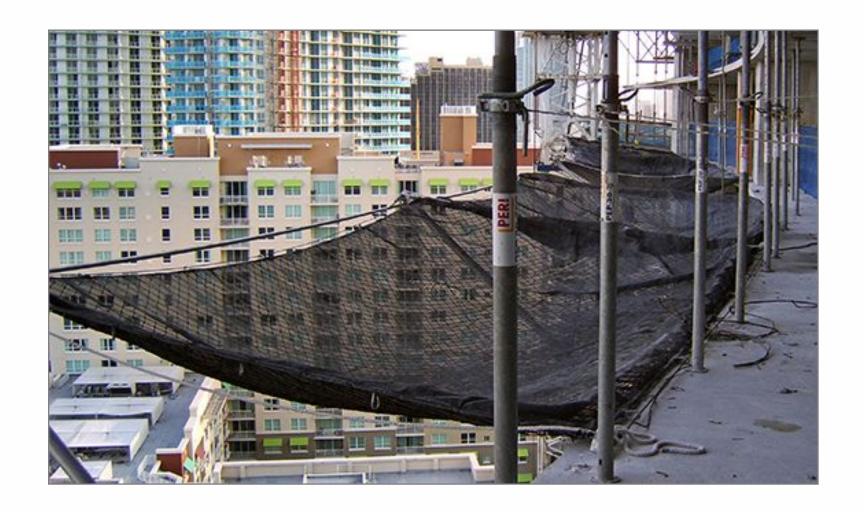
"I only create tests later when my users express the need for them by reporting bugs."

https://www.yegor256.com/2017/03/24/tdd-that-works.html



"I don't need tests at the beginning of the project" https://www.yegor256.com/2017/03/24/tdd-that-works.html

## Safety Net



Chapter #3:

Unit vs. Integration Tests

### Good Tests Are:

- 1) **Short**: less than x lines each
- 2) **Fast**: less than *y* milliseconds each
- 3) **Independent**: runs alone and in a suite
- 4) Portable: runs on your laptop and on mine
- 5) Careful: side effect free, doesn't leave temp files
- 6) **Isolated**: doesn't touch my files



https://www.kenneth-tru yers.net/2012/12/15/key-qualities-of-a-good-uni t-test/  $\rightarrow$ 

```
import java.nio.file.Files;
                                             | import org.junit.jupiter.api.Assertions;
 class Book {
                                             import org.junit.jupiter.api.Test;
  String title() {
                                             3 class BookTest {
    return Files.readAllLines(
                                                @Test
      Paths.get("/my-data/book.txt")
                                                void canRetrieveTitle() {
    )[0];
                                                  String t = new Book().title();
                                                  Assertions.assertEquals(
                                                    "Object Thinking", t
                                             10
                                            11 }
```

Is it Short, Fast, Independent, Portable, Careful, and Isolated?

```
import java.nio.file.Files;
                                              import org.junit.jupiter.api.Assertions;
  class Book {
                                              import org.junit.jupiter.api.Test;
   private Path file;
                                              class BookTest {
   Book(Path f) {
                                                 @Test
     this.file = f;
                                                 void canRetrieveTitle() {
                                                   Path f = Paths.get("/tmp/temp.txt");
   String title() {
                                                   String title = "Object Thinking";
     return Files.readAllLines(
                                                   Files.write(f, title.getBytes());
                                                   String t = new Book().title();
       this.file
     )[0];
                                                   Assertions.assertEquals(title, t);
10
11
                                              11
12 | }
                                              12 }
```

Is it Short, Fast, Independent, Portable, Careful, and Isolated?

```
import java.nio.file.Files;
class Book {
  private Path file;
  Book(Path f) {
  this.file = f;
  }
  String title() {
   return Files.readAllLines(
   this.file
  )[0];
  }
}
```

```
import org.junit.jupiter.api.Assertions;
import org.junit.jupiter.api.Test;
3 | import org.junit.jupiter.api.io.TempDir;
4 class BookTest {
   @Test
   void canRead(@TempDir Path dir) {
     Path f = dir.resolve("temp.txt");
     String title = "Object Thinking";
     Files.write(f, title.getBytes());
     String t = new Book().title();
     Assertions.assertEquals(title, t);
12
13 }
```

Chapter #4:

Test Coverage

```
loop do
195
           json = @api.block(block)
196
           if json[:orphan]
197
              steps = 4
198
             @log.info("Orphan block found at #{block}, moving #{steps} steps back..."
199
             wrong << block
200
             steps.times do
201
               block = json[:previous]
202
               wrong << block
203
               @log.info("Moved back to #{block}")
204
205
               json = @api.block(block)
             end
206
207
             next
208
           end
           checked = 0
209
210
           checked_outputs = 0
           json[:txns].each do |t|
211
             t[:outputs].each_with_index do |o, i|
212
                address = o[:address]
213
                checked_outputs += 1
214
```

https://codecov.io/gh/yegor256/sibit/tree/master/lib

## Coverage Criteria

#### **Function** Coverage

Has each function (or subroutine) in the program been called?

#### **Statement** Coverage

Has each statement in the program been executed?

#### **Edge** Coverage

Has every edge in the control-flow graph been executed?

#### **Branch** Coverage

Has each branch of each control structure been executed?

#### **Condition** Coverage

Has each Boolean sub-expression evaluated both to true and false?

## Mutation Testing + Coverage

## Mutation Testing + Coverage

```
def f(n)
  n * n + 1
3 end
5 # Mutant no. 1
6 def f(n)
  n + n + 1
8 end
10 # Mutant no. 2
def f(n)
12 n * n - 1
13 end
```

Test coverage: 100%

Mutation coverage = 50%

Chapter #5:

Automated Performance Testing

## Some Tools

WebLOAD

LoadNinja

ReadyAPI Performance

LoadView

StormForge

Keysight's Eggplant

Apache JMeter

LoadRunner

**Appvance** 

NeoLoad

LoadComplete

**WAPT** 

Loadster

k6

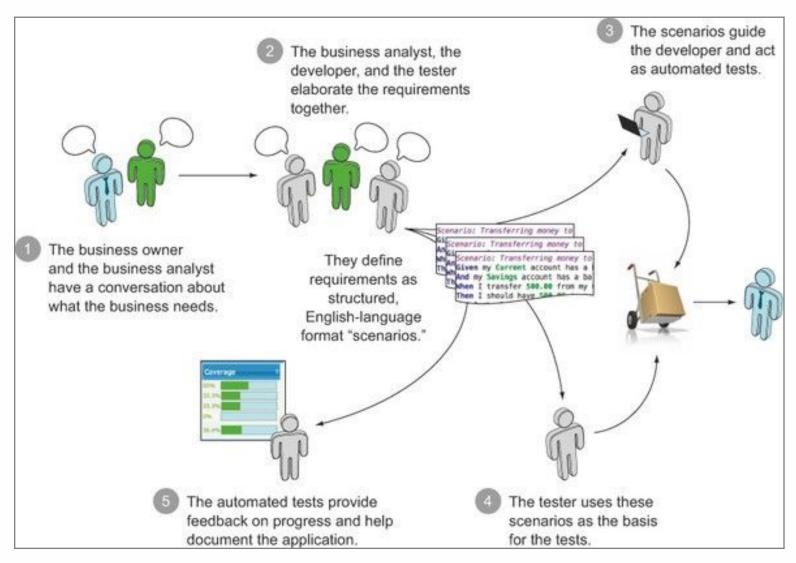
Rational Performance Tester

Testing Anywhere

**Apache Bench** 

Chapter #6:

Behavior Driven Development (BDD)



https://www.agilealliance.org/glossary/bdd

Psychology TDD Unit Coverage Performance BDD QA B.V.C.

Chapter #7:

Testing vs. QA

Test-Driven Development @yegor256

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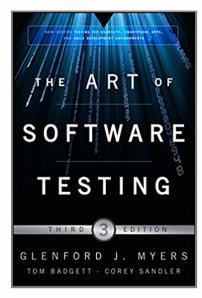
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### Testing $\neq$ Quality Assurance (QA)

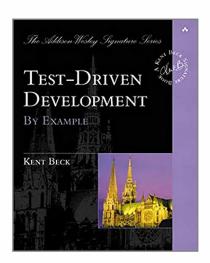


Chapter #8:

Books, Venues, Call-to-Action



"The Art of Software Testing, 3rd Edition" by Glenford J. Myers et Al.



"Test Driven Development: By Example" by Кемт Веск

### Where to publish:

International Symposium on Software Testing and Analysis (ISSTA)

### Call to Action:

Integrate mutation coverage control into your build.

### Still unresolved issues:

- How to test performance right?
- How to create tests automatically?
- How to motivate programmers write tests?
- How to control the quality of testing?

## **Bibliography**