Software Engineering

Software Testing, Part I

Srinivas Pinisetty [1]

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[1]Based on material from Wolfgang Aherndt,...

Motivation for Course Unit on Testing

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Testing is not the only, but the primary method that industry uses to evaluate software under development.

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- The field of testing is large
- This course (unit) is rather small
- Does it make sense to get started even?

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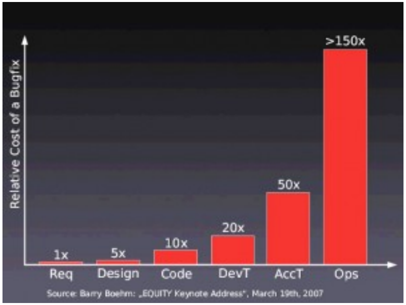
A few basic software testing concepts can be used to design tests for a large variety of software applications.

The testing techniques present in the literature have much more in common than is obvious at first glance.

Motivation for Course Unit on Testing (cont'd)



A Quiz

A simple program

Input

Read three integer values from the command line.
The three values represent the lengths of the sides of a triangle.

Output

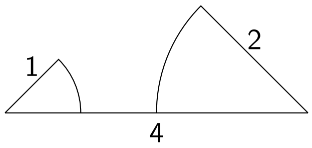
Tells whether the triangle is

Scalene:	no two sides are equal
Isosceles:	exactly two sides are equal
Equilateral:	all sides are equal

Create a Set of at least 15 Test Cases for this program

Solution — 1 Point for each Correct Answer

Q 1: An invalid triangle? e.g. (4,1,2)



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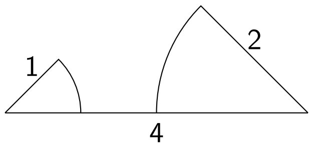

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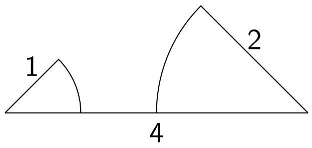


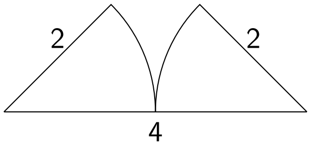
Why not a valid triangle? (a, b, c) with $a > b + c$

Solution — 1 Point for each Correct Answer

Q 2: Some permutations of previous? e.g., (1,2,4), (2,1,4) are still invalid.

Solution — 1 Point for each Correct Answer

Q 3: An invalid triangle with equal sum? e.g., (4,2,2)

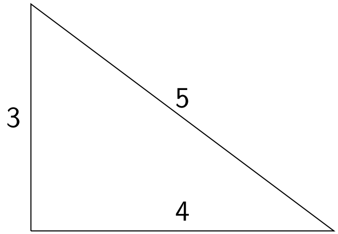


Solution — 1 Point for each Correct Answer

Q 4: Some permutations of previous? e.g., (2,2,4), (2,4,2)

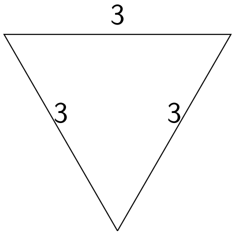
Solution — 1 Point for each Correct Answer

Q 5: A valid scalene triangle? e.g., (3,4,5)



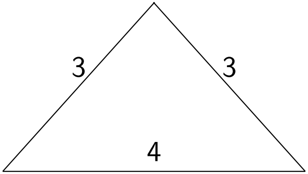
Solution — 1 Point for each Correct Answer

Q 6: An equilateral triangle? e.g., (3,3,3)



Solution — 1 Point for each Correct Answer

Q 7: A valid isosceles triangle? e.g., (3,4,3)



Solution — 1 Point for each Correct Answer

Q 8: All permutations of valid isosceles triangle?
(3,4,3), (3,3,4), (4,3,3)

Solution — 1 Point for each Correct Answer

Q 9: One side with zero value? e.g., (0,4,3)

Solution — 1 Point for each Correct Answer

Q 10: One side with negative value? e.g., (-1,4,3)

Solution — 1 Point for each Correct Answer

Q 11: All sides zero? e.g., (0,0,0)

Solution — 1 Point for each Correct Answer

Q 12: At least one value is non-integer? e.g., (1,3,2.5)

Solution — 1 Point for each Correct Answer

Q 13: wrong number of arguments, e.g., (2,4) or (1,2,3,3)

Solution — 1 Point for each Correct Answer

Q 14 (the most important one):

Did you specify the expected output in each case?

About the Quiz

- Q 1–13 correspond to failures that have actually occurred in implementations of the program
- How many questions did you answer?
  < 5? $5 - 7$? $8 - 10$? > 10?   All?

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- Q 1–13 correspond to failures that have actually occurred in implementations of the program
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  < 5? $5 - 7$? $8 - 10$? > 10? All?
- Highly qualified, experienced programmers score 8 on average

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The discipline of Testing is all about Test Cases

well, almost ...

Remark: At Ericsson, ca. 35% of code is test cases!

Brainstorming

- What is the purpose of testing?

...

Test Process Maturity Level in an Organisation

(adapted from [Beizer] and [AmmannOffutt])

Level 0 There is no difference between testing and debugging.

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Level 0	There is no difference between testing and debugging.
Level 1	Purpose of testing: show correctness.
Level 2	Purpose of testing: show that the software does not work.
Level 3	Purpose of testing: reduce the risk of using the software.
Level 4	Testing is a mental discipline helping IT professionals to develop higher quality software.

Level 0 Thinking

Testing is the same as debugging

- Does *not* distinguish between incorrect behaviour and defects in the program
- Does not help develop software that is reliable or safe

Level 1 Thinking

Purpose: showing correctness

- Correctness is (almost) impossible to achieve
- Danger: you are subconsciously steered towards tests likely to not fail the program.
- What do we know if no failures?

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- Danger: you are subconsciously steered towards tests likely to not fail the program.
- What do we know if no failures?
  good software? or bad tests?
- Test engineers have:
  - no strict goal
  - no real stopping rule
  - no formal test technique

Level 2 Thinking

Purpose: showing failures

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- Puts testers and developers into an adversarial relationship
- What if there are no failures?

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This describes most software companies.

Level 3 Thinking

Purpose: reduce risk

- Whenever we use software, we incur some risk
- Risk may be small and consequences unimportant
- Risk may be great and the consequences catastrophic
- Testers and developers work together to reduce risk

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- Test engineers can become technical leaders of the project

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A mental discipline that increases quality

- Testing only one way to increase quality
- Test engineers can become technical leaders of the project
- Primary responsibility to measure and improve software quality
- Their expertise should help developers
- Purpose of testing: improve ability of developers to produce high quality software

Activities if Test Engineer

Test engineer: IT professional in charge of test activities, including:

- designing test inputs
- running tests
- analysing results
- reporting results to developers and managers

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Test engineer: IT professional in charge of test activities, including:

- designing test inputs
- running tests
- analysing results
- reporting results to developers and managers
- automating any of the above

Testing Levels Based on Software Activity

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assess software with respect to user requirements

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System Testing
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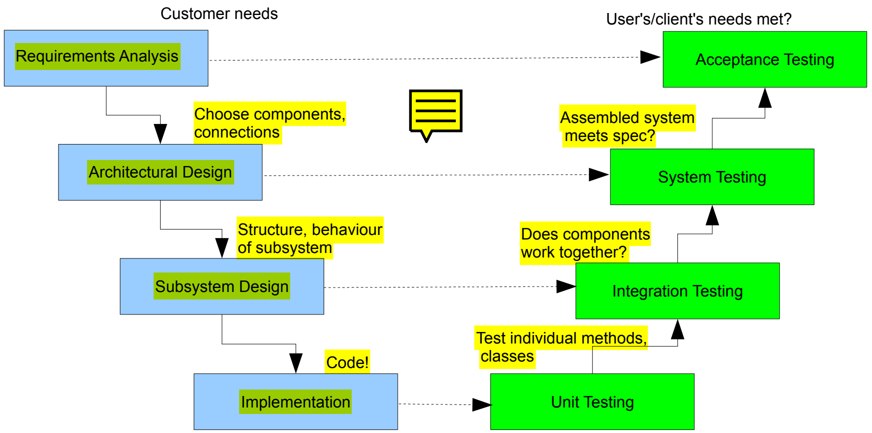
remarks:

– terminology, and depth of this hierarchy, varies in literature

V-Model


Customer needs
User's/client's needs met?
Requirements Analysis
Acceptance Testing
Choose components, connections
Assembled system meets spec?
Architectural Design
System Testing
Structure, behaviour of subsystem
Does components work together?
Subsystem Design
Integration Testing
Test individual methods, classes
Code!
Implementation
Unit Testing

(many variants!)

Testing Levels Based on Software Activity (cont'd)

System Testing – testing system against specification of externally observable behaviour

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This course focuses on lower level: unit testing

Literature related to this lecture

- Introduction to Software Testing - by Paul Ammann, Jeff Offutt
  - Testing levels (Chapter 1)