



# Automated Test Case Generation





# Hello!

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Software Testing is necessary because we all make mistakes. Some of those mistakes are unimportant, but some of them are expensive or dangerous.

The ISTQB



# Outline

1. Defining goals
2. Test data generation
3. Test case generation
4. Achieving goals
5. Whole Test Suite vs Single Target



A decorative graphic on the left side of the slide consists of a cluster of hexagons in various shades of blue and cyan. Some hexagons contain white icons: a lightbulb, a thumbs-up, a smartphone, a magnifying glass, and a gear. A network of small circles is also visible. A large, central hexagon features a white number '0'.

0

# Terminology

What do all these strange words mean?



# Concepts

## **What is a test goal?**

Test goals refer to what you want to achieve when testing something. High coverage can be a test goal with a certain criterion (e.g. branch coverage).

## **What is Single Target?**

The Single Target approach focuses on one specific goal for one target undergoing tests. In OO, it may refer to achieving high branch coverage for one class at a time,

## **What is test data?**

Any data that is used in testing. Data used as input for tests is test data. The expected output is also test data.

## **What is Whole Test Suite?**

The Whole Test suite approach aims at targetting all aspects of a system at the same time. A whole test suite is generated for the entire system, according to one test goal..

## **What is a test case?**

A test case is a sequence of statements used to test one certain aspect.

A decorative graphic on the left side of the slide consists of a cluster of hexagons in various shades of blue and cyan. Some hexagons contain white icons: a lightbulb, a thumbs-up, a smartphone, a magnifying glass, and a gear. A network diagram with a central node and several peripheral nodes is also visible. A large, prominent cyan hexagon in the center of this cluster contains the white number '1'.

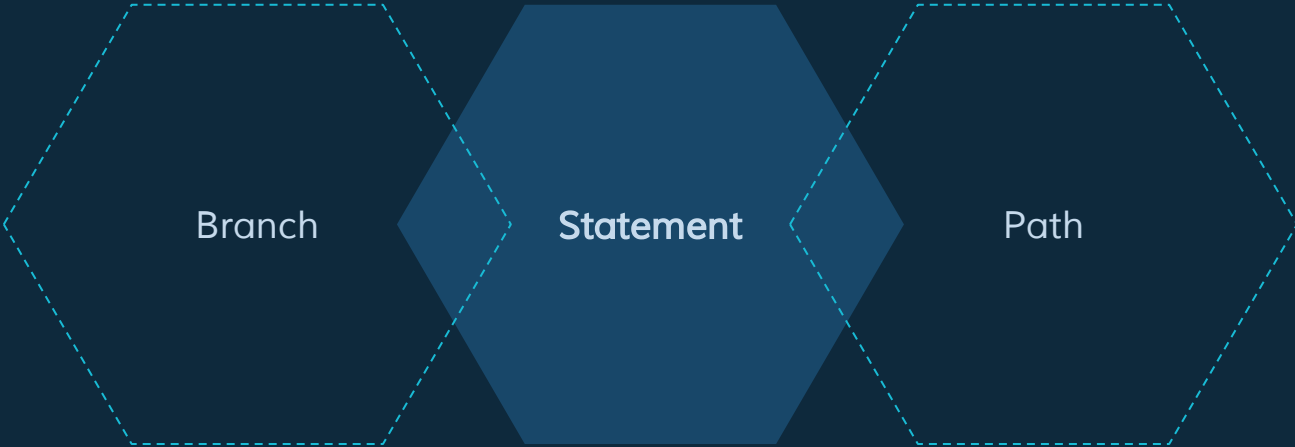
1

# Defining Test Goals

What do I want to achieve by testing?



# Coverage



Branch

**Statement**

Path



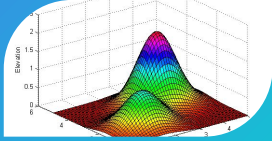


A decorative graphic on the left side of the slide. It features a large central hexagon with a white number '2'. Surrounding this central hexagon are several smaller hexagons of varying shades of blue and cyan. Some of these smaller hexagons contain white icons: a lightbulb, a thumbs-up, a smartphone, a magnifying glass, and a gear. There is also a network-like icon with a central node and radiating lines.

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# Test Data Generation

What is my input data? What is my output data?



# Search-Based Test Data Generation

Applying meta-heuristic  
search-based optimization  
techniques to find near-  
optimal solutions.





# Reformulating Testing Goals as an Optimisation Problem





# Techniques

- ◇ Hill Climbing
- ◇ Simulated Annealing
- ◇ Genetic Algorithm (e.g. Multi-Objective)
- ◇ ...





# Types of Testing



## White-box

The process of deriving tests from the internal structure of the software under test.

- ◇ Symbolic Execution
- ◇ (Dynamic) Domain Reduction



## Gray-box

Combines both structural and functional information for the purpose of testing.

- ◇ Assertion Testing
- ◇ Exception Condition Testing



## Black-box

Test the logical behaviour of a system, as described by some form of specification.

- ◇ Z Specification
- ◇ Specification conformance

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3

# Test Case Generation

I have a problem with data; how do I define a solution?



# Statements

- ◇ Primitives
- ◇ Constructors
- ◇ Fields
- ◇ Methods
- ◇ Assignments



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# Achieving Test Goals

I have test cases but did not achieve my goal; now what?





# Evolution

Evolve a population of test cases with a genetic algorithm and a fitness function that determines when the goal is achieved.



# Two Options

## Whole

- ◇ Start with one goal for a cluster of classes and generate test cases.
- ◇ Apply the genetic algorithm on the test cases.

**(Generates smaller test suites with higher coverage.)**

## Single Target

- ◇ Start with one goal for one target class and generate test cases.
- ◇ Apply the genetic algorithm on the test cases.
- ◇ Repeat the process until all classes have been tested.



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# Whole vs Single Target

Everything together or one at a time. What is the best approach?



# Two Options

## Whole

- ◇ May never cover difficult goals
- ◇ Slightly more coverage does not mean better (e.g. when generated suites are twice as big)

## Single Target

- ◇ Can waste time on infeasible coverage
- ◇ Does not consider collateral coverage

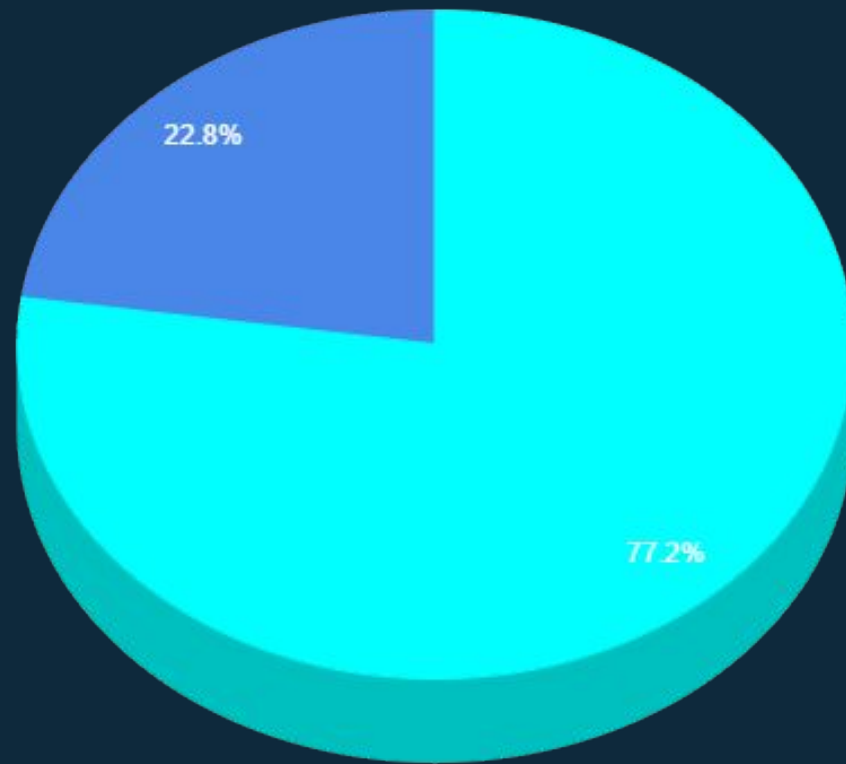




# Performance Comparison

|                         | #Branches | $p < 0.05$ | Never Covered by the Other |
|-------------------------|-----------|------------|----------------------------|
| Whole is better         | 1631      | 1402       | 246                        |
| Equivalent              | 671       | -          | -                          |
| Single Target is better | 81        | 58         | 3                          |







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CONTACT

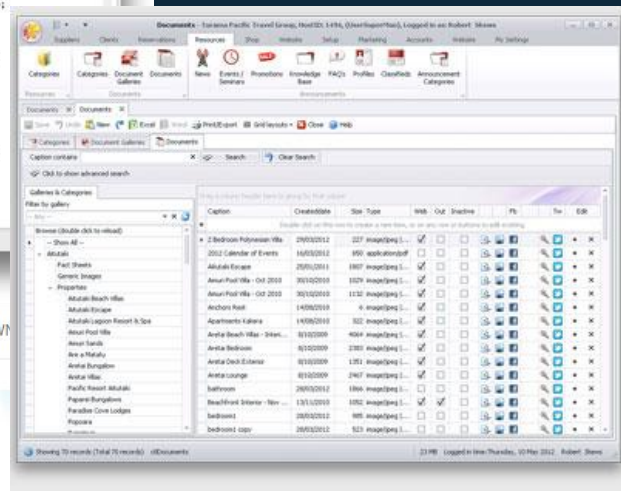
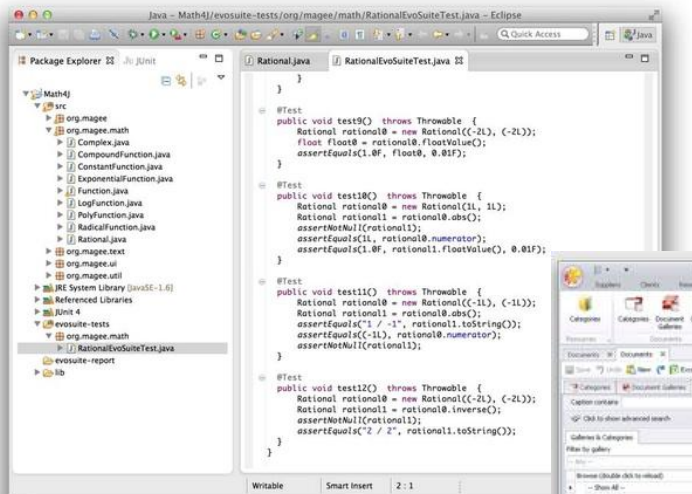
## ABOUT

## DOCUMENTATION

## PUBLICATIONS

## EXPERIMENTAL DATA

DOWN





# Thanks!

## Any questions?

You can find us at:

<https://github.com/TUdelft-CS4110/2016-0x90>

