CISC327 - Software Quality Assurance

Lecture 10

Black Box Testing

Black Box Testing

- Outline
  - Last time we explored the role of systematic testing in the software life cycle
  - Today we continue with:
    - Introduction to testing methods: black box and white box
    - Kinds of black box methods
    - Black box method 1: Systematic functionality testing

Systematic Testing Methods

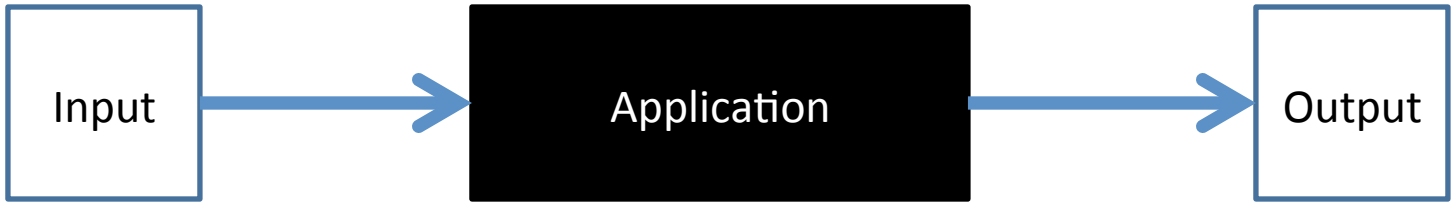
- For a test method to be systematic, it must have:
  - a system (rule) for creating tests
  - a measure of completeness
- Need an easy, systematic way to create test cases
  - to know for sure what to test
- Need an easy, systematic way to run tests
  - to know how to test
- Need an easy, systematic way to decide when we're done
  - to know when we have enough tests

Black Box vs. White Box

- Two Kinds of Methods
  - Systematic testing methods can be divided into two kinds: black box and white box
  - Black box methods cannot see the software code to test it (it may not exist yet), so they can only base their tests on the requirements or specifications
  - White box methods can see what the software's code is, so they can base their tests on the software's actual architecture or code itself

Black Box Methods

- Black box testing is for functionality
  - No knowledge of the internal structure or source code is necessary



Black Box Methods

- Black Box Methods
  - In a black box method, we choose our test cases based solely on the requirements, specification, or (sometimes) design documents
  - Advantage: we can do it independently of the software
    - On a large project, black box tests can be developed in parallel with the development of the software, saving time
  - Normally, black box testing is based on the functional specification (requirements) for the software system

Black Box Methods

- Functional Specifications
  - Can be formal (mathematical), or more often informal (in a natural language such as English)
  - In either case, the functional specification usually contains at least three kinds of information:
    - the intended inputs
    - the corresponding intended actions
    - the corresponding intended outputs
  - Focussing on each one of these separately gives us three different black box systems for testing

Black Box Methods

- Three Kinds of Black Box Methods
  - Systematic black box methods can be divided into three classes corresponding to these three kinds of information:
    - Input coverage tests
    - Output coverage tests
    - Functionality coverage tests

Black Box Methods

- Input coverage tests
  - Based on an analysis of the intended inputs, independent of their actions or outputs
- Output coverage tests
  - Based on an analysis of the intended outputs, independent of their input or actions
- Functionality coverage tests
  - Based on an analysis of the intended actions, with or without their inputs and outputs

Systematic Functionality Testing

- An example
  - We begin with the third of these, functionality coverage testing
  - Functionality coverage attempts to partition the functional specification of the software into a set of small, separate requirements
  - Example: Suppose that the informal requirements for a program we are to write are as follows:
    - "Given as input two integers x and y, output all the numbers smaller than or equal to x that are evenly divisible by y. If either x or y is zero, then output zero."

Systematic Functionality Testing

- Requirements Partitioning
  - Our first step is to physically partition the functional specification into separate requirements
  - In this system we model the separate requirements as independent, even though they are not
  - Example:
    - "Given as input two integers x and y, output all the numbers smaller than or equal to x that are evenly divisible by y. If either x or y is zero, then output zero."

Requirements Partitioning

- "Given as input two integers x and y"
  - R1. Accept two integers as input.
- "output ... the numbers"
  - R2. Output zero or more (integer) numbers.
- "smaller than or equal to x"
  - R3. All numbers output must be less than or equal to the first input number.
- "evenly divisible by y"
  - R4. All numbers output must be evenly divisible by the second number.
- "all the numbers"
  - R5. Output must contain all numbers that meet both R3 and R4.
- "If either x or y is zero, then output zero."
  - R6. Output must be zero (only) in the case where either first or second input integer is zero.

Test Case Selection

- Test Cases for Each Requirement
  - We model each partitioned requirement as independent
  - We create separate test cases for each partitioned requirement
  - Example: For the partitioned requirement:
    - "If either x or y is zero, then output zero."
      R6. Output must be zero (only) in the case where either first or second input integer is zero.

Test Case Selection

- Example: For the partitioned requirement:
  - "If either x or y is zero, then output zero."
    R6. Output must be zero (only) in the case where either first or second input integer is zero.
- We might choose the test cases:
  - R6T1. 0 0 (both zero)
    R6T2. 0 1 (x zero, y not)
    R6T3. 1 0 (y zero, x not)
    R6T4. 1 1 (neither zero)
- Notice these test inputs are the simplest possible and make no attempt to be exhaustive - more on this later

A Systematic Method

- Black Box Functionality Coverage
  - Functionality coverage gives us a system for creating functionality test cases
    - It tells us when we are done (i.e., when we have test cases for every partitioned requirement)
  - But notice this is not the same as acceptance testing, because it treats functional requirements as if they were completely separate, when in fact they are tightly related
    - So it does not replace acceptance testing, we (or the customer) must do that as well
    - Unlike acceptance testing, it is a systematic method, but like other systematic methods, it is only a partial test

Choosing & Organizing Tests

- An Experiment
  - Black box testing performs an experiment on the software system, in the true scientific sense
  - We have a hypothesis that the software has certain properties, and we design a method to test whether the hypothesis holds with our test cases
  - We then observe the results and draw conclusions, in classic scientific method style

Choosing & Organizing Tests

- Experimental Design
  - A fundamental principle of experimental design is the isolation of "variables"
    - This refers to the fact that we should design the experiment such that each possible cause that may affect the outcome (each experimental "variable") can be observed independently
    - Thus when an effect is observed, we can tell which cause is at work
  - The usual way to do this is to design the experiment in steps that only vary one "variable" (possible cause) at a time, keeping everything else constant

Choosing & Organizing Tests

- Test Plan Design
  - The experimental model of software testing gives us two important principles for our test plan:
    1. Test inputs should be chosen to carefully isolate different causes of failure (the experimental variables)
    2. Test cases should be ordered such that each test only assumes features to be working that have already been tested by a previous test

Guidelines for Choosing Test Inputs

- Choosing Inputs
  - For test inputs, this principle means that we should help isolate failure causes, by as much as possible
    1. Consistently choosing the simplest input values possible, in order not to introduce arbitrary variations
    2. Keeping everything constant between test cases, varying only one input value at a time
       (don't try to be "clever" introducing random input variations)
  - These principles hold for all systematic test methods, not just this one

Ordering Tests for QIES

- **T2** can log in in agent mode

  .

  .

  .

- **T14** createservice disallowed in agent mode

Ordering Tests for QIES

- **T14** createservice disallowed in agent mode

  .

  .

  .

- **T2** can log in in agent mode

If T14 doesn't produce the expected result, is it because *(a)* createservice is erroneously allowed, or *(b)* because agent-mode login doesn't work?

Don’t Duplicate Tests

- Some parts of the project requirements are redundant:
  - “after an agent login, only agent transactions and logout are accepted”
  - [createservice] “privileged transaction, only accepted in planner mode”
- This is a natural way of stating the requirements, not an inconsistency
- But don’t write two identical test cases here

Check your levels

- We are *not* doing acceptance testing here
- Instead, breaking down the requirements into pieces and testing each one
- **None** of the test cases you're writing for A1 will be big enough to seem "realistic"

Assumptions

- Front End behaviour is deterministic: same input ⇒ same output.
- Can you think of a kind of testing that *isn't* deterministic?
- Aside: "voting" on airplanes
- Implementors (you!) are reasonable:
  - You won't write code that detects the specific case of 27 createservice transactions in a row so you can crash on purpose

Summary

- Black Box Testing
  - Two classes of systematic test methods, black box and white box
  - Black box methods include input coverage, output coverage, functionality coverage
  - Functionality coverage partitions the functional specification into separate requirements to test
  - Isolate causes by ordering tests by features used, keeping test input values simple, and varying one input value at a time

Summary

- References
  - Sommerville, ch. 8, "Software Testing"
- Next Time
  - More Black Box Testing - Input coverage methods