Test Case Selection Strategies II

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Contents

This lecture covers

- random testing
- partition testing

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Basic Concepts

- Input domain – set of all possible inputs
- Failure-causing inputs – inputs that exhibit failures
- Exhaustive testing –
  - to test the program with the entire input domain

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Basic Concepts (continue)

Consider the following program

```
INPUT I, J, K   // -1M <= I, J, K <=1M, integers
N = I +2*J – 3*K
OUTPUT N
```

Apply exhaustive testing to test this small program

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Basic Concepts (continue)

I has 2,000,001 possible values
J has 2,000,001 possible values
K has 2,000,001 possible values

Number of possible inputs > 8 * (10**18)

Is it feasible to apply exhaustive testing?

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Basic Concepts (continued)

- Exhaustive testing – infeasible
- How to select inputs as test cases?

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Various Test Case Selection Strategies

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An Intuitive Approach

Use the information related to

- Inputs
- Outputs

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Approaches

- Black box approach
  - Does not refer to the program code
  - Examples: random testing, category-partition method, classification tree method
- White box approach
  - Makes use of the program code
  - Examples: control-flow coverage, data-flow coverage

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Random Testing

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Random Testing

selects test cases from the entire input domain randomly and independently

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Random Testing (continued)

- Two approaches
  - Uniform distributions
    each input is of equal selection probability
  - Operational distributions (profiles)
    selection probability follows the probability of being used

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Random Testing (continued)

Consider a program whose inputs are names:

John, Jenny, Mary, Tom, Henry, Annie, David, Fanny, Karen, Peter, …….

(in the descending order of their uses)

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Random Testing (continued)

John, Jenny, Mary, Tom, Henry, Annie, David, Fanny, Karen, Peter, …….

(in the descending order of their uses)

Uniform distributions:

John and Peter have the same chances to be selected as the test case

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Random Testing (continued)

John, Jenny, Mary, Tom, Henry, Annie, David, Fanny, Karen, Peter, …….

(in the descending order of their usage)

Operational distributions

Suppose John 3 times be used than Peter

Then, Probability (John)=3*Probability(Peter)

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Random Testing (continued)

- Advantages
  - Intuitively simple
  - Allows statistical quantitative estimation of the software's reliability
- Disadvantage
  - Ineffective (not using any information to guide the selection of test cases)

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Pseudo Radom Numbers

- Not truly random
- Same sequences with same initial seeds
- Many pseudo random number generators available

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Example

Assume the random number generator (RG) returns a value within [0, 1]

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Example (continued)

Uniform distributions:

Suppose you have 10 names:
Mary, …… ,Tom
Generated value [0, 0.1) – Mary
……
Generated value (0.9, 1] – Tom

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Example (continued)

Operational distributions:

Suppose you have 10 names:
Mary, …… ,Tom
Mary's probability – 0.21
……
Tom's probability – 0.06

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Example (continued)

Mary's probability – 0.21

……

Tom's probability – 0.06

Generated value within [0, 0.21) – Mary

…..

Generated value within (0.94, 1] - Tom

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Partition Testing

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Subdomain Testing

- Partitioning scheme
  - Dividing the input domain into subsets of inputs (known as subdomains)
- Test allocation scheme
  - Selection of test cases from each subdomain

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Subdomain Testing (continued)

- Motivation
- Homogenous or revealing subdomain
  - Either all elements will cause the program to succeed or all cause it to fail
  - It is extremely difficult for every subdomain to be homogeneous

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Partition Testing

- A special case of subdomain testing – subdomains are disjoint
- Examples:
  - Path coverage
  - Category-Partition Method
  - …….

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Example of Path Coverage

Consider the program

```
INPUT X, Y        // 0 <= X, Y, <=10, real numbers
IF (X + Y) >= 5 THEN Z= X + Y
                ELSE Z= 2*X – Y
OUTPUT Z
```

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Example of Path Coverage (continued)

Two execution paths:

Path 1 (X=5,Y=3)	Path 2 (X=2, Y=1)
INPUT X, Y	INPUT X, Y
(X + Y) >= 5 (**TRUE**)	(X + Y) >= 5 (**FALSE**)
Z= X + Y	Z=2*X -Y
OUTPUT Z	OUTPUT Z
Z = 8	Z = 3

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Example of Path Coverage (continued)

The input domain is partitioned into two disjoint partitions

- One partition containing inputs (X, Y) such that (X+Y) is greater than or equal to 5, which will execute the “TRUE” path
- One partition containing inputs (X, Y) such that (X+Y) is not greater than or equal to 5, which will execute the “FALSE” path

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Category-Partition Method

- Specification-based technique
- Major steps:
  - Identify categories from the specifications (major aspects of parameters or environment conditions)
  - Identify the associated choices for each category (disjoint subsets of values for each category)

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Category-Partition Method (continued)

- Define constraints amongst choices (from different categories)
- Generate all valid combinations of choices as test frames via these constraints
- Construct test cases from the generated test frames

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Example

- Develop a program for a bank to process the loan applications
- The program will accept the following details:
  - Employment status – either "employed" or "unemployed"
  - Type of employment – either "self-employed" or "employed by others"
  - Type of contract (only for "employed by others") – either "permanent" or "temporary"
  - Monthly salary (S) – either "$0<S<=$3,000", "$3,000<S<=$5,000", or "S>$5,000"
  - Type of applicant – either "card holder" or "non-card holder"
  - Type of credit card - either "gold" or "classic"
  - Credit limit– either "not more than $2,000" or "$2,001 to $6,000"

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Example (continued)

- Category: "Employment Status"
  - Choices: "employed" and "unemployed"
- Category: "Type of Employment"
  - Choices: "self-employed" and "employed by others"
- Category: "Type of Contract"
  - Choices: "permanent" and "temporary"

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Example (continued)

- Category: “Monthly Salary”
  - Choices: “$1 to $2,999”, “$3,000 to $4,999” and “>$4,999”
- Category: “Type of Applicant”
  - Choices: “card holder” and “non-card holder”
- Category: “Type of Credit Card”
  - Choices: “gold” and “classic”
- Category: “Credit limit”
  - Choices: “not more than $2,000” and “$2001 to $6,000”

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Example (continued)

A possible test frame which corresponds to a partition

- “Employment Status” – “employed”
- “Type of Employment” – “employed by others”
- “Type of contract” – “permanent”
- “Monthly Salary” – “$3,000 to $4,999”
- “Type of Applicant” – “card holder”
- “Type of Credit Card” - “gold”
- “Credit limit”– “$2,001 to $6,000”

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Example (continued)

A possible test case of this test frame (or of this partition)

- "Employment Status" – "employed" - *yes*
- "Type of Employment" – "employed by others" - *yes*
- "Type of contract" – "permanent" – *yes*
- "Monthly Salary" – "$3,000 to $4,999" - *$4,250*
- "Type of Applicant" – "card holder" - *yes*
- "Type of Credit Card" - "gold" – *yes*
- "Credit limit"– "$2,001 to $6,000" - *$4,500*

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Example (continued)

Another possible test frame which corresponds to another partition

- "Employment Status" – "employed"
- "Type of Employment" – "self employed"
- ….
- "Monthly Salary" – "$3,000 to $4,999"
- "Type of Applicant" – "card holder"
- "Type of Credit Card" - "classic"
- "Credit limit"– "$2,001 to $6,000"

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Example (continued)

A possible test case of this partition

- "Employment Status" – "employed" - yes
- "Type of Employment" – "self employed" - yes
- ….
- "Monthly Salary" – "$3,000 to $4,999" - *$6,300*
- "Type of Applicant" – "card holder" - *yes*
- "Type of Credit Card" - "classic" - *yes*
- "Credit limit"– "$2,001 to $6,000" - *$3,150*

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Summary

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