Adaptive Random Testing

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Speaker Biographical Sketch

- Professor & Director of International Outreach
  Department of Computer Science
  University of Texas at Dallas
- Guest Researcher
  Computer Security Division
  National Institute of Standards and Technology (NIST)
- Vice President, IEEE Reliability Society
- Secretary, ACM SIGAPP (Special Interest Group on Applied Computing)
- Principal Investigator, NSF TUES (Transforming Undergraduate Education in
  Science, Technology, Engineering and Mathematics) Project
  - Incorporating Software Testing into Multiple Computer Science and Software
    Engineering Undergraduate Courses
- Founder & Steering Committee co-Chair for the SERE conference
  (IEEE International Conference on Software Security and Reliability)
  (http://paris.utdallas.edu/sere13)
**Basic Concepts**

- Input domain: Set of all possible inputs
- Exhaustive testing:
  - Test the program with the entire input domain
  - Practically infeasible
- Failure-causing inputs: Inputs that exhibit failures

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**Random Testing (1)**

- Random Testing
  - Selects test cases from the entire input domain randomly and independently
- Advantages:
  - Intuitively simple
  - Allows statistical quantitative estimation of the software’s reliability
**Random Testing (2)**

- Two approaches
  - Uniform distributions
  - Operational distributions (profiles)

**How to Improve Random Testing**

- Any common information or characteristics to all faulty programs?

  **Failure-causing inputs**
**Patterns of Failure-Causing Inputs**

- Strip Pattern
- Block Pattern
- Point Pattern

**Types of Failure Patterns**

- **Strip Pattern**
- **Block Pattern**
- **Point Pattern**
**Strip Pattern**

Two Dimensional Input Domain

if \((2x - y > 10)\)

/* The correct statement is if \((2x - y > 20)\) */

then

\[ z = \frac{x}{2y} \]

else

\[ z = xy \]

A different type of error “if \((2x - y \geq 10)\)”

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**Block Pattern**

Two Dimensional Input Domain

if \(((x \geq 4 \text{ and } x \leq 6) \text{ and } \) 
\((y \geq 4 \text{ and } y \leq 6))\)

then

\[ z = x + y \]

/* The correct statement is \(z = x - y\) */

else

\[ z = 100 \]
**Point Pattern**

Two Dimensional Input Domain

```plaintext
if (((x mod 10) = 0) and ((y mod 10) = 0))
then
    z = f(x,y)
    /* should be z = g(x,y) */
else
    z = f(x,y)
```

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**Which Pattern Occurs More Frequently?**

*Block and strip patterns*
Intuition of ART

Failure-causing pattern fixed but unknown

Adaptive Random Testing (1)

- For non-point failure patterns
  - An even spread of random test cases will enhance the fault detection capabilities
**Adaptive Random Testing (2)**

- Simulation and empirical results showed that as compared with random testing, fewer test cases required to detect *the first failure* (smaller *F*-measure)

- *F*-measure of ART ≅ 50-60% of that of RT with replacement

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**How to Achieve “Even Spread” ?**

- Notion of distance
- Notion of exclusion
- ...
**ART by Distance**

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**ART by Exclusion**

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**Even Spread Approaches**

- Distance
  - Distance measures
  - Size of candidate set
  - .......

- Exclusion
  - Exclusion amount
  - Shape of exclusion region
  - .......

Possible topic for your term paper

**ART versus RT**