Tutorial 12

Swinburne University of Technology

Software Testing and Reliability (SWE30009)

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Adaptive Random Testing

Adaptive Random Testing (ART)

- Scope: Is used for non-point failure patterns

- Intuition: Better spread of random test cases will enhance fault detection

ART methods

- ART by best candidates
  - ART for a fixed-size candidate set
- ART by exclusion
  - Restricted random testing
- ART by partitions
  - ART by random partitions

ART by best candidates

- Adaptively pick best test cases from random test case candidates

- Step 1: Generation
  - Generate a set of random candidates
  - Define the specific “best” criterion
- Step 2: Selection
  - Select the “best” candidates amongst this candidate set as the next test case
  - Discard the remaining candidates

ART for a fixed-size candidate set

- Adaptively select new test cases far away from executed test cases

- Step 1: Generation
  - Generate a set of random candidates with a fixed size
- Step 2: Selection
  - For each candidate, find its nearest already executed test case
  - Select the candidate with the largest "distance" to its nearest already executed test case, as the next test case
    - Maximin criterion

ART by exclusion

- Adaptively generate + select new test cases outside exclusion regions of executed test cases

- Step 1: Generation
  - Generate an exclusion region for each arealdy excuted test case
- Step 2: Selection
  - Repeat generating a random candidate
  - Check if a candidate that is outside the exclusion regions of all already executed test cases, as the next test case – otherwise repeat

Restricted Random Testing (RRT)

- Construct exclusion regions based on relative sizes

- Step 1: Generation
  - Define an exclusion ratio (= size of exclusion regions / entire input domain)
  - Define shape of exclusion region
- Step 2: Selection
  - Construct exclusion region for each executed test cases

ART by partitions

- Select new test cases in each partition

- Step 1: Generation
  - Divide the input domain into paritions
- Step 2: Selection
  - Select a partition as the target partition
  - Select a random test case from this partition

ART by random partitions

- Select new test cases in largest partition

- Step 1: Generation
  - Divide the input domain into paritions with information from executed test cases
- Step 2: Selection
  - Select a partition with the largest size as the target partition
  - Select a random test case from this partition

Forgetting test cases

- Random forgetting
- Forget the oldest
- Total forgetting

Reliability & Fault

Reliability

- The **probability** of a system, product or component performs specified functions without failure under specified conditions for a specified period of time.

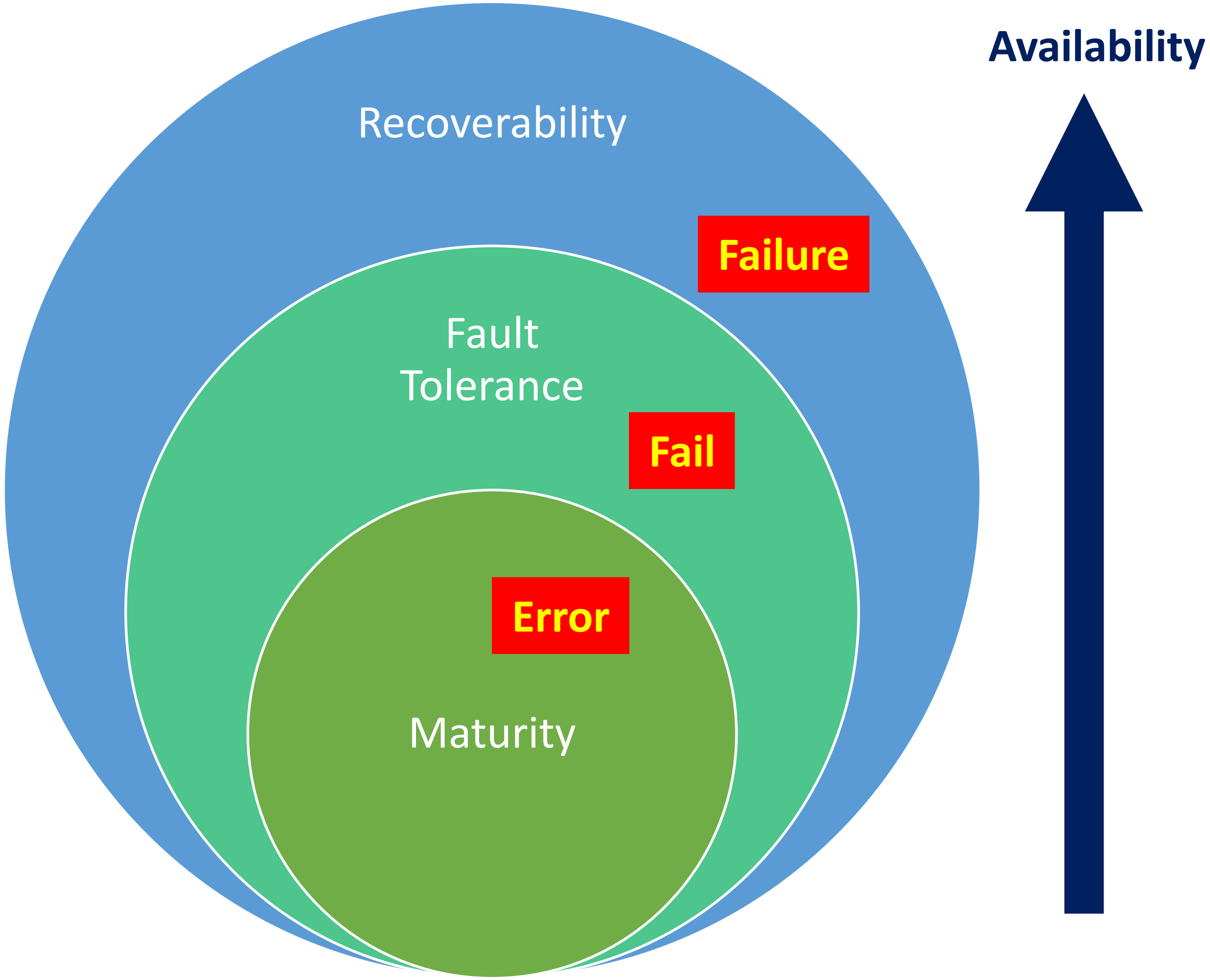
Components of reliability

- Probability
- Intended function
- Satisfactory
- Specific period of time
- Specified conditions

AQS Quality GlossaryDefinition: Reliability

Characteristics of Reliability [ISO 25010]

- Availablity
- Maturity
- Fault tolerance
- Recoverability



SIG Evaluation Criteria Reliability, Guidance for Producers, Software Improvement Group, 2020

Approaches to software reliability

- Fault avoidance
  - Minimizing faults
- Fault detection
  - Revealing faults
- Fault correction
  - Correcting faults
- Fault tolerance
  - Operating in the presence of faults

Fault avoidance

- Minimizing faults
  - An optimal and well-developed approach

- Commonly used techniques
  - Minimizing complexity
  - Improving communication
  - Early error detection during translation

Fault detection

- Revealing faults
  - As early as possible

- Software testing methods
  - Black box
  - White box
  - Gray box

Fault correction

- Fault localization

- Program reparing

Fault tolerance

- Error isolation
- Fallback mechanism
- Redundancy
    - N-version programming
    - Data diversity

Fault prediction

- Error seeding
- Independent testing

Failure occurences

- Time of failure
- Time interval between failures
- Cumulative failures experienced up to a given time
- Failures experienced in a time interval

Failure measures

- Mean value function
  - Average cumulative failures
- Failure intensity function
  - Number of failures per unit time