7. Unit and Integration Testing

Andrea Polini

Software Engineering II – Software Testing
MSc in Computer Science
University of Camerino

Testing Phases and Objectives

- Unit test: each program unit functions as expected
- Integration test: integration of more units interact as expected
- System test: the whole systems behave as expected

Unit testing

Main characteristics

- generally performed by the developer of the unit
- test could be defined before writing the code
- white box adequacy criteria should be defined and targeted

Testing activities

- Test plan
- Test design
- Test codification
- Test environment setting
- Test execution
- Test result analysis

Unit testing strategies

Test derivation

Random testing is a strategy often used to select runs to execute (test cases). In some situations it behaves rather well, in comparisons with more complex strategies. On the other hands there are situations in which performances are not so good. The well-known triangle problem.

JUnit

What's that

JUnit is the implementation for the Java world of the xUnit framework. This is a framework that support the phases of:

- coding
- environment setting
- execution
- analysis

Mocks and Stubs

Unit to test could depends on “server” units

- **stubs**: simple software elements that provide dummy responses to requests from a unit under test
- **mocks**: more complex software elements that provide responses to requests from a unit under tests and can also check correctness of invocations

Integration testing

Integration testing rationale

Integration testing aims at showing mismatches in the interactions among components

It is possible that faults are discovered in relation of uncorrect behaviour of integrated units nevertheless this is not the objective of integration testing

The Mars orbiter example

Integration testing

Questions to answer

- Integration hierarchy
- Sequencing and stubbing
- Test generation

Assumption: all components have been tested well during unit testing

Integration sequence

Dependencies

The definition of an integration strategy should consider dependency (relations) among units.

- data dependency
- functional dependency
- control dependecy

Dependencies have an impact on the integration sequence. Object Relation Diagram permit to capture dependencies among components

Integration sequence

Which are the information that can be used for deciding integration strategies?

Programming paradigm

- OO Programming
  - inheritance, association, aggregation/composition, dependencies (uses, calls, parameter, send, instantiates)
  - In OO programming particularly complex is the management of polymorphism, that creates dynamic dependencies
- Procedural programming
  - call graph

Integration sequence

Which are the information that can be used for deciding integration strategies?

Programming paradigm

- OO Programming
  - inheritance, association, aggregation/composition, dependencies (uses, calls, parameter, send, instantiates)
  - In OO programming particularly complex is the management of polymorphism, that creates dynamic dependencies
- Procedural programming
  - call graph

Deciding on the integration strategy

Integration hierarchy

- Big bang
  - not the same as system integration
  - can lead to difficulties in locating bugs
  - applicable when few components need to be integrated
  - no stubs or mocks need to be created
- Top-down
- Bottom-up

Deciding on the integration strategy

- Availability of code
- Difficulty or ease of constructing stubs (strictly coupled classes)
- difficulty or ease of constructing drivers
- size of the test team
- need of showing partially working programs

Optimal test order

The problem of finding an optimal integration sequence is NP-complete in literature different approaches to derive sub optimal solutions have been proposed.

- Tai-Daniels
- Traon-Jeron-Jezequel-Morel
- Briand-Labiche-Wang

Strategies foresees the analysis of the ORD to identify Strongly Connected Components (SCC) and then the removal of dependencies so to generate DAG with no cycles. Then the analysis give the number of stubs needed to proceed with integration testing.

Test derivation and adequacy

- What are the techniques to derive tests for integration purpose?
- What are the adequacy criteria that can be used?