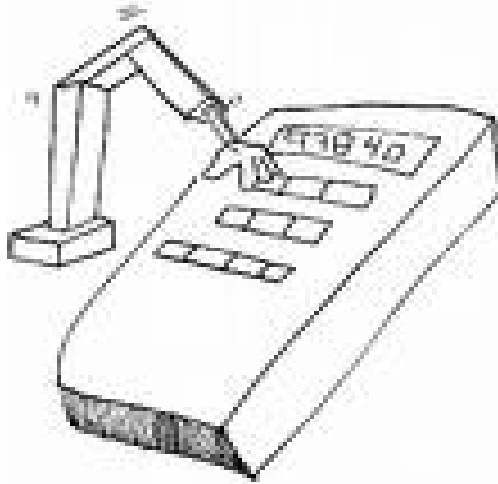


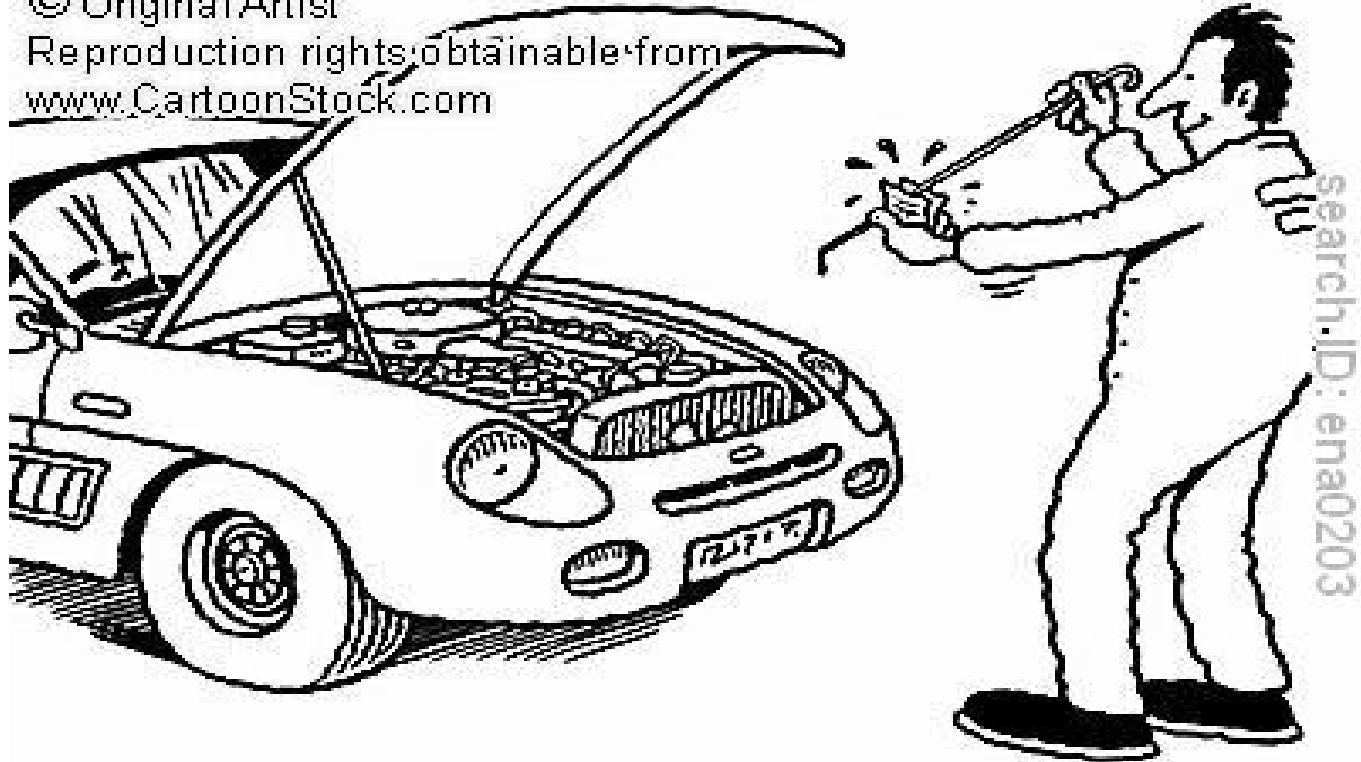
PROGRAMS THAT TEST THEMSELVES!



Formal Methods in Software Development
Shohreh Takyar
Fall 2009

Testing

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Testing and Software Development

I wish programs could test their functionalities themselves...



www.4851652.com

Is it possible?
Let's see...

Outline

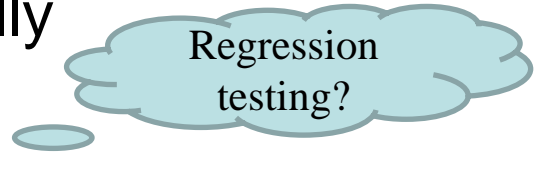
- Basic definitions
 - Automated test, Design by contracts, EiffelStudio
- Automated testing in industry (current state)
 - Test execution, Regression testing, Resilience
- Towards fully automated testing
 - Test preparation, Test oracles, Test minimization
- Summary and future directions

Auto Test

- Definition
 - A set of software tools/programs designed and implemented to test their functionalities themselves
- Components
 - Test generation
 - Test extraction
 - Integration of manual tests

Auto Test (continued)

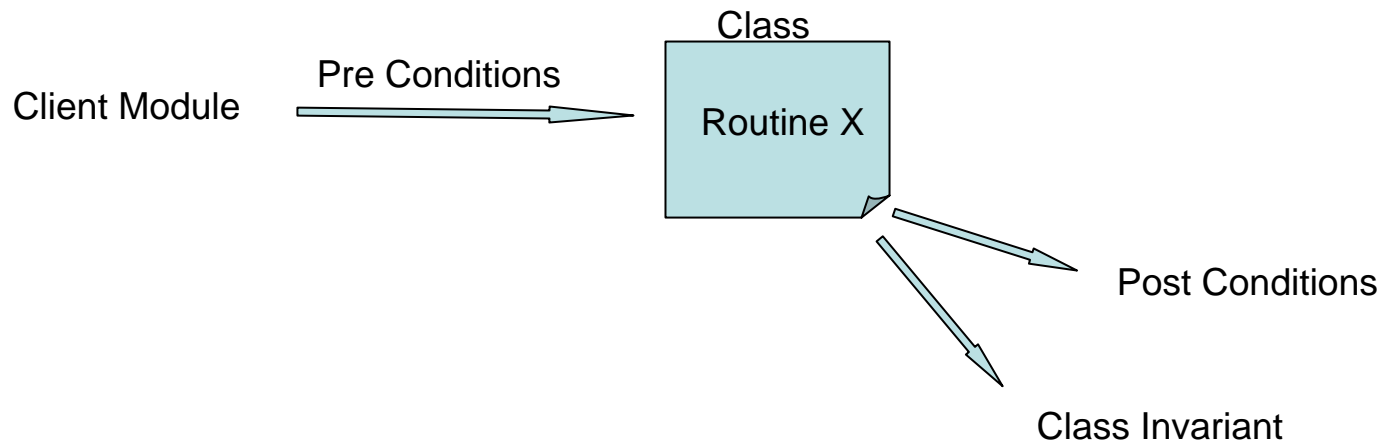
- Test generation
 - Create and run test cases automatically
- Test extraction
 - Contributes to the set of test cases for future regression testing
- Integration of manual tests
 - The final goal of testing is to reveal all possible scenarios that can make a software fail



Regression testing?

Design by Contracts

- Contract components
 - Pre conditions
 - Post conditions
 - Class invariants
 - A set of properties that will be preserved during the routine call



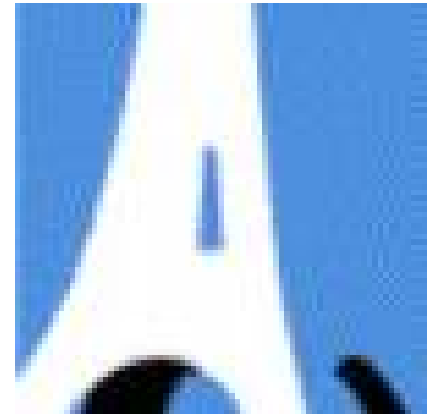
Auto test...
Programming by contracts...
Let's release an auto test Framework...
We can even name it "EiffelStudio" ...



I'm sorry! It has already been done!

Testing Practices in EiffelStudio

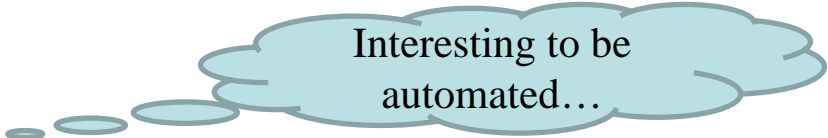
- EiffelStudio presents an integrated version of three components of an auto test
 - Test synthesis (Generation)
 - Test extraction takes place anytime the underlying process is paused in EiffelStudio debugger
 - Manual tests are considered



(<http://eiffelstudio.origo.ethz.ch>)

Automated Testing in Industry (current state)

- Test execution
 - Junit and its positive impact on automated testing
- Regression testing
 - To determine if the new changes have any negative impact on any of the working features of the code
- Resilience (stability)
 - To ensure that the system after each failure is able to recover automatically



Interesting to be automated...

Fully Automated Software Testing

- Test preparation
 - Test generation
 - Test extraction
 - Integration of manual test
- Test oracles
 - A mechanism that determines whether a test has been passed or failed
- Test minimization
 - A way to remove the redundant scenarios without missing any test case

Test Preparation

- Preparing test data in OOP
 - Generate instances of classes (objects pool)
 - Select some of these objects
 - Picking up from the objects pool
 - Generating new instance (preferred strategy)
 - Select arguments for the features to be called
 - Random testing
 - Adaptive random testing (not preferred yet)



Why?



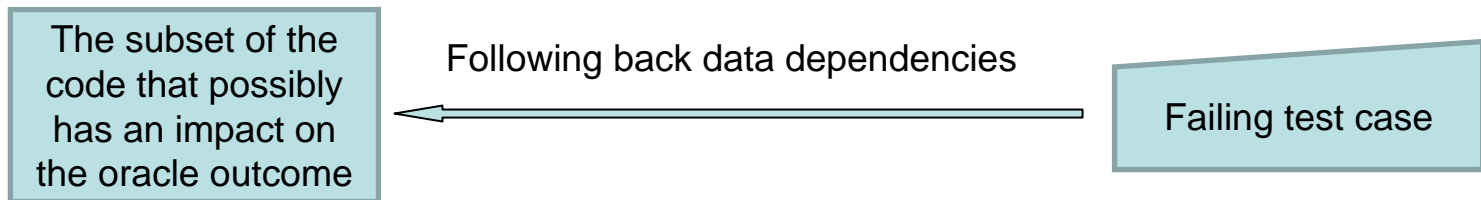
Why?

Test Oracles

- Contracts are in the form of boolean expressions. take advantage!
- Quality of the test oracles relies on the quality of the contracts

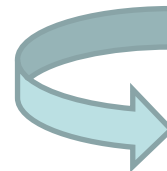
Test Minimization

- **Be careful!** We should not lose/ignore any of failures as a result of minimization
- Minimization strategies
 - Static program slicing (relies on dependencies)



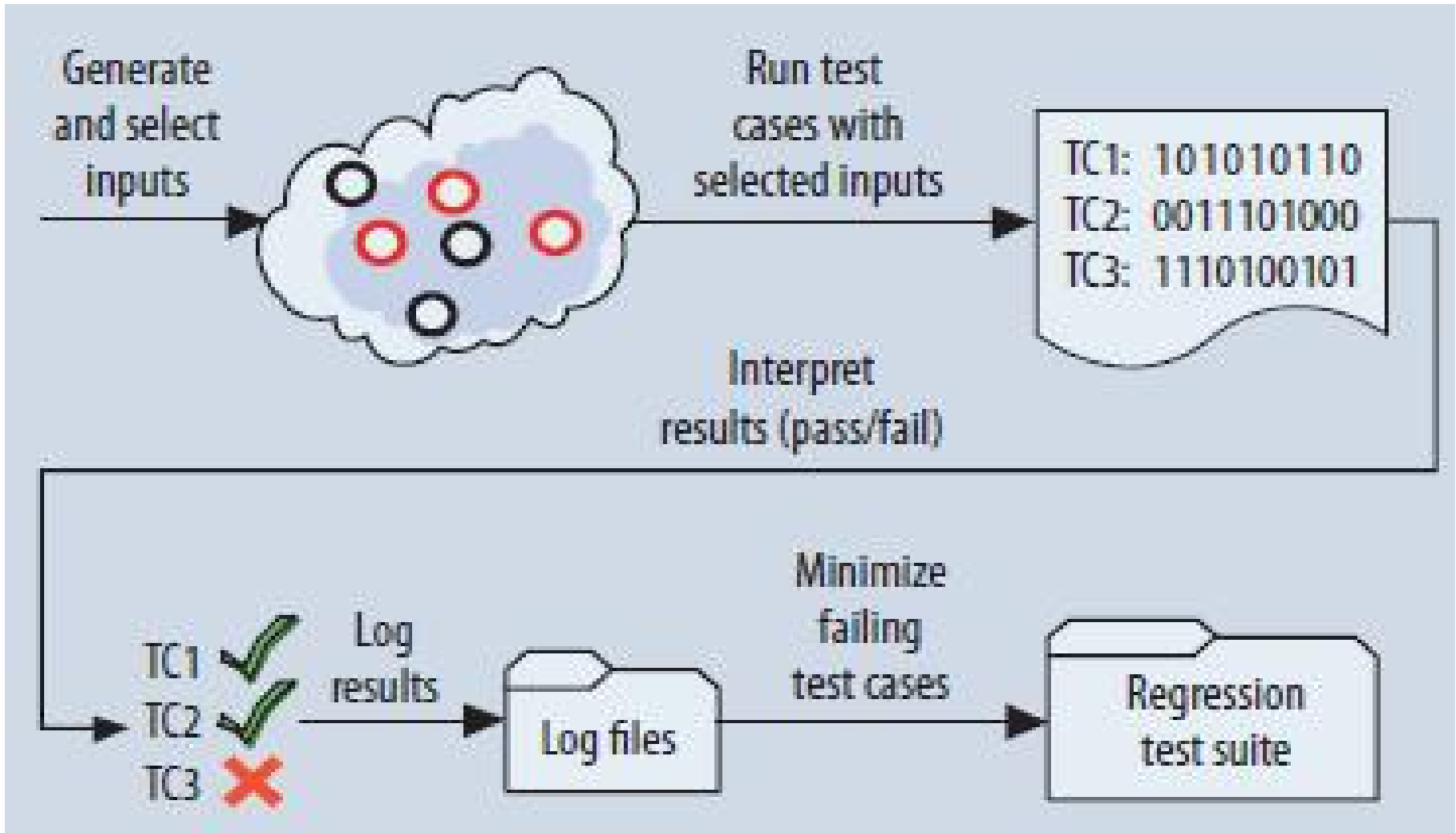
- Delta debugging (verifies causality)

Repeats the test with subsets of these factors



A set of factors that might influence a test outcome

Example



Summary

Current automated testing

Test execution
Regression testing
Resilience

Ongoing process

Test preparation
Test oracles
Test minimization