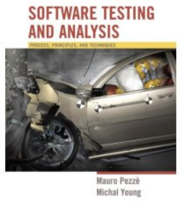
Test Execution

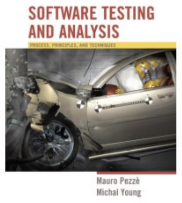
Modulo 2.2

Capitolo 17 del libro



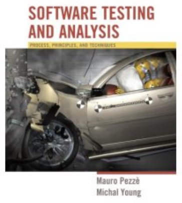
Learning objectives

- Appreciate the purpose of test automation
  - Factoring repetitive, mechanical tasks from creative, human design tasks in testing
- Recognize main kinds and components of test **scaffolding**
- Understand some key dimensions in test automation design
  - Design for testability: Controllability and observability
  - Degrees of generality in drivers and stubs
  - Comparison-based oracles and self-checks



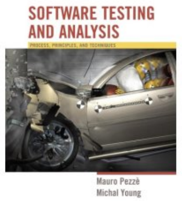
Automating Test Execution

- Designing test cases and test suites is creative
  - Like any design activity: A demanding intellectual activity, requiring human judgment
- Executing test cases should be automatic
  - Design once, execute many times
- Test automation separates the creative human process from the mechanical process of test execution



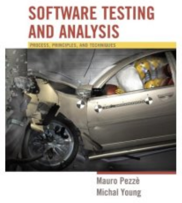
Generation: From Test Case Specifications to Test Cases

- Test design often yields test case specifications, rather than concrete data
  - Ex: "a large positive number", not 420023
  - Ex: "a sorted sequence, length > 2", not "Alpha, Beta, Chi, Omega"
- Other details for execution may be omitted
- Generation creates concrete, executable test cases from test case specifications



Example Tool Chain for Test Case Generation & Execution

- We could combine ...
  - A combinatorial test case generation (citlab) to create test data
    - Optional: Constraint-based data generator to “concretize” individual values, e.g., from “positive integer” to 42
  - DDSteps to convert from spreadsheet data to JUnit test cases
  - JUnit to execute concrete test cases
- Many other tool chains are possible ...
  - depending on application domain



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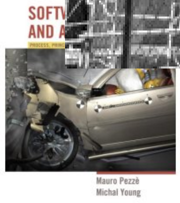
Scaffolding

- Code produced to support development activities (especially testing)
  - Not part of the “product” as seen by the end user
  - May be temporary (like scaffolding in construction of buildings
- Includes
  - Test harnesses, drivers, and stubs



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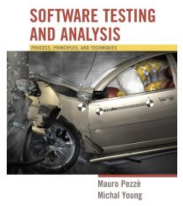
Scaffolding ...

- Test driver
  - A “main” program for running a test
    - May be produced before a “real” main program
    - Provides more control than the “real” main program
      - To driver program under test through test cases
- Test stubs
  - Substitute for called functions/methods/objects
- Test harness
  - Substitutes for other parts of the deployed environment
    - Ex: Software simulation of a hardware device



Unit Testing - Esempio

Esempio

```
foo(int x2, int y2) {

   ......
   gig(x2+2);
   ......
   }
testFoo() {
   ......
   foo(x1+1, y1-1);
   // controllo
}
gig(int x3) {

   ......
}
```

→ `foo`: test unit

Metodo da testare

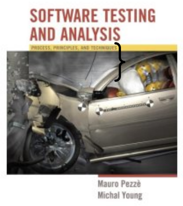
→ `testFoo`: test driver

Metodo che testa foo

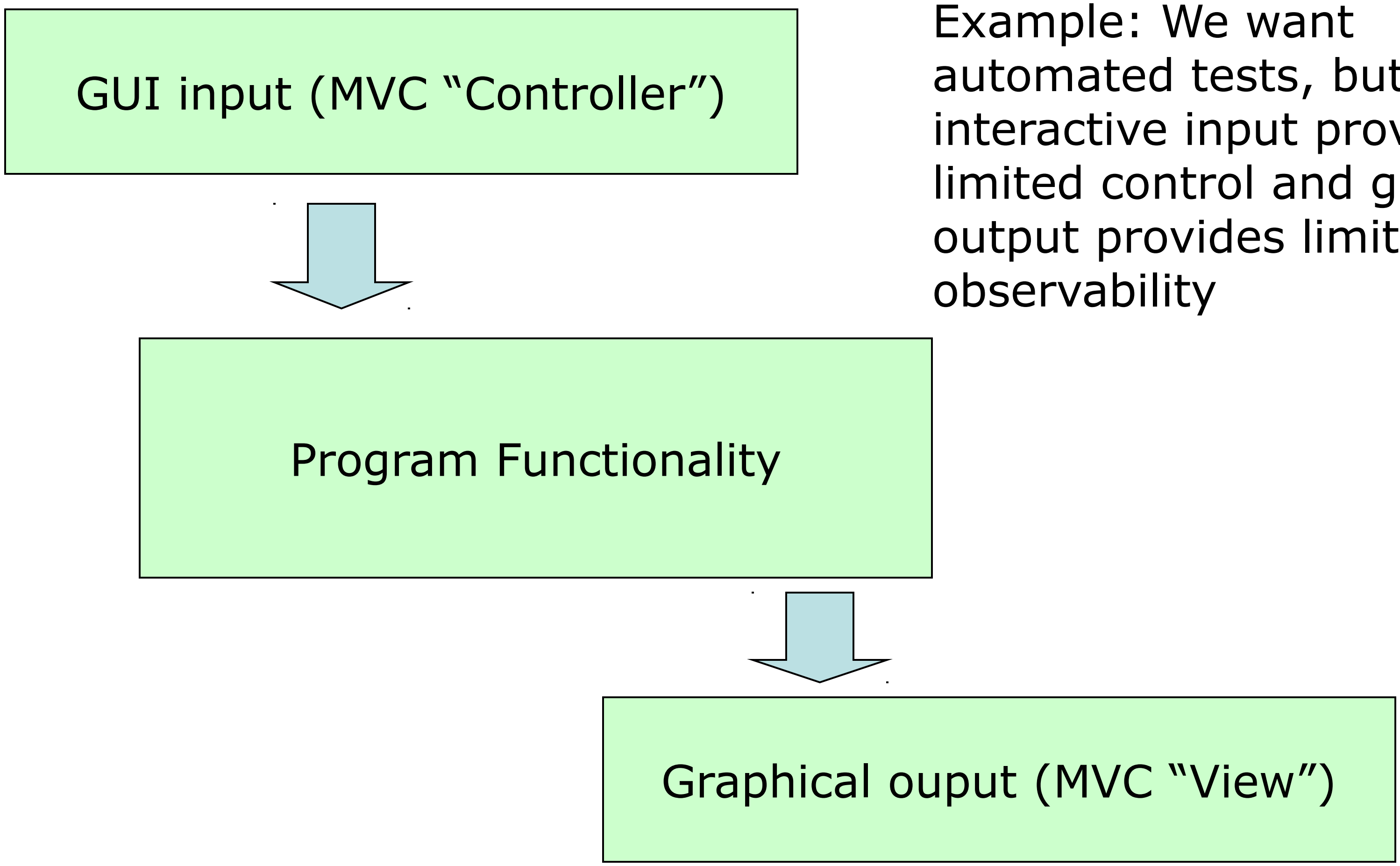
Simula una unità chiamante

→`gig`: test stub (opzionale)

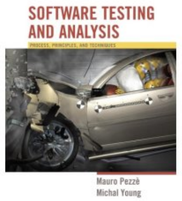
Simula un metodo chiamato da foo in modo di isolare il caso di test dal resto del sistema



Controllability & Observability



Example: We want automated tests, but interactive input provides limited control and graphical output provides limited observability



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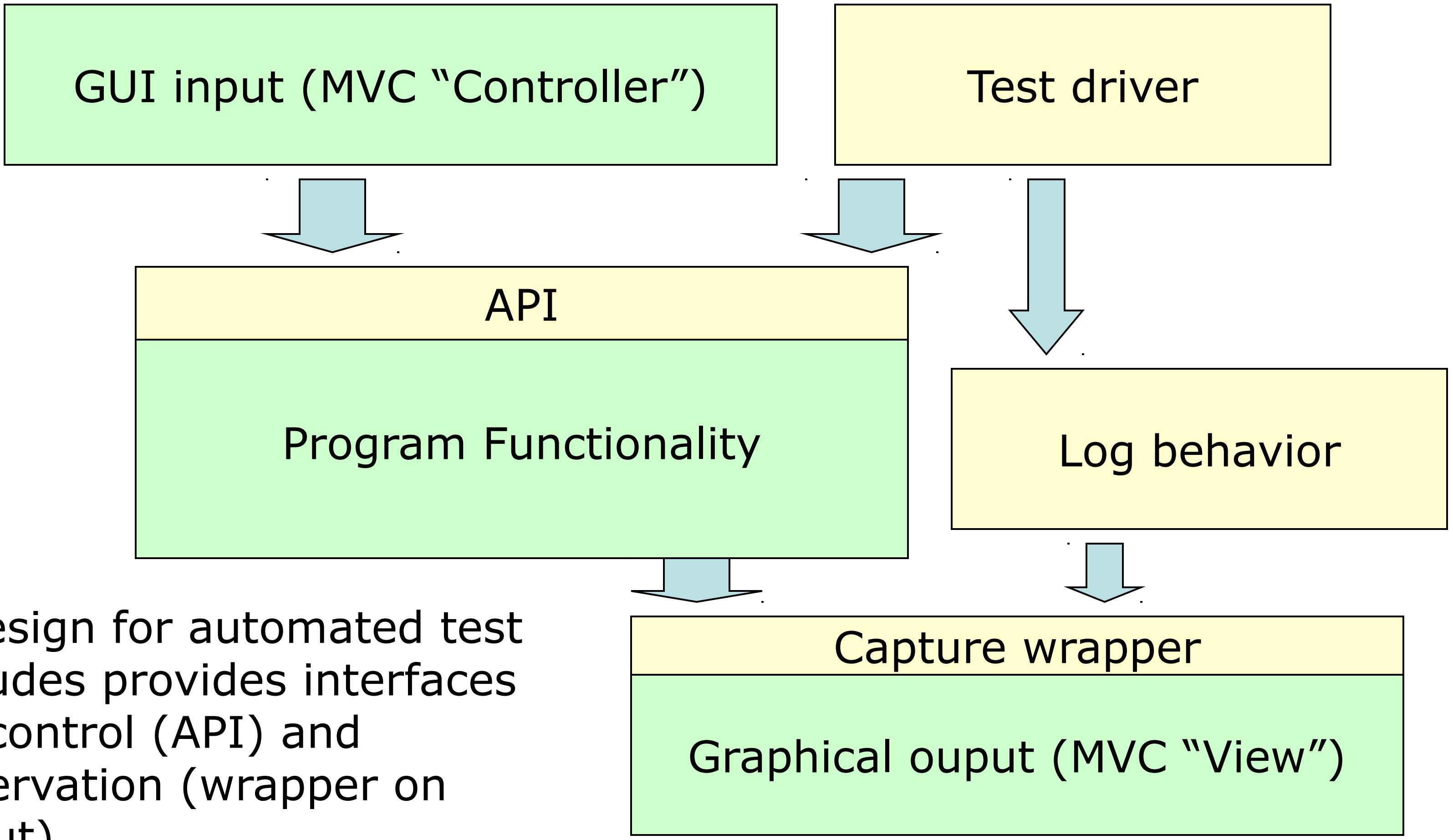
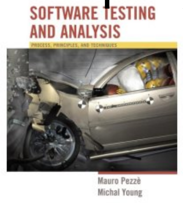
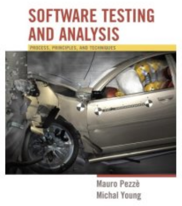


A design for automated test includes provides interfaces for control (API) and observation (wrapper on ouput).



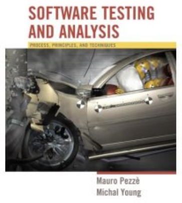
Generic or Specific?

- How general should scaffolding be?
  - We could build a driver and stubs for each test case
  - ... or at least factor out some common code of the driver and test management (e.g., JUnit)
  - ... or further factor out some common support code, to drive a large number of test cases from data (as in DDSteps)
  - ... or further, generate the data automatically from a more abstract model (e.g., network traffic model)
- A question of costs and re-use
  - Just as for other kinds of software



DDSTEPS

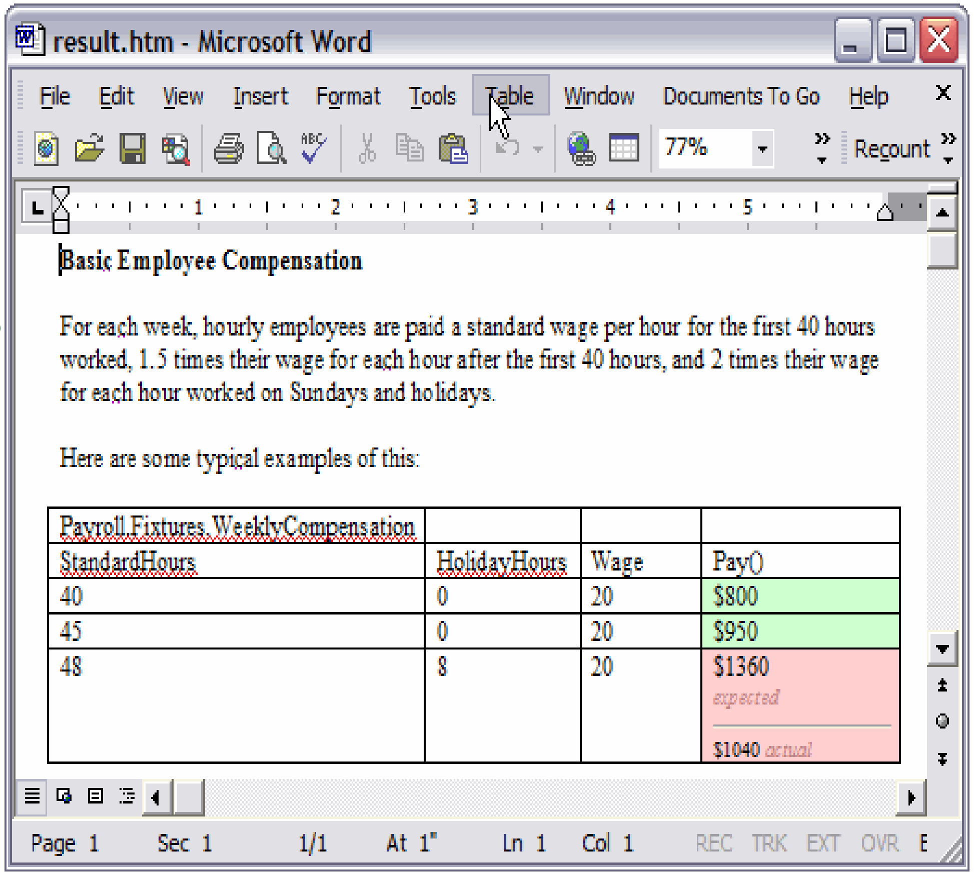
JUnit extension making test cases data driven. Uses external test data (in Excel, XML etc) which is injected into your test case using standard JavaBeans properties. Data enables and integrates toolkits such as jWebUnit and DbUnit. 100% JUnit compatible.



Example: FIT test

Fit works by reading tables in HTML files, produced with a tool like Microsoft Word. Each table is interpreted by a "fixture" that programmers write. The fixture checks the examples in the table by running the actual program.

In this example, the team is building a product to calculate employee pay. The team has worked together to create a Fit document that includes some examples of how hourly pay should be calculated.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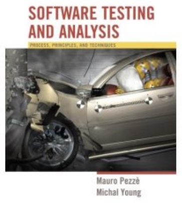
Basic Employee Compensation

For each week, hourly employees are paid a standard wage per hour for the first 40 hours worked, 1.5 times their wage for each hour after the first 40 hours, and 2 times their wage for each hour worked on Sundays and holidays.

Here are some typical examples of this:

Payroll.Fixtures.WeeklyCompensation			
StandardHours	HolidayHours	Wage	Pay()
40	0	20	$800
45	0	20	$950
48	8	20	$1360 *expected* $1040 *actual*



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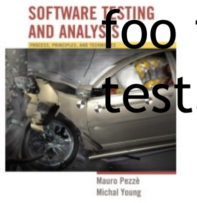
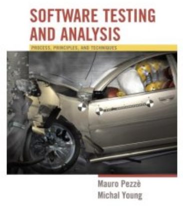
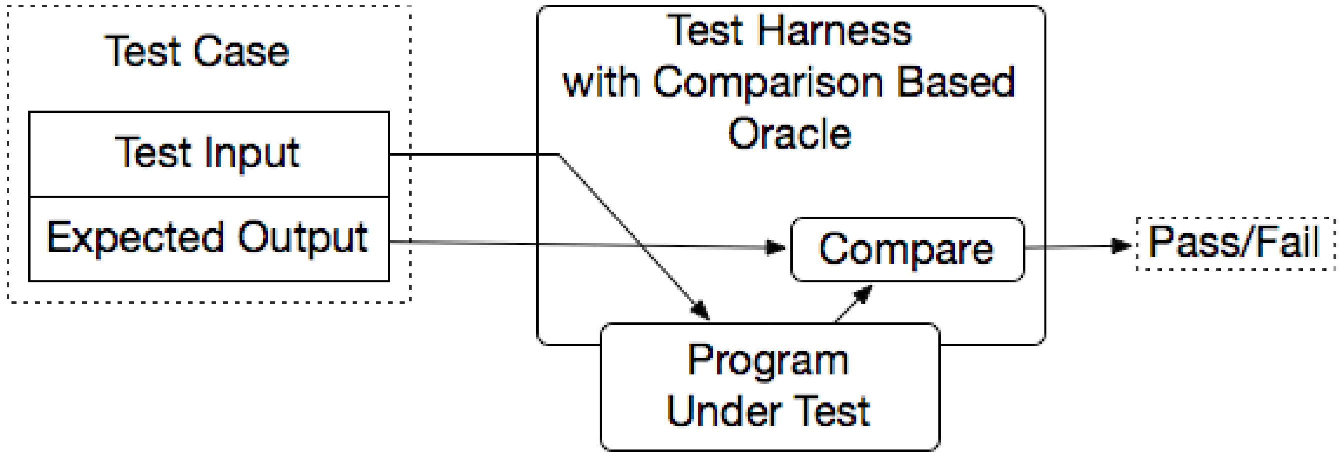


Oracles

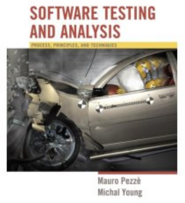
- Did this test case succeed, or fail?
  - No use running 10,000 test cases automatically if the results must be checked by hand!
- Range of specific to general, again
  - ex. JUnit: Specific oracle (“assert”) coded by hand in each test case
  - Typical approach: “comparison-based” oracle with predicted output value
  - Not the only approach!



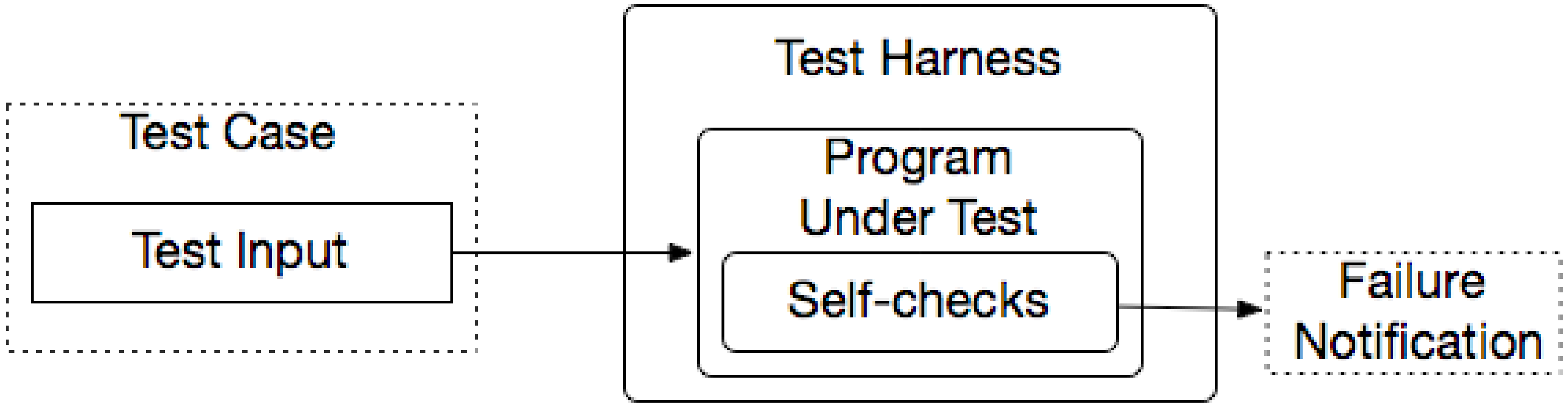
Comparison-based oracle



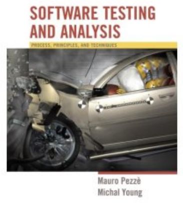
- With a comparison-based oracle, we need predicted output for each input
  - Oracle compares actual to predicted output, and reports failure if they differ
- Fine for a small number of hand-generated test cases
  - E.g., for hand-written JUnit test cases



Self-Checking Code as Oracle



- An oracle can also be written as *self-checks*
  - Often possible to judge correctness without predicting results
- Advantages and limits: Usable with large, automatically generated test suites, but often only a *partial* check
  - e.g., structural invariants of data structures
  - recognize *many* or *most* failures, but not all



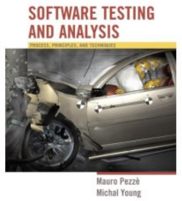
Oracle examples

Comparison-based

- Use assertion as in Junit
- assertEquals(x,y)

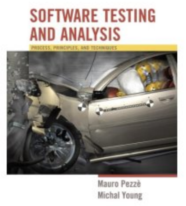
Self-Checking codes

- Use assertion in Java (part of the language)
- assert (s != null)
- ....



Capture and Replay

- Sometimes there is no alternative to human input and observation
  - Even if we separate testing program functionality from GUI, some testing of the GUI is required
- We can at least cut *repetition* of human testing
- *Capture* a manually run test case, *replay* it automatically
  - with a comparison-based test oracle: behavior same as previously accepted behavior
    - reusable only until a program change invalidates it
    - lifetime depends on abstraction level of input and output

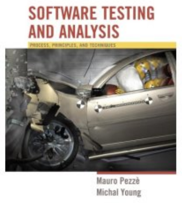


The Tester's Web Automation Tool

Esempio

- Record and playback any web application. Recording saves time and helps non-technical users contribute to automation.
- The Sahi Controller helps easily identify and experiment with elements on any browser.
- The same script works on all browsers.

```
_click(_link("Login"));
_setValue(_textbox("username"), $usr);
_setValue(_password("password"), $pwd);
_click(_submit("Login"));
```



Summary

- Goal: Separate creative task of test design from mechanical task of test execution
  - Enable generation and execution of large test suites
  - Re-execute test suites frequently (e.g., nightly or after each program change)
- Scaffolding: Code to support development and testing
  - Test drivers, stubs, harness, including oracles
  - Ranging from individual, hand-written test case drivers to automatic generation and testing of large test suites
  - Capture/replay where human interaction is required