JUnit exercise

Given a `Date` class with the following methods:

```
- public Date(int year, int month, int day)
- public Date()                          // today
- public int getDay(), getMonth(), getYear()
- public void addDays(int days)    // advances by days
- public int daysInMonth()
- public String dayOfWeek()        // e.g. "Sunday"
- public boolean equals(Object o)
- public boolean isLeapYear()
- public void nextDay()            // advances by 1 day
- public String toString()
```

- Come up with unit tests to check the following:
  - That no `Date` object can ever get into an invalid state.
  - That the `addDays` method works properly.
    - It should be efficient enough to add 1,000,000 days in a call.

Test-Driven Development (TDD)

- Imagine that we'd like to add a method `subtractWeeks` to our Date class, that shifts this Date backward in time by the given number of weeks.

- Write code to test this method *before* it has been written.
  - This way, once we do implement the method, we'll know whether it works.

Black and white box testing

What is the difference between black- and white-box testing?

- **black-box** (procedural) **test**: Written without knowledge of how the class under test is implemented.
  - focuses on input/output of each component or call

- **white-box** (structural) **test**: Written with knowledge of the implementation of the code under test.
  - focuses on internal states of objects and code
  - focuses on trying to cover all code paths/statements
  - requires internal knowledge of the component to craft input
    - example: knowing that the internal data structure for a spreadsheet uses 256 rows/columns, test with 255 or 257

Black-box testing

- black-box is based on requirements and functionality, not code
- tester may have actually seen the code before ("gray box")
  - but doesn't look at it while constructing the tests
- often done from the end user or OO client's perspective
- emphasis on parameters, inputs/outputs (and their validity)

Types of black-box

- requirements based
- positive/negative - checks both good/bad results
- boundary value analysis
- decision tables
- equivalence partitioning - group related inputs/outputs
- state-based - based on object state diagrams
- compatibility testing
- user documentation testing
- domain testing

Boundary and Equivalence testing

- **boundary value analysis**: Testing conditions on bounds between classes of inputs.

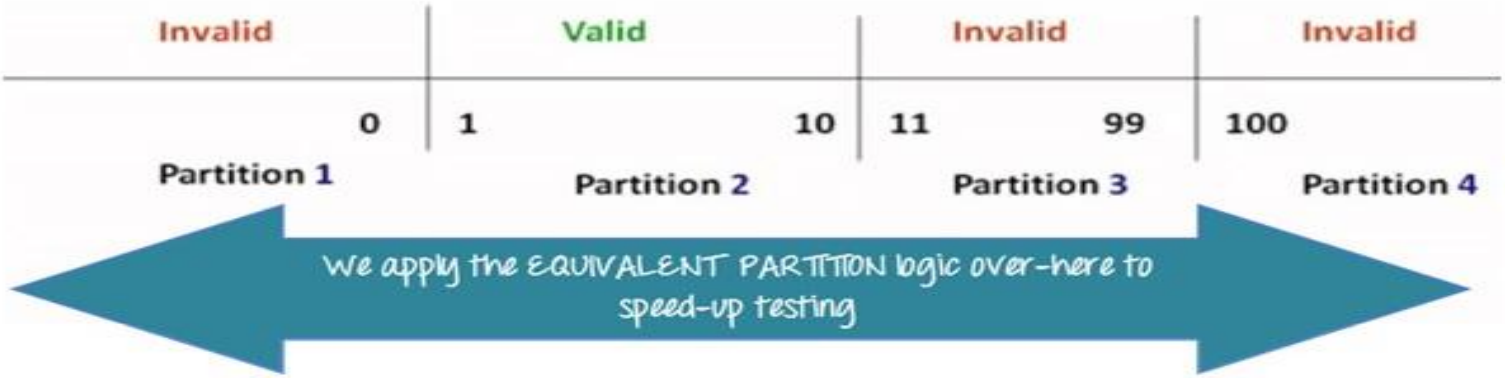
- **equivalence partitioning**:
  - A black-box test technique to reduce # of required test cases.

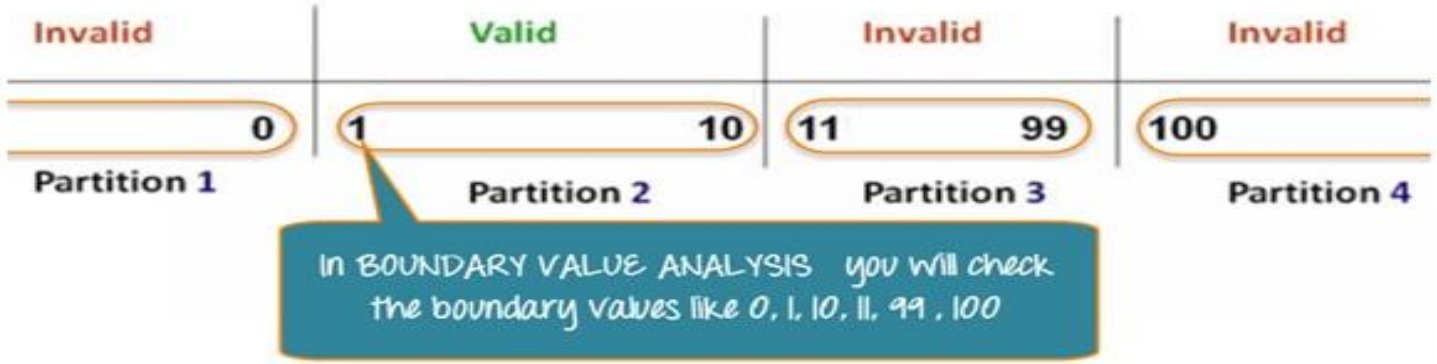
Example

- Let's consider the behavior of Order Pizza Text Box Below
- Pizza values 1 to 10 is considered valid. A success message is shown.
- While value 11 to 99 are considered invalid for order and an error message will appear, **"Only 10 Pizza can be ordered"**

Here is the test condition

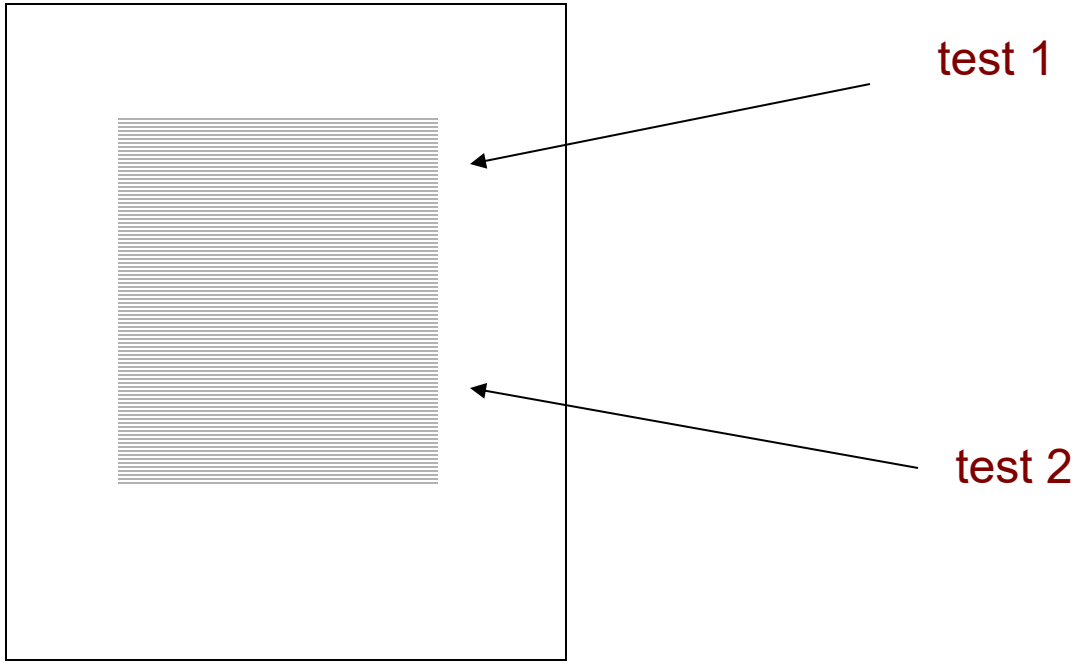
1. Any Number greater than 10 entered in the Order Pizza field(let say 11) is considered invalid.
2. Any Number less than 1 that is 0 or below, then it is considered invalid.
3. Numbers 1 to 10 are considered valid
4. Any 3 Digit Number say -100 is invalid.


Invalid
Valid
Invalid
Invalid
0
1
10
11
99
100
Partition 1
Partition 2
Partition 3
Partition 4
We apply the EQUIVALENT PARTITION logic over-here to speed-up testing


Invalid
Valid
Invalid
Invalid
0
1
10
11
99
100
Partition 1
Partition 2
Partition 3
Partition 4
In BOUNDARY VALUE ANALYSIS you will check the boundary values like 0, 1, 10, 11, 99 , 100

White box tests

Based on code

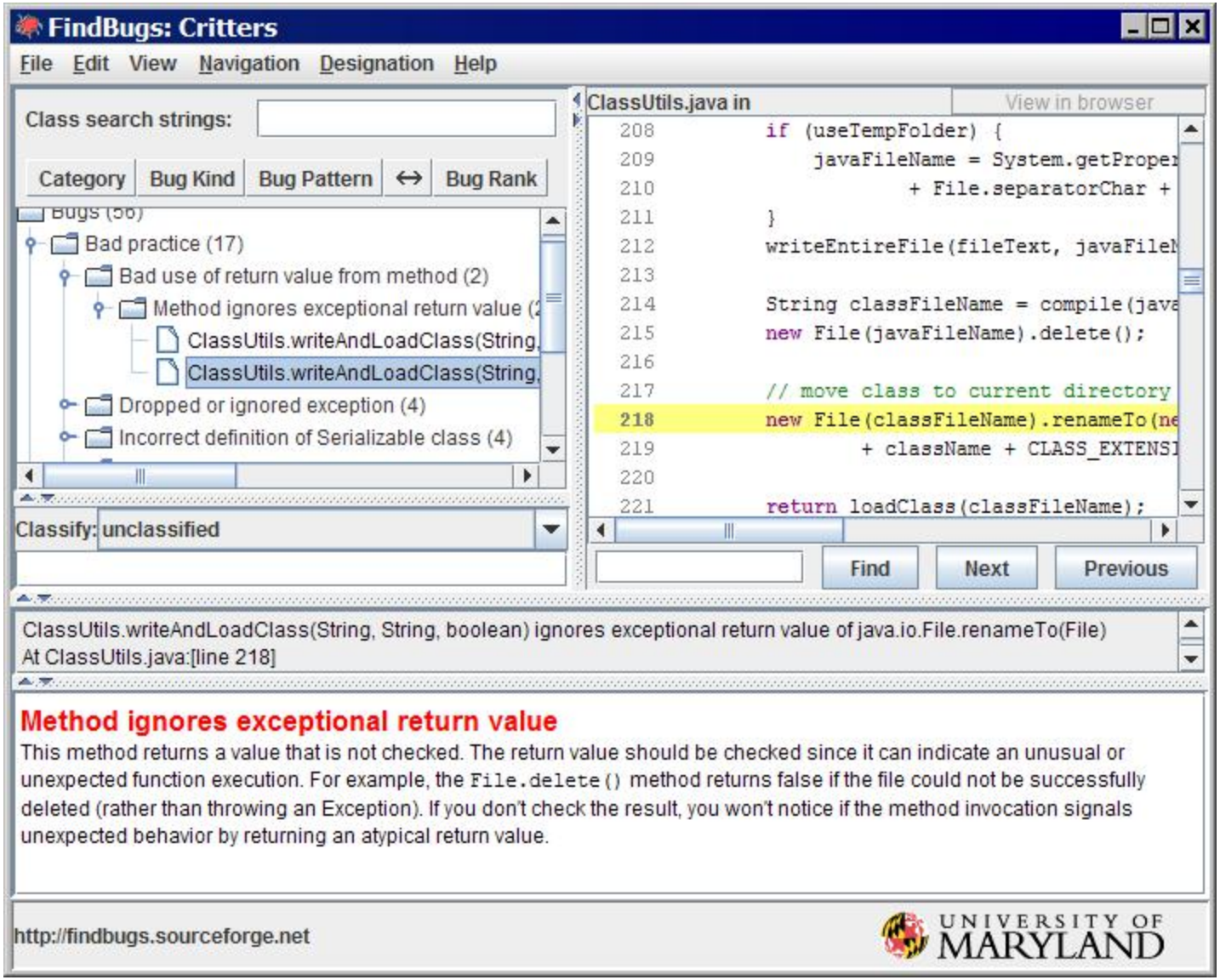


White-box testing

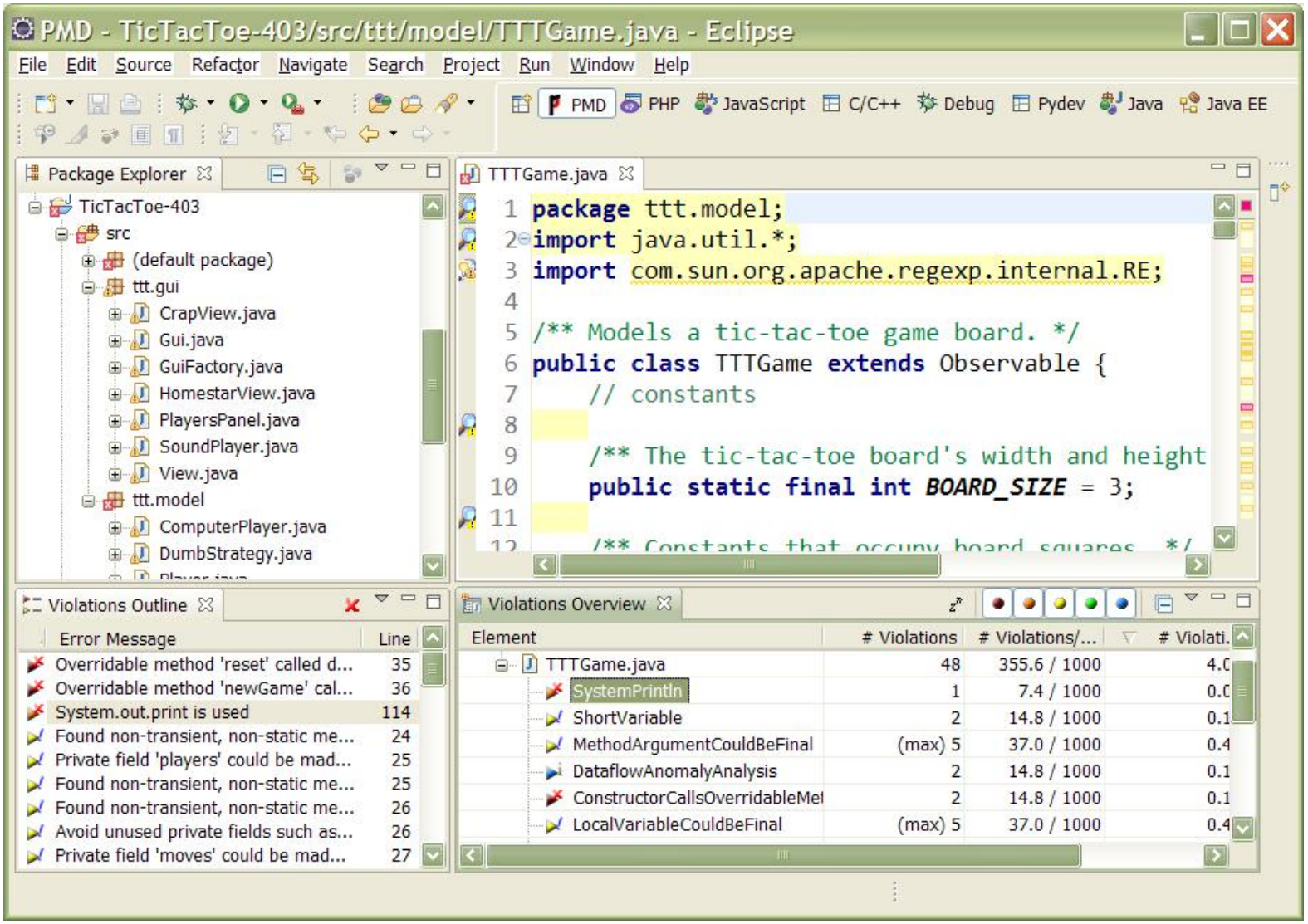
Some kinds of white box testing don't involve unit tests:

- "static testing"
  - code walkthroughs, inspections, code reviews
  - static analysis tools
    - Lint (and variants) — JiveLint, JLint, PMD, CheckR, JSLint, `php -l`
    - CheckStyle — http://checkstyle.sourceforge.net/
    - FindBugs — http://findbugs.sourceforge.net/
  - code complexity analysis tools
    - PMD, CheckStyle, etc.

Static analysis example



Complexity analysis



Testing measures (white box)

- Code coverage – individual modules
- Path coverage – sequence diagrams
- Code coverage based on complexity – test of the risks, tricky part of code (e.g., Unix "you are not expected to understand this" code)

Code coverage testing

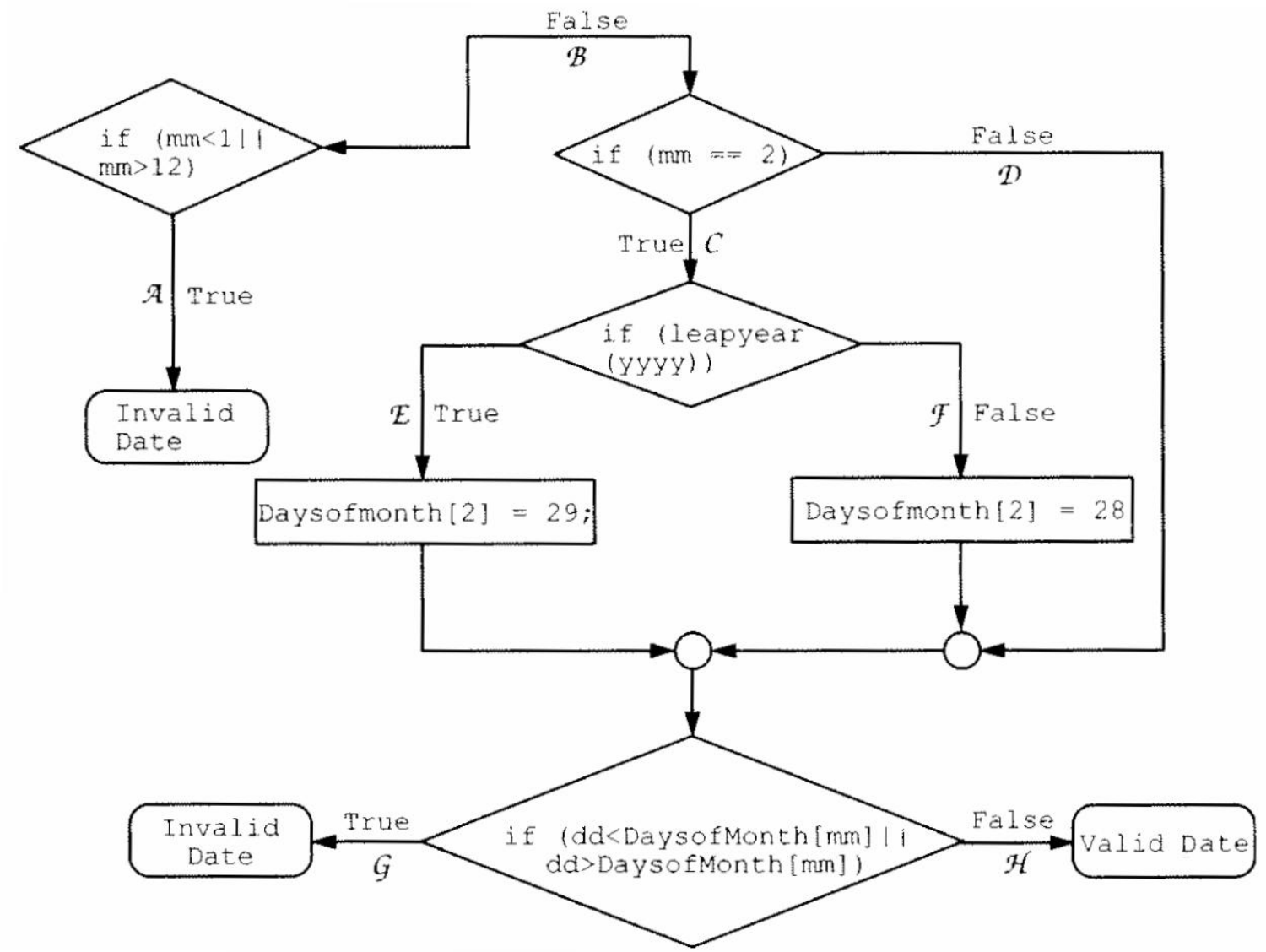
- **code coverage testing**: Examines what fraction of the code under test is reached by existing unit tests.
  - statement coverage - tries to reach every line (impractical)
  - path coverage - follow every distinct branch through code
  - condition coverage - every condition that leads to a branch
  - function coverage - treat every behavior / end goal separately

- Several nice tools exist for checking code coverage
  - EclEmma, Cobertura, Hansel, NoUnit, CoView ...

Path testing

- **path testing**: an attempt to use test input that will pass once over each path in the code
  - path testing is *white* box
  - What would be path testing for daysInMonth(month, year)?
    some ideas:
    - error input: year < 1, month < 1, month > 12
    - one month from [1, 3, 5, 7, 10, 12]
    - one month from [4, 6, 9, 11]
    - month 2
      - in a leap year, not in a leap year

Path coverage example



White box testing is hard

- Developers can't easily spot flaws in their own code.
- Test cases that are too focused on code may not be thinking about how the class is actually going to be used.
- Code coverage tools can give a false sense of security.
  - Just because code is "covered" doesn't mean it is free of bugs.
- Code complexity can be misleading.
  - Complex code is not always bad code.
  - Complexity analysis tools can be overly picky or cumbersome.