Groundwork for Understanding Analysis and Test

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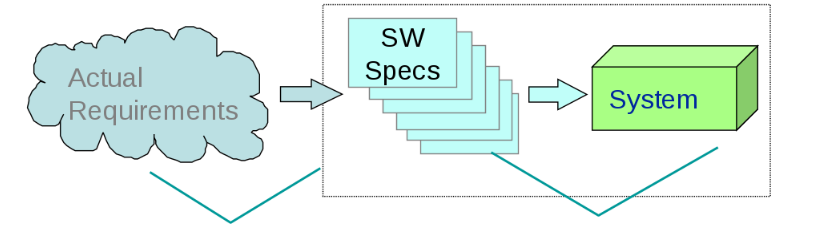
- Validation: does the software system meets the user’s real needs?
  - are we building the right software?
- Verification: does the software system meets the requirements specifications?
  - are we building the software right?

Verification and Validation



Validation
(of the requirements)
Includes usability testing, user feedback

Verification
(of the design)
Includes testing, inspections, static analysis

Verification or Validation Depends on the Specification

Example: Elevator Response Time

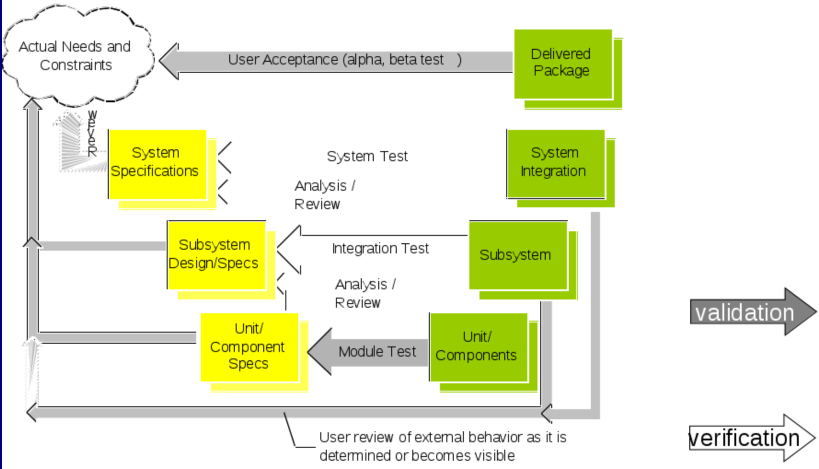
Unverifiable (but validatable) spec:

If a user presses a request button at floor 1, and available elevator must arrive at floor 1 soon

Verifiable Spec

If a user presses a request button at floor 1, an available elevator must arrive at floor 1 within 30 seconds.

Verification and Validation



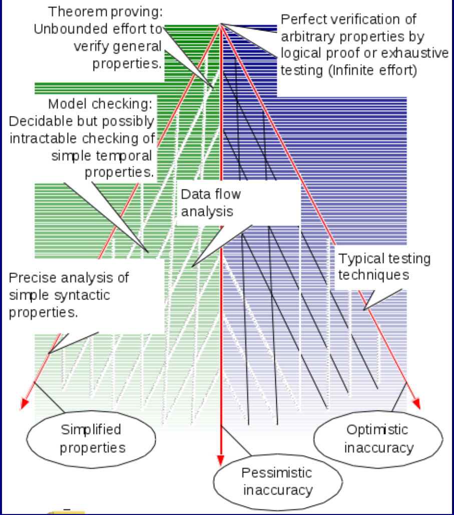
Correctness

- Correctness properties are undecidable
- The halting problem can be embedded in almost every property of interest.

Halting Problem

Wolfram: The determination of whether a Turing machine will come to a halt given a particular input program. The halting problem is solvable for machines with less than four states. ... The problem of whether a general Turing machine halts is undecidable, as first proved by Turing.

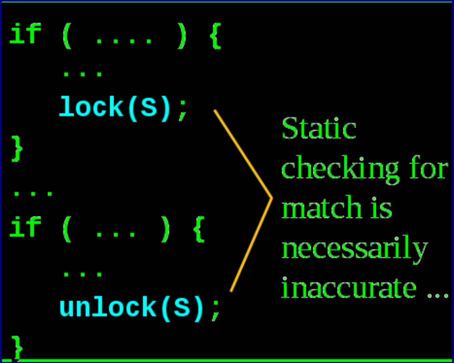
Quality Trade-offs


Theorem proving: Unbounded effort to verify general properties.
Perfect verification of arbitrary properties by logical proof or exhaustive testing (Infinite effort)
Model checking: Decidable but possibly intractable checking of simple temporal properties.
Data flow analysis
Typical testing techniques
Precise analysis of simple syntactic properties.
Simplified properties
Pessimistic inaccuracy
Optimistic inaccuracy

- Optimistic inaccuracy: we may accept some programs that do not possess the property (i.e., it may not detect all violations).
  - testing
- Pessimistic inaccuracy: it is not guaranteed to accept a program even if the program does possess the property being analyzed
  - Automated program analysis techniques
- Simplified properties: reduce the degree of freedom for simplifying the property to check

Simplified Property: Unmatched Semaphore Operations

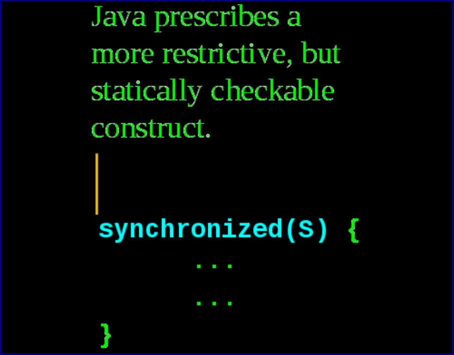
Original Problem



```
if ( .... ) {
   ...
   lock(S);
}
...
if ( ... ) {
   ...
   unlock(S);
}
```

Static checking for match is necessarily inaccurate ...

Simplified Property



Java prescribes a more restrictive, but statically checkable construct.

```
synchronized(S) {
      ...
      ...
}
```

Chapter 2

Choose and complete any two Chapter 2 Exercises (pg 25-27)
Due in the dropbox by January 23, 2014 2359