Assert early and assert often

Practical hints on effective asserting

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... and more tomorrow

- Accuracy of program analysis
- Test case generation/prioritisation
- Post-mortem dump-cracking
- Concurrency safety
- Validation of security
- Programming language design

Benefits of assertions today...

- Test probes
- Program documentation
- Interface specification
- Code optimisation
- Defect tracking
- Reduction of noise from analysis
- Hardening of retail code

Engineering test probes

- Analogy: engine on a test bench
- Instrumented at internal interfaces
- To test tolerances continuously
- And avoid test to destruction
- Opportunity to improve quality by tightening the tolerances

Macros

```
#ifdef DEBUG
#define CHECK(b,str) {
  if (b) { }
  else {report (str);
    assert (false)} }
#else #define CHECK(b,str)
#endif
```

Explanations

- CHECK( assertion, “reason why I think the assertion is true”)
- Otherwise it’s easy to forget.
- Helps both writer and reader.
- Pinpoints risk of similar errors
- Helps to avoid them in future
Other variants

• VSASSERT Visual Studio
• MsoAssert Office
• Debug.Assert C#
• ...

Assumptions

• Used only during early test
SIMPLIFYING_ASSUMPTION
(strlen(input) < MAX_PATH, "not yet checking for overflow")
• Failure indicates test was irrelevant
• Prohibited in ship code

Documentation

• Protection for system against future changes

```c
if (a >= b) { .. a++ ; .. }
...
CHECK(a != b, 'a has just been incremented to avoid equality');
x = c/(a - b)
```

Compile-time

• #define COMPILE_TIME_CHECK (b)
extern dummy[(b)?1:-1]

• Generates report at compile time

• COMPILER_TIME_CHECK (sizeof(x) == sizeof(y), 'addition undefined for arrays of different sizes)

Invariants

• True of every object ...
• ...before and after every method call
• bool invariant ( )
  {...tests that list is circular...}

Invariants

• Integrity checking
• Software audits
• Post-mortem dump-cracking.
Interface assertions

- Useful to implementer and all users
- Used again on each release
- Reduce need to examine code
- Aid the unit test of each module
- Permit modular analysis and proof

Preconditions

void insert(node *n){
    PRECONDITION ( n != NULL &&
    invariant(), 'don’t insert a
    non-existent object');
    SIMPLIFYING-ASSUMPTION
    (find(n) == 0);
    ...
}

Post-conditions

    POST_CONDITION ( find(n) &&
    invariant(), 'the inserted
    object will be found in the
    list')
}

- obligation on method writer to verify

Optimisation

switch (condition) {
    case 0: ... ; break;
    case 1: ... ; break;
    default: UNREACHABLE('condition
    is really a boolean');}

- Compiler emits less code

Defect tracking

- Office Watson keys defects by assertions

- Integrates with RAID data base

- Identifies bugs across builds/releases

- Integral to the programming process

PREFIX_ASSUME

- Reduces PREFIX noise

    pointer = find (something);
    PREFIX_ASSUME ( pointer != NULL,
    "see the insertion three lines back");
    ... pointer ->mumble = blat ...

Rugged code in retail

- VSASSERT assertions are ignored
- VsVerifyThrow ... generate exception
- VsVerify ... user chooses

Life of an assertion

- Design discussions: record decisions
- Project planning: interface contracts
- Test planning: harness design
- Test case selection: violate post-conditions
- Coding: correctness concerns
- Prototyping: simplifying assumptions

... continued

- In later release: detect regression
- Defect tracking: fault classification
- In retail: crash-proofing
- Defect analysis: dump-cracking
- Evolution of legacy: documentation

Conclusion

Assert early,
assert often,
and assert more strongly every time.

Apologies to...

"Vote early, vote often"
is the Politishun's golden rule.

Josh Billings
American humorist, 1816-85.

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