

Advanced Software Testing

Testing Code with Static Analysis



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Advanced Software Testing

- ❖ A series of webinars, this one excerpted from *Advanced Software Testing: V3*, a book for technical test analysts, programmers, and test engineers
- ❖ Black box techniques are useful for checking behavior
- ❖ White box techniques are useful for checking code coverage
- ❖ Static analysis allows us to scrutinize the code to look directly for defects



Static Analysis and Dynamic Testing

- ⊕ Like dynamic testing, static analysis looks for defects in software source code and software models
- ⊕ Unlike dynamic testing, static analysis is performed without actually executing the system
- ⊕ Static analysis involves analysis of the system or its components by a tool, while dynamic testing does not always involve tools
- ⊕ Static analysis can find defects that are hard to find or isolate in dynamic testing
 - ⊞ Examples include maintainability issues, unsafe pointer use
 - ⊞ Isolation is easier because you find the bug, not the symptom



What Can We Analyze?

- ⊕ Program code (e.g. control flow and data flow)
- ⊕ Models of the program (e.g., simulations)
- ⊕ Generated output such as HTML and XML
- ⊕ Requirements and design documents



Benefits of Static Analysis

- ⊕ Early and cheaper detection of bugs (before test execution starts)
- ⊕ Warnings about where bug clusters might exist, due to dangerous programming, high complexity, etc.
- ⊕ Location of bugs dynamic testing might miss
- ⊕ Detection of dependencies and inconsistencies in software models (e.g., such as link problems in Web pages)
- ⊕ Improved maintainability of code and design
- ⊕ Prevention of defects based on metrics gathered and lessons learned from analysis



Typical Static Analysis Bugs

- ⊕ Referencing a variable with an undefined value
- ⊕ Inconsistent interface between modules and components
- ⊕ Variables that are never used
- ⊕ Missing or wrong logic
- ⊕ Excessive complexity
- ⊕ Unreachable (dead) code
- ⊕ Programming standards violations
- ⊕ Security vulnerabilities
- ⊕ Syntax violations of code and software models



Using Static Analysis Tools

- ❖ Typical users are...
 - ❖ Programmers, often during unit and integration testing
 - ❖ Designers and system architects during design
- ❖ During initial introduction against an existing system, static analysis tools may produce a large number of warning messages
- ❖ Compilers do some static analysis, but many sophisticated tools are available

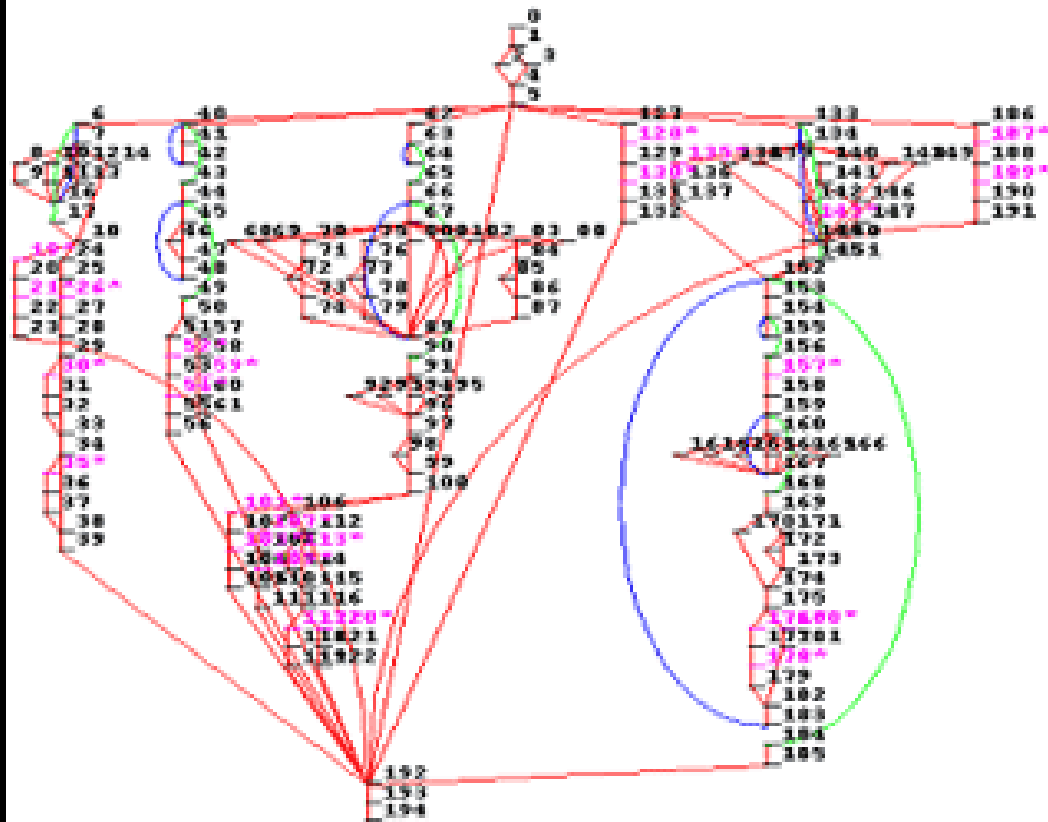
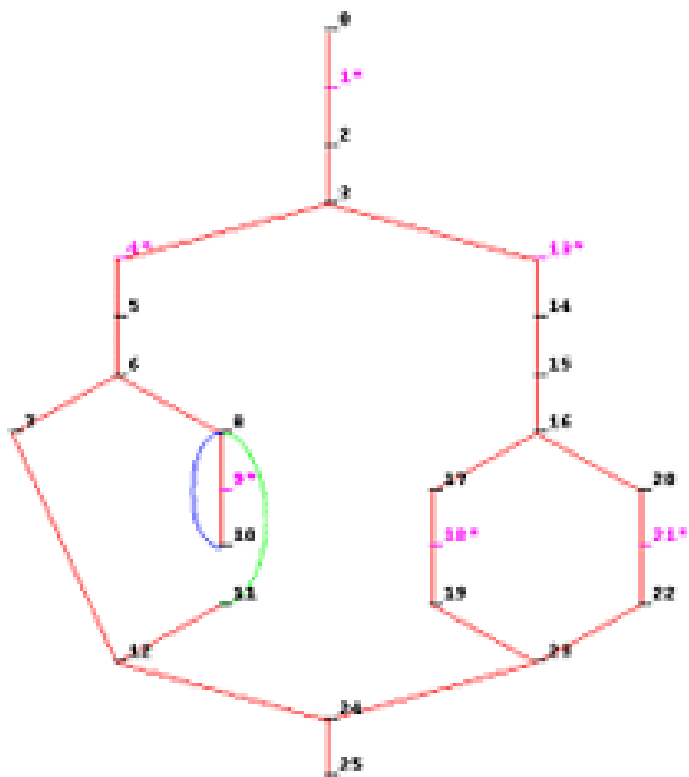


Static Analysis vs. Dynamic Analysis

- ✚ We can test code by executing it (dynamic testing)
- ✚ There are other ways to find defects :
 - ✚ Reviews: people find the bugs
 - ✚ Static analysis: specific methods and tools are applied to the code, looking for a number of different defects and anomalies without actually executing the code, using a tool
 - ✚ Dynamic analysis: using tools to look for failures and anomalies in conjunction with executing the code



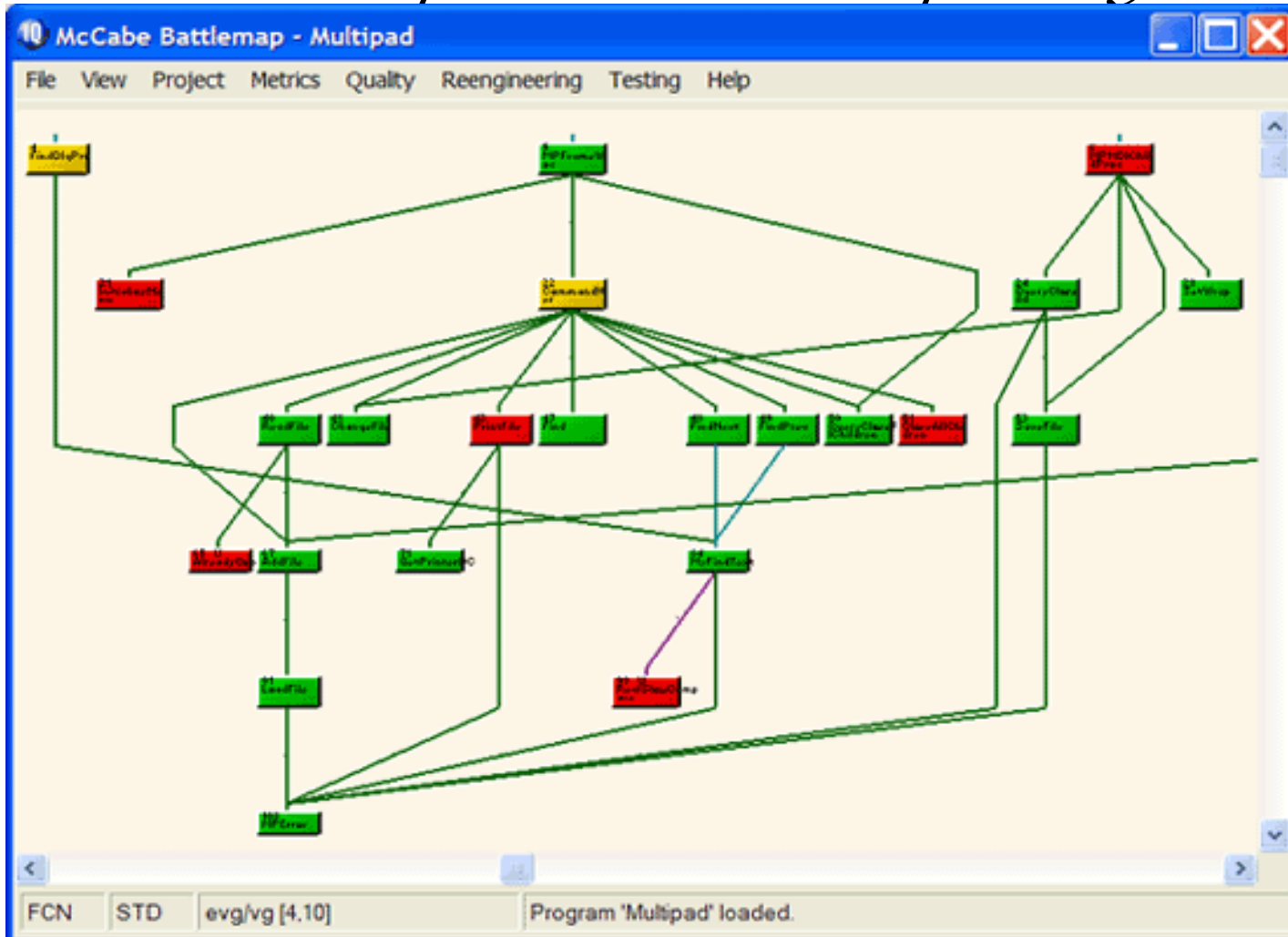
Example: Complexity Analysis



Simple Code vs. Complex Code



Example: Call Complexity





Example: Code Parsing Tools

```
#include <stdio.h>
int main () {
    char c;
    while (c != 'x'); {
        c = getchar();
        if (c = 'x') return 0;
        switch (c) {
            case '\n':
            case '\r':
                printf("Newline\n");
            default:
                printf("%c",c);
        }
    }
    return 0; }
```

Output of **Splint**, an open source static analysis tool

1. Variable c used before definition
2. Suspected infinite loop. No value used in loop test (c) is
3. Assignment of int to char: c = getchar()
4. Test expression for if is assignment expression: c = 'x'
5. Test expression for if not Boolean, type char: c = 'x'
6. Fall through case (no preceding break)



Example: Checkstyle Capabilities

- ⊕ Check for Javadoc comments for classes, attributes and methods
- ⊕ Enforce naming conventions of attributes and methods
- ⊕ Check cyclomatic complexity against a specified limit
- ⊕ Check for the presence of mandatory headers
- ⊕ Check for magic numbers
- ⊕ Check whitespaces between specific characters
- ⊕ Enforce good practices of class construction
- ⊕ Check for duplicated code sections
- ⊕ Check for visibility problems *-- Wikipedia*



Conclusion

- ❖ In this webinar, we've seen how to apply static analysis to find defects in code without running the system
- ❖ In our previous webinars, we looked at various behavior-based test techniques
- ❖ Static analysis allows us to use tools to evaluate the quality of the code directly
- ❖ Static analysis of code can find many defects cheaply and early in the lifecycle



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