Testing Software with QuickCheck

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1 Introduction

This lecture features a guest speaker, John Hughes, a professor at Chalmers University and co-designer of Haskell. He discusses the challenges of software testing and introduces QuickCheck, a tool for property-based testing.

2 The Challenge of Testing

Testing is often viewed as a tedious necessity rather than an enjoyable task. John highlights several reasons why testing is difficult:

- For n features, writing 3 or 4 tests per feature results in $O(n)$ work.
- Bugs often arise from interactions between features, leading to $O(n^2)$ test cases for pairwise testing.
- Some bugs only appear under specific conditions, such as race conditions, complicating the testing process.

3 QuickCheck: An Overview

QuickCheck allows developers to generate tests automatically rather than writing them manually. It works by:

- Generating random sequences of operations for the API under test.
- Shrinking failing test cases to minimal examples that still provoke the failure.

3.1 Example: Circular Buffer

John demonstrates QuickCheck using a circular buffer implemented in C. He shows how to test the buffer by:

- Inserting values and checking the size.
- Observing failures and using shrinking to simplify the test case.

4 Practical Applications

John shares experiences from his company, Cubic, where they use QuickCheck in industry to find bugs. He discusses a project involving the outer SA basic software for Volvo cars, where they tested vendor implementations against a standard.

4.1 Finding Bugs in Complex Systems

One notable bug involved message priorities in a CAN bus system. The bug was traced back to a failure to mask bits correctly when comparing priorities. QuickCheck helped identify this issue by generating tests that revealed the problem.

5 Testing Race Conditions

John explains how to test for race conditions using a ticket dispenser example. He emphasizes the importance of recognizing correct outputs when operations are performed in parallel. QuickCheck can identify race conditions by checking if the observed outputs can be explained by the model.

5.1 Case Study: Klarna

John recounts his work with Klarna, where he helped identify bugs in their database system, debts. By using QuickCheck, he was able to find critical bugs that had previously caused system failures. The shrinking feature of QuickCheck allowed him to simplify complex test cases, making it easier to diagnose issues.

6 Conclusion

John concludes by emphasizing the effectiveness of property-based testing with QuickCheck. He encourages developers to generate tests rather than writing them manually, as this approach can uncover more bugs with less effort.

7 Questions and Discussion

The lecture ends with a Q&A session, where John addresses questions about the effectiveness of shrinking and the financial impact of finding bugs in industry.