Graph matrix technique in white-box testing method

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Abstract: This thesis presents a systematic investigation into the application of graph matrix techniques within white-box testing methodologies. White-box testing, which relies on the internal structure of source code, often faces challenges in managing test coverage and path complexity. This study formalizes the representation of program control flow using directed graphs and their corresponding adjacency and reachability matrices. By leveraging matrix algebra, we propose a novel framework for automating the generation of basis paths and calculating cyclomatic complexity. The research demonstrates how matrix operations can efficiently identify linearly independent paths, thereby optimizing test case selection without sacrificing coverage criteria such as statement, branch, and path coverage. Experimental results on several benchmark programs indicate that the graph matrix approach significantly reduces computational overhead compared to traditional traversal algorithms. Furthermore, the method enhances traceability between code structure and test requirements. The findings suggest that integrating graph matrices into white-box testing tools can improve both the rigor and automation of structural testing, offering a robust mathematical foundation for quality assurance in software engineering.

Keywords: Graph matrix, White-box testing, Control flow graph, Structural testing