Using evolutionary algorithms to select parameters from equivalence classes

Felix Lindlar and Abel Marrero Pérez

Daimler Center for Automotive
Information Technology Innovations
Technische Universität Berlin, Germany
{felix.lindlar,abel.marrero}@dcaiti.com

Abstract. This paper presents some ideas about an approach which aims at extending existing methodologies for functional testing. Experience in automotive applications has shown that when selecting parameters for functional testing, many times a tester has equivalence classes in mind. Instead of losing valuable information in the process, support should be given to make them manageable. The proposed approach suggests evolutionary testing strategies to search for critical representatives within equivalence classes.

Keywords. equivalence classes, evolutionary testing, functional testing, automotive industry

1 Introduction

Modern vehicles rely to an increasing degree on safety-critical systems containing software. A few years ago the malfunction of a software system in a car may have led to the failure of a simple function only. Nowadays this could impose a safety thread to passengers. Embedded control in automotive applications is usually implemented as a distributed set of microcontrollers, called electronic control units (ECUs).

Functions of these controllers depend on each other and are often implemented by different teams or even companies. Integration of software and hardware as well as testing different configurations has become a major issue in automotive system engineering. Conventional manual implementation and testing of software often results in a higher error rate, because not all interdependencies are understood. New methodologies like Model-based techniques can help to overcome this situation.

The focus of this paper is the field of functional testing which serves the purpose of providing confidence in the correct implementation of requirements. Functional tests – usually considered a subcategory of black box tests – do not take the structure of test objects into account. Instead, test cases are derived from the functional requirements specification. A test with all possible input data configurations is called a complete test. Since performing a complete test is too

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time consuming, alternative strategies are usually applied. A common strategy is dividing the domain of each parameter into equivalence classes.

An equivalence class is a range of values for that a tester expects the testing object to show the same output behavior. Defining correct equivalence classes is critical to a successful test suite, errors might otherwise remain undetected. Selection of the actual parameters for the test cases is normally done ad-hoc, based on experience or by performing boundary value analysis. Problems occur when different values within the expected equivalence classes lead to different output behavior. In that case the equivalence classes were chosen incorrectly or imprecisely and the possibility of the test uncovering errors decreases.

Automotive systems often contain elements from the field of control engineering. The unique characteristics of those systems tend to produce faults which are very difficult to foresee and are most likely to be detected by observing the output behavior. Manual test parameter selection may thus be an unacceptable risk of leaving errors undetected.

The proposed approach aims at tackling the problem of selecting appropriate test parameters out of equivalence classes. More confidence can be gained by systematically searching the equivalence classes for interesting test cases and exposing errors rather than selecting samples manually. A major advantage of the systematic method is the higher level of abstraction, since concrete test parameters are selected automatically.

Search automation can be achieved by using evolutionary algorithms. The effectiveness of using evolutionary algorithms for systematic testing has been demonstrated in several cases [1]. The search space for the evolutionary optimization is manageable due to confinements of equivalence classes. A great improvement in quality of the test suite and at the same time a decrease in cost can be achieved.

2 Future Work

Further research will include setting up an environment in order to perform experiments. Thorough case studies with real world industry examples are required to prove the usefulness of the proposed method. Emphasis will be put on the design of the fitness function and manageability of the complexity of the search space.

References

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