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Model based Testing using Evolutionary Approaches

Thesis summary

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Abstract

Increasing the safety of software controlled systems represents a very important stage in the software development process. Software testing aims to detect errors by simulating the system using selected inputs and monitoring the outputs produced. The test scenarios can be derived using certain criteria, since there can be a large amount of possible test scenarios. This thesis presents various methods for model based testing from different types of modelling approaches.

First, we investigate the application of evolutionary-based testing from **EFSMs**. There are currently many approaches developed in this area, but only a few methods use evolutionary algorithms for test suite generation. We proposed several algorithms for test cases generation. We presented three search-based approaches for transition paths generation. All three methods use the same feasibility metric. Since the test selection strategies differ, the resulting paths will cover different cases. In the first case, we minimize the feasibility metric so that the paths obtain will be not only feasible, but the input values needed to trigger each path will also be easier to find. We also consider the transition coverage as a second objective. The two objectives, combined with the shortening operator, will lead the search towards sets of paths that are very easy to execute. The second and the third method use the feasibility metric to guide the search to find complex paths. The second method only searches for one solution, using a single-objective Hybrid GA. The third method uses the multi-objective algorithm NSGA-III, searching for complex set of paths based on the transition coverage criterion, dependences among transitions and similarities between paths. The proposed input data generation algorithm uses a hybrid genetic algorithm (HGA), combining global search (genetic algorithms) and local search techniques. The optimization consists in reducing the number of evolutions and increases the success rate for the genetic algorithm without increasing the number of fitness function computations. A two steps algorithm was obtain by combining the methods for transition coverage sets generation and an improved version of the HGA used for input values generation. To evaluate the effectiveness of the proposed testing methods, we ran experiments on different EFSM models.

In order to develop new testing methodologies for **Cyber Physical Systems**, we investigated the use of search-based approaches in this area. We developed a new search-based testing approach using a Genetic Algorithm to generate test cases for continuous

controllers at the MiL level, discretizing the search space. After designing the requirements of the system under test, we add different functions that measure the satisfiability of the requirements to a simulation environment. The test data algorithm uses the simulation to compute the fitness function and to guide the search to the solution. We illustrate our approach on a cruise control system for a hybrid propulsion bicycle (e-Bike) case study.

There are many evolutionary testing approaches that generate test data from code, finite state machines and other models, but there are no developments in this respect in **membrane computing**. We introduce a testing approach for a special class of kP systems (kP systems that behave similarly to EFSMs), using genetic algorithms to generate test data that lead to a given set of computation steps.