EvoTest, Evolutionary Testing for Complex Systems

Complex systems exhibit emergent behaviour which makes them hard to predict. This presents particularly challenging problems during testing. However, this is a challenge that simply cannot be avoided: testing is a vital part of the quality assurance process. With important partners from Spain (ITI), UK (Kings College, Motorola), France (Motorola, INRIA), Germany (Fraunhofer, DaimlerChrysler), Bulgaria (RILA) and Greece (European Dynamics), EvoTest aims to attack the problem of testing complex systems using evolutionary algorithms.

EvoTest addresses a fundamental problem European software industry is facing: quality assurance of complex software systems. It does so by combining various visions of the IST programme: a multidisciplinary approach to evolving, adaptive and automated testing as a solution to some of the challenges of mastering complexity in software development. This will be achieved by the development, application and evaluation of Evolutionary Testing techniques. Evolutionary Testing is an exciting, novel, nature-inspired solution, which transforms testing into an optimization problem. This allows the problem to be attacked using techniques inspired by Darwinian evolution. To increase the test efficiency for complex systems EvoTest will develop an Automated Evolutionary Testing Framework. This framework will enable fully automatic generation of high quality test cases with high error detection probability. Automation is widely regarded as the key to test efficiency.

EvoTest, Why?

There is strong empirical evidence that deficient testing of both functional and non-functional properties is one of the major sources of software and system errors.

Even though many test automation tools are currently available to aid test planning and control as well as test case execution and monitoring, all these tools share a similar passive philosophy towards test case design, selection of test data and test evaluation. They leave these crucial, time-consuming and demanding activities to the human tester. This is not without reason; test case design and test evaluation are difficult to automate with the techniques available in current industrial practice. The domain of possible inputs (potential test cases), even for a trivial program, is typically too large to be exhaustively explored. One of
the major challenges associated with test case design is the selection of test cases that are effective at finding flaws without requiring an excessive number of tests to be carried out. This is the problem which EvoTest directly attacks.

**EvoTest, What and How?**

The impossibility of anticipating or testing all possible uses and behaviours of a (complex) system suggests a prominent role for Evolutionary Testing, because it relies on very few assumptions about the underlying problem it is attempting to solve. In addition, stochastic optimisation and search techniques are adaptive and, therefore, able to modify their behaviour when faced with new unforeseen situations. These two properties make evolutionary testing approaches ideal for handling complex systems. To achieve the EvoTest objectives:

- EvoTest will develop Evolutionary Testing techniques for more thorough testing.
- These Evolutionary Testing techniques will be applied to solve testing problems for real-world complex systems. The results will be evaluated for functional testing, safety testing, robustness testing, structural testing, etc. The selection of the testing problems to be addressed will be lead by the needs of the industrial partners in EvoTest.
- To improve the power of evolutionary algorithms for searching test scenarios, they will be hybridised with other techniques, either other general-purpose search techniques, or domain-specific methods especially suited for testing.
- To increase the performance and the quality of the Evolutionary Testing, the techniques will be combined with other software engineering techniques, such as slicing and program transformation. These advanced software engineering techniques will be tailored to both reduce the size of the search space and to transform the search space.
- An extensible and open Automated Evolutionary Testing Architecture and Framework will be developed. This will provide general components and interfaces to facilitate the automatic generation, execution, monitoring and evaluation of effective test scenarios.
- The applicability of the Evolutionary Testing Framework will be improved through a user interface which hides the underlying evolutionary computation. This allows software engineers to use the Framework without requiring knowledge of evolutionary computation. This will widen uptake of the EvoTest approach.
- The EvoTest tools and techniques will be rigorously evaluated using real world case studies from the automotive and telecommunications industries.

The EvoTest project is highly timely in seeking to build upon the lead enjoyed by European science, technology and industry in evolutionary testing and in applying this to the real problems of testing complex systems.

**EvoTest, Who?**

The EvoTest project brings together, not merely European leaders in this emerging field, but world leaders. **ITI** (Spain) is project coordinator and research partner providing expertise in software testing and evolutionary computation. Moreover, ITI acts as software developer, implementing various components of the Framework. **INRIA** (France) serves as research partner providing expertise in evolutionary computation. **Fraunhofer FIRST** (Germany) is a research partner providing expertise in software development, technology, validation and verification. **Kings College** (United Kingdom) is a research partner providing expertise in software engineering techniques like slicing and program transformations. **DaimlerChrysler** (Germany) is a case study provider of a complex automotive application. Moreover, they serve as research partner contributing expertise on evolutionary testing. **Motorola** (United Kingdom and France) is a case study provider of telecoms application. Moreover, they contribute experience on reliability analysis and defect models to guide the evolutionary search and to assess the results. **Rila** (Bulgaria) is a case study provider of a complex accessibility solution. Moreover, RILA acts as a software developer. **European Dynamics** (Greece) is a technology provider and software developer.