Comparing TorX, Autolink, TGV and UIO Test Algorithms

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Abstract. This paper presents a comparison of four algorithms for test derivation: TorX, TGV, Autolink and UIO algorithms. The algorithms are classified according to the detection power of their conformance relations. Because Autolink does not have an explicit conformance relation, a conformance relation is reconstructed for it. The experimental results obtained by applying TorX, Autolink, UIO and TGV to the Conference Protocol case study are consistent with the theoretical results of this paper.

1 Introduction

There are several algorithms for test generation using different techniques. From a user point of view (having to select one of them for use) it is interesting to know what the possibilities and limits of these algorithms are.

Possibly the most used algorithm in this area is Autolink (part of the commercial tool TAU/Telelogic [15]) which uses SDL–92 specifications [3] and MSC–92 test purposes [4] for deriving tests. Another technique for test generation is realized in the UIO and UIOv methods ([2]) on which different tools are based (for example the Phact tool used inside of Philips [6]). We can also enumerate other famous algorithms such as TGV developed at IRISA/INRIA Rennes and Verimag Grenoble ([9]) and TorX ([16]), which is the test generation algorithm of the CdR (*Côte–de– Resyste*) project: a project in the area of automatic test derivation formed by Dutch research groups from industry and universities.

One pioneering effort in the direction of comparing the test generations algorithms was done inside the CdR project: the first year of the project was devoted to realizing a benchmarking between the performances of the four algorithms mentioned above ([4,5,9]).

Because the comparison was made by practical experiments, we found it necessary to complete it by doing research for classifying the four algorithms from a theoretical point of view. For researchers acquainted with the different approaches to automated test derivation, the results of the research presented here may seen straightforward. However, due to the fact that the different schools use different notations, we think that the mere act of expressing these methods

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in the same framework is already worthwhile. Another interesting finding of our research is that Autolink does not have an explicit conformance relation. So our work, in which a conformance relation is reconstructed for this algorithm, consolidates the conformance foundation of it. Moreover, our theoretical classification of the four algorithms is consistent with the classification that resulted from the practical experiment. The theory presented in this paper is quite general because it treats a set of test generation algorithms that are well known and come from a large range of domains: academia, commercial, industry.

In our comparison, we judge the error detection power of the algorithms as a function of the conformance relation which they implement. Because two algorithms (TGV and TorX) from four use the *ioco* theory as their formal foundations, we expressed the conformance relations of all algorithms in terms of *ioco* theory (considering that it is the most general one for all of them).

The algorithms are judged in the limit case when they exhaustively generate a large number of tests (as an approximation of an infinite set). In the limit, they can detect only the erroneous implementations which their conformance relation can detect.

The comparison is presented in the paper in the following way:

- Section 2 gives a summary of the *ioco* theory; in this summary TorX and its properties are also described;
- the next sections are dedicated to one algorithm each: Section 3 for TGV, Section 4 for UIO (UIOv) algorithms and Section 5 for Autolink;
- Section 6 describes the conclusions of our research.

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2 The Ioco Theory for Test Derivation (TorX)

The TorX test generation algorithm is at the heart of the TorX architecture. The algorithm has a sound theoretical base, known as the *ioco* theory. Below, we will give a brief summary of this theory. For a full description of the *ioco* theory see [16].

In this theory the behaviours of the implementation system (physical, real object) are tested by using the specification system (mathematical model of the system). The behaviours of these systems are modelled by labelled transition systems. A labelled transition system is defined as follows.

Definition 1. *A labelled transition system is a quadruple* $\langle S, L, \rightarrow, s_0 \rangle$*, where* S *is a (countable) non empty set of states;* L *is a (countable) non empty set of observable actions;* $\rightarrow \subseteq S \times (L \cup \{\tau\}) \times S$ *is a set of transitions;* $s_0 \in S$ *is the initial state.*

The universe of labelled transition systems over L is denoted by $\mathcal{LTS}(L)$. A labelled transition system is represented in a standard way as a graph or by a process–algebraic behaviour expression.