Abstract.

Although a great deal of research has been done in the area of formal methods and their practical use for the specification and verification of software systems, testing issues are very seldom mentioned by those within the formal methods community. All too often, formal methods and testing are regarded as mutually exclusive in the development of software systems.

The aim of this thesis is to investigate from a theoretical point of view the use of Eilenberg's X-machines both as a basis for a specification language and a theory of testing. Some theoretical issues regarding the use of X-machines as a specification method (i.e. minimality, refinement) are investigated and addressed and a testing method based on this model is developed.

The second chapter of the thesis surveys the main existing computational models and introduces the X-machines as a natural generalisation of these models. Two natural subclasses of X-machines (namely straight-move stream X-machines and stream X-machines) are defined and discussed from two points of views: how general they are as specification tools and to what extent they can provide a basis for a theoretical testing method.

The rest of the thesis concentrates on the stream X-machine model. This is investigated further in the third chapter. Two simple operations (i.e. sequential and parallel composition) that can be performed on stream X-machines are defined. Also, two types of stream X-machine minimality are defined and discussed.

The fourth chapter is concerned with testing. First, we survey the main existing testing methods and highlight their limitations. Then we present our testing method in which the test cases are derived from the stream X-machine specification. The applicability of the method is discussed. The method is illustrated with a case study.

If stream X-machines are to be useful as a specification tool, there needs to be a way to develop existing machines into more complex and detailed versions, without having to start anew with each modification. The fifth chapter defines a stream X-machine refinement as a way of developing stream X-machine specifications gradually. This is illustrated with a case study. A testing for refinement method is also given.