

Part II

Algorithms for Solving FSM Equations: BALM

The first part of this book presented the theory of language equations for synchronous composition. The theory was developed with several objectives in mind:

- Generalize and unify several known approaches to solve the unknown component problem within the framework of solving language equations.
- Provide a uniform method for expressing several classes of practical problems.
- Enable an efficient software implementation to explore the limits of practical applications.
- Provide a platform on which new algorithms can be developed and tested.

In Part II, we focus on the efficient implementation aspects of this work. A software system was developed, BALM, the Berkeley Automata and Language Manipulation system, based on the multi-valued logic synthesis environment, MVSIS [46]. Both software packages and their documentation are available from the Download Software link on the web site of the UC Berkeley MVSIS: Logic Synthesis and Verification Group [52]. When implementing the theory, we had the following objectives:

- To validate the theory as well as to refine it during its development when counter-examples showed that some conjectures did not hold.
- To solve some practical problems by making the implementation as efficient as possible.
- To facilitate instruction about finite automata, by developing a generic finite automata calculator supported by the ability to graphically display example results.

BALM utilizes the programming environment of MVSIS as much as possible.¹ The implementation was organized as a set of modules to facilitate porting, reuse in other applications, and ease of maintenance and extension. Multiple implementations of

¹An environment with multi-valued variables was chosen because such variables enable easier specification of automata or FSMs and, at the same time, facilitate debugging.

some of the basic algorithms allow comparative studies. BALM is intended to be used in two modes:

- As a black box, where a user invokes a synthesis script (an automatic sequence of high-level commands to BALM) to solve a given problem. In-depth knowledge of the underlying implementation details is not required.
- As a white box, where BALM is used as a platform that can be programmed for other applications dealing with finite automata and FSMs. Detailed knowledge about programming with MVSIS/BALM is required.

In Chap. 6, we describe some aspects of the implementation of BALM to aid the second type of user. Chap. 7 details how a particularly efficient implementation can be done if (a) the languages are represented initially as deterministic sequential circuits, and (b) the solution is required as an FSM language. Chap. 8 is a summary of how BALM can be used as a black box for a user who wants to try BALM on examples. Chap. 9 illustrates how BALM can be used as an educational tool to show the results of some of the basic automata operations.