

## A SEMIRING-SEMIMODULE GENERALIZATION OF $\omega$ -REGULAR LANGUAGES II<sup>1</sup>

ZOLTÁN ÉSIK<sup>2</sup>

*University of Szeged and Rovira i Virgili University*  
*e-mail: ze@inf.u-szeged.hu*

and

WERNER KUICH<sup>3</sup>

*Technische Universität Wien*  
*e-mail: kuich@tuwien.ac.at*

### ABSTRACT

This paper continues the algebraic theory of Ésik, Kuich [9] on semiring-semimodule pairs and quemirings that is applicable to languages that contain finite and infinite words. The main advantage is that we get rid of the idempotency assumption for the semimodule needed at several places in Ésik, Kuich [9].

Additionally, we consider linear systems as a generalization of rightlinear grammars. Moreover, we develop an algorithm that constructs, for a given finite automaton, an equivalent one without  $\varepsilon$ -moves.

### 1. Introduction

We extend the algebraic theory of Ésik, Kuich [9] on semiring-module pairs and quemirings that is applicable to languages that contain finite and infinite words. We consider the same finite automata as in Ésik, Kuich [9] but define their behavior in a different way. This yields the following result: *If  $(S, V)$  is a complete semiring-module pair and  $\mathfrak{A}$  is a finite  $S'$ -automaton then  $||\mathfrak{A}|| = F + I$ , where  $F$  is the sum of the weights of all finite paths from an initial state to a final state multiplied by the initial and final weights of these states and where  $I$  is the sum of the weights of all infinite paths starting at an initial state, passing infinitely often through repeated states, and multiplied by the initial weight of this initial state.*

---

<sup>1</sup>Full version of a submission presented at the Workshop on *Weighted Automata: Theory and Applications* (Dresden University of Technology, Germany, June 1–5, 2004).

<sup>2</sup>Partially supported by the National Foundation of Hungary for Scientific Research and Aktion Österreich-Ungarn, Wissenschafts- und Erziehungskooperation, Projekt 60ÖU12.

<sup>3</sup>Partially supported by Aktion Österreich-Ungarn, Wissenschafts- und Erziehungskooperation, Projekt 60ÖU12.