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Paul Surer

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Substitutions, coding prescriptions and integer representation

Paul Surer

*Institut für Mathematik, Universität für Bodenkultur (BOKU),
Gregor-Mendel-Straße 33, 1180 Wien, Austria*

Abstract

Coding prescriptions are combinatorial objects linked to a substitution, that is a morphism of the free monoid. Originally they have been introduced in order to code the induced symbolic dynamical system. In the present article we are interested in coding prescriptions of compositions and powers of substitutions. This will provide a very general framework for representing integers. We will study the properties and find several relations with well-known systems of integer numeration.

Keywords: substitutions, integer representation, combinatorics on words
2010 MSC: 11A63, 68R15, 11B39

1. Introduction

We are interested in combinatorial aspects of morphisms of the free monoid, so-called substitutions. More precisely, we study coding prescriptions. Quickly explained, for a substitution σ over an alphabet \mathcal{A} , a coding prescription with respect to σ is given by a complete residue system modulo the length of $\sigma(x)$ for each letter x contained in the alphabet \mathcal{A} . These combinatorial objects have been introduced in [8] in order to relate the dynamical system induced by a primitive substitution with shifts of finite type.

In the actual research we associate a finite directed graph with a coding prescription. This will allow us to define a binary operation for coding prescriptions that is compatible with the composition of substitutions. It will turn out that the finite paths of a given length n of this graph correspond to coding prescriptions with respect to the n th powers of the substitution. In the principal result of the article we use the theory to represent integers by finite paths on the associated graph generalising the result of Dumont and Thomas in [1].

The main ingredient of our paper is combinatorics on words. Contrarily to related articles as [1] (that focus on the free monoid over \mathcal{A}) we consider the free

Email address: paul@surer.at (Paul Surer)
URL: <http://www.palovsky.com> (Paul Surer)

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