

## Some Combinatorial Operators in Language Theory

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### ABSTRACT

Multitildes are regular operators that were introduced by Caron *et al.* in order to increase the number of Glushkov automata. In this paper, we study the family of the multitilde operators from an algebraic point of view using the notion of operad. This leads to a combinatorial description of already known results as well as new results on compositions, actions and enumerations.

*Keywords:* Operads, Automata, Regular expressions, Enumeration

### 1. Introduction

Regular expressions have been studied from several years since they have numerous applications: pattern matching, compilation, verification, bio-informatics *etc.*. From a well known result (Kleene [10]), regular languages can be represented by both automata and regular expressions. From an expression, it is possible to compute an automaton whose number of states is a linear function of the alphabetical width (*i.e.* the number of occurrences of alphabet symbols) [16, 9, 1, 5]. In the opposite direction, there exists no construction providing the linearity. For instance, Ehrenfeucht and Zeiger [7] showed a one parameter family of automata whose shortest equivalent regular expressions have a width exponentially growing with the numbers of states. However this property occurs when the automaton is the Glushkov automaton of an