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# Pseudoknot-Generating Operation<sup>☆</sup>

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## Abstract

A pseudoknot is a crucial intra-molecular structure formed primarily in RNA strands and closely related to important biological processes. This motivates us to define an operation that generates all pseudoknots from a given sequence and consider algorithmic and language theoretic properties of the operation. We design an efficient algorithm that decides whether or not a given string is a pseudoknot of a regular language  $L$ . Our algorithm runs in linear time if  $L$  is given by a deterministic finite automaton. We study closure and decision properties of the pseudoknot-generating operation. For DNA encoding applications, pseudoknot structures are undesirable. We give polynomial-time algorithms that check whether or not a regular language  $L$  contains a pseudoknot or a pseudoknot generated by some string of  $L$ . Furthermore, we show that the corresponding questions for context-free languages are undecidable.

*Keywords:* pseudoknots, pseudoknot-generating operation, closure and decision properties, formal languages

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## 1. Introduction

A ribonucleic acid (RNA) consists of four base types Adenine ( $A$ ), Uracil ( $U$ ), Guanine ( $G$ ) and Cytosine ( $C$ ), and has hydrogen bonds with the

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