

## DEPENDENCY RELATIONS BETWEEN ELEMENTARY INTRAMOLECULAR OPERATIONS IN GENE ASSEMBLY IN CILIATES

ION PETRE AND VLADIMIR ROGOJIN

*Computational Biomodelling Laboratory, Turku Centre for Computer Science, and  
Department of Information Technologies, Åbo Akademi University,  
Turku 20520 Finland  
e-mail: ipetre@abo.fi, vrogojin@abo.fi*

### ABSTRACT

The intramolecular model of gene assembly in ciliates postulates three folding-recombination operations over a single DNA molecule. Those operations are suggested to assemble a macronuclear contiguous gene from its shuffled and inverted micronuclear fragments. The elementary intramolecular model only considers folds containing at most one micronuclear gene fragment. We investigate in this paper the following general question: what micronuclear gene patterns can be assembled by elementary intramolecular operations? Currently a number of efficient solutions exists for micronuclear gene patterns without inverted gene fragments. Going towards an efficient solution for the general question, we investigate in this paper the order relation between elementary intramolecular operations within assembly strategies applicable to gene patterns with inverted fragments.

*Keywords:* gene assembly in ciliates, intramolecular operations, elementary operations, dependency graphs, signed permutations, sorting

### 1. Introduction

Research on gene assembly in ciliates concerns complex manipulation and transformation process of DNA during the sexual activity of conjugation in ciliate organisms [1, 2, 3, 6, 7, 8, 11, 13, 14]. This DNA manipulation process in ciliates is of high interest both for biologists, as well as for computer scientists due to its strong computational flavour. One can interpret the gene assembly in ciliates as a data unscrambling process in terms of sorting linked lists structures [2]. Gene assembly in ciliates has been studied intensively in recent years both regarding its molecular details as well as the theoretical implications of a number of its mathematical and computational models, see [16] for a recent review.

For the reference on biology of ciliates and especially on their gene assembly process during sexual conjugation we refer to [2]. We restrict our attention to ciliates of the subclass *Stichotrichia* for which the features briefly discussed in the following are especially pronounced.