Combinatorics of Genome Rearrangements

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Preface

In 1984, at a congress in Paris, François Jacob, one of the most famous evolutionary scientists, stated that "La molécule de l'hérédité est raboutée, modifiée, coupée, rallongée, raccourcie, retournée" (the molecule of heredity is sewed together, modified, cut, lengthened, shortened, reversed) during evolution. From one cell to another, one individual to another, one species to another, the content of the DNA molecules is often similar, but their organization often differs dramatically. The mutations that affect this organization are called *genome rearrangements*, and the structural differences between molecules in two genomes motivate the study of their combinatorics. Indeed, the inference of the evolutionary events that can explain the multiple combinations of observed genomes can often be formalized as combinatorial optimization problems.

The variety of problems that have been raised in this domain is so interesting from a combinatorial point of view that this field has grown and become partly independent of the application, so that it now belongs as much to mathematics as to biology. The mathematics and algorithmics related to genome rearrangements have witnessed a huge expansion over these last years, and this dynamics seems to be continuing at the present time. Due to this success, the field has swallowed other studies that were developed earlier and without biological motivations. For example, many problems about sorting permutations with constraints are now presented as rearrangement problems, without considering the biological relevance of the constraint.

Although molecular biology gave birth to it, combinatorics of genome rearrangements is now a mathematical and algorithmic field that has found its own coherence. It has its own important results, many peripheral developments, and its famous open problems. A great interest of this domain is the simplicity of the formulation of the problems, compared to the sometimes great complexity or even nonexistence of solutions. Moreover, the fact that the subject has now been studied for nearly two decades and has been discussed only in specialized research literature motivates both a thorough survey of the topic and an introduction to a broader audience. This book intends to fulfill both goals.