On the Location of Poles of Meromorphic Functions and Its Combinatorial Application

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This project explores the application of complex analysis techniques for solving combinatorial problems, particularly in the context of an enumeration problem in the theory of regular languages, with potential applications in pattern searching, including DNA sequence modeling. A Python program was developed using Cxroots, a numerical algorithm for finding the zeros of analytic functions on a contour, to identify the location of poles of meromorphic functions and extract information about the combinatorial structures they describe. Complex analysis techniques, such as Cauchy's residue theorem and contour integration, were utilized for solving the enumeration problem. Specifically, it answers the question of how many strings of length n a specific regular language has. To illustrate the applications of these methods, they were used for finding a pattern in a text and relating it to DNA sequence modeling. The project demonstrates the effectiveness of using complex analysis techniques for solving combinatorial problems and the ability of generating functions of relating both of these disciplines. The developed Python program provides a valuable tool for extracting information about combinatorial structures. The successful solution of the enumeration problem in the theory of regular languages has potential applications in various fields, including pattern searching in DNA sequences. Further research could lead to broader applications in combinatorial problem-solving in different domains.

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