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A Solution to Graph Coloring Problem Using Genetic Algorithm

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Abstract

INTRODUCTION: The Graph Coloring Problem (GCP) involves coloring the vertices of a graph in such a way that no two adjacent vertices share the same color while using the minimum number of colors possible.
OBJECTIVES: The main objective of the study is While keeping the constraint that no two neighbouring vertices have the same colour, the goal is to reduce the number of colours needed to colour a graph's vertices. It further investigate how various techniques impact the execution time as the number of nodes in the graph increases.
METHODS: In this paper, we propose a novel method of implementing a Genetic Algorithm (GA) to address the GCP.
RESULTS: When the solution is implemented on a highly specified Google Cloud instance, we likewise see a significant increase in performance. The parallel execution on Google Cloud shows significantly faster execution times than both the serial implementation and the parallel execution on a local workstation. This exemplifies the benefits of cloud computing for computational heavy jobs like GCP.
CONCLUSION: This study illustrates that a promising solution to the Graph Coloring Problem is provided by Genetic Algorithms. Although the GA-based approach does not provide an optimal result, it frequently produces excellent approximations in a reasonable length of time for a variety of real-world situations.

Keywords: Genetic Algorithm, serial execution, parallel execution, graph colouring

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1. Introduction

The Graph Coloring Problem (GCP) stands as a fundamental challenge in combinatorial optimization, with applications ranging from scheduling to network design. The Graph Coloring Problem (GCP) involves coloring the vertices of a graph in such a way that no two adjacent vertices share the same color while using the minimum number of colors possible. The GCP is known to be NP-hard, making it a computationally challenging task for large-scale graphs. As there is no known polynomial-time algorithm to solve it exactly. However, there are many heuristic algorithms that can find approximate solutions to the graph coloring problem. To address this complex optimization problem, researchers have explored various heuristic and metaheuristic approaches. One such promising technique is the Genetic Algorithm (GA), inspired by the process of natural selection and evolution. The ability of Genetic algorithms to handle vast search spaces and generating optimal solutions for the problems makes it a best fit for solving combinatorial problems like GCP.
Graph coloring has many applications, including: