Project block 1.3

**AN ATTEMPT TO COMPUTE (BOUNDS ON)**

**THE CHROMATIC NUMBER FOR**

**THE VERTEX COLORING PROBLEM**

Group 1

Submission: *place and date*

Maastricht University

Department of Data Science and Knowledge Engineering

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*Group 1*

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Submission: *place and date*

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**PREFACE**

The report aims at reporting our work on Project 1.1 block 1.3.

**Notation:** p. x, t. y means page x, line y from top. Similarly p. x, b. y means page x, line y from bottom.

**Acknowledgement:** We would like to thank our project supervisor for the chance to make a report about this interesting topic, inspiring talks and the great assistance.

**SUMMARY**

*Problem definition or research question*

- Problem definition: Graph Coloring Problem (or Vertex Coloring Problem).

- Research question: the efficiency of heuristic algorithms on different classes of graphs

*Research method*

- Theoretical and Simulation

*Conclusions and recommendations*

**CONTENTS**

Preface

Summary

List of abbreviations and symbols

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   1. Theoretical
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4. Results
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**CHAPTER 1**

**Introduction**

The graph coloring problem (GCP) is one of the most-studied NP-HARD problems in computer science. Given a graph G = (V;E), the task is to assign a color c <= k to all vertices v in V such that no vertices sharing an edge e in E receive the same color and that the number of used colors, k, is minimal. In the recent years, various heuristic and exact approaches for this problem have been developed. However, all of them seem to have advantages and disadvantages, which highly depend on the concrete instance on which they are applied. Consequently, designing an algorithm which finds on each graph the best coloring is hard or, by analogy to the No Free Lunch theorems, even impossible.

One possibility to achieve a better performance is to predict for each instance the algorithm which achieves the best performance. This task is known as algorithm selection problem: Given a set of algorithms and a set of intrinsic features of a particular instance, select the algorithm which is predicted to show the best performance on that instance.

This thesis investigates the application of machine learning techniques to automatic algorithm selection for the GCP. In addition, it discovers some special hidden structures of the graphs which make the process of computing the chromatic number more efficient.

For this purpose, we first present several specific features of a graph, which can be calculated in polynomial time. Then, we evaluate the performance of 3 state-of-the-art (meta)heuristic algorithms for the GCP based on experimental results on x graphs of y public available instance sets. The results clearly show that none of the algorithms is superior to all others. In addition, we analyze the behavior of these algorithms on classes of instances with certain attributes. The experiments show that for each of these classes, there exists at least one heuristic which performs clearly better than the rest.

**CHAPTER 2**

**Methods**

**2.1 ……Theoretical…………..**

**2.2 ……Simulation………..**

**CHAPTER 3**

**Experiments**

- A comparison on multiple graphs between:

1. The exact algorithm: Backtracking

2. 3 heuristic algorithms: Welsh – Powell algorithm, Recursive Largest First algorithm, Genetic algorithm

- We also experiment on the performance of the Backtracking algorithm on computing the clique number of a graph as a lower bound on it.

**CHAPTER 4**

**Results**

**CHAPTER 5**

**Conclusion**

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**APPENDIX**