A Survey of Graph Coloring Algorithm for Solving Constraint-Bound Problems

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1. Introduction

Graph Coloring is a special aspect of graph labeling where vertices of a graph are colored such that no adjacent vertices have the same color. In solving constraint-bound problems with this technique, the optimal solution is one that has the least number of colors. The Swiss Mathematician Leonhard Euler is considered as the Father of the general Graph theory [1], the theory on which graph coloring is based. This theory has a wide application in Mathematics, Computer Science and other branches of science. This proposal therefore surveys some of the applications of graph coloring by looking at its innovation, variations, and improvements to its algorithmic methods over the years.

2. Project Plan and Objective

I am proposing to start this project by looking at Graph coloring from the perspective of Graph theory, what it is, how it has evolved, it's performance, and how it has been applied to solve problems such as:

- Scheduling of exams in the smallest number of time periods such that no individual is required to participate in two exams simultaneously [2]; this has had many applications in the third world where there is resource constraints in delivering quality education.
- Community detection in social networks. In a social network, graph coloring is used to compute seed vertices that can be expanded to high quality overlapping communities in the network [4];

- Nucleic acid sequence design in biochemical networks: Given a set of nucleic acids, a dependency graph is a graph in which each vertex is a nucleotide and two vertices are connected if the two nucleotides form a base pair in at least one of the nucleic acids. The problem of finding a nucleic acid sequence that is compatible with the set of nucleic acids can be modelled as a graph coloring problem on a dependency graph [3];
- Storage of chemicals on the minimum number of shelves such that no two mutually dangerous chemicals (i.e., dangerous when one is in the presence of the other) are stored on the same shelf [2].

These and many more are areas that graph theory, particularly graph coloring has been used. The aim of this project, therefore, is to survey these implementations, compare their results and then draw a conclusion with respect to its algorithmic performance.

3. Conclusion

Although graph coloring has been around for decades, it is still very much used for solving large-scale problems. This project will help investigate its relevance and performance of its various methods as used in solving these complex problems.

I will be working exclusively on this project as I carry out this survey. At the end of this research – which may take the entire month of April – I hope to have achieved a comprehensive survey of this topic. Not only will this help stakeholders make informed decision when choosing graph coloring for solving problems, it will also show what is possible and the types of problems it can solve.

4. References

[1] Bharathi, S. N. (2017). A Study on Graph Coloring. *International Journal of Scientific & Engineering Research, 8*(5), 20 – 30

[2] Frank Thomson Leighton (1979). A Graph Coloring Algorithm for Large Scheduling Problems. *Journal of Research of the Notional Bureau of Standards 84*(6), 489 – 506

[3] Long Yuan, Lu Qin, Xuemin Lin, Lijun Chang and Wenjie Zhang (2017). Effective and Efficient Dynamic Graph Coloring. PVLDB, 11(3), 338 – 351

[4] F. Moradi, T. Olovsson, and P. Tsigas. A local seed selection algorithm for overlapping community detection. In Proceedings of ASONAM, pages 1–8, 2014.