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Modifying and Solving the Hall-allotment Problem using Graph Coloring and Genetic Algorithm

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Abstract

Graph Coloring plays a major role in day to day life. Graph Coloring is applied in various fields. The intense of the work is to visualize how the Graph Coloring Problem is solved using Genetic Algorithm by reducing the chromatic number using till optimum solution is reached.

Keywords: Chromatic Number, Genetic Algorithm, LaTeX Draw

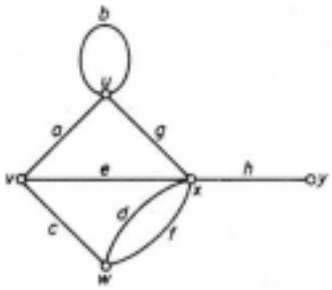
1. Introduction

Various examinations have been conducted in different modes. To reduce the manual efforts, computers are utilizing most of the examinations. This type of exams has been conducted for various grades. So the tragedy occurs while allotting the hall for various branches and also various standards of students. Graph Coloring is used to solve such problems in an easy way. To make this still convenient Genetic Algorithm (GA) is merged with graph coloring[4-8]. So that, huge allotments can be build in a simpler manner.

2. Preliminaries

2.1 Definition: Graph[10]

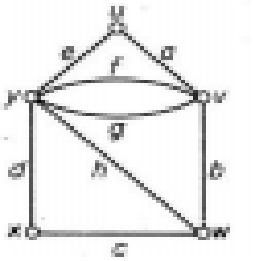
An ordered triple (V(G), E(G), ψ_G) consists of a nonempty set V(G) of vertices, E(G) of edges disjoint from V(G) and an incidence function ψ_G that relates an unordered pair of (not necessarily distinct) vertices with each edge of G.



Example 2.1

2.2 Definition: Finite Graph[1]

A finite graph is a graph with a finite number of vertices.

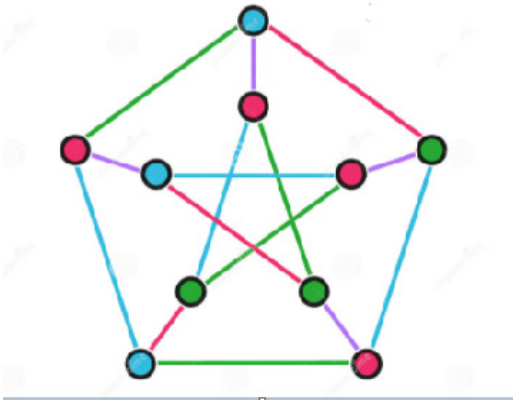


Example 2.2

**Author for correspondence*

2.3 Definition: Graph Coloring[3]

Graph Coloring is an easy way to label graph elements such as vertices, edges and regions according to certain constraints.



Example 2.3

2.4 Definition: Chromatic Number

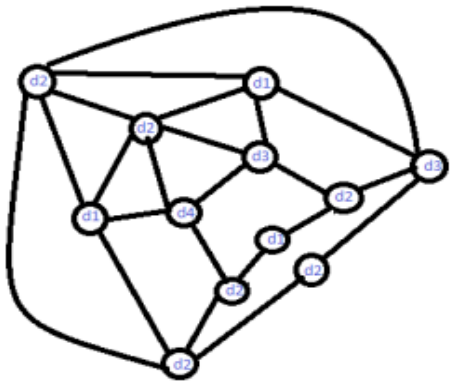
The assignment of k colors to G's vertices in such a way that adjacent vertices receive distinct colors is known as k-coloring[9]. G is said to be k-colorable, if it has k-coloring. The smallest number k for which G is k-colorable is the Chromatic number of G, indicated as $\chi(G)$.

2.5 Definition: Genetic Algorithm

A Genetic Algorithm is a search heuristic based on Charles Darwin's natural evolution hypothesis. This algorithm mimics natural selection in which the fittest individuals are chosen for reproduction in order to create the following generation's children[5,8].

3. Solving Hall Allotment Problem in Graph Coloring using Genetic Algorithm

The hall allotment problem is modulated into a graph coloring problem. Consider the four different branches of students among 12 members. In the CBT the students have to be allotted, but they need not be same branch in their adjacent. Now the problem is converted into a graph coloring problem. Colors represent the examiner who had their branch of students.



3.1 Initialization

The number of colors varies depending on the problem's nature, but it usually includes numerous alternative answers. The beginning colors are frequently generated at random, providing for a wide range of viable solutions. Then the initialization table is shown.

Table 1. Initialization

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
E1	1	0	0	0	0	1	0	0	0	0	0	1
E2	0	1	0	0	1	0	1	0	0	0	0	0
E3	0	0	1	0	0	0	0	1	1	1	0	0
E4	0	0	0	1	0	0	0	0	0	0	1	0

3.2 Selection

Each subsequent generation selects a bit of the present colors to breed a new generation. Individual solutions are chosen based on their fitness with fitter solutions (as assessed by a fitness function) being more likely to be chosen. The fitness function is always problem dependent. In Graph Coloring Problem we minimize the number

Table 2. Selection

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
E1	1	0	0	0	0	1	0	0	0	0	0	1
E2	0	0	1	0	0	0	0	1	1	1	0	0
E3	0	1	0	0	1	0	1	0	0	0	0	0
E4	0	0	0	1	0	0	0	0	0	0	1	0

of colors. Fitness is calculated by the number of colors used. Certain selection methods assess the fitness of each solution and favor the best option. The following is a table of fitness solutions.

3.3 Crossover

Crossover, also known as recombination in Genetic Algorithms is a Genetic Operator that combines the genetic information of two parents to produce new

Table 3. Crossover

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
E1	1	0	0	0	0	1	0	0	0	0	1	0
E2	0	0	0	0	0	0	1	0	1	0	0	1
E3	0	0	1	0	1	0	0	1	0	0	0	0
E4	1	0	0	1	0	0	0	0	0	1	0	0

offspring. Here the crossover point is used in the Graph Coloring problem. Uniform crossover points are used in the problem.

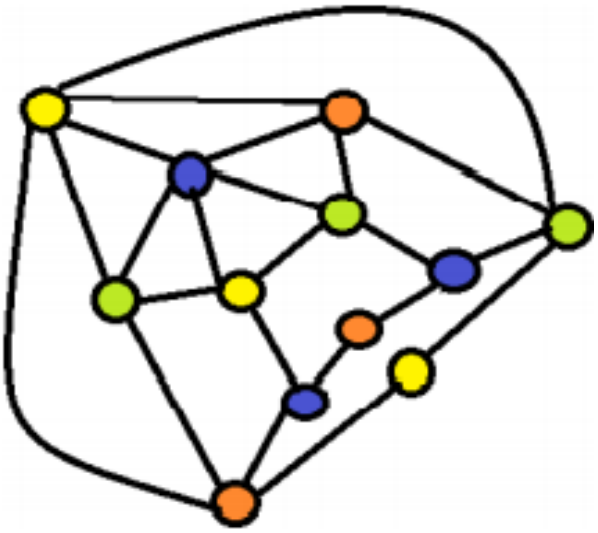
3.4 Mutation

Mutation is a genetic operator that is used to maintain genetic variation in a population of Genetic Algorithm chromosomes from one generation to the next. In the Graph Coloring problem, Uniform Mutation is applied.

Table 4. Mutation

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
E1	0	1	0	1	0	0	0	0	0	0	1	0
E2	1	0	0	0	0	0	1	0	1	0	0	0
E3	0	0	1	0	1	0	0	0	0	0	0	1
E4	0	0	0	0	0	1	0	1	0	1	0	0

This operator selects a uniform random value to replace the value of the chosen 0 or 1. To that 0 or 1, the user set an upper and lower bound. Only Integer and float genes can use this mutation operator, Given below is a table of mutations.



3.5 Evaluate

Again find the fitness of the mutation chromosomes. Then stop if the solution is optimum. It's not an optimum solution. Repeat the process till you get the optimum solution. Now the solution is optimum and all the vertices are colored using the minimum color 4.

4. Conclusion

We conclude in this research that the chromatic number is effectively calculated using the Genetic Algorithm. In this project, we propose a Genetic Algorithm (GA) for Graph Coloring Problem (GCP). We use a binary coding scheme for the first time for GCP. The main variation operator of our GA is the classical crossover operator of the Genetic Algorithm (GA). Due to the nature of the encoding, the generated off springs may become invalid and in that case the off springs are corrected to valid solutions. Then a deterministic improvement technique is applied on the corrected off springs with low probability to locally improve the solution quality. The binary coding makes the local improvement procedure easy. Here we apply the GA in the Hall Allotment problem.

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