Comparative Performance of Ant Colony Optimization with Genetic Algorithm for Graph Coloring Problem

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GROUP 7

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Project Objective

Problem:

Solving Graph coloring problem using Ant Colony Optimization .

Objective:

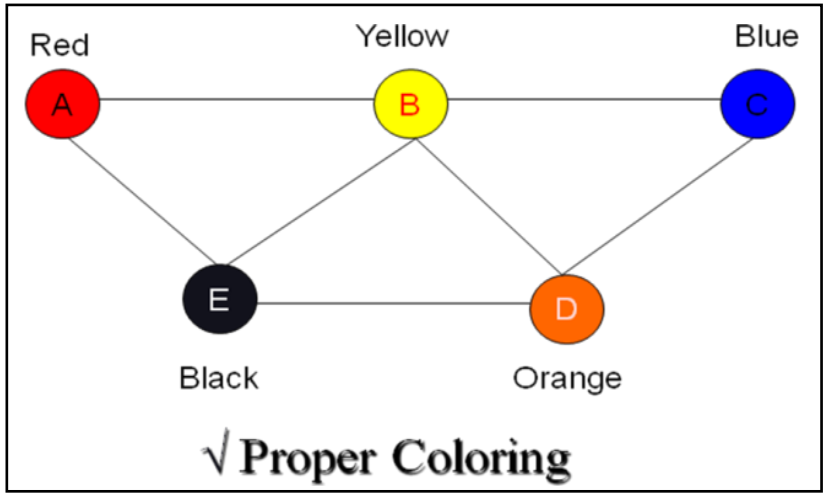
Finding the most optimal chromatic number using Ant Colony Optimization and Comparing CPU time with Genetic Algorithm .

Introduction

Graph coloring is the procedure of assignment of colors to each vertex of a graph G such that no adjacent vertices get same color. The objective is to minimize the number of colors while coloring a graph. The smallest number of colors required to color a graph G is called its chromatic number of that graph. Graph coloring problem is a NP-Complete problem.

Graph Coloring

Graph coloring is the procedure of assignment of colors to each vertex of a graph G such that no adjacent vertices get same color.



Ant Colony Optimization

Ant algorithm was first proposed as a meta-heuristic approach to solving complex optimization problems such as Travelling Salesman Problem (TSP) and Quadratic Assignment Problem (QAP).

Ant's behaviors biologically inspire ACO algorithms to determine the pheromone-based shortest path between the nest and a food source.

Final solution is achieved by the global cooperation of all the ants through the movement in neighboring states, based on some problem-dependent local information, pheromone trail, and ant's private information.

Methodology

The following methods used:

- ❑ Initialize pheromone values
- ❑ Construct a solution update pheromone locally
- ❑ Update pheromone for best solution

Genetic Algorithm

Genetic Algorithms(GAs) are adaptive heuristic search algorithms that belong to the larger part of evolutionary algorithms.

Genetic algorithms are based on the ideas of natural selection and genetics.

Genetic algorithms simulate the process of natural selection which means those species who can adapt to changes in their environment are able to survive and reproduce and go to next generation. In simple words, they simulate “survival of the fittest” among individual of consecutive generation for solving a problem.

Methodology

The following methods used:

- ❑ Initial population creation
- ❑ Fitness calculation
- ❑ Selection process
- ❑ Crossover
- ❑ Mutation

Read from file

The initial graph is read from a .col file

Data fetched:

- ❑ Number of vertices
- ❑ Number of edges
- ❑ Optimal chromatic number
- ❑ Edges

Steps of ACO

Step 1: Generate Initial regions

Step 2: Initialize pheromone concentration for each region

Step 3: Create a Region to explore

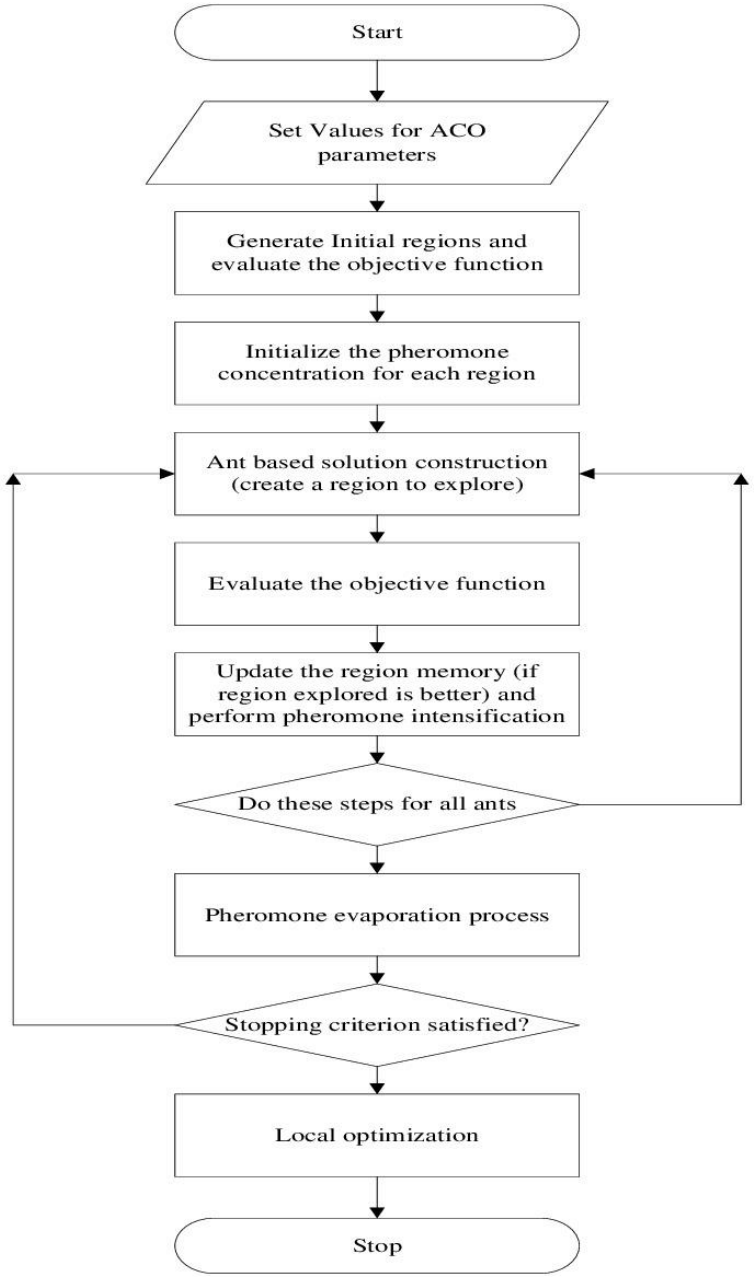
Step 4: Update the region memory if better region found

Step 5: Pheromone evaporation process

GCP using ACO

- Set values for ACO parameters
- Generate Initial regions and evaluate the objective function
- Create a region to explore (Ant based solution construction)
- Evaluate the objective function
- If the region is better update the region memory, perform pheromone intensification and go to step 4.
- Pheromones evaporation process
- Check if stopping criterion is satisfied, if no, go to step 4.
- local optimization
- Stop

Ant Colony Optimization Flow Chart :



Results

Slno.	Graph Instance	Vertex	Edge	Expected Chromatic Number	Chromatic Number Obtained(ACO)	Chromatic Number Obtained (GA)	CPU Time (ACO)	CPU Time (GA)
1.	1-Insertions_4.col	67	232	4	5	5	24.068	28.066
2.	anna.col	138	986	11	11	11	0.000128	0.00347
3.	Myciel4.col	23	71	5	5	5	0.002	0.002
4.	Myciel6.col	95	753	7	7	7	0.0002	0.0002
5.	Queen5_5.col	25	320	5	5	5	0.0005	0.0005
6.	huck.col	74	602	11	11	11	0.000107	0.000647
7.	jean.col	80	508	10	10	10	0.00011	0.01123
8.	queen8_8.col	64	1456	9	10	10	104.727	304.525
9.	queen7_7.col	49	952	7	7	7	0.4216	4.4217

Conclusion

The comparative study and the experimental results both show that the Ant colony optimization approach performs better that the genetic algorithm. For some cases the results are similar but for a majority of the graphs, ACO gives a better optimal solution.

Future Scope

In the future, overcome the limitations of the NP-complete nature of GCP, we mainly focus

on designing one or more heuristic or meta-heuristic evolutionary approaches, we also intend to refine ACO and apply it to optimally color large complex graphs in reasonable time, as well as compare its performance with some other algorithms simulated annealing, Quantum Annealing or may be some hybrid heuristics

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THANK YOU