Assignment 5

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General overview

We have implemented our entire genetic engine from scratch for this assignment , because we had problems with the old one and we didn’t get feasible results from it. We have implemented tournament as selection method because we have used other selection algorithms in past such as SUS , PWS and all this algorithms weren’t good as tournament , so we decided to switch to tournament .The mating method that was chosen is uniform , we take genes from each one of the parents with the same probability . The mutation we have chose is taking a graph , then finding a color that appears minimum number of times and switching it with a color that appears maximum times , this way reduce the number of colors by one , though creating a lot of edge collisions.

In order for the program to run we have to specify number of vertices as N variable and then we create a adjacency matrix that holds all the edges, we get the edges from the file specified , format of file should be as follows :

e NUM\_OF\_EDGE NUM\_OF\_EDGE

For Example :

e 1 267

e 1 303

e 1 169

and so on .

At this point we started to acknowledge that using the a adjacency matrix will result in very bad time complexity when iterating over the edges, so we deiced to implement the edges as list<pair<int, int>> edgeslist, we keep a list of pairs in order to iterate on them and not on the adjacency matrix . We also keep track of all the densities for each vertex, so we will use this number later in order to generate our population.

We have used shared pointer a lot in our solution in order not to pass variables by value , we wanted to improve time and space complexity of the program

When we initialize our population we represent each citizen with array of size of N ( number of vertices) , we save a color as number for each vertex . When we initialize this array for each citizen ,we use the max density number we have computed before. We randomly assign colors to each vertex , the maximum number of colors is the maximum density number , it is the upper bound.

The fitness calculating function we used was , if citizen got no conflict vertices ( collisions) we give it a fitness of 0 , if citizen got conflicts we compute it’s fitness with following formula : Kcolor \* number\_of\_conflict\_vertices \* 7 , that way we give weight according to the number of colors used for each citizen. That way we see citizen that solved the coloring problem for some color.

We also implemented a stop function which checks whether we achieved 2 coloring and the fitness of this solution is 0 , that is the minimum k coloring solution.

Memetics :

We implemented an exploration stage to the genetic engine , the exploration stage consists of 4 different search options , these searches try to solve the coloring problem with given k number or try to reduce the number of K colors and try to solve it with the new K. In order to know what vertices are the “problematic” ones we have a function called findAllConflictVertecies() , this function returns all the color collisions in the graph and the we take care of them. We expand the search tree until certain depth , specified in global variable called const size\_t depth = 2;

1. Hill climbing : we implemented the hill climbing search , which looks for the best configuration available and goes to it .
2. Tabu search – with this search we are looking for a better solution for the coloring problem we save the steps we did in a list<array<size\_t,N>> it’s a an array of previous configurations , we save them in order not go back to steps we already have taken , we do it in order not to go forth and back to the same solution .
3. Simulated annealing – we have used a variable T to represent a temperature for this search , we are using it to determine whether we want to take a “bad” path hoping it will lead us to better solution .This search is the answer to the problem of hill climbing search which can lead us to local maximum .
4. Mixed mode – we randomly choose a search option for each step , for each step any of the previous searches maybe be applied with same probability . We also tried to implement this function with input that will control how many steps were taken using each search. We could pass 3 percentages which sum to 100% , for example ( 50%,30%,20%) , meaning we would use hill climbing for 50% of citizens , tabu search for 30% and simulated annealing for the rest.

We also implemented an information propagation, from 1 citizen to another. The information we choose to pass on is, when 1 citizen have solved a coloring for certain number we want all the other citizens to stop and try to solve coloring problem with more colors than K , because we already have a solution for this number. We change the colors of all the citizens which still have more than K colors to K-1 colors and let them try to solve this problem.

We also tried to mix between number of citizens who use memetics and other that used only genetic algorithms. To check it’s influence on the solutions ,read the conclusions section .