CSCI 4560/6560 Evolutionary Computation

Assignment Number 1: Due 9/15/2025 (by eLC)

The use of Generative AI tools is not allowed

1. [20 points][MID] The *subset*21 problem is stated as follows. Given a set of N positive integers *X* = {*x*1*, x*2*, . . . , xn*}. Find a subset *P* of the set *X* such that the sum of the elements of *P* is equal to 21. For example, if N=5 and the set *X* = {12*,* 17*,* 3*,* 24*,* 6}, the set *P* = {12*,* 3*,* 6} is a valid solution for the *subset*21 problem in this example.

Formulate the *subset*21 problem as a Genetic or Evolutionary Algorithm optimization. You may use binary representation, OR any representation that you think is more appropriate. you should specify:

* + A representation.
  + A fitness function. Give 3 examples of individuals and their fitness values if you are solving the above example (i.e. *X* = {12*,* 17*,* 3*,* 24*,* 6}).
  + A set of mutation and/or crossover and/or repair operators. Intelligent operators that are suitable for this particular domain will earn more credit.
  + A termination criterion for the evolutionary optimization which ensures that you terminate with a valid solution for the *subset*21 problem, if possible, without running indefinitely.

1. [20 points][MID] The graph k-coloring problem is stated as follows: Given an undirected graph *G* = (*V, E*) with N vertices and M edges and an integer k. Assign to each vertex *v* in V a color *c*(*v*) such that 1 ≤ *c*(*v*) ≤ *k* and *c*(*u*) /= *c*(*v*) for every edge (*u, v*) in E. In other words, you want to color each vertex with one of the k colors you have and no two adjacent vertices can have the same color.

For example, the following graph can be 3-colored using the following color assignments: a=1,b=2,c=1,d=2,e=3,f=2,g=3

a---b---c---g

/ \ |

/ \ |

d --- e f

Formulate the graph k-coloring problem as an evolutionary optimization. You may use a vector of integer representation, OR any representation that you think is more appropriate. you should specify:

* + A representation.
  + A fitness function. Give 3 examples of individuals and their fitness values if you are solving the above example.
  + A set of mutation and/or crossover and/or repair operators. Intelligent operators that are suitable for this particular domain will earn more credit.
  + A termination criterion for the evolutionary optimization which ensures that you terminate with a valid solution to the graph k-coloring problem, if possible, without running indefinitely.

1. [20 points][FIN]

The minimum vertex cover problem is stated as follows: Given an undirected graph *G* = (*V, E*) with N vertices and M edges. Find a minimal size subset of vertices *X* from *V* such that every edge (*u, v*) in E is incident on at least one vertex in *X*. In other words, you want to find a minimal subset of vertices that together touch all the edges.

For example, the set of vertices *X* = {a,c} constitutes a minimum vertex cover for the following graph:

a---b---c---g

/ \ |

/ \ |

d e f

Formulate the minimum vertex cover problem as a Genetic Algorithm or another form of evolutionary optimization. You may use binary representation, OR any representation that you think is more appropriate. you should specify:

* + A representation.
  + A fitness function. Give 3 examples of individuals and their fitness values if you are solving the above example.
  + A set of mutation and/or crossover and/or repair operators. Intelligent operators that are suitable for this particular domain will earn more credit.
  + A termination criterion for the evolutionary optimization which ensures that you terminate with a valid solution to the minimum vertex cover problem, if possible, without running indefinitely.