CSCI 4560/6560 Evolutionary Computation

Assignment Number 1: Due 9/14/2023 (by eLC)

1. [20 points][MID] The *subset*₂₁ problem is stated as follows. Given a set of N positive integers \( X = \{x_1, x_2, \ldots, x_n\} \). 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 insures that you terminate with a valid solution for the *subset*₂₁ problem if possible without running indefinitely.

2. [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 \( 1 \leq c(v) \leq k \) and \( c(u) \neq c(v) \) 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 insures that you terminate with a valid solution to the graph k-coloring problem if possible without running indefinitely.

3. [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 insures that you terminate with a valid solution to the minimum vertex cover problem if possible without running indefinitely.