CSCI 4560/6560 Evolutionary Computation

Assignment Number 1: Due 9/4/2018 (in class)

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 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: \( a=1,b=2,c=1,d=2,e=3,f=2,g=3 \)

\[
\begin{array}{c}
 a---b---c---g \\
/ \ \ | \\
/ \ \ | \\
d --- e \ f
\end{array}
\]

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 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.