Implementing a Simple Genetic Algorithm

Description
Code a genetic algorithm (GA) to solve the following optimization problem:
Maximize:

\[ f(x, y) = \exp[-0.7(x + 0.2)^2]*\exp[-0.9y^2] + 2\exp[-(x - 5)^2]*\exp[-(y - 2)^2] \]

in the range \(-8 \leq x, y \leq 7\).

Some implementation guidelines are listed below.
- For simplicity, assume \(x\) and \(y\) take integer values only. Thus, there are 16 possible values for \(x\) and 16 possible values for \(y\), and 256 possible combinations of \(x\) and \(y\).
- Use binary encoding for chromosomes.
- Use a population size, \(N\), of 20 chromosomes.
- Generate the initial population randomly (i.e., generate each bit in a chromosome with a uniform probability to be 0 or 1).
- Use tournament selection with replacement to pair chromosomes (i.e., randomly select 2 or more chromosomes from the population. Choose the best among them as a parent. Replace and repeat to choose another parent and then pair them up for crossover and mutation. Repeat the whole process until \(N\) offspring have been generated.)
- Use one-point crossover with the crossover point chosen randomly and crossover applied with probability \(p_c\) in the range \([0.5, 0.8]\) (e.g. 0.7).
- Apply bit-flipping mutation to the offspring chromosomes (i.e., flip each bit of the chromosome with a probability of \(p_m\) in the range \([0.001, 0.01]\), e.g. 0.005).
- Discard the parents and keep all offspring for the next generation (“generational” GA).
- Plot the maximum fitness in the population versus the generation number.
- Observe and comment on the performance of the algorithm with changes in \(p_c\), \(p_m\), and population size, \(N\).

Implementation
You can code in any programming language (C/C++, MATLAB, etc). Pay particular attention to the following points:
- Data structures for chromosomes
- Encoding and decoding of chromosomes
- Generation and use of random numbers

Submission
This assignment can be done in pairs (i.e., two people can make one submission). Submit a report document (assign2.doc) and the source code file to an appropriate folder in \COMMON\cs431\assignment2\.
Evaluation
The assignment will be graded on the basis of correctness, completeness, and quality of report.