ASSIGNMENT 5

Due December 7, 2004, before 11:00 am

Problem 5 (Counts as two homework problems)

A recent paper by H.-Y. Fan and J. Lampinen ["A Trigonometric Mutation Operator to Differential Evolution", J. Global Optimization, Vol. 27, p. 105-129 (2003)] introduced a new operator to be embedded into the conventional differential evolution algorithm. The operator, described below, provides an alternate way of generating potential offsprings for the next generation.

For every individual i in the current population, three other individuals, i_1, i_2, and i_3, are randomly chosen to be the parents of a potential offspring, $\mathbf{v}^{(i)}$. Indices i, i_1, i_2, and i_3 are to be distinct from each other. According to the above article, the offspring is created by

$$\begin{aligned}\mathbf{v}^{(i)} &= \frac{1}{3}(\mathbf{x}^{(i_1)} + \mathbf{x}^{(i_2)} + \mathbf{x}^{(i_3)}) + (p^{(i_2)} - p^{(i_1)})(\mathbf{x}^{(i_1)} - \mathbf{x}^{(i_2)}) \\ &\quad + (p^{(i_3)} - p^{(i_2)})(\mathbf{x}^{(i_2)} - \mathbf{x}^{(i_3)}) + (p^{(i_1)} - p^{(i_3)})(\mathbf{x}^{(i_3)} - \mathbf{x}^{(i_1)}),\end{aligned}$$

where

$$p^{(i_k)} = \frac{|f(\mathbf{x}^{(i_k)})|}{\sum_{m=1}^{3} |f(\mathbf{x}^{(i_m)})|},$$

for $k = 1, 2, 3$.

The differences in the $p's$ basically are replacing the scale factor s used in the conventional DE/rand/1/bin scheme. These new scales are related to the relative fitnesses of the three parents. The potential offspring is closer to the best parent. This operator is therefore rather greedy and must be used sparingly.

This operator is embedded in the conventional DE as follows:

(1) Initialize the population.

(2) For each individual in the population, generate a potential offspring

 (a) using the above trigonometric operator with probability M_t, or

 (b) using the conventional DE/rand/1/bin operator with probability $1 - M_t$.

(3) Perform a crossover operation.

(4) Select between the original individual, i, and its potential offspring.

(5) Repeat steps 2-4.

This modified DE algorithm now involves a total of 4 DE parameters: the population size n_p, the scale factor for the difference vectors s in the conventional DE/rand/1/bin scheme, the crossover parameter c, and the probability of the trigonometric operator M_t. Since the trigonometric operator is a rather greedy one, it is clear that M_t cannot be too large, otherwise we run into the problem of premature convergence to local minimas.

Your task is to embed the above trigonometric operator into the conventional DE/rand/1/bin scheme by modifying the Matlab program that is posted on the course website for DE. You need to find the best set of DE parameters that enables the modified DE to converge consistently to the correct solution for the 10-parameter Griewangk function, and at the same time requires the fewest number of function evaluations.