ASSIGNMENT 6: Project (25% of course grade)

May 11, 2004

Homework 6 : Incorporating a trigonometric mutation operator in DE

In the conventional DE, for each individual i in the population, a potential off-spring $\mathbf{v}^{(i)}$ is created based on the chromosomes of 3 (or more) other individuals. This process is sometimes referred to as mutation. Notice that knowledge of the fitnesses of these chosen individuals are not used in the creation of the potential off-spring. The most common version, known as *DE/rand/bin*, has

$$\mathbf{v}^{(i)} = \mathbf{x}^{(r_1)} + f \cdot (\mathbf{x}^{(r_2)} - \mathbf{x}^{(r_3)}). \tag{1}$$

It is expected that the convergence rate can be improved by occasionally replacing this mutation operation by a more greedy mutation operation that uses not only information of the chromosomes of the chosen individuals but also their fitness values. One such scheme is called the trigonometric mutation operation.

The potential off-spring is created as follows:

$$\mathbf{v}^{(i)} = (\mathbf{x}^{(r_1)}+\mathbf{x}^{(r_2)}+\mathbf{x}^{(r_3)})/3+(p_2-p_1)(\mathbf{x}^{(r_1)}-\mathbf{x}^{(r_2)})+(p_3-p_2)(\mathbf{x}^{(r_2)}-\mathbf{x}^{(r_3)})+(p_1-p_3)(\mathbf{x}^{(r_3)}-\mathbf{x}^{(r_1)}), \tag{2}$$

where

$$p_k = |f(\mathbf{x}^{(r_k)})|/p, \qquad k = 1, 2, 3,$$

and

$$p = |f(\mathbf{x}^{(r_1)})| + |f(\mathbf{x}^{(r_2)})| + |f(\mathbf{x}^{(r_3)})|.$$

The trigonometric mutation operation replaces the *DE/rand/bin* operation occasionally with probability m. Thus m is an extra search control parameter. Typically m is small (around 0.05), otherwise the greedy scheme often leads to premature convergence to local minimas.

Implement the DE algorithm incorporating the trigonometric mutation operation. Test it on the 10-dimensional Griewangk's function. Find a set of DE control parameters, N_p, f, c, and m, that gives the most robust and rapid convergence. Compare this new scheme with the conventional *DE/rand/bin* scheme. Clearly the conventional scheme can be considered as a special case of the present scheme which can be obtained by setting $m = 0$ and re-adjusting the other control parameters. There by definition this new scheme cannot do worst that the conventional one. The question is that whether the extra complication involving an extra control parameter is worth the effort.