Assignment 3 – Part 1

Due date: March 6, 2014
Type your answers and submit a printed hard copy.
Hand-written solutions are not accepted.
Don’t submit your program code.

1 Computer Exercises (60 marks)

The Rosenbrock function is defined as follows:

\[
\min_{X} f(X) = \sum_{i=1}^{d-1} [100 \times (x_i^2 - x_{i+1})^2 + (1 - x_i)^2], -30.0 \leq x_i \leq 30.0
\]

In this exercise, you will use PSO to find the global optimum of Rosenbrock function with \(d=10\). You will implement three variations of PSO to conduct your experiments. For all PSO variations, the swarm size is 20; the number of time steps \((n)\) is 1,000. The network structure is fully connected gbest PSO.

In the first variation, you will use a linear decreasing inertia weight to update the velocity at each time step \(t\):

- \(\omega(t) = \omega(n) + (\omega(0) - \omega(n)) \times \frac{n-t}{n}; \omega(0) = 0.9, \omega(n) = 0.4.\)
- \(v_i(t) = \omega(t) \times v_i(t-1) + c_1 \times r_1 \times (pbest_i(t-1) - x_i(t-1)) + c_2 \times r_2 \times (gbest_i(t-1) - x_i(t-1)),\)
  where \(c_1 = c_2 = 2\) and \(r_1\) and \(r_2\) are random numbers between 0 and 1.

In the second variation, you will use a linear increasing inertia weight to update the velocity at each time step \(t\):

- \(\omega(t) = \omega(n) + (\omega(0) - \omega(n)) \times \frac{n-t}{n}; \omega(0) = 0.4, \omega(n) = 0.9.\)
- \(v_i(t) = \omega(t) \times v_i(t-1) + \phi_1 \times (pbest_i(t-1) - x_i(t-1)) + \phi_2 \times (gbest_i(t-1) - x_i(t-1)),\)
  where \(\phi_1 = 1.5r_1 + 0.5, \phi_2 = 1.5r_2 + 0.5\) and \(r_1\) and \(r_2\) are random numbers between 0 and 1.

The third variation is the constriction coefficient PSO:

- \(v_i(t) = \chi(v_i(t-1) + c_1 \times r_1 \times (pbest_i(t-1) - x_i(t-1)) + c_2 \times r_2 \times (gbest_i(t-1) - x_i(t-1)),\)
  where \(\chi = 0.729\) and \(c_1 = c_2 = 2.05.\)

In all three PSO variations, \(V_{max} = X_{max} = 30\). When the velocity is larger than \(V_{max}\), clamp it back to \(V_{max}\). Also, when a particle position is pushed outside the boundaries, reset the velocity to 0 and push the position back to its closest boundary as that discussed in the class.
You will make 20 runs for each of the three PSO variations. During each run, you will collect *swarm average fitness*, *swarm best fitness* and *swarm dispersion* at each time step. Next, calculate the mean and standard error. Finally, you will produce one figure that contains the mean and standard error of the swarm average fitness data (15 marks), one figure that contains the mean and standard error of the swarm best fitness data (15 marks) and one figure that contains the mean and standard error of the swarm dispersion data (15 marks).

Based on these 3 figures, discuss at least two PSO behaviors you have observed in your data (15 marks).