Particle Swarm Optimization

PSO is a randomized search technique. It is inspired by real time social interaction. It simulates and mimics the behavior of animal such as swarm of bees.   
In this randomized search technique, where we solve optimization problems by having a population (a set of candidate solutions or particles in this case) then moving these particles in our search space.

The movement of each particle is determined by the velocity of the particle and the position of the particle.

For instance if we wish to minimize a certain objective function:   
first, we start with randomly generated points from the set of points of real numbers. We then associate the velocity and position component to each particle. After that, we evaluate the objective function at each point in the population.

By this method, we create new population with respect to the earlier operation.  
Also at each step, we keep track of two scalers Personal best (the best position reached by the particle) and Global best (the best position so far among all of the particles).  
The pseudocode for the algorithm is:

1. First let the k = 0

d “the dimension of our objective function”

For each

generate random x[i] and generate random v[i]

Set p[i] = x[i]

Set g[0] = global minimum of the objective function of the i (particles)

1. For each

if

set p[i]= x[i]

else

set p[i]= p[i]

1. For each

if

set = x[i]

else

set =

1. For each
2. If (f(g[k]) - x\* < error )   
    stop;

Else  
 set k = k + 1   
 Go to (2).

Where g is the global best p is the personal best v is the velocity of the particle x is the position of the particle r and s are random vectors in the interval (0,1).

Is the inertia of the particle. It shows wheatear the PSO was in exploitation state or exploration state.

“Double click to play the animated gif file”

As we can see in the animated gif [see the gif file ] the choice of our are very important. In the first box we see that for small our search happens close to the possible minimum point.   
And as is as close to 1 we see the particles are scatter in our search space or in an (exploration state).

Finally we see in the middle box that as are in the neighborhood of 0.5 our particles are in a medium state where they explore the search space and search around the possible local or global minimum point.   
  
let us suppose that we have a function

If found our minimum point applying analytical methods we get that the minimum of this function is at

Now applying the PSO on same function with w = 0.5 and c1 = c2 = 2 and 100 iterations we will get.which is a very good approximation.[see the file 2].

Let’s take another function for instance

The minimum of this function is

Again applying our PSO with the same w c1 and c2, we will have which is quit close to our actual minimum point [see the file 3].

To sum up our PSO is a global search algorithm finds our optimal solution by updating a set of randomly selected points in our search space using velocity, personal best and global best of each particle.

References:

E. Chong and S. Zak. An Introduction to Optimization. Wiley Series in Discrete Mathematics

& Optimization. Wiley, 2011.