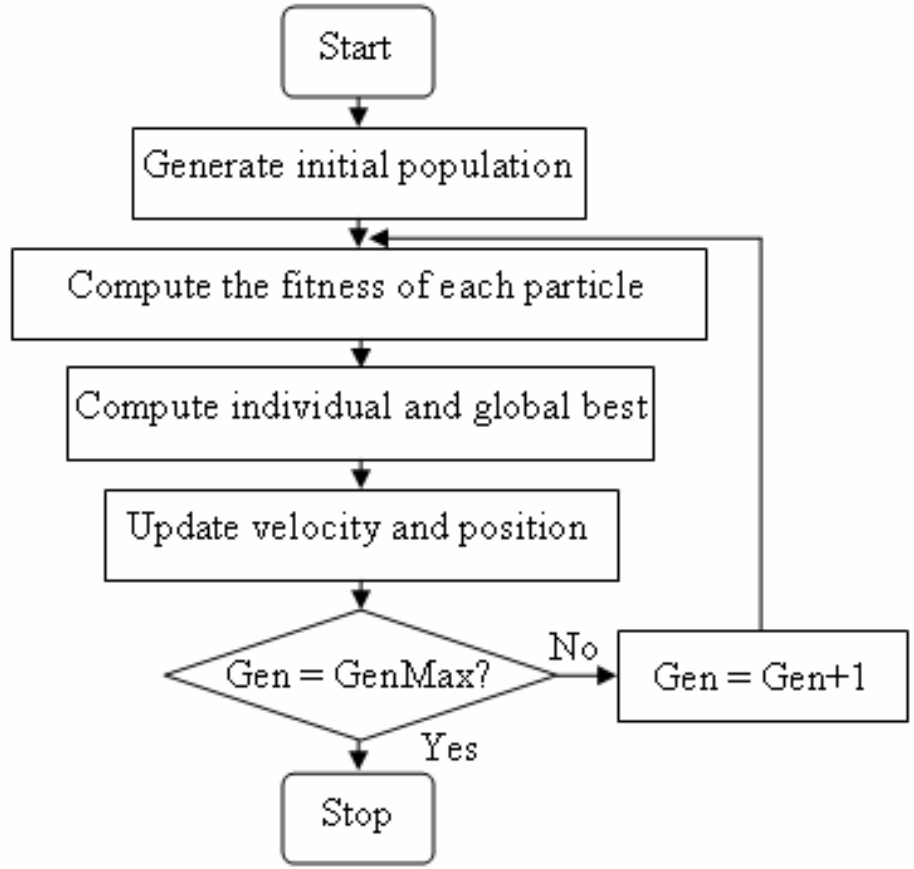
Particle Swarm Optimization (PSO)

1 PSO Concept

- PSO was developed by simulation of simplified social model, where each population is called a swarm.
- Each candidate, called a particle, flies through problem space to look for the optimal position, similar to food searching of bird swarm.
- A particle adapts its position based on its own knowledge, and knowledge of neighboring particles.
- The algorithm is initialized with a population of random particles.
- PSO searches for the optimal solution by updating particles in generations.

2 PSO Programming Flowchart



3 Algorithm

- Let the search space be *N*-dimensional, then the particle *i* is represented by an *N*-dimensional position vector, $x_i = (x_{i1}, x_{i2}, ..., x_{iN})$.
- The velocity is represented also by an *N*-dimensional velocity vector, $v_i = (v_{i1}, v_{i2}, ..., v_{iN})$.
- The fitness of particles is evaluated by the objective function of the optimization problem.
- The best previously visited position of particle *i* is noted as its individual best position, $P_i = (p_{i1}, p_{i2}, ..., p_{iN})$.
- The position of the best individual of the whole swarm is noted as the global best position, $G = (g_1, g_2, ..., g_N)$.
- At each step of searching process, the velocity of particle and its new position are updated according to the following two equations.

$$v_i(k+1) = w.v_i(k) + c_1.r_1.(P_i(k) - x_i(k)) + c_2.r_2.(G(k) - x_i(k))$$

$$x_i(k+1) = x_i(k) + v_i(k)$$

w, called inertia weight, controls the impact of previous velocity of the particle.

r_1, r_2 are random variables in the range of [0,1], c_1, c_2 are positive constant parameters called acceleration coefficients.

The value of each component in *v* is limited to the range $[-v_{\max}, v_{\max}]$ to control excessive roaming of particles outside the search space.