Exercice 1

Consider an illustrative example of a particle swarm optimization system composed of three particles and $V_{max} = 10$. To facilitate calculation, we will ignore the fact that r_1 and r_2 are random numbers and fix them to 0.5 for this exercise. The space of solutions is the two dimensional real valued space R^2 and the current state of the swarm is as follows:

Position of particles: $x_1 = (5,5)$; $x_2 = (8,3)$; $x_3 = (6,7)$;

Individual best positions: $x_1^* = (5,5)$; $x_2^* = (7,3)$; $x_3^* = (5,6)$;

Social best position: $x^* = (5,5)$;

Velocities: $v_1 = (2,2)$; $v_2 = (3,3)$; $v_3 = (4,4)$.

Please answer the following questions:

1. What would be the next position of each particle after one iteration of the PSO algorithm using inertia $\omega = 1$?
2. And using $\omega = 0:1$?
3. Explain why the parameter ω is called inertia.
4. Give an advantage and a disadvantage of a high inertia value.

Exercice 2

1. Appliquer la méthode PSO à l’exemple simple $F(x) = x^2$ et avec $c_1 = c_2 = c_3 = 0.7$.
2. Tracer les trajectoires correspondantes des particules sur la parabole.
3. Appliquer la méthode PSO au cas de la fonction de Rastrigin sur $[-5; 5]^2$:

$Ras(x) = 20 + x_1^2 + x_2^2 - 10(\cos 2\pi x_1 + \cos 2\pi x_2)$ avec 10 particules. Qu’observe t-on?

Exercise 3

Réécrire l'algorithme PSO et discuter sa complexité.

Exercise 4

Appliquer PSO au TSP: interpréster:

- Une particule ;
- Une vélocité ;
- Une différence de positions ;
- Une somme de vélocités ;
- Les deux équations de mise à jour.
- Donner des exemples.

Meme question pour KSP et SAT-3.

Exercice 5

A Particle Swarm Optimization (PSO) is applied to the search of a hidden RF transmitter. The search area is a square stretched out between coordinates $(-100, -100)$ and $(100,100)$. The amplitude of a sampled signal as a function of distance from the emitter is given by:

$$A = \frac{1}{4\pi r^2} + kN(0, \sigma)$$

where A is the measured amplitude, r is distance between transmitter and the sampling location and N is a Gaussian noise distribution with zero mean and σ standard deviation, k is a parameter for adjusting the relative noise level.

a. Explain the canonical PSO.

b. Given 4 particles in a PSO with positions:

   $x_1 = (10,10)$
   $x_2 = (12,8)$
   $x_3 = (11, -10)$
   $x_4 = (-4,9)$

   Calculate an iteration of particle 1 assuming $\omega = 0.98, \omega_1 = 0.04, \omega_2 = 0.02$ and simulate the required probabilities. Also, assume that the position of the hidden emitter is $(0,0)$ and that $k = 0$, i.e. a noise free system.

c. Simulate the next iterations of this PSO problem by altering the the NetLogo version of PSO, found under:
   'File->Models Library->Sample Models->Computer Science->Particle Swarm Optimization'.
   Remark, the UpdateParticleVelocity (the 'to go' function) in the NetLogo program is altered. Also, you could use new random initial position and velocities for the particles.

d. Release the 4 particles from (-75,-75) plus some randomness. How does this affect the optimization?

e. What happen if you add noise to the system? You could set $k = 0{,}0001$. Compare the two different initial positions of the particles. Would you use PSO in a real swarm robotic system where the mobile robots are released from same location?

f. What could be alternative approaches for locating the hidden RF emitter using swarm robotics?

g. Optional:
   Play with different PSOs, parameters and possibly other swarm algorithms on this problem.