TEK5010 MAS

Lecture 3: SI

Exercise: PSO

Question 1

a) Explain the canonical PSO

This is the original PSO of Kennedy & Eberhart, 1995

$$v_{id}' = \underbrace{\omega v_{id}}_{\text{Inertia term}} + \underbrace{\omega_1 \varphi_1 (p_{id} - x_{id})}_{\text{Cognitive term}} + \underbrace{\omega_2 \varphi_2 (p_{gd} - x_{id})}_{\text{Social term}}$$

where v'_{id} is updated velocity of particle i in dimension d

v_{id} is old velocity of particle i in dimension d

$\omega, \omega_1, \omega_2$ are parameters that need to be tuned

$\varphi_1, \varphi_2 \in [0,1]$ uniform random distribution

x_{id} is position of particle i in dimension d

p_{id} is best position of particle i in dim d

p_{gd} is global best position of all particles in dim d

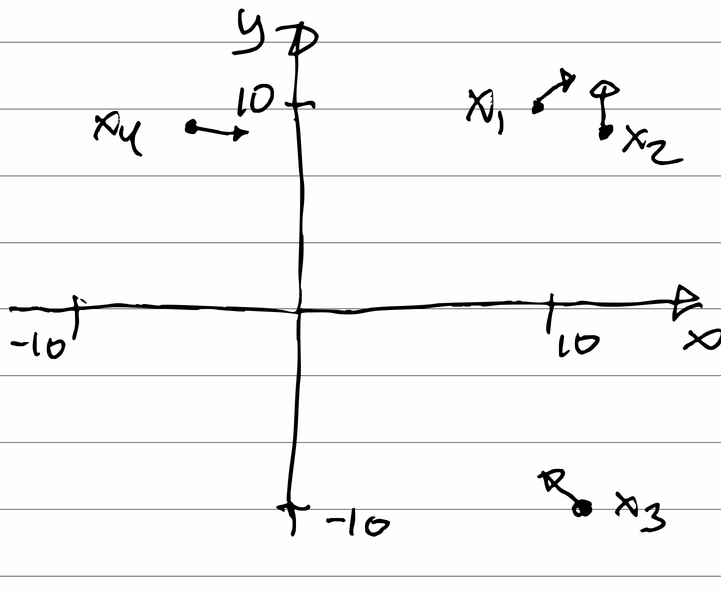
$x'_{id} = x_{id} + v'_{id}$ updated particle position

Random position and velocities of particles at initialization is assumed

b) Calculate an iteration of particle 1

$X_1=(10,10)$ $v_1=(1,0.75)$
$X_2=(12,8)$ $v_2=(0,2)$
$X_3=(11,-10)$ $v_3=(-1,1)$
$X_4=(-4,9)$ $v_4=(2,0)$

assuming $\omega=0.98, \omega_1=0.04, \omega_2=0.02$
$k=0$, emitter is at $(0,0)$



Lets calculate the global best particle

$$r_1 = \sqrt{10^2 + 10^2} = \sqrt{200} \approx 14.14$$
$$r_2 = \sqrt{12^2 + 8^2} = \sqrt{144 + 64} = \sqrt{208} \approx 14.4$$
$$r_3 = \sqrt{11^2 + (-10)^2} = \sqrt{121 + 100} = \sqrt{221} \approx 14.87$$
$$r_4 = \sqrt{(-4)^2 + 9^2} = \sqrt{16 + 81} = \sqrt{97} = 9.85$$

which gives the detected signal power of the emitter at each particle

$$P(r_1) = \frac{1}{4\pi(14.14)^2} + 0 \|N(0,\sigma)\| = 0{,}000398$$
$$P(r_2) = \frac{1}{4\pi(14.4)^2} \approx 0{,}000384$$
$$P(r_3) = \frac{1}{4\pi(14.87)^2} \approx 0{,}000360$$
$$P(r_4) = \frac{1}{4\pi(9.85)^2} = 0{,}000820$$

$\Rightarrow p_g = x_4$ Particle 4 is global best position since it is closest to emitter

$$v'_{11} = w \cdot v_{11} + w_1 \varphi_1 (x_{11} - x_{11}) + w_2 \varphi_2 (x_{41} - x_{11})$$
$$= 0.98 \cdot 1 + 0.04 \cdot 0.3 (10 - 10) + 0.02 \cdot 0.9 (-4 - 10)$$
$$= 0.98 + 0 - 0.252 = 0.728$$

$$v'_{12} = w v_{12} + w_1 \varphi_1 (x_{12} - x_{12}) + w_2 \varphi_2 (x_{42} - x_{12})$$
$$= 0.98 \cdot 0.75 + 0.04 \cdot 0.15 (10 - 10) + 0.02 \cdot 0.1 (9 - 10)$$
$$= 0.735 + 0 - 0.002 = 0.733$$

we have assumed that φ_1 and φ_2 are randomly drawn each time we use them in a calculation

this gives us updated positions

$$x'_{11} = x_{11} + v'_{11} = 10 + 0.73 = 10.73$$
$$x'_{12} = x_{12} + v'_{12} = 10 + 0.73 = 10.73$$

c) Simulate the next particle iterations using NetLogo.