Mon, Apr. 22, 2024

Announcements:

→ HW 5 due tonight

→ Course evaluations open

Topic 12 - Particle Swarm Optimization

Let $x_i(t)$ and $v_i(t)$ denote the position and velocity of particle i at time t.

* $x_i(t+1) = x_i(t) + v_i(t+1)$

$$v_i(t+1) = \underbrace{\alpha \cdot v_i(t)}_{\text{inertia}} + \beta \cdot \underbrace{r_1}_{\text{vector}} \cdot \underbrace{(b_i(t) - x_i(t))}_{\text{vector}} + \gamma \cdot r_2 \cdot (B(t) - x_i(t))$$

$b_i(t)$ = best sol. particle i has ever seen up to time t

$B(t)$ = best sol. any particle has ever seen up to time t

α, β, γ: weighting factors of the three components (1) inertia, (2) personal best, (3) global best

typically, $\alpha \approx 0.9$, $\beta \approx 1$, $\gamma \approx 1$

r_1 and r_2 are random vectors whose components are in $[0, 1]$.

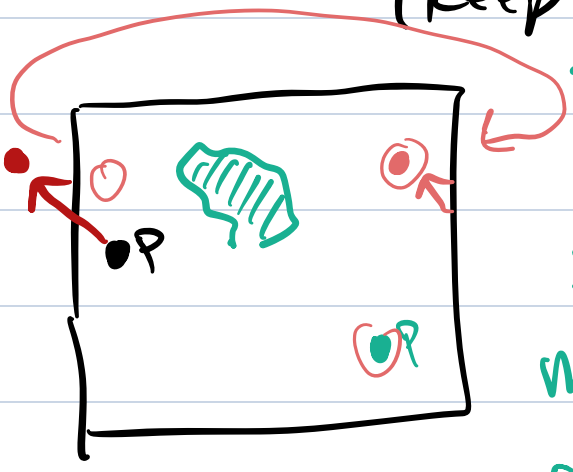
* Code Demo

Problem: What if your particles run away? (what if the particles move to solutions that violate constraints)

→ max and min bounds like $-2\pi \leq x, y \leq 2\pi$

→ constraints like the spring problem

Option 1) If the new position of a particle would violate constraint, just don't move it.
(Keep its new velocity)



The decay α (ex: $\alpha = 0.9$) means the velocity will shrink each time until moving it is eventually okay again.

Option 2) If a particle moves out of bounds, delete it and randomly add a new one somewhere in the search space.

* Sometimes people add another term to the velocity in between "local best" and "global best". For every particle, choose a few other particles randomly to be "informants."
example: 5 others

Add a term

$$r_3 \cdot \delta \cdot \underbrace{([\text{best sol any informant has seen}] - [\text{current position}])}_{x_i(t)}$$

* Nothing like Hill-Climbing here, no tweaks. How can we incorporate some H-C?
  * H-C at the end
  * If differentiable, incorporate gradient into the velocity
  * Switch back and forth between PS mode and HC mode