An Analysis of Particle Swarm Optimization

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METHODOLOGY

In our methodology we have focussed on developing a simplistic code implementing our algorithm. The simplicity of our implementation helped us to understand and analyse the algorithm in a comprehensive way. We ran our Python code multiple times with different number of particles and different number of iterations.

Different values of iterations and particles helped us understand the unique behaviour of our algorithm. In order to better understand the working and the nuances of the algorithm we had to visualize the data using different plots where we could understand the movement of the particles and their clustering behaviour.

Particle position:

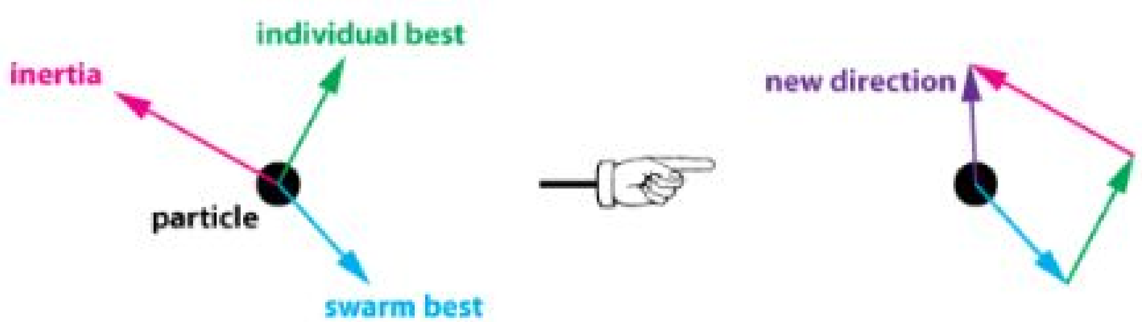
$$x^i_{k+1} = x^i_k + v^i_{k+1}$$

Particle velocity:

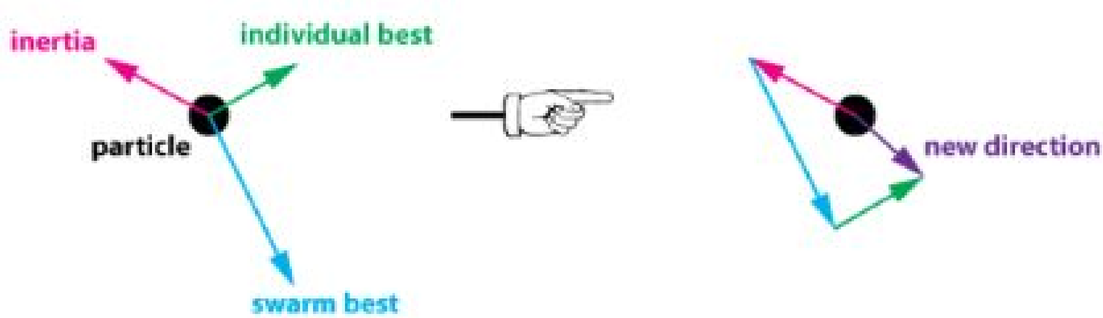
$$v^i_{k+1} = w_k v^i_k + c_1 r_1 \left(p^i_k - x^i_k\right) + c_2 r_2 \left(p^g_k - x^i_k\right)$$

$x^i_k \leftarrow$ PARTICLE POSITION
$v^i_k \leftarrow$ PARTICLE VELOCITY
$p^i_k \leftarrow$ BEST INDIVIDUAL PARTICLE POSITION
$p^g_k \leftarrow$ BEST SWARM POSITION
$w_k \leftarrow$ CONSTANT INERTIA WEIGHT
$c_1,c_2 \leftarrow$ COGNITIVE AND SOCIAL PARAMETERS
$r_1,r_2 \leftarrow$ RANDOM NUMBERS BETWEEN 0 AND 1

A HIGH ENERGY PARTICLE THAT WILL KEEP EXPLORING THE SEARCH SPACE



A LAZY PARTICLE THAT FOLLOWS THE HERD



Using these two simple equations, the basic flow structure of a PSO routine is as follows:

- Initialize
- Optimize
- Terminate

PSEUDOCODE

Input: ProblemSize, $Population_{size}$

Output: P_{g_best}

$Population \leftarrow \emptyset$
$P_{g\_best} \leftarrow \emptyset$

for(i=1 to PopulationSize)
  $P_{velocity} \leftarrow RandomVelocity(\ )$
  $P_{position} \leftarrow RandomPosition(Population_{size})$
  $P_{p\_best} \leftarrow P_{position}$

  if($Cost(P_{p\_best}) <= Cost(P_{g\_best})$)
    $P_{g\_best} \leftarrow P_{p\_best}$

  end(if)
end(for)

while(StopCondition())
  for($P \in Population$)
    $P_{velocity} \leftarrow UpdateVelocity(P_{velocity}, P_{g\_best}, P_{p\_best})$
    $P_{position} \leftarrow UpdatePosition(P_{position}, P_{velocity})$

    if($Cost(P_{position}) <= Cost(P_{p\_best})$)
      $P_{p\_best} \leftarrow P_{position}$

      if($Cost(P_{p\_best}) <= Cost(P_{g\_best})$)
        $P_{g\_best} \leftarrow P_{p\_best}$

      end(if)
    end(if)
  end(for)
end(while)

return(P_{g_best})

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