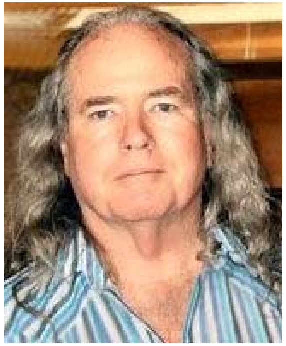
PSO

Particle **S**warm **O**ptimization

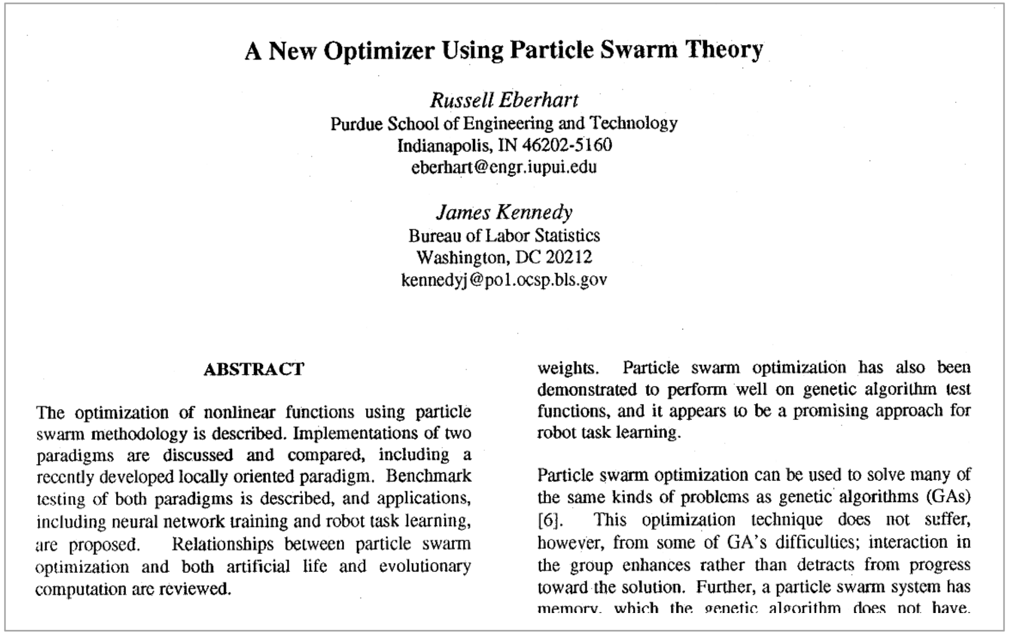
PSO is initially developed by



James Kennedy
Social Psychologist

Russell C. Eberhart
Electrical Engineer

in 1995



A New Optimizer Using Particle Swarm Theory

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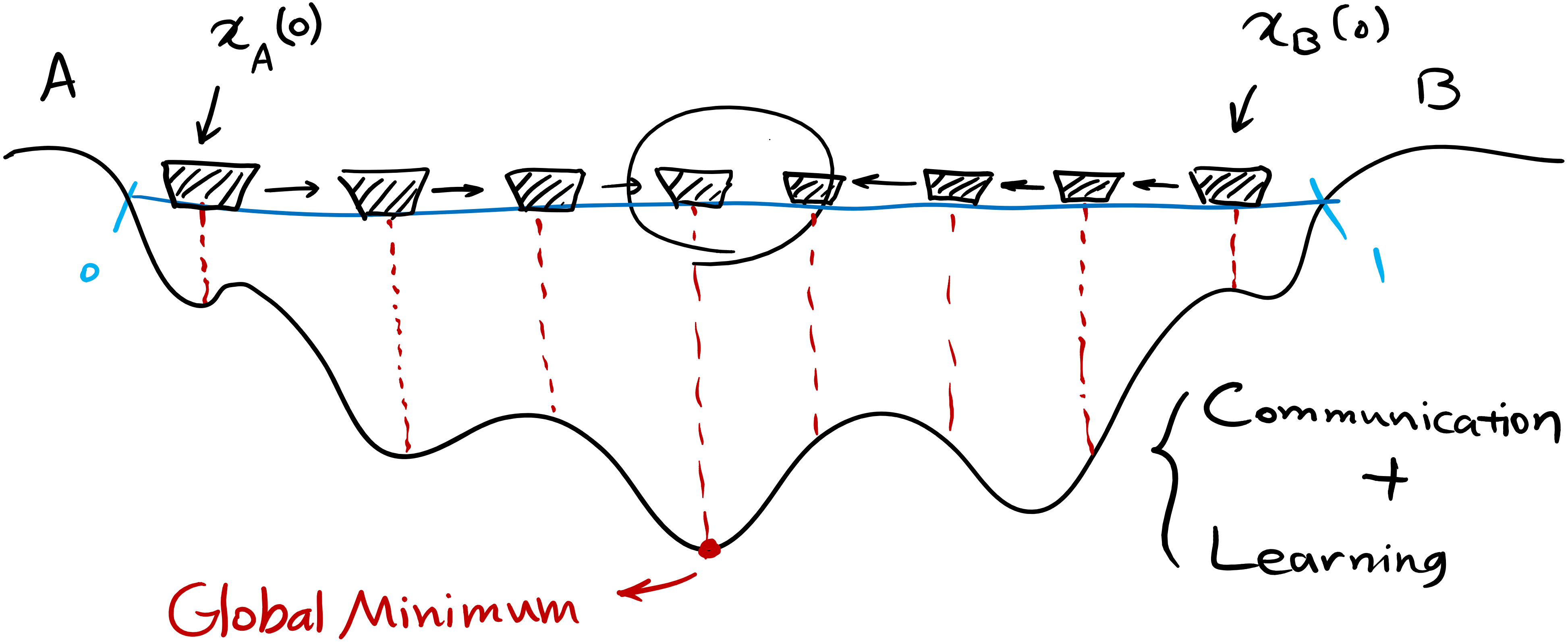
ABSTRACT

The optimization of nonlinear functions using particle swarm methodology is described. Implementations of two paradigms are discussed and compared, including a recently developed locally oriented paradigm. Benchmark testing of both paradigms is described, and applications, including neural network training and robot task learning, are proposed. Relationships between particle swarm optimization and both artificial life and evolutionary computation are reviewed.

weights. Particle swarm optimization has also been demonstrated to perform well on genetic algorithm test functions, and it appears to be a promising approach for robot task learning.

Particle swarm optimization can be used to solve many of the same kinds of problems as genetic algorithms (GAs) [6]. This optimization technique does not suffer, however, from some of GA's difficulties; interaction in the group enhances rather than detracts from progress toward the solution. Further, a particle swarm system has memory, which the genetic algorithm does not have.

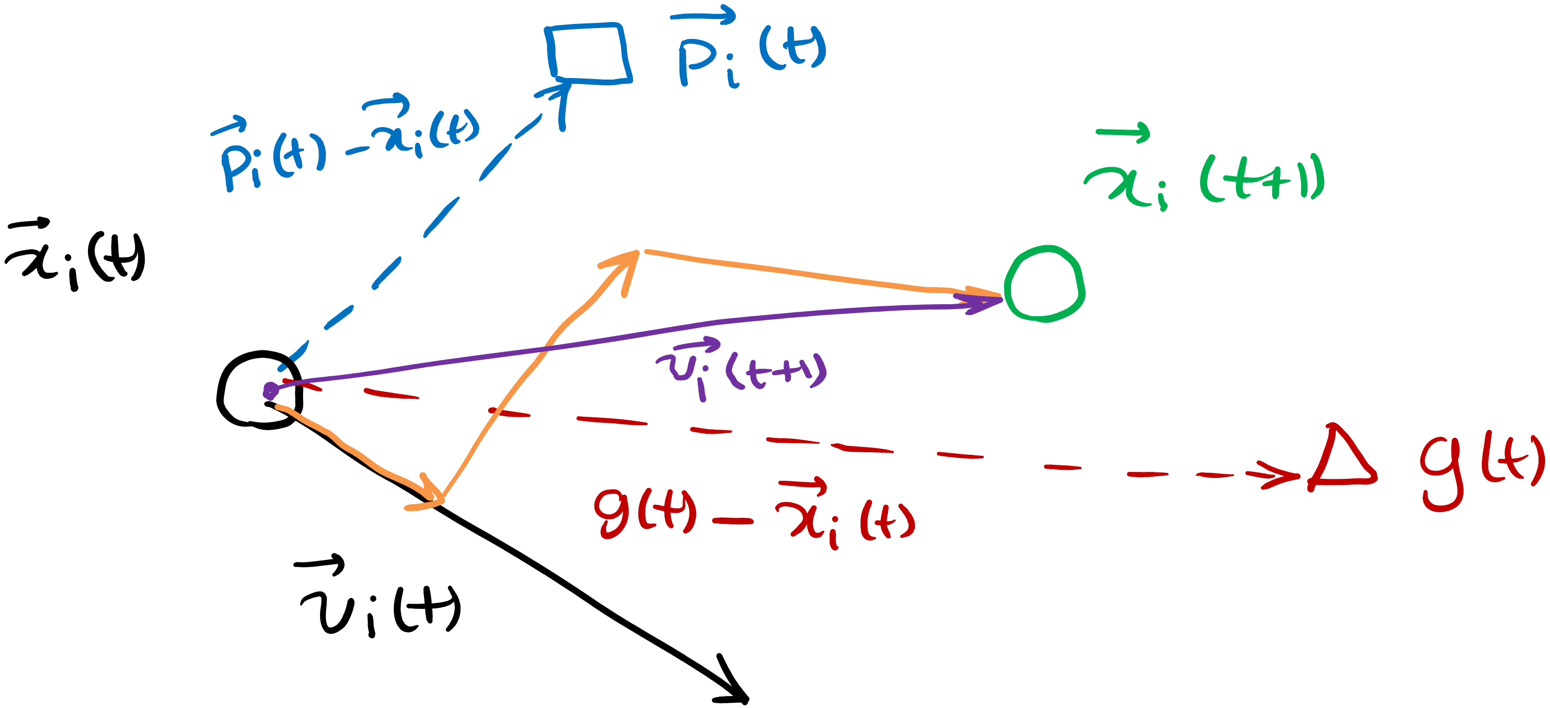


$x_A(0)$
$x_B(0)$
A
B
0
1
Global Minimum
Communication
+
Learning

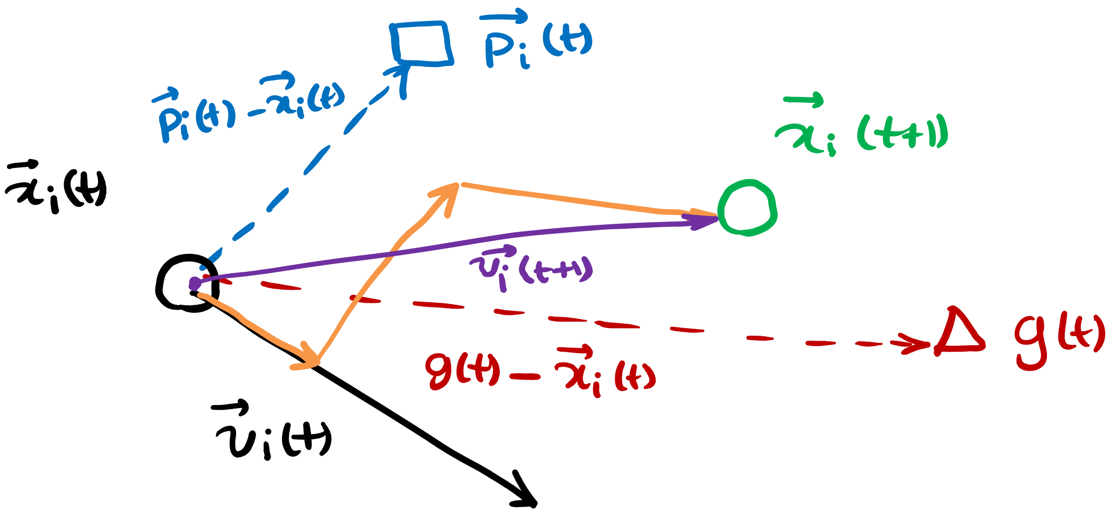
Swarm of Particles

Particle i → Position : $\vec{x}_i(t) \in X$

Particle i → Velocity : $\vec{v}_i(t)$



$\vec{p}_i(t)$
$\vec{p}_i(t) - \vec{x}_i(t)$
$\vec{x}_i(t+1)$
$\vec{x}_i(t)$
$\vec{v}_i(t+1)$
$g(t)$
$g(t) - \vec{x}_i(t)$
$\vec{v}_i(t)$



$$\begin{cases} v_i(t+1) = w\, v_i(t) + c_1\left(p_i(t) - x_i(t)\right) + c_2\left(g(t) - x_i(t)\right) \\ x_i(t+1) = x_i(t) + v_i(t+1) \end{cases}$$

$$v_{ij}(t+1) = w\, v_{ij}(t)$$

Inertia Term

$$r_1, r_2 \sim U(0,1)$$

$$+ r_1 c_1 \left(p_{ij}(t) - x_{ij}(t)\right) \rightarrow$$

Cognitive Component

$$+ r_2 c_2 \left(g_j(t) - x_{ij}(t)\right) \rightarrow$$

Social Component

Acceleration Coefficients

$$x_{ij}(t+1) = x_{ij}(t) + v_{ij}(t+1)$$

Sphere

$$f_{sph}(\vec{x}) = \sum_{i=1}^{n} x_i^2 = \|\vec{x}\|^2$$

$$\vec{x} \in \mathbb{R}^n$$

Clerc and Kennedy, 2002

Constriction Coefficients

$$\chi = \frac{2k}{\left|2 - \phi - \sqrt{\phi^2 - 4\phi}\right|}$$

$$\begin{cases} k = 1 \\ \phi_1 = 2.05 \\ \phi_2 = 2.05 \end{cases}$$

$w = \chi$

$c_1 = \chi \phi_1$

$c_2 = \chi \phi_2$

$0 \leq k \leq 1$

$\phi = \phi_1 + \phi_2 \geq 4$