FINAL PRESENTATION

# PARTICLE SWARM OPTIMIZATION (PSO) FOR MACHINE LEARNING

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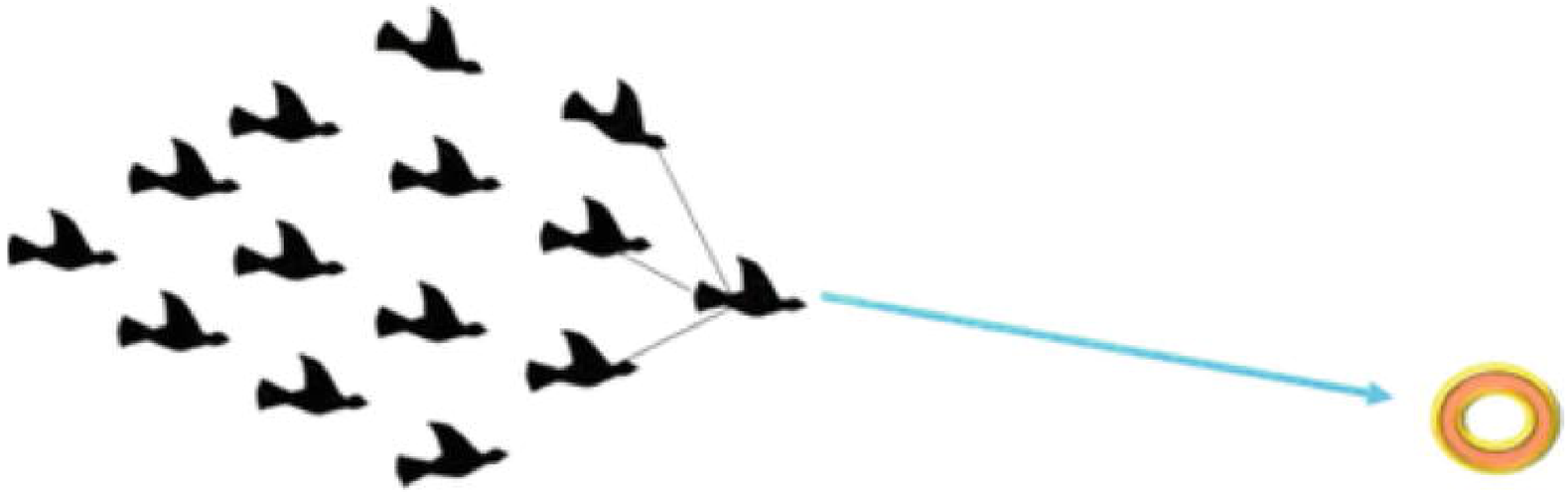
# INTRODUCTION

**What is PSO?**

**What is the use in ML?**

# PARTICLE SWARMS



***Particle Swarm Optimization*** was proposed by Kennedy and Eberhart in 1995. As mentioned in the original paper, sociobiologists believe a ***school of fish or a flock of birds*** that moves in a group ***“can profit from the experience of all other members”***. In other words, while a bird flying and searching randomly for food, for instance, ***all birds in the flock can share their discovery and help*** the entire flock get the best hunt.

# What is meant by PSO?

- PSO is a ***computational method that Optimizes a problem***.
- PSO is inspired by the ***Social Behavior of Birds flocking***.
- Particle Swarm Optimization the ***solution of the problem is represented using Particles***. [***Flocking birds*** are ***replaced with particles*** for algorithm simplicity].
- ***Objective Function is used for the performance evaluation*** for each particle / agent in the current population.
- ***PSO solved problems by having a Population (called Swarms)*** of ***Candidate Solutions*** (Particles). Local and global optimal solutions are used to update particle position in each iteration

- *How to Evaluate Fitness Values for each Particle?*

  ***By Fitness Function.***
- *What is PSO used for?*

  ***To solve Optimization problems.***
- *What is the global best in PSO?*

  ***First Best One is the Best Solution.***
- *How does swarm intelligence work?*

  ***Follow the Bird Which is Nearest to the Food***

**Particle Swarm Optimization (PSO) algorithm:**

For each particle, Initialize particle
END
DO
For each particle, Calculate fitness value
if the fitness value is better than the pBest in history
Set current value as the new pBest.
END
Choose the particle with the best fitness value of all particles as the gBest
For each particle:
Calculate particle velocity and update particle position
END
While max iteration or min error criteria is not attained

## Particle Swarm Optimization (PSO) algorithm step by step:

1. ***Initialize Particle Positions and Velocities:***
    - Randomly initialize the positions and velocities of a group of particles in the solution space.
    - Assign each particle a random initial velocity.
2. ***Evaluate Fitness:***
    - Evaluate the fitness of each particle based on the objective function you're trying to optimize. This function represents how good or bad the solution is.
3. ***Update Personal Best (Pbest):***
    - Update the personal best position (Pbest) for each particle based on its current fitness. If the current position is better than the previous best, update it.
4. ***Update Global Best (Gbest):***
    - Identify the global best position (Gbest) among all the particles. It's the position with the best fitness in the entire swarm.

5. ***Update Velocities and Positions:***

   Update the velocity and position of each particle using the PSO equations:

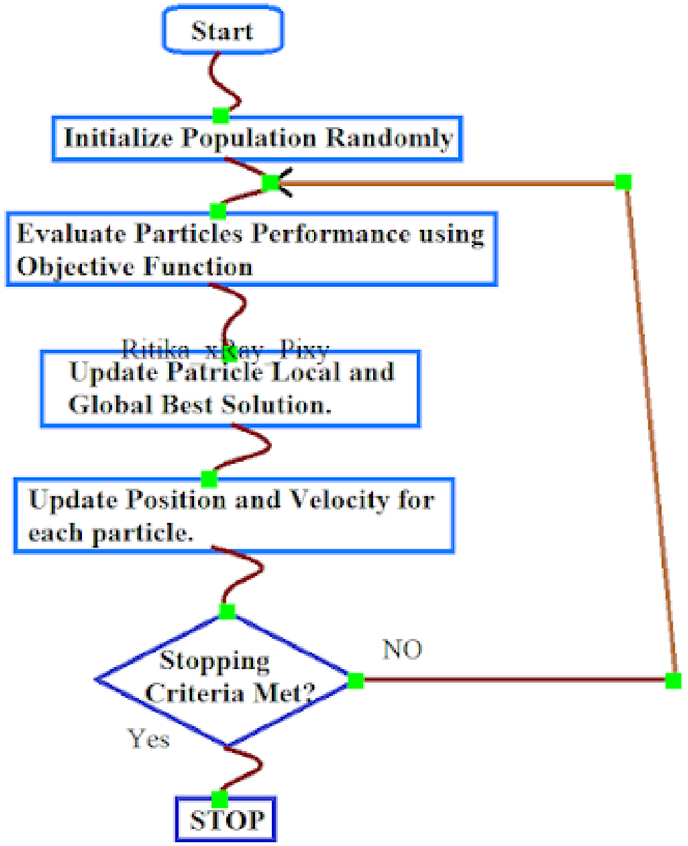
   $V_i(t+1) = w * V_i(t) + c1 * r1 * (Pbest_i - X_i) + c2 * r2 * (Gbest - X_i)$ $X_i(t+1) = X_i(t) + V_i(t+1)$

6. **Repeat:**
   - Repeat steps 2-5 for a predefined number of iterations or until a convergence criterion is met.
7. **Result:**
   - The final positions of the particles represent the solution to the optimization problem.

Where:

- ***V_i(t+1)*** is the ***updated velocity*** of particle i at iteration t+1.
- ***X_i(t+1)*** is the ***updated position*** of particle i at iteration t+1.
- ***w*** is the ***inertia*** weight.
- ***c1*** and *c2* are acceleration ***constants***.
- ***r1*** and ***r2*** are ***random numbers*** between ***0*** and ***1***.
- ***Pbest_i*** is the ***best position*** of ***particle*** i.
- ***Gbest*** is the ***best position*** among ***all particles***.

# PSO Search Strategy:
# Follow the Bird Which is Nearest to the Food.



# Particle Swarm Optimization (PSO) is used in machine learning

***Feature Selection:***

- PSO can be applied to select the most relevant features from a large set. The algorithm optimizes a subset of features that maximizes the performance of a machine learning model. This is especially useful when dealing with high-dimensional datasets where not all features contribute equally to the model's accuracy.