**Worksheet 2 Report Analysis**  
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### Task: Particle Swarm Optimization (PSO) with 10 Agents

A a PSO algorithm with 10 agents operating in a 2D continuous space, is given below. The objective function that has to be minimized is the distance from the origin, that is, (0, 0). Note that in every iteration the agent's velocity and position update are guided by personal best and global best positions.

**Code Breakdown:**

* **Agent initialization:**
  + **Agents:** The initial positions of the agents are randomly set inside the 50x50 grid, while the velocities are in the range -1 to 1.
  + **Personal Best:** The personal best position of the agent, initialized with the initial position, and the personal best value of the objective function initialized to infinity).
* **Objective function**
  + The function below calculates the "goodness" of a position by the Pythagorean theorem to find the Euclidean distance from the origin at (0,0).
  + The best agents are those that are as near to the origin as possible.
* **Velocity update**
  + The agent updates its velocity with three components:
    - **Inertia:** Retains 50% of previous velocity.
    - **Cognitive:** Pulls toward the agent's personal best position by the value of c1.
    - **Social:** Pulls towards the global best position found so far by any agent using the value of c2.
* **Position update**
  + The position of each agent is renewed by adding new acquired velocity to the position after adjustment in the velocity.
* **Challenge**
  + **Increasing c1:** This gives more importance to personal exploration; thus, agents depend more on their best positions. It gives more exploration but might converge slowly if agents don't follow the global best.
  + **Decreasing c1:** Less emphasis on the agent's own experience results in quicker convergence, however, that reduces exploration, risking premature convergence.
  + **Increasing c2:** The agents are influenced to track the global best; hence faster convergence can occur. However, too much reliance on the global best often results in premature convergence, missing out on better solutions.
  + **Decreasing c2:** Agents become more independent, increasing exploration but slowing convergence when agents are too dismissive of the global best.

**Summary and Conclusion:**

This PSO Simulation shows how the agents cooperate to minimize a distance from the origin by balancing their experience/personal best with the swarm's best solution. An inertial, cognitive, and social component drives agents in the search space while the velocity clamping keeps the movement of agents in check.

* **High c1, Low c2:** More exploration, slower convergence.
* **Low c1, High c2:** Faster convergence, less exploration.
* **Balanced c1 and c2:** A good balance between exploration and exploitation.

**Improvements**

Future improvements can be done by dynamically changing the inertial, cognitive, and social weights for an improved convergence or by introducing more agents to introduce extra competition within the search space.