Swarm Intelligence
Homework 12

1 Particle Swarm Optimization [100 points]

Implement the algorithm for PSO that we saw in class. You can do it with a language of your choice (Python, Matlab, Julia, ...). Optimize the 5-dimensional Rastrigin function in the domain $[-5.12, 5.12]^5$:

$$f(\mathbf{x}) = 10n + \sum_{j=1}^{n} \left(x_j^2 - 10\cos(2\pi x_j)\right)$$

where $n = 5$ is number of dimensions of the Rastrigin function we are considering. This function is designed to have a global minimum at the origin, and a large number of local minima across the search space. It's a common benchmark test in optimization.

Run PSO with $P = 100$ particles for $T = 1000$ iterations. Use the following value for the acceleration coefficients: $\psi_1 = \psi_2 = 1.5$.

Study the role of the inertia parameter w. Consider three choice strategies:

1. **Constant:** $w = 1$ constant throughout the run;
2. **Decaying:** $w = 1 - \frac{t}{T}$, where t is the current iteration (starting at 0 and ending at $T - 1$ included);
3. **Random:** $w = \mathcal{U}(0, 1)$, i.e., pick a uniformly random value for the inertia at the start of the run and keep it constant throughout the run.

Run each setting 10 times. Which one performs best?

- Which inertia setting strategy produced the closest solution to the optimum on average across runs?
- Which inertia setting strategy produced the closest solution to the optimum? Is it the same as the previous case?

1.1 Deliverables

Write a brief report with:

- A table reporting all the solutions you found. Each row is a run (from 1 to 10), each column is a choice strategy for w (constant, decaying, random).
- Your answer to questions 1 and 2 above.

No need to more than that — just the table and an answer to the questions justified by the data reported in the table.

Package everything in a zip file called `LastnameFirstname.zip` containing:

```
LastnameFirstname/
  report.pdf [include output plots]
  <your code files>
  README.txt (how to run your code - make it simple!)
```