Lecture 11: Particle Swarm Optimization

Suggested reading: Y. Shi, R. Eberhart, “A Modified Particle Swarm Optimizer,” Evolutionary Computation Proceedings, 1998, pp. 69-73.

GAs and PSOs

- Similarities
  - Both operate on populations (swarms)
  - Neither uses derivatives
  - Both biologically motivated
- Differences
  - GAs based on genetics and evolution
  - PSOs based on social behavior
  - In PSOs, same individuals survive throughout study

Definitions

- Size of search space: $d = [1 \cdots D]$
- Position of i'th particle: $\mathbf{x}_i = [x_{i1} \quad x_{i2} \quad \cdots \quad x_{iD}]^T$
- Best position i'th particle has ever seen:

$$\mathbf{p}_i = [p_{i1} \quad p_{i2} \quad \cdots \quad p_{iD}]^T$$

- Velocity of i'th particle: $\mathbf{v}_i = [v_{i1} \quad v_{i2} \quad \cdots \quad v_{iD}]^T$
- Best position any particle has ever seen:

$$\mathbf{G} = [g_1 \quad g_2 \quad \cdots \quad g_D]^T$$

Position and Velocity Update

$$v_{id} = wv_{id} + c_1 rand()(p_{id} - x_{id}) + c_2 rand()(g_d - x_{id})$$

$$x_{id} = x_{id} + v_{id}$$

Recommended parameters

w: 0.9-1.2

c_1: 1.4

c_2: 0.1

GA/PSO Comparison
Electromagnet Design (12 DOF)

GA:

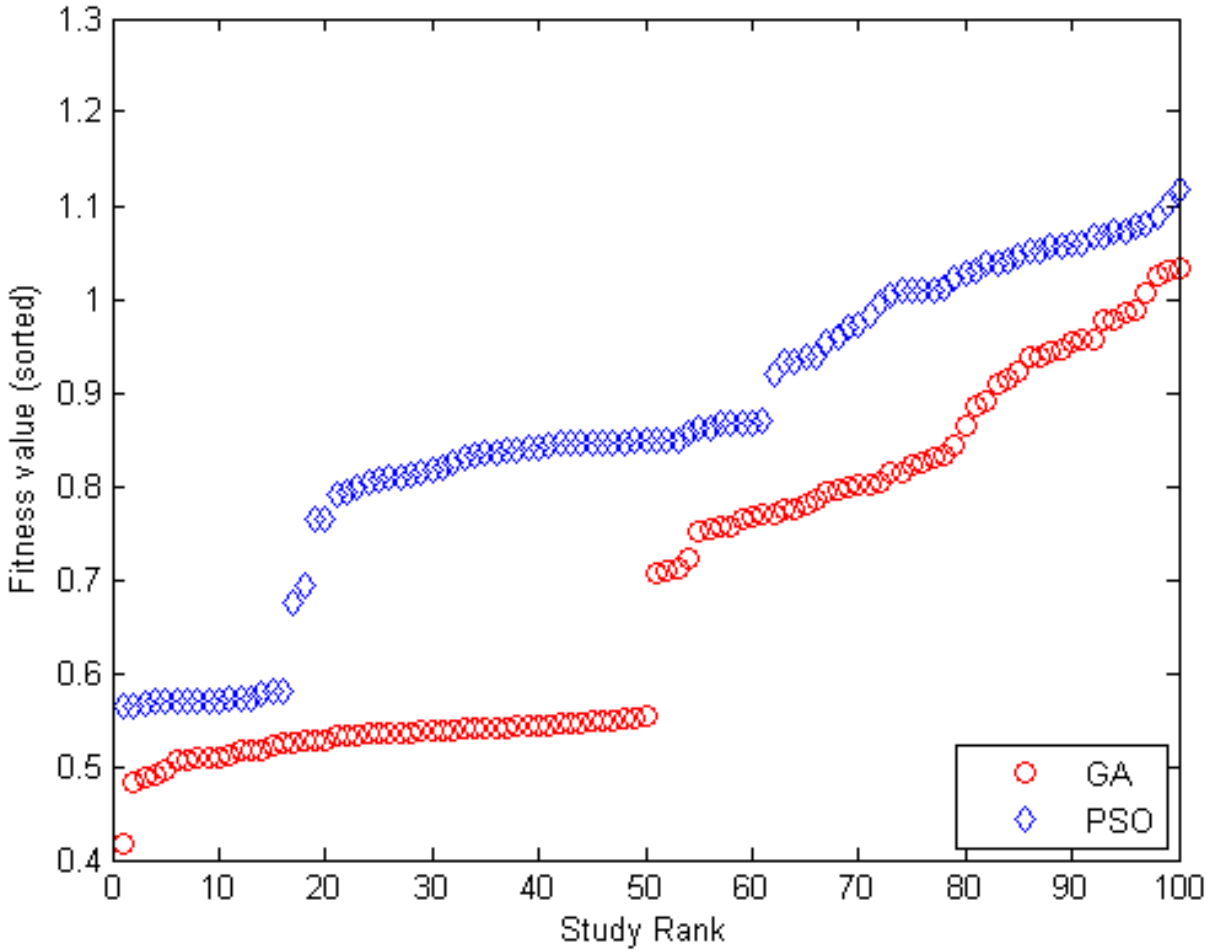
Individuals: 1000

Generations: 5000

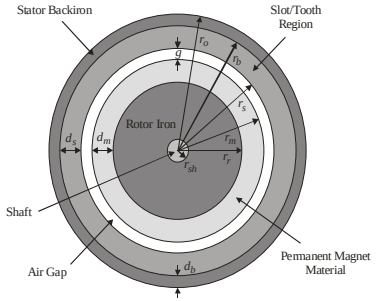
PSO:

Individuals: 400

Iterations: 7025



GA/PSO Comparison
PMSM Design (17 DOF)



GA:

Individuals: 500

Generations: 500

PSO:

Individuals: 378

Iterations: 378