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Numerical Optimization: Particle Swarm Optimization

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Swarms look impressive – Swarm intelligence

- Swarm is compact.
- Each individual reacts on a few neighbors.
- Is this intelligent?
- Find food more efficiently?
- Protection against predators?
- Energy reduction for moving to another place?

Is it reasonable to implement such a strategy for solving numerical optimization problems?

Swarm intelligence?

Swarm is not intelligent – at least not a good search strategy!

Can we still design a good optimization based on the swarm concept?

Particle Swarm Optimization (PSO) Concept

- Distribute N particles (individuals, fishes, birds, agents...) on fitness landscape (usually randomly, but alternatives...)
- Each particle has mass, location, velocity, acceleration
- Each particle knows its current fitness
- Particles have a very primitive communication: Know location of particle with currently best fitness (A)
- Each particle has (very primitive) memory: Reminds location where it had its maximum fitness (B) and where the entire swarm had the maximum fitness (C)
- Particles feel forces towards (A), (B), (C): Weights are introduced
- Search domain may be limited: Reflection strategies when particles would move outside
- Various other options (e.g., limit velocity, plan to reduce velocity)
- Easy to understand but many tuning screws – experience needed

Particle Swarm Optimization works! Well?

- Behavior is usually completely different from that of a fish swarm
- Start randomly: High diversity (good at the beginning, but later?)
- Different patterns of the swarm may be observed, not only trend towards a compact swarm
- Is this an efficient numerical optimization strategy?
- Room for improvement!