AI791 (Computational Intelligence for Optimization Topic 2: Swarm Intelligence

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Presentation Outline I

1. Reading Material

2. Computational Swarm Intelligence
   - What is Swarm Intelligence?
   - What is Computational Swarm Intelligence?
   - Computational Swarm Intelligence Paradigms

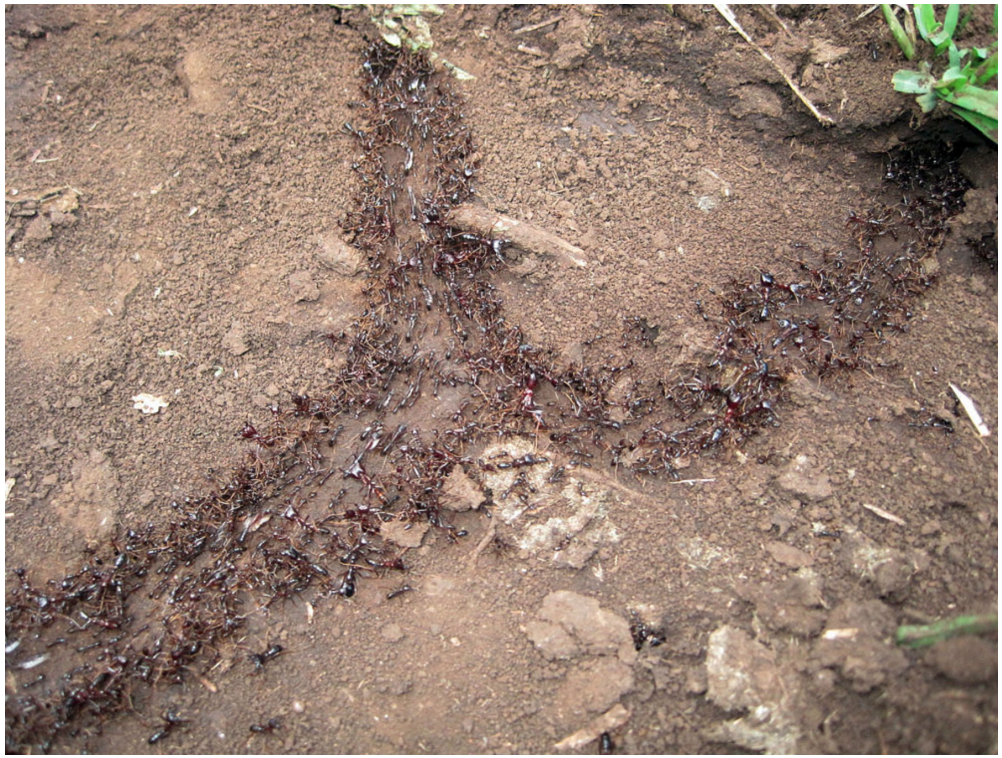
Reading Material

The content of this topic is from Part IV of the prescribed book, *Computational Intelligence: An Introduction*, AP Engelbrecht, Second Edition, Wiley, 2007

Computational Swarm Intelligence

To be discussed:

- What is swarm intelligence?
- What is computational swarm intelligence?
- Computational swarm intelligence paradigms



What is Swarm Intelligence?

Introduction

- In nature, we find many examples of complex organisims that consist of collections of very simple individual organisms
- Each individual organism cannot survive on its own, but collectively a complex organism is formed that exhibits very complex behaviors
- Many computational models of such complex biological organisms have been developed and have been used to solve very difficult real-world problems
- These computational models are usually very simple, because only the individual simple behaviors of the member organisms need to be modeled

What is Swarm Intelligence?

Swarm

What is a swarm?

- A group/collection of (generally mobile) agents which communicate with each other (either directly or indirectly) by acting on their local environment
- Each individual agent is a very simple stimulus/response agent, which
  - senses immediate (local) stimuli,
  - performs a simple action, which
  - effects a change in the local environment

What is Swarm Intelligence?

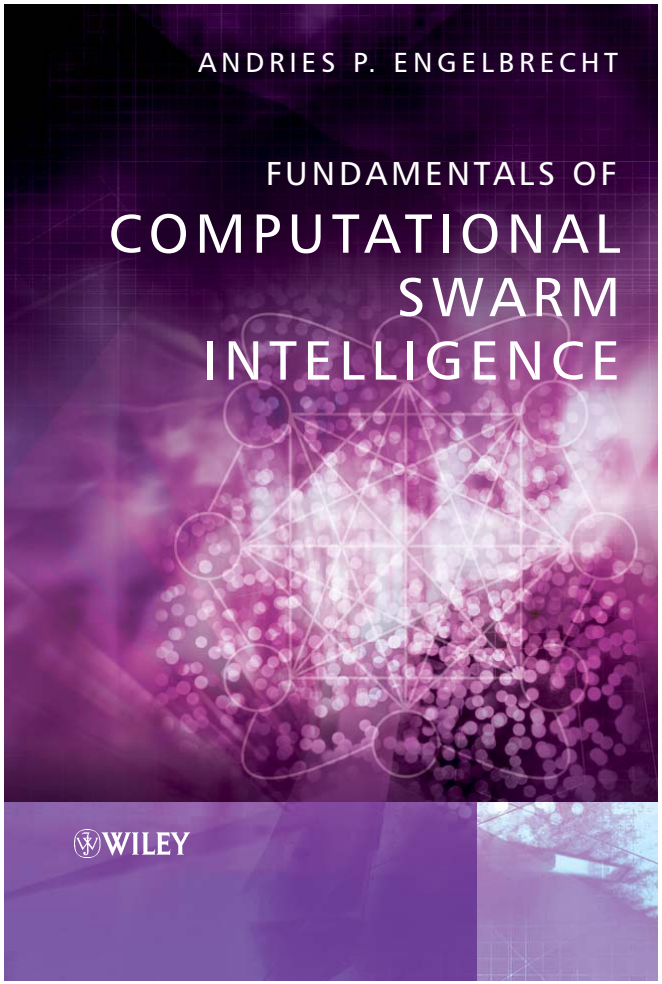
Swarm Intelligence Defined

What is swarm intelligence?

- Interaction among agents results in distributive collective problem-solving behavior
- Swarm intelligence refers to the problem-solving behavior that emerges form such interaction among such simple agents
- Formally: Swarm intelligence is the property of a system whereby the collective behaviors of unsophisticated agents interacting locally with their environment causes coherent functional global patterns to emerge
- Also referred to as collective intelligence
- Self-organized, no centralized control

What is Computational Swarm Intelligence?

Computational swarm intelligence refers to algorithmic models of such collective behavior seen in biological systems



What is Swarm Intelligence?

Paradimgs I

Hussain et al listed 1222 unique publications in meta-heuristics[1]

Campelo and Aranha maintain an extensive list of all metaphor-based meta-heuritstics [2]

Some examples are below:

- Ant Colony Meta-Heuristic
- Particle Swarm Optimization
- Bacterial Foraging Optimization
- Artificial Bee Colony Optimization
- Firefly/Glow Worm Optimization
- Fish School Optimization
- Cat Swarm Algorithm
- Wolf Search Algorithm

[1] K. Hussain, MN. Mohd Salleh, S. Cheng, and Y. Shi, *Metaheuristic research: a comprehensive survey*, Artificial Intelligence Review, 52(4):2191–2233, 2019

[2] F. Campelo and C. Aranha, *EC bestiary: A bestiary of evolutionary, swarm and other metaphor-based algorithms*, http://fcampelo.github.io/ EC-Bestiary/

What is Swarm Intelligence?

Paradimgs II

- Krill Herd Algorithm
- Monkey Search
- Eagle Swarch Strategy
- Wasp Swarm Algorithm
- Bean Optimization Algorithm
- Dolphins Herds Algorithm
- Gravitational Search Algorithm
- Intelligent Waterdrops Algorithm
- Invasive Weed Optimization
- Jumping Frogs Optimization
- Locust Swarms
- Magnetic Optimization Algorithm
- Mosquito Swarms Algorithm
- Rats Herds Algorithm
- River Formation Dynamics
- Roach Infestation Optimization
- Zooplankton Swarms Algorithm
- Stochastic Diffusion Search
- Fungus Search Algorithm
- Dolphin Swarm Algorithm

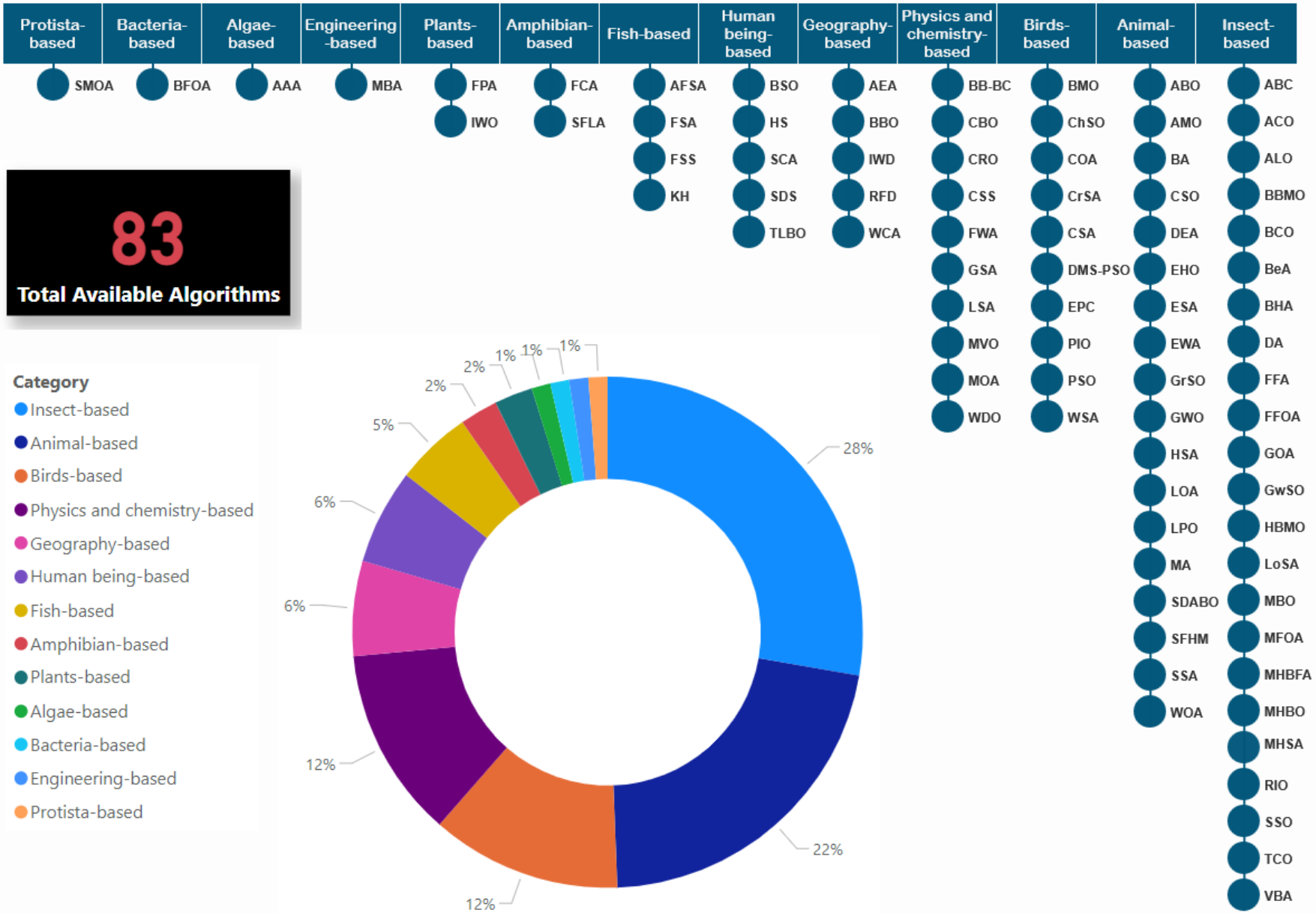
What is Swarm Intelligence?

Paradimgs III

- Wild Monkey Foraging Algorithm
- Desert Ant Foraging Algorithm
- Cuckoo Search Algorithm
- Bat Algorithm
- Fireworks Algorithms
- Feral-Dogs Herd Algorithm
- COVID-19 optimization
- Elephant heard optimization
- Grey wolf optimization
- Wolf pack search
- Slime mould optimization
- Brain storm optimization
- Egrit optimization
- Political optimization algorithm
- Scottis red deer optimization
- African buffalo optimization

What is Swarm Intelligence?

Paradimgs: Categorization



Applications of Computational Swarm Intelligence

The main application of computational swarm intelligence:

- to solve optimization problems

A recent application area of computational swarm intelligence:

- swarm robotics
- drone swarms