



University of Cyprus

Dept. of Computer Sciences
Short Duration Course

Computational Swarm Optimisation

**Professor Andries Engelbrecht,
University of Pretoria, South Africa**

**Where: University of Cyprus
New Campus– Athalassa.
Room No: 148**

**When: Wednesday, 18 March 2009, 10:00 – 16:00
Thursday 19 March 2009, 10:00-16:00**

Computational Swarm Optimisation

Course Outline

Swarm intelligence refers to the problem-solving behavior that emerges from the interaction of very simple agents. An agent in a swarm-based system is a stimulus-response agent, that observes its local environment and then performs a simple action. The result of the action can be another local change to the environment. More formally, swarm intelligence is the property of a system whereby the collective behaviors of unsophisticated agents interacting locally with their environment cause coherent functional global patterns to emerge. Computational swarm intelligence (CSI) refers to algorithmic models of such behaviors.

A number of CSI models have been developed, modeling different behaviors of different swarm-based systems. Of these ant algorithms (AA) and particle swarm optimization (PSO) are the most frequently used models. These models have been applied successfully to mostly optimization problems.

With reference to optimization problems, different classes of optimization problems can be identified. These include static, dynamically changing, unconstrained, constrained, and multi-objective problems. More complex problems exist which are combinations of these classes. Furthermore, variables to be optimized can be binary-valued, discrete-valued, integer-valued, and continuous-valued. Combinations of these variable types may also occur. For most optimization problems we are interested in obtaining one solution. However, for many real-world problems it is necessary to locate all, or as many as possible solutions.

This tutorial will focus on the main two CSI paradigms, namely AA and PSO, and how algorithms from these paradigms can be used to solve the wide variety of optimization problem classes as mentioned above.

The first day will focus on PSO. An introduction to PSO and basic variations of PSO will be given. Some issues with regards to convergence will be discussed. This will be followed by different PSO implementations, and how these implementations addresses the exploration--exploitation trade-off. Next, the different optimization problem classes will be covered, followed by discussions on how PSO can be adapted to optimize problems from each problem class.

The second day will focus on ant algorithms, specifically ant colony optimization. An introduction to the ant colony optimization meta-heuristic (ACO-MH) will be given, followed by a discussion on a number of variations of the ACO-MH. This will be followed by a discussion on how these ACO-MH can be used to solve different optimization problem classes. If time permits, models of the cemetery organization and division-of-labor behaviors of ants will be covered.

Andries Engelbrecht short CV

Andries Engelbrecht is a professor in Computer Science at the University of Pretoria, South Africa. He also holds the position as South African Research Chair in Artificial Intelligence, and leads the Computational Intelligence Research Group at the University of Pretoria, consisting of 50 Masters and PhD students. He obtained his Masters and PhD degrees in Computer Science from the University of Pretoria in 1994 and 1999 respectively. His research interests include swarm intelligence, evolutionary computation, artificial neural networks, artificial immune systems, and the application of these CI paradigms to data mining, games, bioinformatics, and finance. He has published over 130 papers in these fields in journals and international conference proceedings, and is the author of the two books, "Computational Intelligence: An Introduction" and "Fundamentals of Computational Swarm Intelligence". In addition to these, he is a co-editor of the upcoming books, "Applied Swarm Intelligence" and "Foundations on Computational Intelligence". He is very active in the international community, annually serving as a reviewer for over 20 journals and 10 conferences. He is an associate-editor of the IEEE Transactions on Evolutionary Computation, Journal of Swarm Intelligence, and the recent IEEE Transactions on Computational Intelligence and AI in Games. Additionally, he serves on the editorial board of 3 other international journals, and is co-guest-editor of special issues of the IEEE Transactions on Evolutionary Computation and the Journal of Swarm Intelligence. He served on the international program committee and organizing committee of a number of conferences, organized special sessions, presented tutorials, and took part in panel discussions. As member of the IEEE CIS, he is a member of the Games technical committee and chair of its Swarm Intelligence for Games task force. He also serves as a member of the Computational Intelligence and Machine Learning Virtual Infrastructure Network.