Autonomous Intelligent Systems,
Institute for Computer Science VI, University of Bonn

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Exercises for Artificial Life (MA-INF 4201), SS24

Exercises sheet 12, till: Mon 7. June, 2025

30.6.2025

Assignment 77 (2 Points)

What are the major differences between the following groups of animals: *flocks*, *herds* and *swarms*?
What difference with respect to the behavior of the individuals can you determine in this groups?

Assignment 78 (2 Points)

In the Didabot experiment the Didabots are creating so called *heaps* or *Clusters* of boxes.
Give a definition of a *cluster* and try to formulate a mathematical criterion that can decide if an arrangement of boxes has clusters or not.

Assignment 79 (1 Point)

Find and cite a recent application of swarming behavior in the field of movie industrie.
Give a scientific acceptable citation.

Assignment 80 (2 Points)

Explain a set of rules for autonomous agents, that is capable of generating swarm-like behavior.
Please use your own words for the explanation.

Assignment 81 (2 Points)

How will the resulting clusters be affected in the Didabot-Experiment when changing from one Didabot to multiple Didabots?
Explain your solution.

Assignment 82 (3 Points)

A group of particles has been defined for a PSO algorithm to be organized as a ring of K particles. The update for the velocities for each of these particles in the group shall only depend on the former velocity, their personals-best and on the best of the $r = 1$ neighborhood (as defined for 1-dim CAs).
Derive the formula to update the velocity under these conditions.
In addition, write down the formula using your favorite programming language.
(Every programming language is elligible, as long as you can name it, and explain the syntax and the formula that you have used).

Assignment 83 (3 Points)

Explain the task of the $\mathcal{R}$ function in PSO velocity update.
What is the purpose and how can/should it be implemented.

Programming Assignment: G (10 Points, due date **Mon 14.7.2025**)

Remark: handing-in earlier is possible

Write a Python (or C, C++ or Java) programm that implements function-minimization using the Particle Swarm Optimization method (PSO).

The function $G(\vec{\mathbf{w}})$ to minimize depends on $\vec{\mathbf{w}}$ which is a 9 dimensional vector $\vec{\mathbf{w}} = (w_0, w_1, w_2, \ldots, w_8)$ and on the logistic function $f(z) = \frac{1}{1+e^{-z}}$.

$$
\begin{aligned}
G(\vec{\mathbf{w}}) = & \left(0.0 - f\Big(w_6 + w_7 * f(w_0) + w_8 * f(w_3)\Big)\right)^2 \\
& + \left(1.0 - f\Big(w_6 + w_7 * f(w_0 + w_1) + w_8 * f(w_3 + w_4)\Big)\right)^2 \\
& + \left(1.0 - f\Big(w_6 + w_7 * f(w_0 + w_2) + w_8 * f(w_3 + w_5)\Big)\right)^2 \\
& + \left(0.0 - f\Big(w_6 + w_7 * f(w_0 + w_1 + w_2) + w_8 * f(w_3 + w_4 + w_5)\Big)\right)^2
\end{aligned}
$$

What is the minimal value for G that can be reached?
Write down the vector $\vec{\mathbf{w}}^*$ that has reached the minimal value for G.
Depict the development of G during the minimization process.