Topic for a Master’s Thesis:
Decentralized on-line machine learning
for swarm intelligence systems

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The notion of (artificial) swarm intelligence (SI) refers to a specific approach to the design of artificial intelligence systems that seeks to mimic problem-solving strategies of biological swarms such as ant colonies. SI systems consist of a population of simple agents, such as robots, that are interacting locally with each other and with their environment. Typically, this is done by letting each agent follow simple rules, and without any centralized control structure [1].

The rules determining the behavior and decisions of individual agents, and hence of the entire swarm, are often predefined by the systems engineer. As an interesting alternative, one can think of using machine learning methods in order to equip the agents with the capability of learning and adapting their behavior based on observations and feedback from the environment. In spite of the existence of a few works on this topic, the combination of SI and machine learning is still in its infancy. The current thesis is meant to make a contribution along this direction.

More concretely, the goal of the thesis is to develop, analyze and evaluate local, decentralized machine learning methods that allow a swarm to learn and take decisions (make predictions) in a simple problem setting, such as binary classification. Important challenges in this regard include the local exploitation of global feedback as well as the need for information aggregation strategies to reach consensus decisions on the swarm level. As a point of departure, it will be useful to look at recent work on distributed on-line machine learning, such as [2], although the setting is not exactly the same and not directly connected to swarm intelligence.

The requirements for the thesis include the following: formalization of a concrete problem setting; development, implementation and analysis of learning algorithms suitable for that setting; experimental evaluation using simulation studies and synthetic data.

Prerequisites: Basic knowledge in machine learning and swarm intelligence, programming skills.

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References
