Observation and Control of Collaborative Systems (OCCS)

DFG SPP 1183 Organic Computing

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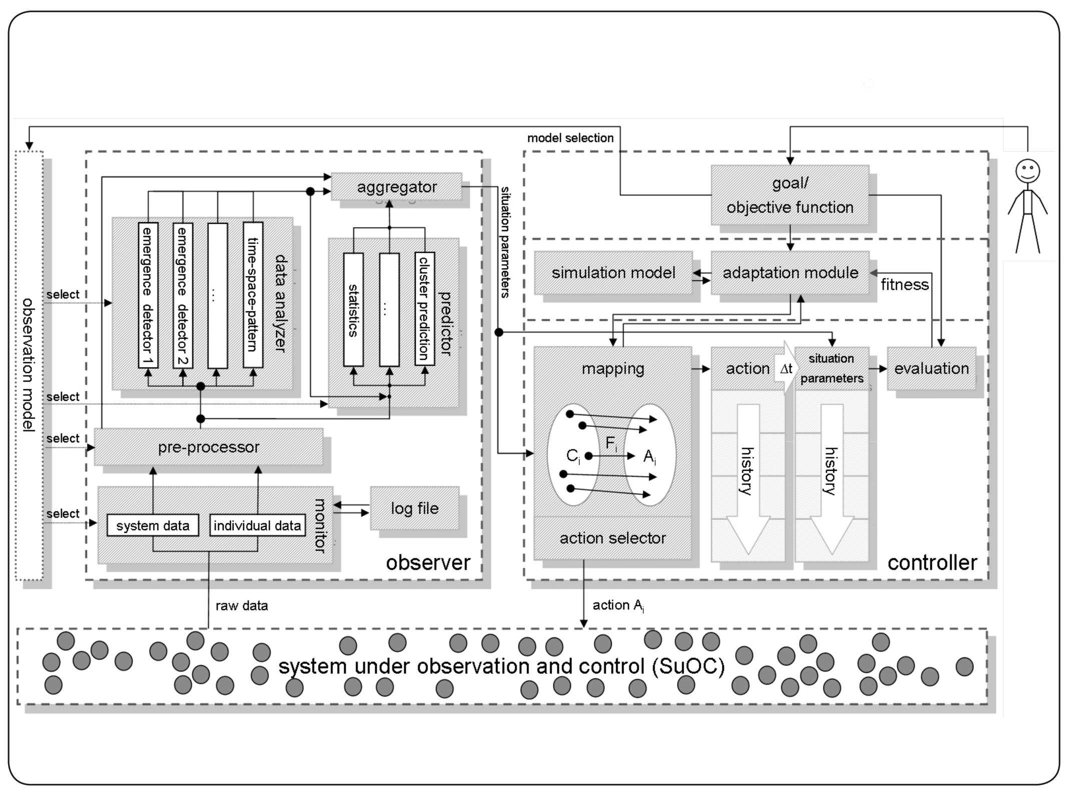
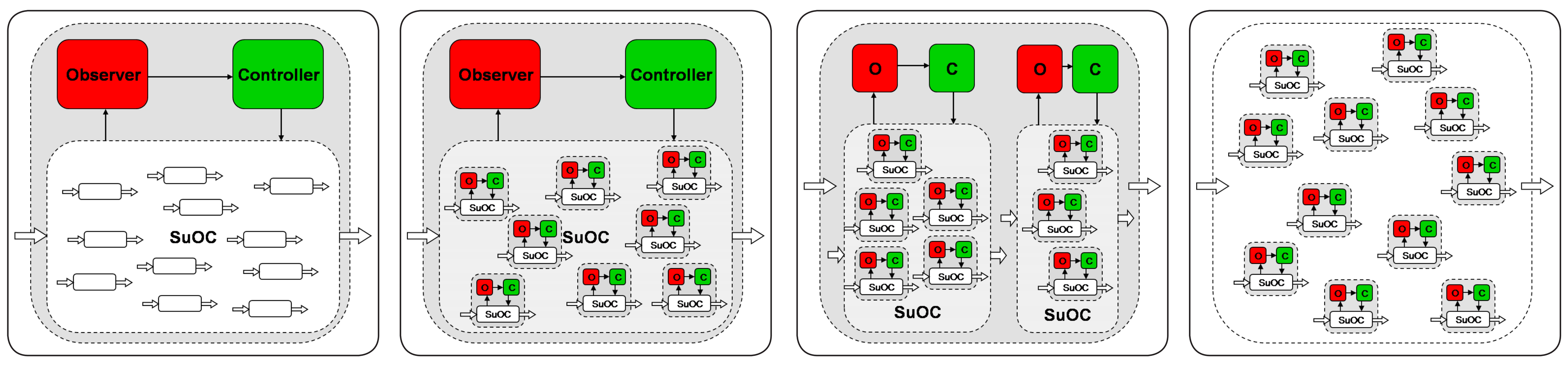
Goals

- Concentration on distributed and collaborative o/c architectures
- Dealing with collective learning as part of the distributed controllers
- Systematic investigation of collaboration patterns in OC systems
- Quantifying robustness and flexibility
- Developing the capability of generating reasonable predictions

Observer/Controller Architecture

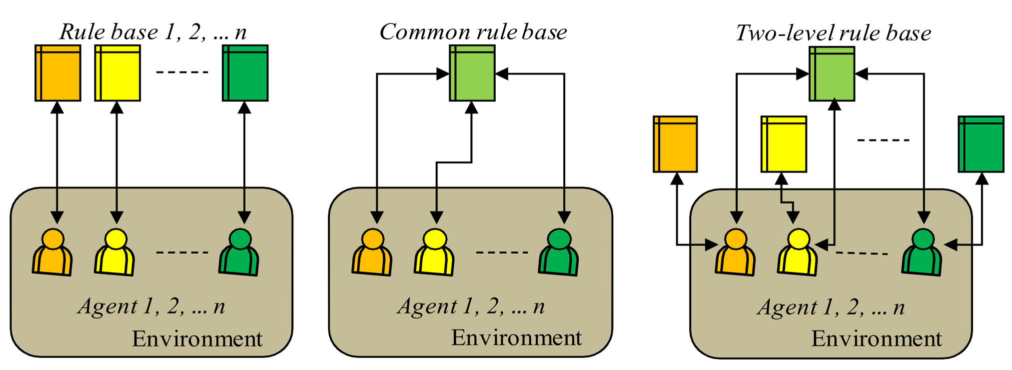


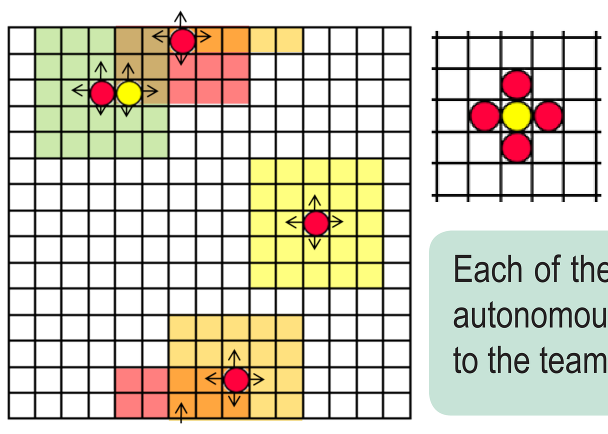
- The system under observation and control (SuOC) consists of a set of interacting intelligent autonomous units.
- The observer measures, analyses, and reports the system behaviour to the controller.
- The controller applies adequate actions to the SuOC to achieve a given goal.



Learning Architectures in OC Systems

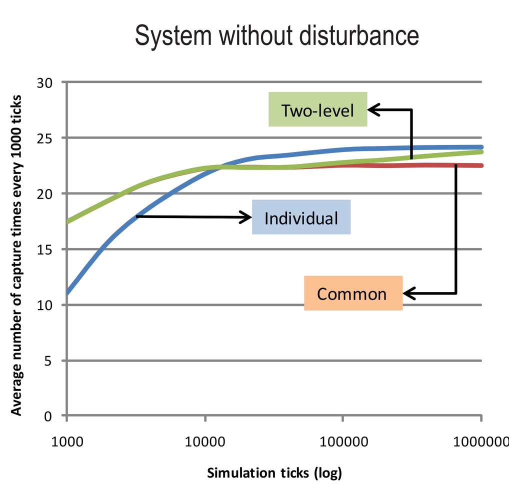
- Implementation of XCS in OC systems using individual, common and two-level rule bases.
- The architectures were tested using the predator/prey pursuit scenario.
- The common rule base learns quicker than the individual rule base, but performs inferior in the long run.
- The two-level rule base combines the advantages of both individual and common rule bases and performs better against disturbance on predator's receiver.

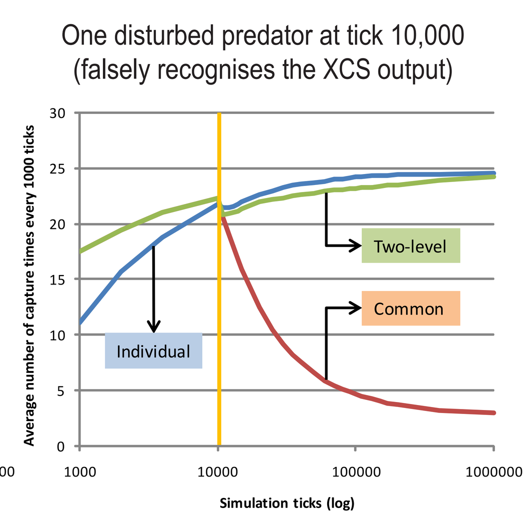




Four homogeneous predators having local observation areas aim to capture a prey.

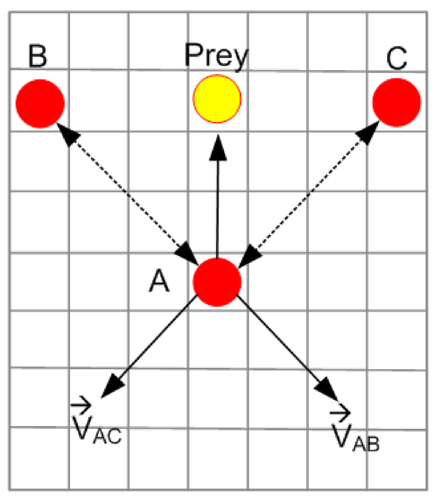
Each of the predators makes decisions autonomously while trying to contribute to the team at the same time.



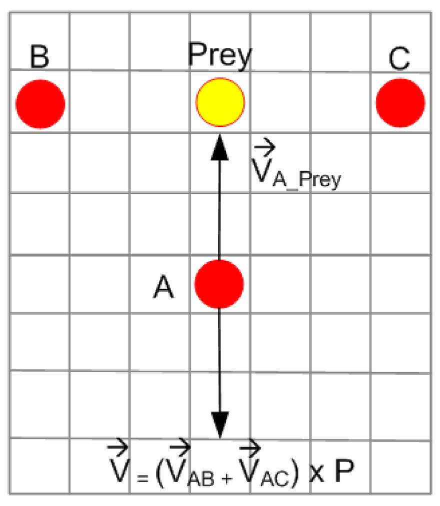


Collaboration Patterns in OC Systems

A scenario with slow predators and a fast prey which move and interact on a two-dimensional grid according to a repulsion/attraction model.



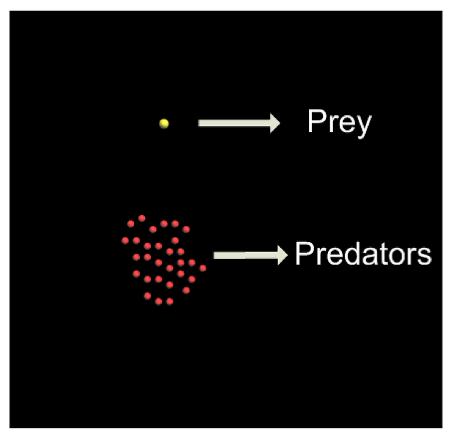
The repulsion and attraction vectors of a predator



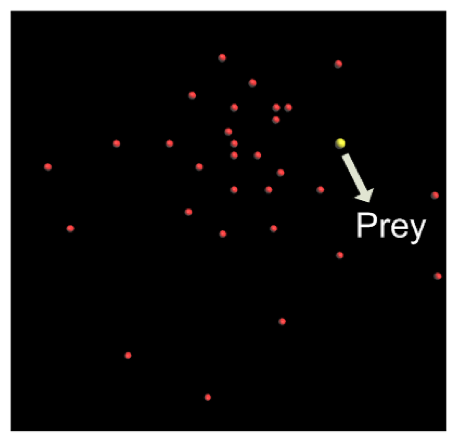
The attraction vector and the sum of both repulsion vectors

- A predator is attracted by the prey and repelled by other predators.
- The prey is repelled by the predators and also by the boundaries of the environment.
- Each predator uses a single parameter (P) to adapt the magnitude of the repulsion vectors from other predators.

- **Non-collaborative behaviour:** The repulsion parameters (P) are all set to 0, i.e., each predator pursues the prey on its own without considering other predators.
- **Collaborative behaviour:** The repulsion parameters have a non-zero value, i.e., the predators consider each other while moving, and pursue the prey collectively.



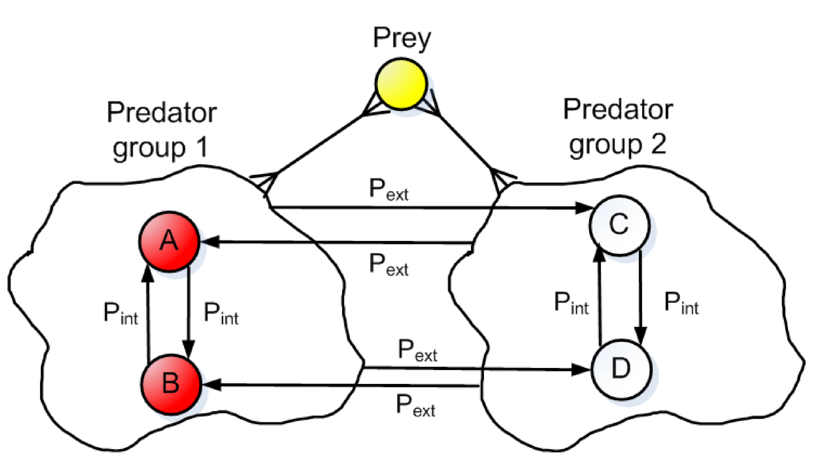
The non-collaborative system where each predator tries to pursue the prey individually.



The collaborative system where predators pursue the prey collectively.

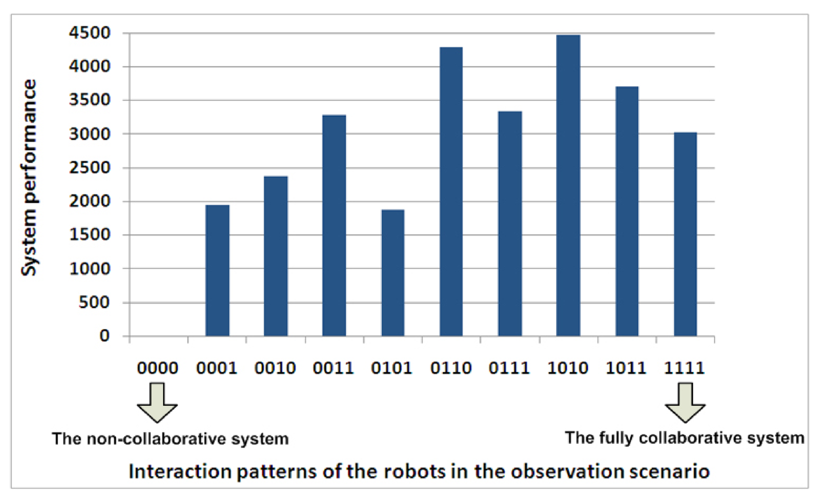
- The predators adapt their repulsion parameters using a swarm-based optimisation algorithm similar to Particle Swarm Optimisation (PSO).

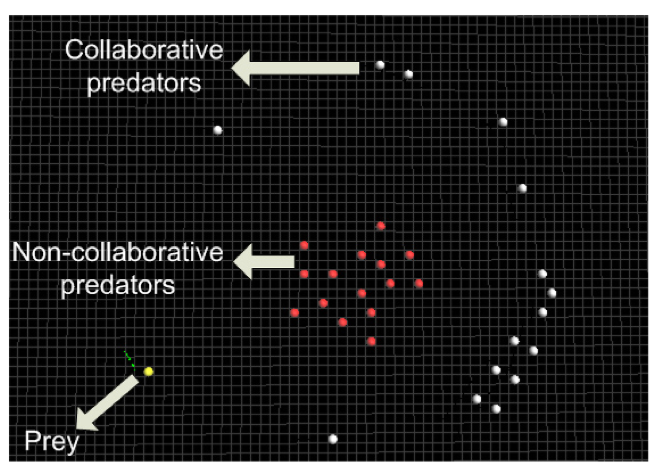
Investigation of more sophisticated collaboration patterns using two different groups of predators



- Predators optimise two repulsion parameters P_{int} and P_{ext} to determine their internal and external group behavior.
- Systematic investigation of different interaction patterns of the predators between the fully collaborative and the non-collaborative one.

- **Result**: Neither the non-collaborative nor the fully collaborative system provides the best system performance.
- The optimum is between the non-collaborative and the fully collaborative system behaviour.





- The optimal system behaviour is achieved with collaborative predators that chase the prey towards non-collaborative ones.

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