

## Multi-Agent Systems

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### Exercise Sheet 9

**Due: January 10, 2020**

The following exercises build upon our agent implementation framework that you can find at <http://gki.informatik.uni-freiburg.de/teaching/ws1920/multiagent-systems/framework.tar.gz>. You will need a current version of Python (version 2 or 3) as well as Pygame and Numpy (which you can, e.g., install via `pip install`) to run it. Note that a detailed documentation of our framework is contained in `framework/README.md`.

#### Exercise 9.1 (Swarm Formation Programming, 4+4+4)

Your task in this exercise is to implement some of the swarm formation algorithms by Sugihara and Suzuki.<sup>1</sup> Use the template provided in `formation.py`. The idea is to control the whole group of agents using the keyboard. Currently, the user can instruct all the agents to randomly *walk around* (by pressing **W**), or to *freeze* (by pressing **SPACE**). Furthermore, it is possible to select and deselect agents with the mouse. Selected agents can later be used as designated corner agents of a polygon.

- (a) Implement the `CIRCLE` and `FILLCIRCLE` behaviors. The user should be able to trigger them by pressing respectively **R** and **F** on the keyboard.
- (b) Implement the `CONTRACTION` and `FILLPOLYGON` behaviors. The user should be able to trigger them by pressing respectively **C** and **P** on the keyboard (e.g., after having selected the corner agents – which will remain on their places – from a circle of agents).
- (c) Implement some collision avoidance behavior. Your solution needs not to be optimal.

#### Exercise 9.2 (Bonus: Simulation Experiments, 4)

Consider the following set of parameters: `ControllerType` (`UnicycleController`, `DifferentialController`),  $N$  (number of agents),  $D$  (diameter of the circle),  $\delta$  (tolerance), and  $V$  (number of vertices of the shape, if applicable). Write down four hypotheses about how you think the systematic variation of some subset of the parameters affects the behavior of the swarm. Run simulations and describe your observations. Can your hypotheses be confirmed?

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<sup>1</sup>[http://dx.doi.org/10.1002/\(SICI\)1097-4563\(199603\)13:3<127::AID-ROB1>3.0.CO;2-U](http://dx.doi.org/10.1002/(SICI)1097-4563(199603)13:3<127::AID-ROB1>3.0.CO;2-U)