Citation
Goings, Sherri, Emily PM Johnston, and Naozumi Hiranuma. "The effect of communication on the evolution of cooperative behavior in a multi-agent system." *Proceedings of the Companion Publication of the 2014 Annual Conference on Genetic and Evolutionary Computation*. ACM, 2014.

Problem Description
The problem described in this paper is to determine a movement strategy for each of three “predator” individuals that allows them to cooperatively trap a single “prey” individual in a simulated two-dimensional toroidal world. A single evaluation consists of placing 3 predators and 1 prey in some position in the simulated world, then iterating through time-steps where at each step all 4 individuals choose a movement direction and speed based on the information each has about the current positions of the other 3 individuals. The 4 movements then are simulated to happen simultaneously. The individual evaluation ends when either the prey is “caught” by at least 1 predator coming within 1 distance-unit of the prey, or when 475 time-steps have passed.

The representation used for a predator strategy was a neural network with input values entering through the input layer nodes and output values coming from the output layer nodes. Different hidden layer structures were experimented with. Experiments were done using varying numbers and types of inputs, but all of them involved inputs for the position offsets of one or more of the other individuals relative to the current individual. The outputs were always 5 values that determined the current individual’s next move (4 weights for cardinal directions that calculated the direction to move, and 1 value that set the fraction of the maximum allowable distance to move in the given direction).

The behavior of the prey is preset; it changes over time as the predators improve, but it always changes in the same way that is defined at the beginning of an experiment. The predator strategies each evolved separately in individual populations. The quality of an individual predator strategy was determined by running 10 evaluations, each with a different pair of other predators (one from each of the other 2 populations). The fitness of a predator for a single evaluation was highest if the prey was “caught” by any predator (the fitness of all 3 predators is the same for a single evaluation, as the goal is to cooperate together to catch the prey, not compete for it). If the prey was not caught, the fitness was based on the average distance of the prey to the 3 predators. The total fitness of the predator strategy being tested for that generation was the average of the fitness over all 10 evaluations.

Parameters
Several parameters are discussed, a few are detailed below.

- Determining when to end evolution: It seemed that if a certain threshold fitness was reached that run was ended. Specifically, the fitness was high enough if the best group of 3 predators caught the highest-level prey in 7 out of 9 benchmark tests (prey started in a different position in each test). For experiments where that fitness was never reached, a limit of either 500 or 1000 generations was imposed.

- Population size: This experiment used 3 distinct populations, one for each predator. Each of the 3 populations contained 250 individuals.

- Selection method, mutation, crossover: not mentioned (I believe (hope?) that we submitted a separate “methods” supplement due to length restrictions for the paper)