Selective attention in artificial organisms

Fabio Ruini[1] and Domenico Parisi[2]

[1]University of Plymouth, School of Computing, Communications and Electronics
[2]Institute of Cognitive Sciences and Technologies, National Research Council, Rome
fabio.ruini@plymouth.ac.uk

Behaviour has two levels, which we will call strategic and tactical. At the strategic level the organism has to choose which particular activity to pursue at any given time (e.g., looking for food, finding a sexual partner, escaping from dangers, sleeping). At the tactical level it must implement the particular sequence of actions that makes it possible to achieve the goal of the chosen activity. The strategic level has important consequences for attention. Since an organism receives many different stimuli at the same time, it has to selectively attend to the ones that are relevant to the current activity while ignoring those which are not.

A population of organisms lives in an environment with randomly distributed food elements in which a predator appears from time to time. The organism's behaviour is controlled by a neural network with input units encoding the location of the nearest food and other input units encoding the location of the predator when it is present. Both sets of input units are connected to a single layer of internal units, which in turn are connected to the output units that control the organism's movements. The connection weights of the neural architecture are evolved using a genetic algorithm where the organism's fitness depends on both the number of food elements eaten and the organism's ability to avoid being reached by the predator. We contrast two populations of organisms, one with the basic neural architecture and the other one with an architecture which includes an additional set of units which receive connections from the input units encoding the predator's location and send connections to the internal layer. Both populations are able to evolve the appropriate behaviour which consists in looking for food when the predator is absent and flying away from the predator when it is present, ignoring food. However, the population with the additional units reaches higher levels of fitness compared with the population with the simpler architecture. Two additional control simulations show that higher levels of fitness are not obtained if we simply increase the number of internal units or if we connect the additional units directly to the output layer.

To better understand why the additional units yield a better performance we compared the activation patterns of the internal units when the locations of both food and predator are encoded in the input units and when only the latter is encoded and there is no food. This comparison shows that the contribution of the additional units consists in making the activation patterns more similar in the two conditions, with the activation patterns becoming even more similar as the predator comes closer to the organism. In other words, the additional units allow the organism's nervous system to better filter out the information from food when the predator is present and, therefore, they might be considered as functionally equivalent to the modulatory influence of subcortical structures on frontal cortex in real organisms.