Adaptive Behavior of Incrementally Evolved Neural Networks based on Cellular Automata*

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1 INCREMENTAL EVOLUTION

Evolutionary algorithm is known as one of the promising approaches to control a mobile robot. Several researchers have attempted to construct the mobile robot controller that can avoid obstacles, evade predators, or catch moving prey by evolutionary algorithm such as genetic algorithms and genetic programming.

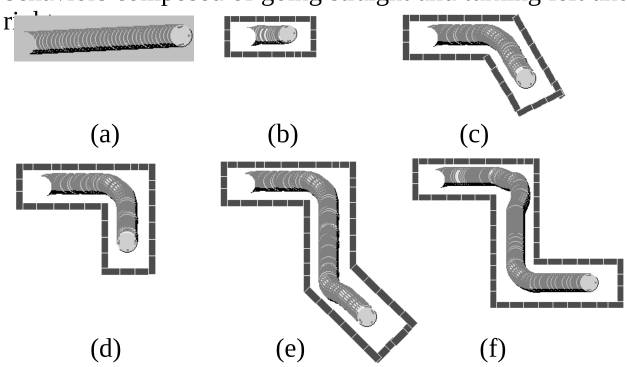
In previous work, we presented the results of applying the CAM-Brain, evolved neural networks based on cellular automata (CA), to control a mobile robot [1]. However, the direct evolution has a difficulty that the controller cannot generalize well to new environments. In this paper, we attempt to solve it by incremental evolution, which starts with simpler environments and gradually develops the controller with more general and complex environments.

Evaluation tasks $\{t_1, t_2, t_3, ..., t_n\}$ are derived by transforming a goal task in incremental evolution, where n is the number of tasks and t_n is the goal task. In this set, t_i is easier task than t_{i+1} for all i: $0<i<n$. Thus, population is evaluated in task t_i and then task t_{i+1}, and it goes by the goal task, t_n, finally [2]. It is expected to produce complex and general behaviors which can adapt in changing environment.

2 SIMULATION RESULTS

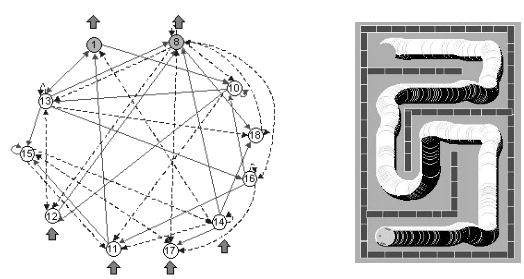
Because a mobile robot can perform complicated behaviors with the combination of going straight and turning left and right, we make a module to evolve to do these basic behaviors by incremental evolution. After the CAM-Brain module is evolved in the environment intended to go straight, successful chromosomes are copied to the next population. Then it is evolved in the environment to go straight and turn right. Progressing this process the controller evolves to go straight and turn left and right. Efficient evolution is expected because of the reduced search space by incremental evolution.

Fig. 1 shows the trajectories of a successful robot in each environment. The environment in Fig. 1 (a) leads the robot to going straight on the situation of no obstacles and Fig. 1 (b) does in the situation of obstacles. Fig. 1 (c) and (d) induce to turn right and Fig. 1 (e) and (f) induce to turn left. Fig. 2 shows the architecture of neural networks evolved incrementally and results of applying it to different and more difficult environments. This shows that the robot evolved by the incremental evolution can navigate smoothly in the new environments required the behaviors composed of going straight and turning left and right.



(a) (b) (c) (d) (e) (f)

Figure 1: Trajectories of the successful robot in each environment.



(a) (b)

Figure 2: The architecture and results. (a) The architecture of NNs. (b) The results of applying to other environments.

References

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