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APPLICATION OF RECURRENT NEURAL CONTROLLERS FOR ROBOT COMPLEX TASK PERFORMANCE

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Abstract. *For autonomous intelligent robots continually interacting with the environment it is essential to store temporal and sequential information. In this paper, we consider a non-Markovian sequential task in which the preceding state alone does not determine the next action. To achieve a better fitness, the agent must have a working memory to reach the target position, must ignore irrelevant sensory inputs, and at a higher level, it has to deal with the non-Markovian order of sequential task. In our work, we applied an extended evolutionary algorithm to evolve the structure and the weight connections of the recurrent neural controller. In order to improve the convergence of evolution and reduce the computation time, we employed a multi-population Genetic Algorithm (MPGA) where subpopulations cooperate and compete with eachother. Simulation and experimental results using the Cyber Rodent robot show that optimal recurrent neural architectures were generated through the course of evolution.*
Keywords: Recurrent neural controller, Multi-Population GA, Robot

1. **Introduction.** Robots operating in everyday life environments are often required to perform sequential actions, which require the storage and update of internal states. Therefore, recurrent neural networks are expected to be effective for robot complex task performance. In connectionist studies, supervised learning algorithms were applied to recurrent neural networks [1]. Reinforcement learning algorithms have also been applied to recurrent neural networks for control of locomotion [2] and sequential behaviors [3].

Evolution of recurrent networks has also been explored for locomotion ([4]) and sequential behaviors [5-7]. For example, Urzelai and Floreano [5] evolved neural controllers for a Khepera robot to travel back and forth between lighted and dark target areas, using proximity, light and visual sensors. Yamauchi and Beer [7] showed that continuous time recurrent neural networks capable of sequential behavior and learning can be evolved to display reinforcement learning-like abilities. The task studied was generation and learning of short bit sequences based on reinforcement from the environment.

In this work, we consider a more complex non-Markovian sequential task in which the memory of a preceding event alone does not determine the next action to be taken. Therefore, in addition to ordinary working memory of the most recent event, the agent must store and update a higher-order working memory.

On the other hand, evolutionary algorithms gives better results compared with reinforcement learning when only delayed reinforcement is available to the learning robot because it does not rely on the moment-to-moment guidance. However, as the complexity of the task increases, it is often difficult to decide which evolutionary algorithm is best suited and how operators and parameters must be combined. In order to improve the