

# Learning of Coordinated Actions with Deep Reinforcement Learning in Doubles Pong Game

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Venue: E-JUST – HQ, Room 207.

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**Abstract:** In this talk, an experimental study to investigate if the cooperative and coordinated behaviors between joint and concurrent learning agents can emerge using deep Q-learning will be presented. Multi-agent systems (MAS) arise in a variety of domains. The collective effort is one of the main building blocks of many fundamental systems that exist in the world and thus, decision making under uncertainty for collaborative work is one of the important and challenging issues for intelligent cooperative multiple agents. However, the decisions for cooperation are highly sophisticated because agents may have a shared goal or individual goals to achieve and their behavior is inevitably influenced by others. On the other hand, deep learning technique is recently used to identify/classify objects or situations, but applying it for identification of coordinated and cooperative activities has just begun and actually only a few results were reported. Therefore, we attempt to explore whether agents using deep Q-networks (DQN) can learn cooperative behavior. We use doubles pong game that is a simple example (because there are only two agents) but has so many states to learn using the framework of reinforcement and Q learning. We then investigate how they learn to divide their works (division of labor) through iterated game executions. In our approach, each agent uses its own DQN to modify its behavior and they jointly learn their area of responsibility. Our experiments indicate that effective cooperative behaviors with balanced division of work load emerge.

**Bio:** Toshiharu Sugawara is a professor of Department of Computer Science and Engineering, Waseda University, Japan, since April, 2007. He received his B.S. and M.S. degrees in Mathematics, in 1980 and 1982, respectively, and a Ph.D in Engineering, in 1992, from Waseda University. In 1982, he joined Basic Research Laboratories, Nippon Telegraph and Telephone Corporation. From 1992 to 1993, he was a visiting researcher in Department of Computer Science, University of Massachusetts at Amherst, USA. His research interests include multi-agent systems, distributed artificial intelligence, machine learning, and distributed network management.