Vector Quantization for State-Action Map Compression (Prof. T. Arai and Mr. R. Ueda)

Dynamic Programming (DP) has been proposed by Bellman in the 50s as a direct method for solving optimal control problems. Though computational complexity of DP is huge, its application range is expanding thanks to the development of computers.

We have utilized DP for planning of behavior for a small soccer robot, which is show in Fig. 1. When we create a control policy, which is written on a huge memory array and is called a state-action map, by DP on a powerful computer, a problem occurs: the small robot does not have enough memory to unfold the state-action map. We think that this problem is common to systems that are controlled by small computers if DP is applied to them.

Under the circumstance, we have the motivation to try compressing state-action maps. The vector quantization technique is used for the compression. As shown in the figures below, this method has been applied to decision making for soccer robots, the puddle world task, and the Acrobot that are standard problems of artificial intelligence and robotics. In the tasks, we have verified that the compression method can reduce size of state-action maps with high compression ratio (1/10 – 1/1000).

Keywords: dynamic programming, vector quantization, RoboCup, puddle world task, the Acrobot

References

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2) R. Ueda, T. Arai, and K. Takeshita: "Vector Quantization for State-Action Map Compression - Comparison with Coarse Discretization Techniques and Efficiency Enhancement," Proc. of IEEE/RSJ IROS, pp. 166-171, 2005.
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Fig. 1 behavior of a robot with DP result

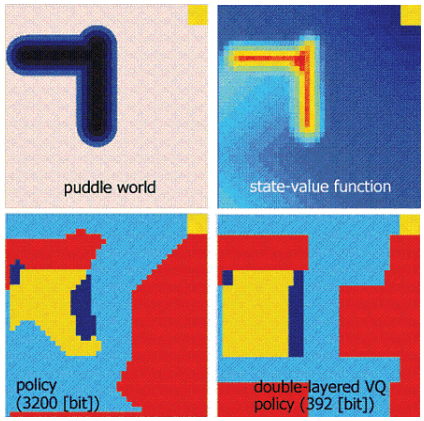

Fig. 2 compression of a policy for the puddle world task

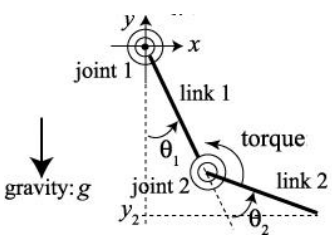

Fig. 3 the Acrobot and its compressed control policy