Decision Making by State-Action Map and Its Application

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When a robot must decide its behavior in real-time, a look-up table that contains appropriate behavior for every state in the environment and the robot is useful. That is because the robot can choose its behavior only by a reference of memory at every moment. We have studied creation of the look-up tables, which are called state-action maps with dynamic programming. Then, various offspring of the method have been proposed also (e.g. compression method of state-action map1), real-time Q-MDP method2)).

In Fig. 1, a robot (ERS-7 made by SONY) approaches to the ball with a state-action map. The robot iterates map reference at every step of walking with self-localization result and measurement of the ball, and creates the sequence of actions as shown in the figure. A state-action map is used for a goalkeeper in Fig. 2. In this map, the pose of the robot, the velocity and position of the ball are considered. The goalkeeper can judge its strategy (blocking at the goal, seizing the ball, etc.) from the state-action map. Our current challenge in this study is to create cooperative behavior of two robots without heuristics. In Fig. 3, two robots behave on simulation with a huge state-action map, which contains actions of 610 million states. We have obtained the huge map within one week with a computer that have 3GB RAM and a 3.6GHz Pentium 4 CPU.

Keywords: Dynamic programming, Vector Quantization

References

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2) R. Ueda, T. Arai, K. Sakamoto, Y. Jitsukawa, K. Umeda, H. Osumi, T. Kikuchi and M. Komura: “Real-Time Decision Making with State-Value Function under Uncertainty of State Estimation -Evaluation with Local Maxima and Discontinuity,” Proc. of IEEE ICRA, pp. 3475-3480, 2005.

Fig. 1 Behavior for obtaining the ball

Fig. 2 Goalkeeper behavior

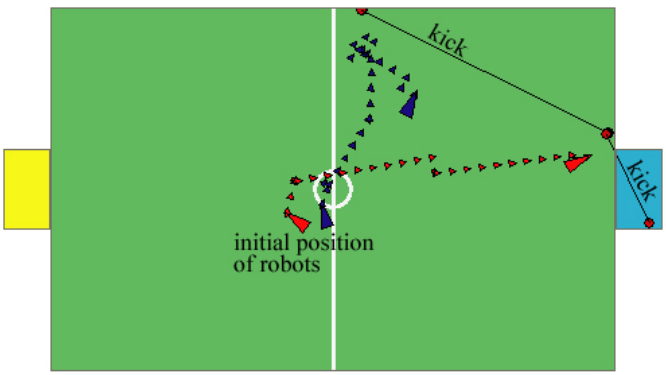

Fig. 3 Cooperative behavior of two robots on simulator