

# Decentralized Reinforcement Learning Applied to Mobile Robots

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**Abstract.** In this paper, decentralized reinforcement learning is applied to a control problem with a multidimensional action space. We propose a decentralized reinforcement learning architecture for a mobile robot, where the individual components of the commanded velocity vector are learned in parallel by separate agents. We empirically demonstrate that the decentralized architecture outperforms its centralized counterpart in terms of the learning time, while using less computational resources. The method is validated on two problems: an extended version of the 3-dimensional mountain car, and a ball-pushing behavior performed with a differential-drive robot, which is also tested on a physical setup.

**Keywords:** Multiagent learning · Decentralized control · Reinforcement learning · Robot soccer

## 1 Introduction

Reinforcement learning (RL) has been increasingly used to learn complex behaviors for robots in the real world [1,2]. One of the main challenges is the large number of training trials required, especially in systems with many state and action variables [3]. For such problems, distributed reinforcement learning can be used to address this issue [4]. For instance, in mobile robotics, a common high-level motion command is the desired velocity vector (e.g.:  $[v_{right}, v_{left}]$  for a differential robot, or  $[v_x, v_y, v_\theta]$  for an omnidirectional robot). If each component of this vector is handled individually, a distributed control scheme can be applied. By taking care of the coordination among the agents, it is possible to use decentralized methods [5] to learn behaviors which require these motion commands, taking an advantage of parallel computation and other benefits of multiagent systems (MAS) [4,6].

In Decentralized Reinforcement Learning (DRL), a problem is decomposed in several learning tasks, or sub-problems, whose information and resources are managed separately and these tasks work together toward a common goal. In

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