

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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RoboCup 2016: Robot World Cup XX Sven Behnke, Raymond Sheh, Sanem Sariel, Daniel D. Lee, 2017-11-01 This book includes the post conference proceedings of the 20th RoboCup International Symposium held in Leipzig Germany in July 2016 In addition to the 38 contributions to the symposium selected from 63 submissions the book also contains 15 champion papers of teams winning individual leagues of the RoboCup 2016 competition the Amazon Picking Challenge and the Harting Open Source Award The papers present current research in the fields of robotics and artificial intelligence with a special focus to robot hardware and software environment perception action planning and control robot learning multi robot systems and human robot interaction RoboCup 2017: Robot World Cup XXI Hidehisa Akiyama, Oliver Obst, Claude Sammut, Flavio Tonidandel, 2018-09-12 This book includes the post conference proceedings of the 21st RoboCup International Symposium held in Nagoya Japan in September 2017 The 33 full revised papers and 9 papers from the winning teams presented were carefully reviewed and selected from 58 submissions The papers are organized on topical sections on Robotics Artificial intelligence Environment perception State estimation and much more Sensor Fusion and Decentralized Control in Autonomous Robotic Systems Paul S. Schenker, G. T. McKee, 1997 **Strategies for Collective Minimalist Mobile Robots** Chris Melhuish, 2001-04-11 Many might think that the robot industry is not ready yet to build an abstract painter with a political theory Perhaps Melhuish engineering U of the West of England agrees because what he talks about instead is the idea of getting a whole lot of dumb robots to work together to accomplish something smart The inspiration for the approach are social insects which are limited individually yet can as a group achieve remarkable feats He presents minimalist strategies for controlling and coordinating such a system in the domains of moving through the environment creating work gangs of a desired size and acting on the environment Distributed in the US by ASME c Book News Inc **Computer & Control Abstracts** ,1996 *1998 IEEE International Conference on Evolutionary Computation Proceedings* IEEE Neural Networks Council, 1998 This collection of papers from the ICEC conference covers a wide range of aspects of evolutionary computing This includes principles of evolutionary computation such as adaptation and self adaption variation operators representational issues and theoretical investigations International Aerospace Abstracts ,1999 **Sensor Fusion and Decentralized Control in Robotic Systems** ,2001 Documentation Abstracts ,1997 *Proceedings of the ... IEEE Conference on Evolutionary Computation* ,1998 *RoboCup ...* ,2001 *Index to IEEE Publications* Institute of Electrical and Electronics Engineers, 1997 Issues for 1973 cover the entire IEEE technical literature *Government Reports Announcements & Index* ,1996 **Artificial Intelligence Abstracts** ,1991 **Intelligent Autonomous Systems 7** Maria Gini, 2002 The goal of the Seventh International Conference on Intelligent Autonomous Systems IAS 7 was to exchange and stimulate research ideas that make future robots and systems more intelligent and autonomous This volume of proceedings contains 71 technical papers by authors from 15 countries **Proceedings of the ... SICE Annual Conference** Keisoku

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