In the Name of God

Iran University
of Science and
Technology

Reinforcement Learning in Control

Dr. Saeed Shamaghdari

Electrical Engineering Department
Control Group

Fall 2025 | 4041

Motivation

Robot Motor Skill Coordination with EM-based Reinforcement Learning
(Paper)

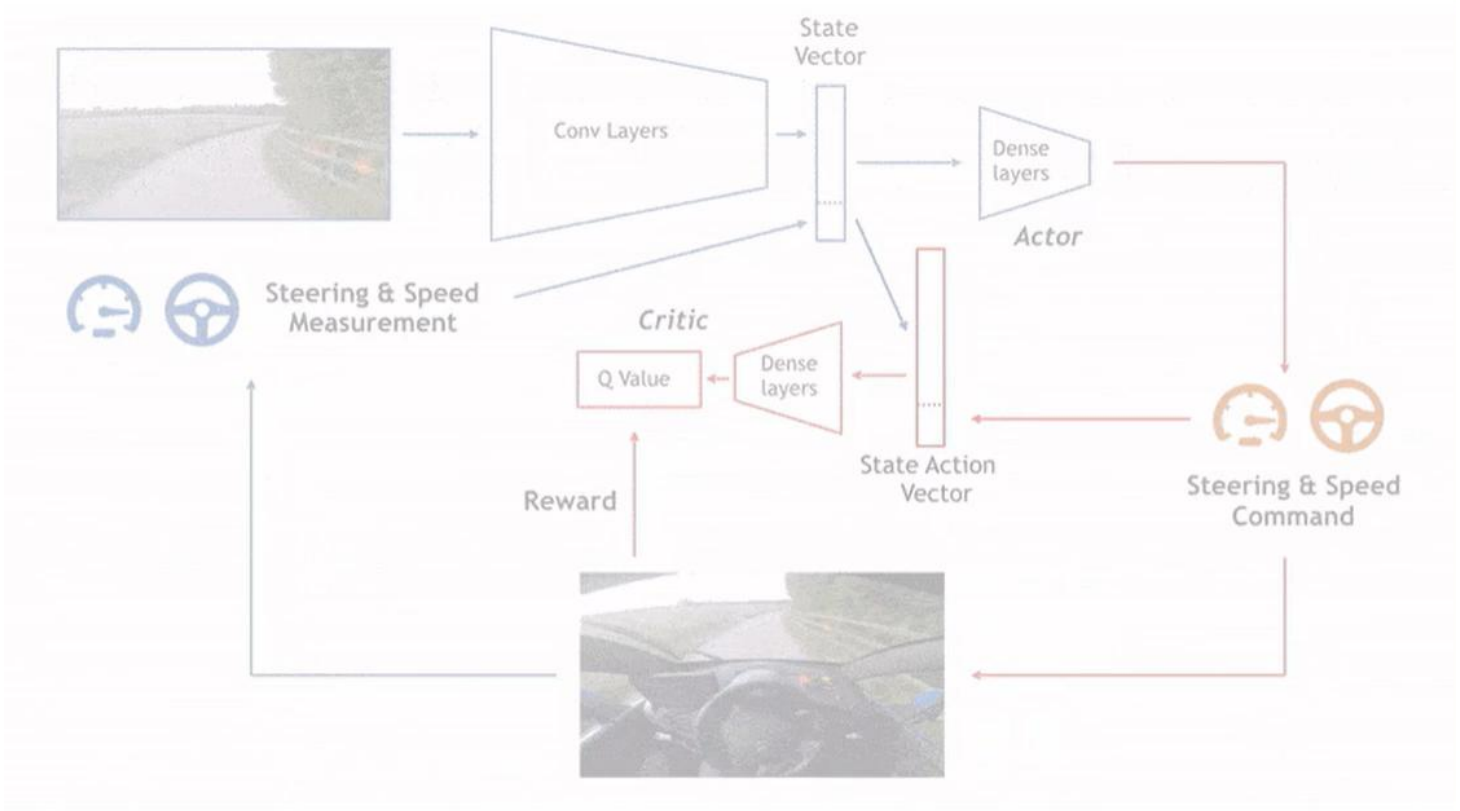
I Motivation

Learning to Drive in a Day
(Paper)

I Motivation

Learning to Drive in a Day
(Paper)

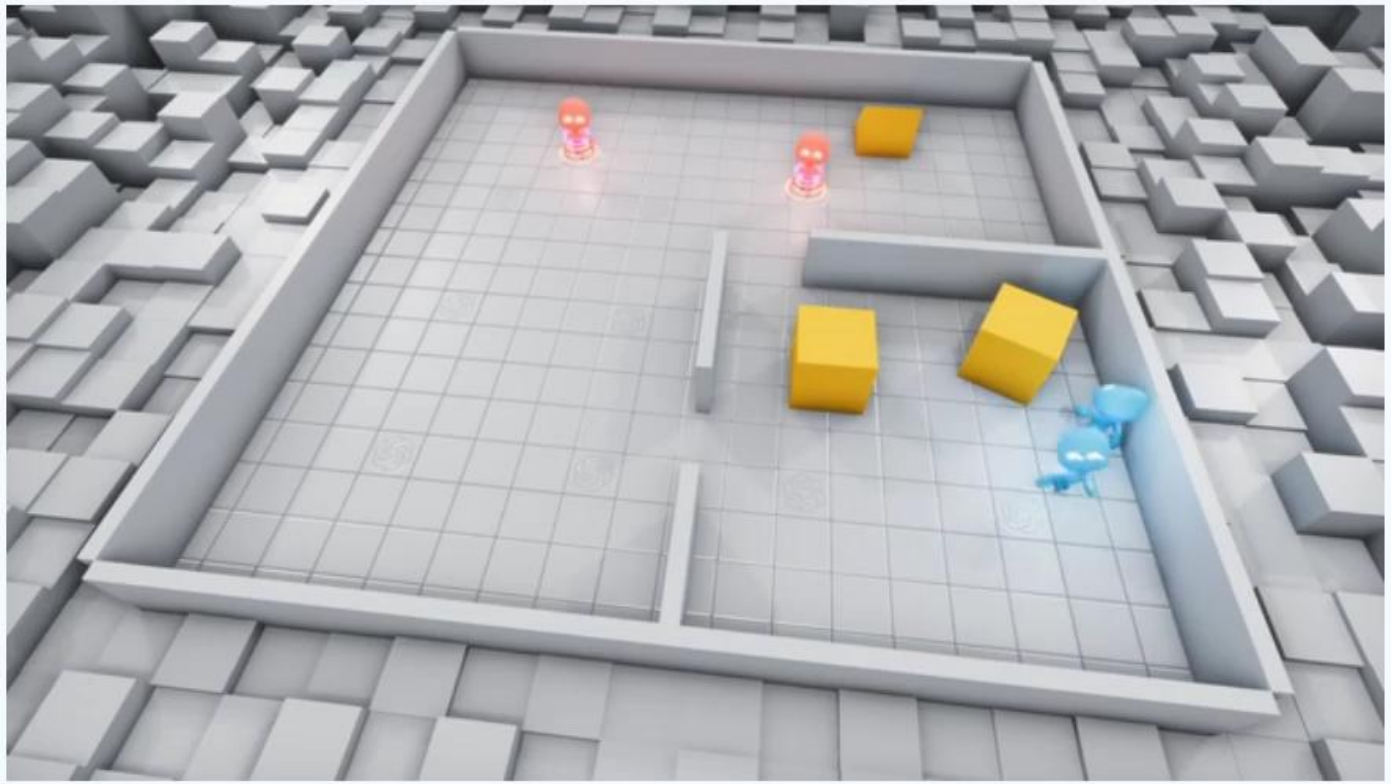
I Motivation



Learning to Drive in a Day
([Paper])

EMERGENT TOOL USE FROM MULTI-AGENT AUTOCURRICULA
(Paper) (Webpage)

I Motivation



EMERGENT TOOL USE FROM MULTI-AGENT AUTOCURRICULA
(Paper) (Webpage)

Table of Contents

Table of Contents

Table of Contents

Table of Contents

Part 1: Reinforcement Learning in Computer Science

Table of Contents

Part 1: Reinforcement Learning in Computer Science

Table of Contents

Part 1: Reinforcement Learning in Computer Science

Table of Contents

Table of Contents

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

I Optimal Control of Continuous/Discrete Systems

Table of Contents

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

VI RL Algorithms for Nonlinear Systems

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

Table of Contents

Part 2: Reinforcement Learning in Control Engineering

Class Format

Course Website

Exercises and Simulations:

- Assignments (Simulation + Theory, Class Exercises) (5)
- Comprehensive Exercise 1 (General RL) (1)

Quiz:

- **4 Theory Quizzes (6)**

Final Project (6)

Seminars:

- **Short Seminar:** RL Simulation Platforms (0.75)

  Team-based (2 members)

  The presentation should include a full platform introduction and sample simulation results.

  Example Platforms: Gymnasium, PettingZoo, and …

- **Comprehensive Seminar:** General RL Methods (0.75)

  Team-based (2 members)

  Example Topics: Inverse RL, Offline RL, Multi-Agent RL, Rl Applications in Generative Models and …

Project: (1.5)

Team-based (2 members)

- Select an RL-based control paper
- Ensure **simulation feasibility**
- Present like seminars
- Simulate the paper and reproduce results
- Submit full **report + code**

Project: (1.5)

Team-based (2 members)

- Select an RL-based control paper
- Ensure **simulation feasibility**
- Present like seminars
- Simulate the paper and reproduce results
- Submit full **report + code**

Class participation
Best class notes (lectures + exercises + extra materials)

Project: (1.5)

Team-based (2 members)

- Select an RL-based control paper
- Ensure **simulation feasibility**
- Present like seminars
- Simulate the paper and reproduce results
- Submit full **report + code**

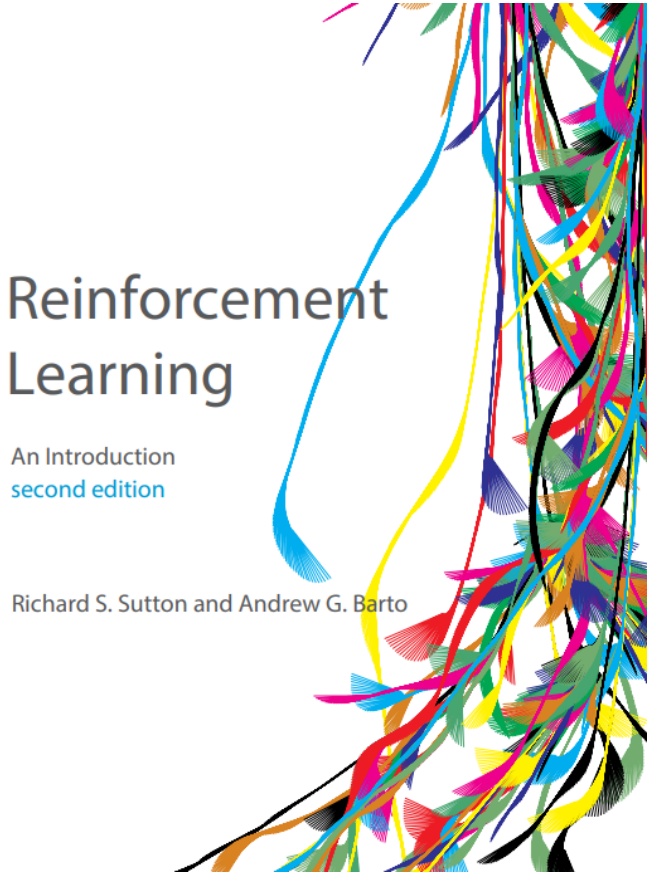
Class participation
Best class notes **+ extra materials)**

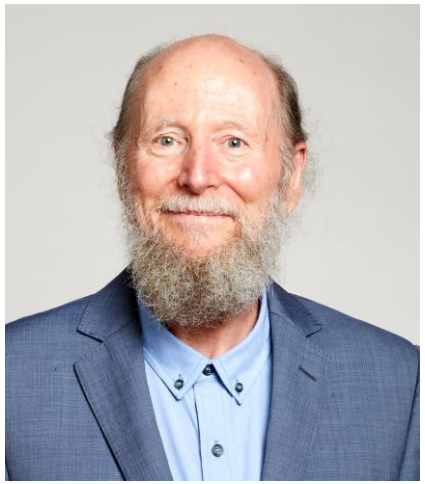
Bonus Points !

References

Books:

1. Sutton, R.S and Barto, A.G., Reinforcement Learning: An Introduction 2018



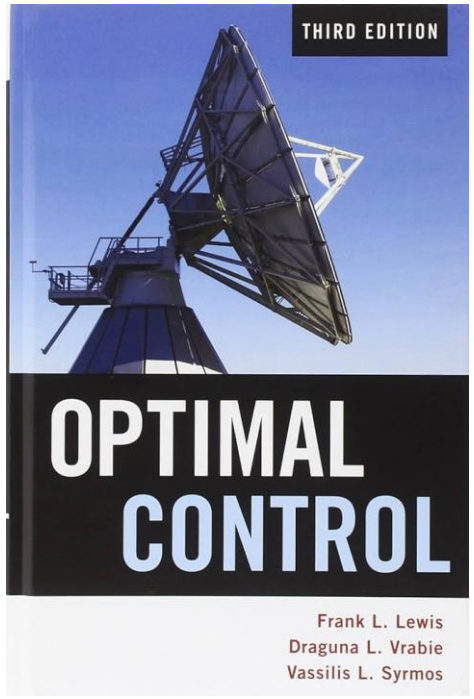


Books:

1. Sutton, R.S and Barto, A.G., Reinforcement Learning: An Introduction 2018
2. Szepesvari, Csaba., Algorithms for Reinforcement Learning

Books:

1. Sutton, R.S and Barto, A.G., Reinforcement Learning: An Introduction 2018
2. Szepesvari, Csaba., Algorithms for Reinforcement Learning
3. Lewis, F.L., Vrabie, D. and Syrmos, V.L., Optimal Control 2012



Articles:

4. Lewis, F.L. and Vrabie, D., Reinforcement Learning and Adaptive Dynamic Programming for Feedback Control, 2009
5. Lewis, F.L., Vrabie, D. and Vamvoudakis, K.G., reinforcement learning and feedback control, 2012
6. Lewis, F.L., Vrabie, D. and Syrmos, V.L., Optimal Control, 2012
7. Vrabie, D., Pastravanu, O., Abu-Khalaf, M. and Lewis, F.L., adaptive optimal control for continuous-time linear systems based on policy iteration, 2009
8. Jiang, Y. and Jiang, Z.P., Computational adaptive optimal control for continuous-time linear systems with completely unknown dynamic, 2012
9. Kiumarsi, B., Lewis, F.L., Modares, H., Karimpour, A. and Naghibi-Sistani, M.B, Reinforcement Q-learning for optimal tracking control of linear discrete-time systems with unknown dynamics, 2014

Articles:

10. Wang, T., Zhang, H. and Luo, Y., Stochastic linear quadratic optimal control for model-free discrete-time systems based on Q-learning algorithm, 2018
11. Liu, D. and Wei, Q., policy iteration adaptive dynamic programming algorithm for discrete-time nonlinear systems, 2014
12. Al-Tamimi, A., Lewis, F.L. and Abu-Khalaf, M., Discrete-Time Nonlinear HJB Solution Using Approximate Dynamic Programming: Convergence Proof, 2008
13. Liu, D. and Wei, Q., policy iteration adaptive dynamic programming algorithm for discrete-time nonlinear systems, 2014
14. Al-Tamimi, A., Lewis, F.L. and Abu-Khalaf, M., Discrete-Time Nonlinear HJB Solution Using Approximate Dynamic Programming: Convergence Proof, 2008
15. Liu, D. and Wei, Q., policy iteration adaptive dynamic programming algorithm for discrete-time nonlinear systems, 2014

Articles:

16. Rizvi, S.A.A. and Lin, Z., Output feedback Q-learning for discrete-time linear zero-sum games with application to the H-infinity control, 2018 – Cited by 12
17. Kim, J.H. and Lewis, F.L., Model-free H∞ control design for unknown linear discrete-time systems via Q-learning with LMI, 2010
18. Kiumarsi, B., Lewis, F.L. and Jiang, Z.P., H∞ control of linear discrete-time systems: Off-policy reinforcement learning, 2017
19. Liu, D., Li, H. and Wang, D., Neural-network-based zero-sum game for discrete-time nonlinear systems via iterative adaptive dynamic programming algorithm, 2013
20. Zhu, Y., Zhao, D. and Li, X., Iterative Adaptive Dynamic Programming for Solving Unknown Nonlinear Zero-Sum Game Based on Online Data, 2016

Prerequisites

Prerequisites

Modern Control

Probability and Statistics

Teaching Assistants

- Seyede Setare Khosravi
  - Email: strhkhosravi@gmail.com
  - ID: t.me/strhkhosravi
- Sajad Rafiee
  - Email: Rafiee_sajad@elec.iust.ac.ir
  - ID: t.me/sajad_rafiee