FOUNDATIONS AND APPLICATIONS OF REINFORCEMENT LEARNING

Dr. Sudipta Majumder

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Kripa-Drishti Publications, Pune.

Book Title: **Foundations and Applications of Reinforcement Learning**

Author By: **Dr. Sudipta Majumder**

Price: ₹500

1st Edition

ISBN: **978-93-48091-67-3**

Published: **July 2024**

Publisher:

Kripa-Drishti Publications

A/ 503, Poorva Height, SNO 148/1A/1/1A,
Sus Road, Pashan- 411021, Pune, Maharashtra, India.
Mob: +91-8007068686
Email: editor@kdpublications.in
Web: https://www.kdpublications.in

PREFACE

In an era defined by rapid advancements in artificial intelligence, Reinforcement Learning has emerged as a cornerstone in developing intelligent systems capable of learning from interaction. Unlike traditional paradigms of supervised and unsupervised learning, reinforcement learning introduces a dynamic framework where agents adapt and evolve strategies by navigating complex environments, making decisions, and maximizing rewards over time.

This book seeks to demystify the foundational principles and cutting-edge developments in reinforcement learning. It spans from the fundamentals—introducing agents, environments, policies, and rewards—to more advanced topics like temporal difference learning, deep reinforcement learning, and practical applications in domains such as robotics, gaming, finance, and healthcare. Our focus is to equip readers with both theoretical knowledge and practical insights, fostering a comprehensive understanding of the field.

We have meticulously designed the content to cater to a diverse audience, from students and researchers exploring the basics to practitioners seeking to apply reinforcement learning to real-world challenges. Through illustrative examples, case studies, and hands-on implementations, this book bridges the gap between conceptual clarity and application-oriented expertise.

The journey of writing this book has been driven by the transformative potential of reinforcement learning. As the field continues to evolve, its implications in shaping autonomous systems, optimizing decision-making, and solving complex problems grow ever more profound. It is our hope that this book will serve as both a guide and an inspiration for those venturing into the exciting domain of reinforcement learning.

Abbreviations

Reinforcement Learning (RL)

Temporal Difference (TD)

Intensive Care Unit (ICU)

Graphics Processing Units (GPUs)

Deep Reinforcement Learning (DRL)

Markov Decision Process (MDP)

States (S)

Actions (A)

Rewards (R)

Monte Carlo (MC)

Heating, Ventilation, and Air Conditioning (HVAC)

SARSA stands for State-Action-Reward-State-Action (SARSA)

Simulation of Urban Mobility (SUMO)

Deep Q-Learning (DQL)

Deep Q-Network (DQN)

Deep Q-Learning (DQL)

Natural Language Processing (NLP)

Convolutional Neural Network (CNN)

Proximal Policy Optimization (PPO)

A3C (Asynchronous Advantage Actor-Critic)

Deep Deterministic Policy Gradient (DDPG)

Soft Actor-Critic (SAC)

Least-Squares Temporal Difference (LSTD)

Gaussian Processes (GPs)

Support Vector Machines (SVMs)

Radial Basis Function (RBF)

Gradient Boosting Machines (GBMs)

Stochastic Gradient Descent (SGD)

INDEX

List of Figures

List of Tables

ABOUT THE AUTHOR

Dr. Sudipta Majumder

Dr. Sudipta Majumder embarked on his academic journey by completing his Bachelor of Technology (B.Tech) in Computer Science and Engineering from the North Eastern Regional Institute of Science and Technology (NERIST) in 2009. Eager to expand his knowledge, he pursued a Master of Technology (M.Tech) in Information Technology, followed by a Doctorate (Ph.D.) in Network Security, both from the prestigious from the North Eastern Regional Institute of Science and Technology. His doctoral research focused on advancing the field of network security, a domain he is deeply passionate about.

Dr. Majumder's primary research interests lie in the areas of internet of things, machine learning, Peer-to-Peer Networks, Wireless Networks, and Network Security. He is particularly fascinated by the challenges and opportunities presented by modern communication systems and strives to contribute innovative solutions to these fields.

Currently, Dr. Majumder serves as a Senior Assistant Professor in the Department of Computer Science and Engineering at the Dibrugarh University Institute of Engineering and Technology (DUIET), Dibrugarh University. His role allows him to guide the next generation of engineers, foster research, and collaborate with industry experts to bridge the gap between academia and real-world applications.

In addition to his academic responsibilities, Dr. Majumder is a dedicated life member of the Computer Society of India (CSI), where he actively engages with fellow professionals to promote knowledge-sharing and advancements in the field of computing.

KRIPA DRISHTI PUBLICATIONS

Price: ₹ 500

Kripa-Drishti Publications
A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,
Pune – 411021, Maharashtra, India.
Mob: +91 8007068686
Email: editor@kdpublications.in
Web: https://www.kdpublications.in

ISBN: 978-93-48091-67-3

9 789348 091673