From Markov Decision Processes to Reinforcement Learning with Python

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Preface

This notes are based in the course from Berstekas for the MIT see all lectures and other resources for complete the understanding.

Outline

The texbook for chapter one is the Bertsekas' book (Bertsekas 2005). Chapter 2 and 3 are adapted from Suttons' book (Ch.3,Ch.4 Sutton and Barto 2018). For application and broad conection with more Matchine Learning Applications we refer to (Brunton and Kutz 2019). Also we recomend for a handbook of algorithms (Szepesvári [2022] \copyright 2022). For applictions wiht implemented code we follows the books (Bilgin 2020).

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References

Bertsekas, Dimitri P. 2005. *Dynamic Programming and Optimal Control. Vol. I.* Third. Athena Scientific, Belmont, MA.

Bilgin, E. 2020. *Mastering Reinforcement Learning with Python: Build Next-Generation, Self-Learning Models Using Reinforcement Learning Techniques and Best Practices.* Packt Publishing. https://books.google.com.mx/books?id=s0MQEAAAQBAJ.

Brunton, Steven L., and J. Nathan Kutz. 2019. *Data-Driven Science and Engineering.* Cambridge University Press, Cambridge. https://doi.org/10.1017/9781108380690.

Sutton, Richard S., and Andrew G. Barto. 2018. *Reinforcement Learning: An Introduction.* Second. Adaptive Computation and Machine Learning. MIT Press, Cambridge, MA.

Szepesvári, Csaba. [2022] \copyright 2022. *Algorithms for Reinforcement Learning.* Vol. 9. Synthesis Lectures on Artificial Intelligence and Machine Learning. Springer, Cham. https://doi.org/10.1007/978-3-031-01551-9.