Introduction to Reinforcement Learning

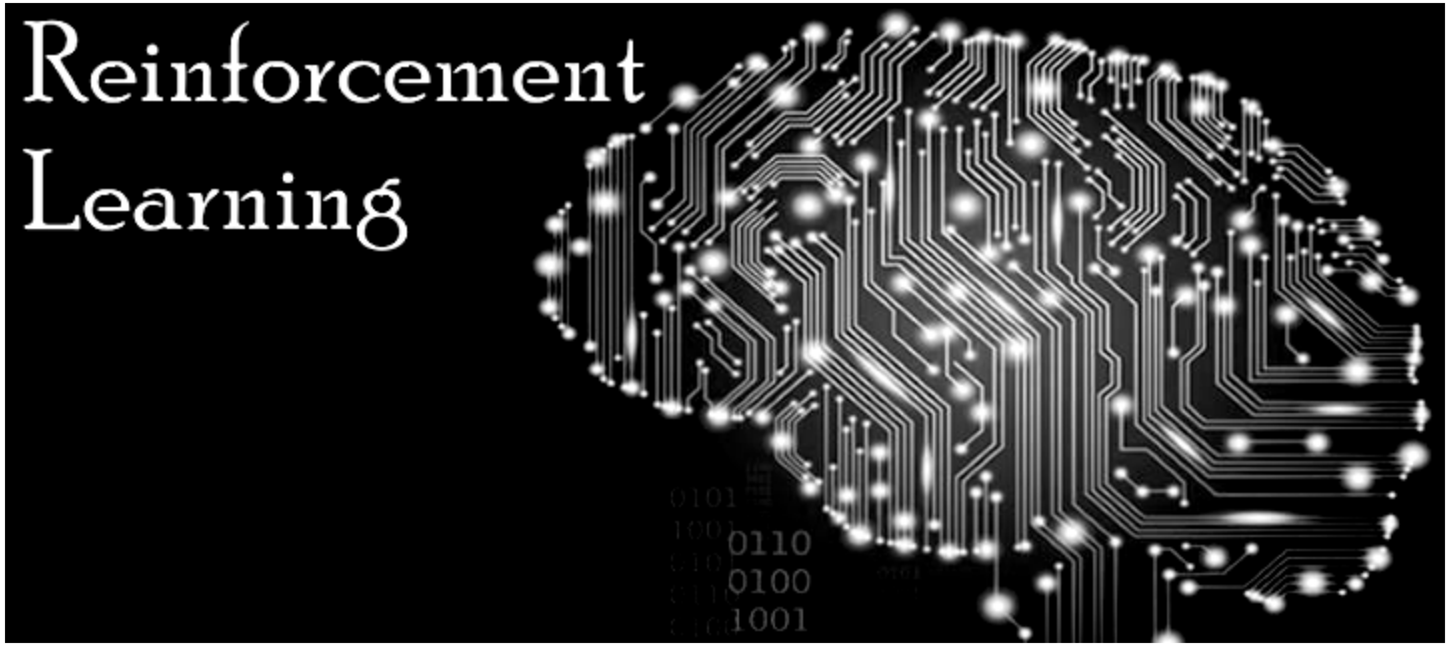
w/ some applications to Energy

LEC 1a: Course Organization

Instructors: Professor Scott Moura & Saehong Park

TA: Xinyi Zhao

Summer 2020



Why take this course?

Obtain <u>conceptual</u> understanding of reinforcement learning

Why take this course? (details)

- Demystify reinforcement learning
- Obtain a solid foundation for the basic fundamental concepts
- Explore via an energy systems example
- It’s only EIGHT days and 12 hours

This course is <u>**NOT**</u> about…

- Open source software
  - e.g. Google Deep Mind, OpenAI, TensorFlow, Matlab RL Tooxbox, Pytorch, etc.
- Reducing RL to coding
- Deep RL tricks
- Surveying the most famous algorithms of 2020
  - We take a long time horizon view about the past, present, and future

Prerequisite Previous Coursework

- Multivariable calculus
- Linear algebra
- Random variables & Probability
- Optimization
- Machine Learning
- Numerical computing

Very helpful (but not required) previous/concurrent coursework

- Dynamical Systems & Feedback Control
- Stochastic processes
- Statistical learning & Information Theory

Startups out of my courses

ECALCHARGE Smart Charging Solutions

eLum ORCHESTRATE ENERGY & DATA

WattTime

Selected Companies that recruit my students

stem

Advanced Microgrid Solutions

TESLA ENERGY

enel x

PUBLIC UTILITIES COMMISSION STATE OF CALIFORNIA

TOTAL COMMITTED TO BETTER ENERGY

BERKELEY LAB

LA DWP Los Angeles Department of Water & Power

Exclusive access to alumni above! Join the CE295 LinkedIn Group: https://www.linkedin.com/groups/7068321

Class Format

Live Lecture Dates:

China Time: 7, 8, 9, 10 (Tu – Fri), 14, 15, 16, 17 (Tu – Fri); 08:30 – 10:05

Berkeley Time: 6, 7, 8, 9 (M– Th), 13, 14, 15, 16 (M – Th); 17:30 – 19:05

Remote Teaching: Zoom (detailed login info coming soon)

Course Website: https://scott-moura.github.io/rl/

Discussions: WeChat & Slack

Professor Scott MOURA

smoura@berkeley.edu

Office Hours:

30min after class

Co-instructor: Saehong Park

sspark@berkeley.edu

Office Hours: 30min after class

Teaching Assistant:

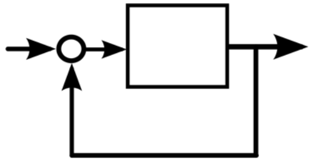
Xinyi Zhao

zxyyx48@163.com

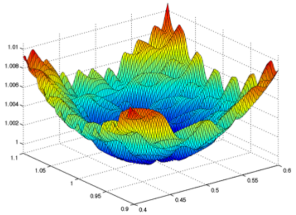
About me

eCAL
energy, controls, & applications lab

FUNDAMENTAL RESEARCH



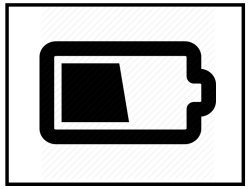
Dynamic Systems & Control



Optimization

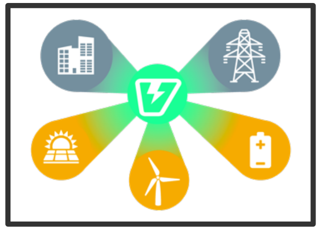
Data Science

APPLICATIONS



Battery Management Systems (#BATT)

Automated, Connected, & Electric Vehicles (#ACES)



Distributed Energy Resources (#DER)

Professor Scott Moura

Postdoc – UC San Diego

PhD MechE – University of Michigan

MS MechE – University of Michigan

BS MechE – UC Berkeley

Selected Honors

- Carol D. Soc Distinguished Grad Student Mentoring Award
- NSF CAREER Awardee
- Hugo O. Schuck Best Paper Award
- Best Student Paper, as advisor (ACC, IFAC, DSCC)
- UC President’s Postdoctoral Fellow
- NSF Graduate Research Fellow

eCAL
energy, controls, & applications lab


Dr. Luis COUTO (ULB/Oxford)


Laurel DUNN


Zach GIMA


Saehong PARK


Dong ZHANG


Zhe ZHOU


Sangjae BAE


Bertrand TRAVACCA


Mathilde BADOUAL


Soomin WOO


Yiqi ZHAO


Ioanna KAVVADA


Aaron KANDEL


Patrick KEYANTUO


Dylan KATO


Teng ZENG


Jing YU (TBSI)


Shirin YOUSEFIZADEH (Aalborg, DK)


Andrea POZZI (Pavia, IT)


Upadhi VIJAY


Pedro ERRAZURIZ


Sihan LIU


Yan XIAO


Jonathan KESTELMAN

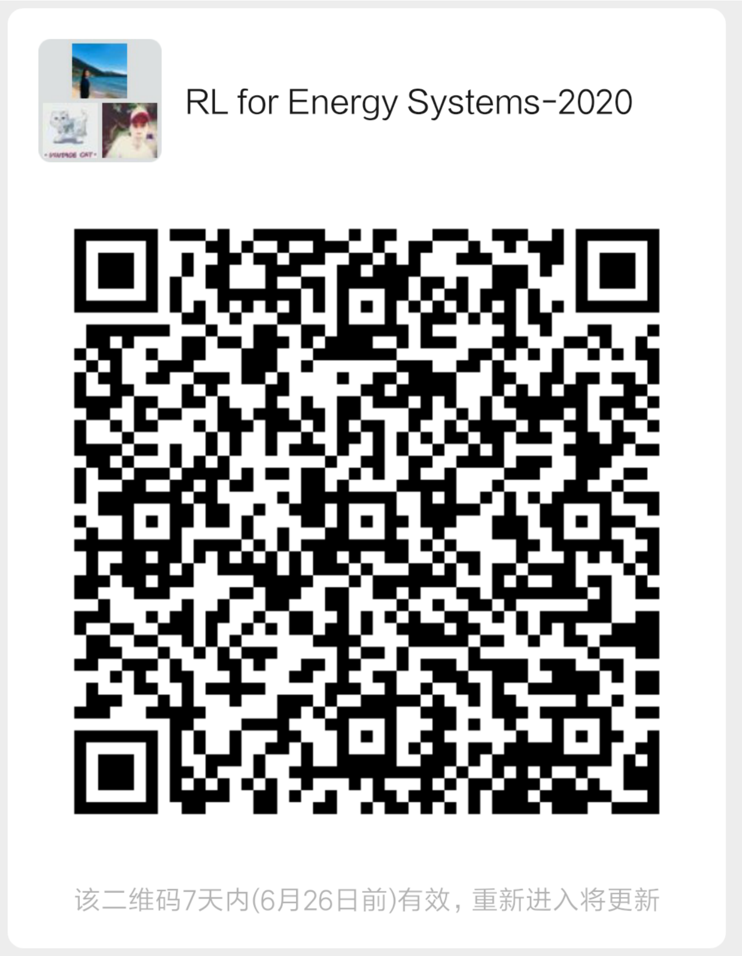

Deep DAYARAMANI


Sonia MARTIN


Vanessa HERNANDEZ-CRUZ


German PEREA

WeChat


RL for Energy Systems-2020
该二维码7天内(6月26日前)有效，重新进入将更新


Scott Moura
Shenzhen, Guangdong
Scan the QR code to add me on WeChat


Saehong Park (박세홍,...
Scan the QR code to add me on WeChat

Slack

Click to Join!

https://join.slack.com/t/introtorlucbtbsi/shared_invite/zt-flhuxmhu-rmGkBUOIpSxzI3d8I5F_yQ

Course Organization

Lectures

- Pre-recorded videos
- During lecture time, watch videos, pause, discuss

Notes

- Course notes available at https://scott-moura.github.io/rl/

Assignments

- Two assignments
- Application to Offshore Wind Energy

Topic Outline

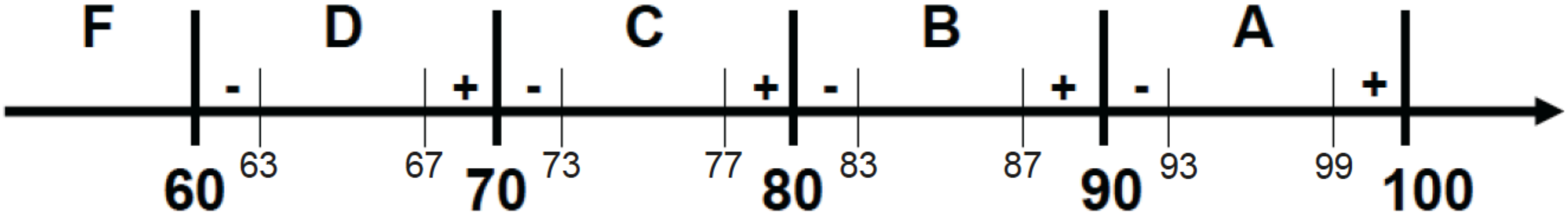
1. Optimal Control
2. Dynamic Programming
    1. Principal of Optimality & Value Functions
        - Case Study: Linear Quadratic Regulator (LQR)
3. Policy Iteration & Value Iteration
    - Case Study: LQR
4. Approximate Dynamic Programming (ADP)
    1. Temporal Difference (TD) Error
    2. Value Function Approximation
        - Case Study: LQR
    3. Online RL with ADP
    4. Actor-Critic Method
        - Case Study: Offshore Wind
5. Q-Learning
    1. Q-learning algorithm
    2. Advanced Q-learning algorithm, i.e., DQN
6. Policy Gradient
    1. Vanilla policy gradient (REINFORCE)
7. Actor-Critic using Policy Gradient
    1. Actor-Critic using Policy Gradient
    2. Advanced Actor-Critic algorithm, i.e., DDPG
8. RL for energy systems
    1. Case Study: Battery Fast-charging

Textbooks (none are required)

The following are recommended for additional background:

1. D. P. Bertsekas and J. Tsitsiklis, Neuro-Dynamic Programming, Athena Scientific, 1996
2. Powell, W. B. (2007). Approximate Dynamic Programming: Solving the curses of dimensionality (Vol. 703). John Wiley & Sons.
3. R. S. Sutton and A. G. Barto, Reinforcement Learning: An Introduction, 2017
4. Lewis, F., & Vrabie, D. (2009). Reinforcement learning and adaptive dynamic programming for feedback control. IEEE Circuits and Systems Magazine, 9(3), 32–50. http://doi.org/10.1109/MCAS.2009.933854
5. Lewis, F. L., & Vrabie, D. (2009). Reinforcement learning and adaptive dynamic programming for feedback control. IEEE Circuits and Systems Magazine, 9(3), 32–50. http://doi.org/10.1109/MCAS.2009.933854
6. J. Si, A. Barto, W. Powell D. Wunsch (2004). Handbook of Learning and Approximate Dynamic Programming.

Grading



Straight scale (we may curve up, but it has never been necessary)

Participation	50pts	Based on attendance and interaction. Award at instructor’s discretion
Assignments	50pts	Two assignments, 25pts each
TOTAL	**100pts**	

How to Succeed (in Remote Learning Courses)

- Ask questions in class! MORE important in remote learning
  - LIVE discussion
- See instructors during office hours
- Be resourceful!
- Send us a WeChat/Slack.

- You are not alone!
- Work together! Lift each other! Succeed Together!
- You are responsible for making a better world for yourself & all