MO89905: Learning-based Control for Mobility Systems

Fall 2025

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Class Time:	T/Th 13:00 – 14:30	**Class Room:**	F407 Munji Campus
Instructor:	Kyunghwan Choi	**Email:**	kh.choi@kaist.ac.kr
Office Hours:	After class or by appointment		

Course Pages: TBD.

Description: This course introduces reinforcement learning (RL) from a control-theoretic and optimization perspective, with emphasis on online decision-making and theoretical guarantees. Core topics include approximate dynamic programming (ADP) for both finite and infinite-horizon settings, including value function approximation, rollout methods, value and policy iteration, and policy space approximation. The course covers both model-based and selected model-free approaches under a unifying approximation framework. Additional topics include state aggregation and model learning, with an emphasis on their roles in improving prediction, control, and decision-making. Applications focus on real-time decision-making and control in mobility systems. A final project requires students to design and implement learning-based controllers in online or sequential decision environments.

Objectives: This course has been designed for students

- To explore the state of the art of ADP/RL at a graduate level
- To explore the common boundary between AI and optimal control
- To provide a bridge that workers with background in either field find it accessible

Textbook:

- D. Bertsekas, *"Reinforcement Learning and Optimal Control,"* Athena Scientific, 2019.

Supplementary Materials:

- D. Bertsekas, *"A Course in Reinforcement Learning,"* 2nd Edition, Athena Scientific, 2024 (online).
- R. S. Sutton and A. G. Barto, "*Reinforcement Learning: An Introduction*," 2nd Edition, MIT Press, 2018 (online; a valuable resource that approaches the subject from the AI point of view).

Prerequisites:

- Familiarity with calculus and probability theory
- Proficiency in MATLAB or Python programming

Assesment:

- Homework (20%)
- Midterm (40%)

- Term Project (40%)
  - Report (30%), Presentation (10%)

Course Policy:

- This class follows the general rules of KAIST.

Course Schedule:

Week	Topic	Remark
1	Introduction	
2	Finite-horizon exact DP	HW1
3	Approximation in value space	
4	Rollout	
5	Parametric approximation	HW2
6	No class – Chuseok holiday	
7	Model-based and model-free parametric ADP	
8	Midterm exam	
9	Infinite-horizon RL	
10	Value iteration	HW3
11	Policy iteration	
12	Approximation in policy space	HW4
13	Aggregation	
14	Model learning I	
15	Model learning II	Term project report due
16	Term project presentations	