Reinforcement Learning China Summer School

RLChina 2020

# Introduction and Opening

夏令营官网： **rlchina.org**
夏令营对于所有同学、学者公开开放，
扫描下方二维码进入报名入口：

Prof. Jun Wang

Computer Science, UCL

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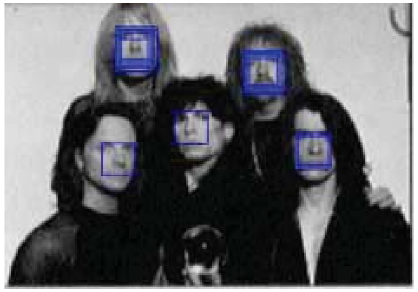
http://www0.cs.ucl.ac.uk/staff/Jun.Wang/

July 27, 2020

# Progress of Artificial Intelligence



Face detection (Computer Vision)

**Recognition**
**(识别)**

Face++旷视 依图

SenseTime 商汤科技 DeepGlint 格灵深瞳


Play Go (Reinforcement Learning)

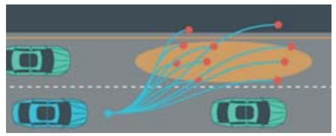
**Decision Making**
**(单个智体决策)**

DeepMind
(rooted from UCL)

OpenAI

**EMBODIED INTELLIGENCE**
(rooted from UC Berkeley)

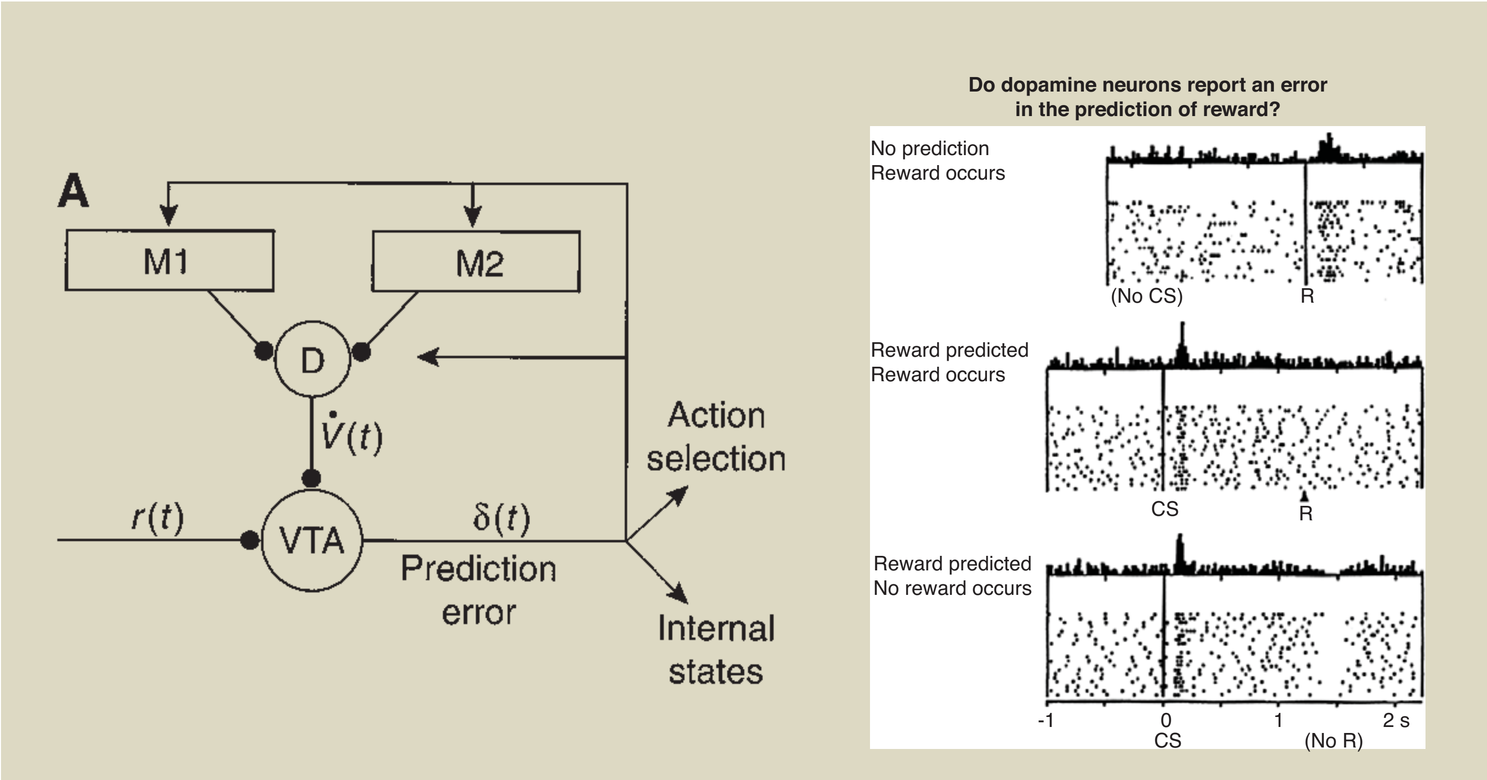
**Multi-agent AI and Distributed Decision Making**
**(多智体决策)**


Bots Routine and Navigation Distributed Optimisation

Multi-objectives optimisation

# Classical conditioning (Pavlov 1906) & reinforcement Learning

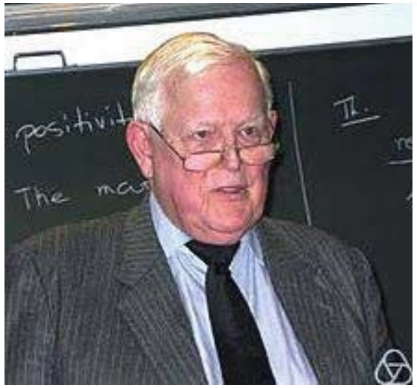



[Schultz, Wolfram, Peter Dayan, and P. Read Montague, 1997]

# The Duality Between Estimation and (Single) Control

## A New Approach to Linear Filtering and Prediction Problems[1]

**R. E. KALMAN**
Research Institute for Advanced Study,[2]
Baltimore, Md.



*The classical filtering and prediction problem is re-examined using the Bode-Shannon representation of random processes and the "state transition" method of analysis of dynamic systems. New results are:*

*(1) The formulation and methods of solution of the problem apply without modification to stationary and nonstationary statistics and to growing-memory and infinite-memory filters.*

*(2) A nonlinear difference (or differential) equation is derived for the covariance matrix of the optimal estimation error. From the solution of this equation the coefficients of the difference (or differential) equation of the optimal linear filter are obtained without further calculations.*

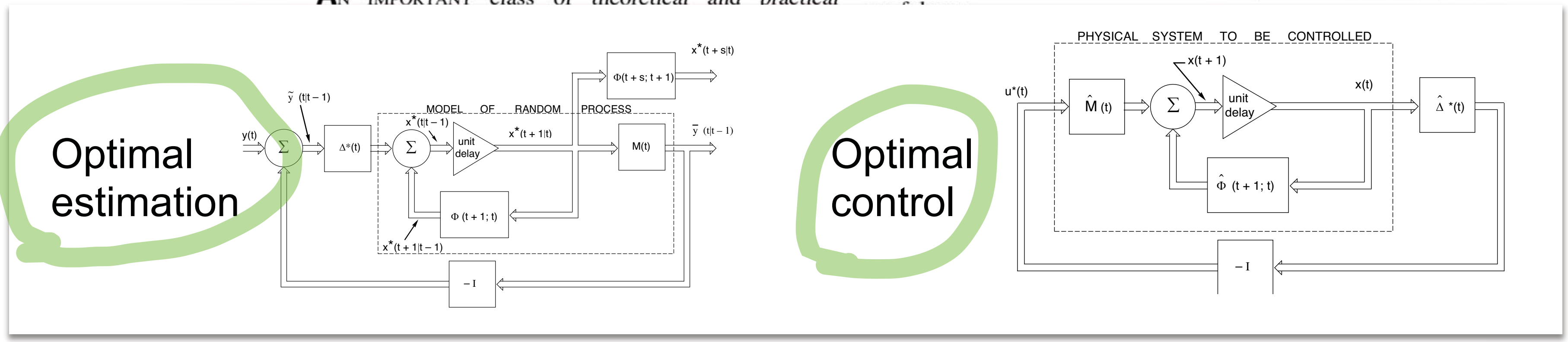
*(3) The filtering problem is shown to be the dual of the noise-free regulator problem. The new method developed here is applied to two well-known problems, confirming and extending earlier results.*

*The discussion is largely self-contained and proceeds from first principles; basic concepts of the theory of random processes are reviewed in the Appendix.*

### Introduction

AN IMPORTANT class of theoretical and practical

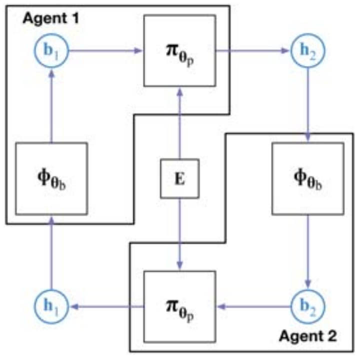
Present methods for solving the Wiener problem are subject to a number of limitations which seriously curtail their practical

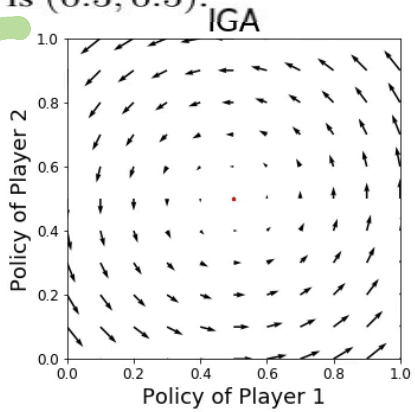



Kalman, Rudolph Emil. "A new approach to linear filtering and prediction problems." (1960): 35-45.

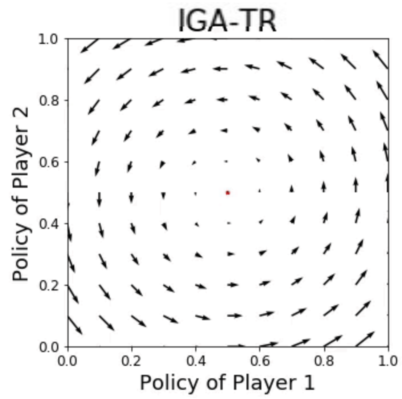
# Multiagent gradient ascent

An example matrix game is $R_r = \begin{bmatrix} 0 & 3 \\ 1 & 2 \end{bmatrix}$, $R_c = \begin{bmatrix} 3 & 2 \\ 0 & 1 \end{bmatrix}$ with the initial strategy $(\alpha, \beta) = (0.0, 0.9)$. The only Nash Equilibrium is $(0.5, 0.5)$.

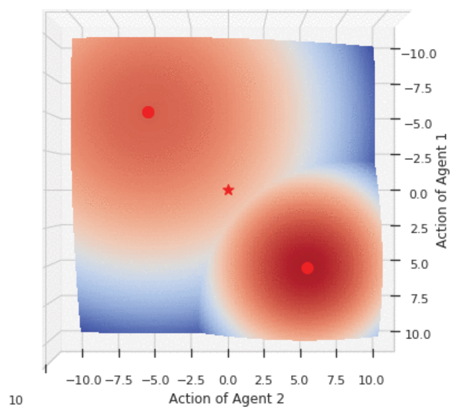


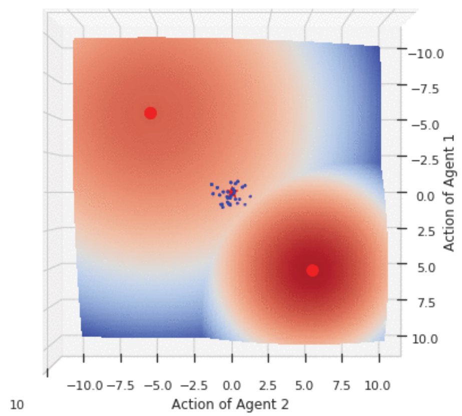

Independent learner




Aware of other agent



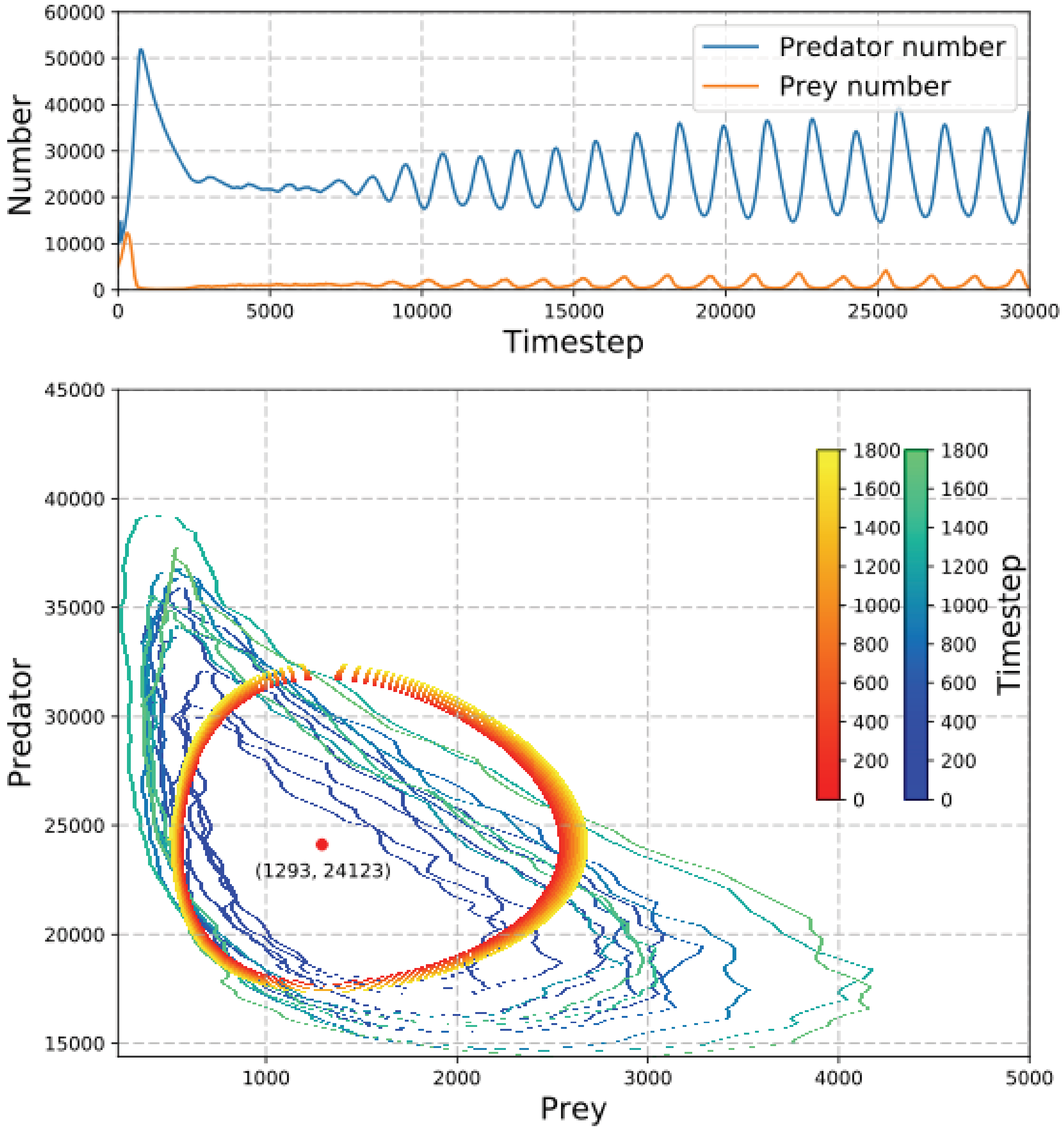

PR2-AC




DDPG-OM

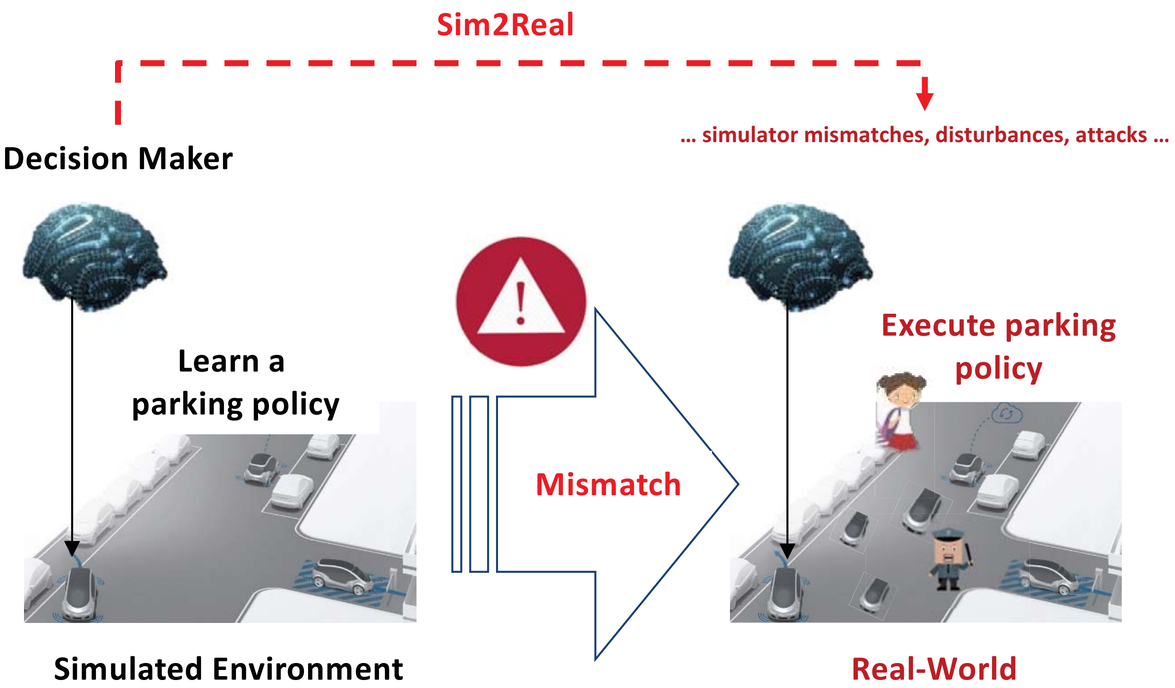
Wen, Ying, et al. "Probabilistic recursive reasoning for multi-agent reinforcement learning." ICLR19

# The Dynamics of the Artificial Population



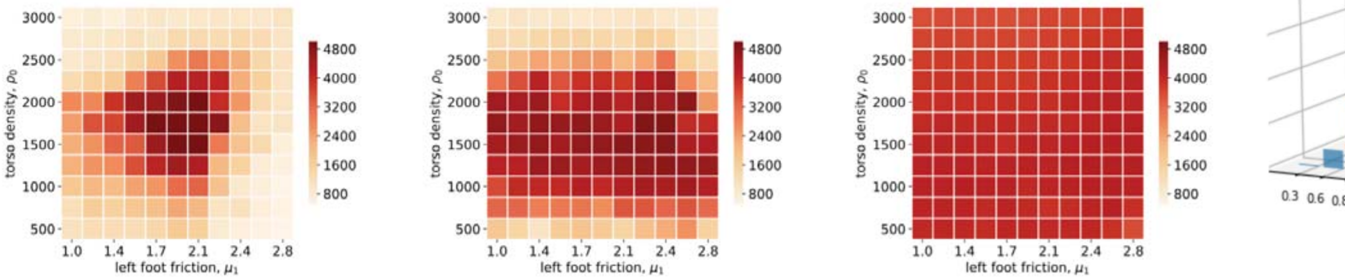

Yaodong Yang , Lantao Yu , Yiwei Bai , Jun Wang , Weinan Zhang , Ying Wen , Yong Yu, , Dynamics of Artificial Populations by Million-agent Reinforcement Learning, 2017

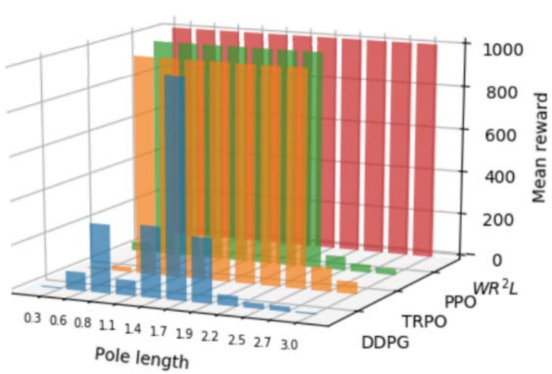
# Robustness in Machine Decision Making




Abdullah MA, Ren H, Ammar HB, Milenkovic V, Luo R, Zhang M, Wang J. Wasserstein Robust Reinforcement Learning. arXiv preprint arXiv:1907.13196.

- **Robustness** against the changes in data environments
- **Safety** of the executed decisions to catastrophic failures



# Lecturers

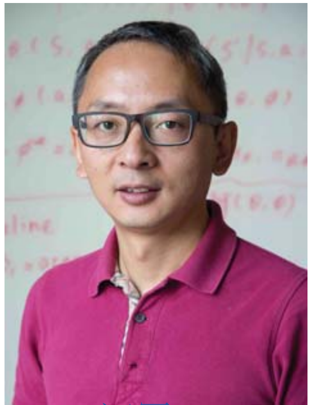

安波


Haitham Bou Ammar

基础
优化
的基础课


郝建业


卢宗青

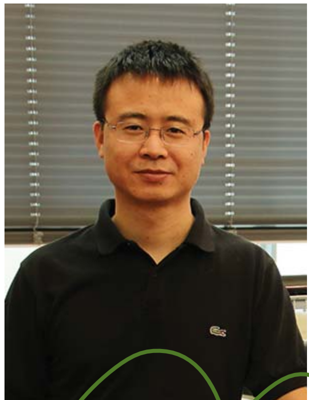

汪军


徐任远

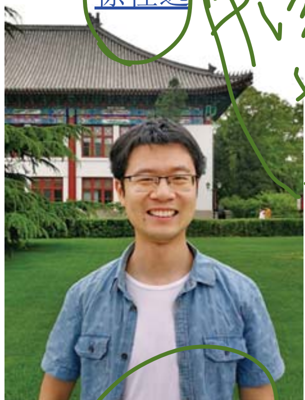
伦敦大学
博后


杨耀东


俞扬


张崇洁

清华


张海峰

中科院自动化所


张伟楠

上交


朱占星

① single agent

| DateTime | Course | Teacher |
| --- | --- | --- |
| 2020-07-27 19:00-19:10 | Openning and Introduction | 汪军 |
| 2020-07-27 19:10-20:50 | Value-based Reinforcement Learning | 卢宗青 |
| 2020-07-28 19:00-20:40 | Policy-based RL and RL Theory | 汪军 |
| 2020-07-29 19:00-20:40 | Optimisation in Learning | Haitham |
| 2020-07-30 19:00-20:40 | Model-based Reinforcement Learning | 张伟楠 |
| 2020-07-31 19:00-20:40 | Control as Inference | 朱占星 |
| 2020-08-01 19:00-20:40 | Imitation Learning | 俞扬 |
| 2020-08-03 19:00-20:40 | Hierarchical Reinforcement Learning 决策空间复杂的情况. | 郝建业 |
| 2020-08-04 19:00-20:40 | Game Theory Basic | 张海峰 |
| 2020-08-05 19:00-20:40 | ② Multi-agent Systems | 安波 |
| 2020-08-06 19:00-20:40 | Deep Multi-agent Learning | 张崇洁 |
| 2020-08-07 19:00-20:40 | Advances in Multi-agent Learning | 杨耀东 |
| 2020-08-08 19:00-20:40 | Mean-field Games and Controls | 徐任远 |
| 2020-08-08 20:40-21:10 | Panel Discussion | 全体导师 |

# Today’s lecture: introduction of RL and value-based methods

卢宗青
北京大学计算机科学系“博雅”助理教授。在2017年9月加入北京大学之前，他在美国宾夕法尼亚州立大学计算机系从事博士后工作。他于2014年4月获得了新加坡南洋理工大学计算机博士学位，并获得了东南大学的硕士学位和学士学位。他的主要研究领域包括（多智能体）强化学习、移动/边缘智能系统等。