Machine Learning for Systems and Control

5SC28

Lecture Overview

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L1: Introduction

- What is Machine Learning
- Model Structures
- Estimation Framework

L2: Gaussian Processes

- Gaussian Process – Mean Function, Covariance Function, MAP
- Reproducing Kernel Hilbert Space – Representer Theorem
- Kernel Choice and Hyper-Parameter Optimization

L1 + L2 → Data-Driven Estimation of Dynamical Models

L3: Artificial Neural Network

- Artificial Neural Network - Layers, Neurons, Approximation Properties
- Estimating an ANN - Gradient Descent, Backpropagation, Regularization
- From ANN to GP

L1 + L3 → Data-Driven Estimation of Dynamical Models

L4: Deep Artificial Neural Networks

- Deep ANN Components and Structures
- Training a Deep ANN - SGD, Vanishing Gradient, Overfitting
- Deep ANN Structures for Dynamical Systems

L1 + L4 → Estimating Data-Driven Dynamical Models

L5: Reinforcement Learning Basics

- Exploration vs Exploitation
- Markov Decision Process
- Basic Q-Learning – Q-Function, Value Function, Bellman Equation, Temporal Difference

L5 → Control of Systems with Discrete Action and State Space

L6: Q-Learning with Function Approximation

- Temporal Difference with Function Approximation for Prediction
- Temporal Difference with Function Approximation for Control
- Deep Q-Networks - Target Network, Replay

L2-4 + L5-6 →

Control of Systems with Discrete Action and Continuous State Space

L7: Actor-Critic Reinforcement Learning

- Gradient Policy Methods – Policy Gradient Theorem, REINFORCE
- Actor-Critic – Actor, Critic, A2C

L2-4 + L5-7

→ Control of Systems with Continuous Action and State Space

L8: Model Internalization RL

- Bayesian View on RL
- PILCO – Model Learning, Value Function Calculation, Policy Optimization

L2 + (L3-4) + L5,7-8 →

Data-Efficient Control of Systems with Continuous Action and State Space