ME338《工程机器学习基础》课程大纲

1、2021 春季学期——2024 秋学期 (2)

2、2025 春学期起 (9)

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	**工程机器学习基础** **Machine Learning for Engineering**
2.	**授课院系** **Originating Department**	机械与能源工程系 Department of Mechanical and Energy Engineering
3.	**课程编号** **Course Code**	ME338
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业核心课 Major Core Courses
6.	**授课学期** **Semester**	春季 Spring
7.	**授课语言** **Teaching Language**	英文 English
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	责任教师： 张巍 机械与能源工程系 zhangw3@sustech.edu.cn 2021 年春季学期由潘佳（外聘教师）老师授课 Wei Zhang Department of Mechanical and Energy Engineering zhangw3@sustech.edu.cn Jia Pan jpan@cs.hku.hk
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours	48				48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	线性代数 A （MA107A） 概率论与数理统计（MA212） 计算机程序设计基础 B（CS102B） Linear Algebra A (MA107A) Probability and Statistics (MA212) Introduction to Computer Programming (CS102B)
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	
14. 其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程将介绍机器学习相关的基本知识，为日后学生在机器学习相关方面的深入学习与应用打下基础。本课程将教学生如何解决线性回归问题、如何用逻辑回归的方法制定和解决线性分类问题、如何使用 k-means 来制定和解决聚类问题，还将让学生对过拟合、交叉验证、模型阶数选择、特征选择、神经网络和 PCA 等概念和方法有所了解，同时让学生积累一定的优化以及概率模型相关的经验。为保障学生的实际动手与应用能力，本课程还将教学生如何用 Python/Scikit-Learn/PyTorch 实现基本的机器学习和深度学习任务。通过上述教学方式使学生掌握基础的统计与机器学习相关理论及动手实践能力。

This course aims to teach students basic knowledge of machine learning and lay a foundation for their further study and application in machine learning. This course will teach students how to formulate and solve linear regression problems, how to formulate and solve linear classification problems using logistic regression, and how to formulate and solve clustering problems using k-means. Students will also know the basic methods and concepts of over-fitting, cross-validation, model-order selection, feature selection, neural networks, PCA, etc., and gain experience with optimization and probabilistic models. In order to ensure students' hands-on and practical abilities, this course will also teach students how to implement basic machine-learning and deep learning tasks in Python/sklearn/PyTorch.

16. 预达学习成果 Learning Outcomes

完成本课程的学习后，学生应能够完成：
（1）制定并解决线性回归问题；
（2）用逻辑回归的方法制定和解决线性分类问题；
（3）使用 k-means 来制定和解决聚类问题；
（4）了解过拟合，交叉验证，模型阶数选择，特征选择，神经网络，主成分分析；
（5）获得一些与优化和概率模型相关的经验；
（6）在 Python/sklearn/PyTorch 中实现基本的机器学习和深度学习任务。
After this course, students should be able to:
Formulate and solve linear regression problems.
Formulate and solve linear classification problems using logistic regression.
Formulate and solve clustering problems using k-means.
Understand over-fitting, cross-validation, model-order selection, feature selection, neural networks, PCA.
Gain experience with optimization and probabilistic models.
Implement basic machine-learning and deep learning tasks in Python/sklearn/PyTorch.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

课程内容	教学要求	学时分配
绪论 • 机器学习的应用背景 • 本课程的性质、任务和主要内容 • 机器学习的基本概念 Introduction • Application background of Machine Learning • The objectives and outcome of Machine Learning • Concept of Machine Learning	了解机器学习的发展历程及应用背景 了解机器学习的基本概念 了解机器学习任务的分类及其特点 Understand the history, application, and importance of Machine Learning Understand the basic concept of Machine Learning Understand the classification of different machine learning tasks	2h
线性回归 • 例子:了解糖尿病患者的血糖水平 • 多变量线性模型 • 最小二乘解 • 最小二乘解的几何解释 • Python 实现多元线性回归 • 特殊情况:简单线性回归 • 特征转换 Linear Regression • Motivating Example: Understanding Glucose Levels in Diabetics • The Multiple Variable Linear Model • The Least-Squares Solution • Understanding the LS Solution • Multiple Linear Regression in Python • Special Case: Simple Linear Regression • Feature Transformations	将一个机器学习任务描述为多元线性回归：识别特征和目标变量；识别特征转换的可能性，例如独热码 以矩阵/向量的形式描述回归模型 了解最小二乘解的模型参数 通过 R2 评估拟合情况 了解如何使用 numpy 和 sklearn 包在 Python 中实现线性回归 Formulate a machine learning task as multiple linear regression: Understand advantage over simple linear regression; Identify feature and target variables; Recognize possibilities for feature transformation, such as one-hot-coding Describe the regression model in matrix/vector form Understand the least-squares solution for the model coefficients Assess goodness-of-fit via R2 Know how to implement linear regression in Python using the numpy and sklearn packages	4h
验证及偏差-方差权衡 • 不同误差的类型 • 交叉验证 • 偏差-方差权衡 • 机器学习中的模型阶数选择及 Python 示例 Validation and Bias Variance Trade-off • Types of error • Cross validation • Bias variance trade-off • Python solution to model order selection examples of machine learning	了解机器学习中模型阶数选择问题 了解不同误差类型 理解偏差-方差权衡 掌握交叉验证方法 掌握多项式拟合的阶数选择 了解如何用 python 实现机器学习的模型阶数选择 Understand the model order selection problem in machine learning Understand different error types of data fitting Understand the concept of bias variance trade-off Understand cross validation method Understand the order selection of polynomial fitting Know how to do model order selection in python	2h
正则化最小二乘与特征选择 • 例子:预测前列腺癌 • 岭回归 • LASSO 回归 • 两种回归方式与特征权重的关系 • 正则化回归的概率解释 Regularized Least-Squares and Feature Selection • Motivating Example: Predicting Prostate Cancer	理解特征选择背后的动机和思想 了解一些基础的特征选择方法: 穷举搜索，逐步选择，目标互相关，正则化 理解岭回归和 LASSO 以及它们的系数路径 理解它们与 MLE 和 MAP 之间的联系 了解如何使用 sklearn 实现 LASSO 理解如何使用交叉验证选择正则化强度 Understand motivation and idea behind feature selection Understand feature selection methods based on: exhaustive search, stepwise selection, target cross-correlation,	4h

• Ridge Regression • LASSO • Probabilistic Interpretation of Regularized Regression	regularization Understand ridge regression and LASSO: interpret their coefficient paths Know how to implement LASSO using sklearn know how to select the regularization strength using cross-validation Understand connections to ML estimation and MAP estimation	
逻辑回归 • 逻辑回归与分类问题的关联 • 二分类问题 • 多分类问题 • 分类误差分析 • 机器学习中的逻辑回归分类问题及 Python 示例 Logistic Regression • Relationship between Logistic Regression and Classification Problems • Binary classification problems • Multiclass classification problems • Classification error metrics • Python solution to logistic regression classification problems of machine learning	了解逻辑回归与分类问题的关联 了解逻辑函数表达式、交叉熵、正则化等概念 掌握使用逻辑回归进行二分类和多分类的方法 掌握分类问题的误差分析方法 了解如何在 Python 中实现用逻辑回归进行数据分类 Understand the relationship between Logistic Regression and Classification problems Know logistic function, cross-entropy, ML fitting, regularization Learn how to use logistic regression in classification problems Understand the error metric of classification problems Know how to implement and access classification using sklearn	4h
非线性优化与梯度下降 • 例子：为逻辑回归构建优化器 • 多变量函数的梯度梯度下降 • 自适应步长 • 凸性 Nonlinear Optimization & Gradient Descent • Motivating Example: Build an Optimizer for Logistic Regression • Gradients of Multi-Variable Functions Gradient Descent • Adaptive Stepsize • Convexity	确定优化问题中的损失函数、参数和约束条件 计算损失函数的梯度 了解如何在 Python 中高效计算梯度 掌握如何编写梯度下降的迭代表达式 了解步长对收敛性的影响 熟悉自适应步长方案，如 Armijo 规则 判断损失函数是否为凸函数 理解凸性对梯度下降的影响 Identify the cost function, parameters, and constraints in an optimization problem Compute the gradient of a cost function for scalar, vector, or matrix parameters Know how to efficiently compute a gradient in Python Write the gradient-descent update Understand the effect of the stepsize on convergence Be familiar with adaptive stepsize schemes like the Armijo rule Determine if a loss function is convex Understand the implications of convexity for gradient descent	4h
最大边缘分类和支持向量机 • 例子：识别手写数字 • 最大边际分类 • 支持向量分类器 • 支持向量机 Maximum-Margin Classification and the Support Vector Machine • Motivating Example: Recognizing Handwritten Digits • Maximum-Margin Classification • The Support Vector Classifier • The Support Vector Machine	理解线性分类边界的几何性质 掌握边际最大化分类器 理解支持向量机(SVM) 了解如何使用 sklearn 实现 SVC 和 SVM Understand the geometry of the linear classification boundary Understand the margin-maximizing classifier Understand the support vector classifier (SVC) Understand the support vector machine (SVM) Know how to implement the SVC and SVM with sklearn	4h
神经网络 • 例子:特征学习转换 • 前馈神经网络 • 随机梯度下降法	理解 2 层前馈神经网络的特征学习转换、网络结构、激活函数的选择以及训练损失 理解小批量训练和随机梯度下降 理解梯度计算的反向传播方法	6h

• 使用 PyTorch 实现和训练神经网络 • 通过反向传播计算梯度 Neural Networks • Motivating Example: Learning a Feature Transformation • Feed-Forward Neural Networks • Training via Stochastic Gradient Descent • Implementing and Training Neural Nets with PyTorch • Gradient Computation via Back-Propagation	了解如何使用 PyTorch 实现神经网络 Understand 2-layer feedforward neural networks: include learning feature transformations, network architecture, choice of activation functions and training loss Understand mini-batch training and stochastic gradient descent Understand the back-propagation approach to gradient computation Know how to implement a neural network using PyTorch	
卷积和深度神经网络 • 例子：ImageNet 大型视觉识别挑战 • 深度网络和特性层次结构 • 二维卷积基础知识 • 卷积神经网络 • 在 PyTorch 中创建和可视化卷积层 • 训练 CNN 网络：Backpropagation， Batch-Norm，Dropout 等 • 从著名的预先培训的网络中学习 Convolutional and Deep Neural Networks • Motivation: ImageNet Large-Scale Visual Recognition Challenge • Deep Networks and Feature Hierarchies • 2D Convolution Basics • Convolutional Neural Networks • Creating and Visualizing Convolutional Layers in PyTorch • Training CNNs: Backpropagation, Batch-Norm, Dropout, Etc. • Transfer Learning from Famous Pre-Trained Networks	认识到 CNN 网络可用来学习和挖掘层次特征 二维卷积： 理解局部模式匹配 理解卷积的边界条件以及其和相关性之间的关系 知道如何使用 scipy.signal 和 PyTorch 实现卷积 卷积神经网络： 理解卷积层，稠密层，子抽样，池化理解反向传播训练识别训练技巧，如批处理规范、辍学、数据扩充 迁移学习和预培训网络： 熟悉 AlexNet、VGG、Inception、ResNet 等著名网络，知道如何在 PyTorch 中使用预先训练好的网络 Recognize CNNs as learning and exploiting hierarchical features 2D convolution: Understand as local pattern matching Understand boundary conditions and relation between convolution and correlation Know how to implement convolution with scipy.signal and PyTorch Convolutional neural networks: Understand convolutional layers, dense layers, subsampling, pooling Understand backpropagation training Recognize training tricks like batch-norm, dropout, data augmentation Transfer learning and pre-trained networks: Be familiar with AlexNet, VGG, Inception, ResNet, and other famous networks Know how to work with pre-trained networks in PyTorch	6h
主成分分析 • 降维 • 主成分分析 • 数据可视化 PCA • 通过 SVD 计算 PCA • Python 示例:特征面和基于 PCA 的分类 Principal Component Analysis • Dimensionality Reduction • Principal Component Analysis (PCA) • PCA for Data Visualization • Computing PCA via the SVD • Python Example: Eigenfaces and PCA-based Classification	了解特征降维的需求 将主成分分析理解为 RSS-极小化线性逼近 理解正交投影 将 PCA 理解为子空间拟合 理解数据协方差特征向量在 PCA 中的作用 了解如何使用 PoV 度量 PCA 的性能 了解如何使用 SVD 计算 PCA 了解如何将 PCA 用于数据可视化 了解 PCA 系数在监督学习任务中的应用 Recognize need for feature dimensionality reduction Understand PCA as RSS-minimizing linear approximation Understand orthogonal projection Recognize PCA as subspace fitting Understand the role of the data-covariance eigenvectors in PCA Know how to measure PCA performance using PoV Understand how to compute PCA using the SVD Understand how PCA can be used for data visualization Understand how the PCA coefficients can be used in supervised learning tasks	4h

集群、K-Means、NMF 和 EM • 例子:文档集群 • 集群和 k-means • 文本挖掘与 Bag-of-Words，TF-IDF，和 K-means • 低阶模型：LSA 和 NMF • 高斯混合模型(GMMs) • GMMs 的期望最大化拟合 • 其他聚类方法 Clustering, K-Means, NMF, and EM • Motivating Example: Document Clustering • Clustering and K-Means • Text Mining with Bag-of-Words, TF-IDF, and K-Means • Low-Rank Models: LSA and NMF • Gaussian Mixture Models (GMMs) • Expectation-Maximization (EM) Fitting of GMMs • Other Clustering Methods	了解 k-means 聚类目标和 Lloyd 算法 理解用于文本挖掘的术语文档矩阵和 TF-IDF 分数 理解 NMF，它与 PCA 的关系，以及它在集群中的应用 了解 GMMs 及其在集群中的应用 了解 EM 算法及其在 GMM 参数拟合中的应用 Understand the k-means clustering objective and Lloyd's algorithm Understand term-document matrices and TF-IDF scores for text-mining Understand NMF, its relation to PCA, and application to clustering Understand GMMs and their application to clustering Understand the EM algorithm and its application to GMM parameter fitting	4h
随机森林和其他集成方法 • 并行集成方法：装袋和粘贴 • 决策树和随机森林 • 顺序集成方法：Boosting Random Forests and other Ensemble Methods • Parallel Ensemble Methods: Bagging and Pasting • Decision Trees and Random Forests • Sequential Ensemble Methods: Boosting	了解集成方法：装袋、粘贴、以及随机特征选择 理解决策树：特征阈值和决策区域、自上而下的树归纳训练、同质性指标、随机森林 了解顺序集成方法如 Adaboost 和 Gradient boosting Understand parallel ensemble methods bagging, pasting random feature selection Understand decision trees feature thresholding and decision regions training via top-down tree induction homogeneity metrics: variance reduction, gini impurity, random forests Understand sequential ensemble methods like Adaboost, Gradient boosting	4h

18. **教材及其它参考资料 Textbook and Supplementary Readings**

Textbook: James, Witten, Hastie, and Tibshirani, *An Introduction to Statistical Learning*, 2013.
Supplementary Readings: Soroush Nasiriany, Garrett Thomas, William Wang, and Alex Yang, *A Comprehensive Guide to Machine Learning*, 2018.
Ethem Alpaydin, Introduction To Machine Learning, 3rd edition, 2015
Sebastian Raschka, Python Machine Learning, 2015

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance				
课堂表现 Class Performance				
小测验 Quiz		10%		
课程项目 Projects		25%		
平时作业 Assignments		35%		

期中考试 **Mid-Term Test**		30%		
期末考试 **Final Exam**				
期末报告 **Final Presentation**				
其它（可根据需要改写以上评估方式） **Others (The above may be modified as necessary)**				

20. 记分方式 **GRADING SYSTEM**

√ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问， 请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	**工程机器学习基础** **Machine Learning for Engineering**
2.	**授课院系** **Originating Department**	机械与能源工程系 Department of Mechanical and Energy Engineering
3.	**课程编号** **Course Code**	ME338
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业核心课 Major Core Courses
6.	**授课学期** **Semester**	春季 Spring
7.	**授课语言** **Teaching Language**	英文 English
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	责任教师： 周博宇 机械与能源工程系 Department of Mechanical and Energy Engineering Boyu Zhou uv.boyuzhou@gmail.com
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other (Please specify)	总学时 Total
学时数 Credit Hours	48				48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	线性代数 （MA113） 概率论与数理统计（MA212） 计算机程序设计基础（CS109）等 Linear Algebra (MA113) Probability and Statistics (MA212) Introduction to Computer Programming (CS109)
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	
14. 其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程旨在使学生掌握机器学习的基本概念、主要任务及发展历史，重点理解其在工程与机器人领域的应用，如导航、感知和决策。学生将学习线性回归与正则化技术（如岭回归和 LASSO）、逻辑回归在分类任务中的应用（如机器人视觉中的物体分类），以及梯度下降与反向传播的原理。课程还将介绍神经网络及深层网络（如 CNN、ResNet 和 Transformer）的应用，重点探讨在机器人视觉中的实际案例及训练技巧。其他内容包括主成分分析（PCA）在降维中的作用、聚类算法在环境建模中的应用，以及决策树和集成方法在任务优化中的实践。学生还将学习模仿学习和强化学习，理解其在机器人行为策略优化中的价值，并探索图神经网络、生成模型（如 Diffusion 和 VAE），以及基础大模型（如分割一切和视觉语言模型）在机器人中的潜力。

This course aims to provide students with a solid understanding of the fundamental concepts, tasks, and history of machine learning, focusing on its applications in engineering and robotics, such as navigation, perception, and decision-making. Students will learn linear regression and regularization techniques (e.g., Ridge Regression and LASSO), logistic regression for classification tasks (e.g., object classification in robotic vision), and the principles of gradient descent and backpropagation. The course introduces neural networks and deep networks (e.g., CNNs, ResNet, and Transformer), with practical cases in robotic vision and training techniques. Other topics include PCA for dimensionality reduction, clustering for environment modeling, and decision trees and ensemble methods for task optimization. Students will also explore imitation and reinforcement learning for robotic behavior strategies, as well as Graph Neural Networks, generative models (e.g., Diffusions and VAEs), and foundational models (e.g., Segment Anything and Vision-Language Models) for robotics applications.

16. 预达学习成果 Learning Outcomes

完成本课程的学习后，学生应能够完成：
（1）制定并解决线性回归问题；
（2）用逻辑回归的方法制定和解决线性分类问题；
（3）使用 k-means 来制定和解决聚类问题；使用主成分分析等方法对高维数据进行降维；
（4）熟悉神经网络，深度网络模型，注意力机制，Transformer 等；
（5）了解机器人学习方法，比如模仿学习、强化学习；了解机器人相关的基础模型，以及在导航、操作等任务的应用。
（6）在 Python/sklearn/PyTorch 中实现基本的机器学习和深度学习任务。

After this course, students should be able to:
(1) Formulate and solve linear regression problems;
(2) Formulate and solve linear classification problems using logistic regression;
(3) Formulate and solve clustering problems using k-means; Perform dimensionality reduction on high-dimensional data using methods such as Principal Component Analysis (PCA);
(4) Become familiar with neural networks, deep network models, attention mechanisms, and Transformer architectures;
(5) Understand robotic learning methods, such as imitation learning and reinforcement learning; Learn about foundational models related to robotics and their applications in tasks like navigation and manipulation;.
(6) Implement basic machine-learning and deep learning tasks in Python/sklearn/PyTorch.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

章节	教学内容	学时分配
绪论 Introduction	介绍机器学习的基本概念、主要任务及发展历史，重点探讨机器学习在工程与机器人领域的应用，如机器人导航、感知、决策。 Introduce the basic concepts, main tasks, and historical development of machine learning, with a focus on its applications in engineering and robotics, such as navigation, perception, and decision-making.	2h
线性回归与正则化 Linear Regression and Regularization	学习线性回归的基本原理及正则化技术（如岭回归与LASSO）。 Learn the basic principles of linear regression and regularization techniques, such as Ridge Regression and LASSO.	4h
分类问题与逻辑回归 Classification Problems and Logistic Regression	探讨逻辑回归在分类任务中的应用，包括机器人视觉中的物体分类，学习性能评估指标及优化方法。 Explore the applications of logistic regression in classification tasks, including object classification in robotic vision, and study performance evaluation metrics and optimization methods.	4h
反向传播与梯度下降 Backpropagation and Gradient Descent	学习梯度下降算法及反向传播原理，分析学习率等的影响。 Learn the gradient descent algorithm and backpropagation principles, and analyze the impact of parameters such as the learning rate.	4h
神经网络 Neural Networks	讲解神经网络的基本结构和前向传播过程，通过案例学习神经网络在机器人感知与运动控制中的应用。 Explain the basic structure and forward propagation process of neural networks, and learn their applications in robotic perception and motion control through case studies.	4h
深度神经网络 Deep Neural Networks	学习深层神经网络，卷积神经网络（CNN），熟悉知名网络架构（ResNet等）。学习注意力机制、Transformer等架构。了解在机器人视觉中的应用以及训练技巧（如批归一化、Dropout）。 Study deep neural networks, convolutional neural networks (CNNs), and familiarize yourself with well-known architectures such as ResNet. Learn attention mechanisms and Transformer architectures. Understand their applications in robotic vision and training techniques such as batch normalization and Dropout.	6h
降维与主成分分析 Dimensionality Reduction and Principal Component Analysis	讲解主成分分析（PCA）及其在数据降维和可视化中的作用，分析高维感知数据的降维处理。 Explain principal component analysis (PCA) and its role in data dimensionality reduction and visualization, with an emphasis on handling high-dimensional perception data.	4h
聚类 Clustering	学习常用聚类算法（如K-means和高斯混合模型），并探讨其在机器人环境建模和场景分割中的应用。 Learn common clustering algorithms such as K-means and Gaussian Mixture Models, and explore their applications in robotic environment modeling and scene segmentation.	4h
决策树和集成 Decision Trees and Ensembles	讲解决策树及其集成方法（如随机森林和Gradient Boosting），探索机器人任务中的决策优化问题。 Explain decision trees and ensemble methods such as Random Forest and Gradient Boosting, and explore decision optimization problems in robotic tasks.	4h
模仿学习 Imitation Learning	概述模仿学习的基本概念，学习如何通过模仿人类示范优化机器人行为策略，如机器人抓取、操作任务。 Provide an overview of the basic concepts of imitation learning and study how to optimize robotic behavior strategies through human demonstrations, such as robotic grasping and manipulation tasks.	2h

强化学习 Reinforcement Learning	学习强化学习的核心理论与算法（如Q-learning和策略梯度），并探讨其在机器人自主决策与控制中的应用。 Learn the core theories and algorithms of reinforcement learning, such as Q-learning and policy gradient, and explore their applications in robotic autonomous decision-making and control.	2h
图神经网络 Graph Neural Networks	介绍图神经网络的基本原理，以及在机器人跟踪、匹配等任务的应用。 Introduce the basic principles of graph neural networks and their applications in robotic tasks such as tracking and matching.	2h
生成模型 Generative Models	学习生成模型（如VAE、Diffusion）的基础知识，并探索其在机器人感知数据生成与模拟中的潜力。 Learn the foundational knowledge of generative models such as VAEs, and Diffusion models, and explore their potential in generating and simulating robotic perception data.	2h
机器人基础模型 Foundational Models for Robotics	综述机器人常见的基础大模型，比如分割一切，视觉语言模型等及其应用。 Provide an overview of commonly used foundational models in robotics, such as "segment anything" and vision-language models, and their applications.	4h

18. 教材及其它参考资料 Textbook and Supplementary Readings

Textbook: James, Witten, Hastie, and Tibshirani, *An Introduction to Statistical Learning*, 2013.
Supplementary Readings: Soroush Nasiriany, Garrett Thomas, William Wang, and Alex Yang, *A Comprehensive Guide to Machine Learning*, 2018.
Ethem Alpaydin, Introduction To Machine Learning, 3rd edition, 2015
Sebastian Raschka, Python Machine Learning, 2015

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance				
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects		40		
平时作业 Assignments		30		
期中考试 Mid-Term Test				
期末考试 Final Exam		30		
期末报告 Final Presentation				
其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary)				

20. 记分方式 **GRADING SYSTEM**

√ A. 十三级等级制 **Letter Grading** ☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority
