

## 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.	<b>课程名称 Course Title</b>	深度学习基本原理与实践 Fundamentals and Methods of Deep Learning
2.	<b>授课院系 Originating Department</b>	信息系统与管理工程系 Department of Information Systems & Management Engineering
3.	<b>课程编号 Course Code</b>	MIS 316
4.	<b>课程学分 Credit Value</b>	3
5.	<b>课程类别 Course Type</b>	专业核心课 Major Core Courses
6.	<b>授课学期 Semester</b>	春季 Spring
7.	<b>授课语言 Teaching Language</b>	中英双语 Bilingual
8.	<b>授课教师、所属学系、联系方式 Instructor(s), Affiliation &amp; Contact</b> (For team teaching, please list all instructors)	卢涛, 信息系统与管理工程系 Tao Lu, Department of Information Systems & Management Engineering lut@sustech.edu.cn
9.	<b>实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact</b>	待公布 To be announced
10.	<b>选课人数限额(可不填) Maximum Enrolment (Optional)</b>	

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	32	0	32	0	64
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	MIS306 数据挖掘及商务应用 MIS306 Data Mining and Business Applications				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 None				
14. 其它要求修读本课程的学系 Cross-listing Dept.	无 None				

### 教学大纲及教学日历 SYLLABUS

#### 15. 教学目标 Course Objectives

课程目标是教授本科高年级学生深度学习的基础理论和应用方法。理论基础方面，课程会教授一些深度学习模型会涉及到的基础机器学习原理以及深度学习的理论原理。应用方面，课程会带领学生学会如何使用一些常用的深度学习模型，并且指导学生在实际场景中应用深度学习技术。

This course is designed to instruct the theoretical foundations as well as applications about deep learning algorithms for high grade undergraduate students. From the theoretical perspective: the course will deliver: 1) fundamental machine learning theories related to deep learning algorithms, and 2) underlying theoretical mechanism of deep learning models. Also, from the application perspective: the course will guide the students to master: 1) How to use and apply deep learning models, and 2) How to design and develop models in real life settings.

#### 16. 预达学习成果 Learning Outcomes

希望学生学完课程之后能够：

- 1) 理解所有深度学习算法的底层概念；
- 2) 掌握深度学习算法的理论和推导过程；
- 3) 理解一些常用深度学习模型的作用机制；
- 4) 能够在一些实际场景下使用和应用深度学习算法。

After learning the course, students are expected to:

- 1) Understand all the basic fundamental concepts in deep learning algorithms;
- 2) Master the underlying theories and corresponding derivations;
- 3) Understand the underlying mechanisms of several commonly used model specifications;
- 4) Be able to use and apply these models into real life settings;

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.)**

**理论和实验课（共 64 学时）**

**理论课（32 学时）**

**第一章 绪论（2 学时）**

简要介绍机器学习、主要是深度学习理论和应用的发展轨迹。包含但不限于：脑神经模型、神经网络全拟合理论、非线性激活函数、并行计算等

**第二章 模型评估与选择（2 学时）**

介绍机器学习模型的评估方法，教授各种评估指标的理论基础，结合各种评估标准讲解模型选择的利弊权衡方法。

**第三章 神经网络模型（2 学时）**

介绍神经网络模型的基本原理和模型推理计算过程。

**第四章 反向传播（2 学时）**

介绍神经网络反向传播的计算原理和过程。

**第五章 梯度下降（2 学时）**

介绍机器学习，主要是神经网络模型的训练方法。

**第六章 过拟合与正则化（2 学时）**

介绍机器学习，主要是神经网络模型的过拟合问题，并介绍一些常用的对抗过拟合的方法。

**第七章 计算学习理论（2 学时）**

介绍机器学习计算学习理论，比如 PAC 学习和 VC 维

**第八章 期中复习考试（2 学时）**

对上半学期学习的理论指数进行一个回顾复习，组织期中考试。

**第九章 深度学习模型应用（2 学时）**

介绍一些目前深度学习正在应用的业界场景

**第十章 卷积神经网络（2 学时）**

介绍卷积神经网络的模型结构、计算原理和应用场景

### 第十一章 循环神经网络（2学时）

介绍循环神经网络的模型结构、计算原理和应用场景

### 第十二章 残差神经网络（2学时）

介绍残差神经网络的模型结构、计算原理和应用场景

### 第十三章 嵌入式模型（2学时）

介绍嵌入式模型的模型结构、计算原理和应用场景

### 第十四章 生成模型（2学时）

介绍生成模型的模型结构、计算原理和应用场景

### 第十五章 前沿理论分享（2学时）

介绍一些前沿的机器学习理论和模型实践

### 第十六章 项目汇报（2学时）

组织同学作项目报告

### 实验课（32学时）

#### 第一单元 基于 python 的深度学习算法基础（6学时）

带领学生实现 python 代码基础：数据处理、基本机器学习算法实现、模型评价方法实现

#### 第二单元 深度学习模型代码基础（4学时）

带领学生实现各项深度学习模型基础代码：PyTorch、模型架构、梯度下降算法

#### 第三单元 深度学习基础模型实现（6学时）

带领学生实现各项基础深度学习模型：卷积神经网络、循环神经网络、残差神经网络

#### 第四单元 深度学习进阶模型实现（6学时）

带领学生实现各项进阶深度学习模型：嵌入式模型、生成模型

#### 第五单元 算法应用项目（6学时）

带领学生小组设计、实现一个应用项目，开发一个可用算法

#### 第六单元 应用项目展示（4学时）

带领学生小组展示开发的应用算法

## Lecture and Tutorial (64 hours)

### Lecture (32 hours)

#### Chapter 1 Introduction (2 hours)

Briefly introduce machine learning, especially deep learning theory and applications. Include but not restricted to: brain model, how neural networks can fit any function, non-linear activation function, parallel computing.

#### Chapter 2 Model Evaluation and Selection (2 hours)

Introduce the evaluation methods of machine learning, teach common evaluation methods, and combine evaluation methods to tell how to select machine learning models.

#### Chapter 3 Neural Network Models (2 hours)

Introduce the fundamental theory and model inference process of deep learning.

#### Chapter 4 Backpropagation (2 hours)

Introduce the backpropagation theory and the calculation process.

#### Chapter 5 Gradient Descent (2 hours)

Introduce the training theory and process of the machine learning, especially deep learning.

#### Chapter 6 Overfit and Regularization (2 hours)

Introduce the overfitting problem in deep learning, and common methods to mitigate the overfitting curse.

#### Chapter 7 Computational Learning Theory (2 hours)

Introduce the computational theory of machine learning, e.g., PAC learning, VC dimension.

#### Chapter 8 Midterm Recap and Exam (2 hours)

Give a recap to the theoretical part of the first half semester, and organize the mid-term exam.

#### Chapter 9 Deep Learning Applications (2 hours)

Introduce some industry applications of deep learning

#### Chapter 10 Model Specification: CNN (2 hours)

Introduce convolutional neural networks' (CNN) structure, fundamental computation theory, and the application scenarios.

#### Chapter 11 Model Specification: RNN (2 hours)

Introduce recurrent neural networks' (RNN) structure, fundamental computation theory, and the application scenarios.

Chapter 12 Model Specification: Resnet (2 hours)

Introduce residual neural networks' (Resnet) structure, fundamental computation theory, and the application scenarios.

Chapter 13 Model Specification: Embedding (2 hours)

Introduce embedding models' structure, fundamental computation theory, and the application scenarios.

Chapter 14 Model Specification: GAN (2 hours)

Introduce generative adversarial networks' (GAN) structure, fundamental computation theory, and the application scenarios.

Chapter 15 Cutting Edge Progresses (2 hours)

Introduce the cutting-edge deep learning method and practice

Chapter 16 Projects Report (2 hours)

Organize the students to give project report presentations.

**Tutorial (32 hours)**

Module 1: Python Based Deep Learning Foundations (6 hours)

Lead the students to learn python programming basics: data processing, basic machine learning realization, model evaluation realization.

Module 2: Deep Learning Foundations Implementations (4 hours)

Lead the students to learn deep learning programming Foundations: PyTorch, model structure, gradient decent

Module 3: Basic Deep Learning Models Implementations (6 hours)

Lead the students to learn basic deep learning models programming implementations: CNN, RNN, Resnet

Module 4: Advanced Deep Learning Models Implementations (6 hours)

Lead the students to learn advanced deep learning models programming implementations: Embedding models, GAN, and etc.

Module 5: Algorithm Application Project (6 hours)

Lead the students to design, realize an applicable algorithm.

Module 6: Project Presentation (6 hours)

Lead the students to present the algorithm they designed.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT press.

Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2021). *Dive into deep learning*. arXiv preprint arXiv:2106.11342.

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		10		
课堂表现 Participation		10		
小测验 Quiz				
课程项目		20		
平时作业 Graded Team Assignments		10		
期中考试 Mid-Term Quiz		30		
期末考试 Final Exam				
期末报告 Final Presentation		20		
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