

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	运筹与优化 Operational Research and Optimization
2.	授课院系 Originating Department	统计与数据科学系 Department of Statistics and Data Science
3.	课程编号 Course Code	STA201
4.	课程学分 Credit Value	3
5.	课程类别 Course Type	专业基础课 Major Foundational Courses
6.	授课学期 Semester	秋季 Fall
7.	授课语言 Teaching Language	中英双语 English & Chinese
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)	
9.	实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact	无 NA / 待公布 To be announced / 已确定的实验员/助教联系方式 Please list all Tutor/TA(s) (请保留相应选项 Please only keep the relevant information)
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	MA107 高等代数 I / MA107A 线性代数 A MA107 Advanced Linear Algebra I / MA107A Linear Algebra A				
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

本课程通过理论与实例相结合的形式使得学生能充分掌握运筹与优化的基本工具、理论和方法,尤其在数学和数据科学领域。初步掌握模型化方法来描述、分析、建模和求解现实的运筹优化问题,进而支持决策。

By providing a balanced view of "theory" and "practice", the course should allow the student to understand, use, and build practical analysis and planning of complex systems in the field of big data and data science. The goal of this course is to teach students to formulate, analyze, and solve mathematical models that represent real-world optimization problems for decision analysis.

16. 预达学习成果 Learning Outcomes

通过本课程的学习,学生预期可达到:

- 掌握运筹与优化分支(线性&动态规划、网络优化、运输与指派、排队论、数据建模等)的基本理论、方法
- 运用所学知识和方法对实际优化及数据问题进行量化分析、建模、检验及应用推广
- 独立或以小组的形式分析运筹优化的应用案例并给出最佳决策
- 应用课程提供的软件(Matlab, excel)解决实际优化问题

On successful completion of the course, students should be able to:

- Understand the basic theoretical workings (including linear and dynamic programming, the transportation and assignment problems; network optimization models, dynamic programming, queueing models, and mathematical models in data science, etc.) in operational research and optimization.
- Formulate a real-world problem as a mathematical model and quickly explore, solve it if possible, check and apply it.
- Build their own formulations independently or in groups, to expand existing formulations, to critically evaluate the impact of model assumptions and to choose an appropriate solution technique for a given formulation.
- Be able to implement practical cases by software (MATLAB, .etc) presented in class.

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.)

绪论：简介（2学时）

运筹学的起源、性质和影响；运筹学与分析论的崛起；运筹学建模方法综述；定义问题和收集数据、数学建模、模型求解、检验模型、准备应用模型等

Part 0: Introduction (2 hours)

The Origins, nature, impact and algorithms of Operations Research
The Rise of Analytics Together with Operations Research
Overview of the Operations Research Modeling Approach
Defining the Problem and Gathering Data
Formulating a Mathematical Model
Deriving Solutions from the Model
Testing the Model
Preparing to Apply the Model
Implementation and Conclusions

第一部分：(大规模、确定或不确定) 线性规划（16学时）

线性规划导论；线性规划模型；大型的线性规划模型；求解线性规划问题——单纯形法；在计算机上的实施；求解线性规划问题的内点算法；应用 LINDO 和 LINGO 的介绍；对偶理论；不确定条件下的线性规划；灵敏度分析；鲁棒优化；机会约束；带补偿的随机规划；线性规划的其他算法；整数线性规划等

Part 1 : (Large, certainty or uncertainty) Linear Programming (16 hours)

Introduction to Linear Programming & The Linear Programming Model
Very Large Linear Programming Models
Solving Linear Programming Problems: The Simplex Method
Computer Implementation
The Interior-Point Approach to Solving Linear Programming Problems
An Introduction to Using LINDO and LINGO
Duality Theory, Primal - Dual Relationships
Linear Programming under Uncertainty
Sensitivity Analysis | Robust Optimization | Chance Constraints;
Stochastic Programming with Recourse
Other Algorithms for Linear Programming
Integer programming

第二部分：运输和指派问题（4学时）

运输问题；用于运输问题的单纯形法；指派问题；求解指派问题的特殊算法；案例解析：往市场运输木材，Texago Corp.选址问题的案例研究等

Part 2: The Transportation and Assignment Problems (4hours)

The Transportation Problem
A Streamlined Simplex Method for the Transportation Problem
The Assignment Problem
A Special Algorithm for the Assignment Problem
Case 1: Shipping Wood to Market
Case 2: Continuation of the Texago Case Study

第三部分：网络优化模型（4学时）

原形范例;网络术语;最短路径问题;最小支撑树问题;最大流问题;最小费用流问题;网络单纯形法;一个项目时间—费用平衡优化的网络模型等

Part 3: Network Optimization Models (4hours)

Prototype Example & The Terminology of Networks
The Shortest-Path Problem
The Minimum Spanning Tree Problem
The Maximum Flow Problem
The Minimum Cost Flow Problem

The Network Simplex Method
A Network Model for Optimizing a Project's Time – Cost Trade-Off

第四部分：动态规划(6 学时)

动态规划的范例； 动态规划问题的特征； 多阶段决策过程； 最优性原理； 确定性动态规划； 随机性动态规划； 资源分配问题等

Part 4: Dynamic Programming (6 hours)

A Prototype Example for Dynamic Programming
Characteristics of Dynamic Programming Problems
Multistage Decision Process
Optimal Substructure Property
Deterministic Dynamic Programming
Probabilistic Dynamic Programming
Case Analysis

第五部分：决策分析（4 学时）

原形范例;不进行试验的决策;进行试验时的决策制定; 决策树;用电子表格对决策树进行灵敏度分析; 效用理论;决策分析的实际应用等

Part 5: Decision Analysis (4 hours)

Decision Making without Experimentation
Decision Making with Experimentation
Decision Trees
Using Spreadsheets to Perform Sensitivity Analysis on Decision Trees
Utility Theory
The Practical Application of Decision Analysis

第六部分：凸优化(12 学时)

凸集和凸函数； 梯度下降法； 牛顿法； 拟牛顿法； 内点法； 次梯度法； 近端梯度法； 交替方向乘子法等

Part 6: Convex optimization (8 hours)

Convex sets and convex functions
Gradient descent methods
Newton's method
Quasi-Newton methods
Interior-point methods
Subgradient method
Proximal gradient method
Alternating direction method of multipliers

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

参考教材（Reference Textbook）：

1. Fred S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, 10th Edition, McFraw-Hill Education, ISBN:978-0-07-352345-3. 2015.
2. Luenberger, D. G., & Ye, Y. Linear and nonlinear programming (3rd Edition). Reading, MA: Addison-wesley. 2008.
3. Boyd, Stephen, Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.

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		10		
平时作业 Assignments		20		
期中考试 Mid-Term Test		20		
期末考试 Final Exam		50		
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