量化管理非线性方法
Nonlinear Methods in Quantitative Management
教学大纲
Subject Syllabus

一、课程信息 Subject Information

课程编号: Subject ID	3100313009	开课学期: Semester	5
课程分类: Category	专业教育 PA	所属课群: Section	专业基础 MF
课程学分: Credit Points	3	总学时/周: Total Hours/Weeks	48
理论学时: LECT. Hours	48	实验学时: EXP. Hours	0
PBL 学时: PBL Hours	0	实践学时/周: PRAC. Hours/Weeks	0
开课学院: College	东北大学 悉尼智能科技学院	适用专业: Stream	应用统计学 AS
课程属性: Pattern	必修 Compulsory	课程模式: Mode	互认 EQV
中方课程协调人: NEU Coordinator	于艳辉 Yanhui Yu	成绩记载方式: Result Type	百分制 Marks
先修课程: Requisites	高等数学建模 Advanced Mathematical Modeling		
英文参考教材: EN Textbooks	NONLINEAR PROGRAMMING（THIRD EDITION）		
中文参考教材: CN Textbooks	《最优化方法》作者:张薇、薛嘉庆编著,出版社:东北大学出版社		
教学资源: Resources	https://lms.cloudcampus.com.cn/courses/37		
课程负责人(撰写人): Subject Director	于艳辉 Yanhui Yu	提交日期: Submitted Date	单击或点击此处输入日期。
任课教师(含负责人): Taught by	于艳辉 Yanhui Yu		
审核人: Checked by	韩鹏	批准人: Approved by	史闻博
		批准日期: Approved Date	单击或点击此处输入日期。

二、教学目标 Subject Learning Objectives (SLOs)

注：毕业要求及指标点可参照悉尼学院本科生培养方案，可根据实际情况增减行数

Note: GA and index can be referred from undergraduate program in SSTC website. Please add/reduce lines based on subject.

<table>
<tr>
<td rowspan="2">整体目标:
Overall Objective</td>
<td colspan="2">《量化管理非线性方法》是应用统计学专业重要的专业基础课程之一。通过本课程的学习，了解最优化方法的发展过程及发展方向，掌握最优化理论基础、最优性条件、线性搜索技术、最速下降法、牛顿法、共轭梯度法、拟牛顿法、罚函数法等内容，使学生掌握这些最优化方法的基本要点及理论性质，培养和提高学生解决相关实际问题的能力，为今后的实际工作奠定必要的基础。</td>
</tr>
<tr>
<td colspan="2">Nonlinear Methods in Quantitative Management is one of the important professional basic courses for applied statistics majors. Through the study of this course, understand the development process and development direction of optimization methods, master the theoretical basis of optimization, optimality conditions, linear search technology, steepest descent method, Newton method, conjugate gradient method, quasi-Newton method, penalty function It enables students to master the basic points and theoretical properties of these optimization methods, cultivate and improve students' ability to solve practical problems, and lay a necessary foundation for future practical work.</td>
</tr>
<tr>
<td rowspan="7">（1）专业目标:
Professional Ability</td>
<td>1-1</td>
<td>了解最优化方法的发展过程及发展方向
Understand the development process and development direction of the optimization method</td>
</tr>
<tr>
<td>1-2</td>
<td>掌握最优化理论基础、最优性条件
Master the theoretical basis of optimization and optimality conditions</td>
</tr>
<tr>
<td>1-3</td>
<td>掌握线性搜索技术、最速下降法
Master linear search techniques, steepest descent method</td>
</tr>
<tr>
<td>1-4</td>
<td>掌握牛顿法、共轭梯度法
Master Newton's method, conjugate gradient method</td>
</tr>
<tr>
<td>1-5</td>
<td>掌握 DFP 算法、步长加速法、最小二乘问题的解法
Master DFP algorithm, step size acceleration method, least squares problem solution</td>
</tr>
<tr>
<td>1-6</td>
<td>掌握 Zoutendijk 容许方向法
Master the Zoutendijk Admissible Direction Method</td>
</tr>
<tr>
<td>1-7</td>
<td>掌握罚函数法
Master the penalty function method</td>
</tr>
<tr>
<td rowspan="2">（2）德育目标:
Essential Quality</td>
<td>2-1</td>
<td>培养遵守法律、懂规则、守规则的新时代公民
Cultivate citizens of the new era who abide by the law, understand and obey the rules</td>
</tr>
<tr>
<td>2-2</td>
<td>了解主要矛盾和次要矛盾，在面对复杂问题的时候要实事求是、抓住主要矛盾
Understand the main contradiction and secondary contradiction, seek truth from facts and grasp the main contradiction in the face of complex problems</td>
</tr>
</table>

	2-3	培养服务意识，具有"以人为本"的服务精神 Cultivate service consciousness and have the service spirit of "people-oriented"
	2-4	培养具有不畏困难、不惧失败、锲而不舍、敢于尝试、迎难而上的精神，并在学习过程中培养自己的细心和耐心的勇气和精神 Cultivate the spirit of not fearing difficulties or failure, perseverance, daring to try, and cultivate their own careful and patient courage and spirit in the process of learning
	2-5	培养有条理和计划，做到心中有数、有条不紊、循序渐进地完成一项工作 Cultivate a sense of order and plan, and complete a work in an orderly and gradual manner

课程教学目标与毕业要求的对应关系 Matrix of GA & SLOs

毕业要求 GA	指标点 GA Index	教学目标 SLOs
1、理学知识：具有扎实的数学基础，能够将数学、自然科学和专业知识用于解决复杂实际问题 **1. Science Knowledge**: Apply knowledge of mathematics, natural science, fundamentals and an engineering specialization to the solution of complex engineering problems	1-1：具有较强的演绎推理能力、准确计算能力、分析归纳能力、抽象思维能力，掌握数学、自然科学和相关专业知识，并使用其建立正确的数学、物理学等模型以解释复杂实际问题 1-1: Capable of deductive reasoning, accurate calculation, analysis and induction and abstract thinking. Establishing correct mathematical and physical models with the professional knowledge of mathematics, natural science, etc. to solve complex practical problems 1-3：了解本专业涉及相关行业的发展趋势以及相关产业的运营模式，具备在本专业相关领域进行方案设计、技术创新的能力 1-3: Understanding the development and operations of related industries in this major; capable of conducting program design and technological innovation in related fields of this major	1-1 到 1-7
4、研究：能够基于科学原理并采用科学方法对复杂实际问题进行研究，包括设计实验、分析与解释数据、并通过信息综合得到合理有效的结论 4. Investigation: Conduct	4-1：能够基于科学原理并采用科学方法，在本专业相关理论指导下对复杂实际问题设计实验进行研究 4-1: Capable of design experiments on complex problems with scientific knowledge and research methods of this major	1-1 到 1-7

| investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions | 4-2：能够结合本专业知识对实验数据进行分析与解释，设计并优化实验方案，并通过信息综合得到合理有效的结论
4-2: Capable of analyzing and interpreting the experimental data, designing and optimizing the experimental schemer with the knowledge of this major; reasonable and effective conclusions are obtained through information synthesis | |
| | 4-3：能够追踪国际前沿技术动态，掌握本专业涉及的重要技术指标以及达到指标所需的技术途径
4-3: Capable of tracking the international cutting-edge technology trends; mastering the important technical indicators involved in the major and the technical approaches required to achieve the indicators | |

三、教学内容 Content (Topics)

注：以中英文填写，各部分内容的表格可根据实际知识单元数量进行复制、扩展或缩减

Note: Filled in both CN and EN, extend or reduce based on the actual numbers of knowledge unit

(1) 理论教学 Lecture

知识单元序号: Knowledge Unit No.	1	支撑教学目标: SLOs Supported	1-1、1-2、2-2、2-4
知识单元名称 Unit Title	最优化理论基础 Optimization theoretical basis		
知识点: Knowledge Delivery	最优化问题实例 Examples of optimization problems		
	最优化问题的基本概念 Basic concepts of optimization problems		
	二维问题的图解法 Graphical method for two-dimensional problems		
	梯度和 Hesse 矩阵 Gradients and Hesse matrices		
	多元函数的 Talor 展开 Talor expansion of multivariate functions		
	凸函数与凸规划 Convex functions and convex programming		
	极小点的判定条件 Judgment conditions for minimum point		

		了解: Recognize	最优化发展的基本历史 Basic history of optimal development
学习目标: Learning Objectives		理解: Understand	最优化问题实例 Examples of an optimization problem
		掌握: Master	最优化基本概念，二维问题的图解法，梯度和 Hesse 矩阵，多元函数的 Talor 展开，凸函数与凸规划，极小点的判定条件 Basic concepts of optimization, graphical method for two-dimensional problems, gradient and Hesse matrices, Talor expansion of multivariate functions, convex functions and convex programming, minimum point judgment conditions
德育目标 Moral Objectives	了解主要矛盾和次要矛盾，在面对复杂问题的时候要实事求是、抓住主要矛盾 Understand the main contradiction and secondary contradiction, seek truth from facts and grasp the main contradiction in the face of complex problems		
	培养具有不畏困难、不惧失败、锲而不舍、敢于尝试、迎难而上的精神，并在学习过程中培养自己的细心和耐心的勇气和精神 Cultivate the spirit of not fearing difficulties or failure, perseverance, daring to try, and cultivate their own careful and patient courage and spirit in the process of learning		
重点: Key Points	梯度和 Hesse 矩阵，凸函数与凸规划，极小点的判定条件 Gradients and Hesse matrices, convex functions and convex programming, minimum point determination conditions		
难点: Focal Points	多元函数的 Talor 展开 Talor expansion of multivariate functions		

知识单元序号: Knowledge Unit No.	2	支撑教学目标: SLOs Supported	1-3，1-4，1-5，2-4、2-5
知识单元名称 Unit Title	无约束优化问题 Unconstrained optimization problem		
知识点: Knowledge Delivery	线性搜索技术 Linear search technique		
	最速下降法 Steepest descent		
	Newton 法 Newton's method		
	F-R 共轭梯度法 F-R conjugate gradient method		
	DFP 算法 DFP algorithm		
	步长加速法		

	Step acceleration	
	最小二乘问题的解法 Solution to the least squares problem	
学习目标: Learning Objectives	理解: Understand	线搜索算法的收敛性，熟悉各算法的理论性质 Convergence of line search algorithms, familiar with the theoretical properties of each algorithm
	掌握: Master	本章各算法的计算步骤 The calculation steps of each algorithm in this chapter
德育目标 Moral Objectives	培养具有不畏困难、不惧失败、锲而不舍、敢于尝试、迎难而上的精神，并在学习过程中培养自己的细心和耐心的勇气和精神 Cultivate the spirit of not fearing difficulties or failure, perseverance, daring to try, and cultivate their own careful and patient courage and spirit in the process of learning	
	培养有条理和计划，做到心中有数、有条不紊、循序渐进地完成一项工作 Cultivate a sense of order and plan, and complete a work in an orderly and gradual manner	
重点: Key Points	最速下降法的算法步骤 The algorithm steps of the steepest descent method	
	Newton 法的算法步骤 Algorithmic steps of Newton's method	
	F-R 共轭梯度法的算法步骤 Algorithm steps of F-R conjugate gradient method	
	DFP 算法的算法步骤 Algorithmic steps of the DFP algorithm	
	步长加速法的算法步骤 Algorithm steps of step acceleration method	
难点: Focal points	F-R 共轭梯度法的算法步骤 Algorithm steps of F-R conjugate gradient method	
	DFP 算法的算法步骤 Algorithmic steps of the DFP algorithm	

知识单元序号: Knowledge Unit No.	3	支撑教学目标: SLOs Supported	1-6，1-7、2-5
知识单元名称 Unit Title	约束优化问题 Constrained Optimization Problem		
知识点: Knowledge Delivery	最优性条件 Optimality condition		
	Zoutendijk 容许方向法 Zoutendijk admissible direction method		
	罚函数法 Penalty function method		

	内点法简介 Introduction to interior point method		
	梯度投影法 Gradient projection method		
学习目标: Learning Objectives	理解: Understand	熟悉各算法的理论性质 Familiar with the theoretical properties of each algorithm	
	掌握: Master	约束优化问题的最优性条件，本章各算法的理论性质 Optimality conditions for constrained optimization problems, theoretical properties of the algorithms in this chapter	
德育目标 Moral Objectives	培养有条理和计划，做到心中有数、有条不紊、循序渐进地完成一项工作 Cultivate a sense of order and plan, and complete a work in an orderly and gradual manner		
重点: Key Points	最优性条件 Optimality condition		
	Zoutendijk 容许方向法 Zoutendijk admissible direction method		
	罚函数法 Penalty function method		
	梯度投影法 Gradient projection method		
难点: Focal points	罚函数法 Penalty function method		

三、教学安排 Teaching Schedule

注：可根据实际情况增减行数

Note: Please add/reduce lines based on subject.

教学内容 Teaching Content	学时(周)　Hour(Week)			
	理论 LECT.	实验 EXP.	课外实践 PBL	集中实践 PRAC.
最优化理论基础 Optimization theoretical basis	12			
无约束优化问题 Unconstrained optimization problem	24			
约束优化问题 Constrained optimization problem	12			
总计 Total	48			

五、教学方法 Teaching Methodology

注：可根据实际情况增减行数或修改内容

Note: Please add/reduce lines or revise content based on subject.

勾选 Check	教学方法与特色 Teaching Methodology & Characters
☑	多媒体教学：基于信息化设备的课堂教学 Multi-media-based lecturing
☑	实践能力传授：理论与行业、实际案例相结合 Combining theory with industrial practical problems
☑	课程思政建设：知识讲授与德育相结合 Knowledge delivery with ethic education
☐	PBL 教学：问题驱动的分组学习与交流 Problem-based learning
☐	其他:单击或点击此处输入文字。 Other:单击或点击此处输入文字。

六、成绩评定 Assessment

注：可根据实际情况增减行数或修改内容

Note: Please add/reduce lines or revise content based on subject.

考核环节: Assessment Content	平时 Behavior	环节负责人: Director	于艳辉 Yanhui Yu
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	50
考核方式: Measures	满分 100 分，出勤，20 分；课堂小测验，30 分；作业，50 分。 The full score is 100 points, attendance, 20 points; group work, 30 points; homework, 50 points.		

考核环节: Assessment Content	期末 Final	环节负责人: Director	于艳辉 Yanhui Yu
给分形式: Result Type	百分制 Marks	课程总成绩比重(%): Percentage (%)	50
考核方式: Measures	满分 100 分，通过批阅期末考试试卷给出学生成绩。 The full score is 100, and the students' scores are given by marking the final examination papers.		

七、改进机制 Improvement Mechanism

注：未尽事宜以教学团队以及学院教学指导委员会商定为准。

Note: Matters not covered in this file shall be determined by TAB of SSTC, NEU.

教学大纲改进机制 Subject Syllabus Improvement Mechanism			
考核周期(年): Check Period (YR)	4	修订周期(年): Revise Period (YR)	4

改进措施: Measures	课程负责人根据课程教学内容与人才培养目标组织课程团队讨论并修改教学大纲，报分管教学工作副院长审核后由执行院长批准。 The subject coordinator shall be responsible for the syllabus discussion and improvement, and the revised version shall be submitted to deputy dean (teaching affairs) for reviewing then to executive dean for approval

成绩评定改进机制 Assessment Improvement Mechanism			
考核周期(年): Check Period (YR)	1	修订周期(年): Revise Period (YR)	1
改进措施: Measures	课程负责人根据课程教学内容、课堂教学效果以及成绩分布，对课程教学方法和成绩评定环节进行改进，并同步优化评定办法。 The subject coordinator shall revise the syllabus based on the teaching content, effect and result distribution while optimize the assessment measures.		