課程編號：26N103

115 全國夏季學院課程計畫書

所屬學校	國立臺灣大學
課程中文名稱	作業研究：模型與演算法
課程英文名稱	Operations Research: Models and Algorithms
授課教授中文姓名	孔令傑
任職單位/系所	資訊管理學系
授課教授 e-mail	lckung@ntu.edu.tw

二、課程規劃		
課程名稱	作業研究：模型與演算法	
課程類別	☐ A 類討論課 ☑ C 類一般課	
授課方式	☐實體課程 ☐同步遠距課程（請檢附相關通過辦法之文件、會議記錄等） ☑非同步遠距課程	
課程領域	☐ 文學與藝術 ☐ 歷史思維 ☐ 世界文明 ☐ 哲學與道德思考 ☐ 公民意識與社會分析 ☑ 數學數位與量化分析 ☐ 物質科學 ☐ 生命科學	
與課程相關之聯合國永續發展目標(SDGs)（複選）	☑SDG1 消除貧窮 (No Poverty) ☑SDG2 消除飢餓 (Zero Hunger) ☑SDG3 良好健康和福祉 (Good Health and Well-being) ☐SDG4 優質教育 (Quality Education) ☐SDG5 性別平等 (Gender Equality) ☐SDG6 潔淨水與衛生 (Clean Water and Sanitation) ☐SDG7 可負擔的潔淨能源 (Affordable and Clean Energy) ☑SDG8 尊嚴就業與經濟發展 (Decent Work and Economic Growth) ☐SDG9 產業創新與基礎設施 (Industry, Innovation and Infrastructure) ☐SDG10 減少不平等 (Reduced Inequalities) ☑SDG11 永續城市與社區 (Sustainable Cities and Communities) ☑SDG12 負責任的消費與生產 (Responsible Consumption and Production) ☐SDG13 氣候行動 (Climate Action) ☐SDG14 水下生命 (Life below Water) ☐SDG15 陸域生命 (Life on Land) ☐SDG16 和平正義與有力的制度 (Peace, Justice and Strong Institutions) ☐SDG17 夥伴關係 (Partnerships for the Goals)	
英文授課比例	☐全中文授課(上課語言、材料皆無英文) ☑全英文授課(上課語言、材料皆無中文) ☐中文、英文皆有 上課語言（中文：　%；英文：　%） 教材（中文：　%；英文：　%） （因同學英文程度不同，請務必註明，以供學生選課評估）	
修課人數上限	100 人	
特殊限制	是否**開放**高中生修課	☑ 是 ☐ 否
	是否**開放**準大學生（高三升大一之新生）修課	☑ 是 ☐ 否
	是否**開放**研究生修課	☑ 是 ☐ 否
學分數	2 學分	
上課起迄日	2026-07-02 ~ 2026-08-14	

上課總週數	上課共7週，是否連續每週排課？ ☑是，上課時間連續數週不中斷 ☐否，中間中斷　　週
上課地點	□ 非同步遠距、國立臺灣大學（含 3 次同步遠距、2 次實體考試） 校總區 校區
上課教室	☐已確定：教室 ☑尚未確定
上課時間及節數	07/20 08/10 | Week 一 | 15:30 ~ 17:20 | Total 2 times 07/02 | Week 四 | 15:30 ~ 17:20 | Total 1 times 07/24 08/14 | Week 五 | 15:30 ~ 17:20 | Total 2 times 07/04 07/11 07/18 07/25 08/01 08/08 | Week 六 | 00:00 ~ 01:00 | Total 6 times 07/05 07/12 07/26 08/02 08/09 | Week 日 | 00:00 ~ 01:00 | Total 5 times

課程目標
Students can learn how to use algorithms to solve different types of optimization programs and use Gurobi solver with Python to solve these problems efficiently.

教學內容及進度		
次別	上課日期/時間	課程內容
1	2026/07/02 (四) 15:30 - 17:20	【同步遠距】 Part I: Course Overview Module Description: This lecture gives students an overview of what they may expect from this course, including the fundamental concept and brief history of Operations Research. We will also talk about how mathematical programming can be used to solve real-world business problem. Learning Objectives: After this lecture, students will get a concrete idea about this course. Course Content: Reading: NTU MOOC course information & QAs (1min) Video: Prelude. (2min) Video: 1-1: Motivation. (18min) Video: 1-2: Business analytics. (21min) Video: 1-3: Mathematical programming. (23min) Video: 1-4: History. (14min) Video: 1-5: Preview for this course. (5min) Assessment: Quiz: Quiz for Week 1 (20 min)
2	2026/07/04 (六) 00:00 - 01:00	Linear Programming Module Description: Linear programming (LP) is one of the most important method to achieve the outcome of optimization problems. We can use LP models for various decisions, including production, inventory, personnel scheduling, etc. Learning Objectives: Students will learn the basic elements of a linear program, how to formulate linear programs, how to solve a two-variate linear program with the graphical approach, and how to solve a general linear program with Microsoft Excel. Course Content: Video: 2-0: Opening. (5min) Video: 2-1: Introduction. (3min)

		Video: 2-2: Elements of a mathematical program (1). (9min) Video: 2-3: Elements of a mathematical program (2). (13min) Video: 2-4: Linear programming. (7min) Video: 2-5: Graphical approach. (13min) Video: 2-6: Three types of LPs. (7min) Video: 2-7: Simple LP formulation - Product mix. (13min) Video: 2-8: Simple LP formulation - Production and inventory. (14min) Video: 2-9: Simple LP formulation - Personnel scheduling. (8min) Video: 2-10: Compact LP formulation - Production and Inventory. (11min) Video: 2-11: Compact LP formulation – Product mix. (8min) Video: 2-12: Computers – The Solver add-in and Example 1 – producing desks and tables. (TA) (9min) Video: 2-13: Computers – Example 2: personnel scheduling. (TA) (4min) Video: 2-14: Closing remarks. (6min) Assessment: Quiz: Quiz for Week 2 (20 min)
3	2026/07/05 (日) 00:00 - 01:00	Integer Programming Module Description: In many practical areas, some of the optimization problems occur with integrality constraints imposed on some of the variables. Facility location, machine scheduling, and vehicle routing are some examples. Integer Programming (IP) provides a mathematical way to solve these problems. Learning Objectives: Students will learn how to formulate integer programs, see various applications, and learn how to use Microsoft Excel to solve a general integer program. Course Content: Video: 3-0: Opening. (6min) Video: 3-1: Introduction. (8min) Video: 3-2: IP formulation (1). (11min) Video: 3-3: IP formulation (2). (9min) Video: 3-4: Facility location – Overview. (5min) Video: 3-5: Facility location – Covering. (10min) Video: 3-6: Facility location - UFL. (9min) Video: 3-7: Machine scheduling - Overview. (8min) Video: 3-8: Machine scheduling - Completion time minimization. (12min) Video: 3-9: Machine scheduling - Makespan minimization. (7min) Video: 3-10: Traveling salesperson problem - Basics. (11min) Video: 3-11: Traveling salesperson problem - Subtour elimination. (13min) Video: 3-12: Computers – Example 1 – personnel scheduling. (TA) (4min) Video: 3-13: Computers – Example 2 – facility location. (TA) (6min) Video: 3-14: Closing remarks. (8min) Assessment:

		Quiz: Quiz for Week 3 (20min)
4	2026/07/11 (六) 00:00 - 01:00	Nonlinear programming Module Description: In the real life, many problems involve nonlinearities. Examples include pricing, inventory, and portfolio optimization. For such problems, we may use Nonlinear Programming (NLP) to formulate them into models and solve them. Learning Objectives: Students will learn how to formulate nonlinear programs, see various applications, and learn how to use Microsoft Excel to solve a general nonlinear program. Course Content: Video: 4-0: Opening. (5min) Video: 4-1: Introduction. (12min) Video: 4-2: The EOQ problem. (9min) Video: 4-3: Formulating the EOQ model. (9min) Video: 4-4: The portfolio optimization problem. (8min) Video: 4-5: Portfolio optimization. (9min) Video: 4-6: Linearizing an absolute value function. (10min) Video: 4-7: Linearizing max_min functions. (11min) Video: 4-8: Linearizing products 1A. (6min) Video: 4-9: Linearizing products 1B 1C and 1D. (8min) Video: 4-10: Linearizing products 2A. (5min) Video: 4-11: Linearizing products 2B, 2C, and 2D. (10min) Video: 4-12: Remarks - why linearization. (3min) Video: 4-13: Computers – Portfolio optimization problem. (TA) (5min) Video: 4-14: Closing remarks. (2min) Assessment: Quiz: Quiz for Week 4 (20min)
5	2026/07/12 (日) 00:00 - 01:00	Case Study: Personnel Scheduling Module Description: In this lecture, we introduce a real business case that has been solved with Operations Research by the instructor. The problem is for a company to schedule its customer service representatives to minimize the total amount of staff shortage. We will demonstrate the problem, process of conducting an OR study, integer programming formulation, and result. Learning Objectives: Students will see a real case being solved by Operations Research and obtain more ideas about the way to conducting an OR study. Course Content: Video: 5-0: Opening. (4min) Video: 5-1: Background and motivation. (6min) Video: 5-2: Research objective. (8min) Video: 5-3: Problem description - objective. (9min) Video: 5-4: Problem description - constraints. (8min) Video: 5-5: Model formulation - objective. (11min) Video: 5-6: Model formulation - constraints. (11min) Video: 5-7: Results. (9min) Video: 5-8: Closing remarks. (3min)

		Assessment: Quiz: Quiz for Week 5 (20min)
6	2026/07/18 (六) 00:00 - 01:00	Summary and Future Directions Module Description: In the final lecture of this course, we will summarize what we have learned. We will also preview what we may learn in future courses. Learning Objectives: Students will get a wrap up for this course and an idea about further studies. Course Content: Video: 6-1: Review for this course. (16min) Video: 6-2: Preview of the next course. (6min) Video: A story that never ends. (2min) Assessment: Quiz: Quiz for Week 6 (40min)
7	2026/07/20 (一) 15:30 - 17:20	【同步遠距】 Modern Development and Practical Applications of OR
8	2026/07/24 (五) 15:30 - 17:20	【實體考試】Midterm Exam
9	2026/07/25 (六) 00:00 - 01:00	Part II: Course Overview Module Description: In the first lecture, we briefly introduce the course and give a quick review about some basic knowledge of linear algebra, including Gaussian elimination, Gauss-Jordan elimination, and definition of linear independence. Learning Objectives: After this lecture, students can have an idea about what they are going to learn, and get into the ideas about what we need in linear algebra to learn this course. Course Content: Reading: NTU MOOC course information & QAs (1min) Video: Prelude. (2min) Video: 1-1: Overview. (9min) Video: 1-2: The row and column views for a linear system – A two-dimensional example. (6min) Video: 1-3: The row and column views for a linear system – A three-dimensional example. (9min) Video: 1-4: Using Gaussian elimination to solve Ax=b – Nonsingular. (24min) Video: 1-5: Using Gauss-Jordan elimination to solve A^(-1) – Singular. (13min) Video: 1-6: Linear dependence and independence. (10min) Assessment: Quiz: Quiz for Week 1 (20 min)
10	2026/07/26 (日) 00:00 - 01:00	The Simplex Method Module Description: Complicated linear programs were difficult to solve until Dr. George Dantzig developed the simplex method. In this week, we first introduce the standard form and the basic solutions of a linear

		program. With the above ideas, we focus on the simplex method and study how it efficiently solves a linear program. Finally, we discuss some properties of unbounded and infeasible problems, which can help us identify whether a problem has optimal solution. Learning Objectives: After this lesson, students can understand the basic concept of the simplex method, how it works, and how to implement it. Course Content: Video: 2-0: Opening. (5min) Video: 2-1: Introduction. (4min) Video: 2-2: Standard form – Extreme points. (6min) Video: 2-3: Standard form – Standard form LPs. (8min) Video: 2-4: Standard form – Standard form LPs in matrices. (4min) Video: 2-5: Basic solutions – Independence among rows. (6min) Video: 2-6: Basic solutions – Basic solutions. (4min) Video: 2-7: Basic solutions – An example for listing basic solutions. (6min) Video: 2-8: Basic solutions – Basic feasible solutions. (8min) Video: 2-9: Basic solutions – Adjacent basic feasible solutions. (8min) Video: 2-10: The simplex method – The idea. (6min) Video: 2-11: The simplex method – The first move. (12min) Video: 2-12: The simplex method – The second move. (7min) Video: 2-13: The simplex method – Updating the system through elementary row operations. (8min) Video: 2-14: The simplex method – The last attempt with no more improvement. (4min) Video: 2-15: The simplex method – Visualization and summary for the simplex method. (7min) Video: 2-16: The tableau representation – An example. (6min) Video: 2-17: The tableau representation – Another example. (8min) Video: 2-18: Solving unbounded LPs. (6min) Video: 2-19: Infeasible LPs – The two-phase implementation. (10min) Video: 2-20: Infeasible LPs – An example. (10min) Video: 2-21: Computers – Gurobi and Python for LPs. (TA) (6min) Video: 2-22: Computers – An example. (TA) (7min) Video: 2-23: Computers – Model-data decoupling. (TA) (7min) Video: 2-24: Closing remarks. (6min) Assessment: Quiz: Quiz for Week 2 (20 min)
11	2026/08/01 (六) 00:00 - 01:00	The Branch-and-Bound Algorithm Module Description: Integer programming is a special case of linear programming, with some of the variables must only take integer values. In this week, we introduce the concept of linear relaxation and the Branch-and-Bound algorithm for solving integer programs. Learning Objectives:

		After this lesson, students can understand how the Branch-and-Bound algorithm works and how to implement it. Course Content: Video: 3-0: Opening. (6min) Video: 3-1: Introduction. (3min) Video: 3-2: Linear relaxation. (4min) Video: 3-3: Properties of linear relaxation. (10min) Video: 3-4: Idea of branch and bound. (6min) Video: 3-5: Example 1 for branch and bound (1). (6min) Video: 3-6: Example 1 for branch and bound (2). (9min) Video: 3-7: Example 2 for branch and bound. (5min) Video: 3-8: Remarks for branch and bound. (8min) Video: 3-9: Solving the continuous knapsack problem. (11min) Video: 3-10: Solving the knapsack problem with branch and bound. (11min) Video: 3-11: Heuristic algorithms. (11min) Video: 3-12: Performance evaluation. (8min) Video: 3-13: Remarks for performance evaluation. (6min) Video: 3-14: Computers – Gurobi and Python for IPs. (TA) (11min) Video: 3-15: Closing remarks. (6min) Assessment: Quiz: Quiz for Week 3 (20min)
12	2026/08/02 (日) 00:00 - 01:00	Gradient Descent and Newton’s Method Module Description: In the past two weeks, we discuss the algorithms of solving linear and integer programs, while now we focus on nonlinear programs. In this week, we first review some necessary knowledge such as gradients and Hessians. Second, we introduce gradient descent and Newton’s method to solve nonlinear programs. We also compare these two methods in the end of the lesson. Learning Objectives: After this lesson, students can understand how gradient descent and Newton’s method work, and compare pros and cons of these two methods. Course Content: Video: 4-0: Opening. (7min) Video: 4-1: Introduction. (8min) Video: 4-2: Gradient descent – Gradient and Hessians. (7min) Video: 4-3: Gradient descent – A gradient is an increasing direction. (9min) Video: 4-4: Gradient descent – The gradient descent algorithm. (11min) Video: 4-5: Gradient descent – Example 1. (8min) Video: 4-6: Gradient descent – Example 2. (9min) Video: 4-7: Newton’s method – Newton’s method for a nonlinear equation. (6min) Video: 4-8: Newton’s method – Newton’s method for a single-variate NLPs. (7min) Video: 4-9: Newton’s method – An example for single-variate Newton’s method. (7min)

		Video: 4-10: Newton’s method – Newton’s method for multi-variate NLPs. (9min) Video: 4-11: Computers – Gurobi and Python for NLPs. (TA) (8min) Video: 4-12: Closing remarks. (6min) Assessment: Quiz: Quiz for Week 4 (20min)
13	2026/08/08 (六) 00:00 - 01:00	Design and Evaluation of Heuristic Algorithms Module Description: As the last lesson of this course, we introduce a case of NEC Taiwan, which provides IT and network solutions including cloud computing, AI, IoT etc. Since maintaining all its service hubs is too costly, they plan to rearrange the locations of the hubs and reallocate the number of employees in each hub. An algorithm is included to solve the facility location problem faced by NEC Taiwan. Learning Objectives: After this lesson, students can understand the practical application of the algorithms we have introduced, and thus have more comprehensive knowledge about the course. Course Content: Video: 5-0: Opening. (7min) Video: 5-1: Background. (10min) Video: 5-2: Motivation and objective. (9min) Video: 5-3: Three levels of modeling. (7min) Video: 5-4: Conceptual modeling. (9min) Video: 5-5: Mathematical modeling (1). (9min) Video: 5-6: Mathematical modeling (2). (7min) Video: 5-7: Results. (7min) Video: 5-8: A heuristic algorithm. (10min) Video: 5-9: Pseudocode. (7min) Video: 5-10: Performance evaluation. (4min) Video: 5-11: Closing remarks. (5min) Assessment: Quiz: Quiz for Week 5 (20min)
14	2026/08/09 (日) 00:00 - 01:00	Course Summary and Future Learning Directions Module Description: In the final week, we review the topics that we have learned and give students a summary. Besides, we briefly preview the advanced course to provide future direction of studying. Learning Objectives: After this lecture, students will wrap up the course and have the ideas about further studies. Course Content: Video: 6-1: Summary and discussions. (15min) Video: 6-2: Preview of the next course. (8min) Video: A story that never ends. (2min) Assessment: Quiz: Quiz for Week 6 (40min)

15	2026/08/10 (一) 15:30 - 17:20	【同步遠距】Modern Development and Practical Applications of OR
16	2026/08/14 (五) 15:30 - 17:20	【實體考試】Midterm Exam

教學助理規劃	助教預計人數：1 1.協助線上系統維護、 2.協助教師線上討論、 3.協助學生學習進度追蹤、 4.協助教師行政事宜、
指定用書	無
參考書籍	Suggested Reading: Introduction to Operations Research by Hillier and Lieberman, tenth edition, McGraw Hill.
作業設計	自主練習：一週兩次，一次約一小時 作業：一學期兩次，一次約六小時 期中考：一學期一次，一次兩小時 期末考：一學期一次，一次兩小時
成績評定方式	作業：30% 期中考：35% 末考：35%
預估學生一週須投入時間	自主練習：1 週 2 小時 同步遠距或非同步遠距課程：6 週共 30 小時，1 週 5 小時 作業：12 小時，1 週 2 小時
修課程度建議	□無基礎要求，有興趣皆可修課 ☑建議說明：Required: (1) matrix arithmetic (2) computer programming Suggested: (3) algorithms (4) differential calculus
課程文字介紹	Operations Research (OR) is a field in which people use mathematical and engineering methods to study optimization problems in Business and Management, Economics, Computer Science, Civil Engineering, Electrical Engineering, etc. In this course, we focus on the “modeling and applications” and “algorithms” parts. The major objective is to let students

	know the fundamental way of using OR to support decision making in all kinds of business applications, including production, inventory, pricing, locations, among others. Students will learn how to formulate mathematical programs and use computers to solve these business problems. Moreover, students will also learn the underlying algorithms that solves linear programs, integer programs, and nonlinear programs. This will benefit their future studies in related fields.	
課程宣傳	海報	無
	影片	https://www.youtube.com/watch?v=8G6gjjeHr4s
其他補充資料	所有線上課程的全部教學影片連結： https://ocw.aca.ntu.edu.tw/courses/mooc0052 https://ocw.aca.ntu.edu.tw/courses/mooc0053	