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**	**优化方法 Optimization Methods**
2.	**授课院系 Originating Department**	**计算机科学与工程系 Department of Computer Science and Engineering**
3.	**课程编号 Course Code**	CS342
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业选修课 Major Elective 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）**	Hisao Ishibuchi，讲席教授，计算机科学与工程系，hisao@sustech.edu.cn Hisao Ishibuchi, Chair professor, Department of Computer Science and Engineering, hisao@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact**	待公布 To be announced **（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**	32		32		64

12.	先修课程、其它学习要求 **Pre-requisites or Other Academic Requirements**	NA
13.	后续课程、其它学习规划 **Courses for which this course is a pre-requisite**	NA
14.	其它要求修读本课程的学系 **Cross-listing Dept.**	NA

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

This course explains a wide variety of optimization algorithms for combinatorial problems, linear programming problems, nonlinear problems, and multi-objective problems. This course starts with combinatorial optimization algorithms such as greedy algorithms, local search, variable neighbourhood search, variable neighbourhood descent, simulated annealing, taboo search, and branch and bound algorithms. Next, linear programming is explained. Then, optimization algorithms for nonlinear problems are explained, which include gradient descent, Newton's methods, Levenberg-Marquardt modification, quasi-Newton methods, and conjugate direction methods. This course also explains two approaches for multi-objective optimization. One approach is to search for a single final solution, and the other approach is to search for multiple non-dominated solutions. The course objective e is to understand the search mechanism in each optimization algorithm. In addition to this main objective, students will learn how to implement some basic optimization algorithms such as greedy algorithms, local search algorithms, and multi-objective algorithms for typical combinatorial optimization problems. Currently, many linear and nonlinear programming packages are available. Students will learn how to use such packages. Students will also learn that modern artificial intelligence techniques are closely related to optimization algorithms.

16. 预达学习成果 Learning Outcomes

On completion of this course, the student should be able to:

(1) understand the relation between optimization and learning,

(2) understand the categorization of optimization problems,

(3) understand greedy algorithms, local search algorithms, and exact algorithms for combinatorial optimization,

(4) implement local search algorithms for typical combinatorial optimization problems,

(5) understand linear programming problem formulations and linear programing algorithms,

(6) use of linear programing package,

(7) understand unconstrained nonlinear optimization algorithms,

(8) understand the optimality condition for nonlinear optimization problems with equality constraints,

(9) understand the optimality condition for nonlinear optimization problems with inequality constraints,

(10) implement multi-objective optimization algorithms.

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.)

Section 1. Introduction (learning and optimization, optimization problems, optimization algorithms, local solutions, and global solutions).
[Lab Session]
Implementation of simple enumeration-based optimization algorithms for knapsack problems and travelling salesman problems. Estimation of their computation time for a wide range of problem size.

Section 2. Greedy algorithms for combinatorial optimization.
[Lab Session]
Implementation of simple greedy algorithms for knapsack problems and travelling salesman problems. Estimation of their computation time for a wide range of problem size.

Section 3. Local search and neighborhood structures for combinatorial optimization.
[Lab Session]
Calculation of neighborhood structure size for various neighborhood structures.

Section 4. Variable neighborhood search, variable neighborhood descent, simulated annealing, and taboo search.
[Lab Session]
Implementation of a local search algorithm for travelling salesman problems.

Section 5. Branch and bound algorithms, and subset selection algorithms.
[Lab Session]
Implement a branch and bound algorithms for knapsack problems.

Section 6. Linear programming problem formulations and applications.
[Lab Session]
Creation of four types of linear programing problem examples: problems with a single optimal solution, multiple optimal solutions, unbounded optimal solutions, and no feasible solutions.

Section 7. Linear programming algorithms.
[Lab Session]
Use of different linear programming packages and their comparison with respect to the computation time and scalability.

Section 8. Integer linear programming algorithms.
[Lab Session]
Use of integer linear programming package and comparison with linear programming package.

Section 9. Unconstrained nonlinear optimization and gradient descent.
[Lab Session]
Understand the relation between contour lines and steepest gradient descent directions by drawing them for nonlinear functions.

Section 10. Newton's methods and Levenberg-Marquardt modification.
[Lab Session]
Use of Newton’s method for simple test problems.

Section 11. Quasi-Newton methods and conjugate direction methods.
[Lab Session]
Comparison between Newton’s methods and quasi-Newton methods using simple test problems.

Section 12. Nonlinear optimization with equality constraints.
[Lab Session]
Understand Lagrange Condition by drawing contour lines of a nonlinear function and an equality constraint.

Section 13. Nonlinear optimization with inequality constraints.
[Lab Session]
Understand Karush-Kuhn-Tucker Condition by drawing contour lines of a nonlinear function and inequality constraints.

Section 14. Problem formulation and basic concepts in multi-objective optimization.
[Lab Session]
Implementation of a multi-objective algorithm for two-objective travelling salesman problems by modifying a single-objective algorithm.

Section 15. Methods to search for single final solution in multi-objective optimization.
[Lab Session]
Preparation of a PowerPoint file for explaining the implemented multi-objective algorithm for two-objective travelling salesman problems.

Section 16: Methods to search for multiple solutions in multi-objective optimization.
[Lab Session]
Final presentation about the implemented multi-objective algorithm for two-objective travelling salesman problems.

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

(Textbooks)

B. Guenin, J. Könemann an d L. Tunçel: A Gentle Introduction to Optimization, Cambridge University Press.

Edwin K. P. Chong, and Stanislaw H. Zak: An Introduction to Optimization, John Wiley & Sons.

(Supplementary Readings)

Jon Kleinberg and Eva Tardos: Algorithm Design, Addison Wesley.

Kaisa Miettinen: Nonlinear Multiobjective Optimization, Kluwer.

Kalyanmoy Deb: Multi-Objective Optimization Using Evolutionary Algorithms, Wiley.

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		10%		Some simple questions will be given to students in each class.
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		40%		Some optimization problems will be given to students as homework assignments

期中考试 **Mid-Term Test**				
期末考试 **Final Exam**		40%		
期末报告 **Final Presentation**		10%		An optimization algorithm will be designed and presented.
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
