课程大纲
COURSE SYLLABUS

1.	课程代码/名称 **Course Code/Title**	**CSE5018 (CS406) /高级优化算法 Advanced Optimization Algorithms**
2.	课程性质 **Compulsory/Elective**	**Elective**
3.	课程学分/学时 **Course Credit/Hours**	**3/64**
4.	授课语言 **Teaching Language**	英文 **English**
5.	授课教师 **Instructor(s)**	**Hisao Ishibuchi**
6.	是否面向本科生开放 **Open to undergraduates or not**	**Yes**
7.	先修要求 **Pre-requisites**	（如面向本科生开放，请注明区分内容。 If the course is open to undergraduates, please indicate the difference.） **CSE5003 (CS419) 高级算法 Advanced Algorithms** **(no difference between postgraduate and undergraduate students)**

8. 教学目标
Course Objectives

This course explains a variety of advanced topics on optimization algorithms, which include hyper-heuristics, interactive optimization, memetic algorithms, constraint handling, surrogate models, multi-tasking, transfer optimization, noisy optimization, and multi-objective optimization. The course objective is to learn how to design single-objective and multi-objective optimization algorithms. In addition to this main objective, students will learn how to evaluate and compare different optimization algorithms. When we apply an optimization algorithm to a particular application problem, we need to appropriately specify its parameters and operators. By implementing local search for flowshop scheduling and travelling salesperson problems, students will understand that different specifications are needed for different problems. The design of an optimization algorithm for a particular application problem can be viewed as an optimization task. Students will learn how to handle the design of an optimization algorithm as an optimization task in the framework of hyper-heuristics. In real-world applications, it is often the case that optimization problems do not have a mathematically formulated objective function. Solutions are evaluated by decision makers subjectively in some problems. In other problems, solutions are evaluated by computer simulations. In those cases, solution evaluations are usually noisy. Some other optimization problems have multiple objectives. Students will learn how to handle such a wide variety of optimization problems. Especially when an optimization problem has multiple objectives, the optimization task is not to find a single optimal solution but to search for non-dominated solutions as many as possible. Students will learn various approaches for multi-objective optimization such as scalarizing function-based methods, constraint-based methods, reference point-based methods, and evolutionary multi-objective optimization algorithms.

9. 教学方法
Teaching Methods

Lectures, weekly assignments and presentations.

10. 教学内容
Course Contents

Section 1	Categorization of optimization algorithms Relation between the solution quality and the computation time Formulation of the travelling salesman problem
Section 2	Greedy algorithm for the travelling salesman problem General framework of local search (first move and best move) Local search implementation for the travelling salesman problem
Section 3	Effects of the choice of a neighbourhood structure on local search behaviour

	Iterated local search Random key coding for travelling salesman problem
Section 4	Binary, permutation and random key coding for the knapsack problem Neighbourhood structures for the knapsack problems Various constraint handling methods
Section 5	Difficulties in performance comparison and anytime algorithms Formulation of the flowshop scheduling problems Heuristic algorithms for the flowshop scheduling problem
Section 6	Local search for the flowshop scheduling problem Variable neighbourhood search
Section 7	Simulated annealing (SA) and taboo search (TS) Data driven optimization algorithms
Section 8	Basic framework of evolutionary computation Genetic operations (crossover and mutation) Crossover operator for the travelling salesman problem
Section 9	Fitness evaluation and selection in evolutionary computation Basic idea of memetic algorithms Various implementation issues of memetic algorithms
Section 10	Hyper-heuristics (online and offline) An implementation example of an offline hyper-heuristic algorithm
Section 11	Various topics related to optimization: Noisy optimization, experiment-based optimization, surrogate-based optimization, transfer optimization, multi-tasking optimization
Section 12	Basic concepts in multi-objective optimization Comparison between traditional approach and evolutionary approach
Section 13	Evolutionary multi-objective optimization Performance indicators for evaluating a solution set
Section 14	Visual comparison methods of solution sets Design of evolutionary multi-objective optimization Test problems for evolutionary multi-objective optimization
Section 15	Decomposition-based evolutionary multi-objective optimization algorithms Indicator-based evolutionary multi-objective optimization algorithms
Section 16	Evolutionary many-objective optimization

11. 课程考核
Course Assessment

（①考核形式 Form of examination；②.分数构成 grading policy；③如面向本科生开放，请注明区分内容。If the course is open to undergraduates, please indicate the difference.）

Class performance including attendance, assignments and presentations: 40%
Final presentation: 10%
Final examination: 50%
(no difference between postgraduate and undergraduate students)

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

(Supplementary Readings)

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