Course Name	Theory and Practice of Algorithms		
Semester, Year	First Semester, 2019 (Spring Term)	Number of Credits	2 credits
Course level	5000	Course Number	027032
Instructor(s) (Institution)	Thomas Zeugmann 大学院情報科学研究院		
Course Objectives	Students become acquainted with different algorithm design techniques that allow to achieve the most efficient solution of a problem on hand. In particular, we study design techniques for deterministic algorithms, probabilistic algorithms, parallel algorithms, and distributed algorithms. Students will also become acquainted with the most significant recent breakthroughs in these fields.		
Course Goals	Algorithmic theory and state-of-the-art algorithmic design techniques are taught. Students should acquire the ability to choose the most appropriate design technique when solving the problem on hand. Students should learn the advantages and disadvantages of the different design techniques for deterministic, probabilistic, parallel and distributed algorithms.		
Course Schedule	1. The Master Theorem which determines the solutions of recursive equations, Introducing some important discrete structures, (finite) groups, rings, fields, finite fields, and the ring of remainders modulo a natural number. 2. Finite Groups, Finite Rings, and Finite Fields extended Euclidean algorithm, modular inverses, Chinese Remaindering, Euler's phi-function 3. Properties and structure of finite fields, cyclicity 4. Field integers, and the algebraic structure of finite fields 5. Main theorem on finite fields, modular exponentiation, primes and pseudo primes 6. Testing Primality Efficiently (deterministic algorithm) - Part I: Complexity 7. Testing Primality Efficiently (deterministic algorithm) - Part I: Correctness 8. DFT plus applications (roots of unity) 9. Fast integer multiplication (Karatsuba, Schonhage--Strassen) 10. The Magic of Probability (Testing the identity of huge databases) 11. More probabilistic algorithms (Freivalds matrix multiplication checker, Solovay and Strassen Primality Test) 12. Parallel Algorithms, Introduction, Models, Uniform Families of Circuits 13. Parallel Algorithms, Integer Addition, Iterated Integer Addition, Multiplication 14. Distributed Algorithms, Leader Election 15. Distributed Algorithms, Leader Election, Lower Bounds		
Homework	For homework, original materials will be distributed, and references will be indicated in the class.		
Grading System	Evaluation will be carried out by exercises and the final examination.		
Textbooks / Reading List	Computational Complexity: A Modern Approach Sanjeev Arora, Boaz Barak Cambridge University Press 2009 Randomized Algorithms Rajeev Motwani, Prabhakar Raghavan Cambridge University Press 1995 Design and Analysis of Randomized Algorithms Juraj Hromkovic 2005 2005 Quantum Computing Jozef Gruska McGraw-Hill Publishing Company 1999		
Websites			
Website of Laboratory	http://www-alg.ist.hokudai.ac.jp/		
Additional Information	Basic knowledge of discrete mathematics, probability theory and data structures is needed. In addition, we assume familiarity with linear algebra, complex analysis and Hilbert space theory.		