Special Subjects of the Department of Informatics

Field	Subject Code	Subject	Credit	Content of subject	
Foundations of Informatics	20DIFa01	Logic in Computer Science	2	Type theory gives a fundamental framework for programming languages and software specification. This course will introduce type theory and give its explain in a mathematically rigorous way.	TATSUTA Makoto
	20DIFa02	Theory of Numerical Methods	2	We will study the Krylov subspace method, which is an important class of iterative methods for solving systems of linear equations, by reading in turn, the book: Liesen, Strakos, "Krylov Subspace Methods −Principles and Analysis−".	HAYAMI Ken
	20DIFa04	Algorithm	2	Explain basic concepts and techniques on algorithm, which is the theory of the way of compute, by showing applications in the real world, from the view point of algorithms theory.	UNO Takeaki
	20DIFa06	Discrete Mathematics	2	Discrete mathematics has become popular in recent decades because of its applications to computer science. Concepts and notations from discrete mathematics are useful to study or describe objects or problems in computer algorithms and programming languages.	KAWARABAYASHI Ken−ichi
	20DIFa09	Mathematical Logic	2	An introductory−intermediate level course in mathematical logic. Topics are chosen among those related to applications of logic in computer science.	TATSUTA Makoto
	20DIFa10	Quantum information systems	2	This course focuses on implementations of quantum information devices and systems. It covers most recent quantum information device designs and system architecture. We study the elements necessary for quantum information device design, which includes gate operation, error correction, as well as the quantum control required. As quantum systems, we cover quantum sensors, quantum repeaters, and large−scale quantum computers.	NEMOTO Kae
	20DIFa11	Quantum Computation	2	Introduction of elementary mathematical thory of quantum information. Namely, we deel with entanglement, data compression, and state estimation.	MATSUMOTO Keiji
	20DIFa14	Computational Neuroscience	2	Computational neuroscience aims to understand how the brain transmits information and develop a computer program that has the same function of the brain. This course will introduce the methodology of computational neuroscience.	KOBAYASHI Ryota
	20DIFa15	Sublinear Algorithms	2	"Efficient" algorithms have meant polynomial−time algorithms. As the data size is increasingly large, however, even polynomial−time algorithms could be too slow. To handle such large data, "sublinear algorithms" have been developed in the last decades, where sublinear means less than linear. This course will cover theoretical foundations of sublinear−time algorithms as well as their applications to practical problems such as the analysis of web/social graphs.	YOSHIDA Yuichi
	20DIFa19	Control theory and optimization	2	This course will introduce basics of control theory and optimization. We will also discuss selected topics in classical control, modern control, post−modern control and optimizations.	KISHIDA Masako
	20DIFa17	Graph Algorithms	2	A graph is a representation of connections between objects, and various problems can be formulated on graphs. This course will introduce algorithms for graph problems from basic ones to advanced ones.	IWATA Yoichi

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Foundations of Informatics	20DIFa18	Algorithmic Market Design	2	Market design is a field of research that considers how to design rules of markets, such as matching and auction markets. Through game-theoretic analysis, this field aims to design market rules that yield socially desirable outcomes, while each participant acts selfishly. In this course, we learn theory and applications of market design, while laying emphasis on its algorithmic and discrete-mathematical aspects.	YOKOI Yu
	20DIFa20	Numerical Analysis	2	This course gives an overview of numerical analysis and numerical algorithms, in particular numerical linear algebra (especially eigenvalue problems and the SVD) and approximation theory (polynomials and rational functions). While the goal is to understand the mathematical foundations, we focus on subjects that are particularly applicable in scientific computing.	NAKATSUKASA Yuji
Information Infrastructure Science	20DIFb01	Computer System Design	2	This course will focus on (1) advanced computer architectures, high-end microprocessor, implementation technologies on processors, and (2) fault-tolerant system architectures and techniques for error recovery, error detection, automatic test pattern generation, and formal verification, all of which are indispensable for designing highly-reliable high-performance computer systems.	YONEDA Tomohiro GOSHIMA Masahiro
	20DIFb02	Information and Communication Systems	2	This course provides an introduction of the principle, algorithms, system architecture, and performance evaluation methods of information and communication systems.	JI Yusheng ABE Shunji KANEKO Megumi FUKUDA Kensuke
Software Science	20DIFc01	Distributed Systems	2	This lecture address several recent topics in distributed algorithms and software technologies for distirbuted systems.	SATOH Ichiro
	20DIFc02	Data Engineering	2	This course overviews basic theories for data analysis and processing and studies the recent progress in text mining.	TAKASU Atsuhiro
	20DIFc03	Software Engineering	2	Understanding the importance of software dependability, getting familar with various methods to achieve requested dependability levels of systems, and obtaininging basic skills necessary to study related issues in new software-rich systems such as CPS, IoT, or SoS. Lectures with excersizes combined.	NAKAJIMA Shin
	20DIFc04	Signal processors	2	In this course I will explain the basic concepts of digital signal processing. Also explain the current status of the art of signal processing hardware architectures.	HASHIZUME Hiromichi
	20DIFc05	Probabilistic Models in Informatics	2	The focus of this course is probabilistic models that play important roles in informatics for the modeling of real world data. This course deals from the basics to the application of probability theory, and discuss important topics for using probabilistic models such as learning and evaluation.	KITAMOTO Asanobu
	20DIFc14	Modeling in Software Development	2	In this lecture course, we learn modeling techniques for efficient development of large-scale and high-quality software systems. We overview activities in various phases of development process and argue modeling techniques for each phase. We also discuss various development paradigms, such as object-oriented, model-driven, and agile development, as well as the state-of-the-art topics.	ISHIKAWA Fuyuki
	20DIFc08	XML Databases	2	This course overviews fundamental theory and techniques of XML Databases, and surveys state of arts in this research area.	KATO Hiroyuki
	20DIFc10	Mathematical Structures in Programming	2	This course discusses the mathematical structures in programs and explains how mathematical reasoning plays an important role in designing efficient algorithms and constructing correct programs.	HU Zhenjiang
	20DIFc13	Programming Languages and theory	2	In this class we learn the foundation of programming languages and implement a small programming language.	TSUSHIMA Kanae

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Software Science	20DIFc15	Mathematical Structures in Formal Methods	2	Formal methods refer to a body of mathematical techniques used for guaranteeing correctness of computer systems. This course introduces the mathematical foundation of formal methods. Our technical focus will be on automata theory, especially on automata that classify infinite words.	HASUO Ichiro
	20DIFc16	Formal Methods for Cyber-Physical Systems	2	Application of information systems is getting rapidly diversified. A notable example is cyber-physical systems (CPS), in which physical dynamics and digital control closely interact with each other. Assuring safety and quality of CPS is a research topic of social impact: CPS serve a number of safety-critical applications, while the scale and complexity of CPS is growing fast. Moreover, from the academic point of view, quality assurance of CPS poses interesting challenges on software science with their unique features such as continuous dynamics, quantitative quality measures, stochastic behaviors and uncertainties. In this course, several lecturers take turns to present some advanced techniques in CPS quality assurance. These techniques originate from formal methods, a branch of software science where mathematical and logical rigor is emphasized for the purpose of quality assurance.	HASUO Ichiro
	20DIFc17	Software Verification		This course gives a lecture on technologies for software verification. In particular, it introduces techniques based on type systems, which make it possible to verify software exhaustively and rigorously.	SEKIYAMA Taro
Multimedia Information Science	20DIFd01	Digital media infrastructure	2	The goal of this course is to provide a general view of basic theories and techniques on information media. The topics include (i) theories and techniques to manipulate textual information that is one of the basic elements of information media, (ii) those for large-scale processing of multimedia information, (iii) those with regard to media security for fair use of multimedia content, (iv) those for handling visual contents based on computer graphics, and (v) those with regard to numerical analysis for physics simulations.	ECHIZEN Isao KATAYAMA Norio ANDO Ryoichi TAKAYAMA Kenshi AIZAWA Akiko
	20DIFd02	Fundamentals of Media Processing	2	This course explains the overview of the basic technologies related to whole aspect of media processing especially pattern recognition theory and signal processing theory. These technologies are indispensable for media analysis, feature extraction, media conversion, and so on. Project works such as video information processing will be assigned upon necessity to deepen the understanding.	KODAMA Kazuya IKEHATA Satoshi MO Hiroshi SATOH Shin'ichi
	20DIFd03	Applications of Multimedia Processing	2	As an application of media processing technologies, this course focuses on image media and gives the overview of latest topics on image processing, analysis, editing, and visualization. The topics include (i) 3D information reconstruction from images using computer vision techniques, and (ii) realistic visualization of 3D information using computer graphics techniques. Computational photography and inverse rendering are also discussed which are developed by combining computer vision and computer graphics techniques.	SUGIMOTO Akihiro GOTODA Hironobu SATO Imari ZHENG YinQiang
	20DIFd04	Interactive Media	2	In this course, we will explain human interaction with information system and human interaction with human. We first explain basic fundamental concepts and techniques such as user behavior modeling, design method, evaluation method, machine learning, speech science, multimedia retrieval. We then elaborate practical applications such as spoken dialogue system, crossmodal retrieval system, and reading comprehension problem.	ARAI Noriko AIHARA Kenro YAMAGISHI Junichi YU Yi

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Intelligent Systems Science	20DIFe01	Logical Foundations for Artificial Intelligence	2	The principles of Artificial Intelligence are studied. In particular, symbolic representation of knowledge and inference are investigated in detail.	INOUE Katsumi
	20DIFe02	Reasoning Science	2	We study theoretical foundations of advanced reasoning such as nonmonotonic reasoning and its implementation and applications.	SATOH Ken
	20DIFe03	Knowledge Sharing System	2	Firstly the concept of knowledge sharing is identified. Then key techniques are introduced; Semantic Web, Ontology and Social network analysis.	TAKEDA Hideaki
	20DIFe04	Human-Agent Interaction	2	This course will introduce fundamental concepts, methodologies, and applications of HAI.	YAMADA Seiji
	20DIFe05	Cluster Analysis	2	This course deals with the theoretical and practical issues surrounding the topic of cluster analysis for knowledge discovery. A comparative review of clustering strategies will be presented, as well as their applications, and the data structures needed to support them. Particular attention will be given to the implications of data representations and algorithmic design choices on the scalability and applicability of the various approaches studied.	HOULE Michael E
	20DIFe06	Machine Learning	2	In this course, we will discuss theoretical and practical aspects of machine learning. We study several machine learning techniques including concept learning, Bayesian learning, and ensemble learning.	ICHISE Ryutaro
	20DIFe16	Robot Informatics	2	This course introduces the basic knowledge of informatics that is required to develop intelligent robot systems. It also focuses on real-time sensor information processing and system integration method for the development of robot systems.	INAMURA Tetsunari
	20DIFe08	Natural Language Processing	2	This course aims to introduce the fundamental techniques of natural language processing (NLP), i.e. the study of human languages from a computational and engineering perspective. Topics include part-of-speech tagging, lexical analysis, parsing algorithms, grammar formalisms, word sense disambiguation, evaluation issues and machine learning of natural language.	AIZAWA Akiko
	20DIFe10	Intelligent User Interfaces	2	We will study a selection of intelligent systems and interfaces.	PRENDINGER Helmut
	20DIFe11	Intelligent Web Systems	2	This lecture will introduce semantic web technologies and web mining techniques.	OHMUKAI Ikki
	20DIFe12	Communication Environments	2	We exchange various kinds of information and establish human relationships not only in face-to-face conversation but also in talk via mobile phone, internet environment, and so on. This course describes a diversity of communication studies and the methodologies to discuss about communication environments in our daily lives.	BONO Mayumi
	20DIFe14	Econophysics	2	You can learn the basic concepts and analysis techniques for macroeconomics, econometrics, and statistical physics to be useful in information science. I will explain the Big data and modeling for social phenomena.	MIZUNO Takayuki
	20DIFe15	Data mining	2	This course introduces data mining from theory to practice.	SUGIYAMA Mahito
	20DIFe17	Cognitive Robotics	2	Cognitive robotics tries to synthetically understand the human intelligence and cognitive mechanisms by integrating the perspective of cognitive neuroscience, robotics, and machine learning. This course introduces its fundamental concepts, methodologies, and recent research topics. Related research fields such as robot learning and computational psychiatry are also briefly introduced.	MURATA Shingo

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Information Environment Science	20DIFf01	Digital Publications	2	Students will study on digital information resources from the viewpoint of information environment through lecture and case study.	OYAMA Keizo
	20DIFf02	Information Retrieval	2	Principles and methods of information retrieval. An examination of the central concept in Information Retrieval, methods, consideration for the relationship to user's context, retrieval purpose, task and need as well as characteristic of information objects.	KANDO Noriko
	20DIFf07	Methodology of Scientometrics	2	This course focuses on methodology and case analysis of the scientmetorics for measuring scientist's research activity, research trends and development of science. We discuss technique to extract internal factor to explain the characteristics of the empirical distribution with comparing a mathematical model in natural science.	NISHIZAWA Masaki
	20DIFf08	ICT-enabled Business	2	This course focuses on how E-business including Electronic Commerce or Electronic Money affects the economic activity or social structure.	OKADA Hitoshi
	20DIFf11	Introduction to Statistical Methods in Bibliometrics	2	Bibliometrics has become a standard tool of science policy and research management in the last decades. All significant compilations of science indicators heavily rely on publication and citation statistics and other, more sophisticated bibliometric techniques. This course aims to introduce the underlying statistics, together with related multivariate analysis methods, and information theory especially focusing on entropy and mutual information.	SUN Yuan
	90DIFg01	Research in Informatics for Ph.D. thesis ⅠA	1	This course gives discussions and advices for writing a Ph.D. thesis.	All professors
	90DIFg02	Research in Informatics for Ph.D. thesis ⅠB	1		
	90DIFg03	Research in Informatics for Ph.D. thesis ⅡA	1		
	90DIFg04	Research in Informatics for Ph.D. thesis ⅡB	1		
	90DIFg05	Research in Informatics for Ph.D. thesis ⅢA	1		
	90DIFg06	Research in Informatics for Ph.D. thesis ⅢB	1		
	90DIFg07	Research in Informatics for Ph.D. thesis ⅣA	1		
	90DIFg08	Research in Informatics for Ph.D. thesis ⅣB	1		
	90DIFg09	Research in Informatics for Ph.D. thesis ⅤA	1		
	90DIFg10	Research in Informatics for Ph.D. thesis ⅤB	1		
	90DIFg11	Seminar on Basic Knowledge in Informatics ⅠA	2	This course gives discussions and seminars in order for students to acquire basic knowledge and skills which are necessary for research in Informatics.	All professors
	90DIFg12	Seminar on Basic Knowledge in Informatics ⅠB	2		
	90DIFg13	Seminar on Basic Knowledge in Informatics ⅡA	2		
	90DIFg14	Seminar on Basic Knowledge in Informatics ⅡB	2		
	90DIFg15	Research in Informatics for Master Thesis ⅠA	1	This course gives discussions and advices for writing a master-thesis-level research paper. * "Research in Informatics for Master Thesis ⅡB" is mandatory course for 5-year doctoral course students.	All professors
	90DIFg16	Research in Informatics for Master Thesis ⅠB	1		
	90DIFg17	Research in Informatics for Master Thesis ⅡA	2		
	90DIFg18	Research in Informatics for Master Thesis ⅡB	2		