[Title]			[Instructor]		
Large-scale Discrete Structure Processing			Koji Iwanuma / Hidetomo Nabeshima		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK501	2	Computer Science and Engineering	2nd Semester	Fri.／I	Japanese

[Outline and purpose]

As the Internet explosively has spread, we have experienced a flood of information. Consequently, there is a growing demand for advanced computing techniques which effectively handle large-scale data as much as possible. The purpose of this course is to give students an understanding of large-scale discrete data structures and some core algorithms for efficiently compute them. The first half of this course introduces the basics of transaction data mining and some advanced topics for online approximation mining algorithms for data streams. In the second half of the course, modern algorithms on propositional logic which handle large-scale discrete data and their applications are introduced.

[Objectives]

- To understand basic natures of huge transactional data and fundamental mining computation principles.
- To learn some state of the art technologies for online approximation computation of huge date stream mining.
- To learn modern algorithms on propositional logic for discrete data and their applications.

[Requirements]

A grounding of linear algebra, analytics, discrete mathematics, Boolean algebra, algorithms and data structure, information theory, and database

[Evaluation]

Students are evaluated primarily based on homework.

[Textbooks]

None

[References]

- J. Han and M. Kamber, Data Mining – Concepts and Technique – Second Edition, Morgan Kaufmann Pub.(ISBN:1558609016)
- P. Tan, M. Steinbach and V. Kumar, Introduction to Data Mining, Adison-Wesley (ISBN:0321464494)
- Armin Biere et.al., Handbook of Satisfiability Second Edition, IOS-Press (ISBN: 9781643681603)

[Schedule]

1. Data mining: basic natures of huge transactional data, mining frameworks and principles (1).
2. Data mining: basic natures of huge transactional data, mining frameworks and principles (2).
3. Data mining: fundamental association rule mining.
4. Data mining: advanced association rule mining.
5. Data mining: measures for evaluating the interestingness of association rules
6. Data mining: basic algorithms for mining a single data stream.
7. Data mining: advanced online approximation algorithms for mining multi-dimensional data streams.
8. Discrete algorithms: introduction of modern algorithms for discrete data.
9. Discrete algorithms: integer programming and constraint satisfaction problem.
10. Discrete algorithms: fundamental of Boolean propositional satisfiability.
11. Discrete algorithms: principles of modern SAT solvers.
12. Discrete algorithms: SAT encoding and SAT based constraint satisfaction solvers.
13. Discrete algorithms: introduction of BDD/ZDD.
14. Discrete algorithms: applications of BDD/ZDD.
15. Summary.

[Title]			[Instructor]		
Advanced Software Engineering			Masakazu Takahashi / Yoshimichi Watanabe		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK502	2	Computer Science and Engineering	1st Semester	Mon. / II	Japanese

[Outline and purpose]

We aim to learn methods that are applied to develop software with high quality and functionality. Students will be able to acquire advanced requirements analysis and software design methods (structured method and object-oriented method for real-time system) that are required to develop through lectures and exercises. Furthermore, we will discuss development planning, verification planning, and quality management related to the development of such software.

[Objectives]

- To be able to create development and verification plans for real-time software.
- To be able to analyze and design for real-time software.
- To be able to manage quality and safety for real-time software.

[Requirements]

Students are required to have knowledge of software engineering and programming.

[Evaluation]

- Homework 80%
- Exercise 20%

[Textbooks]

Handouts and related research paper will be distributed.

[References]

- Derek J. Hatley and Imtiaz A. Pirbhai, Strategies for real-time system specification, Dorset House Publishing, 1988.
- Bruce Douglass, Real-time UML, 2nd edition, developing efficient objects for embedded systems, Addison Wesley Longman Inc., 2001.

[Schedule]

(01) Planning software development and verification
(02) Structured Analysis for real time systems 1 (sequential systems and combination systems)
(03) Structured Analysis for real time systems 2 (control flow diagrams)
(04) Structured Analysis for real time systems 3 (activation tables and decision tables)
(05) Structured Analysis for real time systems 4 (case studies)
(06) Exercise 1 (planning, development planning, verification planning, and designing)
(07) Exercise 2 (designing)
(08) Object oriented development for real time systems 1 (requirements modeling)
(09) Object oriented development for real time systems 2 (analysis modeling)
(10) Object oriented development for real time systems 3 (static analysis)
(11) Object oriented development for real time systems 4 (dynamic analysis)
(12) Object oriented development for real time systems 5 (class design and design quality)
(13) Lecture by an external lecturer (project management)
(14) Lecture by an external lecturer (tools for project management)
(15) Summary of this class

[Title]			[Instructor]		
Parallel Computing			Hidetoshi Ando/ Tomohiro Suzuki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK503	2	Computer Science and Engineering	2nd Semester	Tue.／I	Japanese

[Outline and purpose]

Parallel computing technologies bring out high performance computation power of modern multi-core CPUs and GPUs. The practical knowledge of parallel computing using such devices and its cluster system contributes to the large-scale scientific computing, big data analysis and machine learning. This course provides such skills and knowledge.

[Objectives]

At the end of this course, the students should be able to: understand the basic knowledge of program optimizations for recent CPUs, understand the characteristic problems of parallel computing and its solutions, and understand the typical pattern of parallel computing and its efficient implementations on the GPU.

Programming skill (C or C++)

[Evaluation]

Homework (Parallel Computing: 50%, GPU Computing: 50%)

[Textbooks]

[References]

1. 片桐孝洋，スパコンプログラミング入門，東京大学出版会，ISBN:978-4-13-062453-4
2. 寒川光ほか，HPC プログラミング，オーム社，ISBN:978-4-274-20746-4

[Schedule]

1. Introduction to parallel and high-performance computing (Suzuki)
2. Fundamentals of high-performance computing (Suzuki)
3. Parallel programing with OpenMP (Data parallel) (Suzuki)
4. Parallel programing with OpenMP (Task parallel) (Suzuki)
5. Parallel programing with MPI (Interprocess communication) (Suzuki)
6. Parallel programing with MPI (Asynchronous communication) (Suzuki)
7. Parallel matrix-vector multiplication (Suzuki)
8. Parallel matrix-matrix multiplication (Suzuki)
9. Introduction to GPU computing (Ando)
10. Fundamentals of GPU programming (Ando)
11. Basic parallel patterns (Map, Stencil) (Ando)
12. Basic parallel patterns (Reduction, Recurrence) (Ando)
13. Advanced parallel patterns (SCAN) (Ando)
14. Advanced parallel patterns (Ballot) (Ando)
15. Advanced topics on GPU computing (Ando)

[Title]			[Instructor]		
Machine Learning			Motonobu Hattori		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK505	2	Computer Science and Engineering	1st Semester	Tue.／II	Japanese

[Outline and purpose]

Based on various information obtained from the outside world, we humans classify a target and find the regularity behind the event. Machine learning is a technology that aims to give these capabilities to a computer, and it is applied in a wide range of fields such as pattern recognition, information retrieval, medical diagnosis, data mining, and so on. This course aims at understanding a fundamental theory and technique of machine learning and being able to apply the technique of machine learning to specific problems.

[Objectives]

1. To be able to explain the classification, the basic procedure, and notes of machine learning methods
2. To be able to explain the similarities and differences among various machine learning methods
3. To be able to apply an appropriate machine learning method to a specific problem

[Requirements]

A grounding of linear algebra, calculus, discrete mathematics, probability and statistics, and programming

[Evaluation]

Exams: 80%
Small tests: 20%

[Textbooks]

[References]

Trevor Hastie et. al, The Elements of Statistical Learning, Data Mining, Inference, and Prediction, Second Edition, Springer New York, 2009.
Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer New York, 2006.

[Schedule]

The class will be given in Japanese, but the materials and examination questions will be in English. On-demand lecture videos will be provided in English.

1. Introduction
2. Linear Regression
3. Linear Discriminant Function
4. Linear Discriminant Analysis
5. Decision Trees
6. Naïve Bayes
7. Multilayer Neural Networks
8. Midterm Review and Exam
9. Support Vector Machine
10. Ensemble Learning
11. Deep Learning1: Loss functions, learning methods and their improvement
12. Deep Learning2: Examples of deep neural networks and techniques for improving accuracy
13. Clustering
14. Karhunen-Loève Expansion
15. Course Review and Final Exam

[Title]			[Instructor]		
User-Centered Design Methodology			Kentaro Go / Masaki Omata / Yuichiro Kinoshita		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK508	2	Computer Science and Engineering	1st Semester	Thu.／I	Japanese

[Outline and purpose]

This graduate course is an introduction to User-Centered Design (UCD) methodology, a discipline concerned with the research, design, implementation, and evaluation of interactive products, systems, and services for human use based on users' requirements and context of use. The first part surveys the history of UCD and provides the overview of the discipline focusing on the viewpoint of design process and product. It specifically considers service concepts in HCD. The second part introduces Kansei engineering, a set of methodologies that translate users' impression or feelings into concrete product parameters and support future product design. The third part of the course focuses on user interface design based on the physiological properties of human senses.

[Objectives]

Upon completion of this course, the students are expected to be able to:

1. Explain the history and overview of UCD, specifically from the viewpoint of process, product, and services.
2. Explain the design procedure in Kansei engineering and utilise subjective evaluation data to design products and services.
3. Describe the physiological properties of human senses and explain the importance of user interface design on the basis of the properties.

[Requirements]

Undergraduate-level HCI and/or User interface design course(s)
Basic statistics and linear algebra

[Evaluation]

The following is the grading scheme. The assignments include short repots and/or quizzes.
First and third part assignment(s): 60%
Second part assignment(s): 40%

[Textbooks]

N/A

[References]

- Yvonne Rogers, Helen Sharp, and Jenny Preece, Interaction Design: Beyond Human-Computer Interaction (3rd Edition), Wiley, 2011, ISBN-10: 0470665769.
- 長沢 伸也, 神田 太樹 (編), 数理的感性工学の基礎―感性商品開発へのアプローチ, 海文堂出版, 2010, ISBN-10: 4303723940.
- Tom Tullis, Bill Albert, Measuring the user experience：collecting, analyzing, and presenting usability metrics：pbk 2nd ed, Morgan Kaufmann, an imprint of Elsevier, ISBN:0124157815,
- 日本バーチャルリアリティ学会編, バーチャルリアリティ学, 日本バーチャルリアリティ学会, ISBN:9784904490051,.

[Schedule]

First part
1. Overview of User-Centered Design (UCD) methodology (Kentaro Go)
2. UCD process (Kentaro Go)
3. Service design (Kentaro Go)
Second part:
4. Kansei engineering / subjective evaluation methods (Yuichiro Kinoshita)
5. Analysis of subjective evaluation data I (factor analysis) (Yuichiro Kinoshita)
6. Analysis of subjective evaluation data II (visualisation of subjective evaluation data) (Yuichiro Kinoshita)
7. Analysis of subjective evaluation data III (quantification theory) (Yuichiro Kinoshita)
8. Product design based on subjective evaluation data (Yuichiro Kinoshita)
Third part
9. Human senses and user interfaces I (physiological properties of human senses) (Masaki Omata)
10. Human senses and user interfaces II (input and output interfaces) (Masaki Omata)
11. Virtual reality and mixed reality (Masaki Omata)
12. User interface for smartphones (Masaki Omata)
13. Usability testing (Masaki Omata)
14. User experience for Internet of Things (Masaki Omata)
15. Metaverse (Masaki Omata)

[Title]			[Instructor]		
Computer Vision			Masahiro Toyoura / Hideo Saito		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK509	2	Computer Science and Engineering	2nd Semester	Thu.／III	English

[Outline and purpose]

Computer Vision (CV), i.e., the research area for realizing the visual function of humans by computer, has been studied for over 40 years, along with robotics and artificial intelligence. Applications of CV have also spread in to many fields including media processing, human interface, computer graphics, and entertainment. This course covers CV from fundamental theory to recent applications.

[Objectives]

1. Understand the basic principles of computer vision
2. Understand and be able to implement basic algorithms of computer vision, such as feature extraction and tracking from image, depth estimation and image recognition
3. Understand the latest trends in computer vision technology.

[Requirements]

Programming skills for implementing the exercises and the experimental project is strongly expected. A basic understanding of linear algebra is mandatory.

[Evaluation]

Programming assignments related to the lecture content (about 4 times)

[Textbooks]

Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd ed., Springer (ISBN:978-3-030-34371-2) http://szeliski.org/Book

[References]

None.

[Schedule]

This course will be conducted online.
Lesson 1: Description of Class Outline; Introduction of Computer Vision
Lesson 2: Image Formation
Lesson 3: Image Processing
Lesson 4: Camera Model/Camera Calibration
Lesson 5: Feature Detection and Matching
Lesson 6: Image Alignment and Stitching
Lesson 7: Geometric Transform of Image
Lesson 8: Structure from Motion and SLAM
Lesson 9: Depth Estimation
Lesson 10: 3D Reconstruction
Lesson 11: Depth Image Merging
Lesson 12: Image Based Rendering
Lesson 13: Computational Photography (1)
Lesson 14: Computational Photography (2)
Lesson 15: Vision Based Recognition

[Title]			[Instructor]		
Digital Speech Processing			Kenji Ozawa		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK510	2	Computer Science and Engineering	2nd Semester	Tue.／Ⅳ	Japanese

[Outline and purpose]

Speech plays an important role in human communication and human-machine interface. Since audio signals including music and environmental sound are called speech signals in the media such as televisions, digital speech processing means acoustic signal processing in general. This course addresses the technology to perform the speech signal processing through programming exercises using Python language.

[Objectives]

1. To understand the spectral analysis technology of sound by discrete Fourier transform.
2. To understand the function of digital filters and acquire techniques from filter design to execution.
3. To understand the basics of speech signals and acquire the technology to perform automatic recognition and synthesis.

[Requirements]

Integral and differential calculus, Introductory statistics, Introductory digital signal processing

[Evaluation]

Report: 60%
Mini-examination (quiz): 40%

[Textbooks]

Kenji Ozawa, Introduction to digital acoustical signal processing — Exercise with Python, Corona Pub., Tokyo (2022).

[References]

[Schedule]

1. Overview of speech and acoustical information technology, Launching exercise environment (Chapter 1)
2. Analog to digital conversion (Chapter 2)
3. Fourier series and spectrum (Chapter 3, the first half)
4. Complex Fourier series and complex spectrum (Chapter 3, the second half)
5. Discrete Fourie transform (Chapter 4, the first half)
6. Fast Fourie transform, Windowing function (Chapter 4, the second half)
7. Fourier transform (Chapter 3, column; Chapter 4, the last part)
8. Midterm report preparation exercise
9. Impulse response and convolution (Chapter 5, the first half)
10. Digital filter (FIR filter, IIR filter) (Chapter 5, the second half)
11. Various acoustical signal processing Pt. 1 (Chapter 5, the last part), Final report preparation exercise Pt. 1
12. Various acoustical signal processing Pt. 2 (Chapter 6, the first half)
13. Microphone-array signal processing (Chapter 6, the second half)
14. Speech Recognition and Synthesis (Chapter 7)
15. Final report preparation exercise Pt. 2

[Title]			[Instructor]		
Natural Language and Image Media Processing			Fumiyo Fukumoto / Takahiko Furuya / Jiyi Li		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK511	2	Computer Science and Engineering	1st Semester	Wed./ III	Japanese/English

[Outline and purpose]

This course covers fundamental topics in Natural Language Processing (NLP) and Image media processing. The course is split into three parts and taught by three instructors.

The first part of the course addresses the issue of NL analysis and its applications. We begin with a discussion of what is NLP and introduce some computational models for language analysis. The latter half of the first part introduces recent trends in NLP, i.e., solutions for several NLP tasks based on deep learning techniques.

The second part of the course gives an overview of recurrent neural networks and language models as text analysis methods. We then cover BERT, an advanced form of Word2Vec, incorporating attention and transformers. Following that, we study neural language generation. Finally, we will also provide an overview of methodologies for solving complex problems through the combination of human and computer capabilities.

The third part of the course focuses on analysis of scenes and objects in 2D image and 3D shape model. We first review basic mechanism of human vision and data representation of 2D image. We then discuss approaches using deep learning, especially DNN architectures for 2D vision and their effective training. We will also cover recent developments in cross-modal media processing using language and images.

[Objectives]

1. To understand the basics of NL analysis and some deep learning techniques for NLP
2. To familiar with the field and technology of crowdsourcing and human computation, which aim for collaborative problem-solving between humans and computers.
3. To understand some deep learning techniques for 2D/3D image analysis and to be able to implement basic image recognition algorithms that employ deep neural networks.

[Requirements]

Integral and differential calculus, Introductory statistics, Linear algebra. Knowledge on machine learning, such as clustering, support vector machine, and neural network will be helpful.
It is highly recommended to take GTK505 “Machine Learning” class at the same time.
Programing skills in Python will be required for some assignments. It is beneficial if you are familiar with PyTorch, TensorFlow and Keras deep learning frameworks.

[Evaluation]

* First part: Report 30%
* Second part: Report 30%
* Third part: Report 40%

[Textbooks]

* First part: None
* Second part: None
* Third part: None

[References]

None

[Schedule]

Lectures 1 to 5: taught by Fumiyo Fukumoto
Lectures 6 to 10: taught by Jiyi Li
Lectures 11 to 15: taught by Takahiko Furuya

1. Introduction to Deep Learning and Natural Language Processing
2. Introduction to Colab and Python (Exercise)
3. Classification with Neural Network (Exercise)
4. Representation Learning of Words
5. Representation Learning of Words (Exercise)
6. Recurrent Neural Networks and Language Models for Natural Language Processing
7. Attention and Transformers for Natural Language Processing
8. Pretraining for Natural Language Processing
9. Neural Language Generation for Natural Language Processing
10. Crowdsourcing and Human Computation
11. Human vision, data representation of 2D image
12. Architecture of DNN for 2D image analysis
13. Effective training of DNN for 2D image analysis
14. Recent developments in 2D image analysis
15. Deep learning for 3D shape analysis

[Title]			[Instructor]		
Global Communication for Engineers			Keiko Okumura		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK513	2	Computer Science and Engineering	Intensive	／	／

[Outline and purpose]

In a world of globalization and multiculturalism, communication becomes the vehicle that truly brings people together. This course will provide students with an understanding of international and intercultural communications to engage better with their global engineering colleagues.
This course will be delivered online by means of interactive lectures with student presentations and student-led discussions in English. The weekly interactive lectures will introduce the key topics for discussion and provide the context for theoretical models and key terms of study.

[Objectives]

Upon completion of this course students should be able to:
1. Identify elements of culture that impact interpersonal communication
2. Identify the challenges of being a competent communicator in intercultural settings
3. Develop and use the appropriate communication skills in intercultural settings
4. Consider various types of corporate culture and intercultural conflicts in the engineering workplacec

[Requirements]

1. We are expected to show respect for each other irrespective of language ability, cultural beliefs, age, nationality, sexual orientation, etc.
2. We should be ready to give others equal opportunity to
formulate and express opinions, experiences, and ideas. All students should be supportive of a cooperative learning environment

[Evaluation]

Reflection Papers and Reports (self-reflection, basic knowledge and understanding): 20%
Active Class Participation: 40%
Group Presentations (team work, analytical and problem solving skills, communication/presentation skills): 40%

[Textbooks]

Materials will be provided on Moodle or in the class.

[References]

Gert Jan Hofstede, Paul B. Pedersen, Geert Hofstede, Exploring culture: exercises, stories and synthetic cultures, Intercultural Press, 9781877864902, 2002.
Helen Spencer-Oatey, Daniel Z. Kadar, Intercultural politeness: managing relations across cultures: hbk, Cambridge University Press, 9781107176225, 2021
Shaules, Joseph & Abe, Juri, Different realities: adventures in intercultural communication, Nan'un-do, 978-4523175650, 2007.
[compiled by] Larry A. Samovar ... [et al.], Intercultural communication: a reader 14th ed, Cengage Learning, 9781285077390, 2015

[Schedule]

Week 1 (W1): Introduction to the course and each other
W2: Cultural Identity
W3: Cultural Iceberg Model－A model for Cultural Appreciation
W4: Stereotypes
W5: Intercultural Interaction; Verbal Communication
W6: Intercultural Interaction: Non-verbal Communication
W7: Diversity in the Workplace
W8: Perception
W9: Communication Styles including Directness, Use of Silence and Cognitive Styles
W10: Communication Styles: High/Low Context and High/Low Involvement Cultures
W11: Personal Values and Cultural Values
W12: Beliefs and Values
W13: Culture Shock, Cultural Adaptation and Managing Differences
W14 & W15 Group presentations and Summary

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering I			( )		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK601	1	Computer Science and Engineering	Intensive	／	Japanese／English

[Outline and purpose]

In this lecture, we invite technologists and researchers of universities, private companies and public institutions that are active at the cutting edge in related fields of computer science and engineering to lecturers and learn about the latest trend of research technology development. Through participation in this lecture and exchange of opinions directly with instructors, students will deepen their understanding of the significance and value of the thesis theme.

[Objectives]

Students will understand the significance and value of their master thesis theme. Specific goals will be indicated in each lecture.

[Requirements]

From the contact person, it is shown along with lecture announcement.

[Evaluation]

From the contact person, it is shown along with lecture announcement.

[Textbooks]

N/A

[References]

N/A

[Schedule]

Please note that the lecture date and time will be posted on CNS.

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering Ⅱ			Issei Fujishiro		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK602	1	Computer Science and Engineering	2nd Semester	Mon.／Ⅱ	Japanese／English

[Outline and purpose]

With the advent of HPC, WSN, and GII, digital data to be simulated, measured, and retrieved has been getting larger and more complex. The main target of this course is a method of computing, called computer visualization, which provides insights gained through visual analysis of salient structures and behaviors embedded in such a data. After fundamental principles are surveyed, we place particular focus on representative techniques to visualize scalar fields in 2D, 3D, 3D+time, and multi-dimensions along the dedicated taxonomies. Up-to-date R&D topics are chosen to discuss the potentials of scalar data visualization, including advanced visual data mining based on differential topology and dimensional reduction schemes.

[Objectives]

1. To be familiar with dedicated paradigm and taxonomies;
2. To acquire proficiency in fundamental principles and representative techniques;
3. To be able to visualize practical datasets with standard tools such as Paraview; and
4. To acquire familiarity with recent R&D topics of computer visualization.

[Requirements]

Prerequisite includes basic knowledge about database, computer graphics, image processing, and numerical analysis.

[Evaluation]

Short quizzes (50%: Level of understanding the content of each class) and term report (50%: Visualizing open datasets)

[Textbooks]

[References]

1. NIH/NSF Visualization Research Challenge Report January 2006.
2. NVAC: Illuminating the Path: The Research and Development Agenda for Visual Analytics, 2005.
3. T. Munzner: Visualization Analysis and Design, AK Peters/CRC Press, 2014.
4. M. Nakajima and I. Fujishiro (eds.): Computer Visualization (in Japanese), Kyoritsu-Syuppan, 2000.

[Schedule]

This course will be held online using Zoom live-streaming.
1: Orientation
2: Introduction to scientific visualization
3: Visualization paradigm and taxonomy
4: Marching Squares algorithm and its disambiguation
5: Indirect/direct volume visualization
6: Topologically accentuated volume rendering
7: Advanced volume visualization based on differential topology
8: Multidimensional data visualization

[Title]			[Instructor]		
Seminar in Computer Science and Engineering IA			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK603	1	Computer Science and Engineering	1st Semester		Japanese／English

[Outline and purpose]

This exercise is conducted in small group and seminar format by cooperation of laboratory unit or a few laboratories. It is carried out in parallel with Research Work in Computer Science and Engineering IA. Students will select the themes to be studied, voluntarily and positively learn papers and other materials on the relevant fields, summarize the results in presentation materials, present at the seminar, and discuss. Students will also participate in planning related to other students' research topics, learn how to approach a wide range of fields and subjects, and learn how to communicate among researchers and work together. Although the content and target of this seminar are overlapped with the “research work” conducted at the same time, “research work” conducts intensive research work on his / her research subject mainly under the guidance of the academic supervisor. On the other hand, “seminar” shares the result in the laboratory, discusses it, and gives feedback to the research.

[Objectives]

The goal is to define the direction of new research to organize what students have learned in the undergraduate courses and to identify necessary topics in carrying out the research.

[Requirements]

General knowledge of computer science and engineering field

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Selection of research agenda #1
2. Selection of research agenda #2
3. Method of collecting data
4. Survey on previous research #1
5. Survey on previous research #2
6. Survey on previous research #3
7. Acquisition of related knowledge #1
8. Acquisition of related knowledge #2
9. Acquisition of related knowledge #3
10. Reading papers written in foreign language and acquisition of related knowledge #1
11. Reading papers written in foreign language and acquisition of related knowledge #2
12. Reading papers written in foreign language and acquisition of related knowledge #3
13. Reading papers written in foreign language and acquisition of related knowledge #4
14. Reading papers written in foreign language and acquisition of related knowledge #5
15. Reading papers written in foreign language and acquisition of related knowledge #6

[Title]			[Instructor]		
Seminar in Computer Science and Engineering IB			all academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK604	1	Computer Science and Engineering	2nd Semester		Japanese／English

[Outline and purpose]

This exercise is conducted in small group and seminar format by cooperation of laboratory unit or a few laboratories. It is carried out in parallel with Research Work in Computer Science and Engineering IB. Students make concrete and feasible plans for the themes selected in Seminar in Computer Science and Engineering IA, actually conduct preliminary research and surveys, and present the results at a presentation session including members of other laboratories. Although the content and target of this seminar are overlapped with the “research work” conducted at the same time, “research work” conducts intensive research work on his / her research subject mainly under the guidance of the academic supervisor. On the other hand, “seminar” shares the result in the laboratory, discusses it, and gives feedback to the research.

[Objectives]

The goal is to conduct preliminary research and surveys on the selected themes, and to make presentation the results.

[Requirements]

General basic knowledge in the field of computer science and engineering
Results of Seminar in Computer Science and Engineering IA and Research Work in Computer Science and Engineering Research IA

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Preparation for preliminary research #1
2. Preparation for preliminary research #2
3. Preparation for preliminary research #3
4. Preliminary research #1
5. Preliminary research #2
6. Preliminary research #3
7. Preliminary research #4
8. Preliminary research #5
9. Preliminary research #6
10. Preliminary research #7
11. Preparation for mid-term presentation of master's thesis
12. Preparation for mid-term presentation of master's thesis
13. Preparation for mid-term presentation of master's thesis
14. Mid-term presentation of master's thesis
15. Mid-term presentation of master's thesis

The timing of the mid-term presentation of the master's thesis will be specified later. (In the above syllabus, it is assigned to 11 to 15, but it may be conducted at other times, for example, in the middle of the semester.)

[Title]			[Instructor]		
Seminar in Computer Science and Engineering IIA			All academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK605	1	Computer Science and Engineering	1st Semester"		English／Japanese"

[Outline and purpose]

This exercise is conducted in small group and seminar format by cooperation of laboratory unit or a few laboratories. It is carried out in parallel with Research Work in Computer Science and Engineering IIA. Based on the results of the preliminary research conducted in Seminar in Computer Science and Engineering IA and IB, the research theme will be reviewed and the policy will be revised if necessary. After clarifying the direction of master's thesis research, students will demonstrate their originality and work on research, and present the results at a presentation session including members of other laboratories. Although the content and target of this seminar are overlapped with the “research work” conducted at the same time, “research work” conducts intensive research work on his / her research subject mainly under the guidance of the academic supervisor. On the other hand, “seminar” shares the result in the laboratory, discusses it, and gives feedback to the research.

[Objectives]

The goals are to organize research results and reexamine research themes, to determine the theme of the master's thesis, and to conduct preliminary research.

[Requirements]

Results of Seminar in Computer Science and Engineering I and Research Work in Computer Science and Engineering Research I

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Examination of result of preliminary research and planning of the present research #1
2. Examination of result of preliminary research and planning of the present research #2
3. Conducting research and investigation #1
4. Conducting research and investigation #2
5. Conducting research and investigation #3
6. Conducting research and investigation #4
7. Conducting research and investigation #5
8. Conducting research and investigation #6
9. Conducting research and investigation #7
10. Conducting research and investigation #8
11. Conducting research and investigation #9
12. Conducting research and investigation #10
13. Conducting research and investigation #11
14. Preparation for oral presentation
15. Oral presentation

[Title]			[Instructor]		
Seminar in Computer Science and Engineering IIB			All academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK606	1	Computer Science and Engineering	2nd Semester"		"English／Japanese"

[Outline and purpose]

This exercise is conducted in small group and seminar format by cooperation of laboratory unit or a few laboratories. It is carried out in parallel with Research Work in Computer Science and Engineering IIB. Students will examine the results obtained in Seminar in Computer Science and Engineering Exercise IIA and conduct research necessary to overcome the remaining problems. Write and present a master's thesis as a culmination of research. Although the content and target of this seminar are overlapped with the “research work” conducted at the same time, “research work” conducts intensive research work on his / her research subject mainly under the guidance of the academic supervisor. On the other hand, “seminar” shares the result in the laboratory, discusses it, and gives feedback to the research.

[Objectives]

The objectives are to write a master's thesis and to make a presentation of it.

[Requirements]

Results of Seminar in Computer Science and Engineering IIA and Research Work in Computer Science and Engineering IIA.

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Conducting research and survey #1
2. Conducting research and survey #2
3. Conducting research and survey #3
4. Conducting research and survey #4
5. Making the outline of his or her thesis #1
6. Making the outline of his or her thesis #2
7. Writing his or her thesis #1
8. Writing his or her thesis #2
9. Writing his or her thesis #3
10. Writing his or her thesis #4
11. Writing his or her thesis #5
12. Preparation for an oral presentation #1
13. Preparation for an oral presentation #2
14. Preparation for an oral presentation #3
15. Oral presentation

[Title]			[Instructor]		
Research Work in Computer Science and Engineering IA			All academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK607	2	Computer Science and Engineering	1st Semester		

[Outline and purpose]

This course is conducted in the laboratory under the guidance of each academic advisor, and will be conducted in parallel with Seminar in Computer Science and Engineering Exercise IA. Each student selects his or her own research theme, voluntarily and actively studies papers and other materials in related fields, summarizes the results, and presents them at seminars with deep discussion. Students select the theme to be studied, voluntarily and actively study treatises and other materials in related fields, summarize the results in presentation materials, present them at seminars, and hold discussions. Although the contents and goals of this research overlap with the "seminars" that are conducted at the same time, the “seminars” are conducted in the form of seminar in collaboration with each laboratory or a small number of laboratories, and presentation discussions are the main focus. On the other hand, research involves intensive research work on one's own research theme, mainly under the guidance of an academic advisor.

[Objectives]

The goals are to organize what each student has learned in the faculty, to set the direction of new research to be pursued in the future, and to identify the matters necessary for carrying out that research.

[Requirements]

General basic knowledge in the field of computer science and engineering

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Selection of research subject #1
2. Selection of research subject #2
3. Method of collecting materials
4. Survey on previous researches #1
5. Survey on previous researches #2
6. Survey on previous researches #3
7. Acquisition of related knowledge #1
8. Acquisition of related knowledge #2
9. Acquisition of related knowledge #3
10. Reading papers in foreign languages and acquisition of related knowledge #1
11. Reading papers in foreign languages and acquisition of related knowledge #2
12. Reading papers in foreign languages and acquisition of related knowledge #3
13. Reading papers in foreign languages and acquisition of related knowledge #4
14. Reading papers in foreign languages and acquisition of related knowledge #5
15. Reading papers in foreign languages and acquisition of related knowledge #6

[Title]			[Instructor]		
Research Work in Computer Science and Engineering IB			All academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK608	2	Computer Science and Engineering	2nd Semester		

[Outline and purpose]

This course is conducted in the laboratory under the guidance of each academic advisor, and will be conducted in parallel with Seminar in Computer Science and Engineering Exercise IB. Students make concrete and feasible plans for the themes selected in Research Work in Computer Science and Engineering IA, actually conduct preliminary research and surveys, and present the results at a presentation session including members of other laboratories. Although the contents and goals of this research overlap with the "seminars" that are conducted at the same time, the “seminars” are conducted in the form of seminar in collaboration with each laboratory or a small number of laboratories, and presentation discussions are the main focus. On the other hand, research involves intensive research work on one's own research theme, mainly under the guidance of an academic advisor.

[Objectives]

The goal is to conduct preliminary research and surveys on the selected themes, and to make presentation the results.

[Requirements]

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Preparation for preliminary research #1
2. Preparation for preliminary research #2
3. Preparation for preliminary research #3
4. Preliminary research #1
5. Preliminary research #2
6. Preliminary research #3
7. Preliminary research #4
8. Preliminary research #5
9. Preliminary research #6
10. Preliminary research #7
11. Preparation for mid-term presentation of master's thesis
12. Preparation for mid-term presentation of master's thesis
13. Preparation for mid-term presentation of master's thesis
14. Mid-term presentation of master's thesis
15. Mid-term presentation of master's thesis

The timing of the mid-term presentation of the master's thesis will be specified later. (In the above syllabus, it is assigned to 11 to 15, but it may be conducted at other times, for example, in the middle of the semester.)

[Title]			[Instructor]		
Research Work in Computer Science and Engineering IIA			All academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK609	2	Computer Science and Engineering	1st Semester"		English／Japanese

[Outline and purpose]

This course is conducted in small group and seminar format by cooperation of laboratory unit or a few laboratories. It is carried out in parallel with Seminar in Computer Science and Engineering IIA. Based on the results of the preliminary research conducted in Research Work in Computer Science and Engineering IA and IB, the research theme will be reviewed and the policy will be revised if necessary. After clarifying the direction of master's thesis research, students will demonstrate their originality and work on research, and present the results at a presentation session including members of other laboratories. Although the content and target of this seminar are overlapped with the “seminar” conducted at the same time, “research work” conducts intensive research work on his / her research subject mainly under the guidance of the academic supervisor. On the other hand, “seminar” shares the result in the laboratory, discusses it, and gives feedback to the research.

[Objectives]

The goals are to organize research results and reexamine research themes, to determine the theme of the master's thesis, and to conduct preliminary research.

[Requirements]

Results of Seminar in Computer Science and Engineering I and Research Work in Computer Science and Engineering Research I

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Examination of result of preliminary research and planning of the present research #1
2. Examination of result of preliminary research and planning of the present research #2
3. Conducting research and investigation #1
4. Conducting research and investigation #2
5. Conducting research and investigation #3
6. Conducting research and investigation #4
7. Conducting research and investigation #5
8. Conducting research and investigation #6
9. Conducting research and investigation #7
10. Conducting research and investigation #8
11. Conducting research and investigation #9
12. Conducting research and investigation #10
13. Conducting research and investigation #11
14. Preparation for oral presentation
15. Oral presentation

[Title]			[Instructor]		
Research Work in Computer Science and Engineering IIB			All academic supervisors		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK610	2	Computer Science and Engineering	2nd Semester"		English／Japanese

[Outline and purpose]

This course is conducted in small group and seminar format by cooperation of laboratory unit or a few laboratories. It is carried out in parallel with Seminar in Computer Science and Engineering IIB. Students will examine the results obtained in Research Work in Computer Science and Engineering Exercise IIA and conduct research necessary to overcome the remaining problems. Write and present a master's thesis as a culmination of research. Although the content and target of this research work are overlapped with the “seminar” conducted at the same time, “research work” conducts intensive research work on his / her research subject mainly under the guidance of the academic supervisor. On the other hand, “seminar” shares the result in the laboratory, discusses it, and gives feedback to the research.

[Objectives]

The objectives are to write a master's thesis and to make a presentation of it.

[Requirements]

Results of Seminar in Computer Science and Engineering IIA and Research Work in Computer Science and Engineering IIA.

[Evaluation]

Based on subjective learning and the participation situation of research discussions at seminars, the achievement objectives are evaluated comprehensively.

[Textbooks]

Each academic supervisor will assign reading materials related to the research theme.

[References]

N/A

[Schedule]

1. Conducting research and survey #1
2. Conducting research and survey #2
3. Conducting research and survey #3
4. Conducting research and survey #4
5. Making the outline of his or her thesis #1
6. Making the outline of his or her thesis #2
7. Writing his or her thesis #1
8. Writing his or her thesis #2
9. Writing his or her thesis #3
10. Writing his or her thesis #4
11. Writing his or her thesis #5
12. Preparation for an oral presentation #1
13. Preparation for an oral presentation #2
14. Preparation for an oral presentation #3
15. Oral presentation

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering III					
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK611	1	Computer Science and Engineering	Intensive	／	Japanese

[Outline and purpose]

In this lecture, we invite technologists and researchers of universities, private companies and public institutions that are active at the cutting edge in related fields of computer science and engineering to lecturers and learn about the latest trend of research technology development. Through participation in this lecture and exchange of opinions directly with instructors, students will deepen their understanding of the significance and value of the thesis theme.

[Objectives]

Students will understand the significance and value of their master thesis theme. Specific goals will be indicated in each lecture.

[Requirements]

From the contact person, it is shown along with lecture announcement.

[Evaluation]

From the contact person, it is shown along with lecture announcement.

[Textbooks]

N/A

[References]

N/A

[Schedule]

Please note that the lecture date and time will be posted on CNS.

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering Ⅳ					
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK612	1	Computer Science and Engineering	Intensive	／	Japanese/ English

[Outline and purpose]

In this lecture, we invite technologists and researchers of universities, private companies and public institutions that are active at the cutting edge in related fields of computer science and engineering to lecturers and learn about the latest trend of research technology development. Through participation in this lecture and exchange of opinions directly with instructors, students will deepen their understanding of the significance and value of the thesis theme.

[Objectives]

Students will understand the significance and value of their master thesis theme. Specific goals will be indicated in each lecture.

[Requirements]

From the contact person, it is shown along with lecture announcement.

[Evaluation]

From the contact person, it is shown along with lecture announcement.

[Textbooks]

N/A

[References]

N/A

[Schedule]

Please note that the lecture date and time will be posted on CNS.

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering Ⅳ			Issei Fujishiro		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK612	1	Computer Science and Engineering	1st Semester	Fri.／III	Japanese/ English

[Outline and purpose]

The main target of this course is computer visualization, which is a method of computing to provide insights gained through visual analysis of salient structures and behaviors embedded in large and complex data. In this course, fundamental visualization techniques such as vector/scalar field visualization and information visualization are covered, and then, several up-to-date R&D topics are chosen to discuss the potentials of this technology, including visual analytics, XR-based visualization, and Visualization & AI.

[Objectives]

1. To acquire proficiency in fundamental principles and representative techniques;
2. To be able to visualize practical datasets with standard tools such as Paraview; and
3. To acquire familiarity with recent R&D topics of computer visualization.

[Requirements]

Prerequisite includes basic knowledge about database, computer graphics, image processing, and numerical analysis.
It is preferrable to have taken Advanced Topics in Computer Science and Engineering II in 2021AY.

[Evaluation]

Short quizzes (50%: Level of understanding the content of each class) and term report (50%: Level of the entire content of this course)

[Textbooks]

Handouts will be distributed.

[References]

1. NIH/NSF Visualization Research Challenge Report January 2006.
2. NVAC: Illuminating the Path: The Research and Development Agenda for Visual Analytics, 2005.
3. T. Munzner: Visualization Analysis and Design, AK Peters/CRC Press, 2014.
4. M. Nakajima and I. Fujishiro (eds.): Computer Visualization (in Japanese), Kyoritsu-Syuppan, 2000.

[Schedule]

This course will be held online using Zoom live-streaming.
1: Orientation
2: Visualizing vector fields
3: Visualizing tensor fields
4: Fundamentals of information visualization
5: Introduction to visual analytics
6: XR-based visualization: Juxtaposition and multi-modality
7: Visualization and AI
8: Visualization and perceptive psychology

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering V			(Dominik Köppl)		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK613	2	Computer Science and Engineering	1st Semester	Thu./II	English / Japanese

[Outline and purpose]

The course on compact data structures is designed for graduate students and focuses on compact and compressed data structures. This lecture will introduce advanced techniques and algorithms to design and implement efficient data structures for managing massive data sets.
Students will have the opportunity to deepen their understanding of fundamental data structures and learn specialized techniques that improve space and time efficiency of basic solutions. The course will concentrate on various compact and compressed data structures, for instance wavelet trees, block trees, text indexing data structures, and many more.
Students will be equipped to effectively analyze, design, and implement advanced data structures. Additionally, they will gain the skills to evaluate the performance of such data structures and select appropriate structures for specific application scenarios. The course will try to cover both theoretical and practical aspects, including algorithm analysis, complexity theory, and implementation details.
This course provides students with a solid foundation to succeed in areas such as data compression, information retrieval, bioinformatics, databases, and many other fields where processing huge amount of data is relevant. By participating in this course, students will be able to tackle demanding challenges in managing large volumes of data and develop efficient solutions.
The course should be attractive for students competing in programming competitions, striving to improve their algorithmic know-how for application at top companies (GAFAM), where job interviews usually require showing algorithmic skills.

[Objectives]

1. Understand the space and time complexity of algorithms and data structures to judge their efficiency
2. Select and combine appropriate abstract data types, data structures, and algorithms to solve complex problems
3. Know methods to tackle big data problems
4. Able to adapt solutions to related problems
5. Solve problems with optimal methods
6. Express complexities of algorithms and data structures in compressed terminology such as repetitiveness measures.

[Requirements]

The course requires knowledge that can be acquired through successful participation in the courses TCS207　アルゴリズムとデータ構造 I and TCS209 アルゴリズムとデータ構造 II.

[Evaluation]

This course is conducted as a seminar, where all participants present. For each presentation, it is required to make an individual appointment to give details on what will be presented, and how. After the presentations, the participants write their preliminary reports. These reports will be distributed among the participants for peer review. After the peer review process, the participants can review and improve their reports before final submission.

[Textbooks]

- Veli Mäkinen, Djamal Belazzougui, Fabio Cunial, Alexandru I. Tomescu: "Genome-Scale Algorithm Design: Biological Sequence Analysis in the Era of High-Throughput Sequencing", Cambridge University Press, 2nd edition , 2023, ISBN 978-1009341257
- Paolo Ferragina: "Pearls of Algorithm Engineering", Cambridge University Press, June 2023, ISBN 978-1009128933
- Gonzalo Navarro: "Compact Data Structures: A Practical Approach", Cambridge University Press, 2016, ISBN 978-1316588284
- Enno Ohlebusch: "Bioinformatics Algorithms Sequence Analysis, Genome Rearrangements, and Phylogenetic Reconstruction", Oldenbusch Verlag, 2013, ISBN: 978-3000413162

- Felipe A. Louza , Simon Gog , Guilherme P. Telles: "Construction of Fundamental Data Structures for Strings", Springer, 2020, ISBN 978-3030551070

[References]

N/A

[Schedule]

1. Bit Vectors
2. Rank/Select Data Structures I
3. Rank/Select Data Structures II
4. Entropy Compression I
5. Entropy Compression II
6. Lempel-Ziv-compressed Data Structures I
7. Lempel-Ziv-compressed Data Structures II
8. Compact Data Structures I
9. Compact Data Structures II
10. Text Indexing Data Structures I
11. Text Indexing Data Structures II
12. Compressed Data Structures I
13. Compressed Data Structures II
14. Compressed Data Structures III
15. Compressed Data Structures IV

[Title]			[Instructor]		
Advanced Topics in Computer Science and Engineering VI			Hiromitsu Nishizaki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK614	1	Computer Science and Engineering	Intensive	／	Japanese

[Outline and purpose]

In this lecture, we invite technologists and researchers of universities, private companies and public institutions that are active at the cutting edge in related fields of computer science and engineering to lecturers and learn about the latest trend of research technology development. Through participation in this lecture and exchange of opinions directly with instructors, students will deepen their understanding of the significance and value of the thesis theme.

[Objectives]

Students will understand the significance and value of their master thesis theme. Specific goals will be indicated in each lecture.

[Requirements]

From the contact person, it is shown along with lecture announcement.

[Evaluation]

From the contact person, it is shown along with lecture announcement.

[Textbooks]

N/A

[References]

N/A

[Schedule]

Please note that the lecture date and time will be posted on CNS.