[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, IOS-Press (ISBN:1586039296)

[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 for 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)
(07) Exercise 2 (analyzing requirements)
(08) Exercise 3 (designing architectures)
(09) Object oriented development for real time systems 1 (requirements modeling)
(10) Object oriented development for real time systems 2 (analysis modeling)
(11) Object oriented development for real time systems 3 (static analysis)
(12) Object oriented development for real time systems 4 (dynamic analysis)
(13) Object oriented development for real time systems 5 (class specification design and design quality)
(14) Lecture by an external lecturer (project management)
(15) Lecture by an external lecturer (tools for project management)

[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.／II	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]		
Internet Engineering			Hidetoshi Mino		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK504	2	Computer Science and Engineering	2nd Semester	Tue.／IV	

[Outline and purpose]

This course aims at studying the Internet as a transmission medium, focusing on the transport and network layers.

[Objectives]

Through this class students will be able to:
1. describe structure of IP address and principle of routing.
2. configure routers and design, build, test, and troubleshoot small sized networks.
3. explain how TCP controls congestion.
4. explain how NAT works.
5. build simple IPv6 networks.
6. explain how IPv6 over v4 tunneling works.

[Requirements]

Basic knowledge of TCP/IP

[Evaluation]

Mid-term examination： 50%
Final examination：50%

[Textbooks]

[References]

[Schedule]

1. Basics of IP
2. Labs in IP networks
3. Principles of routing
4. Labs in routing
5. Link state protocols and path-vector protocols
6. Transport layer protocols
7. Reliability of TCP and congestion control
8. Mid-term exam.
9. Network address transformation
10. Labs in NAT
11. IPv6
12. Labs in IPv6
13. IPv6 over v4 tunneling
14. Labs in IPv6 over v4 tunneling
15. Final exam.

[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 understand classification, the basic procedure, and notes of machine learning methods
2. To understand common points and difference of various machine learning methods
3. To apply appropriate machine learning method to specific problems
4. To understand basic English literature on machine learning

[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]

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	

[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 part assignment(s): 35%
Second part assignment(s): 35%
Third part assignment(s): 30%

[Textbooks]

[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.
- 舘 暲, 佐藤 誠, 廣瀬 通孝 (監修), 日本バーチャルリアリティ学会 (編集), バーチャルリアリティ学, コロナ社, 2010, ISBN-10: 4904490053.
- William Albert, Thomas Tullis, Measuring the User Experience, Second Edition, Morgan Kaufmann, 2013 ISBN-10: 0124157815.

[Schedule]

First part
1. Overview of User-Centered Design (UCD) methodology (Kentaro Go)
2. UCD process (Kentaro Go)
3. Understanding and specifying the context of use and requirements (Kentaro Go)
4. Producing and evaluating design solutions (Kentaro Go)
5. Service design (Kentaro Go)

Second part:
6. Kansei engineering / subjective evaluation methods (Yuichiro Kinoshita)
7. Analysis of subjective evaluation data I (factor analysis) (Yuichiro Kinoshita)
8. Analysis of subjective evaluation data II (visualisation of subjective evaluation data) (Yuichiro Kinoshita)
9. Analysis of subjective evaluation data III (quantification theory) (Yuichiro Kinoshita)
10. Product design based on subjective evaluation data (Yuichiro Kinoshita)

Third part
11. Human senses and user interfaces I (physiological properties of human senses) (Masaki Omata)
12. Human senses and user interfaces II (input and output interfaces) (Masaki Omata)
13. Virtual reality and mixed reality (Masaki Omata)
14. User interface for smartphones (Masaki Omata)
15. Usability testing (Masaki Omata)

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

[Outline and purpose]

This course offers opportunity to learn both analysis and synthesis of visual information, namely, computer vision and 2D/3D computer graphics.
(First half: Masahiro Toyoura)
In the first half, the fundamental theories on computer vision, especially on 3D shape reconstruction, will be discussed. The latest topics of computer vision will be introduced, and unsolved problems will be overviewed. After learning about camera calibration, depth estimation by multiple cameras will be practically implemented. Human-centered image processing will be discussed through the topics on eye tracking, human vision, immersive video representation, and others.
(Latter half: Xiaoyang Mao)
The second half deals with visual information synthesis. Advanced filtering techniques for 2D images, image segmentation, stitching, texture analysis and transfer, and others will be discussed.

[Objectives]

1. The student understands fundamental algorithms, and implements depth image reconstruction from video captured by multiple cameras.
2. The student understands human vision, and implements eye tracking by eye captured video and synthesizes/presents attractive video considering human vision.
3. The student is able to acquire newly available image analysis and synthesis methods on his/her own, benefit from and implement the methods.

[Requirements]

One must have the knowledge of linear algebra and calculus, skills in programming (e.g., by using C++, MATLAB and python), as well as understanding of important algorithms and data structures. One should also know basics of image processing techniques (e.g., image filtering) and computer graphics.

[Evaluation]

Students are evaluated by quizzes and reports that involves programming.

[Textbooks]

None.

[References]

To be announced.

[Schedule]

1. Introduction on computer vision, guidance of the course
2. Internal camera calibration
3. External camera calibration
4. Depth estimation with stereo vision (1) – rectification and feature point matching
5. Depth estimation with stereo vision (2) – global optimization
6. Eye tracking
7. Human vision
8. Camera models and immersive video presentation
9. Fractals and natural images
10. Texture synthesis
11. Texture and image editing, advanced image filtering
12. Gradient-domain image filtering
13. Poisson editing and its applications
14. Paper survey presentation (1)
15. Paper survey presentation (2)

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

[Outline and purpose]

Speech is an important way for human-to-human communication as well as human-machine-interface. This course covers major topics in Speech processing. The first part of the course addresses the issues of speech recognition, physiological and psychological bases of speech, and hearing. The second part of the course addresses the issue of speech synthesis and its principal based on digital signal processing and speech processing.

[Objectives]

1. To understand the physiological bases of speech generation and hearing, and the psychological characteristics of speech and sound perception.
2. To understand the basis of speech recognition, audio perceptual coding, and data compression.
3. To understand the basis of digital signal processing required for understanding speech synthesis.
4. To understand the traditional speech analysis/synthesis algorithms based on the signal processing.

[Requirements]

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

[Evaluation]

Report: 50%
Mini-examination (quiz): 50%

[Textbooks]

[References]

[Schedule]

1. Overview of speech and acoustical information technology. (Acoustics) Fourier transform and spectrum
2. (Acoustical physiology) Anatomical and physiological bases of hearing. (Speech processing 1) Bases of speech synthesis and high-efficiency speech coding
3. (Speech processing 2) Feature extraction of speech, Audio perceptual coding
4. (Speech processing 3) Bases of speech recognition, Statistical pattern recognition
5. (Speech processing 4) Finite-state automaton, Basic acoustical model for speech recognition
6. (Speech processing 5) Advanced acoustical model for speech recognition, Language model
7. (Speech processing 6) Advanced language model, Search algorithm
8. First half: (Psychology of hearing) Loudness, Pitch, Timbre
8. Second half: Overview of speech analysis/synthesis
9. (Speech modeling) Vocoder
10. (Speech analysis 1) Fundamental frequency estimation
11. (Speech analysis 2) Spectral envelope estimation
12. (Speech analysis 3) Aperiodicity estimation
13. (Voice conversion) Voice conversion and voice morphing
14. (Speech synthesis 1) Text-to-speech speech synthesis
15. (Speech synthesis 2) State-of-the-art speech synthesis

[Title]			[Instructor]		
Natural Language and Image Media Processing			Ryutarou Ohbuchi / Fumiyo Fukumoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK511	2	Computer Science and Engineering	1st Semester	Tue.／Ⅳ	Japanese/English

[Outline and purpose]

This course covers fundamental topics in Natural Language Processing (NLP) and Image media processing. This course is split into the first and the second half, and taught by two instructors.

The first half 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 trend on NLP, i.e., solutions on several NLP tasks based on deep learning techniques.

The second part of this source focuses on analysis and processing, namely, object recognition, of image and other visual media. We first review basic concepts of image processing, followed by traditional approach to object recognition by using template matching and local image feature aggregation. We then discuss approaches using deep learning, especially convolutional neural network (CNN), for scene recognition, object recognition and object detection.

[Objectives]

1. To understand the basics of NL analysis
2. To understand some deep learning techniques for NLP
3. To understand basic techniques for image analysis and object recognition.
4. To be able to implement basic object recognition algorithms that employs (1) local image feature aggregation and (2) convolutional neural network.

[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 and/or C++ will be required for some assignments. It is beneficial if you are familiar with Tensorflow and Keras deep learning frameworks. Familiarity with other frameworks, e.g., PyTorch, would also help.

[Evaluation]

* First Half:
Report 50%, Mini-examination (quiz) 50%

* Second Half:
Assignments involving programming in Python, Keras, and Tensorflow 100%.

[Textbooks]

* First half:
None

* Second half:
If you can read Japanese,
原田 達也, 画像認識, 講談社, ISBN:978-4-06-152912-0

[References]

1. S. Nagao, “Natural Language Processing”, Iwanami, ISBN:9784000103558
2. Y. Saitoh, “Deep Learning from Scratch”, O’REILLY, ISBN-9784873117584
3. Aurélien Géron, “Hands-on machine-learning with Scikit-Learn, Keras & Tensorflow”, 2nd Edition, ISBN:978-1-492-03264-9
4. Jan Erik Solem, “Programming Computer Vision with Python: Tools and algorithms for analyzing images”, O’Reilly, ISBN:978-1449316549

[Schedule]

Lectures 1 to 7: taught by Fumiyo Fukumoto
Lectures 8 to 15: taught by Ryutarou Ohbuchi.

1. (Morphological Analysis) Viterbi, HMM
2. (Syntactic Analysis)　Tree Structure, Context Free Grammer, CKY
3. (Syntactic Analysis)　Chart Parser, Decision Tree
4. (Deep Learning for NLP) Simple Word Vector Representations
5. (Deep Learning for NLP) Sentence Analysis
6. (Deep Learning for NLP) Sentiment Analysis
7. (Deep Learning for NLP) Sentence Classification
8. Introduction to image recognition
9. Local features, interest point detectors
10. Local feature descriptor, coding and pooling,
11. Geometric verification, machine learning,
12. Classifiers, gradient descent method
13. Deep neural network, image recognition using CNN
14. Regularization, loss landscape, various CNN architectures
15. Unsupervised representation learning, practical aspects of CNN training

[Title]			[Instructor]		
Phenomenology of Environment			Shuji Morita		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK512	2	Computer Science and Engineering	2nd Semester	Thu.／Ⅲ	English

[Outline and purpose]

We will study, with the help of phenomenology and cultural history, how people recognize and live various aspects of their social and cultural environments. We will discuss in teams questions raised by the teacher or by ourselves and then give an account of discussions to other teams.

[Objectives]

The purpose of this course is to enable you to discuss questions in English.
You will learn basic notions of some approaches including phenomenology and cultural history.
We hope to give students an opportunity to both reflect on their own cultures and gain an understanding of other cultures.

[Requirements]

Brush up your skills of expression through activities in English while opening your eyes to another culture.
Students are expected to participate fully in different class activities such as discussion, writing, presentation.

[Evaluation]

Participation in class activities: 60%
Output (Research, Presentation): 40%

[Textbooks]

[References]

There will be weekly handouts.

[Schedule]

01) Introduction : brainstorming exercise (self presentation)
02) Semantics of rainbow : brainstorming exercise (seat)
03) Structural analysis : brainstorming exercise (food)
04) Structural analysis : food
05) Structural analysis : brainstorming exercise (clothing)
06) Structural analysis : clothing
07) Group presentation & Recapitulation
08) Cultural history : brainstorming exercise (landscape)
09) Cultural history : invention of landscape (Europe, Japan, China)
10) Comparative analysis of stories : brainstorming exercise (folktales)
11) Comparative analysis of stories : folktales
12) Analysis of stories : rewriting stories
13) Analysis of stories : films
14) Analysis of stories : Life and death on the screen
15) Group presentation & Recapitulation

[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 I I			( )		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK602	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]		
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]

Advanced Topics in Computer Science and Engineering V			Kenji Ozawa / Kentaro Go		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK613	1	Computer Science and Engineering	2nd Semester	Wed.／I	Japanese

[Outline and purpose]

In this special lecture, Bayesian statistics will be discussed. Bayesian statistics is a powerful methodology for extracting useful information from data, and various applications are practiced also in machine learning and artificial intelligence fields. In the first half of the lecture, we begin with Bayes' theorem and learn how to evaluate posterior distribution by sampling. In the latter half, we learn some methods of using Bayesian statistics for statistical processing in experiments. Students will understand the basics of experimental data analysis by Bayesian statistics while comparing with significance test and classical statistical analysis using p value.

[Objectives]

5. Understand the framework of Bayesian reasoning.
6. Learn how to evaluate posterior distribution by sampling (Hamiltonian Monte Carlo method).
7. Learn experimental design methods and the corresponding Bayesian statistics.

[Requirements]

Undergraduate-level statistics (random variables, descriptive statistics, inference statistics, significance tests)

[Evaluation]

[Textbooks]

1. 豊田秀樹, 基礎からのベイズ統計学: ハミルトニアンモンテカルロ法による実践的入門, 朝倉書店, ISBN:978-4254122121
2. 豊田秀樹, はじめての統計データ分析 ―ベイズ的〈ポスト p 値時代〉の統計学, 朝倉書店, ISBN:978-4254122145

[References]

[Schedule]

[Lecturer: Kenji Ozawa]
1. Bayes' theorem on probability, naive Bayes classifier
2. Subjective probability
3. Random variable and probability distribution, maximum likelihood estimation
4. Bayes' theorem on distribution, Bayesian estimation
5. Metropolis Hasting Method
6. Hamiltonian Monte Carlo method (principle)
7. Hamiltonian Monte Carlo method (practical training)
8-a. Summary of the first half of the lecture (45 minutes)

[Lecturer: Kentaro Go]
8-b. Fundamentals of experimental method (45 min)
9. Experimental method and data organization
10. Estimate for one group of data
11. Guess the difference between two independent groups
12. Correspondence between correlation and difference between two groups
13. Estimation of multi-group difference by experimental design
14. Proportion and speculation of cross table
15. Summary of the latter half of the lecture