[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 and the Web spread, we experience 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 stream. 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: sequential data mining.
6. Data mining: basic data stream online mining.
7. Data mining: advance data stream online mining with approximation methods.
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]		
Software Engineering			Masakazu Takahashi / Yoshimichi Watanabe		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK502	2	Computer Science and Engineering	2nd 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 70%
- Exercise 30%

[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) Object oriented development for real time systems 1 (requirements analysis)
(07) Object oriented development for real time systems 2 (finding objects and defining classes)
(08) Object oriented development for real time systems 3 (designing timing and sequences)
(09) Object oriented development for real time systems 4 (designing architecture)
(10) Object oriented development for real time systems 5 (designing mechanism and details)
(11) Object oriented development for real time systems 6 (case study)
(12) Quality and safety management for real-time systems
(13) Exercise 1 (planning)
(14) Exercise 2 (analyzing requirements)
(15) Exercise 3 (designing architectures)

[Title]			[Instructor]		
Parallel Computing			Hidetoshi Ando/ Tomohiro Suzuki		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK503	2	Computer Science and Engineering	2nd Semester	Man.／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 (Sort, Merge) (Ando)
14. Advanced parallel patterns (Scan) (Ando)
15. Advanced topics on GPU computing (Ando)

[Title]			[Instructor]		
Internet Engineering			Hidetoshi Mino /Atsushi Kara		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK504	2	Computer Science and Engineering Computer Science and Media Engineering Embedded and Integrated System Development	1st Semester	Tue.／V	

[Outline and purpose]

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

[Objectives]

The main topics consist of the congestion avoidance mechanism of TCP, IP addressing and routing principles, configuring routers, IP security and VPN.

[Requirements]

Basic knowledge of TCP/IP

[Evaluation]

Thorough understanding of the course topics: 50%
Active involvement in the class: 50%

[Textbooks]

Hand-out

[References]

[Schedule]

1. Introduction
2. Basis of TCP (Header structure 1)
3. Basis of TCP (Header structure 2, MTU/MSS)
4. Basis of TCP (Stating and closing connections 1)
5. Basis of TCP (Starting and closing connections 2)
6. Congestion control of TCP (Delayed Ack, Nagle Algorithm, Window control, Slow Start)
7. Congestion control of TCP (Congestion Avoidance, Fast Retransmit, Fast Recovery)
8. Improving performance of TCP (Path MTU Discovery, Window Scale Option)
9. Basis of IP (Address structure, Netmask, Default Gateway)
10. Basis of IP (CIDR, Subnetting, Address aggregation)
11. Dynamic Routing Protocol (Principle of RIP1/RIP2)
12. Dynamic Routing Protocol (RIP1/RIP2, Split Horizon, Poisoned Reverse, RIP-MD5)
13. IP Security (IPsec)
14. IP Security (ISAKMP and IKE)
15. Summary

See the following Web page:
http://www.u-aizu.ac.jp/~kara/
for the course schedule updates and hand-out material.

[Title]			[Instructor]		
Machine Learning			Motonobu Hattori		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK505	2	Computer Science and Engineering	1st Semester	Thu.／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: 70%
Projects: 30%

[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. Error Back Propagation
8. Support Vector Machine
9. Boltzmann Machine
10. Deep Learning
11. Ensemble Learning
12. Learning Vector Quantization, K-means
13. Gaussian Mixture Model, Multi Dimensional Scaling
14. Principal Component Analysis
15. Course Review and Final Exam

[Title]			[Instructor]		
Visual Information Processing			Ryutarou Ohbuchi/ Xiaoyang Mao		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK506	2	Computer Science and Engineering	2nd Semester	Mon.／III	

[Outline and purpose]

This course offers opportunity to learn both analysis and synthesis of visual information, namely, 2D image analysis, recognition, and 2D and 3D computer graphics. We do so by combining such fundamentals as computer vision, machine learning, computer graphics, numerical computation, linear algebra, and others.
The course is divided into two parts, and is taught by two instructors.
(First half: Ryutarou Ohbuchi)
The first half is taught by Ohbuchi, and emphasizes analysis. Methods to realize recognition, retrieval, tracking and other functions on 2D images will be discussed. To be a bit more specific, feature detection and image descriptor for images, machine learning algorithms for recognition, retrieval, or classification of images are discussed. Machine learning algorithms, such as clustering, classification, or dimensionality reduction are also discussed.
(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, matting, and others will be discussed.

[Objectives]

The student could implement fundamental algorithms for 2D image comparison, retrieval, and recognition. She/he could also understand and explain several state-of-the-art algorithms for image synthesis.
The student is able to research newly available image analysis and synthesis methods on his/her own to implement and benefit from the methods.

[Requirements]

One must have command of linear algebra and calculus, skills in programming (e.g., by using C++), as well as understanding of important algorithms and data structures. One should also know basics of image processing techniques (e.g., image filtering) and 3D computer graphics. It is highly beneficial to know machine learning, for example, clustering, classifiers such as Support Vector Machines, dimensionality reduction, or regression.

[Evaluation]

Students are evaluated by quizzes (about 6) and reports that involves programming.

[Textbooks]

To be announced.

[References]

To be announced.

[Schedule]

1. Introduction, human vision, camera model
2. Image filtering basics, template matching
3. Edge detection, scale space
4. Interest points, local image features
5. Aggregation and comparison of local features
6. Classifiers (SVM and randomized forests)
7. Clustering, dimension reduction
8. Image recognition, retrieval, and identification
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]		
Natural Language and Speech Information Processing			Kenji Ozawa / Fumiyo Fukumoto		
[Code]	[Credits]	[Program]	[Semester]	[Hours]	[Language of instruction]
GTK507	2	Computer Science and Engineering	1st Semester	Mon.／I	

[Outline and purpose]

Speech and natural language are important ways for human-to-human communication. This course covers major topics in Speech and Natural Language processing. The first part of the course addresses the issues of speech, i.e., physiological and psychological bases of speech and hearing, and speech information processing using a computer. The second part of the course addresses the issue of the natural language, and introduces computational models of language analysis based on machine learning, and their applications, text categorization, information retrieval, and text summarization.

[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 acoustical signal processing, e.g. audio perceptual coding and data compression.
3. To understand the basics of natural language analysis.
4. To understand the basics and state-of-the-art of NLP applications, text categorization, information retrieval, and text summarization based on statistics and machine learning.

[Requirements]

Integral and differential calculus, Introductory statistics

[Evaluation]

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

[Textbooks]

None

[References]

1. Sound and humans, Acoustical Society of Japan Ed., Corona Pub., ISBN: 978-4-339-01303-0
2. Probabilistic Language Model, K. Kita, Univ. of Tokyo Press, ISBN4-13-065404-7
3. Information Retrieval and Natural Language Processing, T. Tokunaga, Univ. of Tokyo Press ISBN4-13-065405-5
4. Information Retrieval Algorithms, K. Kita, Kyoritsu Press, ISBN4-320-12036-1

[Schedule]

(1 to 7 by Kenji Ozawa)
1. Overview of speech and acoustical information technology. (Acoustics) Fourier transform and spectrum
2. (Acoustical physiology 1) Anatomical and physiological bases of the peripheral system of hearing
3. (Acoustical physiology 2) Anatomical and physiological bases of the central system of hearing and speech generation
4. (Acoustical psychology 1) Perception of loudness and pitch
5. (Acoustical psychology 2) Perception of timbre and speech
6. (Acoustical signal processing 1) Speech synthesis and high-efficiency speech coding
7. (Acoustical signal processing 2) Speech recognition and audio perceptual coding

(8 to 14 by Fumiyo Fukumoto)
8. (Natural Language Analysis) Morphological Analysis
9. (Text Categorization 1) Naive Bayes, and Support Vector Machines
10. (Text Categorization 2) Aggromerative clustering, K-means, and Semi-supervised clustering
11. (Information Retrieval 1) Full-text search, Vector space model, and Baysian network model
12. (Information Retrieval 2) Ranking by PageRank and AdaRank
13. (Text Summarization) Feature selection, and summarization
14. (Evaluation methods) MAP, IRS, Precision, Recall, and F-measure

15. Sum-up (Kenji Ozawa and Fumiyo Fukumoto)

[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]

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.
- 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]		
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