Course title: ADVANCED GRAPHICS ALGORITHMS

Credits: 4

Course outline:

Geometrical description and modeling; Transforms; Color, Shading and Lighting; Texturing;
Rasterizing and Fragment processing; Blending and Transparency;
Lighting Techniques; Collision Detection; Realistic Scene; Natural Details

Literature


3. Randima Fernando and Mark J. Kilgard: Cg he Cg Tutorial, The Definitive Guide to programmable Real-Time Graphics, Addison-Wesley, 2005
Course title: ADVANCED IMAGE PROCESSING

Credits: 4

Aim of the course:

The course is to provide mathematical foundations and practical techniques for some important topics in digital image processing and review some advanced techniques for some fundamental areas. Education Aims: to develop a foundation that can be used as the basis for further study and research in the basis for further study and research in image processing.

Course outline:


Literature


Course title: ADVANCED NUMERIC AND SYMBOLIC COMPUTING

Credits: 4

Aim of the course:

The course enables the students to deeply understand the numerical methods, involving their complexity, precision, and memory requirements. The graduated students will be capable to design such computational algorithms that can achieve preset precision requirements, while running on rounding error prone hardware and software components.

Course outline:

Orthogonalization algorithms, the Gram-Schmidt process, Householder transformations and Givens rotations. Numerical solution of the eigenvalue problem, Jacobi rotations, the QR algorithm, perturbation and separation theorems.

Approximations in linear spaces, generalized interpolation, Haar spaces, rational and spline interpolation, best approximations, orthogonal polynomials, Chebyshev approximations.

Solving systems of equations by iterative methods, fixed point theorems and fixed point iteration, relaxation methods, generalized Newton’s methods.

Numerical integration, quadrature rules based on interpolating functions, Gaussian and Romberg quadrature, error estimates and convergence.

Differential equations, initial value problems, linear multistep methods for the numerical solution of IVPs, consistency, stability and convergence.

Boundary value problems for second-order ordinary differential equations.

Literature:

3. R. Plato, Concise numerical mathematics, AMS, 2003
Course title: ADVANCED PROGRAMMING

Credits: 5

Aim of the course:

Make the students learn the generic programming paradigm and the practical usage of the C++ language and the Standard Template Library.

Course outline:


Literature


Course title: ANALYSIS

Credits: 5

Course outline:


Literature:


Course title: APPLICATIONS OF LINEAR PROGRAMMING

Credits: 4

Aim of the course:

The course enables the students to understand the functioning of linear programming algorithms, their application to such optimization programs that are built on the simplex method. Those who have completed this course will be capable to apply linear programming tools for general real life problems.

Course outline:


Literature:

Course title: AUTOMATA AND FORMAL LANGUAGES

Credits: 6

Aim of the course:

The course provides students with deeper understanding of the mathematical background of formal and programming languages, formal models in computer science, and foundations of computer science.

Course outline:


Literature:

Course title: COMPUTER VISION

Credits: 5

Aim of the course.

Students will learn the fundamentals of 3D reconstruction from a stereo image pair as well as the basics of motion analysis. They will solve a project assignment in small teams, which develops their ability to work in a team, find creative solutions to real problems, analyse various aspects of their algorithms and to present their ideas in written and oral form.

Course outline:

Camera geometry, parameters of 3D -> 2D projection.
Surface reconstruction from a single image 1.: shape from shading.
Surface reconstruction from a single image 2.: shape from texture.
Stereo Vision, epipolar geometry, Essential Matrix, Fundamental Matrix.
3D reconstruction from a pair of images.
3D reconstruction from multiple views.
Photometric stereo, motion-based reconstruction.
3D reconstruction and virtual view generation.

Literature

Course title: DATA MINING

Credits: 5

Aim of the course:

In recent years, data mining has been used widely in several areas of science and it is also important in business areas like customer relationship management, market basket analysis. Therefore the solid knowledge on data mining can be important for both the students learning towards PhD studies and students moving to industry.

Course outline:

Introduction to data mining (feature representation, main tasks),
Data visualization, Multidimensional scaling, Locally linear embedding,
Regression,
Sequence similarity measures, dynamic time warping,
Vector space model, Latent semantic indexing,
Clustering (sequential and hierarchical agglomerative methods),
Probabilistic and soft clustering.

Literature:

2. P.N. Tan, M. Steinbach, V. Kumar: Introduction to Data Mining, Pearson Addison Wesley, 2006 (769p)
3. J. Han, M. Kamber: Data mining: Concepts and Techniques, 2nd ed., Morgan Kaufman, 2006 (800p)
Course title: DISTRIBUTED APPLICATION DEVELOPMENT

Credits: 5

Aim of the course:

The course is an introduction to elementary Windows programming in C#. By accomplishing the course students will be able to write basic Windows Forms applications utilizing the standard Windows graphical user interface. They are given examples on how to build applications in CLR (CLR is a development class library) and how to connect to databases via ODBC/OLE DB interface. The course includes a lecture on mixed programming language development (C++/VB/J#/C#), and a short overview about managed C++ CLR programming.

Course outline:

Main features of the C# programming language, the basics of the development environment. The language syntax, changes, differences. The memory usage paradigm of the .NET C#. The structure of C# programs.

How the .NET Framework does work? Access and usage of most important CLR library classes for the development of Windows Forms applications.

The most common Forms components and their properties. Customizing Forms, making them alive by processing different messages and responding to them. SDI, MDI and MultiSDI style user interface. How to write MDI (Multiple Document Interface) applications.

Introduction to resources. Writing international applications by the help of the CultureInfo and the ResourceManager helper classes.

Processing information stored in the Settings database. Binding component properties to user Settings.

Writing threaded applications, the timer component. Introduction to graphics. What is managed C++?

Writing database client applications using ADO.NET. Connecting to ODBC and OLE DB data sources like Oracle, MySQL, MS SQL Server.

Literature:


Course title: EMBEDDED SYSTEMS

Credits: 5

Aim of the course:

To develop low-level, close-to-hardware programming competences in the students.

Course outline:

Introduction to embedded systems (SW/HW architectures). Cross-platform software development. Embedded operating systems (embedded Linux, VxWorks, software without operating system). Special tools for embedded software development (On-chip debugging support, JTAG, ICD, ICE). Hardware interfaces (UART, ICC, USB, network interface). Real-time systems, multitasking, inter-process communication, timing and memory handling. Debugging methodologies

Literature


Course title: GAME THEORY

Credits: 5

Aim of the course:

The course provides the necessary competences in game theory: the students will be enabled to classify the game theoretical models, learn basic theoretical background to basic algorithms and will be capable to recognize game theoretical problems, build models, and solve related practical problems.

Course outline:


Groups decision making, Arrow theorem. Choquet measure.


Literature:


Course title: GRAPH THEORY

Credits: 5

Aim of the course:

Introducing the major graph theoretical notations and basic graph algorithms and algorithmic techniques. The students successfully completing the course must be able to understand graph theory problems, to solve efficiently the basic graph problems, distinguish tractable and intractable problems and be acquainted with the major graph theoretical techniques.

Course outline:


Literature:

Course title: IMAGE PROCESSING SYSTEMS

Credits: 5

Aim of the course:

Knowledge on various image processing and visualization software libraries and systems.

Course outline:

Lecture and hands-on exercises with several image processing libraries and systems:

MATLAB + Image Processing Toolbox.

ImageJ: image processing routines, plugin and macro development.

VTK (Visualization Toolkit): graphical and visualization model, objects for image processing.

ITK (Insight Segmentation and Registration Toolkit): data visualization, access, and processing objects, filters, transformations.

Slicer: basic operations, loading and displaying image volumes, developing new modules

IPL; OpenCV; IDL (Interactive Data Language): IDL basics, graphical and image processing routines

Literature

3. VTK: http://www.vtk.org
4. ITK: http://www.itk.org
5. Slicer: http://www.slicer.org
7. OpenCV: http://opencv.willowgarage.com
Course title: LEGAL, ETHICAL AND INFORMATICS ISSUES OF PERSONAL DATA PROTECTION

Credits: 3

Aim of the course:

The course gives introductory legal knowledge about personal data processing. By accomplishing the course students will have sufficient background knowledge about European laws and conventions governing the Hungarian data protection legislation, and about the Hungarian law itself. The course discusses ethical questions of utilizing personal data for business and research purposes. The topics include works and achievements of top European data protection experts, and Hungarian data protection commissioners.

Course outline:

Historical overview. The immunity of home and private life and the confidentiality of personal correspondence and communication; Basic concepts concerning to the course, and international legal instruments controlling jurisdiction on personal data protection; Overview of most important international treaties, and Hungarian laws, decisions of the Constitutional Court; The recommendations of the Council of Europe and Working documents of the European Commission; Elements of the special legal rulings concerning to personal health data; Outstanding data protection commissioners in the EU member states, and their activities; Ethics of database research in the mirror of international publications; Special biometric personal data: fingerprints, iris image, lip print, blood, DNA, proteomic profile; Questions of physical data protection, encryption. Crimes against electronic systems. The task of the DPOs (Data Protection Officers). Methods for anonymisation of personal data and the most important ethical questions of anonymisation; The transparent state and the opaque citizen, and the freedom of information based on Lásló Majtényi's work. The Hungarian Data Protection Commissioners, annual reports, and their most important statements.

Literature:

Course title: MACHINE LEARNING ALGORITHMS

Credits: 6

Aim of the course.

During the course the students learn the foundations of machine learning. This gives the skill of using such techniques in developing algorithms for applied problems.

Course outline:

Introduction to machine learning,
Theory of machine learning (Vapnik-Chervonenksi dimensions, PAC learning),

Perceptron and neural nets,

The regression task,

Generative and discriminative approaches,

Training by Maximum Likelihood.

Literature:

Course title: NONLINEAR OPTIMIZATION

Credits: 4

Aim of the course:

The competencies that will be provided by the course: ability to recognize the advantageous nonlinear optimization models, capability to select the proper solution algorithms, and to be able to interpret the obtained result in a professional way. The students will learn how to transform the original problem setting to obtain a more favorable form in terms of computational complexity and result precision.

Course outline:

Introduction, unconstrained optimization, convex sets and convex functions in optimization.


Karush-Kuhn-Tucker optimization conditions, Penalty function method, Optimization with equation constraints, Lagrange multipliers.

Case studies.

Literature:


Course title: **ON-LINE ALGORITHMS**

**Credits:** 4

Aim of the course:

During the course the students learn the basic methods to handle the algorithmic problems where there is lack of information. This knowledge is useful in managing IT systems. Moreover the course also improves the skill of using mathematical methods to analyze algorithms.

Course outline:


Literature:


3. Cs. Imreh, Competitive analysis, in Algorithms of Informatics, (Volume I, eds Antal Iványi), 395-428
Course title: PARALLEL PROGRAMMING

Credits: 5

Aim of the course:

The main aim of the course is that the students get a firm understanding of the parallel programming paradigm. By studying the details of the Occam language and the components of the Java programming language that deal with parallelism and concurrency, the students get the opportunity to acquire a deep understanding of how parallel programs are constructed and what kind of data structures can be used in solving problems.

Course outline:


Literature:

1. Course syllabus: /pub/Parhuzamos/ParallelProgramming.pdf
Course title: PROGRAM SYSTEMS DEVELOPMENT

Credits: 5

Aim of the course:

The goal of the course is to provide a basic understanding of the issues a system architect could face during the design and development of a robust and scalable software system. The course focuses on the JEE ecosystem, but it shows the issues solved on a more abstract level in order to enable the students the understanding of other possible ecosystems (.NET, PHP, etc).

Course outline:

Distributed systems (cloud vs. traditional enterprise applications, CAP). Crosscutting issues (security, transactions, etc). Middleware: the goal of the middleware in enterprise world, categories, services of the middleware. Implementing the business logic: 4th and 5th generation languages. Implementing the domain model: relational vs OO modeling. Ontologies. Handling the end user interaction (Ajax, JSF, SEAM). Defining the business logic (EJB)

Persistence: ORM. Service oriented architectures, ESB. Orchestration: BPEL. Crosscutting issues: security

Literature:


Course title: SOFTWARE DEVELOPMENT

Credits: 5

Aim of the course:

Provide introductory information in basic Windows programming. By accomplishing the course students will be able to write applications utilizing the standard Windows graphical user interface in C and C++. Students are given examples on how to build applications in MFC (MFC is a C++ development class library) and how to connect to databases via ODBC interface. The course provides basic knowledge about X-Window graphical system as a comparison.

Course outline:

Windows Software development by command line tools; the usage of the make utility;

Development environments for applications running in graphical windowing operating systems: Windows API, Cygwin, X-Window, and OpenMotif;

Overview of X-Window system, presentation of several demonstrating software source codes;

X emulators in Windows, using the X font server;

Software development in Win32 SDK; Frequently used file types by their extensions: (.def, .rc, .res, .resx, .c, .cpp).

The Win32 resource files, their content, and structure;

How to write Win32 API programs, native window handling in C/C++;

Dialog windows, message processing.

Main features of the window components (menus, buttons, textboxes, listboxes, ...) in Windows. How to handle dialog windows and their components.

Writing Windows applications in MFC. MDI and SDI software development in MFC; the document/view, architecture and serialization.

Using ODBC interface for connecting and querying different database systems like MS Access, dBase, Oracle, MySQL.

Literature:


Course title: SPEECH RECOGNITION AND NATURAL LANGUAGE PROCESSING

Credits: 5

Aim of the course:

The course shows the applications of artificial intelligence methods in the area of speech recognition and natural language processing. Besides teaching the most important results of the area it helps the students to learn to build artificial intelligence based solutions on applied problems.

Course outline.


Literature:

Course title: TREE AUTOMATA

Credits: 5

Aim of the course:

Tree automata deal with tree structures, rather than the strings of more conventional state machines. Tree automata can be thought of, among others, as formal models for parsing of context free languages. The course gives an introduction to the most important concepts and constructions concerning tree automata.

Course outline:


Literature:


4. Z. Fülöp, H. Vogler, Weighted Tree Automata and Tree Transducers, in: Handbook of Weighted Automata (Szerk.: M. Droste, W. Kuich és H. Vogler), Springer-Verlag, 2009, Chapter 9, 313-403