

GRADUATE PROGRAMME

Data Integration and Data Warehouses IDH

The first module of the lecture presents the topic of data-level integration. The other module is devoted to data warehousing, which includes the development of integrated data stores containing the organization's uniformed historical data. The solutions of this kind are built for the purpose of analytical processing, including data exploration and knowledge discovery tools, as well as for archiving. Due to high data volumes and because of specific usage patterns, the approach to design, maintenance and evolution of data warehouses require a specific approach, much different than in case of traditional, transactional databases. The main goal of the lecture is to present main principles and methods for designing and optimizing data warehouse applications.

Linguistic Engineering INL

The lecture aims to present issues concerning processing of unstructured text data (mainly in Polish but also in English). During the course different levels of natural language description will be presented and the methods of morphological analysis, syntactic, and semantic as well as various formalisms used for these tasks will be shown. The presentation covers the most important existing linguistic resources that can be used to create new applications and existing software tools which allow for basic linguistic analysis. The course also contains an overview of different types of natural language processing applications: extracting information, identifying named entities, terminology extraction and machine translation.

Data Exploration and Visualisation EWD

The aim of the course is to present the basic cycle and the methods of data mining and exploration. There are discussed the methods of data preprocessing, summarisation, cleaning, visualisation and exploratory data analysis. Then, there are presented basic techniques such as: regression, classification and clustering. In addition, there are presented selected techniques and tasks such as: the elements of text mining, web mining or graph mining. The lectures are enriched with the labs where the techniques are practised on data with the usage of the R package.

Programming for Data Science PAD

The aim of this course is to provide the student with the knowledge about the programming tools used in data analysis and big data. During the course, the students will have the opportunity to practice the use of two most popular languages used in the aforementioned tasks: Python and R. When learning Python, students will be provided with an introduction to the language and its syntax, in order to later focus on libraries and modules dedicated to data analysis (Numpy, Pandas) and machine learning (Sklearn, Theano, Gensim). During the R section of the course, students are introduced to the syntax and use of the language, and later are shown its use in data analysis, machine learning, and data visualization.

Puzzle Based Learning - online course PUZ

Puzzle-learning is a teaching method which has been known for several years and is based on the idea that learning is easier and the results more impressive when a student solves puzzles rather than learns by heart. The aim of the lecture is to teach students the art of formulating and solving unstructured tasks of the types known to us from everyday life. The additional aim is to raise students' mathematical awareness and to show them that the world of mathematics and physics can be fascinating and attractive, at the same time also useful.

Creating IT Startups TSI

The goal of the class is to present issues related to: Entrepreneurship – planning and implementing business strategies, identifying business opportunities, risk taking and assessment, assessing strengths and weakness of a business operation. The ability to search, select and critically analyze information. Through the analysis of own and competitive companies' results, students acquire skills needed to draw conclusions-based data analysis. Preparation and assessment presentation of financial plans Skills required to prepare a marketing plan for a new/innovative product or service based on IT solutions. During the workshops/tutorials students will prepare group projects which will include: and idea and description of the product/app/service and a marketing and financial plan. Assessment will be based on the evaluation of written reports and group presentations.

Project Management ZPRO

The course is intended to provide a brief introduction into the core topics of project management that are mostly independent of particular branch of industry. The first module presents an overview of the most popular project management methodologies, PRINCE2, PMBoK standards, and Critical Chain Project Management and Agile Project Management in particular. The second module is devoted to a project team lifecycle, interaction dynamics, business communication skills as well as personal and professional development, especially in the context of globalization and team distribution.

Advanced Modeling and Analysis of Information Systems ZMA

The goal of this course is an introduction, analysis and gain of practical skills in advanced modeling of data and processes. The first part of the course is dedicated to the conceptual specification language ORM (Object-Role Modeling) for data modeling and specification. A detail comparison of ORM with other languages such as ER and UML let highlight its special features that support the language universality and superiority. The second part of the course concentrates on to process modeling techniques and languages used for modeling and specification of processes. The lecture will introduce the application of workflows in banking. Using workflows as an example of advanced Information Systems application, we introduce typical process specification language. The particular focus is placed on a structural language with its grammar being part of WfMC specification. Selected aspects of verification and validation of complex process specification as well problems related to migration of processes to their new forms due to the dynamic changes of the process structure, enrich and complement this part of the course material. The course concludes an overview of the Model Driven

Architecture (MDA) and existing international standards governing the specification unification. All lectures are well illustrated by many realistic examples.

Data Protection in Big Data Environments BZBD

As part of the course, students learn about the issues of data protection in cloud computing from the technical and legal side. The technical aspects will be focused on cryptographic methods of data protection by ensuring confidentiality, privacy or anonymity. Other technical aspects will concern the modeling and analysis of IT systems using Big Data, with particular emphasis on best practices in the field of cybersecurity. The legal aspects focus on personal data protection issues in the light of the GDPR.

AI Ethics ESI

The module aims are to broaden knowledge and raise awareness of Emerging Information Technology Ethics and to encourage them to discuss their opinion with their peers respecting and taking into consideration diversity of opinions.

Big Data Processing and Analytics ADD

The goal of this course is to present the challenges and opportunities of big data mining. The course will generally focus on the following three aspects of big data:

- Large Scale Data Processing (outlining various useful computational paradigms, such as MapReduce and an implementation environment Hadoop);
- Large Scale Data Mining (including scalability issues of deriving patterns, clusters, trees and other knowledge structures from big data);
- Applications to complex big data set (on the examples taken from the areas of stream data and web/text mining).

Graphs and their Applications GIZ

Due to the omnipresence of graphs in most of modern applications in computer science (e.g. computer and telecommunication networks, world wide web, social networks, semantic knowledge graphs, etc.) the course has the goal of delivering basic conceptual, algorithmic and mathematical tools concerning graphs that are useful in modeling and solving practical modern computational problems in industry and science. There will be discussed fundamental theoretical concepts as well as examples of their practical modern applications with the use of computers.

PROFILE-SPECIFIC (SPECIALIZATION) COURSES

Database Management ZBD

The first part of the course is devoted to presentation of technical aspects of database management systems. It includes the physical model of a database, architecture of a database management system, building of indexes, query processing and transaction management. The second part of the course is devoted to the database tuning. It includes performance measuring, drawing conclusions from these readings and developing hints which can boost the performance of the database. Laboratory exercises will include administration tasks of databases. The examples come from the two database systems: Oracle and MS SQL Server.

Introduction to Big Data WPBD

As part of the subject "Introduction to Big Data", students will become acquainted with the basic issues and terminology related to this area in information technology. We will describe the competences needed in data analytics professions, Big Data engineer and Data Science professional. Data on the increase of data generated by machines, people and organizations will be presented. We will discuss the strategies of integrating large data, basic assumptions of processing algorithms and methods of their storage. The most important tools related to the processing of large data sets, their acquisition, installation and configuration will be presented. We will present methods for creating our own environments for Big Data analysis as well as the possibilities of using commercial cloud solutions. In addition to software solutions, the possibilities of hardware solutions will be discussed.

Digital Signal and Image Processing PSO

This unit will familiarize students with various concepts behind 1-D and 2-D signal processing (i.e. sound and image) including both continuous and discrete, with an emphasis on discrete signals. The course is split in two parts: first, initial information is explained using 1-D signals as examples, and following that in part two, the same topics are expanded for 2-D signals. The course will describe, among others, the following topics: description and parameterization of signals, transforms (e.g. DFT, FFT, DCT, Z), convolution, digital filters, sampling and quantization. Practical applications will also be shown during the lecture, which can come in use for analysis, synthesis and general signal processing.

The laboratories are being held in parallel to the lectures and deal with the same topics. The theoretical knowledge gained during the lectures is utilized by the students to perform exercises using scientific and engineering computation software and sample data (audio and images).

Cloud Platforms and Technologies TPC

Cloud applications are nowadays getting a lot of attention from both developers and users. Students are going to learn about the standards and technologies utilized by various platforms for developers of web and cloud applications. They are also going to get familiar with some tools, designed to analyze and optimize performance of such applications. Moreover they are going to learn about commonly used frameworks for simulation of cloud systems/distributed algorithms and popular testing environments for network applications.

Introduction to Machine Learning WUM

The course introduces or reminds basic mathematical concepts and techniques used in machine learning and introduces basic ML concepts and techniques with emphasis on deep learning and gradient method. Various concepts and architectures concerning neural networks are presented such as perceptron, back-propagation, feed-forward, neural networks, CNN, RNN, elements of regularization and practical aspects of training NN.

Business Process Modeling and Management MZP

The course aims to provide theoretical and practical issues of business process management according to the best and up to date business process management. The students will learn about different kind of processes in business and non-business organizations, the concept of process management in different management schools as well as forms of process integration that leads to multi and synergy effects in strategic, and operational dimensions. They will know how to identify, model, implement, direct and control as well as to develop different processes in different kinds of organizations. There will be also presented workflows, their measurements and process mining issues.

Big Data - modeling, management, processing and integration BGD

During the lecture students will learn about Big Data problems occurring in their everyday environment, learn to identify them and effectively manage them for the needs of the organization. They will learn to use virtually unlimited sources of large data, discover new ones, and design tools to acquire them. They will discover the basic Data Science techniques on the practical level to model Big Data abstraction classes, choose appropriate operations to work with these models, learn to distinguish classic data management techniques from Big Data management techniques. In addition, we will present tools for data processing and integration based on the analysis of the process from the stage of extracting interesting data from the database to the use of real results obtained through the application collection. Software, the use of which will be presented in practical examples, will include Apache Hadoop Ecosystem, Apache Spark, AsterixDB, HP Vertica, Impala, Neo4j, Redis, SparkSQL.

Mobile Wireless Systems SMB

With the increasing popularity of mobile devices and the technology that they offer, there is an increased demand for practical applications, which could extend current capabilities. As part of the course, students have the possibility to acquire new skills regarding software development for mobile devices. They learn about the development environment and the platforms which can expand the functionality of their apps. Particular emphasis is put on the ability to use cloud computing as a mechanism to support and enhance the developed applications.

NoSQL Databases NBD

Increasing popularity of NoSQL databases and functional languages provides new challenges. Choice of correct tools for a project requires understanding of concepts behind various types of databases, their advantages and disadvantages as well as use cases for which they were designed. Increasing role of functional languages requires familiarity with basic concepts such

as non-mutable state, pattern matching and various approaches to concurrent processing. The goal of this course is to familiarize students with most important classes of NoSQL databases, their applications, as well as basic concepts used in one of the most popular languages allowing programmers to utilize the functional programming paradigm – Scala. Students will also improve their programming skills.

Advanced Methods in Computer Security ZMI

The aim of the course is to present the current state of knowledge on issues related to the safety and security of the information, software and computer systems. At the beginning will be presented the basic concepts, techniques and cryptographic algorithms. Then the issues will be discussed basics of cryptography and cryptographic protocols. In the following lectures will be presented issues of information security management based on standards such as ISO / IEC 27001: 2007, ISO / IEC 17799: 2007, BS 25999 and COBIT. Another issue raised in the course will focus on the subject of risk analysis of IT systems. The final issue raised in the lecture will be safety requirements in force in Poland, the Law on the protection of personal data.

Applications of Machine Learning ZUM

Machine learning (ML) is the basis of artificial intelligence, and its development has allowed to create systems that are able to learn and to extract knowledge. The scope of applications of such systems is constantly expanding, and the purpose of this lecture is to familiarize students with the most interesting ML applications, especially those that directly contact people. Specific techniques used in such systems and measures of their performance will also be presented.

BLOCK COURSES

Service-Oriented Network Systems SSU

This course covers advanced fundamental principles of service-oriented network systems, studying foundational and applied material in the field. Topics include protocol mechanisms, evolution of remote method invocation, overlay networks, implementation principles and practices, finally advanced dynamic service-oriented networks. The goal of this course is to teach networking fundamentals/techniques and overlay communication networks required for service-oriented computing. By the end of this course, you will have acquired a deep understanding of various network concepts, related protocols, and developed extensive knowledge that you can use to develop sophisticated service-oriented network applications. Case studies, programming projects, and relevant papers support the course.

Software Engineering INN

This course is designed to introduce the student to theory and practice of software engineering (SE) and technologies associated with the design, construction, and testing of software systems, particularly quality software for large, complex computing systems. Students learn UML-based systems modeling and several unified processes. The course explores the tools used for building and testing software systems, particularly in the context of open source software. Students will participate through research and group projects. This class is time intensive. The group project requires three homework assignments of out of class work.

Advanced Multimedia Techniques ZTM

The aim of this subject is to familiarize students with the concept of the so-called deep learning and artificial intelligence methods concerning widely understood multimedia. The subject allows students to experience a simplified process of designing intelligent applications based on machine learning for a given solution. Particular attention is paid to data classification, generative models, audio analysis and natural language processing in the context of machine translation. As part of the course, students also develop their programming skills during the construction and tuning of prepared exercises.

Neuroplasticity vs neurodegeneration: The brain and the computer MKR

Join renowned AI-neuroscientist who will lead highly interactive lectures addressing core problems underlying the complexity of computation processes in the brain. We will be comparing creativity of brain and machine computations. Topics include from computations in a single neuron to networks of neurons or ANNs where we will try to find possible sources of creativity. In the following step, we will be looking for possible sources of creativity in brain's structures. We will start with understanding of neuronal computation representations for the content of visual images as the visual system processes the majority of information coming to the brain. In the next step, we will talk about functional meaning and organization of different brain structures, from phantoms through body representation and the sense of self to moral consequences. Related topics include not only creativity in physiological but also an opposite - pathological brains: as related not only to neural degeneration (Parkinson's Disease) but also to

patients after strokes or accidents. By looking into pathological mechanisms in the brain we may find their mechanisms also how to introduce creative, compensatory mechanisms. Why study brain? No present theory yet approaches a tenable explanation for the existence of any decisive computations directly related to our experiences. Nevertheless, the questions we can advance about the basis of perceptual experience motivate experimental approaches to currently tractable problems from single neuron electrophysiology to systems neurobiology to cognitive neuroscience, psychology, history of science and behavioral neurology and enrich such diverse fields as linguistics, philosophy and even the genetic contributions to brain evolution and development. In fact, it is the interdisciplinary opportunities for further advances in understanding perceptual computations that have been the decisive factors for the selection of our topics. Why might you wish to take this course? You will have the opportunity to explore how we are trying to understand computations in the brain upon current methods and approaches and how we hope to expand our strategies and conceptual frameworks in the future. We regard this course as an intellectual, creative adventure addressing one of the most challenging problems of our time. We invite you to participate in this adventure.

Knowledge Systems SWI

Several knowledge discovery systems including systems for actionable knowledge discovery will be presented. Attributes discretization techniques and notion of a reduct with classical strategies to find it will be covered. Next we introduce a problem of failing queries and strategies for solving them through relaxation techniques, including Muslea algorithm will be covered. The concept of data actionability and methods for actionable knowledge discovery will be presented. Text mining and sentiment mining strategies will be covered. Finally, methods for building recommender systems in business, healthcare, and fine art will be shown.

Digital Image Processing: Algorithms and Applications CPO

In this course, students will learn theoretical basics of 2-D signal processing that will include 2-D Fourier Transform (2-D FFT), Z transform, and difference equations. Design of 2-D filters for image processing applications will be discussed. Image enhancement and restoration techniques will be presented. In addition, the students will be introduced to the wavelet-based techniques applied in image processing. In particular, wavelet-based edge representation of images will be discussed and illustrated with applications in biomedical image analysis.

Wavelet Analysis: Theory and Applications AFA

The course covers theoretical basics and design methods involved in signal processing with wavelets. The student will use software design tools provided within Matlab, in particular, wavelet toolbox with graphical user interface (GUI). The course participants will be provided with some additional software developed over years by the instructor and his students. They will get acquainted with the tool that is in the center of modern signal processing research and applications. Such topics as medical image processing using modulus maxima technique, humanoid robot trajectory programming under velocity and acceleration constraints using polynomial spline wavelet transform, robust image watermarking, investigation of interaction dynamics of signals in complex systems with application to analysis of correlated medical

signals, and signal integrity analysis will be discussed in this course and included in final projects.