### Study plan

### Name of study plan: Master specialization Software Engineering, in Czech, 2020

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch: Program of study: Informatika

Type of study: Follow-up master full-time

Required credits: 108
Elective courses credits: 12
Sum of credits in the plan: 120

Note on the plan: Tato verze studijního plánu je ur ena pro ro níky, které byly p ijaty ke studiu od

akademického roku 2020/2021 do prezen ní formy studia magisterského programu. . Garant: Ing. Michal

Valenta, Ph.D., email: michal.valenta@fit.cvut.cz

Name of the block: Compulsory courses in the program

Minimal number of credits of the block: 63

The role of the block: PP

Code of the group: NI-PP.2020

Name of the group: Compulsory Courses of Master Study Program, Version 2020, in Czech

Requirement credits in the group: In this group you have to gain 63 credits

Requirement courses in the group: In this group you have to complete 6 courses

Credits in the group: 63 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-KOP	Combinatorial Optimization  Jan Schmidt, Ji í Vysko il, Petr Fišer Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	6	2P+2C	Z	PP
NI-DIP	Diploma Project Zden k Muziká Zden k Muziká (Gar.)	Z	30	270ZP	L,Z	PP
NI-MPR	Master Project Zden k Muziká Zden k Muziká (Gar.)	Z	7		Z,L	PP
NI-MPI	Mathematics for Informatics Št pán Starosta, Jan Sp vák Št pán Starosta Št pán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NI-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík (Gar.)	Z,ZK	6	2P+2C	L	PP
NI-VSM	Selected statistical Methods Jitka Hrabáková, Petr Novák, Daniel Vašata, Ivo Petr, Pavel Hrabák, Jana Vacková <b>Pavel Hrabák</b> Pavel Hrabák (Gar.)	Z,ZK	7	4P+2C	L	PP

## Characteristics of the courses of this group of Study Plan: Code=NI-PP.2020 Name=Compulsory Courses of Master Study Program, Version 2020, in Czech

NI-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain k	nowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not	only to select and	implement but
also to apply and evalu	ate heuristics for practical problems.		
NI-DIP	Diploma Project	Z	30
NI-MPR	Master Project	Z	7

1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. The external supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/student/studijni/formulare). The completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester.

NI-MPI Mathematics for Informatics Z,ZK 7

The course comprises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analysis, smooth optimization and multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic includes selected numerical algorithm and their stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear presentation and argumentation.

#### NI-PDP Parallel and Distributed Programming

ZK

6

21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Parallel computing systems are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on selected problems, they will learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course includes a semester project of practical programming in OpenMP and MPI for solving a particular nontrivial problem.

#### NI-VSM Selected statistical Methods

Z,ZK

7

The course leads the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with multivariate normal distribution, application of entropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random processes with focus on Markov chains. The high point of the course is the Queuing theory and its application in networks.

Name of the block: Compulsory courses in the specialization

Minimal number of credits of the block: 35

The role of the block: PS

Code of the group: NI-PS-SI.20

Name of the group: Compulsory Courses of Master Specialization Software Engineering, v.2020, in Czech

Requirement credits in the group: In this group you have to gain 35 credits

Requirement courses in the group: In this group you have to complete 7 courses

Credits in the group: 35

NOTE OIL THE	group.					
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-ADP	Architecture and Design patterns Filip K ikava, Jan Kurš, Jan Zimolka, Tomáš Chvosta, Ji í Borský <b>Jan Kurš</b> Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-AM1	Middleware Architectures 1  Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek, Jan Verelst Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	PS
NI-PIS	Enterprise Information Systems Vlastimil Jinoch, Martin Závrbský, Martin Mach, Martin Hasaj David Buchtela David Buchtela (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-PDB	Advanced Database Systems Yelena Trofimova, Michal Valenta Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	PS

# Characteristics of the courses of this group of Study Plan: Code=NI-PS-SI.20 Name=Compulsory Courses of Master Specialization Software Engineering, v.2020, in Czech

NI-ADP Architecture and Design patterns

The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software

architectures used in large-scale distributed systems.

NI-AM1 Middleware Architectures 1

Z,ZK

5

Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications.

#### NI-FME Formal Methods and Specifications

Z,ZK

5

Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some software tools that allow to prove basic properties of software.

#### NI-NUR User Interface Design

Z,ZK

5

Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to design advanced UIs.

#### II-NSS Normalized Software Systems

ZK

5

Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures.

NI-PIS Enterprise Information Systems

"ZK

5

The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data (BigData) and their use in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunications sectors will be explained on real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the business strategy of the company. Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation of information systems in the company / organization.

NI-PDB Advanced Database Systems

Z,ZK

5

Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines.

Name of the block: Compulsory elective courses

Minimal number of credits of the block: 10

The role of the block: PV

Code of the group: NI-PV-SI.20

Name of the group: Compulsory Elective Master Courser for Specialization Software Engineering, version

2020

Requirement credits in the group: In this group you have to gain at least 4 credits

Requirement courses in the group: In this group you have to complete at least 1 course

Credits in the group: 4 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-MEP	Modelling of Enterprise Processes Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	PV
NI-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl, David Buchtela David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	PV
NI-TSW	Software Product Development Petra Pavlí ková Ond ej Pluha Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	PV

# Characteristics of the courses of this group of Study Plan: Code=NI-PV-SI.20 Name=Compulsory Elective Master Courser for Specialization Software Engineering, version 2020

NI-MEP	Modelling of Enterprise Processes	Z,ZK	5
The subject is focused	on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approac	ch for (re)enginee	ring and
implementation of proce	esses, organisation structures and information support in big enterprises and institutions.		
NI-DSS	Decision Support Systems	Z,ZK	5
The aim of the course is	s to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principle	s of data-oriented	, model-oriented
and knowledge-oriented	d decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They	will also learn abo	out the principles
of conceptually and ont	ologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithm	ıs.	
NI-TSW	Software Product Development	KZ	4
The course is presented	d in Czech.		

Code of the group: NI-PV-KMK.20

Name of the group: Compulsory Elective Courses for Master Specialization Communication and management

competencies

Requirement credits in the group: In this group you have to gain at least 6 credits

Requirement courses in the group: In this group you have to complete at least 2 courses

Credits in the group: 6

Note on the group:

Pro specializace NI-MI.2020 a NI-SI.2020

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-CAP	Cultural and Social Anthropology Alena Libánská, Tomáš Houdek, Jakub Šenovský Jakub Šenovský Alena Libánská (Gar.)	ZK	2	2P	Z	PV
NI-HPZ	Master humanities from a study abroad Zden k Muziká	Z	2	0+0	Z,L	PV
NI-EMZ	Master Management economics course from a study abroad Zden k Muziká	Z	4	0+0	Z,L	PV
NI-MPX	Management practice David Buchtela David Buchtela (Gar.)	Z	4	5XD	Z,L	PV

NI-MPL	Managerial Psychology Jan Fiala Jan Fiala Jan Fiala (Gar.)	ZK	2	2P	Z,L	PV
NI-SEP	World Economy and Business Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	PV
NI-LNG	Introduction to Linguistics for IT Students Václav Cvr ek Václav Cvr ek (Gar.)	ZK	2	2P	L	PV
NI-VEM	Scientific thinking Petr Klán, Tomáš Houdek, Helena Štorchová Petr Klán Petr Klán (Gar.)	KZ	2	1P+1C	L	PV

## Characteristics of the courses of this group of Study Plan: Code=NI-PV-KMK.20 Name=Compulsory Elective Courses for Master Specialization Communication and management competencies

NI-CAP Cultural and Social Anthropology

ZK

7

The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is presented in Czech.

NI-HPZ Master humanities from a study abroad

Master course "Humanities that has been studied abroad" is covered by the Humanities from a study abroad in Compulsory Humanities Module that is required in the curriculum. The substitution is approved by the Vice-Dean for study affairs on behalf of the Dean at the request of the student.

NI-EMZ Master Management economics course from a study abroad

The master's management-economic course "Management economics course from a study abroad" covers in the study plan the nature of the economics elective subjects acquired by students as part of their trip abroad. Completion by compensation is therefore assumed. Recognition is decided by the vice-dean for study and pedagogical activities on behalf of the dean and on the basis of the student's request.

NI-MPX Management practice

The Student can once, within its master's degree graduate (to apply) management practices in the selected subject of practice (business subject) on the operational, tactical or strategic level of management (typically at the position of project manager, middle or top manager). The selected subject of practice and professional filling is assessed well in advance the course guarantor. In the selected subject of practice may not have a substantial ownership interest or substantial decision-making influence of the relatives of the student (e.g. as a member of the top management).

NI-MPL	Managerial Psychology	ZK	2
NI-SEP	World Economy and Business	Z,ZK	4

This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.

NI-LNG Introduction to Linguistics for IT Students

2

This one-semester course should provide a gentle introduction to linguistics and language research for students majoring in IT and programming. Students get acquainted with basic concepts used in language descriptions as well as major theories influencing the current mainstream in linguistics. Specific attention will be paid to empirical and quantitative methods in linguistics, including the use of language corpora, and to specific issues of Czech.

VI-VEM Scientific thinking

ΚZ

2

The objective of the course is to get acquainted with scientific methods and discovery of order and laws of the universe, including the aspects of human life. The subject combines scientific methods in natural sciences, mathematics, computer science and humanities. Another aim is to introduce rules and requirements of scientific communication via research papers and posters.

Name of the block: Elective courses

Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NI-V.2021

Name of the group: Purely Elective Master Courses

Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

Note on the group:

In addition to the courses listed here, you can enroll as an elective any course that is offered within your study program and form of study that you did not enroll as a compulsory subject in the program/branch/specialization or a compulsory elective course. Courses of this group that a student

has completed in the bachelor study at CTU cannot be re-completed.

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-AOA	Completing a professional event Zden k Muziká	Z	1			V
NI-ATH	AlgorithmicTheories of Games Dušan Knop, Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+2C	L	V
NI-AFP	Applied Functional Programming Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl (Gar.)	KZ	5	2P+1C	L	V
NI-APH	Architecture of computer games  Adam Vesecký Adam Vesecký Adam Vesecký (Gar.)	Z,ZK	4	2P+1C	Z	V

NI-VGA	Video Games Architecture  Jan Matoušek	Z,ZK	5	2P+1C	Z	V
NI-BPS	Wireless Computer Networks Ji í Kašpar, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-BLO	Blockchain Róbert Lórencz, Jakub R ži ka, Josef Gattermayer, Marek Bielik Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-CTF	Capture The Flag Ji í Dostál, Martin Šutovský, Ivana Trummová, Ladislav Marko, František Ková <b>Ji í Dostál</b> Ji í Dostál (Gar.)	KZ	4	3C	Z	V
NI-DPH	Game Design Adam Vesecký	Z,ZK	5	2P+1C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-PSD	Public Services Design Ond ej Brém, David Pešek David Pešek Ond ej Brém (Gar.)	KZ	4	1P+2C		V
NI-DID	Digital drawing Pesek Bavia Pesek on a g Biolin (dai.)  Denisa Nová ková, Eliška Novotná Denisa Nová ková Denisa Nová ková (Gar.)	Z	2	4C	Z,L	V
NI-DZO	Digital Image Processing	Z,ZK	4	2P+1C	L	V
NI-DDM	Distributed Data Mining Tomáš Borovi ka	KZ	4	3C	L	V
NI-PAM	Efficient Preprocessing and Parameterized Algorithms Ond ej Suchý Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-ESC	Experimental Project Course  Jan Matoušek, Ond ej Brém Ond ej Brém (Gar.)	KZ	8	0P430R452C	L	V
NI-GLR	Games and reinforcement learning	Z,ZK	4	2P+2C	L	V
NI-GNN	Juan Pablo Maldonado Lopez  Graph Neural Networks	Z,ZK	4	1P+1C	L	V
NI-GRI	Miroslav epek Miroslav epek Miroslav epek (Gar.)  Grid Computing	Z,ZK	5	2P+1C	Z	V
NI-HCM	André Sopczak, Petr Fiedler Pavel Tvrdík André Sopczak (Gar.)  Mind Hacking	ZK	5	2P+1C	 Z	V
NI-HSC	Marcel Ji ina, Josef Holý Marcel Ji ina Marcel Ji ina (Gar.)  Side-Channel Analysis in Hardware	Z,ZK	4	2P+2C	Z	V
	Vojt ch Miškovský, Petr Socha Petr Socha Vojt ch Miškovský (Gar.)  History of Mathematics and Informatics	·				
NI-HMI2	Alena Šolcová Alena Šolcová (Gar.)  Information Security	ZK	3	2P+1C	Z	V
NI-IBE	lgor ermák	ZK	2	2P	Z	V
NI-IVS	Intelligent embedded systems Miroslav Skrbek Miroslav Skrbek (Gar.)	KZ	4	1P+3C	L	V
NI-IKM	Internet and Classification Methods  Martin Hole a Martin Hole a (Gar.)	Z,ZK	4	1P+1C	L	V
NI-IAM	Internet and Multimedia	Z,ZK	4	2P+1C	L	V
NI-IOT	Internet of Things Jan Jane ek	Z,ZK	4	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan	Z,ZK	3	2P+1C	L	V
NI-KTH	Combinatorial Theories of Games Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+1C	L	V
NI-FMT	Finite model theory Tomáš Jakl Tomáš Jakl (Gar.)	Z,ZK	4	2P+1C	L	V
NI-CCC	Creative Coding and Computational Art Radek Richtr, Josef Kortán Radek Richtr Radek Richtr (Gar.)	KZ	4	1P+2C	Z,L	V
NI-KYB	Cybernality	ZK	5	2P	Z	V
NI-LSM2	Statistical Modelling Lab Kamil Dedecius Kamil Dedecius (Gar.)	KZ	5	3C	Z,L	V
NI-LOM	Linear Optimization and Methods  Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPL	Managerial Psychology	ZK	2	2P	Z,L	V
NI-MSI	Jan Fiala Jan Fiala Jan Fiala (Gar.)  Mathematical Structures in Computer Science	Z,ZK	4	2P+1C	L	V
NI-MZI	Jan Starý  Mathematics for data science	Z,ZK	4	2P+1C	L	V
FIT-ITI	Št pán Starosta  Modern IT infrastructure	Z,ZK	5	2P+1C	Z,L	V
NI-MOP	Ivan Sime ek  Modern Object-Oriented Programming in Pharo	KZ	4	3C	Z	V
NI-NLM	Jan Blizni enko Robert Pergl Robert Pergl (Gar.)  Neural Language Models	Z	5	2P+1C	L	V
NI-NMS	Neural Networks, Machine Learning and Randomness  Martin Hole a	Z,ZK	4	1P+1C	Z	V

NI-OLI   Linux Drivers   Jaroslav Borecký Miroslav Skribek Jaroslav Borecký Miroslav Skribek Jaroslav Borecký Miroslav Skribek (INIE-PML   Personalized Machine Learning   Rodrigo Augusto Da Silva Alves Karel Klouda Rodrigo Augusto Da Silva Alves (Gar.)	Z,ZK Z,ZK ZK Z,ZK Z,ZK Z,ZK Z,ZK KZ Z,ZK KZ	4 5 4 4 5 5 4 5	2P+2C 2P+1C 2P+1C 2P+1C 2P+2C 1P+1C 2P+1C 2P+1C	L Z Z,L L Z L Z	V V V V V V
NIE-PML  Personalized Machine Learning Rodrigo Augusto Da Silva Alves Karel Klouda Rodrigo Augusto Da Silva Alves (Gar.)  NI-ARI  Computer arithmetic Pavel Kubalik Alois Pluhá ek (Gar.)  Computer Grafics 1 Radek Richtr Radek Richtr Radek Richtr (Gar.)  NI-PG1  Computer Vision Radek Richtr Radek Richtr Radek Richtr (Gar.)  NI-PIV  Computer Vision Radek Richtr  NI-EDW  Enterprise Data Warehouse Systems Jakub Krej i, Robert Koliá Jakub Krej i Magda Friedjungová (Gar.)  NI-PVR  Advanced Virtual Reality Petr Pauš Petr Pauš Petr Pauš (Gar.)  Advanced machine learning Zden k Buk, Miroslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)  Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)  NI-APT  Advanced Program Testing Plotre Donat-Bouillud Pierre Donat-Bouillud (Ga NI-PVS  Advanced embedded systems Miroslav Skrbek  NI-DNP  Advanced NET David Šenký, Nikolas Jiša David Šenký Nikolas Jiša (Gar.)  NI-PYT  Advanced Python Miroslav Hron ok  NIE-PDL  Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-RUB  Programming in Scala Ji i Dan ek Ji Dan ek (Gar.)  NI-RUB  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS3  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	z,zk z,zk z,zk z,zk z,zk kz z,zk kz z,zk	4 4 5 5 4 5	2P+1C 2P+1C 2P+2C 1P+1C 2P+1C	Z,L L Z L	V V V V
NI-ARI Computer arithmetic Pavel Kubalik Avois Pluhá ek (Gar.)  NI-PG1 Computer Grafics 1 Radek Richtr Radek Richtr Radek Richtr (Gar.)  NI-PIV Computer Vision Radek Richtr NI-EDW Enterprise Data Warehouse Systems Jakub Krej i, Robert Kotlá Jakub Krej i Magda Friedjungová (Gar.)  NI-PVR Advanced Virtual Reality Petr Pauš Petr Pauš Petr Pauš (Gar.)  Advanced machine learning Zden k Buk, Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Minoslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Pierre Donat-Bouillud Programming in Scala Ji Dan ek Ji Dan ek Ji Dan ek (Gar.)  NI-ROZ Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1 Programming Language Seminar Pierre Donat-Bouillud Programming Language Seminar Pierre Donat-Bouillud Programming Language Seminar	ZK Z,ZK Z,ZK KZ Z,ZK KZ Z,ZK  KZ Z,ZK	4 5 5 4 5	2P+1C 2P+2C 1P+1C 2P+1C	L Z L Z	V V
NI-PG1   Computer Grafics 1   Radek Richtr	Z,ZK Z,ZK KZ ek, Z,ZK KZ Z,ZK	5 5 4 5	2P+2C 1P+1C 2P+1C	Z L Z	V
NI-PIV  Computer Vision Radek Richtr  Enterprise Data Warehouse Systems Jakub Krej i, Robert Kotlá Jakub Krej i Magda Friedjungová (Gar.)  NI-PVR  Advanced Virtual Reality Petr Pauš Petr Pauš (Gar.)  Advanced machine learning Zden k Buk, Miroslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Miroslav epek, Miroslav epek (Gar.)  Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)  NI-APT  Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)  NI-PVS  Advanced embedded systems Miroslav Skrbek  NI-DNP  Advanced NET David Šenký, Nikolas Jíša David Šenký Nikolas Jíša (Gar.)  NI-PYT  Advanced Python Miroslav Hron ok  NIE-PDL  Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-PSL  Programming of distributed systems in GO  NI-PSL  Programming in Scala Ji í Dan ek Ji í Dan ek Ji í Dan ek (Gar.)  NI-RUB  Programming in Ruby Cyril erný Cyril erný Cyril erný (Gar.)  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	Z,ZK  KZ  ek, Z,ZK  KZ  Z,ZK	5 4 5	1P+1C 2P+1C	L Z	V
NI-EDW   Enterprise Data Warehouse Systems   Jakub Krej i, Robert Kotlá Jakub Krej i Magda Friedjungová (Gar.)	KZ ek, Z,ZK  KZ Z,ZK	5 4	2P+1C	Z	
NI-PVR  Advanced Virtual Reality Petr Pauš Petr Pauš Petr Pauš (Gar.)  Advanced machine learning Zden k Buk, Miroslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)  NI-IOS  Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)  NI-APT  Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud (Ga NI-PVS  Advanced embedded systems Miroslav Skrbek  NI-DNP  Advanced .NET David Senký, Nikolas Jiša David Šenký Nikolas Jiša (Gar.)  NI-PYT  Advanced Python Miroslav Hron ok  NIE-PDL  Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-GOL  Programming in Scala Ji Dan ek Ji Dan ek (Ji Dan ek (Gar.)  NI-RUB  Programming in Ruby Cyril erný Cyril erný (Gar.)  NI-ROZ  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS3  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	ek, Z,ZK  KZ  z,ZK	5			V
NI-AML   Advanced machine learning   Zden k Buk, Miroslav epek, Rodrigo Augusto Da Silva Alves, Petr Šimán Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)	KZ z,ZK	4	2P + 1C		
Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)  NI-APT  Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud (Ga  NI-PVS  Advanced embedded systems Miroslav Skrbek  NI-DNP  Advanced .NET David Šenký, Nikolas Jíša David Šenký Nikolas Jíša (Gar.)  NI-PYT  Advanced Python Miroslav Hron ok  NIE-PDL  Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-GOL  Programming of distributed systems in GO  NI-PSL  Programming in Scala Ji í Dan ek Ji í Dan ek (Gar.)  NI-RUB  Programming in Ruby Cyril erný Cyril erný Cyril erný (Gar.)  NI-ROZ  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS2  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	z,ZK			L	V
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NI-PVS  Advanced embedded systems  Miroslav Skrbek  NI-DNP  Advanced .NET  David Šenký, Nikolas Jíša David Šenký Nikolas Jíša (Gar.)  NI-PYT  Advanced Python  Miroslav Hron ok  NIE-PDL  Practical Deep Learning  Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-GOL  Programming of distributed systems in GO  NI-PSL  Programming in Scala  Ji í Dan ek Ji í Dan ek (Ji í Dan ek (Gar.)  NI-RUB  Programming in Ruby  Cyril erný Cyril erný (Gar.)  NI-ROZ  Pattern Recognition  Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar  Pierre Donat-Bouillud  Programming Language Seminar  Pierre Donat-Bouillud  Programming Language Seminar  Pierre Donat-Bouillud  Programming Language Seminar		5	2P+1C	Z	٧
NI-DNP  Advanced .NET David Šenký , Nikolas Jíša David Šenký Nikolas Jíša (Gar.)  NI-PYT  Advanced Python Miroslav Hron ok  NIE-PDL  Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-GOL  Programming of distributed systems in GO  NI-PSL  Programming in Scala Ji í Dan ek Ji í Dan ek (Gar.)  NI-RUB  Programming in Ruby Cyril erný Cyril erný (Gar.)  NI-ROZ  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS2  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar		4	2P+2C	Z	V
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NIE-PDL  Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)  NI-GOL  Programming of distributed systems in GO  NI-PSL  Programming in Scala Ji i Dan ek Ji i Dan ek (Gar.)  Programming in Ruby Cyril erný Cyril erný Cyril erný (Gar.)  NI-ROZ  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS2  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	KZ	4	3C	Z	V
NI-GOL Programming of distributed systems in GO  NI-PSL Programming in Scala Ji í Dan ek Ji í Dan ek (Gar.)  NI-RUB Programming in Ruby Cyril erný Cyril erný (Cyril erný (Gar.)  NI-ROZ Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1 Programming Language Seminar Pierre Donat-Bouillud  NI-PLS3 Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	KZ	5	2P+1C	Z	V
NI-RUB  Programming in Ruby Cyril erný Cyril erný Cyril erný (Gar.)  NI-ROZ  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS3  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	KZ	5	0P+3C	Z	V
NI-RUB  Programming in Ruby Cyril erný Cyril erný (Gar.)  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS3  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	Z,ZK	4	2P+1C	Z	V
NI-ROZ  Pattern Recognition Radek Richtr, Michal Haindl Michal Haindl Michal Haindl (Gar.)  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS3  Programming Language Seminar Pierre Donat-Bouillud  NI-PLS2  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	KZ	4	3C	Z	٧
NI-PLS1  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	Z,ZK	5	2P+1C	Z	V
NI-PLS3  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar Pierre Donat-Bouillud  Programming Language Seminar	Z	2	0P+1C	Z	V
Pierre Donat-Bouillud  Programming Language Seminar	Z	2	0P+1C	Z	V
Programming Language Seminar	Z	2	0P+1C	L	V
NI-PLS4  Pierre Donat-Bouillud, Filip K ikava Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z	2	0P+1C	L	V
NI-SCE1 Computer Engineering Seminar Master I Hana Kubátová Miroslav Skrbek Hana Kubátová (Gar.)	Z	4	2C	L,Z	V
NI-SCE2 Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L,Z	V
NI-SZ1 Knowledge Engineering Seminar Master I Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	٧
NI-SZ2 Knowledge Engineering Seminar Master II Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	V
PI-SCN  Seminars on Digital Design Petr Fišer Petr Fišer (Gar.)	ZK	4	2P+1C	Z,L	V
NI-MLP  Machine Learning in Practice  Jan Hu in Daniel Vašata Daniel Vašata (Gar.)	Z,ZK	5	2P+1C	Z	V
FIT-SEP World Economy and Business Tomáš Evan	Z,ZK	4	2P+2C	L	V
NI-SEP World Economy and Business Tomáš Evan Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-TVR  Virtual Reality Technology Tomáš Nová ek Tomáš Nová ek (Gar.)	Z,ZK	3	1P+1C	L,Z	٧
NI-TS1  Theoretical Seminar Master I  Dušan Knop, Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Ga	z Z	4	2C	Z	V
NI-TS2  Theoretical Seminar Master II Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	L	V
NI-TS3 Theoretical Seminar Master III		4	2C	Z	V
Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)  NI-TS4  Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)  Theoretical Seminar Master IV Ond ej Suchý, Tomáš Valla Tomáš Valla Ond ej Suchý (Gar.)	Z	4	2C	L	V

NI-TKA	Category Theory Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-TNN	Theory of Neural Networks Martin Hole a Martin Hole a (Gar.)	Z,ZK	5	2P+1C	L	V
NI-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	V
FI-TOP	Academic writing Tomáš Nová ek	Z	2	10B	Z	V
NI-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VOL	Elections Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NI-VPR	Research Project Št pán Starosta Št pán Starosta Št pán Starosta (Gar.)	Z	5		Z,L	V
NI-ZS10	Master internship abroad for 10 credits  Zden k Muziká Zden k Muziká (Gar.)	Z	10		Z,L	V
NI-ZS20	Master internship abroad for 20 credits  Zden k Muziká Zden k Muziká (Gar.)	Z	20		Z,L	V
NI-ZS30	Master internship abroad for 30 credits  Zden k Muziká Zden k Muziká (Gar.)	Z	30		Z,L	V
Characteristics of th	e courses of this group of Study Plan: Code=NI-V.2021 Name=P	urely Electiv	/e Master	Courses	<u>'                                    </u>	
	anagerial Psychology	y			ZK	2
	orld Economy and Business				Z,ZK	4
	Czech. However, there is an English variant in the program Informatics (N1801 / 4793).	The course intro	nduces stude			•
•	pes that predominantly by comparing individual countries and key regions of world economic					-
	ss in diverse societies as well as indexes of economic freedom, corruption and economic				ū	
, ,	•	•			•	
	on the knowledge in the form of discussions based on individual readings. It is advised to	take bachelor	ever or triis c	Juise DIE-3		
NI-AOA C	ompleting a professional event				Z	1
The subject is participation	in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, con	cluded with a wo	rkshop, a te	st, drafting a	a report, etc	Such an even
must be approved in advan	ce by the vice-dean for pedagogical activities or the vice-dean for science and research	and is presente	d within the I	FIT through	a website, i	infomail, etc.
NI-ATH A	gorithmicTheories of Games			7	Z,ZK	4
I	a branch of mathematics, which has broad applications in economy, biology, politics and	computer scien	co This thoo		,	=
		-		-		-
	etitive process by designinng a mathematical model and investigating the strategies. The					
which are the states of the	game where no player wants to deviate from his strategy. Due to the recent development	of computers, int	ernet, social	networks, o	nline auctio	ns, advertising
multiagent systems and oth	ner concepts the algorithmic point of view is gaining attention. In addition to existential quality	uestions we stud	y the proble	ns of efficie	nt computa	tion of various
solution concepts. In this co	ourse we introduce the basics of game theory of many players, solution concept (usually	equilibria) and i	methods of tl	neir computa	ation.	
NI-AFP A	pplied Functional Programming				KZ	5
	Czech. Functional programming represents one of the traditional programming paradig	me Traditional a	nd novel fund	1		-
·					_	
· · · · · · · · · · · · · · · · · · ·	functional paradigm becomes an important construct of traditionally imperative language	es (C++, C#, Jav	a). As sucn,	mastering ti	nis paradigi	m becomes a
	a software engineer: the theory and especially the practice.					
NI-APH A	rchitecture of computer games			Z	z,zk	4
Students will gain a basic ur	nderstanding of the various issues in the field of computer games development, especially	from a technical	point of view	but also fro	m design ar	nd philosophica
perspective. They will get a	grasp of component-oriented and functional-oriented architecture, game mechanics, dec	cision-making pro	ocesses and	base compo	onents that	form an integra
	vill also understand the basics of pathfinding, networking and scripting and apply them in			-		_
•	game, with a strong focus on nontrivial game mechanics.	•	, ,		•	
<del></del>	ideo Games Architecture				z,ZK	5
1			ماده المدامة			
	ange of topics, procedures and methodologies related to the development of computer					
	In the lectures, students will be guided through the history of development, the structure					
	s, graphics, artificial intelligence and multiplayer. The exercises will then cover selected to	ecnnological topi	cs in greater	detail, inclu	ding ways o	or implementing
-	the form of practical demonstrations.					
NI-BPS W	/ireless Computer Networks			Z	z,zk	4
Students will learn about the	e modern technologies, protocols, and standards for wireless networks. They will under	stand the routing	mechanism	s in ad-hoc	networks, r	multicast and
broadcast mechanisms, an	d data flow control mechanisms. They will also learn about principles of communication	in sensor netwo	rks. They get	knowledge	of security	mechanisms
for wireless networks and g	et skills of configuration of wireless network elements and simulation of wireless network	ks using suitable	e tools.			
NIE-BLO B	lockchain			7	Z,ZK	5
1	e foundations of blockchain technology, smart contract programming, and gain an overvi	ew of most notah	le blockchair			_
	decentralized application, and assess whether integration of a blockchain is suitable for			-	-	_
	chains and information security. It is concluded with a defense of a research or applied s			-		-
· ·	n of blockchain-based solutions in both academia and business.	project,	on prope	5010 0.00	101 1111	
<u> </u>				<del>- 1</del>	V7	
l l	apture The Flag	d of out	:4.		KZ	4
	ntroduce students to CTF competitions and let them gain practical experience in the fiel	a of cyber secur	ıty.			
NI-DPH G	ame Design			Z	z,zk	5
The course complements to	ne NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) cours	se, while focusing	primarily or	game desi	gn. It is inte	nded for peopl
interested in deeper knowle	edge of the principles used for games design, such as: level design, gameplay design, c	haracter design,	game mech	anics desigr	n, storytellir	ng, and game
development cycle. The stu	dents will get an overview of game development from the designer's perspective, from the	neoretical concer	ots to practic	al implemen	tation appli	ed to semestra
projects.	5 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		,	,	~F.F	

Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with

projects.

Design Sprint

testing the prototypes (plus final presentation).

NI-PSD Public Services Design KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representations.	
Course is aimed at students-designers as well as clients.	
NI-DID Digital drawing Z	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course is fit for anyone	
practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge.	mie mame te
NI-DZO Digital Image Processing Z,ZK	4
This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are I implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outsi	· · ·
of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-t	
frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context of the context of th	
interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha in NI-DDM Distributed Data Mining KZ	matting. 4
Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands on experience wi	
data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations and will be capable	le to propose
approaches to parallelize other algorithms. The course is prezented in czech language.	4
NI-PAM   Efficient Preprocessing and Parameterized Algorithms   Z,ZK   There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these	4 problems
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common description of the common description description of the common description	
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small)	
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing which is not possible in the algorithm and preprocessing in the preproc	
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not be a suitable first step, whatever is the subsequent solution method. We will plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not be a suitable first step, whatever is the subsequent solution method. We will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does not be a suitable first step.	
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.	
NI-ESC Experimental Project Course KZ	8
"The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, methodologies, as in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design projects, collaborate	
experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills in user-centered	
user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."	· ·
NI-GLR Games and reinforcement learning Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligence. This course is	s intended to
give you both theoretical and practical background so you can participate in related research activities. Presented in English.  NI-GNN Graph Neural Networks Z,ZK	4
The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural networks for creating	-
representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last part of the course a	also covers
graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.	
NI-GRI Grid Computing Z,ZK Grid computing and gain knowledge about the world-wide network and computing infrastructure.	5
NI-HCM Mind Hacking ZK	5
Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, information systems	s and assets,
the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive security is growing in i	
the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet environment have impacts such as disruption of social cohesion, threats to democracy or war.	ve real societal
NI-HSC Side-Channel Analysis in Hardware Z,ZK	4
This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get fa	amiliar with
various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with hostical and power attacks. They also get profiled in host designing the SCA comparence and explains the appropriate profiled attacks and get familiar with hostical and power attacks.	nigher-order
attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage.  NI-HMI2 History of Mathematics and Informatics ZK	3
This course is presented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms, transformations,	
functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development.	
NI-IBE Information Security ZK	2
Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international standards in the understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., penetration testing).	his area. They
NI-IVS Intelligent embedded systems KZ	4
Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The course is an adversarial action of the course is an adversarial action.	
of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programming and advanced to the course of the latest and the latest and the course of the latest and the la	
development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students develop advance combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies	ed applications
NI-IKM Internet and Classification Methods Z,ZK	4
In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering, in recommend	
In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering, in recommend in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving these four kinds	ation systems, of problems.
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NI-IOT Internet of Things The subject is focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is familiarization with available development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (GNU Forth). FITE-EHD Introduction to European Economic History Z,ZK 3 The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion. Combinatorial Theories of Games NI-KTH Z,ZK Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackfle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics NI-FMT Finite model theory 7.7K The aim of the course is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of logical properties of database systems. Since its inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as descriptive complexity theory, the Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics. Creative Coding and Computational Art K7 Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA BLE,) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL). NI-KYB Cybernality 5 Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams). NI-LSM2 Statistical Modelling Lab K7 5 The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clutter, or video tracking. We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters. Linear Optimization and Methods Z,ZK 5 Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming. NI-MSI Mathematical Structures in Computer Science Z,ZK 4 Mathematical semantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scott model of lambda calculus. Introduction to category theory. Mathematics for data science In this course, students are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in data science. The studied topics include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle, gradient methods) and selected notions from probability theory and statistics. FIT-ITI Z,ZK Modern IT infrastructure 5 NI-MOP Modern Object-Oriented Programming in Pharo ΚZ Object-oriented programming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where its ability to natural abstraction is used to build complex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills of design and implementation of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development needs and areas of interest. In addition to deepening object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work on interesting projects and OO technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvement in the Pharo Consortium. NI-NLM **Neural Language Models** Ζ 5 In this course, students will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The goal of the course is to teach students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific literature. NI-NMS Neural Networks, Machine Learning and Randomness Z,ZK Stochastic methods, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a number of other machine learning models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks that rely substantially on randomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general stochastic approach to training neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including neural networks, are used in one of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms. NI-NMU New media in art and design ZK The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game and sound. The main goal is to familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially in lectures devoted to specific art projects NI-OLI Linux Drivers Z,ZK The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining powerful processors and FPGAs increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development for master's students. The course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical experience

NIE-PML Personalized Machine Learning		
	Z,ZK	5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique character		
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal int to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from the systems of the course, we will explore the latest PML methods from the course, we will explore the latest PML methods from the course of the		
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.	leoretical, algorithi	iic, and practical
NI-ARI Computer arithmetic	Z,ZK	4
Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.	2,210	7
NI-PG1 Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge	1	signed for those
interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of	the course is the s	tudy of scientific
articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas a		ter graphics.
NI-PIV Computer Vision	Z,ZK	5
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing the control of the computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing the control of the computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing the control of the computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing the control of the computer vision course focuses on the control of the contro	-	-
the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theory	=	
practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, col and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (inc	-	-
motion detection, visual expressiveness (saliency).	Sidding Olviv, Itolvi	v, 1020, v11),
NI-EDW Enterprise Data Warehouse Systems	Z,ZK	5
The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods		-
not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction		
visualization.		
NI-PVR Advanced Virtual Reality	KZ	4
The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D r		-
things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will be a subject to their applications and will be a subject to the sub		
in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply t in virtual reality, or directly create a complex game for VR.	he knowledge gain	ed in this subject
	7.71/	5
NI-AML   Advanced machine learning The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field	Z,ZK	-
processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the		-
NI-IOS Advanced techniques in iOS applications	KZ	4
Students will learn the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all	1	-
BI-IOS.		9
NI-APT Advanced Program Testing	Z.ZK	5
Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The	1 '	_
advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.		
NI-PVS Advanced embedded systems	Z,ZK	4
The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advantage of applications are course includes a series of advantage of applications.	anced topics like se	curity support,
working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical and also pract	ctical experiences w	rith embedded
systems.		
	7.71/	4
NI-DNP Advanced .NET	Z,ZK	4
NI-DNP Advanced .NET Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAU	II (WPF, UWP), Bla	zor and also will
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NI-PLS4	Programming Language Seminar	Z	2
	uage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in whic guages and related fields. Participating students are expected to present a paper of their interest and actively participate in th		
	programming languages. Farticipating students and researchers interested in programming languages.	e discussions. H	ie reading group
NI-SCE1	Computer Engineering Seminar Master I	Z	4
The Seminar of Comput	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	e to failures and	attacks. Students
	ially within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the		
articles and other professemester.	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teach	thers. The topics	are new for each
NI-SCE2	Computer Engineering Seminar Master II	Z	4
	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	<del>-</del>	l
are approached individu	nally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the	he subject is wor	k with scientific
· · · · · · · · · · · · · · · · · · ·	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teach	thers. The topics	are new for each
semester.	Vacual das Engineering Cominer Meeter I	7	4
NI-SZ1 On this seminar you wil	Knowledge Engineering Seminar Master I  present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top resea	Z irch labs around	the world
-	n how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top made		
and summer schools, a	s well as FIT's own Summer Research Program (VyLet).		
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
· · · · · · · · · · · · · · · · · · ·	present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top resea		
	n how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top mac s well as FIT's own Summer Research Program (VyLet).	cnine learning an	a Ai conferences
PI-SCN	Seminars on Digital Design	ZK	4
	problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description		· ·
synthesis and optimizat	ion algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial p	oroblems emergir	ng in EDA.
NI-MLP	Machine Learning in Practice	Z,ZK	5
· · · · ·	ng methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to,	=	
<del>-</del>	ents through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practica Irn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and undi	·=	-
FIT-SEP	World Economy and Business	Z,ZK	4
	d in Czech. The course introduces students of technical university to the international business. It does that predominantly by	,	ļ -
=	economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well		
· · · · · ·	c development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of	f discussions ba	sed on individual
	take bachelor level of this course BIE-SEP as a prerequisite.	7.71/	
NI-TVR	Virtual Reality Technology   ced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of co	Z,ZK	yatars (position
	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of	-	**
reality will be presented		_	
NI-TS1	Theoretical Seminar Master I	Z	4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class		-
•	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a. The capacity is limited by the the potentials of the teachers of the seminar.	a work with scie	ntific papers and
NI-TS2	Theoretical Seminar Master II	Z	4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a clas		l
	iteriaed for stadents which want to come in deeper contact with contemporary theoretical computer science, it is mostly a clas		up. The students
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	ssical reading gro	•
other scholarly literature	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is . The capacity is limited by the the potentials of the teachers of the seminar.	ssical reading gro a work with scie	ntific papers and
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other scholarly literature NI-TS3 Theoretical seminar is in are treated individually other scholarly literature NI-TS4 Theoretical seminar is in are treated individually other scholarly literature NI-TS4 Theoretical seminar is in are treated individually other scholarly literature NI-TKA NI-TNN In this course, we study pertaining to artificial ne synaptic mappings, net and in connection with sproblem of overtraining employed for neural net to neural networks, we theorem). Afterwards, we being dense in important functions with continuous random sample, and with of the conditional expect acquainted with an analy with its analogy for neur topology of the networks NI-CPX	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a. The capacity is limited by the the potentials of the teachers of the seminar.  Theoretical Seminar Master III intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a the capacity is limited by the the potentials of the teachers of the seminar.  Theoretical Seminar Master IV itended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a three capacity is limited by the the potentials of the teachers of the seminar.  Category Theory  Theory of Neural Networks  neural networks from the point of view of the theory of function approximation and from the point of view of signal transmission work training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transformation and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with training and the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most work training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within its notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Kole will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappin to Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect is aderivatives, and of larg	sical reading gross a work with science and a work with science and train with science and train with science and train with science and train with science and scienc	4 up. The students ntific papers and 4 up. The students ntific papers and 4 up. The students ntific papers and 5 Il basic concepts ogy, somatic and onical topology, ention to the exation methods mation approach m, Vituškin neural networks are, spaces of ning based on a poget an estimate ers and get get acquinted arch for the

FI-TOP Academic writing Publishing is an important and required part of research activity. It is not only about obtaining research results but also about applying them in the form of publication. Writing scientific

publications can be useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the course, students will learn how to write a scientific article, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an article and reviewing someone else's article. The course will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Dates will be determined based on the availability of enrolled students.

Introduction to Discrete and Computational Geometry

The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component

or triis discipline, and t	o be able to solve simple algorithme problems with a geometric component.		
NI-VOL	Elections	Z,ZK	5
We will cover the basic	es of (committee) elections and, in general, opinion aggregation.		
NI-VYC	Computability	Z,ZK	4
Classical theory of rec	ursive functions and effective computability.		
NI-VPR	Research Project	Z	5
Student obtains the cr	edits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.		
NI-7S10	Master internship abroad for 10 credits	7	10

Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.

Master internship abroad for 20 credits

Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line

NI-ZS30 Master internship abroad for 30 credits

The course is prezented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and extent of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks of full-time employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects if the internship exceeds the academic year's dead-line.

Code of the group: NI-SI-VS.20

Name of the group: Elective Vocational Courses for Master Specialisation Software Engineering

Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

Note on the group.

All compulsory subjects of specializations with the exception of this specialization

Note on the group		iizations with	tile exc	CPIIOI O	i tilio opeo	ializatioi i
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-ADM	Data Mining Algorithms Pavel Kordík, Daniel Vašata, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-AIB	Algorithms of Information Security  Martin Jure ek, Róbert Lórencz, Olha Jure ková Martin Jure ek Róbert  Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM2	Middleware Architectures 2 Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	L	V
NI-BML	Bayesian Methods for Machine Learning Ond ej Tichý, Kamil Dedecius Ond ej Tichý, Kamil Dedecius (Gar.)	KZ	5	2P+1C	L	V
NI-BVS	Embedded Security Martin Novotný Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NI-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-DSV	Distributed Systems and Computing Pavel Tvrdík Jan Fesl Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DDW	Web Data Mining Jaroslav Kucha, Milan Doj inovski <b>Jaroslav Kucha</b> Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	V
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GEN	Code Generators Petr Máj, Jan Janoušek <b>Petr Máj</b> Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V

	Hamburg Consider					
NI-HWB	Hardware Security Ji í Bu ek <b>Ji í Bu ek</b> Ji í Bu ek (Gar.)	Z,ZK	5	2P+2C	L	V
NI-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NI-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	V
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MEP	Modelling of Enterprise Processes Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPJ	Modelling of Programming Languages	Z,ZK	5	2P+1C	Z	V
NI-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NON	Nonlinear Continuous Optimization and Numerical Methods  Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	V
NI-OSY	Operating Systems and Systems Programming Petr Zemánek, Tomáš Martinec Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-BUI	Business Informatics Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	V
NI-KRY	Advanced Cryptology Ji Bu ek, Róbert Lórencz Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-PAS	Advanced Aspects of Business David Buchtela, St pánka Havlíková, Dominik Vítek, Ji í Maršál, Jana Soukupová, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PDD	Data Preprocessing Marcel Ji ina Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-RUN	Runtime Systems Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski, Jakub Klímek Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SIM	Digital Circuit Simulation and Verification  Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SIB	Network Security Ji í Dostál, Simona Forn sek, Martin Šutovský, Martin Holec Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SCR	Statistical Analysis of Time Series Kamil Dedecius Kamil Dedecius (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SBF	System Security and Forensics Simona Forn sek, Marián Svetlík Simona Forn sek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl, David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TES	Systems Theory Ji i Vysko il, Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TSP	Testing and Reliability Petr Fišer Martin Da hel Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-TSW	Software Product Development Petra Pavlí ková Ond ej Pluha Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	V
NI-UMI	Artificial intelligence Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
NI-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PON	Selected Topics in Optimization and Numerical mathematics Karel Klouda, Št. pán Starosta, Daniel Vašata Daniel Vašata Št. pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VMM	Retrieval from Multimedia Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V
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Characteristics of the courses of this group of Study Plan: Code=NI-SI-VS.20 Name=Elective Vocational Courses for Master Specialisation Software Engineering

NI-MEP	Modelling of Enterprise Processes	Z,ZK	5
-	on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach	h for (re)engineer	ring and
NI-DSS	esses, organisation structures and information support in big enterprises and institutions.  Decision Support Systems	Z,ZK	5
	to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles	' !	- 1
	decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They		
	ologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms	,	
NI-TSW	Software Product Development	KZ	4
The course is presented NI-ADM		Z,ZK	5
	Data Mining Algorithms algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the studen	' '	-
	put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation s		- 1
methods).			
NI-AIB	Algorithms of Information Security	Z,ZK	5
<del>-</del> -	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, sto hic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detec		
	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.	Juon and the use	Of Illacillile
NI-AM2	Middleware Architectures 2	Z,ZK	5
Students will learn new	trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architect		nd technologies
	buted cache and databases, smart contracts, realtime communication and web security.		
NI-BML	Bayesian Methods for Machine Learning	KZ	5
	on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studi ption of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidder		
	etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose	•	
	presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging		-
some of them.			
NI-BVS	Embedded Security	Z,ZK	5
<del>-</del>	wledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cry		
of computer systems.	ded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resour	ces for securing in	iternal functions
NI-BKO	Error Control Codes	Z,ZK	5
The goal of the course i	s to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via	,	_
NI-DSV	Distributed Systems and Computing	Z,ZK	5
	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of comput		
	sic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms the safety in case of failures.	at support high av	/ailability of both
NI-DDW	Web Data Mining	Z,ZK	5
	t methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain		-
techniques for Web craw	ling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an over	view of most rece	nt developments
	and recommendation systems.		_
NI-EPC	Effective C++ programming	Z,ZK	5
	se the modern features of contemporary versions of the C++ programming language for software development. The course fo m of writing maintainable and portable source code and creating correct programs with low memory and processor time requi		niming ellectivity
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
	of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both accounts the structure of th	, ,	-
They will be able to use	the knowledge in design of applications that utilize pattern matching.		
NI-GEN	Code Generators	Z,ZK	5
· ·	f translating programs written in high-level programming languages are essential for understanding the field of systems progra		-
	ithms and techniques used to translate more complex programming constructs of modern languages employed in systems pro Proretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.	ogramming. Stude	ents will become
NI-GAK	Graph theory and combinatorics	Z,ZK	5
	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithr		
•	sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected		,, o , l
	y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory	y will be also app	lied in the fields
NI-HWB	ds, formal languages and bioinformatics.  Hardware Security	Z,ZK	5
	e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegua		-
•	They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stud	_	
the cryptographic accele	erators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the co		
NI-KOD	Data Compression	Z,ZK	5
	I to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of dat erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, st	•	<u> </u>
•	methods used in image, audio, and video compression.	aacina icaili liie l	andamentals ul
NI-MKY	Mathematics for Cryptology	Z,ZK	5
	er knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. I	In particular, the c	course focuses
•	g a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discre-	ete logarithm. The	problem of
	solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.	7 71/	
NI-MVI Students will understand	Computational Intelligence Methods  d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to	Z,ZK   many problems. T	5 hev will learn
	k and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.	, p. 00.01110. 1	.,

NI-MPJ Modelling of Programming Languages	Z,ZK	5
The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserv	e the semantics o	f the language.
This course explores the semantics of programming languages. The students will learn the language models with emphasis on functional languages, stu	udents are expecte	ed to understand
he basics of the lambda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with sema	ntic modeling and	execution tools.
NI-MTI Modern Internet Technologies	Z,ZK	5
SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration	- A single network	k, oriented on
ICP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, vid	eo and data to acl	hieve seamless
ntegrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundre	ds of millions of us	sers and billions
of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and	d Traffic Prioritisat	ion - These
echnologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela	y, jitter, type of pro	otocol). 4.
Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of f	ailures.	
NI-NON Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such met	hods to real-world	problems. They
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. Tl	ney will learn to so	olve systems of
inear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to impleme	nt these algorithm	s sequentially
as well as in parallel.		
NI-OSY Operating Systems and Systems Programming	Z,ZK	5
The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel	el data structures.	Key topics are:
process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The	course also addre	sses kernel
development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portabili	ty. Specifics of ker	nel architecture
n embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within la	abs, students will v	work on projects
ocused on development of LINUX kernel modules.		
NI-BUI Business Informatics	Z,ZK	5
The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of	of business proces	s management,
CT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manage	ment, and lifecycle	e management
of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governa	nce, the importan	ce of ICT for
ousiness and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manageme	nt, revenue and in	vestment
management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).		
NI-KRY Advanced Cryptology	Z,ZK	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know	the mathematica	I principles of
andom number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they	can apply to the in	ntegration of
heir own systems or to the creation of their own software solutions.		
NI-PAS Advanced Aspects of Business	Z,ZK	4
The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run t	neir own business	or business
nanagement, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.		
NI-GPU GPU Architectures and Programming	Z,ZK	5
Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the	CUDA programmii	ng environment,
which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical or	computational stru	ctures, students
will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.		
NI-PDD Data Preprocessing	Z,ZK	5
Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various da	ta sources, such a	is images, texts,
ime series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characte	ristics from image:	s or from web
pages.		
NI-REV Reverse Engineering	Z,ZK	5
Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens		
s called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dec	dicated to reverse	engineering of
applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be d	edicated to debug	gers: how
debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the comput	er malware scene	. The focus of
the course is on the seminars, where students will solve practically oriented tasks from the real world.		
NI-RUN Runtime Systems	Z,ZK	5
This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experi	ence in design and	implementation
of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compi	lation Memory ma	nagement
Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implement	ations of real-world	d VMs, including
Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs		
NI-SWE Semantic Web and Knowledge Graphs	Z,ZK	5
The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web to	echnologies, meth	ods and best
practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg	e graphs and their	r systematic
quality assurance.		
NI-SIM Digital Circuit Simulation and Verification	Z,ZK	5
The aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le		els and with the
properties of proper tools. The course covers recent verification methods, too.		
NI-SIB Network Security	Z,ZK	5
NI-SCR Statistical Analysis of Time Series	Z,ZK	5
The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange pric		_
problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a co	,pioyillolik) 6	
ts parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the	nvenient process	, Journald
	•	sed on practical
edi-wond examples. Doni the lab classes and the rectures exploit freely available software packages in order to provide easy and straightful ward tra	main principles ba	
eal-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward tra he academic to the real world.	main principles ba	
he academic to the real world.	main principles ba nsfer of students'	knowledge from
he academic to the real world.  NI-SYP Parsing and Compilers	main principles ba nsfer of students' Z,ZK	knowledge from 5
he academic to the real world.	main principles ba nsfer of students' Z,ZK	knowledge from 5
the academic to the real world.  NI-SYP Parsing and Compilers  The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of	main principles ba nsfer of students' Z,ZK	knowledge from 5

NI-SRE System Security and Forensics Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication concepts). Furthermore, students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic analysis techniques and the importance of operating system/operating system artifacts or file system for attack analysis and detection). Systems Theory Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems. NI-TSP Testing and Reliability Z,ZK Students will gain knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to prepare a test set with the help of the intuitive path sensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with built-in-self-test equipment. They will be able to compute, analyze, and control the reliability and availability of the designed circuits. NI-UMI Artificial intelligence Z.ZK The course covers search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programming and automated planning. The main principles and practical applications of discussed techniques will be illustrated. NI-EHW **Embedded Hardware** Z,ZK 5 The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures. NI-FSW **Embedded Software** 5 Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence. NI-VCC Virtualization and Cloud Computing Z.ZK Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development). NI-APR Selected Methods for Program Analysis This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs. Selected Topics in Optimization and Numerical mathematics The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. Z,ZK NI-VMM Retrieval from Multimedia 5 The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines.

NI-MCC Multicore CPU Computing

Z,ZK

Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.

#### List of courses of this pass:

Code	Name of the course	Completion	Credits	
FI-TOP	Academic writing	Z	2	
Publishing is an im	portant and required part of research activity. It is not only about obtaining research results but also about applying them in the form	of publication. Writi	ng scientific	
publications can be	e useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the cou	rse, students will le	earn how to	
write a scientific art	icle, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an	article and reviewir	ng someone	
else's article. The	course will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. De	ates will be determi	ined based	
	on the availability of enrolled students.			
FIT-ITI	Modern IT infrastructure	Z,ZK	5	
FIT-SEP	World Economy and Business	Z,ZK	4	
This course is pre	This course is presented in Czech. The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries			

and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.

FITE-EHD Introduction to European Economic History

The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course

does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion. NI-ADM Z.ZK 5 **Data Mining Algorithms** The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods). NI-ADP Z,ZK Architecture and Design patterns 5 The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems. NI-AFP **Applied Functional Programming** 5 This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice. Algorithms of Information Security Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems Middleware Architectures 1 Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications. NI-AM2 Middleware Architectures 2 5 Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. Advanced machine learning NI-AML Z.ZK 5 The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of recommendation systems, image processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed. Completing a professional event The subject is participation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafting a report, etc. Such an event must be approved in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT through a website, informail, etc. Architecture of computer games NI-APH Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also from design and philosophical perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base components that form an integral part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important part of the course is an implementation of a simple game, with a strong focus on nontrivial game mechanics. NI-APR Selected Methods for Program Analysis Z,ZK 5 This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs. NI-APT Advanced Program Testing Z,ZK 5 Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution. NI-ARI Computer arithmetic Z.ZK 4 Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units. NI-ATH AlgorithmicTheories of Games Z.ZK 4 Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation. NI-BKO Error Control Codes 5 The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels NI-BMI Bayesian Methods for Machine Learning The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them. NI-BPS Wireless Computer Networks Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools NI-BUI **Business Informatics** Z,ZK The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management. ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management, and lifecycle management of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).

NI-BVS **Embedded Security** Z,ZK 5 Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems. NI-CAP Cultural and Social Anthropology 7K 2 The one-semester course aims to acquaint students with the basics of social and cultural anthropology as a scientific discipline dealing with the diversity of the world - examples from anthropological research from our "exotic" cultures (topics: kinship, religion, social exclusion, migration, globalization, , material culture, language, health, history, death, etc ...) will be shown. The course is presented in Czech. NI-CCC Creative Coding and Computational Art K7 Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL). NI-CPX Complexity Theory Z.ZK 5 Students will learn about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the theory concerning practical (in)tractability of difficult problems. NI-CTF Capture The Flag The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security. NI-DDM Distributed Data Mining ΚZ 4 Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands on experience with large scale data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations and will be capable to propose approaches to parallelize other algorithms. The course is prezented in czech language. NI-DDW Web Data Mining Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems. Digital drawing The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color theory, which they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course is fit for anyone who wants to practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge. NI-DIP Diploma Project 30 Z,ZK NI-DNP Advanced .NET 4 Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WPF, UWP), Blazor and also will get notions of Azure DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing technologies ASP.NET Core, Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT. NI-DPH Z.ZK Game Design The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game design. It is intended for people interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics design, storytelling, and game development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semestral projects NI-DSS **Decision Support Systems** Z,ZK 5 The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-oriented and knowledge-oriented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will also learn about the principles of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms. NI-DSV Distributed Systems and Computing Z,ZK Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communication channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that support high availability of both data and services, and safety in case of failures. NI-DSW Design Sprint Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation). NI-DVG Introduction to Discrete and Computational Geometry 5 The course intends to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with the most fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component. Digital Image Processing NI-DZO Z,ZK This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting. NI-FDW Enterprise Data Warehouse Systems 7.7K The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowledge not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the area of reporting and data visualization. NI-EHW **Embedded Hardware** Z,ZK The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures

NI-EMZ	Master Management economics course from a study abroad	Z	4
	gement-economic course "Management economics course from a study abroad" covers in the study plan the nature of the economic	•	
students as part of	their trip abroad. Completion by compensation is therefore assumed. Recognition is decided by the vice-dean for study and pedagogous dean and on the basis of the student's request.	gical activities on b	ehalf of the
NI-EPC	Effective C++ programming	Z,ZK	5
	to use the modern features of contemporary versions of the C++ programming language for software development. The course focu		_
	iciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor to		.,
NI-ESC	Experimental Project Course	KZ	8
	ct course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, n		_
	ology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design pro	-	
experts, and learn	to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills	in user-centered of	design and
	user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."		
NI-ESW	Embedded Software	Z,ZK	5
Embedded software	e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the ba	sic techniques of p	rogramming
in C language and	d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, u	p to sophisticated t	echniques
	combined with artificial intelligence.		
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowle	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces	s time and memory	complexity.
N. 5145	They will be able to use the knowledge in design of applications that utilize pattern matching.	7.71	
NI-FME	Formal Methods and Specifications	Z,ZK	5
Students are able to	o describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some so	itware tools that all	low to prove
NII ENAT	basic properties of software.	7 71/	4
NI-FMT	Finite model theory se is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of	Z,ZK	of database
	nception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as de-	•	I
systems. Office its i	Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.	scriptive complexity	, triedry, trie
NI-GAK	Graph theory and combinatorics	Z,ZK	5
	ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.		_
-	e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top	•	- 1
•	heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory v	• .	,, o , l
	of combinatorics on words, formal languages and bioinformatics.		
NI-GEN	Code Generators	Z,ZK	5
Advanced techniq	ues of translating programs written in high-level programming languages are essential for understanding the field of systems prograr	nming. This primari	ily involves
understanding the a	algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems progr	amming. Students	will become
			20000
	familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming lan		
NI-GLR	Games and reinforcement learning	Z,ZK	4
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audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation for audience. NI-IBE Information Security 2 Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international standards in this area. They understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., penetration testing). NI-IKM Internet and Classification Methods In this course, the students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering, in recommendation systems, in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving these four kinds of problems. On the background of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle with 2-hour lectures and 2-hour exercises. During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult their semester tasks. NI-IOS Advanced techniques in iOS applications 4 Students will learn the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the basics from the beginners class NI-IOT Internet of Things Z,ZK 4 The subject is focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is familiarization with available development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (GNU Forth). NI-IVS Intelligent embedded systems Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The course is an advance version of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programming and advance application development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students develop advanced applications combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies Data Compression Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data compression methods being used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, students learn the fundamentals of lossy data compression methods used in image, audio, and video compression. NI-KOP Combinatorial Optimization Z.ZK The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems. NI-KRY Advanced Cryptology 7 7K 5 Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions. Combinatorial Theories of Games Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics. Cybernality Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams). Introduction to Linguistics for IT Students This one-semester course should provide a gentle introduction to linguistics and language research for students majoring in IT and programming. Students get acquainted with basic concepts used in language descriptions as well as major theories influencing the current mainstream in linguistics. Specific attention will be paid to empirical and quantitative methods in linguistics, including the use of language corpora, and to specific issues of Czech. Linear Optimization and Methods Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming. NI-LSM2 Statistical Modelling Lab ΚZ 5 The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clutter, or video tracking. We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters. NI-MCC Multicore CPU Computing Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications NI-MEP Modelling of Enterprise Processes Z.ZK 5 The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions.

NI-MKY	Mathematics for Cryptology	Z,ZK	5
_	deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In		
on the problem o	f solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discre factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on	-	lobieiii oi
NI-MLP	Machine Learning in Practice	Z,ZK	5
	earning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ide		
=	students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically		
	sing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and		
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
-	gramming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where plex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills		
	in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development n		
addition to deepen	ing object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work	on interesting proje	cts and OO
<del>_</del>	ms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involven	ent in the Pharo C	onsortium.
NI-MPI	Mathematics for Informatics	Z,ZK	7
-	orises topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analyation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last top	· ·	
_	stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear pre		
NI-MPJ	Modelling of Programming Languages	Z,ZK	5
_	formation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve t	, ,	
	s the semantics of programming languages. The students will learn the language models with emphasis on functional languages, stude	=	
	mbda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with semantic		
NI-MPL	Managerial Psychology	ZK	2
NI-MPR	Master Project	Z	7
	in the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial ta r. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of		
-	ne information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/s		
completed and sign	ned form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic	that the student ha	as reserved
is rather general,	the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should aim at fine-tuning the FT topic so that the upcoming semester should also seemed to the upcoming semester should be upcoming to the upcoming semister should be	he FTT will be com	plete and
AH MEN	approvable at the end of the semester.	- 1	
NI-MPX	Management practice	Z	4
	ice, within its master's degree graduate (to apply) management practices in the selected subject of practice (business subject) on the conent (typically at the position of project manager, middle or top manager). The selected subject of practice and professional filling is a	-	- 1
_	In the selected subject of practice may not have a substantial ownership interest or substantial decision-making influence of the rela		
-	member of the top management).		
NI-MSI	Mathematical Structures in Computer Science	Z,ZK	4
Mathematical se	emantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scot	model of lambda	calculus.
NII MTI	Introduction to category theory.	7 71/	
NI-MTI SYNOPSIS The s	Modern Internet Technologies ubject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration -	Z,ZK   A single network o	5 riented on
	arry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video		
ntegrated services	. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds	of millions of users	and billions
	there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and		
•	ow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela eration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters i		OCOI). 4.
NI-MVI	Computational Intelligence Methods	Z,ZK	5
	erstand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to m		
	how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations,	etc.	
NI-MZI	Mathematics for data science	Z,ZK	4
	ents are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in description of the control o		
ınclude mainly: li	near algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ	iple, gradient meth	ods) and
NI-NLM	selected notions from probability theory and statistics.  Neural Language Models	Z	5
	ents will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. Th		
	students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific li	•	
NI-NMS	Neural Networks, Machine Learning and Randomness	Z,ZK	4
Stochastic method	ls, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a num		ne learning
	irse "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks, and machine learning are the discussion and machine learning to the final true topics, it explains the general	-	-
	Il as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general d shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including ne		- 1
.carai notworks an	of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algo		
NI-NMU	New media in art and design	ZK	3
	luces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game ar		
familiarize the stud	ent with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially	in lectures devoted	to specific
NII NION	art projects.	<b></b>	
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
	roduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methoc inite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They	· · · · · · · · · · · · · · · · · · ·	- 1
	juations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement		
	as well as in parallel.		

NI-NSS Normalized Software Systems	ZK	5
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, su theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues o	•	· 1
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These		
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and	-	
This knowledge allows students to realize new levels of evolvability in software architectures.		
NI-NUR User Interface Design	Z,ZK	5
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal use notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to		
NI-OLI Linux Drivers	Z,ZK	4
The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining power	, i	d FPGAs
increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development fo		ts. The
course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical expension of the provided Research Programming Systems and Systems Programming	·	5
NI-OSY Operating Systems and Systems Programming  The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel data	Z,ZK   structures. Kev to	
process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The course	-	
development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. Speci		
in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, stu focused on development of LINUX kernel modules.	dents will work or	n projects
NI-PAM Efficient Preprocessing and Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary		
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one call		
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponential and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time p		
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution m		
plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presure	mably) does not e	xist. We
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation sc		
NI-PAS   Advanced Aspects of Business The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run their or	Z,ZK	4
management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspe		u3111633
NI-PDB Advanced Database Systems	Z,ZK	5
Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database may be a supplied to the course deals with new concepts of database may		
databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER the course deals with performance evaluation of database machines.	, Gremlin). The la	st part of
NI-PDD Data Preprocessing	Z,ZK	5
Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data source		jes, texts,
time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteristics	from images or fr	om web
pages.  NI-PDP Parallel and Distributed Programming	Z.ZK	6
21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Pa	,	-
are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms.	-	
with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operation environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on sel		
learn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course incl	-	-
practical programming in OpenMP and MPI for solving a particular nontrivial problem.		. ,
NI-PG1 Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The co interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the cour		
articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topic	-	
NI-PIS Enterprise Information Systems	Z,ZK	5
The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data to the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data to the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data to the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data to the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data to the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data to the current IT requirements of large companies in the Czech Republic (Top 100).	, ,	
in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunications se real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the busines	· · · · · · · · · · · · · · · · · · ·	
Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation of		
company / organization.		
NI-PIV Computer Vision	Z,ZK	5
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing. Studenthe basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical keys	• .	
practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color repres	=	
and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including to	CNN, RCNN, YOL	.O, ViT),
motion detection, visual expressiveness (saliency).  NLDLS1  Programming Language Seminar	7	
NI-PLS1   Programming Language Seminar The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we	Z discuss scientific	2 papers
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discu		
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		
NI-PLS2 Programming Language Seminar Programming Language Seminar	Z	2
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discu		
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.	2.230.	

NI-PLS3 Programming Language Seminar Ζ 2 The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages. NI-PLS4 Programming Language Seminar Z 2 The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages. NI-PON Selected Topics in Optimization and Numerical mathematics Z,ZK The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-PSD Public Services Design ΚZ The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives. Course is aimed at students-designers as well as clients. Programming in Scala Z,ZK The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g.pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra, Scalaz, etc. NI-PVR Advanced Virtual Reality ΚZ The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D models in Blender, and among other things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also deal with creating applications in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the knowledge gained in this subject in virtual reality, or directly create a complex game for VR. NI-PVS Advanced embedded systems Z,ZK The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced topics like security support, working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical experiences with embedded systems. NI-PYT Advanced Python K7 The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python (BI-PYT) left of. The course is very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework. The course is lead by external teachers from Red Hat. Reverse Engineering Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens before and after the main function is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedicated to reverse engineering of applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be dedicated to debuggers: how debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer malware scene. The focus of the course is on the seminars, where students will solve practically oriented tasks from the real world. Pattern Recognition The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects. NI-RUB Programming in Ruby ΚZ This course is presented in Czech. Runtime Systems NI-RUN Z,ZK 5 This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience in design and implementation of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compilation Memory management Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementations of real-world VMs, including Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs NI-SBF System Security and Forensics Z,ZK 5 Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication concepts). Furthermore, students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic analysis techniques and the importance of operating system/operating system artifacts or file system for attack analysis and detection). NI-SCE1 Computer Engineering Seminar Master I The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCE2 Computer Engineering Seminar Master II The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCR Statistical Analysis of Time Series The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, employment) and industrial problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenient process model, estimate its parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main principles based on practical real-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer of students' knowledge from the academic to the real world. NI-SEP World Economy and Business This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures,

NI-SIB NI-SIB NEWTON SECURITY OF A CONTRIBUTION	,	g business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for	ŭ	
NI-SIM Digital Circuit Simulation and Varification  The air of the causes to transparie the students with principate of digital card survivation of E. Rigaptar Transfer Loedy and TLM (formacion Loed) Modeling by leaves and with the proposed set of great process. The causes reviews recent varietation methods, too.  NI-SIVE  Semantic Web and Knowledge Graphs The students will barn he nost noars concepts and inchronogies of the Semantic Web and Knowledge Graphs The students will barn he nost noars concepts and inchronogies of the Semantic Web and Knowledge Graphs The students will barn he nost noars concepts and inchronogies of the Semantic Web and Knowledge Graphs The students will barn he nost noars concepts and inchronogies of the Semantic Web and Knowledge Graphs The students will be an inchronogies of the Semantic Web technologies of the Semant	· ·			
The aim of the coines is a acquaint the audient with principles of rigidal critical annualizion at PLII, Register Franchis Level Montaling) locals and with the properties of the coines of the properties	_		,	
N-SVIE Semantic Web and Knowledge Graphs The subservance will learn the most recent concepts and security will provide the providence of the Semantic Web. and Knowledge Graphs providence for modelling, integration, optimizing, querying and comprehence for the Semantic Web. The course will provide an overview of the Semantic Web.  N-SVP The counter subsidiary and the semantic Web. The counter will provide an overview of the Semantic Web.  N-SVP The counter subsidiary and the semantic Web. The counter will provide the semantic will be subsidiary and the semantic will be considered to the counter of the semantic will be considered to the counter of the semantic will be considered to the counter of the semantic will be considered to the counter of the semantic will be considered to the counter of the semantic will be considered to the counter of the semantic will be considered to th		ı		I
The students will learn the most recent excepts, and charbologies of the Germanic Web. The course oil provides and recent of recentively person and history systems.  NI-SYP Parsing and Complies The reclade balls upon the horseledge of furthermentals of authority the provides of the pro			<u> </u>	
planations for modelling, integration, publishing, querying and communiqued of servantive squality expensions.  NI-SYP P Parting and Compilers  The module buside spot the invokedge of fundamentatic of automatic through the property of the			1	1
NI-SYP Parsing and Compilers The module builds upon the knowledge of fundamentals of aucontain theory, formal language and formal translation theories. Students gain knowledge of various varients and spotial possible for the control of the parsing and are introduced to special applications of partners, and as incomental and passible parsing.  NI-SZ1 Knowledge Engineering Serminar Master I  Z 4  Additionally, you will present a research paper from a top insenture research page to you go are the variety of the parsing of the parsing of the parsing of the parsing of the partners of the parsing of the parsing of the parsing of the partners of the parsing of the			-	
NI-SYP   Paraing and are introduced to special applications of paraes, such as incremental and parallel paraing.  NI-SZ1   Knowledge of fundamentals of automatal are introduced to special applications of paraes, such as incremental and parallel paraing.  NI-SZ1   Knowledge Engineering Sermian Master II   Value of the service of the se	practices for mod		graphs and their s	systematic
The modulo bilish upon the knowledge of fundamentals of automate theory, furnal language and formal transition theories. Suburding pain knowledge of various variants and explications of 1.82 transport and an included to pecial applications of parents, and the information and parallel parting.  NI-S21   Knowledge Engineering Serminar Master I   Z 4 on this serminar you will present a research paper from a top transport property present and was clerific papers. The work in the serminar value and parting the property provided and service and services and summer as the services of the parting of the property provided and services and serv	NI-SYP		7 7K	5
On this sentimary pow will present a research paper from a lop institute / research group to your person. You will be an what is been gooded in top greatersh thats a mount due words. Additionally, you will be annothed to the property present and read according peers. The work is the sentimary pow will be annothed to the property present and read according peers. The work is the sentimary pow will be annothed to the property present and read according peers. The work in the sentimary the present peers you will be annothed be annothed by the present and read according peers. The work in the sentimary they peers you will be annothed by the present a research paper from a lop institute / research group to your peer. You will be annothed be not presented in the sentimary they will be annothed by the present a research paper from a lop institute / research group to your peer. You will be annothed to present the sent and the present discount the world. Additionally, you will be annothed by the present the world. Additionally, you will be annothed by the present the present peers of the present the present the present the world. Additionally, you will be annothed by the present the position of the present theory and agonitate that from the passing this complexity is the suggest of modes that described on appeted of the systems that are emportant to the task at hand, and adominate loan for shadying to lose modes. This adopt will present theory and agonitate that from the point of view of probability through the present theory and agonitate that from the point of view of probability through the present theory and agonitate that the present theory and agoni				_
On this seminar you will present a research paper from a top institute? research group to your peers. You will learn what is being cooled in top research labs around the world. Additionally, you will seem how to properly present and read solectific papers. The world in the seminar will peep serve you started and profet from top consuche learning and All conferences and summer schools, as well as ET's own Summer Research Program (VyLot).  NI-S22  Knowledge Engineering Gerniar Master II  On this seminar you will present a seem from a top institute? research group to your peers. You will learn what is being cooled in top research labse around the world. Additionally, you will learn how to properly present and read scientific papers. The world in the seminar will peep repeat you to attend (and profit from top present hearning and All conferences and summer schools, as well as ETI's own Summer Research Program (VyLet).  NI-TES  NI-TES  Systems Theory  Today, numarked has the ability to develop systems of incredible complexely (e.g., train, morprocessors, ariptanes, nuclear power plants), However, the costs of namaging that complexity is a direction of a final program have become critical. A key bendrings for marking the correlativity is the usage of models that documents only the complexity of the support of the systems that are important for the task at hand, and automated tools for analyzing flower models. This subject will present theory and algorithms that form the basis to the residence of the systems that are important for the task at hand, and automated tools for analyzing flower models. This subject will present theory and algorithms that form the basis to the residence of the systems that are important for the point of view of probability theory in the systems that are important for the point of view of probability theory in the system presents of point of the world of point of the world probability theory in the point of view of probability theory in the point of view of probability theory in the point of		of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.		
Additionally, you will learn how to properly present and seal ocereptions, per value at 151 soon of numer for search program of the control o	NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
And summer schools, as well as FITs own Summer Research Program (VyLet).  NI-SZZ   Knowledge Engineering Serminar Master II   Z   4  On this seminar you will present a research paper from a top institute, irreserving group to your peers. You will learn what is being considen top research labase conduct the world. Additionally, you will searn how to properly present and read scientific pepers. The world in the seminar will prepare you to started und profit from (you papers) may be an additionally to the seminar schools, as well as FITs own Summer Research Program (VyLet).  NI-TES   Systems of the seminar schools are sufficiently to the support of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the boals for the modeling and analysis of corregions systems.  NI-TRA   Category Theory   Z,ZK   5  In this course, we study reusal networks from the point of view of the through a subject will present theory and algorithms that some the point of view of probability theory, At first, we recall base concepts practing of particular learning and the role of time in neural networks. In connection with members from the point of view of probability theory, At first, we recall base concepts practing on the seminar place and the role of them in mental networks. In connection with network topology, sometic and synaptic mappings, with the composition from the special of the seminar sometime to the point of view of probability theory. At first, we recall base concepts are present to proposed from any supplication of the seminar place and the role of the first that traini				
NI-SZZ Months services you will present a research paper from at put residue, ir research group to your person, will will arrain what is being coded in top research abs around the world. Additionably, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from top machine learning and Al conferences and surmers schools, as well as 175 voin Summer Research Polgamy (Vyleti).  NI-TES Systems Theory Systems and summer schools, as well as 175 voin Summer Research Polgamy (Vyleti).  NI-TES Systems Theory Systems and summer schools, as well as 175 voin Summer Research Polgamy (Vyleti).  NI-TES Systems Theory Systems and several properties of the constitution of the school properties of the complexity is the usage of models that describe only those supposes of the systems that are important for the task at hand, and automated tools of analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complexity special present theory and algorithms that form the basis for the modeling and analysis of complexity special present theory and algorithms that form the basis for the modeling and analysis of complexity special present theory and algorithms that form the basis for the modeling and analysis of complexity systems.  NI-TKA Category Theory Theory of Neural Networks.  NI-TKA Category Theory Theory of Neural Networks.  NI-TKA Category Theory Theory of Neural Networks.  NI-TKA Category Theory of Neural Networks.  NI-TKA Neural Networks.  NI-TKA Neural Networks.  NI-TKA Neural Networks.  NI-TKA Neura	Additionally, you will		ne learning and AI	conferences
On this sommar you will present a research paper from a top institutor, research proup to your peers, You will learn what is being cocked in top research labs around rife world. Additionally, you will learn what is the present and read or confirm (papers) who will hope sense with the present will be present and (and portific from) typ machine learning and Al conferences and summer schools, as well as FITs own Summer Research Program (VyLed).  NI-TES    Systems Theory   ZZK   5   Today, humankind has the ability to develop systems of incredible complexity of e.g., trains, microprocessors, ariptenes, nuclear power plants). However, the costs of managing this cornel channels of a given speak system system will be a supported to the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analyzing of complexity site to complexity the term of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analyzing of complex systems.  NI-TINA   Category Theory   ZZK   5   In this course, we study neural networks from the point of vew of the theory of function approximation and from the point of vew of probability theory At first, we recall basis concepts the present analyzing theory and analyzing theory analyzing theory and analyzing theory and ana	NI-S72		7	4
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NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gai	in knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	organizations. Th	ey will get
acquainted with vi	rtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie	ntly operate and	optimize the
	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective		-
management of co	mplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in	the use of mode	rn integration
	and development tools (Continuous integration and development).		
NI-VEM	Scientific thinking	KZ	2
•	the course is to get acquainted with scientific methods and discovery of order and laws of the universe, including the aspects of huma	•	
scientific methods	s in natural sciences, mathematics, computer science and humanities. Another aim is to introduce rules and requirements of scientific	communication v	/ia research
NII V C A	papers and posters.	7 71/	
NI-VGA	Video Games Architecture	Z,ZK	5
	s a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of view of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and fu		- 1
	t, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, in		• • •
J	some game mechanics, in the form of practical demonstrations.		
NI-VMM	Retrieval from Multimedia	Z,ZK	5
	s general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feat	•	1
	objects, indexing, and structure of distributed search engines.		
NI-VOL	Elections	Z,ZK	5
	We will cover the basics of (committee) elections and, in general, opinion aggregation.	•	'
NI-VPR	Research Project	Z	5
	Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.		'
NI-VSM	Selected statistical Methods	Z,ZK	7
The course leads	the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with mu	ıltivariate normal	distribution,
application of ent	ropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rand	lom processes wi	th focus on
	Markov chains. The high point of the course is the Queuing theory and its application in networks.		
NI-VYC	Computability	Z,ZK	4
	Classical theory of recursive functions and effective computability.		
NI-ZS10	Master internship abroad for 10 credits	Z	10
	once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institut the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex		
		rent of the interns	silip. Auxiliai y į
	MI-7S20, MI-7S30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks	s of full-time emn	lovment with
a foreign institution	MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 weeks on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects is		
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NI-ZS20	on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects academic year's dead-line.  Master internship abroad for 20 credits	if the internship e	xceeds the
NI-ZS20 Each student can	on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects academic year's dead-line.	if the internship e  Z tion. Before the in	20 uternship the
NI-ZS20 Each student can Dean of the FIT, or	on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects academic year's dead-line.  Master internship abroad for 20 credits once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institution.	if the internship e  Z tion. Before the interns	20 Iternship the ship. Auxiliary
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synthesis and optimization algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial problems emerging in EDA.