## Study plan

## Name of study plan: Master specialization Computer Science, 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: 98
Elective courses credits: 22
Sum of credits in the plan: 120
Note on the plan: Garant: prof. Ing. Jan Holub, PhD., email: jan.holub@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 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 Pavel Hrabák 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 g	ain 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 e	valuate heuristics for practical problems.		
NI-DIP	Diploma Project	Z	30
NI-MPR	Master Project	Z	7
during the semeste supervisor enters t completed and sig is rather general, t	of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partia r. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the e he information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut hed 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 he immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that and of the semester.	nd of the semeste .cz/student/studijn topic that the stud	r. 2. The external ii/formulare). The ent has reserved
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

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. 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 acquainted 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

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-TI-PS.20

Name of the group: Compulsory Courses of Master Specialization Computer Science, Presented in Czech, Version 2020

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 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-ADM	Data Mining Algorithms Pavel Kordík, Daniel Vašata, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	PS
NI-KOD	Data Compression Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	PS
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS

# Characteristics of the courses of this group of Study Plan: Code=NI-TI-PS.20 Name=Compulsory Courses of Master Specialization Computer Science, Presented in Czech, Version 2020

NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses on	algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the stude	nts should know n	nachine 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 mo	dels (e.g., kernel
methods).			
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge	of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both ac	cess time and me	mory complexity.
They will be able to use	the knowledge in design of applications that utilize pattern matching.		
NI-GAK	Graph theory and combinatorics	Z,ZK	5
The goal of the class is	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith	ms. The emphasis	s will be not only
on undestanding the bas	sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected	I topics from graph	and hypergraph
coloring, Ramsey theor	y, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo	ry will be also app	lied in the fields
of combinatorics on wo	ds, formal languages and bioinformatics.		
	do, formal languageo ana biomormanoo.		
NI-KOD		Z,ZK	5
NI-KOD	Data Compression to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data	· · ·	-
NI-KOD Students are introduced	Data Compression	ita compression m	nethods being
NI-KOD Students are introduced used in practice. The ov	Data Compression to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data	ita compression m	nethods being
NI-KOD Students are introduced used in practice. The ov	Data Compression to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s methods used in image, audio, and video compression.	ita compression m	nethods being
NI-KOD Students are introduced used in practice. The ov lossy data compression NI-MVI	Data Compression to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s	ta compression m tudents learn the Z,ZK	hethods being fundamentals of 5
NI-KOD Students are introduced used in practice. The ov lossy data compression NI-MVI Students will understan	Data Compression to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s methods used in image, audio, and video compression. Computational Intelligence Methods	ta compression m tudents learn the Z,ZK	hethods being fundamentals of 5
NI-KOD Students are introduced used in practice. The ov lossy data compression NI-MVI Students will understan	Data Compression         It to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s methods used in image, audio, and video compression.         Computational Intelligence Methods         d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to	ta compression m tudents learn the Z,ZK	hethods being fundamentals of 5
NI-KOD Students are introduced used in practice. The ov lossy data compression NI-MVI Students will understan how these methods woo NI-NON	Data Compression It to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s methods used in image, audio, and video compression. Computational Intelligence Methods d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to k and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.	ta compression r tudents learn the Z,ZK many problems. T Z,ZK	hethods being fundamentals of 5 They will learn 5
NI-KOD Students are introduced used in practice. The ov lossy data compression NI-MVI Students will understan how these methods woo NI-NON Students will be introdu	Data Compression a to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s methods used in image, audio, and video compression. Computational Intelligence Methods d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to ik and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc. Nonlinear Continuous Optimization and Numerical Methods	ta compression r tudents learn the Z,ZK many problems. T Z,ZK hods to real-world	tethods being fundamentals of 5 They will learn 5 d problems. They
NI-KOD Students are introduced used in practice. The ov lossy data compression NI-MVI Students will understan how these methods woo NI-NON Students will be introdu will also learn the finite	Data Compression to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of date erview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s methods used in image, audio, and video compression. Computational Intelligence Methods d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to it and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc. Nonlinear Continuous Optimization and Numerical Methods ced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods of such methods of optimization and splications of such methods of optimization and applications of such methods the methods of optimization and splications of such methods of optimization and applications of such methods the methods of optimization and paper of the most popular methods of optimization and applications of such methods the methods of optimization and splications of such methods of optimization and applications of such methods the methods of optimization and splications of such methods of optimization and applications of such methods the methods and techniques of the most popular methods of optimization and applications of such methods the methods and techniques of the most popular methods of optimization and applications of such methods the methods and techniques of the methods of optimization and applications of such methods the methods and techniques of the methods of optimization and applications of such methods the methods and techniques of the methods of optimization and applications of such methods the methods and techniques of the methods and the methods of optimization and applications of such methods the methods and techniques of the methods and the methods and the methods and techniques of the methods	ta compression r tudents learn the Z,ZK many problems. T Z,ZK hods to real-world hey will learn to so	tethods being fundamentals of 5 They will learn 5 d problems. They olve systems of

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.)	ΚZ	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 Ji í Dostál Ji í Dostál (Gar.)	ΚZ	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 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 Ond ej Brém (Gar.)	KZ	8	0P+30R+52C	L	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GNN	Graph Neural Networks Miroslav epek Miroslav epek (Gar.)	Z,ZK	4	1P+1C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler <b>Pavel Tvrdík</b> André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-HCM	Mind Hacking Marcel Ji ina, Josef Holý Marcel Ji ina Marcel Ji ina (Gar.)	ZK	5	2P+1C	Z	V
NI-HSC	Side-Channel Analysis in Hardware Vojt ch Miškovský, Petr Socha Petr Socha Vojt ch Miškovský (Gar.)	Z,ZK	4	2P+2C	Z	V
NI-HMI2	History of Mathematics and Informatics Alena Šolcová Alena Šolcová (Gar.)	ZK	3	2P+1C	Z	V
NI-IBE	Information Security Igor 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 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 Tomáš Valla (Gar.)	Z,ZK	4	2P+1C	L	V
NI-FMT	Finite model theory Tomáš Jakl 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 Dušan Knop (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPL	Managerial Psychology Jan Fiala Jan Fiala Jan Fiala (Gar.)	ZK	2	2P	Z,L	V
NI-MSI	Mathematical Structures in Computer Science Jan Starý	Z,ZK	4	2P+1C	L	V
NI-MZI	Mathematics for data science Št pán Starosta	Z,ZK	4	2P+1C	L	V
FIT-ITI	Modern IT infrastructure Ivan Šime ek	Z,ZK	5	2P+1C	Z,L	V
NI-MOP	Modern Object-Oriented Programming in Pharo Jan Blizni enko Robert Pergl Robert Pergl (Gar.)	KZ	4	3C	Z	V
NI-NLM	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-NMU	New media in art and design Zden k Svejkovský Zden k Svejkovský Zden k Svejkovský (Gar.)	ZK	3	2P+0C	Z	V
NI-OLI	Linux Drivers Jaroslav Borecký, Miroslav Skrbek Jaroslav Borecký Miroslav Skrbek (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-PML	Personalized Machine Learning Rodrigo Augusto Da Silva Alves Karel Klouda Rodrigo Augusto Da Silva Alves (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík Alois Pluhá ek (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-PG1	Computer Grafics 1 Radek Richtr Radek Richtr Radek Richtr (Gar.)	ZK	4	2P+1C	L	V
NI-PIV	Computer Vision Radek Richtr	Z,ZK	5	2P+2C	Z	V
NI-EDW	Enterprise Data Warehouse Systems Jakub Krej í, Robert Kotlá Jakub Krej í Magda Friedjungová (Gar.)	Z,ZK	5	1P+1C	L	V
NI-PVR	Advanced Virtual Reality Petr Pauš Petr Pauš (Gar.)	KZ	4	2P+1C	Z	V
NI-AML	Advanced machine learning Zden k Buk, Miroslav epek, Rodrígo Augusto Da Silva Alves, Petr Šimánek, Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)	Z,ZK	5	2P + 1C	L	V
NI-IOS	Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)	KZ	4	2P+2C	L	V
NI-APT	Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PVS	Advanced embedded systems Miroslav Skrbek	Z,ZK	4	2P+2C	Z	V
NI-DNP	Advanced .NET David Šenký , Nikolas Jíša David Šenký Nikolas Jíša (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-PYT	Advanced Python Miroslav Hron ok	KZ	4	3C	Z	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)	KZ	5	2P+1C	Z	V
NI-GOL	Programming of distributed systems in GO	KZ	5	0P+3C	Z	V
NI-PSL	Programming in Scala Ji í Dan ek <b>Ji í Dan ek</b> Ji í Dan ek (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-RUB	Programming in Ruby Cyril erný Cyril erný Cyril erný (Gar.)	KZ	4	3C	Z	V
NI-ROZ	Pattern Recognition	Z,ZK	5	2P+1C	Z	V

NI-PLS1	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	Z	V
NI-PLS3	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	Z	V
NI-PLS2	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	L	v
NI-PLS4	Programming Language Seminar 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	v
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 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 (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	v
NI-TS1	Theoretical Seminar Master I Dušan Knop, Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	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 Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	v
NI-TS4	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 Martin Hole a (Gar.)	Z,ZK	5	2P+1C	L	v
NI-CPX	Complexity Theory Dušan Knop, Ond ej Suchý 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 Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VOL	Elections Dušan Knop 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 (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 the courses of this group of Study Plan: Code=NI-V.2021 Name=Purely Elective Master Courses

NI-AOA	Completing a professional event	Z	1
The subject is participa	tion in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, dr	afting a report, et	c.Such an event
must be approved in ad	vance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT the	nrough a website,	infomail, etc.
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 str	udies the behavio	ur of agents
(players) of a certain co	mpetitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game	e theory is to find	the equilibria,
which are the states of t	he game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social netw	orks, online aucti	ons, advertising,
multiagent systems and	l other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of	f efficient computa	ation of various
solution concepts. In thi	s course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their c	computation.	
NI-AFP	Applied Functional Programming	KZ	5
This course is presente	d in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel function	al programming la	nguages are on
the rise nowadays and	the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mas	tering this paradig	m becomes a
necessary competence	of a software engineer: the theory and especially the practice.		

NI-APH Architecture of computer games	Z,ZK	4
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		-
perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base	-	
part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An im	portant part of the	e course is an
implementation of a simple game, with a strong focus on nontrivial game mechanics.		
NI-VGA Video Games Architecture	Z,ZK	5
The course covers a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of	view, but also fror	n a design and
philosophical point of view. In the lectures, students will be guided through the history of development, the structure of game engines, component ar	nd functional archi	tecture typical of
game development, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater details	ail, including ways	of implementing
some game mechanics, in the form of practical demonstrations.		
NI-BPS Wireless Computer Networks	Z,ZK	4
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 know	wledge of security	/ mechanisms
for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.		
NIE-BLO Blockchain	Z,ZK	5
Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain pla		-
code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place		-
relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares	the students for ir	nplementing or
supervising implementation of blockchain-based solutions in both academia and business.		
NI-CTF Capture The Flag	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.		
NI-DPH Game Design	Z,ZK	5
The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on gar	•	
interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanic		
development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical im	plementation app	lied to semestral
projects.		
NI-DSW Design Sprint	Z	2
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 va		, ,
the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting v	vith research and	finishing with
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 developme		
suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration of the students of a students of a students will be allocated as a student of the students of the s	ion with client repi	esentatives.
Course is aimed at students-designers as well as clients.	7	0
NI-DID Digital drawing	<u>Z</u>	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p	-	-
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 practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice ga	-	e who wants to
		4
NI-DZO Digital Image Processing This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical	Z,ZK	-
implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that i	-	-
of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDF		
frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray of	-	-
interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, a		
NI-DDM Distributed Data Mining	KZ	4
Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain han	1	-
data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementation	-	-
approaches to parallelize other algorithms. The course is prezented in czech language.		
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 nece		-
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	-	-
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exp		
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomia		
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solut	ion method. We w	ill present a
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	s not exist. We
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 principle	s, methodologies,	and tools used
in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design	projects, collabor	ate with industry
experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their sk	ills in user-center	ed design and
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 intellig	gence. This course	e is 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 r	networks for creat	ng vector
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	e 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 part of the course	e also covers

Grid computing and gain knowledge about the world-wide network and computing infrastructure.

NI-HCM	Mind Hacking	ZK	5
	emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks,		
	e security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive sec on warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Inter	, , ,	•
	tion of social cohesion, threats to democracy or war.		
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
	d to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical atta	-	
	nannels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks are	-	h higher-order
NI-HMI2	practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel inform History of Mathematics and Informatics	ZK	3
	d in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithr	1	-
	s, etc.) note on possibilities of applications of some mathematical methods in informatics and its development.	,	
NI-IBE	Information Security	ZK	2
	tion and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internat		this area. They
	r management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., pen		
NI-IVS	Intelligent embedded systems ystems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The	KZ	4
-	Ided system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot progra		
e e	provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, studer	•	
	of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies		
NI-IKM	Internet and Classification Methods	Z,ZK	4
	ents get acquainted with classification methods used in four important internet, or generally network applications: in spam filte ystems and in intrusion detection systems. However, they will learn more than only how classification is performed when solvi	-	-
	hese applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycl	-	
-	xercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult the		
NI-IAM	Internet and Multimedia	Z,ZK	4
	ocused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes a	-	
	als (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practice		
	ons. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording		
for audience.		5	
NI-IOT	Internet of Things	Z,ZK	4
	on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is fa	amiliarization with	available
	(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
	a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global e story. As European countries have been dominant actors in this process it focuses predominantly on their roles in the econom		
	to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial inst	-	-
	economic history of particular European countries but rather the impact of trade and role of particular events, institutions and	d organizations in	history. Class
-	a mixture of lecture and discussion.	7 71/	
NI-KTH	Combinatorial Theories of Games y is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory st	Z,ZK	4
	propertitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game		-
	the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-pl	-	-
	y, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea	•	
-	games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The t		-
	blished the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force oduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theo	-	-
	eoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course	•	•
	yse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph the	ory, as well as for	PhD students
looking for research top			
NI-FMT	Finite model theory s to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiabilit	Z,ZK	4
	ption in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as	, , , ,	
	Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.	decemptive comp	liosaly alcoly, alc
NI-CCC	Creative Coding and Computational Art	KZ	4
	ical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows		
.,	tudents to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques as the subscript of the state of the subscript of the state of the subscript o		s.
(Institute of Intermedia	The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture ar FEL)	na Metropolitan Pi	ianning) and ilivi
NI-KYB	Cybernality	ZK	5
	d with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand t		1
-	stems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker a	activities and beha	avior. The course
	operation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams).		_
NI-LSM2	Statistical Modelling Lab	KZ	5
-	dvanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the pre the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters.	sence of clutter, o	DI VIDEO TRACKING.
NI-LOM	Linear Optimization and Methods	Z,ZK	5
	lications of optimization methods in computer science, economics, and industry. They are aware of practical importance of line		1
	ptimization software and are familiar with languages used in programming of that software. They get skills in formalization of c		-
	duling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, trav	• •	
in linear programming.	, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems.	mey get orientation	on in algorithms
NI-MPL	Managerial Psychology	ZK	2

	Mathematical Structures in Computer Science	Z,ZK	4
NI-MSI Mathematical compation	s of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Sco		
			a calculus.
Introduction to category			
NI-MZI	Mathematics for data science	Z,ZK	4
In this course, students	are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used i	n data science. Th	ne studied topics
	Igebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality prir	nciple, gradient me	ethods) and
selected notions from p	robability theory and statistics.		
FIT-ITI	Modern IT infrastructure	Z,ZK	5
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
	nming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, wh		tural abstraction
	modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the s		
	odern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their developmen	-	-
	bject programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to wo		
	f semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involve		-
NI-NLM	Neural Language Models	Z	5
	will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models	. The goal of the c	ourse is to teach
	nguage 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	4
Stochastic methods, i.e	. methods based on randomness, are extremely important for the construction and training of neural networks as well as a network of the second s	umber of other ma	achine learning
models. The course "N	eural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural netwo	rks that rely subst	antially 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 gene	eral stochastic app	proach to training
neural networks and sh	lows 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 a	pplications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms.		
NI-NMU	New media in art and design	ZK	3
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 m	ain goal is to
	with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especia		-
art projects.		,	
NI-OLI	Linux Drivers	Z,ZK	4
	stem is an important operating system for personal computer and also for embedded systems. Systems on chip and combining		
	of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver developmine		
-			uueniis. me
	edge of Linux operating system architecture, principles of development of various types drivers, including practical experience		-
NIE-PML	Personalized Machine Learning	Z,ZK	5
	earning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteris		
	ommonly used in applications such as recommender systems, which recommend items to users based on their personal inte		
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	eoretical, algorithn	nic, and practical
perspectives. Specifica	lly, we will focus on cutting-edge models that are of interest to both the research and commercial communities.		
perspectives. Specifica	lly, we will focus on cutting-edge models that are of interest to both the research and commercial communities.	Z,ZK	4
NI-ARI		Z,ZK	-
NI-ARI Students will learn vari	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units.		-
NI-ARI Students will learn vari NI-PG1	Computer arithmetic bous data representations used in digital devices and will be able to design arithmetic operations implementation units.	ZK	4
NI-ARI Students will learn vari NI-PG1 The course builds on g	Computer arithmetic bous data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge	ZK e. The course is de	4 esigned for those
NI-ARI Students will learn vari NI-PG1 The course builds on guinterested in advanced	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the state of th	ZK e. The course is de the course is the s	4 signed for those tudy of scientific
NI-ARI Students will learn vari NI-PG1 The course builds on guinterested in advanced articles and their subset	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of tr quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an	ZK e. The course is de the course is the s d topics of compu	4 signed for those tudy of scientific
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t equent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision	ZK e. The course is de the course is the s d topics of compu Z,ZK	4 esigned for those study of scientific ter graphics. 5
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get	4 esigned for those study of scientific ter graphics. 5 acquainted with
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of d	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of te quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of o practical applications a	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as r representations,	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of o practical applications a and recognition and se	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, colo gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (include gme	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as r representations,	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of practical applications a and recognition and se motion detection, visua	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret ind implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, colo gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (incl expressiveness (saliency).	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as r representations, uding CNN, RCN	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, ViT),
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of o practical applications a and recognition and se motion detection, visua NI-EDW	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret ind implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, colo gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (incl expressiveness (saliency). Enterprise Data Warehouse Systems	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as or representations, uding CNN, RCNI	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, ViT),
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NI-ARI Students will learn vari NI-PG1 The course builds on guinterested in advanced articles and their subset NI-PIV The Computer Vision c the basic principles of of practical applications a and recognition and se motion detection, visua NI-EDW The Enterprise Data W not only in designing w visualization. NI-PVR The course introduces stu in available 3D engines in virtual reality, or dire NI-AML The course introduces processing, control and NI-IOS Students will learn the BI-IOS. NI-APT Testing a program is es advanced program test NI-PVS The course is focused	Computer arithmetic Computer arithmetic Computer arithmetic Computer Grafics 1 Computer Vision Com	ZK a. The course is the s d topics of compu- Z,ZK g.Students will get tical knowledge as r representations, uding CNN, RCN Z,ZK and will gain prac- to the area of repor- KZ odels in Blender, a also deal with creat e knowledge gained Z,ZK f recommendation methods discussed KZ ne basics from the Z,ZK goal of the coursed Z,ZK and of the coursed Z,ZK solution the coursed Z,ZK and topics like set and to	4 4 asigned for those tudy of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, ViT), 5 tical knowledge rting and data 4 and among other ting applications ed in this subject 5 systems, image ed. 4 beginners class 5 is to present 4 acquirity support,

NI-DNP	Advanced .NET	Z.ZK	4
	overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI	, ,	zor and also will
get notions of Azure De	vOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilized	zing technologies	ASP.NET Core,
	and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.		
NI-PYT	Advanced Python	KZ 🛛	4
, v	is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Pyth	. ,	
teachers from Red Hat.	s only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursew	vork. The course is	lead by external
NIE-PDL		KZ	5
	Practical Deep Learning I to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine	1 1	-
-	I develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su	-	-
language processing.		•	
NI-GOL	Programming of distributed systems in GO	KZ	5
NI-PSL	Programming in Scala	Z,ZK	4
	the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language fea	1 2 1	matching and
advance standard librar	y. 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. F	Play, Cassandra,
Scalaz, etc.		,	
NI-RUB	Programming in Ruby	KZ	4
This course is presente			
NI-ROZ	Pattern Recognition	Z,ZK	5
	is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the s ill learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a		
NI-PLS1		Z	2
-	Programming Language Seminar juage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in whi	1 – 1	
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the		
	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		
NI-PLS3	Programming Language Seminar	Z	2
The Programming Lang	juage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in whi	ch we discuss scie	entific papers
about programming lan	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the	he discussions. Th	e reading group
is a joint venue betweer	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		
NI-PLS2	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 whi		
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the second MEE CLINE this area to all attributes and second here interested in programming longuages.	he discussions. Th	e reading group
NI-PLS4	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.	7	2
-	Programming Language Seminar juage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in whi	Ch we discuss said	_
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the		
	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		lo rouding group
NI-SCE1	Computer Engineering Seminar Master I	Z	4
	ter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	1 1	ttacks. Students
are approached individu	ually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	the subject is worl	k with scientific
articles and other profes	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	chers. The topics a	are new for each
semester.			
NI-SCE2	Computer Engineering Seminar Master II	Z	4
	ter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance with the selected expression of the selected expression.		
	Jally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	-	
semester.		chers. The topics a	are new ior each
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
	I present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top rese	1 1	
-	rn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top ma		
and summer schools, a	s well as FIT's own Summer Research Program (VyLet).		
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
On this seminar you wil	I present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top rese	arch labs around t	he world.
	rn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top ma	achine learning and	d AI conferences
	s well as FIT's own Summer Research Program (VyLet).		
PI-SCN	Seminars on Digital Design	ZK	4
-	problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description	-	-
	ion algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial		-
NI-MLP	Machine Learning in Practice ing methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to	Z,ZK	5 implementation
	ents through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practic	-	
-	arn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and un	-	
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	1 ' 1	dual countries
and key regions of world	economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as we	Il as indexes of eco	onomic freedom,
	ic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form	of discussions bas	ed on individual
	b take bachelor level of this course BIE-SEP as a prerequisite.		
NI-SEP	World Economy and Business	Z,ZK	4
	d in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students in the description of the second students of the second students and the second students are the second students and the second students are the se		-
	It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about a single so indexes of economic freedom, corruption and economic development, which are needed	-	
	siness in diverse societies as well as indexes of economic freedom, corruption and economic development, which are neede ve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this cours	-	
		<b>c_</b> . uo u pi	

NI-TVR	Virtual Reality Technology	Z,ZK	3
	iced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of c		
	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways o	of using virtual and	d augmented
reality will be presented		-	4
NI-TS1	Theoretical Seminar Master I		4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a clas and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		-
-	e. The capacity is limited by the the potentials of the teachers of the seminar.		
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 cla	-	-
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		
other scholarly literatur	e. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS3	Theoretical Seminar Master III	Z	4
Theoretical seminar is i	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classifier of the students which want to come in deeper contact with contemporary theoretical computer science.	ssical reading gro	up. The students
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	s a work with scie	ntific papers and
	e. The capacity is limited by the the potentials of the teachers of the seminar.	_	
NI-TS4	Theoretical Seminar Master IV		4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classified and an active the second bin the second		
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is e. The capacity is limited by the the potentials of the teachers of the seminar.	s a work with scie	nunc papers and
NI-TKA	Category Theory	Z,ZK	4
	Theory of Neural Networks	Z,ZK Z,ZK	4 5
NI-TNN	reural networks from the point of view of the theory of function approximation and from the point of view of probability theory	· ·	÷
	eural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmissi		
	work training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transfor		
	somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with tra		
	and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most		
employed for neural ne	work training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within	the topic approxi	mation approach
to neural networks, we	first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko	olmogorov theorer	n, Vituškin
theorem). Afterwards, v	ve will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mapp	ings computed by	neural networks
	nt Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect		
	us derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on exp		-
	th probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see h	-	-
	ctancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak la logy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the cen	-	-
	ral networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can b		• •
topology of the network			
		7 7K	5
NI-CPX	Complexity Theory	Z,ZK	5 ing practical
NI-CPX	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		
NI-CPX Students will learn abo	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems.	he theory concern	ing practical
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems. Academic writing	he theory concern	ing practical 2 Writing scientific
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the fo	he theory concern Z rm of publication. course, students v	ing practical 2 Writing scientific vill learn how to
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The course	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the fo efful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the e what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting se will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester.	The theory concern Z rm of publication. course, students v an article and rev	2 Writing scientific vill learn how to iewing someone
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en	Complexity Theory Ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the for efful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting se will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. rolled students.	The theory concern Z rm of publication. course, students v an article and rev Dates will be deter	Ing practical 2 Writing scientific vill learn how to iewing someone ermined based
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en NI-DVG	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the fo efful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the o what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting se will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. rolled students. Introduction to Discrete and Computational Geometry	The theory concern Z Trm of publication. course, students v an article and rev Dates will be deter Z,ZK	2 Writing scientific vill learn how to iewing someone ermined based
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## Code of the group: NI-TI-VS.20 Name of the group: Elective Vocational Courses for Master Specialization Computer Science Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

Note on the group:

Povinné předměty všech specializací s výjimkou této specializace.

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-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	V
NI-AM1	Middleware Architectures 1 Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (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 Jaroslav Kucha Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	V
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	V
NI-GEN	Code Generators Petr Máj, Jan Janoušek <b>Petr Máj</b> Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-HWB	Hardware Security Jií Bu ek Jií Bu ek (Gar.)	Z,ZK	5	2P+2C	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-MPJ	Modelling of Programming Languages	Z,ZK	5	2P+1C	Z	V
NI-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	z	V
NI-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NSS	Normalized Software Systems Robert Pergl, Marek Suchánek, Jan Verelst Robert Pergl Robert Pergl (Gar.)	ZK	5	2P	L	V
NI-OSY	<b>Operating Systems and Systems Programming</b> Petr Zemánek, Tomáš Martinec <b>Petr Zemánek</b> Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-BUI	Business Informatics Petra Pavlí ková Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	V
NI-PIS	Enterprise Information Systems Vlastimil Jinoch, Martin Závrbský, Martin Mach, Martin Hasaj David Buchtela David Buchtela (Gar.)	Z,ZK	5	2P+1C	L	V
NI-KRY	Advanced Cryptology Ji í 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, Št 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-PDB	Advanced Database Systems Yelena Trofimova, Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PDD	Data Preprocessing Marcel Ji ina Marcel Ji ina Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	V

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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 Kohlik Martin Kohlik Martin Kohlik (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 David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TES	Systems Theory Ji í Vysko il, Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TSP	<b>Testing and Reliability</b> Petr Fišer <b>Martin Da hel</b> 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 Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V

# Characteristics of the courses of this group of Study Plan: Code=NI-TI-VS.20 Name=Elective Vocational Courses for Master Specialization Computer Science

NI-ADM	Data Mining Algorithms	Z,ZK	5				
The course focuses on	algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the studen	nts should know n	achine learning				
basics. The emphasis is	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-MVI	Computational Intelligence Methods	Z,ZK	5				
Students will understan	d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to	many problems. T	hey will learn				
how these methods wo	k and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.						
NI-SYP	Parsing and Compilers	Z,ZK	5				
The module builds upon	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge o	f various variants	and applications				
of LR parsing and are in	troduced to special applications of parsers, such as incremental and parallel parsing.						
NI-AIB	Algorithms of Information Security	Z,ZK	5				
Students will get acquai	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, st	udents will learn t	ne mathematical				
principles of cryptograp	nic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection	ction and the use	of machine				
learning in detection sy	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.						
NI-ADP	Architecture and Design patterns	Z,ZK	5				
The objective of this co	irse is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis	as well as with u	nderstanding 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	e of object-orient	ed programming				
and get familiar with the	commonly used object-oriented design patterns that represent the best practices for solving common software design problem	is. In the second p	part the students				
will be introduced to the	principles of software architecture design and analysis. This includes the classical architectural styles, component based system	ms, and some ad	vanced software				
architectures used in la	ge-scale distributed systems.						
NI-AM1	Middleware Architectures 1	7 71/	5				
	Midulewale Alchilectules 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 syst	,	-				
		tem architecture,	web service				
	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syst	tem architecture,	web service				
architecture and aplicati	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syst	tem architecture,	web service				
architecture and aplication of applications.	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system on servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous cor	tem architecture, mmunications and Z,ZK	web service I high availability 5				

NI-BML	Bayesian Methods for Machine Learning	KZ	5			
-	n practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it stud					
	ption of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidde					
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						
some of them.	presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imagin	ig. The students w	ill try to solve			
NI-BVS	Embedded Security	Z,ZK	5			
	Medge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cr	1 '	-			
-	led systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resou					
of computer systems.						
NI-BKO	Error Control Codes	Z,ZK	5			
	s to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted v	1 1	-			
NI-DSV	Distributed Systems and Computing	Z,ZK	5			
Students are introduced	to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of compu	iting processes and	d communication			
channels. They learn ba	sic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms the	nat support high a	vailability of both			
data and services, and	-		1			
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		-			
	ling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an ove and recommendation systems.	erview of most rece	ent developments			
NI-EPC		Z,ZK	5			
	Effective C++ programming se the modern features of contemporary versions of the C++ programming language for software development. The course f		-			
	n of writing maintainable and portable source code and creating correct programs with low memory and processor time requ		in ing chocking			
NI-FME	Formal Methods and Specifications	Z,ZK	5			
	scribe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some	1 1	-			
basic properties of softw	vare.					
NI-GEN	Code Generators	Z,ZK	5			
Advanced techniques of	translating programs written in high-level programming languages are essential for understanding the field of systems prog	ramming. This prir	marily involves			
	thms and techniques used to translate more complex programming constructs of modern languages employed in systems pr	rogramming. Stud	ents will become			
	coretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.					
NI-HWB	Hardware Security	Z,ZK	5			
	• knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stu	-	-			
-	erators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the co	-	Swiedge about			
NI-MKY	Mathematics for Cryptology	7.7K	5			
NI-MKY Students will gain deepe	Mathematics for Cryptology ar knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.	Z,ZK	5 course focuses			
Students will gain deepe	Mathematics for Cryptology er knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. g a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discr	In particular, the	course focuses			
Students will gain deepe on the problem of solvin	er knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.	In particular, the	course focuses			
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NI-PIS	Enterprise Information Systems	Z,ZK	5
	on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage		
, °	ence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunicati		•
	nore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the		
company / organization	nted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and oper	ation of informatio	n systems in the
NI-KRY	Advanced Cryptology	Z,ZK	5
	essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know		-
	tors. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they		
-	the creation of their own software solutions.		
NI-PAS	Advanced Aspects of Business	Z,ZK	4
	s to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run t		or business
	y in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.		
NI-PDB	Advanced Database Systems	Z,ZK	5
Students orient themse	lves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of databased of the course deals with new concepts of the course deals with new concepts of the course deals with new concepts of databased of the course deals with new concepts of the course	base machines (so	called NoSQL
databases), with the re	lated new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CV	YPHER, Gremlin).	The last part of
	erformance evaluation of database machines.		
NI-GPU	GPU Architectures and Programming	Z,ZK	5
-	ledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the		-
	spread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical	computational stru	uctures, students
	ion programming techniques and methods of programming multiprocessor GPU systems.		
NI-PDD	Data Preprocessing	Z,ZK	5
	re raw data for further processing and analysis. They learn what algorithms can be used to extract information from various da		
	arn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characte	eristics from image	s or from web
pages.		7 71	
NI-REV	Reverse Engineering	Z,ZK	5
	inted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is der		
	C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be c		
	ing work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computing work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computing work and which methods can be used to detect it.	•	
	minars, where students will solve practically oriented tasks from the real world.		
NI-RUN	Runtime Systems	Z,ZK	5
-	iction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experi		-
	from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC comp	-	-
-	and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implement	-	-
	speculations, and deoptimizations Language implementation frameworks Read-world VMs		, 0
NI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
	Semantic Web and Knowledge Graphs the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t	1 '	-
The students will learn practices for modelling,		echnologies, meth	nods and best
The students will learn practices for modelling, quality assurance.	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	echnologies, meth ge graphs and thei	nods and best ir systematic
The students will learn practices for modelling, quality assurance. NI-SIM	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg Digital Circuit Simulation and Verification	echnologies, meth ge graphs and thei	nods and best ir systematic 5
The students will learn practices for modelling, quality assurance. NI-SIM The aim of the course i	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg Digital Circuit Simulation and Verification s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le	echnologies, meth ge graphs and thei	nods and best ir systematic 5
The students will learn practices for modelling, quality assurance. NI-SIM The aim of the course i properties of proper too	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg Digital Circuit Simulation and Verification s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le obs. The course covers recent verification methods, too.	echnologies, meth ge graphs and thei Z,ZK evel Modeling) leve	hods and best ir systematic 5 els and with the
The students will learn practices for modelling, quality assurance. NI-SIM The aim of the course i properties of proper too NI-SIB	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledg Digital Circuit Simulation and Verification s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le	echnologies, meth ge graphs and thei Z,ZK evel Modeling) lev Z,ZK	ods and best ir systematic 5 els and with the 5
The students will learn practices for modelling, quality assurance. NI-SIM The aim of the course i properties of proper too NI-SIB NI-SCR	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge Digital Circuit Simulation and Verification s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Levels). The course covers recent verification methods, too. Network Security Statistical Analysis of Time Series	echnologies, meth ge graphs and thei Z,ZK evel Modeling) lev Z,ZK Z,ZK	oods and best ir systematic 5 els and with the 5 5
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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	ne base of advand	ced embedded
systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discuss	ed, including stan	dardized means
of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NI-ESW Embedded Software	Z,ZK	5
Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the	e 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 sophisticat	ed techniques
combined with artificial intelligence.		
NI-VCC Virtualization and Cloud Computing	Z,ZK	5
Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	d organizations. T	hey will get
acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to eff	iciently operate a	nd optimize the
performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effect	ive technology to	day for the
management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical ski	lls in the use of me	odern integration
and development tools (Continuous integration and development).		
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 dy	namic analysis. Ir	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, optimize	ations, error detec	tion. In Dynamic
Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.		
NI-PON Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge o	f continuous optin	nization obtained
in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on comput	ers. Hence, the re	elevant concepts
of numerical matematics, mainly numerical linear algebra, are explained too.		
NI-VMM Retrieval from Multimedia	Z,ZK	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	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or	multicore proces	sors with shared
and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowle	edge of architectu	rally specific
optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs	and memory inter	face 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	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 scier					
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	irse, 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 reviewing	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. Da	ates will be determ	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	sented in Czech. The course introduces students of technical university to the international business. It does that predominantly by c	omparing individua	I countries			
and key regions of	vorld economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as	indexes of econon	nic freedom,			
corruption and eco	nomic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of d	iscussions based o	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	Z,ZK	3			
The course introdu	ces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global eco	nomy 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 Em	pire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institut	ions is deciphered.	The course			
does not cover de	tailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and c	organizations in his	tory. Class			
	meetings will consist of a mixture of lecture and discussion.					
NI-ADM	Data Mining Algorithms	Z,ZK	5			
	s on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students		•			
basics. The empha	sis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation sys	tems) and models	(e.g., kernel			
	methods).					
NI-ADP	Architecture and Design patterns	Z,ZK	5			
	s course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as		0			
	ies, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge o		• •			
	n the commonly used object-oriented design patterns that represent the best practices for solving common software design problems.					
will be introduced to	o the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems	, and some advanc	ed software			
	architectures used in large-scale distributed systems.					
NI-AFP	Applied Functional Programming	KZ	5			
This course is pres	ented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional p	rogramming langu	ages are on			
the rise nowadays	and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, master	ring this paradigm	pecomes a			
	necessary competence of a software engineer: the theory and especially the practice.					

NI-AIB	Algorithms of Information Security	Z,ZK	5		
Students will get ac	quainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, stude		athematical		
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 syste	ms.			
NI-AM1	Middleware Architectures 1	Z,ZK	5		
	ly new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syste				
architecture and ap	lication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm	nunications and hig	h availability		
	of applications.				
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 architecture	es, concepts and te	ecnnologies		
NI-AML	for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. Advanced machine learning	Z,ZK	5		
	ces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of rec		-		
	control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the	-	-		
NI-AOA	Completing a professional event	Z	1		
	cipation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafti		ch an event		
	I in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT three				
NI-APH	Architecture of computer games	Z,ZK	4		
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 p	hilosophical		
perspective. They w	vill get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base co	mponents that forn	n an integral		
part of most game	es. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An impo	ortant part of the co	ourse 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		
	ces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynar	-	-		
we will look at the a	art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimization	ns, error detection.	In Dynamic		
	Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.	7 71/			
	Advanced Program Testing	Z,ZK	5		
resung a program	is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The go advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.	al of the course is	to present		
NI-ARI		Z,ZK	4		
	Computer arithmetic Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementa		4		
NI-ATH	AlgorithmicTheories of Games	Z,ZK	4		
	theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory stu		-		
-	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game t		-		
	s of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social network	-	-		
multiagent system	s and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of el	fficient computatior	n of various		
solution	concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods c	of their computation	ı.		
NI-BKO	Error Control Codes	Z,ZK	5		
-	I of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transr	nitted via channels			
NI-BML	Bayesian Methods for Machine Learning	KZ	5		
	sed on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies				
	description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden tions etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a		-		
-	will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging.		-		
	some of them.				
NI-BPS	Wireless Computer Networks	Z,ZK	4		
	about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad				
broadcast mechar	nisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowle	edge of security me	echanisms		
	for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable	ole tools.			
NI-BUI	Business Informatics	Z,ZK	5		
	se is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of b		•		
	architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management		-		
	nd resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governan e context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manageme	-			
business and th	management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).	int, revenue and int	/estiment		
NI-BVS	Embedded Security	Z,ZK	5		
	knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptography and cryptanalysis.				
-	bedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources	- · ·			
	of computer systems.				
NI-CCC	Creative Coding and Computational Art	KZ	4		
Students work on p	ractical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the	basic graphics cou	irses (MGA,		
-	ces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization technique		-		
modern technologi	es. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and N	Metropolitan Planni	ng) and IIM		
	(Institute of Intermedia FEL).	7 71/			
NI-CPX	Complexity Theory	Z,ZK	5		
Students Will lear	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the (in)tractability of difficult problems.	e meory concerning	y practical		
NI-CTF	Capture The Flag	KZ	4		
	The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber se		4		

NI-DDM	Distributed Data Mining	KZ	4
	state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands of	-	-
data processing fra	amework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations a approaches to parallelize other algorithms. The course is prezented in czech language.	ind will be capable	to propose
NI-DDW	Web Data Mining	Z,ZK	5
	arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain	I	
	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie		-
	in the field of social web and recommendation systems.		
NI-DID	Digital drawing	Z	2
	oduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, persp		-
	r apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course	-	
NI-DIP	r learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practic	Z	ge. 30
NI-DIP	Diploma Project Advanced .NET		30 4
	ا Auvanced .ive ا re an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WI	Z,ZK	-
	re DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing		
Ū.	Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.	Ū	
NI-DPH	Game Design	Z,ZK	5
	ments the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game of		
	er knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics d		-
development cycle.	The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical impler projects.	nentation applied to	o semestral
NI-DSS	Decision Support Systems	Z,ZK	5
	rse is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of	I ' I	-
	ented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will		
of c	conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods a	nd algorithms.	
NI-DSV	Distributed Systems and Computing	Z,ZK	5
	uced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing		
channels. They lear	rn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that s	support high availat	oility of both
NI-DSW	data and services, and safety in case of failures. Design Sprint	7	2
	projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to valida	ted prototype in 5 c	_
	Judents will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with		
	testing the prototypes (plus final presentation).		
NI-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	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 fundame	ntal notions
	of this discipline, and to be able to solve simple algorithmic problems with a geometric component.		
NI-DZO	Digital Image Processing Ints a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical alg	Z,ZK	4
	e an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also		-
	processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR		
frequency domain,	abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conv	version, context enh	nancement,
	gid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, ad		
NI-EDW	Enterprise Data Warehouse Systems	Z,ZK	5
	ta Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and ing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the second second second second second second second		-
not only in design	visualization.		j and data
NI-EHW	Embedded Hardware	Z,ZK	5
	basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the		
systems, that profit	from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed,	including standard	ized means
	of internal communication, parallelism extraction and utilization in special structures and system architectures.		
NI-EPC	Effective C++ programming	Z,ZK	5
	v to use the modern features of contemporary versions of the C++ programming language for software development. The course focus iciency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor t		g enectivity
NI-ESC	Experimental Project Course	KZ	8
	t course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, n	I I	
	logy-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design pro	-	
experts, and learr	to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills	in user-centered c	lesign and
	user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."		
NI-ESW	Embedded Software		5
	e course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the ba d code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, u		0 0
	combined with artificial intelligence.		
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
	edge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both acces		
	They will be able to use the knowledge in design of applications that utilize pattern matching.		
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	ftware tools that all	ow to prove
	basic properties of software.		

NI-FMT	Finite model theory	Z,ZK	4
	rse is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as des		
systems. Since its	Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.		uieory, uie
NI-GAK	Graph theory and combinatorics	Z,ZK	5
The goal of the cla	iss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.	The emphasis will	be not only
-	he basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top		
coloring, Ramsey	theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory w of combinatorics on words, formal languages and bioinformatics.	ill be also applied	in the fields
NI-GEN	Code Generators	Z,ZK	5
	ues of translating programs written in high-level programming languages are essential for understanding the field of systems program	· ·	ly involves
understanding the	algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming	-	will become
NI-GLR	familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming lang	guages. Z,ZK	4
	Games and reinforcement learning recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen	· · ·	
	give you both theoretical and practical background so you can participate in related research activities. Presented in Englis		
NI-GNN	Graph Neural Networks	Z,ZK	4
	oduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural n		-
representations of	of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last p graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and pro		so covers
NI-GOL	Programming of distributed systems in GO	KZ	5
NI-GPU	GPU Architectures and Programming	Z,ZK	5
	knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CU	,	
which is already a v	widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com	putational structure	es, students
	will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.	7 71/	-
NI-GRI	Grid Computing Grid computing and gain knowledge about the world-wide network and computing infrastructure.	Z,ZK	5
NI-HCM	Mind Hacking	ZK	5
	is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, info	I I	-
the domain of cog	nitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive secur	ty is growing in imp	portance in
the context of infor	mation warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet	environment have i	real societal
NI-HMI2	impacts such as disruption of social cohesion, threats to democracy or war.	ZK	3
	History of Mathematics and Informatics resented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithm		-
	functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its develop		
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
	edicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attack	-	
	ide channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel	-	-
NI-HWB	Hardware Security	Z,ZK	5
	es the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguard	s against abuse of	the system
	neans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stude		edge about
NI-IAM	yptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions Internet and Multimedia	Z,ZK	4
	se is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acq		
	signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical u		
	nissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effe		
the quality and late	ency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording th for audience.	e scene up to the p	presentation
NI-IBE	Information Security	ZK	2
	prmation and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internation		
	nd methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g.		
NI-IKM	Internet and Classification Methods	Z,ZK	4
	students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering		-
	ion systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving d of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle w		
-	During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consul		
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 the b	asics from the begi	nners class
	BI-IOS.	7 71/	4
NI-IOT The subject is t	Internet of Things focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is fa	Z,ZK amiliarization with a	4 available
	development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (G		
NI-IVS	Intelligent embedded systems	KZ	4
-	ded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The		
-	embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programr ures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students (	-	
	combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web tech	-	~pp://0000010
NI-KOD	Data Compression	Z,ZK	5
	bduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data	-	- 1
used in practice. T	he overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude	ents learn the fund	amentals of
	lossy data compression methods used in image, audio, and video compression.		

The statest sell give texnelogie and understanding second synchronomic terminal procession. The problem and the statest set and provide set and the statest set and th	NI-KOP	Combinatorial Optimization	Z,ZK	6
NH-KRY         Advanced Cryptology         Z.K         5           Substrist will seen in searchist of apparatyses and the enabrated increases of markets and agendatic spanners and agendatic spanners.         The enabrate approximation of the construction spanners and adures.         The enabrate approximation of the construction spanners and adures.           NH-KRH         Combinatorial Theories of Games         Z/K         4           Advanced proximation of the construction spanners and adures.         The adure approximation of the construction spanners and adures.         The adure approximation of the adure adure adures.           NH-KRH         Combinatorial Theories of Games         Combinatorial Theories of Games         The adure adures adures and adures.           Advance the spanne shares of the games adure to basice from he streng planners. The text of the spanners active to the adure adure adures adure adures adure	The students will		y to select and imp	blement but
Students will earn the assertial to cryptaneyies and ne rathematical principles of constructing symmetric and asymmetric phase, they will kove pranetypoint by the base on avoide or graphody will be a nervised or graphody with the gran apply to the symmetric and asymmetric phases, which they can apply to the symmetric and symmetric and symmetric phases, which they can apply to the symmetric and symmetric and symmetric phases, which they can apply to the symmetric and symmetric and symmetric phases, which they can apply to the symmetric and sym		also to apply and evaluate heuristics for practical problems.		
Includes under generators. They will have an useries of cryptaneylas are the for accord of the care cryptaneylas with they can apply us the integration of have and solutions.  N-KTH Combinational Theories of Games ZZK A CLX A CL				
Intercent on statute scalars.         Z.ZK         4           Traditional game flewy is a board of mathematic, which has broad applications in economy, bodge, policis and compare scenes. This they statutes the behaviour of games flewing is a contrained model and hexading in the statutes.         2.ZK         4           Traditional game flewy is a board of mathematic, which has broad applications in economy, bodge, policis and compare scenes. This they statutes have board in the ophilos.         The statutes of the games have no game scenes is a statute of the statutes of th				
NH-CHT         Combinatorial Theories of Games         Z.ZK         4           Traditorial grane fore lays a torthor of matrixed, which are backard approximation of the sharings. The traditional sub-off description of the compatibility of a cartial range difference of the grane where in give worths disolated and investigating the sharing disolated and where were disolated approximation. The sharing disclose of the description of the grane where in the sharing disclose of the description of the descrip	random number		an apply to the inte	egration of
Traditions given provide the part of a binder motion of mathematica, which has brook applications in according, topology, patities and compare takes of the applications in according to the applications in according to the applications in according to the applications in a binding of the applications in according to the applications in a binding of the applications in the applications and applications in the applications and applications in the applications in t				
independent and the states of the grant where on plane theory is the first freque theory is the first freque theory is the plane theory is the pla	NI-KTH	Combinatorial Theories of Games	Z,ZK	4
which are the states of the game where no player wants is deviate from his stategy. Historically, the second big development in game theory through use the state of the states is the states are more states and the states are more states and the states are more states are states and the states are more states are states and the states are more states are states and the states are more states and the states are more states are states and the states are more states and the states are more states are stat	-			-
ames, we by Conve, Berkater, and Guy They download a theory, originally used for solving and games in 66, in the sulf indegrafied. The solvent interpretation stage is the weak of download at the segure and the submit of the solvents in the solvent is solvents in the solvent in the solve			-	
there is a comparable games can be added, their is played annumerously. This lock to the algobale agroups the study continuously agroups and the functions reported to the study of the st				
wink of bestaketing between productional games (like locations and heap in give game) and games (like locations we built be builded on the form of the game and any station of the game and the game and any station of the game and the game			0	
is no effected. Back introduced the "take probabilities method", which are to take the inprogramming approximation of graphithms. The course requires independent vorse, ability to mathematically analyse, think and procf. The course is alto subtake to takehold subtak			-	-
genes. We boul on theoretical analysis of genes and building the theory, not on the programming aspects of genes eaviery adjustments. The course requires independent work, stalls to the building the theory, and ell as for PDD students being performants are course requires independent work and prod. The course is also students to the truty way, who attended introduction to graph theory, a well as for PDD students being performants. The course is also students to the truty eavier, who attended with the fundamentals of teglatation and international activities in the area of fighting cybercine. Students will used maintee the truth eaviers of the state agencies and subjects dealing with otherse of the cyberspace (steppedie). ECON and E			-	
In enterendically analyse, think and proof. The course is also shalled to thurshole subjects         IN-KYB         ZK         5           N-KYB         Cybernality         ZK         5           Subjects are approximately analyse, think and proof. The course is also shalled to main intransicional activities in the area of highing option:         Subjects and international activities in the area of highing option:         Subjects and international activities in the area of highing option:         Subjects and international activities in the area of highing option:         Subjects and international activities and behavior. The course we all also discuss the comparison of the subject activities and behavior. The course is also discuss the course and integer programming. They are able to work with optimization software and are finaliar with languages activities of the comparison of the comparison of optimization problems, steeled, issues for executive, or documational comparison of the comparison of optimization problems, steeled, issues for executive, or documational comparison of the comparison of optimization problems, steeled, issues for eactivities in the area optimization in adjocations in the subject of SUK 42 is advanced multiple target tracking (TTT). This demain courses taking of nutliple targets using radar under the presence of dure, or vice to tacking of analysis of the costant of problem and target or optimization molecular in adjocation of provide targets with a steel of the costant of problem and target or optimization problems is analysis. The problem of the costant of problem and target or optimization in adjocativity is and the advance of the costant of problem and target or optimization in adjocativity is and target or optimization in the problem of the costant of problem anadvanco the advance of the costant of problem analysis an				
INHXYB         Chybernality         ZK         5           Students get acquirined with the fundamentatio of deplation and international activities in the area of fighting opterzine. Students with the derivatione and the desalitation of attacks and the investmentation activities in the area of fighting opterzine. Students with the derivationes and the investmentation activities in the area of fighting opterzine. Students with a device activities and behavior. The outside students and the investmentation and the fifting opterzine. Students with a device activities and behavior. The outside and the investmentation problems in computer solence. economics, and adaption of resources (transportation problems. The year as ware of practical involutionation problems. The year of the state integration and the problem with the problem with the problem base of the problem with the problem base of the problem	-		-	-
NHXB         Cybernality         ZK         5           Students get current of systems for computer survaliance and ratific monthrains in the analy and fighting optorcrime. Students will understam the discuss the current of the studence and visual and the discuss the comparison of the studence and visual and the discuss the comparison of the studence and visual and the discuss the comparison of the studence and visual and the discuss the comparison of the studence and visual and the analyses of the analyses of the studence and visual and the analyses and the analyses of the studence and the studence and times and index and visual and the studence and thestudence and the studence and thestude studence and the studence a			,	
Students upt acquinated with the fundamentas of tegistation and international activities in the area of tighting cypercrime. Students with a discret archives and the distribution of a tanks and the origonary activities and ethorizon. The occurse will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (space) (SRT and CERT team). Inclead CERT team	NI-KYB		7K	5
have an overview of systems for computer surveillance and traffic monitoring in the opterspace. Students with also barnitarize themselves with hacker advices and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with diverse of the proteopace (segncially CSRF and CERT turns).  NI-LOM Linear Optimization and Methods ZZK 5  Students learn the apticulation ordenization methods in consoluter Science. Comparison, and indicating transportation problems and integer programming. They are avery with optimization and setting sources and comparison of the sources than optimization and the students of the sources and comparison. They get an overview of computational complexity of optimization problems. They get orientation in algorithms is the spice (SLM) and students and the students of the sources and modeling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms is the spice (SLM) and the student of the sources and modeling of conflicts via the game theory. They get an overview of computational complexity of optimization are multices proceeding of the sources of clutters or via the table of the sources of clutters or via the stude of the sources of clutters or via the sources of clutters or via the stude of the sources of the source of the sources of clutters or via the stude of the sources of the source of				
will also discuss the cooperation of the state agencies and subjects dealing with defends         IZX         5           Students learn the applications of pointration methods in computer science, economics, and industry. They are avers of practical importance of inferration in degrap programming. They are avers of practical importance of inferration in degrap programming. They are avers of practical importance, and industry. They are averse of practical importance.         Computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems. They get orientation in degrap the science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation) problems. They get orientation in algorithms in linear programming.         IXIII SMI         Statistical SMI				
NH-MC         Linear Optimization and Methods         ZZK         5           Students isom the applications on the application of the analysis that and the approximation. They are availed to vork with optimization advance and using or proceeding a students proceeding and the approximation and the approximation and the approximation advance and using or proceeding and the approximation. They det skills in formation problems. In the application of advance and using a students proceeding advance and using a students proceeding advance and using a students proceeding. The student advance and using a students proceeding advance and using a students and the approximation.         NLLSMZ         5           NLLSMZ         Statistical Modelling Lab         KZ         5           Statistical modelling of nulliple target taxing match using the approximation and using a status of the and the status of the and the proceeding status and the status of the and the status of the and the proceeding status and the status of the and the proceeding status and the status of the status of the status of the status of the and the status of the status of the status of the st				
Students learn the applications of optimization methods in computer science, acconomics, and industry. They are aware of percent amportance of linesr and integer programming. They are aware of percent amportance of the science of computation of optimization problems, traveling satesman 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. They are oriented on a discretion of the science (science) and the science of culture, or whole tracking (MTT). This domain covers simultaneous tracking of multiple target usarge relation of the presence of culture, or whole tracking with an advected on the science of the scien			,	5
are able to work with optimization software and are familiar with languages used in programming of that software. They get stills increatization of optimization problems in computer software s	-		I ' I	-
science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, traveling satesman 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. In the appropriate tracking (MTT), This domain covers simultaneous tracking of multiple target tracking (MTT). This domain covers simultaneous tracking of multiple target tracking (MTT). This domain covers simultaneous tracking of multiple target tracking ATT). This domain covers simultaneous tracking of multiple target tracking the presence of culture, or video tracking. We wait at the state-of-the-att flitters, in particulat the PHD (Probability Proshes) and PMBM (Poisson Multi-Barroulli) filters. View of the state of th				
Initial programming.         KZ         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-ant filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters.           NI-MCC         Multicore CPU Computing         Z,ZK         5           Students will get acquainted in deall with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shaded and an virtually stated menoris, with their acto topy them stoc common computation nodes of power systems. Students will get acquainted in deall with advance support to the widening gap between the computational requirements of multi-core CPUs and memory interface throughout. On specific conversion interface throughout. On specific conversion interface throughout. On specific conversion interface throughout to the widening gap between the computational requirements of multi-core CPUs and memory interface throughout the problem of factorization will also be solved on elliptic curves. Students will with thereade programming the most mortant mathematical problems concerning the security of ciphers. In particular, the curves foundes with the modern encryption systems based on histores.           NI-MCP         Machine Learning in Practice         Z_ZK         5           Applying machine learning the modern and system. The indextore of the model partormation system, where its ability to nature statements in protectice in advances and areas of the model in particular. The advance and areas of the second maning withe modern and understandate report.      <			•	•
INI-ISM2         Statistical Modelling Lab         KZ         5           The topic of LSM2 is advanced multiple target tracking (MTI). This domain covers simulaneous tracking of multiple targets using radar under the presence of clutter, or video tracking (MTI). This domain covers simulaneous tracking of multiple targets using radar under the presence of clutter, or video tracking (MTI). This domain covers simulaneous tracking of multiple targets using radar under the presence of clutter, or video tracking (MTI). This domain covers simulaneous tracking of multiple targets using radar under the presence of video tracking of transmission.         States the state of the art times in particular the PHD (Probability Hypothesis Density) and PMEM (Peisson Multi-Bernoulli) filters.         States the state of the art times in particular the PHD (Probability Hypothesis Density) and PMEM (Peisson Multi-Bernoulli) filters.         States the state of the art the presence of the art to the organization techniques used to radue to the preformance of the dot the wholen gas particular the complexity of clutters.         States the state of the art the state of the art the the states of the art of creating these supplications.         ZZK         5           Students will gain theore throwledge of algebraic procedures solving the most important mathematical problem concern the technical model in the solving on system to phonymain lequinementation.         ZZK         5           NI-MLP         Matchine Learning in Practo         ZZK         5           NI-MLP         Matchine Learning in Practo         ZZK         5           Object-oriented programming in corunot so the clicen to tooleal in the wole doce on the wole algobre	issues from econo	mics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. The	y get orientation in	algorithms
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 vice tracking. We aim at the state-off-ne-art filters, in particular the PHD (Probability Hypohesis Density) and PMBM (Poisson Multi-Bernoull) filters.           NI-MCC         Multificore CPU Computing         Z_ZK         5           Students will get acquinted in detail with hardware support and programming technologies for the creation of parallel multifixeade computations on memory interface throughput.         Ch specific         Students will get acquinted in the total with and the support and parallel multifixeade for programming technologies for the creating and also larm the basics of the art of creating these applications.         NI-MCK         Multicore CPUS and memory interface throughput.         Ch specific non-trivial multifixeade programming technologies for the creating and the sequence of the students of the creating of the creating and students will interface of programming as parallel multifixeade programming in Practice.         NI-MCK         Multicore Creating the most important mathematical problems concerning the security of cliphrs. In particular, the cool multicore to creating and the problem of adorts and the problem of discrete logarithm. The problem of the creating in Practice.         Z/ZK         5           NI-MLP         Machine Learning in Practice.         Z/ZK         5           Addition to describe the whole process from explorating the interface of the students.         Z/ZK         5           NI-MOP         Modern Object-Oriented Programming in Practice.         Z/ZK         5 <t< td=""><td></td><td>in linear programming.</td><td></td><td></td></t<>		in linear programming.		
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 vice tracking. We aim at the state-off-ne-art filters, in particular the PHD (Probability Hypohesis Density) and PMBM (Poisson Multi-Bernoull) filters.           NI-MCC         Multificore CPU Computing         Z_ZK         5           Students will get acquinted in detail with hardware support and programming technologies for the creation of parallel multifixeade computations on memory interface throughput.         Ch specific         Students will get acquinted in the total with and the support and parallel multifixeade for programming technologies for the creating and also larm the basics of the art of creating these applications.         NI-MCK         Multicore CPUS and memory interface throughput.         Ch specific non-trivial multifixeade programming technologies for the creating and the sequence of the students of the creating of the creating and students will interface of programming as parallel multifixeade programming in Practice.         NI-MCK         Multicore Creating the most important mathematical problems concerning the security of cliphrs. In particular, the cool multicore to creating and the problem of adorts and the problem of discrete logarithm. The problem of the creating in Practice.         Z/ZK         5           NI-MLP         Machine Learning in Practice.         Z/ZK         5           Addition to describe the whole process from explorating the interface of the students.         Z/ZK         5           NI-MOP         Modern Object-Oriented Programming in Practice.         Z/ZK         5 <t< td=""><td>NI-LSM2</td><td>Statistical Modelling Lab</td><td>KZ</td><td>5</td></t<>	NI-LSM2	Statistical Modelling Lab	KZ	5
INMCC         Multicore CPU Computing         Z,ZK         5           Students will get acquainted in detail with hardware support and programming technologies for the cestion of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (superformative systems. Students will get a convectionally 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 programms, students will also lear not basics of the art of creating these applications.           NI-MKY         Mathematics for CryptolOgy         Z,ZK         5           Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course of converses and the problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on latices.         NI-MLP         Agaking machine learning methods to real projects in practice involves many other necessary tasks - trom understanding the intentions of the cliento, ideally, technical implementation or explanation to the standard CREP-DM methodology, not only theoretically but also practically. The alm is to experime cell data processing and learn how to describe the whole process from explanation to evaluation of the model performance in the first of adaption to involve the applications. In this course, webuild on the course again de toportamity to work on interestand projects and O/ tasks will applicate in on the individual approach to students, where its ability to natural abstatradion or object systems in mod	The topic of LSM2		ce of clutter, or vid	leo tracking.
Students will gei acquainted in detail with hardware support and programming technologies for the creation of parallel multithroaded 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 architectually specific optimization techniques used to reduce the performance for due to the widering gap between the computational requirements of multi-core CPUs and memory interface throughput or objects. In particular, the course focuses on the problem of solving a system of polynomial equations over a finite field, the problem of the problem of discortization.         Z,ZK         5           NI-MLP         Matchine Learning in Practice         Z,ZK         5           Applying machine learning methods to real projects in practice in whore smary other necessary tasks. Thom understanding the intentions of the cleantly, technical implementation. The ourse guides students through all phases of a project according to the student CRISP-DM methodology, not only theoretically but also practically. The aim is to experimence real data processing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a polestable report.           NI-MOP         Modern Object-Oriented Programming in Pharo         KZ         4           Object-oriented programming is currently one of the most widespread paradigms of software crastion, especially entity releases, the subelly to network on interesting projects and OO technologies in terms of systems have 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 Coosc		We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli)	filters.	
and virtually stared memories, which are today the most common computing nodes of powerful (supericomputer 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-cose CPUs and memory interface throughput. NI-MKY Mathematics for Cryptology Z,ZK 5 Students will also learn the basics of the art of creating these applications. The problem of factorization of sign numbers and the problem of sloeres logarithm. The problem of factorization of algor numbers and the problem of sloeres logarithm. The problem of factorization of sign numbers and the problem of factorization will also be solved on elliptic curves. Students will numbers and the problem of factorization of algor numbers and the problem of factorization will also be solved on elliptic curves. Students will numbers and the problem of factorization of algor numbers and the problem of a clearat du nuderstandaling the intentions of the client to, ideally, technical implementation. The curves guides students through all phases of a project according to the standard CRISP-DM methodolgy, not only theoretically but also practically. The sim is to experience real data processing and learn how to describe the whole process from exploration to evaluation of the model proformance in the form of a clear and understandable report. NI-MOP Modern Object-Oriented Programming is currently one of the most widespread paradigms of software creation, especially enthelically, tabetariation of object systems in modern pure object system Planc (https://pharo.org). The course focuses on individual approad. NI-MPI Mathematics for informatics of informatics with and evelopment needs and areas of interest. In diduce objects from multi-write the performatic and multi-write the performatic and multi-write the performatic and the process in a distribution of object according to the semestribut of understandable problem of aclear and understan	NI-MCC	Multicore CPU Computing	Z,ZK	5
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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-MPJ Modelling of Programming Languages (in particular, they are correct if they preserve the semantics of the language. The students will learn the language in particular, they are correct if they preserve the semantics of the languages. The students will earn the language models with emphasis on functional languages, students are expected to understand the basics of the lambda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with semantics of the language. NI-MPL Managerial Psychology ZK 2 7 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 assessment for the course MI-MPR at the end of the semester. 2. The external supervisor of the final thesis topic and gets together with analysie to be granted. 3. If the FT topic that the student has reserved is rather get acquisite the SZL coordinator, who will arrange for the credit using the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the supervisor assigns to the semester. If the requirements the supervisor assigns to the supervisor approvable at the end of the semester. Supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic that th	-			
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integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters i	d Traffic Prioritisatio ay, jitter, type of pro	n - These
NI-MVI         Computational Intelligence Methods           Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to mostly nature intelligence that are mostly nature intelligence and applicable to mostly nature.		5 y will learn
NI-MZI         Mathematics for data science	Z,ZK	4
In this course, students are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in d	1 '	udied topics
include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality printer and addicted actions) and addicted actions.	ciple, gradient meth	nods) and
selected notions from probability theory and statistics.           NI-NLM         Neural Language Models	Z	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		-
students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific I		
NI-NMS Neural Networks, Machine Learning and Randomness	Z,ZK	4
Stochastic methods, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a num models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks		-
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		
neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including neural networks and machine learning.		used in one
of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algo	orithms.	3
NI-NMU New media in art and design The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game are	1	
familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially		-
art projects.		
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 method will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The		-
linear algebraic equations 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		-
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issu architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. The second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements.		
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability		
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, format potions and processures. They get acquiainted with graphical speech and multimodal UIs. Thanks to the gained knowledge, the students will be able acquired with graphical speech and multimodal UIs.		
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	le to design advanc	ed Uls. 4
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	practical programming in OpenMP and MPI for solving a particular nontrivial problem.		
NI-PG1	Computer Grafics 1	ZK	4
	n graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The	1	
	ced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the	-	
	subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and	-	
NI-PIS	Enterprise Information Systems	Z,ZK	5
The course is focus	ed on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of b	ig data (BigData) a	nd their use
	elligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication		-
-	hermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the bus		
Students will be acc	quainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operatio	n of information sy	stems in the
	company / organization.	771/	F
NI-PIV	Computer Vision on course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing.St	Z,ZK	5
	es of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoreti	-	
	is and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color re	•	
and recognition ar	d segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (includ	ing CNN, RCNN,	OLO, ViT),
	motion detection, visual expressiveness (saliency).		
NI-PLS1	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 scient	ific papers
about programming	languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the o		ading group
	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		-
NI-PLS2	Programming Language Seminar	Z	2
	Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which I languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the c		
about programming	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		aung group
NI-PLS3	Programming Language Seminar	Z	2
	Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which	-	1
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	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language	es.	
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 scien	ific papers
about programming	languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the o		ading group
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NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
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	on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of co	-	
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NI-RUN	Runtime Systems	Z,ZK	5
	troduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experienc	· · ·	lementation
of a compiler and	d a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compil	ation Memory man	agement
Just-in-time compile	ation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementatio	ns of real-world VM	ls, including
	Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs		
NI-SBF	System Security and Forensics	Z,ZK	5
•	familiar with aspects of system security (principles of end station security, principles of security policies, security models, authenticat	• •	
students will get fai	miliar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensi	c analysis techniqu	les and the
	importance of operating system/operating system artifacts or file system for attack analysis and detection).	7	4
NI-SCE1	Computer Engineering Seminar Master I		4
	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the		
	rofessional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher		
	semester.		
NI-SCE2	Computer Engineering Seminar Master II	7	4
	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	. – .	-
	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the		
articles and other p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher	rs. The topics are n	ew for each
	semester.		
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 prices	, employment) and	l industrial
problems (modellin	g of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conve	nient process mod	el, estimate
its parameters, ana	lyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the mai	n principles based	on practical
real-world example	s. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfe	er of students' knov	vledge from
	the academic to the real world.		
NI-SEP	World Economy and Business	Z,ZK	4
	resented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of the second students of the second students are the second students of the second students are the second students		-
	ness. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about dif g business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for	-	
	p improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course	-	
NI-SIB	Network Security		5
		Z,ZK Z,ZK	5
NI-SIM	Digital Circuit Simulation and Verification rse is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level		-
	properties of proper tools. The course covers recent verification methods, too.	would will the second s	
NI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
	learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web tec	· · ·	-
	lelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	-	
	quality assurance.	5 1	,
NI-SYP	Parsing and Compilers	Z.ZK	5
	upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of va	arious variants and	applications
	of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.		
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
On this seminar	you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research	arch labs around th	e world.
Additionally, you wil	I learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top maching the seminar will prepare you to attend (and profit from) top maching the seminar will be a seminar will b	ne learning and AI o	conferences
	and summer schools, as well as FIT's own Summer Research Program (VyLet).		
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
	r you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research		
Additionally, you wil	Il learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machin	ne learning and AI o	conferences
	and summer schools, as well as FIT's own Summer Research Program (VyLet).		
NI-TES	Systems Theory	Z,ZK	5
	d has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However		
	ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of m tems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and alg		-
	the modeling and analysis of complex systems.	shanno ulat IOIIII li	10 00010 101
NI-TKA	Category Theory	Z,ZK	4
NI-TNN		Z,ZK	5
	Theory of Neural Networks study neural networks from the point of view of probability theory. At		-
	al neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission,		-
	, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transforma	1 07	
	n with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with train		
	ining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most im		
	I network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the		
to neural networ	ks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko	Imogorov theorem,	Vituškin
	ds, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings	-	
being dense in im	portant Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to	o a finite measure,	spaces of
	inuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expect	-	
	d with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how i		
	al expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law	-	-
	n analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the centra	-	-
with its analogy i	for neural networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be topology of the network.	employed to searc	
L	topology of the foction.		

NI-TS1	Theoretical Seminar Master I	Z	4
Theoretical semina	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic	al reading group. T	he students
are treated individu	ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a	work with scientific	papers and
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS2	Theoretical Seminar Master II	, Z	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a		
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	NOTE WITH SCIENTING	papers and
NI-TS3	Theoretical Seminar Master III	7	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic	I – I	•
	ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a		
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS4	Theoretical Seminar Master IV	Z	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic		
are treated individu	ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a state of	work with scientific	papers and
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	771	
NI-TSP	Testing and Reliability knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to pre	Z,ZK	5 the help of
-	ensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with bu		-
	will be able to compute, analyze, and control the reliability and availability of the designed circuits.	in in con toot oquip	
NI-TSW	Software Product Development	KZ	4
	The course is presented in Czech.	. I	
NI-TVR	Virtual Reality Technology	Z,ZK	3
	troduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of cont	-	
tracking, hand tra	cking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of	using virtual and a	ugmented
	reality will be presented.		
NI-UMI	Artificial intelligence	Z,ZK	5
The course covers	s search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programn The main principles and practical applications of discussed techniques will be illustrated.	ing and automated	a planning.
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
	n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and		
-	rtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie	-	
performance pa	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effect	ve technology toda	ay for the
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 modern	n integration
	and development tools (Continuous integration and development).		
NI-VGA	Video Games Architecture	Z,ZK	5 decise and
	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		-
	; physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, in		
	some game mechanics, in the form of practical demonstrations.	0,	
NI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtain:	s general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of fea	ure extraction from	multimedia
	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.	771	7
NI-VSM	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with m	Z,ZK	7 istribution
	ropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rand		
	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 institu		
	the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex		
	MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 week	-	-
	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.	ii the internship exi	ceeus ine
NI-ZS20	Master internship abroad for 20 credits	Z	20
	once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institu	I I	
	the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex		-
	MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 week	-	-
a foreign institutio	on. 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 exe	ceeds the
	academic year's dead-line.		00
NI-ZS30	Master internship abroad for 30 credits	other foreign scien	30 stific and/or
	tented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or . Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provid	-	
	of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KO		
	ime employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This a	-	-
	subjects if the internship exceeds the academic year's dead-line.		

NIE-BLO	Blockchain	Z,ZK	5
Students will under	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platforn	ms. They will be abl	e to design,
code and deploy a	a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places a	an increased emph	asis on the
relationship betwe	een blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the	e students for imple	menting or
	supervising implementation of blockchain-based solutions in both academia and business.		
NIE-PDL	Practical Deep Learning	KZ	5
This course is des	signed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine lea	arning framework. T	hroughout
the course, studen	ts will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such a	as computer vision	and natural
,			
,	language processing.	-	
NIE-PML	language processing. Personalized Machine Learning	Z,ZK	5
NIE-PML		· · ·	5
NIE-PML Personalized made	Personalized Machine Learning	s and behaviors of	5 individual
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NIE-PML Personalized made entities. While PML	Personalized Machine Learning chine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristic _ is commonly used in applications such as recommender systems, which recommend items to users based on their personal interest other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theore	ts and behaviors of ts, its principles car etical, algorithmic, a	5 individual be applied
NIE-PML Personalized mar entities. While PML to a wide range of c PI-SCN	Personalized Machine Learning chine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristic is commonly used in applications such as recommender systems, which recommend items to users based on their personal interest other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theore perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial commu-	s and behaviors of ts, its principles car etical, algorithmic, a unities.	5 individual be applied nd practical 4

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