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

Master Project

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:

NI-MPR

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 gain k	nowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not	only to select and	implement but
also to apply and evalu	ate heuristics for practical problems.		
NI-DIP	Diploma Project	Z	30

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

NI-MPI Mathematics for Informatics Z,ZK 7

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

Parallel and Distributed Programming

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

NI-VSM Selected statistical Methods

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

as well as in parallel.

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:

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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 (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 (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 (Gar.)	Z,ZK	5	2P+1C	Z	PS

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 study	dents should know r	nachine learnin
basics. The emphasi methods).	is is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation	n systems) and mo	dels (e.g., kern
NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
•	dge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both use the knowledge in design of applications that utilize pattern matching.	access time and me	mory complexit
They will be able to t			
NI-GAK The goal of the class	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algority basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select	•	
NI-GAK The goal of the class on undestanding the coloring, Ramsey the	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor	thms. The emphasised topics from graph	s will be not onl and hypergrap
NI-GAK The goal of the class on undestanding the coloring, Ramsey the	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select eory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the	thms. The emphasised topics from graph	s will be not onl and hypergrap
NI-GAK The goal of the class on undestanding the coloring, Ramsey the of combinatorics on NI-KOD	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select eory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the words, formal languages and bioinformatics.	thms. The emphasised topics from grapheory will be also app	s will be not onl and hypergrap blied in the field
NI-GAK The goal of the class on undestanding the coloring, Ramsey the of combinatorics on NI-KOD Students are introdu used in practice. The	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select eory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the words, formal languages and bioinformatics. Data Compression	thms. The emphasised topics from grapheory will be also app	s will be not only and hypergraphical in the field 5 nethods being
NI-GAK The goal of the class on undestanding the coloring, Ramsey the of combinatorics on NI-KOD Students are introdu used in practice. The	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select eory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the words, formal languages and bioinformatics. Data Compression used to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of everview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition	thms. The emphasised topics from grapheory will be also app	s will be not only and hypergraphical in the field 5 nethods being
NI-GAK The goal of the class on undestanding the coloring, Ramsey the of combinatorics on NI-KOD Students are introdu used in practice. The lossy data compress NI-MVI Students will unders	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select eory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the words, formal languages and bioinformatics. Data Compression used to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of everview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition methods used in image, audio, and video compression. Computational Intelligence Methods stand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable	thms. The emphasised topics from grapheory will be also appears and the second students learn the	s will be not only an and hypergraphic blied in the field 5 nethods being fundamentals of 5
NI-GAK The goal of the class on undestanding the coloring, Ramsey the of combinatorics on NI-KOD Students are introdu used in practice. The lossy data compress NI-MVI Students will unders	Graph theory and combinatorics s is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algor basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, select eory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the words, formal languages and bioinformatics. Data Compression used to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of everview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition methods used in image, audio, and video compression. Computational Intelligence Methods	thms. The emphasised topics from grapheory will be also appears and the second students learn the	s will be not only an and hypergraphic blied in the field 5 nethods being fundamentals of 5

NI-SYP Parsing and Compilers

The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.

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

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			٧
NI-ATH	AlgorithmicTheories of Games Dušan Knop, Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+2C	L	V
NI-AFP	Applied Functional Programming Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl (Gar.)	KZ	5	2P+1C	L	٧
NI-APH	Architecture of computer games Adam Vesecký Adam Vesecký Adam Vesecký (Gar.)	Z,ZK	4	2P+1C	Z	٧
NI-VGA	Video Games Architecture Jan Matoušek	Z,ZK	5	2P+1C	Z	٧
NI-BPS	Wireless Computer Networks Ji í Kašpar, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	٧
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.)	KZ	4	3C	Z	V
NI-DPH	Game Design Adam Vesecký	Z,ZK	5	2P+1C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	٧
NI-PSD	Public Services Design Ond ej Brém, David Pešek David Pešek Ond ej Brém (Gar.)	KZ	4	1P+2C		٧
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná 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	٧
NI-PAM	Efficient Preprocessing and Parameterized Algorithms Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-ESC	Experimental Project Course Jan Matoušek, Ond ej Brém Ond ej Brém (Gar.)	KZ	8	0P+30R+52C	L	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	٧
NI-GNN	Graph Neural Networks Miroslav epek Miroslav epek (Gar.)	Z,ZK	4	1P+1C	L	٧
NI-GRI	Grid Computing André Sopczak, Petr Fiedler Pavel Tvrdík 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 Solcová Alena Solcová (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 (Gar.)	Z,ZK	4	2P+1C	L	V
NI-FMT	Finite model theory Tomáš Jakl Tomáš Jakl (Gar.)	Z,ZK	4	2P+1C	L	V
NI-CCC	Creative Coding and Computational Art Radek Richtr, Josef Kortán Radek Richtr Radek Richtr (Gar.)	KZ	4	1P+2C	Z,L	V
NI-KYB	Cybernality	ZK	5	2P	Z	V
NI-LSM2	Statistical Modelling Lab Kamil Dedecius Kamil Dedecius (Gar.)	KZ	5	3C	Z,L	V
NI-LOM	Linear Optimization and Methods Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPL	Managerial Psychology 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 Sime 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 (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 (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 Petr Pauš (Gar.)	KZ	4	2P+1C	Z	V
NI-AML	Advanced machine learning Zden k Buk, Miroslav epek, Rodrigo 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 (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 Jif Dan ek Jif Dan ek Jif 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 Radek Richtr, Michal Haindl Michal Haindl (Gar.)	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	٧
NI-SCE2	Computer Engineering Seminar Master II Hana Kubátová 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 Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-TVR	Virtual Reality Technology Tomáš Nová ek 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 (Gar.)	Z	4	2C	Z	V
NI-TS2	Theoretical Seminar Master II Ond ej Suchý, Tomáš Valla 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	٧
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 (Gar.)	Z,ZK	5	2P+1C	L	V
NI-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	V
FI-TOP	Academic writing Tomáš Nová ek	Z	2	10B	Z	V
NI-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VOL	Elections Dušan Knop Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NI-VPR	Research Project Št pán Starosta Št pán Starosta Št pán Starosta (Gar.)	Z	5		Z,L	V
NI-ZS10	Master internship abroad for 10 credits Zden k Muziká Zden k Muziká (Gar.)	Z	10		Z,L	V
NI-ZS20	Master internship abroad for 20 credits Zden k Muziká Zden k Muziká (Gar.)	Z	20		Z,L	V
NI-ZS30	Master internship abroad for 30 credits Zden k Muziká Zden k Muziká (Gar.)	Z	30		Z,L	V
Characteristics of t	he courses of this group of Study Plan: Code=NI-V.2021 Name=P	urely Electiv	e Maste	r Courses	_ 	
NI-AOA (Completing a professional event in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concarse by the vice-dean for pedagogical activities or the vice-dean for science and research	cluded with a wo	rkshop, a te	est, drafting a	Z report, etc.S	
NI-ATH	AlgorithmicTheories of Games s a branch of mathematics, which has broad applications in economy, biology, politics and			Z	,ZK	4

Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation. Applied Functional Programming This course is presented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional programming languages are on the rise nowadays and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mastering this paradigm becomes a necessary competence of a software engineer: the theory and especially the practice.

NI-APH	Architecture of computer games	Z,ZK	4
-	c understanding of the various issues in the field of computer games development, especially from a technical point of view, but a et a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base	=	
	ey will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important of the process of pathfinding and scripting and apply them in practical exercises (labs).	•	
	ple game, with a strong focus on nontrivial game mechanics.		
NI-VGA	Video Games Architecture de range of topics, procedures and methodologies related to the development of computer games - from a technical point of video.	Z,ZK	5 a design and
	ew. In the lectures, students will be guided through the history of development, the structure of game engines, component an		- 1
	sics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater deta	il, including ways	of implementing
	in the form of practical demonstrations.	7 71/	4
NI-BPS Students will learn about	Wireless Computer Networks It the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in a	Z,ZK ad-hoc networks,	-
	and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get know		
	nd get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.	7 714	
NIE-BLO Students will understand	Blockchain I the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain plat	Z,ZK	5 able to design
	ire decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place	-	- 1
•	ockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares to	he students for im	plementing or
<u> </u>	tion of blockchain-based solutions in both academia and business.	V7	4
NI-CTF The course is designed	Capture The Flag to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.	KZ	4
NI-DPH	Game Design	Z,ZK	5
	ts the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on gam	-	
-	by by ledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics students will get an overview of game development from the designer's perspective, from theoretical concepts to practical im	-	
projects.	students will get all overview of game development from the designer's perspective, from theoretical concepts to practical im-	рістістіацогі аррі	led to semestrar
NI-DSW	Design Sprint	Z	2
-	ojects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to val		
testing the prototypes (p	will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting wolus final presentation).	ith research and t	inisning with
NI-PSD	Public Services Design	KZ	4
	e students to specifics of UX, Service design and development for public sector. We will look into the design and development	•	
	ignesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration Ints-designers as well as clients.	on with client repr	esentatives.
NI-DID	Digital drawing	Z	2
	e students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, pe		
	y in their own design works. Students will also gain experience in drawing and painting with digital and analog tools.The cou g and painting.The course is organized as a thematic practices covering parts of theory and practical exercise to practice ga	-	e who wants to
NI-DZO	Digital Image Processing	Z.ZK	4
_	comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical a	, ,	both easy to
·='	interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is		
	ing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR raction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray c	-	- 1
	ossible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, ac		
NI-DDM	Distributed Data Mining	KZ	4
	e-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hand Fork Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementation	-	- 1
· · ·	te other algorithms. The course is prezented in czech language.	s and will be cape	bic to propose
NI-PAM	Efficient Preprocessing and Parameterized Algorithms	Z,ZK	4
	ation problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often nece	-	· ·
	vill demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one sfrom practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity expo		
. , .	input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomia	,	· ·
•	the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution		
•	ed algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (e relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.	presumably) does	not exist. We
NI-ESC	Experimental Project Course	KZ	8
	urse offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles		-
	-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design		- 1
-	egrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their ski ion, as well as gain experience working in a team to design and prototype a functional solution."	iis in user-centere	a design and
NI-GLR	Games and reinforcement learning	Z,ZK	4
	nt learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intellig	ence. This course	is intended to
give you both theoretica NI-GNN	Il and practical background so you can participate in related research activities. Presented in English. Graph Neural Networks	Z,ZK	4
_	ן שרמאח ואפערמו אפנישטרגא students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural n	' '	
	s, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last		- 1
	terpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.		
NI-GRI	Grid Computing n knowledge about the world-wide network and computing infrastructure.	Z,ZK	5
and gain			

NI-HCM Mind Hacking Cognitive security is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, information systems and assets, the domain of cognitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive security is growing in importance in the context of information warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet environment have real societal impacts such as disruption of social cohesion, threats to democracy or war. Side-Channel Analysis in Hardware NI-HSC Z.ZK This course is dedicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attacks. Students get familiar with various kinds of side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and get familiar with higher-order attacks. They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel information leakage. NI-HMI2 History of Mathematics and Informatics ΖK 3 This course is presented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms, transformations, recursive functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its development. NI-IBE Information Security 2 Students learn information and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international standards in this area. They understand methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g., penetration testing) Intelligent embedded systems Intelligent embedded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The course is an advance version of the Intelligent embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programming and advance application development. Lectures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students develop advanced applications combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web technologies NI-IKM Internet and Classification Methods Z,ZK In this course, the students get acquainted with classification methods used in four important internet, or generally network applications; in spam filtering, in recommendation systems in malware detection systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving these four kinds of problems. On the background of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle with 2-hour lectures and 2-hour exercises. During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult their semester tasks. NI-IAM Internet and Multimedia The NI-IAM course is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquisition of AV signals (input), presentation of AV signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical use case scenarios of real-time audiovisual transmissions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of various components on the quality and latency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the scene up to the presentation for audience. NI-IOT Internet of Things 7.7K 4 The subject is focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is familiarization with available development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (GNU Forth). Introduction to European Economic History The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion. Z.ZK NI-KTH Combinatorial Theories of Games Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics. NI-FMT Finite model theory Z.ZK The aim of the course is to introduce students to the basics of finite model theory. The original motivation is the questions expressibility and verifiability of logical properties of database systems. Since its inception in the 1970s, the course has evolved rapidly and touched on many other areas of theoretical computer science, such as descriptive complexity theory, the Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics. NI-CCC Creative Coding and Computational Art ΚZ Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,) and introduces students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization techniques with artistic methods using modern technologies. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and Metropolitan Planning) and IIM (Institute of Intermedia FEL). Cybernality Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams). ΚZ Statistical Modelling Lab 5 The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clutter, or video tracking We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters. NI-LOM Linear Optimization and Methods 7.7K Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming. NI-MPL 2 Managerial Psychology ZK

Ni-MSI Mathematical Structures in Computer Science The Computer Science Mathematical Structures in Computer Science The Computer			
Interduction to category Persoy. Marhematics for data science In sits course, students are introducted to those feds or instructions that are researcy for understanding standard methods and algorithms as of in data science. The studied in sits course, students are introduced to those feds or instructions, eigenvalues, depondations, operations or contribution with contrastients, studies principle, guideline intercible and contribution with contrastients, studies principle guideline intercible and contribution of the most studies and students of the contribution of the most studies and	·	,	-
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NI-MOPD Modern Object-Oriented Programming in InPharo Modern Object-Oriented Programming is currently on the mean stitisticated paradigment of an ofware creation, especially enterprise information systems, where its ability to natural abstractions is used to build complex modern applications. In this course, we build on the investment of celest systems in contract pure cities; parties Pharo (Paga-pharon org.). The course focuses or invitability all proposes to students, which development netering and areas of interest, in addition to despending deper programming while, which was generally applicable in other OC barquages, students will allow gain the opportunity to work on interesting projects and OC benefologies in terms of a densetial work with the possibility of today and related baselines, or growing and sensetial work with the possibility of today and related baselines, or growing and sensetial work with the possibility of continued in the contract standard will be an interesting to the possibility of the possibili		1 -, 3	,
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students how to use language models to sobe proclems, make informed risk assessments, and work critically with the sociality literature. NINIMS Neural Networks, Machine Learning and Randomness of the control of the construction and training of neural networks as well as a number of other machine learning and machine. The control of the machine learning and machine learning and factors is a subject to the processor of the machine learning and students in sufficient depth a number of specific types of neural networks are discussed in a sufficient of the treatment of the machine learning and anothers are the machine learning and students are present anothers and machine learning and streatment of the machine learning and allows that, in addition in the use of indemmess in neural networks and machine learning, in the final two topics, it epiglins the general stochastic approach to training and extended to specific extended to specific anothers are disconsistent in the processor and the stream of the machine learning models, including a neural networks, are used in one of the most important applications of amount of the machines in the students of the stream of the machines and the students of the machines and the students and the students are designed to the machines and the students are designed to the students and the students are students and the students an	NI-NLM Neural Language Models	Z	5
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Stochastic methods, i.e. methods, i.e. methods based on randomness, are extremely important for the construction and training of neutral networks as well as a number of other machine learning models. The course invalual networks are within learning models and increases and several networks, and machine learning and the results are sufficiently on the properties of the several networks and machine learning. In the final two topics, it explains the general stochastic approach to training and extreme the results of the several networks and machine learning. In the final two topics, it explains the general stochastic approach to training and extreme the results of the several networks and machine learning. The several service of the machine learning models, is consistent to the issue of using networks and machine learning. The several service of the machine learning models in a network of the machine learning models. The several services are moving image, intermet, computer game and sound. The main post is to minister the setulation with the largest possible range of creative approaches in new media. The subject emphasizes dislogue with students, especially in lectures devoted to specific at projects. In Insulation of the machine learning and the several control of the subject emphasizes dislogue with students, especially in lectures devoted to specific at projects. In Insulation of the several control of the several control of the subject emphasizes dislogue with students, especially in lectures devoted to specific at projects. In Insulation of the several control of the several control of the subject emphasizes dislogue with students, especially in lectures devoted to specific at projects. In Insulation of the several control of the several control of the subject emphasizes dislogue with students, especially in lectures devoted to specific and projects are several to several control of the subject of the several control of the several control of the several control of the several control of the several contro			
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randomness, as well as a number of specific stochastic explosed for neural networks and machine learning, and above that, in addition to the use of randomness in neural networks and machine learning, models, including neural networks, are used in one of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms. IN-INMU New media in art and design with the provided of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms. IN-INMU New media in art and design work. Key topics are moving image, internet, computer game and sound. The main goal is to farminative the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially in lectures devoted to specific art projects. IN-IOLI Linux Drivers The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining powerful pronessors and FPGAs increase the variability of perpletes studystems explained systems. This course is an advanced course in the Linux driver development for master's students. The course provides knowledge of Linux operating system schiecture, principles of development of various types drivers, including practical experience. INIE-PML Personalized Machine Lacarring Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entitles. While PML is a commonly used in applications with a recommendate of promoteristic and practical experiences. INI-PML Computer arithmetic operations in the course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will be cause to a not interest to both the research and communities. INI-PGI Computer Graffes Computer Vision course	· · ·		- 1
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systems.		al experiences wi	th embedded
	systems.		

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		
•	vOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utiliz and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.	ing technologies	ASP.NET Core,
NI-PYT	Advanced Python	KZ	4
	is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Pyth		=
	s only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursew		
teachers from Red Hat.			,
NIE-PDL	Practical Deep Learning	KZ	5
This course is designed	to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine	learning framewo	rk. Throughout
	develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields su	ch as computer v	sion and natural
language processing.		1/7	
NI-GOL	Programming of distributed systems in GO	KZ	5
NI-PSL	Programming in Scala	Z,ZK	4
	he modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language feat γ. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks		_
Scalaz, etc.	, obtained the door of application of fathoritation of Section 2011, mortales, store obtained to door by mainly portrolled mainly mortalists.	and librarioo o.g. i	idy, odobandra,
NI-RUB	Programming in Ruby	KZ	4
This course is presente		1	
NI-ROZ	Pattern Recognition	Z,ZK	5
	s to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the s		•
-	Il learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, ar	nd their numerical	
NI-PLS1	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 which		
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in th I FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.	ie discussions. H	le reading group
NI-PLS3	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 whice		-
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the		
is a joint venue between	FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		
NI-PLS2	Programming Language Seminar	Z	2
	uage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which		
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the	ne discussions. Th	e reading group
	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.	7	2
NI-PLS4	Programming Language Seminar uage Seminar uage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which	Z ch we discuss sci	
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the		
	FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		00 1
NI-SCE1	Computer Engineering Seminar Master I	Z	4
The Seminar of Comput	er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	e to failures and a	ttacks. Students
• • •	ally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of t	•	
	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tead	chers. The topics	are new for each
NI-SCE2	Computer Engineering Comings Master II	Z	4
	Computer Engineering Seminar Master II er Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance		
•	rally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of t		
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 tead	chers. The topics	are new for each
semester.			
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
· · · · · · · · · · · · · · · · · · ·	present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research		
	'n how to properly present and read scientific papers.The work in the seminar will prepare you to attend (and profit from) top ma s well as FIT's own Summer Research Program (VyLet).	cnine learning an	d Al conferences
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
	present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research		
•	n how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top ma		
	s well as FIT's own Summer Research Program (VyLet).	· ·	
PI-SCN	Seminars on Digital Design	ZK	4
This subject deals with	problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description	of digital circuits	and basic logic
-	ion algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial p		-
NI-MLP	Machine Learning in Practice	Z,ZK	5
· · · · -	ng methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to	=	
-	ents through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practic Irn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and unc	-	-
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	•	
•	economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as wel		
· · · · · · · · · · · · · · · · · · ·	c development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of	of discussions bas	ed on individual
	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 of		=
	d in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of toes that predominantly by comparing individual countries and key regions of world economy. Students get to know about of incress in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed	different religions	and cultures,
necessary for doing bus	t does that predominantly by comparing individual countries and key regions of world economy. Students get to know about of	different religions If for the right inve	and cultures, stment decision.

NI-TVR	Virtual Reality Technology	Z,ZK	3
	ced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of co	-	
0,	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways o	f using virtual and	d augmented
reality will be presented	,	7	4
NI-TS1	Theoretical Seminar Master I latended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class	Z	4
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		•
•	. The capacity is limited by the the potentials of the teachers of the seminar.	a work with color	nuno paporo una
NI-TS2	Theoretical Seminar Master II	Z	4
	atended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class		
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	0.0	•
other scholarly literature	. 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 in	tended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class	sical reading gro	up. The students
are treated individually a	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	a work with scie	ntific papers and
-	. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS4	Theoretical Seminar Master IV	Z	4
	ttended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a class		•
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	a work with sciei	ntific papers and
-	The capacity is limited by the the potentials of the teachers of the seminar.	7 71/	4
NI-TKA	Category Theory	Z,ZK	4
NI-TNN	Theory of Neural Networks	Z,ZK	5
=	neural networks from the point of view of the theory of function approximation and from the point of view of probability theory ural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmissic		
-	vork training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transfor		
	omatic 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		
-	work training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within		
to neural networks, we f	irst notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko	Imogorov theoren	n, Vituškin
theorem). Afterwards, w	e will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappi	ngs computed by	neural networks
-	t Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect		
	s derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on exp		•
•	h probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see he		-
· · · · · · · · · · · · · · · · · · ·	tancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak la ogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the cent	_	-
-	al 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.			
NI-CPX		Z.ZK	5
- 1	Complexity Theory t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	Z,ZK	-
- 1	Complexity Theory t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	· '	-
Students will learn about	Complexity Theory t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	· '	-
Students will learn about (in)tractability of difficult FI-TOP Publishing is an importa	Complexity Theory t the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing nt and required part of research activity. It is not only about obtaining research results but also about applying them in the for	e theory concern Z m of publication.	ing practical 2 Writing scientific
Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used	Complexity Theory It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing Int and required part of research activity. It is not only about obtaining research results but also about applying them in the forful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the control of the preparation of a bachelor's or master's thesis.	Z m of publication. vourse, students v	2 Writing scientific vill learn how to
Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used write a scientific article,	Complexity Theory It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing Int and required part of research activity. It is not only about obtaining research results but also about applying them in the form full for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the content of the properties of the prope	Z m of publication. vourse, students wan article and rev	2 Writing scientific vill learn how to iewing someone
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Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used write a scientific article, else's article. The course on the availability of enrichled NI-DVG	Complexity Theory It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing Int and required part of research activity. It is not only about obtaining research results but also about applying them in the for ful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the countries what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting exill be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Introduction to Discrete and Computational Geometry	Z m of publication. vourse, students wan article and rev Dates will be determined.	2 Writing scientific vill learn how to iewing someone ermined based
Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used write a scientific article, else's article. The course on the availability of enrichled NI-DVG The course intends to in	Complexity Theory It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing Int and required part of research activity. It is not only about obtaining research results but also about applying them in the for ful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the county what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting expected with the beginning of the semester and one practicum in the middle of the semester. Introduction to Discrete and Computational Geometry troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar or the students to the discipline of Discrete and Computational Geometry.	Z m of publication. vourse, students wan article and rev Dates will be determined.	2 Writing scientific vill learn how to iewing someone ermined based
Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used write a scientific article, else's article. The course on the availability of enrich NI-DVG The course intends to in of this discipline, and to	Complexity Theory It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing Int and required part of research activity. It is not only about obtaining research results but also about applying them in the for ful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the county what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Dilled students. Introduction to Discrete and Computational Geometry troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar who is a problems with a geometric component.	Z m of publication. vourse, students wan article and rev Dates will be dete	2 Writing scientific vill learn how to iewing someone ermined based 5 lamental notions
Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used write a scientific article, else's article. The course on the availability of enroll NI-DVG The course intends to in of this discipline, and to NI-VOL	Complexity Theory It the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing Int and required part of research activity. It is not only about obtaining research results but also about applying them in the for ful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the county what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Dilled students. Introduction to Discrete and Computational Geometry troduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar was able to solve simple algorithmic problems with a geometric component. Elections	Z m of publication. vourse, students wan article and rev Dates will be determined.	2 Writing scientific vill learn how to iewing someone ermined based
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Students will learn about (in)tractability of difficult FI-TOP Publishing is an importate publications can be used write a scientific article, else's article. The course on the availability of enroll NI-DVG The course intends to info this discipline, and to NI-VOL We will cover the basics NI-VYC Classical theory of recurs NI-VPR Student obtains the creen NI-ZS10 Each student can once of the properties of	the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing In the required part of research activity. It is not only about obtaining research results but also about applying them in the for ful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the order to the foreign university or other foreign scientific and/or research insteaded into two subjective. Introduction to Discrete and Computational Geometry It toduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar to be able to solve simple algorithmic problems with a geometric component. Elections of (committee) elections and, in general, opinion aggregation. Computability sive functions and effective computability. Research Project dits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en. Master internship abroad for 10 credits within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research insteaded for study affairs assesses the professional content. The student must provide evidence of the professional content and examinum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjective. Master internship abroad for 20 credits within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research insteaded for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 we maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjective. Master internship abroad for 20 credits it in chazech language. Each student can once within his / her master's degree have a foreign university or other foreign internship at a foreign	To publication. To publication. To publication. To publication. To purse, students wan article and reverse will be determined by the publication of the publication. The publication of the interest of the in	2 Writing scientific vill learn how to iewing someone ermined based 5 Iamental notions 5 4 5 10 e internship the ernship. Auxiliary mployment with exceeds the 20 e internship the ernship. Auxiliary mployment with exceeds the 30 scientific and/or the professional edits correspond
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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 Jan Kurš Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM1	Middleware Architectures 1 Jaroslav Kucha , Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM2	Middleware Architectures 2 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 Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	V
NI-GEN	Code Generators Petr Máj, Jan Janoušek Petr Máj Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-HWB	Hardware Security Ji i Bu ek Ji i 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 (Gar.) Modern Internet Technologies Viktor erný, 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	Operating Systems and Systems Programming Petr Zemánek, Tomáš Martinec Petr Zemánek Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-BUI	Business Informatics Petra Pavlí ková Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	V
NI-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 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 (Gar.)	Z,ZK	5	2P+1C	Z	V

NI-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-RUN	Runtime Systems Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski, Jakub Klímek Milan Doj inovski Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SIB	Network Security Ji í Dostál, Simona Forn sek, Martin Šutovský, Martin Holec Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SCR	Statistical Analysis of Time Series Kamil Dedecius Kamil Dedecius (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SBF	System Security and Forensics Simona Forn sek, Marián Svetlík Simona Forn sek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl, David Buchtela 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	Testing and Reliability Petr Fišer Martin Da hel Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-TSW	Software Product Development Petra Pavlí ková Ond ej Pluha Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	V
NI-UMI	Artificial intelligence Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
NI-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PON	Selected Topics in Optimization and Numerical mathematics Karel Klouda, Št pán Starosta, Daniel Vašata Daniel Vašata Št pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VMM	Retrieval from Multimedia Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V

Z,ZK

Data Mining Algorithms

NI-ADM

The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods). NI-MVI Computational Intelligence Methods Z,ZK Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to many problems. They will learn how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc. Parsing and Compilers Z,ZK The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing. NI-AIB

Algorithms of Information Security Students will get acquainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, students will learn the mathematical

principles of cryptographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detection and the use of machine learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic systems.

Architecture and Design patterns

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

Middleware Architectures 1 Z.ZK

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

NI-AM2 Middleware Architectures 2 Z,ZK

Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.

NI-BML Bayesian Methods for Machine Learning The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, i models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this put and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical in some of them.	hidden variables (true of urpose, a number of real maging. The students w	object position world examples ill try to solve
NI-BVS Embedded Security	Z,ZK	5
Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations		ives in hardware
and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and		
	resources for securing in	iterrial ranotions
of computer systems.		
NI-BKO Error Control Codes	Z,ZK	5
The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmi	tted via channels.	
NI-DSV Distributed Systems and Computing	Z.ZK	5
1 1 3	1 ' 1	-
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of c		
channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanis	sms that support high av	ailability of both
data and services, and safety in case of failures.		
NI-DDW Web Data Mining	Z,ZK	5
	1 '	-
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will be a supplied to the discovered knowledge and technologies for web data acquisition, analysis and utilization of the discovered knowledge.	-	_
techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain a	in overview of most rece	nt developments
in the field of social web and recommendation systems.		
NI-EPC Effective C++ programming	Z,ZK	5
Students learn how to use the modern features of contemporary versions of the C++ programming language for software development. The contemporary versions of the C++ programming language for software development.	1 / 1	nming effectivity
	· -	mining checulvity
and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time		
NI-FME Formal Methods and Specifications	Z,ZK	5
Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use	some software tools the	at allow to prove
basic properties of software.		
• • •	7.71/	
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		-
understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in syste	ms programming. Stude	ents will become
familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.		
NI-HWB Hardware Security	Z,ZK	5
	1 '	-
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of same course provides the knowledge needed for the analysis and design of computer systems security solutions.		
using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attack	s. Students will gain kno	wledge about
the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of	the computer.	
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 cip	1 ' 1	-
	·	
on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of	i diaarata lagarithaa Tha	
	discrete logarithm. The	problem of
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.	discrete logarithm. The	problem of
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices. NI-MPJ Modelling of Programming Languages	discrete logarithm. The	problem of 5
NI-MPJ Modelling of Programming Languages	Z,ZK	5
NI-MPJ Modelling of Programming Languages The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they p	Z,ZK reserve the semantics of	5 of the language.
NI-MPJ Modelling of Programming Languages The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they p This course explores the semantics of programming languages. The students will learn the language models with emphasis on functional language	Z,ZK reserve the semantics ces, students are expected	5 of the language. ed to understand
NI-MPJ Modelling of Programming Languages The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they p	Z,ZK reserve the semantics cres, students are expecte semantic modeling and	5 of the language. ed to understand
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in BI (Business Intelligence). The principles of solving the over real examples. Furthermore, students will get acquainted with t	companies in the Czech Republic (Top 100). The basis is Data management, storage all architecture of information systems in the banking, insurance and telecommunicati he life cycle of information systems in the company / organization and its impact on the	ons sectors will be business strategy	e explained on of the company.
Students will be acquainted with technologies that have prover company / organization.	n themselves in the elimination of basic risks in the planning, implementation and oper	ation of informatio	n systems in the
	hematical principles of constructing symmetric and asymmetric ciphers. They will know		
their own systems or to the creation of their own software solu	otanalysis methods, elliptic curve cryptography and quantum cryptography, which they tions.	can apply to the i	ntegration of
NI-PAS Advanced Aspects of Busine	SS ompared to the bachelor's degree) knowledge and skills needed to establish and run t	Z,ZK	4
	os and documents), business economics, foreign trade and related aspects.		Of Business
NI-PDB Advanced Database Systems	S mization of SQL queries. The next part of the course deals with new concepts of datal	Z,ZK	5 called NoSOI
databases), with the related new data models (XML, graph da	tabases, column databases) and languages for working with them (XQuery, XPath, C	-	
the course deals with performance evaluation of database man NI-GPU GPU Architectures and Progr		Z,ZK	5
Students will gain knowledge of the internal architecture of mo	dern massively parallel GPU processors. They will learn to program them mainly in the	CUDA programmi	ng environment,
which is already a widespread programming technology of GPU will also learn optimization programming techniques and meth	I processors. As an integral part of the effective computational use of these hierarchical ods of programming multiprocessor GPU systems.	computational stru	ctures, students
NI-PDD Data Preprocessing		Z,ZK	5
	analysis. They learn what algorithms can be used to extract information from various da concepts to solve specific problems in individual projects - e.g., extraction of characte		•
pages.		7.71/	
NI-REV Reverse Engineering Students will get acquainted with the essentials of reverse eng	ineering of computer software. They will learn how processes start and what happens	Z,ZK before and after the	5 ne main function
	ganized and how they interact with 3rd party libraries. Another part of the course is de ciples of disassemblers and obfuscation techniques. A part of the course will also be o		
	ed to detect it. One of the lectures will be dedicated to the latest trends on the compu	•	
the course is on the seminars, where students will solve praction NI-RUN Runtime Systems	cally oriented tasks from the real world.	Z.ZK	5
,	M) for high-level programming languages. There are two goals: Give you hands-on exper	. , .	_
	x Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC comp ough a series of guest lectures, introduce you to various advanced topics and implemen		-
Dynamic optimizations, speculations, and deoptimizations Lar		tations of real work	a vivis, including
NI-SWE Semantic Web and Knowledg	ge Graphs gies of the Semantic Web. The course will provide an overview of the Semantic Web t	Z,ZK	5 and best
•	onsumption of semantic data. The students will also gain skills in creation of knowledg	_	
quality assurance. NI-SIM Digital Circuit Simulation and	Varification	Z,ZK	5
The aim of the course is to acquaint the students with principle	es of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction L	1 '	_
properties of proper tools. The course covers recent verificatio NI-SIB Network Security	n methods, too.	Z,ZK	5
NI-SCR Statistical Analysis of Time S	eries	Z,ZK	5
The course deals with the practical use of the basic time serie	s modelling theory in engineering tasks, ranging from economics (stock exchange price	ces, employment)	
	tworks (network components load, attacks detection). The students learn to select a co of future or intermediate values. The stress is put on understanding and adoption of the	· · · · · · · · · · · · · · · · · · ·	
·	oloit freely available software packages in order to provide easy and straightforward tra	ansfer of students'	knowledge from
the academic to the real world. NI-SBF System Security and Forensi	CS	Z,ZK	5
Students will get familiar with aspects of system security (princ	siples of end station security, principles of security policies, security models, authentic	ation concepts). F	
students will get familiar with forensic analysis as a tool for inv importance of operating system/operating system artifacts or f	estigating security incidents (techniques used by malicious software/attackers and for ile system for attack analysis and detection).	ensic analysis teci	iniques and the
NI-DSS Decision Support Systems		Z,ZK	5
-	nd skills in decision support systems, their classification (Powerova), selected principle ill also gain knowledge of multicriterial decision-making methods and game theory. They		
of conceptually and ontologically oriented decision support sy	stems and the basics of distribution, optimization and evolution methods and algorithm	ns.	
NI-TES Systems Theory Today, humankind has the ability to develop systems of incred	ible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). Howev	Z,ZK	5 anaging this
complexity and of ensuring the correct behavior of a given sys	tem have become critical. A key technique for mastering this complexity is the usage	of models that des	cribe only those
aspects of the systems that are important for the task at hand, the modeling and analysis of complex systems.	and automated tools for analyzing those models. This subject will present theory and	algorithms that fo	rm the basis for
NI-TSP Testing and Reliability		Z,ZK	5
-	nethods for increasing reliability and security. They will get practical skills to be able to tic test generation. They will be able to design easily testable circuits and systems with		
will be able to compute, analyze, and control the reliability and	availability of the designed circuits.		
NI-TSW Software Product Developme The course is presented in Czech.	ent	KZ	4
NI-UMI Artificial intelligence		Z,ZK	5
The course covers search and inference algorithms in major for The main principles and practical applications of discussed ter	ormal paradigms used in artificial intelligence such as logic theories, constraint progra	mming and autom	ated planning.
and processes appropriate or discussed to	1		

NI-EHW **Embedded Hardware** The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures. **Embedded Software** Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence. NI-VCC Virtualization and Cloud Computing Students will gain knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and organizations. They will get acquainted with virtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficiently operate and optimize the performance parameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effective technology today for the management of complex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in the use of modern integration and development tools (Continuous integration and development). NI-APR Selected Methods for Program Analysis Z.ZK 5 This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs. NI-PON Selected Topics in Optimization and Numerical mathematics Z.ZK The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-VMM Retrieval from Multimedia Z.ZK The student obtains general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feature extraction from multimedia objects, indexing, and structure of distributed search engines. NI-MCC Multicore CPU Computing Z.ZK Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific

List of courses of this pass:

optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput.

On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.

Code	Name of the course	Completion	Credits
FI-TOP	Academic writing	Z	2
Publishing is an im	portant and required part of research activity. It is not only about obtaining research results but also about applying them in the form	of publication. Writi	ng scientific
publications can b	e useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the cou	rse, students will le	earn how to
write a scientific ar	ticle, 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. De	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	d countries
and key regions of	world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as	indexes of econon	nic freedom
corruption and eco	promic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of di	scussions based of	n individua
	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 introd	uces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global ecc	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	ons is deciphered.	The course
does not cover de	etailed 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
The course focuse	s on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students	should know mach	ine learning
basics. The empha	isis 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., kerne
	methods).		
NI-ADP	Architecture and Design patterns	Z,ZK	5
The objective of th	is course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as	well as with unde	rstanding of
the challenges, iss	ues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge o	f object-oriented p	rogramming
and get familiar wit	h the commonly used object-oriented design patterns that represent the best practices for solving common software design problems.	n the second part	he students
will be introduced t	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	sented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional p	rogramming langu	ages are on
the rise nowadays	s and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, master	ing this paradigm	oecomes a

necessary competence of a software engineer: the theory and especially the practice.

NI-AIB			
Students will get ac	Algorithms of Information Security equainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, stude	Z,ZK	5
•	otographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detec		
	learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic system		1
NI-AM1	Middleware Architectures 1	Z,ZK	5
	dy new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syste lication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm		
	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 for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.	es, concepts and	technologies
NI-AML	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 t	=	_
NI-AOA	Completing a professional event	Z	1
	icipation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, draftii	-	1
must be approved	d in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT thro	ough a website, ir	fomail, etc.
NI-APH	Architecture of computer games	Z,ZK	4
_	basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also vill get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base co	-	
	es. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An impo	· ·	_
	implementation of a simple game, with a strong focus on nontrivial game mechanics.		
NI-APR	Selected Methods for Program Analysis	Z,ZK	5
	ices you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynan art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizatior	=	
we will look at the a	Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.	is, error detection	i. iii Dynaniic
NI-APT	Advanced Program Testing	Z,ZK	5
Testing a program	is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The go	al of the course is	s to present
	advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.		
NI-ARI	Computer arithmetic Students will learn various data representations used in digital devices and will be able to design arithmetic operations implemental	Z,ZK	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 study	•	r of agents
		iles tile bellaviou	i oi agenta
(players) of a cert	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game the	neory is to find th	e equilibria,
(players) of a cert which are the states	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game the soft the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social network	heory is to find the s, online auctions	e equilibria, , advertising,
(players) of a cert which are the states multiagent system	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game the	neory is to find the s, online auctions ficient computation	e equilibria, , advertising, on of various
(players) of a cert which are the states multiagent system	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game the soft the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social network is and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of effective states.	neory is to find the s, online auctions ficient computation	e equilibria, , advertising, on of various
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NI-DDM Distributed Data Mining ΚZ Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands on experience with large scale data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations and will be capable to propose approaches to parallelize other algorithms. The course is prezented in czech language. NI-DDW Web Data Mining Z,ZK 5 Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems. NI-DID Digital drawing The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, perspective and color theory, which they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course is fit for anyone who wants to practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice gained knowledge NI-DIP Diploma Project Ζ 30 NI-DNP Advanced .NET Z.ZK Students will acquire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WPF, UWP), Blazor and also will get notions of Azure DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing technologies ASP.NET Core, Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT. NI-DPH Game Design Z,ZK The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game design. It is intended for people interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics design, storytelling, and game development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semestral projects. NI-DSS **Decision Support Systems** The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-oriented and knowledge-oriented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will also learn about the principles of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms. Distributed Systems and Computing Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communication channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that support high availability of both data and services, and safety in case of failures. NI-DSW Design Sprint Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validated prototype in 5 days. During the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with research and finishing with testing the prototypes (plus final presentation). NI-DVG Introduction to Discrete and Computational Geometry 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 fundamental notions of this discipline, and to be able to solve simple algorithmic problems with a geometric component. 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 algorithms that are both easy to implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is also valuable outside the domain of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement, interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting. Enterprise Data Warehouse Systems The Enterprise Data Warehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowledge not only in designing warehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to the area of reporting and data visualization. NI-EHW **Embedded Hardware** Z,ZK The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures. NI-EPC Effective C++ programming Z,ZK 5 Students learn how to use the modern features of contemporary versions of the C++ programming language for software development. The course focuses on programming effectivity and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time requirements. **Experimental Project Course** "The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, 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, collaborate with industry experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their skills in user-centered design and user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution." NI-ESW **Embedded Software** Z,ZK 5 Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programming in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated techniques combined with artificial intelligence. NI-FVY 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 access time and memory complexity. 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 describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some software tools that allow to prove basic properties of software.

NI-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 de-		
systems. Office its i	Constraint Satisfaction Problem (CSP), the theory of algorithmic meta-theorems and combinatorics.	soriptive complexity	uncory, unc
NI-GAK	Graph theory and combinatorics	Z,ZK	5
_	ss is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms.	•	- 1
_	e basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected top heory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory w		
g,	of combinatorics on words, formal languages and bioinformatics.	20 2 27	
NI-GEN	Code Generators	Z,ZK	5
	jues of translating programs written in high-level programming languages are essential for understanding the field of systems program	- :	- 1
understanding the	algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems progr familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming lan	-	will become
NI-GLR	Games and reinforcement learning	Z,ZK	4
The field of reinfor	cement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligen		ntended to
AU ONIN	give you both theoretical and practical background so you can participate in related research activities. Presented in English		
NI-GNN The course intro	Graph Neural Networks oduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural n	Z,ZK	4 g vector
	of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last p		- 1
	graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and pro-		
NI-GOL	Programming of distributed systems in GO	KZ	5
NI-GPU	GPU Architectures and Programming nowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI	Z,ZK	5
•	videspread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com		
	will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.	•	,
NI-GRI	Grid Computing	Z,ZK	5
NII LIONA	Grid computing and gain knowledge about the world-wide network and computing infrastructure.	714	
NI-HCM	Mind Hacking is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, info	ZK	5 and assets
	nitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive secur	-	
the context of inforr	nation warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet	environment have r	eal societal
NULLINAIO	impacts such as disruption of social cohesion, threats to democracy or war.	71/	
NI-HMI2 This course is pro-	History of Mathematics and Informatics esented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithm	ZK s transformations	3 recursive
тио общество је р.	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
	dicated 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	_	- 1
· ·	leans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studel yptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions	Ü	dge about
NI-IAM	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 eff ncy of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording th	-	
ine quality and late	for audience.	e scelle up to the p	resentation
NI-IBE	Information Security	ZK	2
	ormation and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internation		- 1
NI-IKM	d methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g. Internet and Classification Methods	Z,ZK	g). 4
	triter her and Classification internet and Classification 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		
NI-IOS	During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consul Advanced techniques in iOS applications	KZ	4
	the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the b		
	BI-IOS.		
NI-IOT	Internet of Things	Z,ZK	4
The subject is t	ocused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is fa development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (G		ivaliable
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		
-	mbedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programment to be actually considered to the course of metics course for the backet of metics of metics course for the backet of metics of metics course for the backet of the backet of the backet of metics of met	-	
uevelopment. Lectl	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	· ·	applications
NI-KOD	Data Compression	Z,ZK	5
Students are intro	oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data	compression meth	ods being
used in practice. Th	ne overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, study	ents learn the funda	amentals of
	lossy data compression methods used in image, audio, and video compression.		

NI-KOP Combinatorial Optimization Z,ZK 6 The students will gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not only to select and implement but also to apply and evaluate heuristics for practical problems. Advanced Cryptology Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the mathematical principles of random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they can apply to the integration of their own systems or to the creation of their own software solutions. Combinatorial Theories of Games Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a certain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player full-information combinatorial games, was by Conway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is to evaluate games such that otherwise incompatible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The third most important step is the work of Beck, who established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force traversal of the game tree, which is no efficient. Beck introduced the "false probabilistic method", which aims to tackfle this problem. In this course we build the foundation of the theory of combinatorial and positional games. We focus on theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requires independent work, ability to mathematically analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory, as well as for PhD students looking for research topics. NI-KYB Cybernality Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams). Linear Optimization and Methods Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer programming. They are able to work with optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optimization problems in computer science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling salesman problems, etc.), issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get orientation in algorithms in linear programming. Statistical Modelling Lab NI-LSM2 ΚZ 5 The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clutter, or video tracking. We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters. Multicore CPU Computing Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications. NI-MKY Mathematics for Cryptology Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course focuses on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discrete logarithm. The problem of factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices NI-MLP Machine Learning in Practice Z,ZK Applying machine learning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ideally, technical implementation The course guides students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically. The aim is to experience real data processing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and understandable report. Modern Object-Oriented Programming in Pharo Object-oriented programming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where its ability to natural abstraction is used to build complex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills of design and implementation of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development needs and areas of interest. In addition to deepening object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work on interesting projects and OO technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvement in the Pharo Consortium. Mathematics for Informatics 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. Modelling of Programming Languages The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve the semantics of the language This course explores the semantics of programming languages. The students will learn 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 semantic modeling and execution tools. NI-MPL Managerial Psychology NI-MPR Master Project 1. At the beginning of the semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial tasks that should be carried out during the semester. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the end of the semester. 2. The external supervisor enters the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.cz/student/studijni/formulare). The completed and signed form must be delivered in person or by email to the SZZ coordinator, who will arrange for the credit to be granted. 3. If the FT topic that the student has reserved is rather general, the immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that the FTT will be complete and approvable at the end of the semester. NI-MSI Mathematical Structures in Computer Science Z,ZK 4 Mathematical semantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Scott model of lambda calculus. Introduction to category theory. NI-MTI Modern Internet Technologies Z.ZK SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration - A single network, oriented on TCP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, video and data to achieve seamless

integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundreds of millions of users and billions of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and Traffic Prioritisation - These technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, delay, jitter, type of protocol). 4. Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of failures. NI-MVI Computational Intelligence Methods Z,ZK 5 Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to many problems. They will learn how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc. Mathematics for data science In this course, students are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in data science. The studied topics include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality principle, gradient methods) and selected notions from probability theory and statistics. NI-NLM Neural Language Models 5 In this course, students will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The goal of the course is to teach students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific literature. NI-NMS Neural Networks, Machine Learning and Randomness Stochastic methods, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a number of other machine learning models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks that rely substantially on randomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general stochastic approach to training neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including neural networks, are used in one of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms. NI-NMU New media in art and design The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game and sound. The main goal is to familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially in lectures devoted to specific art projects. Nonlinear Continuous Optimization and Numerical Methods Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such methods to real-world problems. They will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They will learn to solve systems of linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement these algorithms sequentially as well as in parallel. NI-NSS Normalized Software Systems Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering, such as stability from system theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issues occur in any given software architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. These elements provide the core functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability and entropy-related principles. This knowledge allows students to realize new levels of evolvability in software architectures. NI-NUR User Interface Design Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal user models, the fundamental notions and procesures. They get acquainted with graphical, speech, and multimodal Uls. Thanks to the gained knowledge, the students will be able to design advanced Uls. **Linux Drivers** The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining powerful processors and FPGAs increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development for master's students. The course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical experience. Operating Systems and Systems Programming The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel data structures. Key topics are: process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The course also addresses kernel development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. Specifics of kernel architecture in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, students will work on projects focused on development of LINUX kernel modules. Efficient Preprocessing and Parameterized Algorithms There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necessary to solve these problems exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one can find a common property (parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponentially in this (small) parameter and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial time preprocessing of the input, which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution method. We will 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 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-PAS 4 Advanced Aspects of Business The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run their own business or business management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspects Advanced Database Systems Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database machines (so called NoSQL databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPHER, Gremlin). The last part of the course deals with performance evaluation of database machines. Data Preprocessing Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data sources, such as images, texts, time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteristics from images or from web pages. NI-PDP Parallel and Distributed Programming 21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores. Parallel computing systems are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platforms. Students get acquainted with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication operations, and languages and environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on selected problems, they will

NI-PG1 Computer Grafics 1 The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The course is designed for those interested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the course is the study of scientificanticles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and topics of computer graphics. NI-PIS Enterprise Information Systems The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of big data (BigData) and their use in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunications sectors will be explained on real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the business strategy of the company. Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operation of information systems in the company / organization.
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company / organization:
NI-PIV Computer Vision Z,ZK 5
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing. Students will get acquainted with
the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical knowledge as well as on
practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, 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 scientific papers
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.
NI-PLS2 Programming Language Seminar Z 2
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which we discuss scientific papers
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.
NI-PLS3 Programming Language Seminar Z 2 The Programming Language Seminar I are the format of a reading group in which we discuss scientific pages.
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NI-PLS4 Programming Language Seminar Z 2
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about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the discussions. The reading group
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming languages. NI-PON Selected Topics in Optimization and Numerical mathematics Z,ZK 5
The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained
in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts
of numerical matematics, mainly numerical linear algebra, are explained too.
NI-PSD Public Services Design KZ 4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and development process from the perspective of suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration with client representatives.
Course is aimed at students-designers as well as clients.
NI-PSL Programming in Scala Z,ZK 4
The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language features - e.g. pattern matching and advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and libraries e.g. Play, Cassandra Scalaz, etc.
NI-PVR Advanced Virtual Reality KZ 4
The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D models in Blender, and among other
things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also deal with creating applications
in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the knowledge gained in this subject in virtual reality, or directly create a complex game for VR.
NI-PVS Advanced embedded systems Z,ZK 4
The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced topics like security support,
working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical experiences with embedded
systems.
NI-PYT Advanced Python KZ 4
The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python (BI-PYT) left of. The course is very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework. The course is lead by external
teachers from Red Hat.
NI-REV Reverse Engineering Z,ZK 5
Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens before and after the main function
is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedicated to reverse engineering of
applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be dedicated to debuggers: how debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer malware scene. The focus of
the course is on the seminars, where students will solve practically oriented tasks from the real world.
NI-ROZ Pattern Recognition Z,ZK 5
The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the statistical approach to pattern
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, and their numerical aspects.
NI-RUB Programming in Ruby KZ 4 This course is presented in Czech.
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NI-RUN Runtime Systems Z,ZK 5 This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience in design and implementation of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compilation Memory management Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementations of real-world VMs, including Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs System Security and Forensics NI-SBF Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, authentication concepts). Furthermore, students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensic analysis techniques and the importance of operating system/operating system artifacts or file system for attack analysis and detection). Computer Engineering Seminar Master I The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCE2 Computer Engineering Seminar Master II The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCR Statistical Analysis of Time Series 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 industrial problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenient process model, estimate its parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main principles based on practical real-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer of students' knowledge from the academic to the real world. NI-SEP World Economy and Business Z,ZK This course is presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite. NI-SIB **Network Security** Z,ZK NI-SIM 5 Digital Circuit Simulation and Verification 7.7K The aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers recent verification methods, too. NI-SWE Semantic Web and Knowledge Graphs Z,ZK 5 The students will learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web technologies, methods and best practices for modelling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge graphs and their systematic quality assurance. NI-SYP Parsing and Compilers 5 The module builds upon the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of various variants and applications of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing. Knowledge Engineering Seminar Master I 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 labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and Al conferences and summer schools, as well as FIT's own Summer Research Program (VyLet). NI-S72 Knowledge Engineering Seminar Master II 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 labs around the world. Additionally, you will learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top machine learning and AI conferences and summer schools, as well as FIT's own Summer Research Program (VyLet). NI-TES Systems Theory Z,ZK Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems. NI-TKA **Category Theory** Z.ZK NI-TNN Theory of Neural Networks Z,ZK In this course, we study neural networks from the point of view of the theory of function approximation and from the point of view of probability theory. At first, we recall basic concepts pertaining to artificial neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission, network topology, somatic and synaptic mappings, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transformation into a canonical topology, and in connection with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with training, we pay attention to the problem of overtraining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most important optimization methods employed for neural network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the topic approximation approach to neural networks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Kolmogorov theorem, Vituškin theorem). Afterwards, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings computed by neural networks being dense in important Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to a finite measure, spaces of functions with continuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expectation and training based on a random sample, and with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how it is possible to get an estimate of the conditional expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law of large numbers and get acquainted with an analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the central limit theorem, get acquinted with its analogy 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 employed to search for the topology of the network.

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	Theoretical Seminar Master I	Z	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classi Ially and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a		
are treated marvid	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	WORK WITH SCIENTIFI	с рарего апо
NI-TS2	Theoretical Seminar Master II	Z	4
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	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-TS3	Theoretical Seminar Master III	Z	4
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NI-TS4	Theoretical Seminar Master IV	Z	4 The standards
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classi Ially and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a		
are treated individ	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	WOLK WILL SCIENTILL	ic papers and
NI-TSP	Testing and Reliability	Z,ZK	5
	knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to pre		_
•	ensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with be	•	•
	will be able to compute, analyze, and control the reliability and availability of the designed circuits.	·	
NI-TSW	Software Product Development	KZ	4
	The course is presented in Czech.	<u>-</u>	·
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 con	•	
tracking, hand tr	cking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of	fusing virtual and	augmented
	reality will be presented.		
NI-UMI	Artificial intelligence	Z,ZK	5
The course cover	s search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programs The main principles and practical applications of discussed techniques will be illustrated.	ming and automate	ed planning.
NI-VCC		7.71/	
	Virtualization and Cloud Computing n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	Z,ZK	5
_	rtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to effici	_	-
-	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effec		-
	mplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills		-
	and development tools (Continuous integration and development).		
NI-VGA	Video Games Architecture	Z,ZK	5
	s a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of vi		
	of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and f		
game developmer	t, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail,	including ways of i	implementing
	some game mechanics, in the form of practical demonstrations.		
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 feat objects, indexing, and structure of distributed search engines.	ature extraction from	m multimedia
NI-VOL	Elections	Z,ZK	5
MI-VOL	We will cover the basics of (committee) elections and, in general, opinion aggregation.	Z,ZR	3
	Research Project	Z	5
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NI-VPR	Student obtains the credits for bublished scientific outburs. The details are at https://courses.iif.cvut.cz/Ni-vPR/en	_	•
	Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.		· 7
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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 platforms. They will be able to design, code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places an increased emphasis on the relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the students for implementing or supervising implementation of blockchain-based solutions in both academia and business. NIE-PDL Practical Deep Learning This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural language processing. Personalized Machine Learning Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities. PI-SCN Seminars on Digital Design This subject deals with problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description of digital circuits and basic logic

synthesis and optimization algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial problems emerging in EDA.

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