Study plan

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

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch: Program of study: Informatika

Type of study: Follow-up master full-time

Required credits: 98

Elective courses credits: 22 Sum of credits in the plan: 120

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

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

Vitvar, Ph.D., email: tomas.vitvar@fit.cvut.cz

Name of the block: Compulsory courses in the program

Minimal number of credits of the block: 63

The role of the block: PP

Code of the group: NI-PP.2020

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

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

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

Credits in the group: 63 Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-KOP	Combinatorial Optimization Jan Schmidt, Ji í Vysko il, Petr Fišer Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	6	2P+2C	Z	PP
NI-DIP	Diploma Project Zden k Muziká Zden k Muziká Zden k Muziká (Gar.)	Z	30	270ZP	L,Z	PP
NI-MPR	Master Project Zden k Muziká Zden k Muziká (Gar.)	Z	7		Z,L	PP
NI-MPI	Mathematics for Informatics Št pán Starosta, Jan Sp vák Št pán Starosta Št pán Starosta (Gar.)	Z,ZK	7	3P+2C	Z	PP
NI-PDP	Parallel and Distributed Programming Pavel Tvrdík Pavel Tvrdík 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 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 evalu	late heuristics for practical problems.						
NI-DIP	Diploma Project	Z	30				
NI-MPR	Master Project	Z	7				

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

NI-MPI Mathematics for Informatics Z,ZK 7

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

NI-PDP Parallel and Distributed Programming

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-PS-WI.20

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

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

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

Credits in the group: 35

Note 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-AM1	Middleware Architectures 1 Jaroslav Kucha , Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-AM2	Middleware Architectures 2 Jaroslav Kucha , Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-DDW	Web Data Mining Jaroslav Kucha, Milan Doj inovski Jaroslav Kucha Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-PDB	Advanced Database Systems Yelena Trofimova, Michal Valenta Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	PS
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	PS
NI-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-VMM	Retrieval from Multimedia Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	PS

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

NI-AM1	Middleware Architectures 1	Z,ZK	5				
Students will study nev	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 aplicat	ion servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d high availability				
of applications.	of applications.						
NI-AM2	Middleware Architectures 2	7 7K	5				

Students will learn new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architectures, concepts and technologies

for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.

Web Data Mining Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain an overview of Web mining

techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overview of most recent developments in the field of social web and recommendation systems

NI-PDB Advanced Database Systems Z.ZK 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. 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-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-VMM Retrieval from Multimedia

objects, indexing, and structure of distributed search engines.

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

Name of the block: Elective courses Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NI-V.2021

Name of the group: Purely Elective Master Courses

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

Credits in the group: 0

Note on the group:

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

	has completed in the bachelor study at CTU cannot be	e re-comple	ted.			
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-AOA	Completing a professional event Zden k Muziká	Z	1			V
NI-ATH	AlgorithmicTheories of Games Dušan Knop, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+2C	L	V
NI-AFP	Applied Functional Programming Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl (Gar.)	KZ	5	2P+1C	L	V
NI-APH	Architecture of computer games Adam Vesecký Adam Vesecký Adam Vesecký (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-VGA	Video Games Architecture Jan Matoušek	Z,ZK	5	2P+1C	Z	V
NI-BPS	Wireless Computer Networks Ji í Kašpar, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-BLO	Blockchain Róbert Lórencz, Jakub R ži ka, Josef Gattermayer, Marek Bielik Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-CTF	Capture The Flag Ji í Dostál, Martin Šutovský, Ivana Trummová, Ladislav Marko, František Ková 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	V
NI-PSD	Public Services Design Ond ej Brém, David Pešek David Pešek Ond ej Brém (Gar.)	KZ	4	1P+2C		V
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná Denisa Nová ková (Gar.)	Z	2	4C	Z,L	V
NI-DZO	Digital Image Processing	Z,ZK	4	2P+1C	L	V
NI-DDM	Distributed Data Mining Tomáš Borovi ka	KZ	4	3C	L	V
NI-PAM	Efficient Preprocessing and Parameterized Algorithms Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-ESC	Experimental Project Course Jan Matoušek, Ond ej Brém Ond ej Brém (Gar.)	KZ	8	0P430R4520	L	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GNN	Graph Neural Networks Miroslav epek Miroslav epek (Gar.)	Z,ZK	4	1P+1C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler 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 Šolcová Alena Šolcová (Gar.)	ZK	3	2P+1C	Z	V
NI-IBE	Information Security Igor ermák	ZK	2	2P	Z	V

NI-IVS	Intelligent embedded systems Miroslav Skrbek Miroslav Skrbek (Gar.)	KZ	4	1P+3C	L	V
NI-IKM	Internet and Classification Methods Martin Hole a Martin Hole a Martin Hole a (Gar.)	Z,ZK	4	1P+1C	L	V
NI-IAM	Internet and Multimedia	Z,ZK	4	2P+1C	L	V
NI-IOT	Internet of Things Jan Jane ek	Z,ZK	4	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan	Z,ZK	3	2P+1C	L	V
NI-KTH	Combinatorial Theories of Games Tomáš Valla Tomáš Valla (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 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, concance 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 imp	•	
	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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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
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	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 content of the properties of the properties of the properties of the preparation of a bachelor's or master's thesis. In the content of the properties of the propertie	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 county 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
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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 recursive NI-VPR Student obtains the creen NI-ZS10 Each student can once to course MI-ZS10, MI-ZS a foreign institution. The academic year's dead-lite NI-ZS20 Each student can once to courses MI-ZS10, MI-ZS a foreign institution. The academic year's dead-lite NI-ZS20 The course is prezented.	the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing In 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 control of the students are at the beginning of the semester and one practicum in the middle of the semester. Diled students. Introduction to Discrete and Computational Geometry Introduction to Discrete and Computational Geometry Introduction to Discrete and Computational Geometry Introduction to 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 The research Project Its 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 instice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and account 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 subjects necessary and the professional content and such accounts of the professional content and suc	To publication. To push of publication. To push, students wan article and reverse pates will be determined by the push of the	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
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Code of the group: NI-WI-VS.20

Name of the group: Elective Vocational Courses for Master Specialization Web Engineering

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

Credits in the group: 0

Note on the group:

All compulsory subjects of specializations with the exception of this specialization.

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-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 Tvrdik Jan Fesl Pavel Tvrdik (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub (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-GAK	Graph theory and combinatorics Michal Opler Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	5	2P+2C	L	V
NI-HWB	Hardware Security Ji í Bu ek Ji í Bu ek (Gar.)	Z,ZK	5	2P+2C	L	V
NI-KOD	Data Compression Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	L	V
NI-MKY	Mathematics for Cryptology Martin Jure ek, Róbert Lórencz Róbert Lórencz (Gar.)	Z,ZK	5	3P+1C	L	V
NI-MVI	Computational Intelligence Methods Pavel Kordík Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MEP	Modelling of Enterprise Processes Robert Pergl, Marek Suchánek Robert Pergl Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPJ	Modelling of Programming Languages	Z,ZK	5	2P+1C	Z	V
NI-MTI	Modern Internet Technologies Viktor erný, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NUR	User Interface Design Josef Pavlí ek Josef Pavlí ek Josef Pavlí ek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-NON	Nonlinear Continuous Optimization and Numerical Methods Jaroslav Kruis Jaroslav Kruis (Gar.)	Z,ZK	5	2P+1C	Z,L	V
NI-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, St pánka Havlíková, Dominik Vítek, Ji í Maršál, Jana Soukupová, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	L	V

NI-PDD	Data Preprocessing Marcel Ji ina Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-REV	Reverse Engineering Josef Kokeš Josef Kokeš 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-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 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-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PON	Selected Topics in Optimization and Numerical mathematics Karel Klouda, Št pán Starosta, Daniel Vašata Daniel Vašata Št pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	V
NI-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V

Characteristics of the courses of this group of Study Plan: Code=NI-WI-VS.20 Name=Elective Vocational Courses for Master Specialization Web Engineering

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

Z.ZK

5

NI-ADM

Data Mining Algorithms

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-AIB Algorithms of Information Security Z,ZK 5

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.

NI-ADP Architecture and Design patterns Z,ZK

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

NI-BML Bayesian Methods for Machine Learning KZ 5

The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.

NI-BVS Embedded Security Z.ZK 5

Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems.

NI-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 transmitted via channels.

NI-DSV Distributed Systems and Computing Z,ZK 5

Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of 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-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.

NI-EVY Efficient Text Pattern Matching	Z,ZK	5
Students get knowledge of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both according to the structure of applications that utilize pattern matching.	ess time and mem	ory 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		
basic properties of software.		
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 program		-
understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems pro	gramming. Studer	nts will become
familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages. NI-GAK Graph theory and combinatorics	Z,ZK	5
The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithm		
on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected to		- 1
coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory	will be also appli-	ed in the fields
of combinatorics on words, formal languages and bioinformatics.		
NI-HWB Hardware Security The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguar	Z,ZK	5 of the system
using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Students	_	-
the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the cor	_	
NI-KOD Data Compression	Z,ZK	5
Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data		- 1
used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stu lossy data compression methods used in image, audio, and video compression.	dents learn the fu	indamentals of
NI-MKY Mathematics for Cryptology	Z,ZK	5
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In		-
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 discret	•	
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
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 n how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.	nany problems. Th	ney will learn
NI-MEP Modelling of Enterprise Processes	Z,ZK	5
The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach	, , , , , , , , , , , , , , , , , , ,	
implementation of processes, organisation structures and information support in big enterprises and institutions.	() 0	
NI-MPJ Modelling of Programming Languages	Z,ZK	5
The analysis, transformation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve		
This course explores the semantics of programming languages. The students will learn the language models with emphasis on functional languages, students of the lambda calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with seman		
NI-MTI Modern Internet Technologies	Z,ZK	5
SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration -	,	-
TCP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, vide		
integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundred:		
of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching and technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, delay		
Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of fa		
NI-NUR User Interface Design	Z,ZK	5
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, form		
notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able to		
NI-NON 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 meth	Z,ZK	5 problems They
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. The		
linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implemen	t these algorithms	sequentially
as well as in parallel.		
NI-NSS Normalized Software Systems	ZK	5
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issued to the control of the contro	•	
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements.		٠ .
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability	ty and entropy-rela	ated principles.
This knowledge allows students to realize new levels of evolvability in software architectures.		
NI-OSY Operating Systems and Systems Programming The source of the state of the st	Z,ZK	5
The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The c		
development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability		
in embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within lal	os, students will w	ork on projects
focused on development of LINUX kernel modules.		
NI-BUI Business Informatics The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of	Z,ZK	5 management
ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management of business informatics. Students will gain knowledge in the aleas of		-
of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance of ICT services and resource management (sourcing).		•
business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management	ice, the important	
	•	vestment
management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).	•	vestment
	•	vestment

in BI (Business Intellige real examples. Furthern	Enterprise Information Systems on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of noce). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication ore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the noted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operations.	ons sectors will be business strategy	explained on of the company.
company / organization			
NI-KRY Students will learn the e	Advanced Cryptology essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know	Z,ZK the mathematica	5 I principles of
random number genera	tors. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they	can apply to the ir	ntegration of
their own systems or to	the creation of their own software solutions.		
NI-PAS	Advanced Aspects of Business	Z,ZK	4
	s to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run the	neir own business	or business
	y in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.		
NI-GPU	GPU Architectures and Programming	Z,ZK	5
Students will gain know	edge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the	CUDA programmir	ng environment,
•	pread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical $lpha$	computational stru	ctures, students
will also learn optimizat	ion programming techniques and methods of programming multiprocessor GPU systems.		
NI-PDD	Data Preprocessing	Z,ZK	5
Students learn to prepa	re raw data for further processing and analysis. They learn what algorithms can be used to extract information from various da	ta sources, such a	s images, texts,
time series, etc., and lea	arn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characteı	ristics from images	s or from web
pages.			
NI-REV	Reverse Engineering	Z,ZK	5
Students will get acquai	nted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens	before and after th	e main function
is called. Students will u	inderstand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dec	licated to reverse	engineering of
	++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be d	_	-
	ing work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the comput	er malware scene	. The focus of
	ninars, where students will solve practically oriented tasks from the real world.		
NI-RUN	Runtime Systems	Z,ZK	5
	ction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experie	•	•
· ·	from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compi	· · · · · · · · · · · · · · · · · · ·	-
· ·	and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implement	ations of real-world	d VMs, including
	speculations, and deoptimizations Language implementation frameworks Read-world VMs		
NI-SIM	Digital Circuit Simulation and Verification	Z,ZK	5
	s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le	vel Modeling) leve	els and with the
properties of proper too	ls. The course covers recent verification methods, too.		
NI-SIB	Network Security	Z,ZK	5
NI-SCR	Statistical Analysis of Time Series	Z,ZK	5
The course deals with t	ne practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange pric	es, employment) a	and industrial
problems (modelling of	signals and processes) to computer networks (network components load, attacks detection). The students learn to select a co	nvenient 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 ba	sed on practical
· ·	oth the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward tra	nsfer of students'	knowledge from
the academic to the rea	l world.		
NI-SYP	Parsing and Compilers	Z,ZK	5
The module builds upon	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of	of various variants	and applications
	ntroduced to special applications of parsers, such as incremental and parallel parsing.		
NI-SBF	System Security and Forensics	Z,ZK	5
Students will get familia	r with aspects of system security (principles of end station security, principles of security policies, security models, authentica	ation concepts). Fu	ırthermore,
•	r with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and fore	nsic analysis tech	niques and the
importance of operating	system/operating system artifacts or file system for attack analysis and detection).		
NI-DSS	Decision Support Systems	Z,ZK	5
	s to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles		
_	l decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory.They		ut the principles
	ologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithm		
NI-TES	Systems Theory	Z,ZK	5
-	he ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). Howeve		
· · ·	ring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of		•
	that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and	algorithms that for	m the basis for
the modeling and analy			
NI-TSP	Testing and Reliability	Z,ZK	5
-	ledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to p	-	
· · · · · · · · · · · · · · · · · · ·	zation and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with	built-in-self-test e	quipment. They
	analyze, and control the reliability and availability of the designed circuits.		
NI-TSW	Software Product Development	KZ	4
The course is presented			
NI-UMI	Artificial intelligence	Z,ZK	5
	ch and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint program	nming and automa	ated planning.
	d practical applications of discussed techniques will be illustrated.		
NI-EHW	Embedded Hardware	Z,ZK	5
-	claws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the		
-	n their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussing	ed, including stand	dardized means
or internal communication	on, parallelism extraction and utilization in special structures and system architectures.		

NI-FSW **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. Selected Methods for Program Analysis This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs. Selected Topics in Optimization and Numerical mathematics The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of continuous optimization obtained in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on computers. Hence, the relevant concepts of numerical matematics, mainly numerical linear algebra, are explained too. NI-MCC Multicore CPU Computing Z,ZK 5 Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications. List of courses of this pass: Code Name of the course Completion Credits FI-TOP Academic writing Publishing is an important and required part of research activity. It is not only about obtaining research results but also about applying them in the form of publication. Writing scientific publications can be useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the course, students will learn how to write a scientific article, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an article and reviewing someone else's article. The course will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Dates will be determined based on the availability of enrolled students. FIT-ITI Modern IT infrastructure Z.ZK 5 FIT-SEP 7.7K World Economy and Business This course is presented in Czech. The course introduces students of technical university to the international business. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite. FITE-EHD Introduction to European Economic History Z,ZK 3 The course introduces a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global economy through the description of the key periods in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic history. From large economic area of Roman Empire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institutions is deciphered. The course does not cover detailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and organizations in history. Class meetings will consist of a mixture of lecture and discussion. NI-ADM Data Mining Algorithms Z,ZK The course focuses on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students should know machine learning basics. The emphasis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation systems) and models (e.g., kernel methods). NI-ADP Architecture and Design patterns The objective of this course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as well as with understanding of the challenges, issues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge of object-oriented programming and get familiar with the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the second part the students will be introduced to the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems, and some advanced software architectures used in large-scale distributed systems. NI-AFP **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-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. NI-AM1 Middleware Architectures 1 Z,ZK 5 Students will study new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information system architecture, web service architecture and aplication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous communications and high availability of applications. NI-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 architectures, concepts and technologies for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security. Advanced machine learning NI-AML The course introduces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of recommendation systems, image

processing, control and interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the methods discussed.

perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base components that form part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important part of the component implementation of a simple game, with a strong focus on nontrivial game mechanics. NI-APR Selected Methods for Program Analysis Z,ZK	omail, etc.
must be approved in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT through a website, info NI-APH Architecture of computer games Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also from design and prespective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base components that form part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important part of the components implementation of a simple game, with a strong focus on nontrivial game mechanics.	omail, etc.
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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.	n Dynamic
Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.	
NI-APT Advanced Program Testing Z,ZK	5
Testing a program is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The goal of the course is to	o present
advanced program testing techniques, beyond writing unit tests, especially fuzzing and symbolic execution.	
NI-ARI Computer arithmetic Z,ZK	4
Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.	-
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Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour	١ .
(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	
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, a	- 1
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	
solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation.	·
NI-BKO Error Control Codes 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 transmitted via channels.	
NI-BML Bayesian Methods for Machine Learning KZ	5
The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of a subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of a subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of a subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of a subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory.	
models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true objective and the hidden variables).	
from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real work	
and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will tr	y to solve
some of them.	
NI-BPS Wireless Computer Networks Z,ZK	4
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, mul	ticast and
broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security me	chanisms
for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.	
NI-BUI Business Informatics Z,ZK	5
The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process ma	-
	- 1
ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management, and lifecycle ma	
of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance	
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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. NI-DSV 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 Z,ZK **Embedded Hardware** 5 The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized means of internal communication, parallelism extraction and utilization in special structures and system architectures. NI-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." **Embedded Software** NI-ESW 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. 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. Finite model theory 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. Graph theory and combinatorics The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorithms. The emphasis will be not only on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected topics from graph and hypergraph coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory will be also applied in the fields of combinatorics on words, formal languages and bioinformatics. NI-GEN **Code Generators** Advanced techniques of translating programs written in high-level programming languages are essential for understanding the field of systems programming. This primarily involves understanding the algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems programming. Students will become familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages NI-GLR Games and reinforcement learning The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelligence. This course is intended to give you both theoretical and practical background so you can participate in related research activities. Presented in English NI-GNN **Graph Neural Networks** The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural networks for creating vector representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last part of the course also covers graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems.

NI-GOL			
	Programming of distributed systems in GO	KZ	5
NI-GPU	GPU Architectures and Programming	Z,ZK	5
_	wledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI		
which is already a wide	espread 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.	putational structu	res, students
NI-GRI	Grid Computing	Z,ZK	5
THI OILI	Grid computing and gain knowledge about the world-wide network and computing infrastructure.	2,210	1 0
NI-HCM	Mind Hacking	ZK	5
l l	in emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, info	ormation systems	and assets,
-	re security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive securi		-
the context of informat	ion warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet	environment have	real societal
NI-HMI2	impacts such as disruption of social cohesion, threats to democracy or war.	ZK	2
l I	History of Mathematics and Informatics nted in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms		a recursive
	functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its developr		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
This course is dedicated	ated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attack	ks. Students get fa	amiliar with
	channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and	•	•
	valso get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel		1
NI-HWB	Hardware Security he knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards	Z,ZK	5
•	ne knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguards as. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studer	_	-
-	ographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions	_	-
NI-IAM	Internet and Multimedia	Z.ZK	4
I	s focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acq	uisition of AV sigr	nals (input),
	nals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical u		
	ions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effect of AVV.		-
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 for audience.	e scene up to tne	presentation
NI-IBE	Information Security	ZK	2
I	ation and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internationa		1
	nethods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g.,		-
NI-IKM	Internet and Classification Methods	Z,ZK	4
In this course, the stud	lents get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering	, in recommenda	tion systems,
	systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving		•
-	these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle wi ing the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consult		
NI-IOS	Advanced techniques in iOS applications		
		K7	4
Students will learn the	latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the base	KZ asics from the be	4 ginners class
Students will learn the	1 11		1 .
NI-IOT	latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the base		1 .
NI-IOT The subject is focu	latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the base BI-IOS. Internet of Things sed on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is far	asics from the beautiful Z,ZK amiliarization with	ginners class
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NI-KYB Cybernality ZK 5 Students get acquainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the classification of attacks and have an overview of systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activities and behavior. The course will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT teams). NI-LOM Linear Optimization and Methods Z,ZK 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 K7 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 NI-MCC 5 Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore processors with shared and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of architecturally specific optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory interface throughput. On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications NI-MEP Modelling of Enterprise Processes The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re)engineering and implementation of processes, organisation structures and information support in big enterprises and institutions. Mathematics for Cryptology NI-MKY Z.ZK 5 Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular, the course 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 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 NI-MOP Object-oriented programming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, where its ability to natural abstraction is used to build complex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the skills of design and implementation of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development needs and areas of interest. In addition to deepening object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work on interesting projects and OO technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvement in the Pharo Consortium. NI-MPI 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 ZK NI-MPR Master Project Ζ 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 7 7K Mathematical semantics of programming languages. Data types as continuous lattices, Scott topology. Procedures as continuous mappings. The Scott model of lambda calculus. Introduction to category theory. Modern Internet Technologies 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 quaranteed parameters (bandwidth, delay, litter, 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 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 Z,ZK NI-MZI 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 7 5 In this course, students will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The goal of the course is to teach students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific literature.

NI-NMS Neural Networks, Machine Learning and Randomness	Z,ZK	4
Stochastic methods, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a numl models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networks.		- 1
andomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general s	•	· ·
neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including net of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algor		used in one
NI-NMU New media in art and design	ZK	3
The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game an	nd sound. The main	goal is to
familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially	in lectures devoted	to specific
Art projects. NI-NON Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
Students will be introduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such method		
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They		-
linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement as well as in parallel.	tnese algorithms se	equentially
NI-NSS Normalized Software Systems	ZK	5
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering heory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related issue	·	
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements. Th	, ,	
unctionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability	and entropy-related	d principles.
This knowledge allows students to realize new levels of evolvability in software architectures. NI-NUR User Interface Design	Z.ZK	5
Students will understand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, formal	. , .	
notions and procesures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able		
NI-OLI Linux Drivers The Linux Drivers The Linux Drivers The Linux Drivers NI-OLI Linux Drivers	Z,ZK	4
increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver developmen	•	
course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practical		
NI-OSY Operating Systems and Systems Programming The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel d	Z,ZK	5
process management, memory management, file operations and architecture of modern file systems, device drivers and network programming. The co	-	
development process, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability.	•	
n embedded and real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs, focused on development of LINUX kernel modules.	, students will work	on projects
NI-PAM Efficient Preprocessing and Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necess	=	
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often one parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exponer		
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomial times also represent a way to formalize the notion of effective polynomial times.		
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solution plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (pre-	-	
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation	• •	. 6,4,64, 776
NI-PAS Advanced Aspects of Business	Z,ZK	. 4
The aim of the course is to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run the management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related a		business
NI-PDB Advanced Database Systems	Z,ZK	5
Students orient themselves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of database		
databases), with the related new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CYPH the course deals with performance evaluation of database machines.	IER, Gremlin). The	last part of
NI-PDD Data Preprocessing	Z,ZK	5
Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various data s		-
time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characterist pages.	tics from images or	from web
NI-PDP Parallel and Distributed Programming	Z,ZK	6
21st century in computer architectures is primarily influenced by the shift of the Moore's law into parallelization of CPUs at the level of computing cores	s. Parallel computing	
are becoming a ubiquitous commodity and parallel programming becomes the basic paradigm of development of efficient applications for these platfor with architectures of parallel and distributed computing systems, their models, theory of interconnection networks and collective communication oper	-	
environments for parallel programming of shared and distributed memory computers. They get acquianted with fundamental parallel algorithms and on		۱ ۱
earn the techniques of design of efficient and scalable parallel algorithms and methods of performance evaluation of their implementations. The course	includes a semeste	er project of
practical programming in OpenMP and MPI for solving a particular nontrivial problem. NI-PG1 Computer Grafics 1	ZK	4
The course builds on graphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge. The	1	
nterested in advanced computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the control of the con		
articles and their subsequent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and NI-PIS Enterprise Information Systems	Z.ZK	graphics.
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 bi	, , ,	_
in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunications and expenses of the company (preprinciples and its impact on the business of the company).		
eal examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the bus Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operatior		
company / organization.		

•	Computer Vision n course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing.SI les of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoreti	-	
practical application	ns and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color re nd segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (includ motion detection, visual expressiveness (saliency).	presentations, obj	ect detection
NI-PLS1	Programming Language Seminar	Z	2
- 1	Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which	_	1 1
	glanguages and related fields. Participating students are expected to present a paper of their interest and actively participate in the		
azout programming	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		Juaning group
NI-PLS2	Programming Language Seminar	Z	2
	p Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which	_	1
	glanguages and related fields. Participating students are expected to present a paper of their interest and actively participate in the o		
about programming	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		sading group
NI DI CO		1	
NI-PLS3	Programming Language Seminar	Z	2
	Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which		
about programming	languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the city is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		eading group
NI-PLS4	Programming Language Seminar	Z	2
	g Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which g languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the c is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language	discussions. The re	
NI DON			
NI-PON	Selected Topics in Optimization and Numerical mathematics on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of co	Z,ZK	5 tion obtained
iii uie course Mathe	ematics for informatics. The methods are explained and described along with the details on how they are implemented on computers of numerical matematics, mainly numerical linear algebra, are explained too.	. rience, trie reieva	ant concepts
NII DOD		1/7	
NI-PSD	Public Services Design	KZ	4
	oduce students to specifics of UX, Service design and development for public sector. We will look into the design and development p		
suppliers (devs a	nd designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration	n with client repres	sentatives.
	Course is aimed at students-designers as well as clients.		
NI-PSL	Programming in Scala	Z,ZK	4
The course introdu	uces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language featur	es - e.g.pattern ma	atching and
advance standard li	brary. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and	d libraries e.g. Play	, Cassandra,
	Scalaz, etc.		
NI-PVR	Advanced Virtual Reality	KZ	4
The course introduc	ces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D mode	ls in Blender and	among other
		io ini Bioridoi, dila	arrioring outlot
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		- 1
-	students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr	deal with creating	applications
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-	ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr	deal with creating	applications
in available 3D engi	ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr in virtual reality, or directly create a complex game for VR.	deal with creating nowledge gained in Z,ZK	applications n this subject
in available 3D engi	ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr in virtual reality, or directly create a complex game for VR. Advanced embedded systems	deal with creating nowledge gained in Z,ZK ed topics like secur	applications on this subject 4 rity support,
in available 3D engi	ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr in virtual reality, or directly create a complex game for VR. Advanced embedded systems sed on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advanced	deal with creating nowledge gained in Z,ZK ed topics like secur	applications on this subject 4 rity support,
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In available 3D enging available 3D enging available 3D enging NI-PVS The course is focus working with mass of the course is focus working with mass of the course is called. Students applications write debuggers and described by the aim of the more recognition. Stusies of a compiler and Just-in-time compiler and Just-in-time compiler students will get fait of the seminar of corare approached in a course is an interest of the course is an interest	ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr in virtual reality, or directly create a complex game for VR. Advanced embedded systems sed on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advance is storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practical systems. Advanced Python Unuse is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in Python it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral coursework teachers from Red Hat. Reverse Engineering Quainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens befull understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course will also be 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 the course is on the seminars, where students will solve practically oriented tasks from the real world. Pattern Recognition Foundamental concepts and methods of pattern recognition with emphasis on problems and applications of the students will learn the fundamental concepts and methods of pattern recognition with emphasis on problems and applications of the students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a Programming in Ruby This course is presented in Czech. Running Systems roduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experience at a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpr	A deal with creating nowledge gained in a concepts). Fur ic analysis techniques and attace subject is work with a concepts and attace subject is work with a concept is an attace to concepts. Fur ic analysis techniques and attace subject is work with a concept is an attace to concepts.	applications of this subject 4 rity support, a embedded 4 he course is d by external 5 nain function gineering of gers: how the focus of 5 to pattern aspects. 4 5 plementation nagement Ms, including 5 rthermore, ques and the 4 cks. Students ith scientific

NI-SCE2 Computer Engineering Seminar Master II Ζ The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to failures and attacks. Students are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the subject is work with scientific articles and other professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teachers. The topics are new for each semester. NI-SCR Statistical Analysis of Time Series The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices, employment) and industrial problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a convenient process model, estimate its parameters, analyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the main principles based on practical real-world examples. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfer of students' knowledge from the academic to the real world. NI-SEP World Economy and Business 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 Digital Circuit Simulation and Verification Z,ZK 5 The aim of the course is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level Modeling) levels and with the properties of proper tools. The course covers recent verification methods, too. Semantic Web and Knowledge Graphs 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. Parsing and Compilers NI-SYP 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-SZ1 Knowledge Engineering Seminar Master I Ζ 4 On this seminar you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research 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). 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). Systems Theory Today, humankind has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However, the costs of managing this complexity and of ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of models that describe only those aspects of the systems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and algorithms that form the basis for the modeling and analysis of complex systems. NI-TKA **Category Theory** Z,ZK 4 NI-TNN Theory of Neural Networks 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. NI-TS1 Theoretical Seminar Master I Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. Theoretical Seminar Master II NI-TS2 Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar. Theoretical Seminar Master III Theoretical seminar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classical reading group. The students are treated individually and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a work with scientific papers and other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.

NI-TS4	Theoretical Seminar Master IV	Z	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a v		
are treated individu	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	WORK WITH SCIENTIFIC	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		-
the intuitive path se	ensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with bu	ilt-in-self-test equip	ment. They
=	will be able to compute, analyze, and control the reliability and availability of the designed circuits.		
NI-TSW	Software Product Development	KZ	4
NI-TVR	The course is presented in Czech.	Z,ZK	3
	Virtual Reality Technology roduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of control to the basic concepts of virtual reality.		-
	cking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of	-	
	reality will be presented.		
NI-UMI	Artificial intelligence	Z,ZK	5
The course covers	s search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programm	ning and automated	d planning.
NLVCC	The main principles and practical applications of discussed techniques will be illustrated.	Z,ZK	5
NI-VCC	Virtualization and Cloud Computing n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and		-
•	rtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie	•	, , ,
performance par	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effecti	ve technology toda	ay for the
management of cor	nplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in	n the use of moderr	nintegration
NII V C A	and development tools (Continuous integration and development).	7 71/	
NI-VGA	Video Games Architecture a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of vie	Z,ZK	5
	of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and fu		- 1
	, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, in		
	some game mechanics, in the form of practical demonstrations.		
NI-VMM	Retrieval from Multimedia	Z,ZK	. 5
The student obtains	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.	ure extraction from	multimedia
NI-VOL	Elections	Z,ZK	5
IVI-VOL	We will cover the basics of (committee) elections and, in general, opinion aggregation.	2,21	5
NI-VPR	Research Project	Z	5
	Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.		
NI-VSM	Selected statistical Methods	Z,ZK	7
	the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with mu		
application of enti	ropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rand Markov chains. The high point of the course is the Queuing theory and its application in networks.	iom processes with	1 locus oii
NI-VYC	Computability	Z,ZK	4
- '	Classical theory of recursive functions and effective computability.	, ,	
NI-ZS10	Master internship abroad for 10 credits	Z	10
	once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institu		
,	the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 week		' '
	on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects	•	·
_	academic year's dead-line.		
NI-ZS20	Master internship abroad for 20 credits	Z	20
	once within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research institu		
	the vice-dean for study affairs assesses the professional content. The student must provide evidence of the professional content and ex MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 week		
	on. The maximum number of credits a student can earn for one internship is 30 credits. This amount can be divided into two subjects	•	·
	academic year's dead-line.		
NI-ZS30	Master internship abroad for 30 credits	Z	30
•	ented in chzech language. Each student can once within his / her master's degree have a foreign internship at a foreign university or	_	
	. Before the internship the Dean of the FIT, or the vice-dean for study affairs assesses the professional content. The student must provic of the internship. Auxiliary courses MI-ZS10, MI-ZS20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KO	-	
	ime employment with a foreign institution. The maximum number of credits a student can earn for one internship is 30 credits. This are		
	subjects if the internship exceeds the academic year's dead-line.		
NIE-BLO	Blockchain	Z,ZK	5
	stand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain platform	-	- 1
	secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course places are blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares the	· ·	
	supervising implementation of blockchain-based solutions in both academia and business.		9 01
NIE-PDL	Practical Deep Learning	KZ	5
	igned to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine lea	=	- 1
the course, student	s 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
NIE-PML	language processing. Personalized Machine Learning	7 71/	
	Personalized Machine Learning thine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristic	Z,ZK	5 individual
	is commonly used in applications such as recommender systems, which recommend items to users based on their personal interest		
			'

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

ZK 4
on of digital circuits and basic logic

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.

For updated information see http://bilakniha.cvut.cz/en/FF.html Generated: day 2025-07-03, time 22:34.