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 g	ain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not	only to select and	implement but
also to apply and e	valuate heuristics for practical problems.		
NI-DIP	Diploma Project	Z	30
NI-MPR	Master Project	Z	7
supervisor enters to completed and sig is rather general, t	r. If the requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the en- the information on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut and 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 re immediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that and of the semester.	.cz/student/studijn topic that the stud	i/formulare). The ent has reserved
NI-MPI	Mathematics for Informatics	Z,ZK	7
The course compr	ses topics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate ana	lysis, smooth optir	nization and
multi-variate integr	ation. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The las	t topic includes se	lected numerica

Parallel and Distributed Programming NI-PDP

Z.ZK 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.

6

NI-VSM Selected statistical Methods

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

Name of the block: Compulsory courses in the specialization Minimal number of credits of the block: 35 The role of the block: PS

Code of the group: NI-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:

Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their Code Completion Credits Scope Semester Role members) Tutors, authors and guarantors (gar.) Middleware Architectures 1 NI-AM1 Ζ Z,ZK 5 2P+1C PS Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.) Middleware Architectures 2 NI-AM2 L Z,ZK 5 2P+1C PS Jaroslav Kucha, Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.) Web Data Mining NI-DDW Z,ZK 5 2P+1C L PS Jaroslav Kucha, Milan Doj inovski Jaroslav Kucha Jaroslav Kucha (Gar.) **Advanced Database Systems** NI-PDB Z,ZK 5 2P+1C Ζ PS Yelena Trofimova, Michal Valenta Michal Valenta Michal Valenta (Gar.) Semantic Web and Knowledge Graphs NI-SWE 5 2P+1C Ζ Z,ZK PS Milan Doj inovski, Jakub Klímek Milan Doj inovski Milan Doj inovski (Gar.) Virtualization and Cloud Computing NI-VCC 5 2P+1C L Z,ZK PS Tomáš Vondra, Jan Fesl Tomáš Vondra Tomáš Vondra (Gar.) **Retrieval from Multimedia** NI-VMM Z,ZK 5 2P+1C Ζ PS Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)

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

nes Engineering,			
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 systematics	stem architecture,	web service
architecture and aplicati	on servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d 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 architec	tures, concepts a	nd technologies
for microservices, distru	buted cache and databases, smart contracts, realtime communication and web security.		
NI-DDW	Web Data Mining	Z,ZK	5
Students will learn lates	t methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gair	an overview of W	leb mining
techniques for Web craw	ling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an ove	rview of most rece	nt developments
in the field of social web	and recommendation systems.		
NI-PDB	Advanced Database Systems	Z,ZK	5
Students orient themsel	ves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of datab	ase machines (so	called NoSQL
databases), with the rela	ated new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, CV	(PHER, Gremlin).	The last part of
the course deals with pe	erformance evaluation of database machines.		
NI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
The students will learn t	he most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t	echnologies, meth	ods and best
practices for modelling,	integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowled	e graphs and thei	ir systematic
quality assurance.			
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gain know	edge of architectures of large computer systems that are used in data centers and computer infrastructure of companies an	d organizations. T	hey will get
acquainted with virtualiz	ation principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to eff	iciently operate ar	nd optimize the
performance parameter	s of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effect	ive technology too	day for the
management of complex	x computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical ski	lls in the use of mo	odern integration
and development tools	Continuous integration and development).		

Name of the block: Elective courses Minimal number of credits of the block: 0 The role of the block: V

Code of the group: NI-V.2021 Name of the group: Purely Elective Master Courses Requirement credits in the group: Requirement courses in the group: Credits in the group: 0

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

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-AOA	Completing a professional event Zden k Muziká	Z	1			V
NI-ATH	AlgorithmicTheories of Games Dušan Knop, Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+2C	L	V
NI-AFP	Applied Functional Programming Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl (Gar.)	КZ	5	2P+1C	L	V
NI-APH	Architecture of computer games Adam Vesecký Adam Vesecký Adam Vesecký (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-VGA	Video Games Architecture Jan Matoušek	Z,ZK	5	2P+1C	Z	V
NI-BPS	Wireless Computer Networks Ji í Kašpar, Alexandru Moucha Alexandru Moucha (Gar.)	Z,ZK	4	2P+1C	L	V
NIE-BLO	Blockchain Róbert Lórencz, Jakub R ži ka, Josef Gattermayer, Marek Bielik Josef Gattermayer Róbert Lórencz (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-CTF	Capture The Flag Ji í Dostál, Martin Šutovský, Ivana Trummová, Ladislav Marko, František Ková Ji í Dostál Ji í Dostál (Gar.)	ΚZ	4	3C	Z	V
NI-DPH	Game Design Adam Vesecký	Z,ZK	5	2P+1C	L	V
NI-DSW	Design Sprint Ond ej Brém, Michal Manda Michal Manda David Pešek (Gar.)	Z	2	30B	Z	V
NI-PSD	Public Services Design Ond ej Brém, David Pešek David Pešek Ond ej Brém (Gar.)	KZ	4	1P+2C		V
NI-DID	Digital drawing Denisa Nová ková, Eliška Novotná Denisa Nová ková Denisa Nová ková (Gar.)	Z	2	4C	Z,L	V
NI-DZO	Digital Image Processing	Z,ZK	4	2P+1C	L	V
NI-DDM	Distributed Data Mining Tomáš Borovi ka	KZ	4	3C	L	V
NI-PAM	Efficient Preprocessing and Parameterized Algorithms Ond ej Suchý Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-ESC	Experimental Project Course Jan Matoušek, Ond ej Brém Ond ej Brém (Gar.)	KZ	8	0P+30R+52C	L	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GNN	Graph Neural Networks Miroslav epek Miroslav epek (Gar.)	Z,ZK	4	1P+1C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler 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 Alena Šolcová (Gar.)	ZK	3	2P+1C	Z	V
NI-IBE	Information Security Igor ermák	ZK	2	2P	Z	V

NI-IVS	Intelligent embedded systems Miroslav Skrbek Miroslav Skrbek (Gar.)	KZ	4	1P+3C	L	V
NI-IKM	Internet and Classification Methods Martin Hole a Martin Hole a Martin Hole a (Gar.)	Z,ZK	4	1P+1C	L	V
NI-IAM	Internet and Multimedia	Z,ZK	4	2P+1C	L	V
NI-IOT	Internet of Things Jan Jane ek	Z,ZK	4	2P+1C	L	V
FITE-EHD	Introduction to European Economic History Tomáš Evan	Z,ZK	3	2P+1C	L	V
NI-KTH	Combinatorial Theories of Games Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+1C	L	V
NI-FMT	Finite model theory Tomáš Jakl Tomáš Jakl Tomáš Jakl (Gar.)	Z,ZK	4	2P+1C	L	V
NI-CCC	Creative Coding and Computational Art Radek Richtr, Josef Kortán Radek Richtr Radek Richtr (Gar.)	KZ	4	1P+2C	Z,L	V
NI-KYB	Cybernality	ZK	5	2P	Z	V
NI-LSM2	Statistical Modelling Lab Kamil Dedecius Kamil Dedecius (Gar.)	KZ	5	3C	Z,L	V
NI-LOM	Linear Optimization and Methods Dušan Knop Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MPL	Managerial Psychology Jan Fiala Jan Fiala Jan Fiala (Gar.)	ZK	2	2P	Z,L	V
NI-MSI	Mathematical Structures in Computer Science Jan Starý	Z,ZK	4	2P+1C	L	V
NI-MZI	Mathematics for data science Št pán Starosta	Z,ZK	4	2P+1C	L	V
FIT-ITI	Modern IT infrastructure Ivan Šime ek	Z,ZK	5	2P+1C	Z,L	V
NI-MOP	Modern Object-Oriented Programming in Pharo Jan Blizni enko Robert Pergl Robert Pergl (Gar.)	KZ	4	3C	Z	V
NI-NLM	Neural Language Models	Z	5	2P+1C	L	V
NI-NMS	Neural Networks, Machine Learning and Randomness Martin Hole a	Z,ZK	4	1P+1C	Z	V
NI-NMU	New media in art and design Zden k Svejkovský Zden k Svejkovský Zden k Svejkovský (Gar.)	ZK	3	2P+0C	Z	V
NI-OLI	Linux Drivers Jaroslav Borecký, Miroslav Skrbek Jaroslav Borecký Miroslav Skrbek (Gar.)	Z,ZK	4	2P+2C	L	V
NIE-PML	Personalized Machine Learning Rodrigo Augusto Da Silva Alves Karel Klouda Rodrigo Augusto Da Silva Alves (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ARI	Computer arithmetic Pavel Kubalík Pavel Kubalík Alois Pluhá ek (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-PG1	Computer Grafics 1 Radek Richtr Radek Richtr Radek Richtr (Gar.)	ZK	4	2P+1C	L	V
NI-PIV	Computer Vision Radek Richtr	Z,ZK	5	2P+2C	Z	V
NI-EDW	Enterprise Data Warehouse Systems Jakub Krej í, Robert Kotlá Jakub Krej í Magda Friedjungová (Gar.)	Z,ZK	5	1P+1C	L	V
NI-PVR	Advanced Virtual Reality Petr Pauš Petr Pauš (Gar.)	KZ	4	2P+1C	Z	V
NI-AML	Advanced machine learning Zden k Buk, Miroslav epek, Rodrígo Augusto Da Silva Alves, Petr Šimánek, Vojt ch Rybá Miroslav epek Miroslav epek (Gar.)	Z,ZK	5	2P + 1C	L	V
NI-IOS	Advanced techniques in iOS applications Rostislav Babá ek, Jakub Olejník, Igor Rosocha Martin P Ipitel Martin P Ipitel (Gar.)	KZ	4	2P+2C	L	V
NI-APT	Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-PVS	Advanced embedded systems Miroslav Skrbek	Z,ZK	4	2P+2C	Z	V
NI-DNP	Advanced .NET David Šenký , Nikolas Jíša David Šenký Nikolas Jíša (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-PYT	Advanced Python Miroslav Hron ok	KZ	4	3C	Z	V
NIE-PDL	Practical Deep Learning Martin Barus, Yauhen Babakhin Karel Klouda Karel Klouda (Gar.)	KZ	5	2P+1C	Z	V
NI-GOL	Programming of distributed systems in GO	KZ	5	0P+3C	Z	V
NI-PSL	Programming in Scala Ji í Dan ek Ji í Dan ek Ji í Dan ek (Gar.)	Z,ZK	4	2P+1C	Z	V
NI-RUB	Programming in Ruby Cyril erný Cyril erný Cyril erný (Gar.)	KZ	4	3C	Z	V
NI-ROZ	Pattern Recognition	Z,ZK	5	2P+1C	Z	V

NI-PLS1	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	Z	V
NI-PLS3	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	Z	V
NI-PLS2	Programming Language Seminar Pierre Donat-Bouillud	Z	2	0P+1C	L	v
NI-PLS4	Programming Language Seminar Pierre Donat-Bouillud, Filip K ikava Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z	2	0P+1C	L	V
NI-SCE1	Computer Engineering Seminar Master I Hana Kubátová Miroslav Skrbek Hana Kubátová (Gar.)	Z	4	2C	L,Z	v
NI-SCE2	Computer Engineering Seminar Master II Hana Kubátová Hana Kubátová (Gar.)	Z	4	2C	L,Z	v
NI-SZ1	Knowledge Engineering Seminar Master I Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	v
NI-SZ2	Knowledge Engineering Seminar Master II Pavel Kordík Magda Friedjungová (Gar.)	Z	4	2C	L,Z	v
PI-SCN	Seminars on Digital Design Petr Fišer Petr Fišer Petr Fišer (Gar.)	ZK	4	2P+1C	Z,L	v
NI-MLP	Machine Learning in Practice Jan Hu in Daniel Vašata Daniel Vašata (Gar.)	Z,ZK	5	2P+1C	Z	v
FIT-SEP	World Economy and Business Tomáš Evan	Z,ZK	4	2P+2C	L	v
NI-SEP	World Economy and Business Tomáš Evan Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	v
NI-TVR	Virtual Reality Technology Tomáš Nová ek Tomáš Nová ek (Gar.)	Z,ZK	3	1P+1C	L,Z	v
NI-TS1	Theoretical Seminar Master I Dušan Knop, Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	v
NI-TS2	Theoretical Seminar Master II Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	L	v
NI-TS3	Theoretical Seminar Master III Ond ej Suchý, Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	v
NI-TS4	Theoretical Seminar Master IV Ond ej Suchý, Tomáš Valla Tomáš Valla Ond ej Suchý (Gar.)	Z	4	2C	L	v
NI-TKA	Category Theory Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+1C	L	v
NI-TNN	Theory of Neural Networks Martin Hole a Martin Hole a Martin Hole a (Gar.)	Z,ZK	5	2P+1C	L	v
NI-CPX	Complexity Theory Dušan Knop, Ond ej Suchý Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	5	3P+1C	Z	v
FI-TOP	Academic writing Tomáš Nová ek	Z	2	10B	Z	V
NI-DVG	Introduction to Discrete and Computational Geometry Maria Saumell Mendiola Maria Saumell Mendiola Maria Saumell Mendiola (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VOL	Elections Dušan Knop Dušan Knop Dušan Knop (Gar.)	Z,ZK	5	2P+1C	L	v
NI-VYC	Computability Jan Starý Jan Starý (Gar.)	Z,ZK	4	2P+2C	L	V
NI-VPR	Research Project Št pán Starosta Št pán Starosta (Gar.)	Z	5		Z,L	V
NI-ZS10	Master internship abroad for 10 credits Zden k Muziká Zden k Muziká (Gar.)	Z	10		Z,L	V
NI-ZS20	Master internship abroad for 20 credits Zden k Muziká Zden k Muziká (Gar.)	Z	20		Z,L	V
NI-ZS30	Master internship abroad for 30 credits Zden k Muziká Zden k Muziká (Gar.)	Z	30		Z,L	v

Characteristics of the courses of this group of Study Plan: Code=NI-V.2021 Name=Purely Elective Master Courses

NI-AOA	Completing a professional event	Z	1
The subject is participa	tion in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, dr	afting a report, et	c.Such an event
must be approved in ad	vance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT the	nrough a website,	infomail, etc.
NI-ATH	AlgorithmicTheories of Games	Z,ZK	4
Traditional game theory	is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory str	udies the behavio	ur of agents
(players) of a certain co	mpetitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game	e theory is to find	the equilibria,
which are the states of t	he game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social netw	orks, online aucti	ons, advertising,
multiagent systems and	l other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of	f efficient computa	ation of various
solution concepts. In thi	s course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their c	computation.	
NI-AFP	Applied Functional Programming	KZ	5
This course is presente	d in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel function	al programming la	nguages are on
the rise nowadays and	the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, mas	tering this paradig	m becomes a
necessary competence	of a software engineer: the theory and especially the practice.		

NI-APH Architecture of computer games	Z,ZK	4
Students will gain a basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but		-
perspective. They will get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base	-	
part of most games. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An im	portant part of the	e course is an
implementation of a simple game, with a strong focus on nontrivial game mechanics.		
NI-VGA Video Games Architecture	Z,ZK	5
The course covers a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of	view, but also fror	n a design and
philosophical point of view. In the lectures, students will be guided through the history of development, the structure of game engines, component ar	nd functional archi	tecture typical of
game development, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater details	ail, including ways	of implementing
some game mechanics, in the form of practical demonstrations.		
NI-BPS Wireless Computer Networks	Z,ZK	4
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in	ad-hoc networks,	multicast and
broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get know	wledge of security	/ mechanisms
for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.		
NIE-BLO Blockchain	Z,ZK	5
Students will understand the foundations of blockchain technology, smart contract programming, and gain an overview of most notable blockchain pla		-
code and deploy a secure decentralized application, and assess whether integration of a blockchain is suitable for a given problem. The course place		-
relationship between blockchains and information security. It is concluded with a defense of a research or applied semester project, which prepares	the students for ir	nplementing or
supervising implementation of blockchain-based solutions in both academia and business.		
NI-CTF Capture The Flag	KZ	4
The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber security.		
NI-DPH Game Design	Z,ZK	5
The course complements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on gar	•	
interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanic		
development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical im	plementation app	lied to semestral
projects.		
NI-DSW Design Sprint	Z	2
Students will work on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to va		, ,
the course the students will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting v	vith research and	finishing with
testing the prototypes (plus final presentation).		-
NI-PSD Public Services Design	KZ	4
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and developme		
suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboration of the students of a students of a students will be allocated as a student of the students of the s	ion with client repi	esentatives.
Course is aimed at students-designers as well as clients.	7	0
NI-DID Digital drawing	<u>Z</u>	2
The course will introduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, p	-	-
they will practically apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course practice or learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practice ga	-	e who wants to
		4
NI-DZO Digital Image Processing This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical	Z,ZK	-
implement and have an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that i	-	-
of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDF		
frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray of	-	-
interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, a		
NI-DDM Distributed Data Mining	KZ	4
Course focuses on state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain han	1	-
data processing framework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementation	-	-
approaches to parallelize other algorithms. The course is prezented in czech language.		
NI-PAM Efficient Preprocessing and Parameterized Algorithms	Z,ZK	4
There are many optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often nece		-
exactly in practice. We will demonstrate that many problems can be solved much more effectively than by naively trying all possible solutions. Often	-	-
(parameter) of the inputs from practice-e.g., all solutions are relatively small. Parameterized algorithms exploit that by limiting the time complexity exp		
and polynomially in the input size (which can be huge). Parameterized algorithms also represent a way to formalize the notion of effective polynomia		
which is not possible in the classical complexity. Such a polynomial time preprocessing is then a suitable first step, whatever is the subsequent solut	ion method. We w	ill present a
plethora of parameterized algorithm design methods and we will also show how to prove that for some problem (and parameter) such an algorithm (presumably) does	s not exist. We
will also not miss out the relations to other approaches to hard problems such as moderately exponential algorithms or approximation schemes.		
NI-ESC Experimental Project Course	KZ	8
"The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principle	s, methodologies,	and tools used
in designing technology-driven solutions that are user-centric and industry-relevant. Throughout the semester, students will work on real-world design	projects, collabor	ate with industry
experts, and learn to integrate theory with practical application. Through a hands-on, project-based learning approach, students will develop their sk	ills in user-center	ed design and
user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."		
NI-GLR Games and reinforcement learning	Z,ZK	4
The field of reinforcement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intellig	gence. This course	e is intended to
give you both theoretical and practical background so you can participate in related research activities. Presented in English.		
NI-GNN Graph Neural Networks	Z,ZK	4
The course introduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural r	networks for creat	ng vector
representations of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last		
	part of the course	e also covers
graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and problems. NI-GRI Grid Computing	z part of the course	e also covers

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

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

	Mathematical Structures in Computer Science	Z,ZK	4
NI-MSI Mathematical compation	s of programming languages. Data types as continous lattices, Scott topology. Procedures as continuous mappings. The Sco		
			a calculus.
Introduction to category			
NI-MZI	Mathematics for data science	Z,ZK	4
In this course, students	are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used i	n data science. Th	ne studied topics
	Igebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality prir	nciple, gradient me	ethods) and
selected notions from p	robability theory and statistics.		
FIT-ITI	Modern IT infrastructure	Z,ZK	5
NI-MOP	Modern Object-Oriented Programming in Pharo	KZ	4
	nming is currently one of the most widespread paradigms of software creation, especially enterprise information systems, wh		tural abstraction
	modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and aim to further deepen the s		
	odern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their developmen	-	-
	bject programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to wo		
	f semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involve		-
NI-NLM	Neural Language Models	Z	5
	will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models	. The goal of the c	ourse is to teach
	nguage models to solve problems, make informed risk assessments, and work critically with the scientific literature.		
NI-NMS	Neural Networks, Machine Learning and Randomness	Z,ZK	4
Stochastic methods, i.e	. methods based on randomness, are extremely important for the construction and training of neural networks as well as a network of the second s	umber of other ma	achine learning
models. The course "N	eural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural netwo	rks that rely subst	antially on
randomness, as well as	a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the gene	eral stochastic app	proach to training
neural networks and sh	lows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including	neural networks,	are used in one
of the most important a	pplications of randomness stochastic optimization methods, which include e.g. popular evolutionary algorithms.		
NI-NMU	New media in art and design	ZK	3
The course introduces	students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game	and sound. The m	ain goal is to
	with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especia		-
art projects.		,	
NI-OLI	Linux Drivers	Z,ZK	4
	stem is an important operating system for personal computer and also for embedded systems. Systems on chip and combining		
	of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver developmine		
-			uueniis. me
	edge of Linux operating system architecture, principles of development of various types drivers, including practical experience		-
NIE-PML	Personalized Machine Learning	Z,ZK	5
	earning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteris		
	ommonly used in applications such as recommender systems, which recommend items to users based on their personal inte		
to a wide range of other	fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from the	eoretical, algorithn	nic, and practical
perspectives. Specifica	lly, we will focus on cutting-edge models that are of interest to both the research and commercial communities.		
perspectives. Specifica	lly, we will focus on cutting-edge models that are of interest to both the research and commercial communities.	Z,ZK	4
NI-ARI		Z,ZK	-
NI-ARI Students will learn vari	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units.		-
NI-ARI Students will learn vari NI-PG1	Computer arithmetic bous data representations used in digital devices and will be able to design arithmetic operations implementation units.	ZK	4
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NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of d	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the requent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of o practical applications a	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of the quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas and Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoretical implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as r representations,	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection
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NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of practical applications a and recognition and se motion detection, visua	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret ind implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, colo gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (incl expressiveness (saliency).	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as r representations, uding CNN, RCN	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, ViT),
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NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of o practical applications a and recognition and se motion detection, visua NI-EDW The Enterprise Data W	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret ind implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, colo gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (incl expressiveness (saliency). Enterprise Data Warehouse Systems arehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as or representations, uding CNN, RCNt Z,ZK and will gain prac	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, VIT), 5 tical knowledge
NI-ARI Students will learn vari NI-PG1 The course builds on g interested in advanced articles and their subse NI-PIV The Computer Vision c the basic principles of o practical applications a and recognition and se motion detection, visua NI-EDW The Enterprise Data W	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision burse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret ind implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, colo gmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (incl expressiveness (saliency). Enterprise Data Warehouse Systems	ZK e. The course is de the course is the s d topics of compu Z,ZK g.Students will get tical knowledge as or representations, uding CNN, RCNt Z,ZK and will gain prac	4 esigned for those study of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, VIT), 5 tical knowledge
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NI-ARI Students will learn vari NI-PG1 The course builds on guinterested in advanced articles and their subset NI-PIV The Computer Vision c the basic principles of of practical applications a and recognition and see motion detection, visua NI-EDW The Enterprise Data W not only in designing w visualization. NI-PVR The course introduces stu in available 3D engines in virtual reality, or dire NI-AML The course introduces processing, control and NI-IOS Students will learn the BI-IOS. NI-APT Testing a program is estimation	Computer arithmetic bus data representations used in digital devices and will be able to design arithmetic operations implementation units. Computer Grafics 1 aphic courses (mainly BI-PGA and BI-PGR) and the knowledge from these courses is deepened by state-of-the-art knowledge computer graphics. Students will gain practical knowledge with realistic texturing and raytracing methods. An integral part of t quent implementation. The course will be followed by a course PG2 supplementing the knowledge of PG1 on other areas an Computer Vision Durse focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoret modern through classical and recent approaches based on deep learning, deep neural networks for computer vision (incl expressiveness (saliency). Enterprise Data Warehouse Systems arehouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods arehouses and various architectures, but also their deployment and maintenance. This course also includes an introduction to Advanced Virtual Reality advanced parts of the virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply th tty create a complex game for VR. Advanced machine learning students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of interconnection of physical laws with the field of machine learning. The aim of the exercise is to familiarize students with the fodvanced Program Testing sential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The	ZK a. The course is the s d topics of compu- Z,ZK g. Students will get tical knowledge as r representations, uding CNN, RCNI Z,ZK and will gain prac- to the area of repor- KZ odels in Blender, a also deal with crea- e knowledge gained Z,ZK f recommendation methods discussed KZ he basics from the Z,ZK	4 signed for those tudy of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, ViT), 5 tical knowledge rting and data 4 and among other ting applications ed in this subject 5 systems, image ed. 4 beginners class
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NI-ARI Students will learn vari NI-PG1 The course builds on guinterested in advanced articles and their subset NI-PIV The Computer Vision c the basic principles of of practical applications a and recognition and se motion detection, visua NI-EDW The Enterprise Data W not only in designing w visualization. NI-PVR The course introduces stu in available 3D engines in virtual reality, or dire NI-AML The course introduces processing, control and NI-IOS Students will learn the BI-IOS. NI-APT Testing a program is es advanced program test NI-PVS The course is focused	Computer arithmetic Computer arithmetic Computer arithmetic Computer Grafics 1 Computer Vision Com	ZK a. The course is the s d topics of compu- Z,ZK g.Students will get tical knowledge as r representations, uding CNN, RCN Z,ZK and will gain prac- to the area of repor- KZ odels in Blender, a also deal with creat e knowledge gained Z,ZK f recommendation methods discussed KZ ne basics from the Z,ZK goal of the coursed Z,ZK and of the coursed Z,ZK solution the solution methods discussed Z,ZK and basics from the Z,ZK solution the coursed Z,ZK solution the coursed Z,ZK	4 4 asigned for those tudy of scientific ter graphics. 5 acquainted with s well as on object detection N, YOLO, ViT), 5 tical knowledge rting and data 4 and among other ting applications ed in this subject 5 systems, image ed. 4 beginners class 5 is to present 4 acquirity support,

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

NI-TVR	Virtual Reality Technology	Z,ZK	3
	iced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of c		
	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways o	of using virtual and	d augmented
reality will be presented		-	4
NI-TS1	Theoretical Seminar Master I		4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a clas and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		-
-	e. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS2	Theoretical Seminar Master II	Z	4
-	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a cla	-	-
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		
other scholarly literatur	e. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS3	Theoretical Seminar Master III	Z	4
Theoretical seminar is i	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classifier of the students which want to come in deeper contact with contemporary theoretical computer science.	ssical reading gro	up. The students
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	s a work with scie	ntific papers and
	e. The capacity is limited by the the potentials of the teachers of the seminar.	_	
NI-TS4	Theoretical Seminar Master IV		4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classified and an active the second bin the second		
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is e. The capacity is limited by the the potentials of the teachers of the seminar.	s a work with scie	nunc papers and
NI-TKA	Category Theory	Z,ZK	4
	Theory of Neural Networks	Z,ZK Z,ZK	4 5
NI-TNN	reural networks from the point of view of the theory of function approximation and from the point of view of probability theory	· ·	÷
	eural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmissi		
	work training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transfor		
	somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with tra		
	and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most		
employed for neural ne	work training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within	the topic approxi	mation approach
to neural networks, we	first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko	olmogorov theorer	n, Vituškin
theorem). Afterwards, v	ve will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mapp	ings computed by	neural networks
	nt Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect		
	us derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on exp		-
	th probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see h	-	-
	ctancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak la logy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the cen	-	-
	ral networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can b		• •
topology of the network			
		7 7K	5
NI-CPX	Complexity Theory	Z,ZK	5 ing practical
NI-CPX	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		
NI-CPX Students will learn abo	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems.	he theory concern	ing practical
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems. Academic writing	he theory concern	ing practical 2 Writing scientific
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the fo	he theory concern Z rm of publication. course, students v	ing practical 2 Writing scientific vill learn how to
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The course	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the fo efful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the e what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting se will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester.	The theory concern Z rm of publication. course, students v an article and rev	2 Writing scientific vill learn how to iewing someone
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en	Complexity Theory Ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the for efful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting se will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. rolled students.	The theory concern Z rm of publication. course, students v an article and rev Dates will be deter	Ing practical 2 Writing scientific vill learn how to iewing someone ermined based
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en NI-DVG	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of th t problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the fo efful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the o what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting se will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. rolled students. Introduction to Discrete and Computational Geometry	The theory concern Z rm of publication. course, students v an article and rev Dates will be deter Z,ZK	2 Writing scientific vill learn how to iewing someone ermined based
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en NI-DVG The course intends to in	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the foreful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the original parts such an article should have, and how the peer review process works. Students will also try their hand at presenting see will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. rolled students. Introduction to Discrete and Computational Geometry Introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar or the students is the discipline of the series and computational Geometry.	The theory concern Z rm of publication. course, students v an article and rev Dates will be deter Z,ZK	2 Writing scientific vill learn how to iewing someone ermined based
NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en NI-DVG The course intends to i of this discipline, and to	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the problems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the for off of students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the or what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting see will 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 Introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar to be able to solve simple algorithmic problems with a geometric component.	The theory concerning the theory concerning of publication. The course, students with the most function of the mos	2 Writing scientific vill learn how to iewing someone ermined based 5 lamental notions
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NI-CPX Students will learn abo (in)tractability of difficul FI-TOP Publishing is an import publications can be use write a scientific article, else's article. The cours on the availability of en NI-DVG The course intends to i of this discipline, and to NI-VOL We will cover the basic NI-VPC Classical theory of rect NI-VPR Student obtains the cre NI-ZS10 Each student can once Dean of the FIT, or the courses MI-ZS10, MI-Z a foreign institution. The academic year's dead- NI-ZS20 Each student can once Dean of the FIT, or the courses MI-ZS10, MI-Z a foreign institution. The academic year's dead- NI-ZS30 The course is prezente research institution. Bei content and extent of th to 4 weeks of full-time of	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the troblems. Academic writing ant and required part of research activity. It is not only about obtaining research results but also about applying them in the for 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 e what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Introduction to Discrete and Computational Geometry Introduct be simple algorithmic problems with a geometric component. Elections s of committee) elections and, in general, opinion aggregation. Computability resive functions and effective computability. Research Project dits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en. Master internship abroad for 10 credits within his / her master's degree have a foreign internship at a foreign university or other foreign scientific and/or research ins //ce-dean for study affairs assesses the professional content. The student must provide evidence of the professional content an \$20, MI-ZS30 are used used for the evidence and evaluation of the internship in IS KOS. Every 10 credits correspond to 4 we a maximum number of credits a student can earn for one internship is 30 credits. This amou	Z rm of publication. course, students wan article and rew Dates will be determined Z,ZK Z,ZK Z,ZK Z,ZK Z,ZK Z titution. Before the dextent of the intereship Z Kitution. Before the dextent of the intereship Z Kitution. Before the dextent of the intereship Z Kitution. Before the dextent of the intereship Z Y or other foreign structure of the intereship Y or other foreign structure of KOS. Every 10 or	2 Writing scientific vill learn how to iewing someone ermined based 5 lamental notions 5 4 5 4 5 4 5 20 e internship the ernship. Auxiliary mployment with exceeds the 20 e internship the ernship. Auxiliary mployment with exceeds the 30 scientific and/or the professional edits correspond

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.

Note on the group	Name of the course / Name of the group of courses					anzation
Code	(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 Martin Novotný (Gar.)	Z,ZK	5	2P+2C	L	V
NI-BKO	Error Control Codes Pavel Kubalík Pavel Kubalík Pavel Kubalík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-DSV	Distributed Systems and Computing Pavel Tvrdík Jan Fesl Pavel Tvrdík (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EPC	Effective C++ programming Daniel Langr Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EVY	Efficient Text Pattern Matching Jan Holub Jan Holub Jan Holub (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-FME	Formal Methods and Specifications Stefan Ratschan Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	L	V
NI-GEN	Code Generators Petr Máj, Jan Janoušek 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 Jií Bu ek 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 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 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 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 Petra Pavlí ková (Gar.)	Z,ZK	5	2P+2C	L	V
NI-PIS	Enterprise Information Systems Vlastimil Jinoch, Martin Závrbský, Martin Mach, Martin Hasaj David Buchtela David Buchtela (Gar.)	Z,ZK	5	2P+1C	L	V
NI-KRY	Advanced Cryptology Ji í Bu ek, Róbert Lórencz Ji í Bu ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-PAS	Advanced Aspects of Business David Buchtela, Št pánka Havlíková, Dominik Vítek, Ji í Maršál, Jana Soukupová, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	z	V
NI-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 Marcel Ji ina (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-REV	Reverse Engineering Josef Kokeš Josef Kokeš (Gar.)	Z,ZK	5	1P+2C	Z	V
NI-RUN	Runtime Systems Filip K ikava Filip K ikava 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 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 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 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

NI-ADM	Data Mining Algorithms	Z,ZK	5
The course focuses on	algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the stude	nts should know n	nachine learning
basics. The emphasis is	put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation	systems) and more	dels (e.g., kernel
methods).			
NI-AIB	Algorithms of Information Security	Z,ZK	5
Students will get acquai	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, si	udents will learn t	he mathematical
principles of cryptograp	hic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware dete	ction and the use	of machine
learning in detection system	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.		
NI-ADP	Architecture and Design patterns	Z,ZK	5
The objective of this co	urse is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis	s as well as with u	inderstanding 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	ge of object-orient	ed programming
and get familiar with the	commonly used object-oriented design patterns that represent the best practices for solving common software design probler	ns. In the second j	part the students
will be introduced to the	principles of software architecture design and analysis. This includes the classical architectural styles, component based syste	ems, and some ad	vanced software
architectures used in la	rge-scale distributed systems.		
NI-BML	Bayesian Methods for Machine Learning	KZ	5
The subject is focused of	n practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it stud	ies the construction	on of appropriate
	ption of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidde		
	etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose		
	presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imagin	g. The students w	ill try to solve
some of them.			
NI-BVS	Embedded Security	Z,ZK	5
Students gain basic kno	wledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cr	yptographic primit	tives in hardware
and software (in embed	ded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resou	rces for securing i	nternal functions
of computer systems.			
NI-BKO	Error Control Codes	Z,ZK	5
The goal of the course	s to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted v	ia 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 compu	ting processes and	d communication
channels. They learn ba	sic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms th	at support high a	vailability of both
data and services, and	safety in case of failures.		
NI-EPC	Effective C++ programming	Z,ZK	5
Students learn how to u	se the modern features of contemporary versions of the C++ programming language for software development. The course f	ocuses on program	mming effectivity
and efficiency in the for	m of writing maintainable and portable source code and creating correct programs with low memory and processor time requ	uirements.	

NI-EVY	Efficient Text Pattern Matching	Z,ZK	5
Students get knowledg	e of efficient algorithms for text pattern matching. They learn to use so called succinct data structures that are efficient in both ac	cess time and me	mory complexity.
They will be able to us	e the knowledge in design of applications that utilize pattern matching.		
NI-FME	Formal Methods and Specifications	Z,ZK	5
	scribe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use some	e software tools th	hat allow to prove
basic properties of soft	ware.		
NI-GEN	Code Generators	Z,ZK	5
	of translating programs written in high-level programming languages are essential for understanding the field of systems prog		-
	rithms and techniques used to translate more complex programming constructs of modern languages employed in systems p	rogramming. Stud	ents will become
	eoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.		
NI-GAK	Graph theory and combinatorics	Z,ZK	5
•	to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorith		
e e	sic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected		,
	ry, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theo rds, formal languages and bioinformatics.	ry will be also app	
NI-HWB		Z,ZK	5
	Hardware Security e knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safegu		-
	. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stu	-	-
-	lerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the c	-	emeage about
NI-KOD	Data Compression	Z,ZK	5
	d to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data		1
	verview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, s	-	-
	n methods used in image, audio, and video compression.		
NI-MKY	Mathematics for Cryptology	Z,ZK	5
	per knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers.		-
on the problem of solvi	ng a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discr	ete logarithm. The	e problem of
factorization will also b	e solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NI-MVI	Computational Intelligence Methods	Z,ZK	5
	d methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable to		They will learn
how these methods wo	rk and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.		
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 approa	ch for (re)enginee	ring and
implementation of proc	esses, organisation structures and information support in big enterprises and institutions.		
NI-MPJ	Modelling of Programming Languages	Z,ZK	5
The analysis, transform	nation, and code generation processes depend on the semantics of the language; in particular, they are correct if they preserve	ve the semantics	of the language.
This course explores th	e semantics of programming languages. The students will learn the language models with emphasis on functional languages, st	udents are expect	ed to understand
the basics of the lambo	a calculus and here get acquainted with the advanced lambda calculus. The students also get hands-on-experience with sema	antic modeling and	execution tools.
NI-MTI	Modern Internet Technologies	Z,ZK	5
SYNOPSIS The subject	t "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration	n - A single netwo	rk, oriented on
	whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, vio		
-	Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hundre		
	is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching an		
	vice providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, dela		rotocol). 4.
	ies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case of		
NI-NUR	User Interface Design	Z,ZK	5
	d the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, fo		
	s. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be able	-	
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
	iced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such me		
	element method and the finite difference method used for solving ordinary and partial differential equations in engineering. T	-	-
as well as in parallel.	ons that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement	ent these algorithm	ns sequentially
NI-NSS	Normalized Software Systems	ZK	5
	foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from enginee	1	1
	n thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related i		
	and part of the course, students learn how to construct software architectures using a set of 5 design patterns called elements		
	ion systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stab		-
-	students to realize new levels of evolvability in software architectures.	, ,,	
NI-OSY	Operating Systems and Systems Programming	Z,ZK	5
	tem programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kerne		1
-	memory management, file operations and architecture of modern file systems, device drivers and network programming. The		
development process,	upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portabil	ity. Specifics of ke	ernel architecture
in embedded and real-	ime operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within I	abs, students will	work on projects
focused on developme	nt of LINUX kernel modules.		
NI-BUI			
The aim of the course i	Business Informatics	Z,ZK	5
	Business Informatics s to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas		-
ICT services and archi	s to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas tectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manage	of business proce ment, and lifecycl	ss management, le management
ICT services and archi of ICT services and re-	s to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas tectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manage source management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governation strategy, IT Governation strategy, IT Governations and standards (ITIL) and the principles is a standard strategy of the strategy of the process of creating and implementing information strategy.	of business proce ment, and lifecycl ance, the importar	lss management, le management nce of ICT for
ICT services and archi of ICT services and re- business and the conte	s to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas tectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manage	of business proce ment, and lifecycl ance, the importar	lss management, le management nce of ICT for

	Z,ZK	5
The course is focused on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage	e of big data (BigDa	ita) and their use
in BI (Business Intelligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication		•
real examples. Furthermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the		
Students will be acquainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and op	eration of informatio	in systems in the
company / organization.	7 71/	
NI-KRY Advanced Cryptology	Z,ZK	5
Students will learn the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will kn random number generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which the		
their own systems or to the creation of their own software solutions.	ey can apply to the	Integration of
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 rur		1
management, especially in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.		
NI-GPU GPU Architectures and Programming	Z,ZK	5
Students will gain knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the		1
which is already a widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchica		-
will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.	·	
NI-PDD Data Preprocessing	Z,ZK	5
Students learn to prepare raw data for further processing and analysis. They learn what algorithms can be used to extract information from various	data sources, such	as images, texts,
time series, etc., and learn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of charac	teristics from image	es or from web
pages.		
NI-REV Reverse Engineering	Z,ZK	5
Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happen	s before and after t	he main function
is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is d	edicated to reverse	engineering of
applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be		
debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the comp	outer malware scene	a. The focus of
the course is on the seminars, where students will solve practically oriented tasks from the real world.		
NI-RUN Runtime Systems	Z,ZK	5
This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on expe	erience in design an	d implementation
of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC corr	pilation Memory m	anagement
Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implement	entations of real-wor	ld VMs, including
Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world VMs		.
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) lev	els and with the
properties of proper tools. The course covers recent verification methods, too.		.
NI-SIB Network Security	Z,ZK	5
NI-SCR Statistical Analysis of Time Series	Z,ZK	5
	2,21	5
The course deals with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange p	rices, employment)	and industrial
problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a	rices, employment) convenient process	and industrial model, estimate
problems (modelling of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a 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 stress is put on understanding adoption of the stress is put on understan	rices, employment) convenient process le main principles ba	and industrial model, estimate ased on practical
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NI-ESW	Embedded Software	Z,ZK	5
Embedded software cou	irse acquainted students with the specifics of software development for embedded systems. The course covers the areas from the	, ,	s of programming
in C language and code	e optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing,	up to sophisticat	ed techniques
combined with artificial	intelligence.		
NI-APR	Selected Methods for Program Analysis	Z,ZK	5
This course introduces	you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dy	' namic analysis. Ir	h Static Analysis,
we will look at the art of	reasoning about computer programs without running them. We will look at the analyses for program understanding, optimize	ations, error detec	tion. In Dynamic
Analysis, we will look at	the analyses considering individual program runs using a concrete environment and inputs.		
NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
The course focuses on o	ptimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge o	f continuous optin	nization obtained
in the course Mathemat	ics for informatics. The methods are explained and described along with the details on how they are implemented on comput	ers. Hence, the re	elevant concepts
of numerical matematic	s, mainly numerical linear algebra, are explained too.		
NI-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acquai	nted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations or	n multicore proces	sors with shared
and virtually shared me	mories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowle	edge of architectu	rally specific
optimization techniques	used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs	and memory inter	face throughput.
On specific non-trivial n	nultithreaded 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 portant and required part of research activity. It is not only about obtaining research results but also about applying them in the form	Z	2
publications can be write a scientific art	e useful for students not only in their own publishing activities but also in the preparation of a bachelor's or master's thesis. In the cou icle, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an course will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Da on the availability of enrolled students.	rse, students will le article and reviewir	earn how to
FIT-ITI	Modern IT infrastructure	Z,ZK	5
FIT-SEP	World Economy and Business	Z,ZK	4
This course is pre	sented in Czech. The course introduces students of technical university to the international business. It does that predominantly by c	omparing individua	l countries
, ,	world economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as well as nomic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form of d readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.		
FITE-EHD	Introduction to European Economic History	Z,ZK	3
The course introdu	ices a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global eco	nomy through the	description
	in history. As European countries have been dominant actors in this process it focuses predominantly on their roles in the economic	, ,	
	pire to fragmentation of the Middle Ages, from destruction of WWII to the current affairs, the development of modern financial institut tailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and o meetings will consist of a mixture of lecture and discussion.		
NI-ADM	Data Mining Algorithms	Z,ZK	5
	s on algorithms used in the fields of machine learning and data mining. However, this is not an introductory course, and the students sis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation sys methods).		-
NI-ADP	Architecture and Design patterns	Z,ZK	5
	s course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as		-
and get familiar with	ues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge on the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. In the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems architectures used in large-scale distributed systems.	In the second part t	the students
NI-AFP	Applied Functional Programming	KZ	5
	ented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional p and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, master necessary competence of a software engineer: the theory and especially the practice.		•
NI-AIB	Algorithms of Information Security	Z,ZK	5
	quainted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, stude tographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detec learning in detection systems. The last topic includes practical steganographic methods and attacks on steganographic syste	tion and the use of	
NI-AM1	Middleware Architectures 1	Z,ZK	5
	ly new trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information syste lication servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous comm of applications.		
NI-AM2	Middleware Architectures 2	Z,ZK	5
	new trends and technologies on the Web including theoretical foundations. They will gain an overview of Web application architecture for microservices, distrubuted cache and databases, smart contracts, realtime communication and web security.		
NI-AML	Advanced machine learning	Z,ZK	5
	ces students to selected advanced topics of machine learning and artificial intelligence. The topics present techniques in the field of rec		
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 discus	sed.

NI-AOA	Completing a professional event	Z	1
	cipation in a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, concluded with a workshop, a test, drafti		
	d in advance by the vice-dean for pedagogical activities or the vice-dean for science and research and is presented within the FIT thr	ough a website, inf	omail, etc.
NI-APH	Architecture of computer games	Z,ZK	4
-	basic understanding of the various issues in the field of computer games development, especially from a technical point of view, but also		
	vill get a grasp of component-oriented and functional-oriented architecture, game mechanics, decision-making processes and base co	•	0
part of most game	es. They will also understand the basics of pathfinding, networking and scripting and apply them in practical exercises (labs). An important implementation of a simple game, with a strong focus on paptrivial game mechanics	ortant part of the co	ourse is an
	implementation of a simple game, with a strong focus on nontrivial game mechanics.	7 71/	5
NI-APR	Selected Methods for Program Analysis lices you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynar	Z,ZK	-
	art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizatio	•	
	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
	is essential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The gr		-
	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 implementations	ition units.	•
NI-ATH	AlgorithmicTheories of Games	Z,ZK	4
-	theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory stu		-
	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game to	-	-
	s of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social network		
	s and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of e concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of the statement of the sta		
NI-BKO	Error Control Codes	Z,ZK	5
	I of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transi	1 '	1
NI-BML	Bayesian Methods for Machine Learning	KZ	. 5
	sed on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies		-
-	description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden		
	tions etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a		
	will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging.		
	some of them.		
NI-BPS	Wireless Computer Networks	Z,ZK	4
	n about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ac		
broadcast mecha	nisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowl		echanisms
	for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suital		-
NI-BUI	Business Informatics	Z,ZK	5
	se is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of b architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT manageme	-	-
	nd resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governan		-
	e context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management	-	
	management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).		
NI-BVS	Embedded Security	Z,ZK	5
Students gain basic	knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of crypt	ographic primitives	in hardware
and software (in err	bedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resource	s for securing interr	nal functions
	of computer systems.	·	
NI-CCC	Creative Coding and Computational Art	KZ	4
	practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the		
.,	ices students to suitable visualization methods for traditional as well as for open data. It combines well-known visualization technique es. The aim is to create an interesting visualization project. It is planned to work closely with IPR CAMP (Center of Architecture and I		0
	(Institute of Intermedia FEL).		ing) and nivi
NI-CPX	Complexity Theory	Z,ZK	5
	n about the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the	1 1	1
	(in)tractability of difficult problems.	, , , , , , , , , , , , , , , , , , ,	
NI-CTF	Capture The Flag	KZ	4
_	The course is designed to introduce students to CTF competitions and let them gain practical experience in the field of cyber se	1	I
NI-DDM	Distributed Data Mining	KZ	4
	state-of-the-art approaches for distributed data mining and parallelization of machine learning algorithms. Students will gain hands		large scale
data processing fra	amework Apache Spark and with existing distributed DM / ML algorithms. They will learn principles of their parallel implementations a	and will be capable	to propose
	approaches to parallelize other algorithms. The course is prezented in czech language.		
NI-DDW	Web Data Mining	Z,ZK	5
	arn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will gain		-
techniques for Web	crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an overvie in the field of social web and recommendation systems.	w or most recent de	evelopments
		7	2
NI-DID	Digital drawing oduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, pers	Z	2
	r apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course		-
	r learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practi	-	
NI-DIP	Diploma Project	Z	30
NI-DNP	Advanced .NET	Z,ZK	4
	re an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (W	1 1	-
	re DevOps and GIT. Students will get practical experience in semestral work where they will create a client-server application utilizing		
	Entity Framework Core and (Blazor, .NET MAUI or WPF) and also Azure DevOps and GIT.		

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 peo interested in deeper knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics design, storytelling, and gam development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semes	
	ple
development cycle. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical implementation applied to semes	ne
	tral
projects.	
NI-DSS Decision Support Systems Z,ZK 5	
The aim of the course is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of data-oriented, model-orien	
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 princip	les
of conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithms.	
NI-DSV Distributed Systems and Computing Z,ZK 5	
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing processes and communicat	
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 b data and services, and safety in case of failures.	oth
	rin a
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. Dur 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	~ I
testing the prototypes (plus final presentation).	
NI-DVG Introduction to Discrete and Computational Geometry Z,ZK 5	
The course 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 notice	one
of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	SUIC
NI-DZO Digital Image Processing Z,ZK 4	
This course presents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical algorithms that are 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 dom	
of digital image processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR compression, de-blurring in	
frequency domain, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conversion, context enhancement	
interactive as-rigid-as-possible image deformation, free-form image registration, texture synthesis, interactive segmentation, colorization, painting, adding depth, alpha matting.	
NI-EDW Enterprise Data Warehouse Systems Z,ZK 5	
The Enterprise Data Waterhouses course focuses on the area of business intelligence. Students will be introduced to business intelligence methods and will gain practical knowled	Ine
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 da	-
visualization.	
NI-EHW Embedded Hardware Z,ZK 5	
The course brings basic laws that govern digital design and basic techniques to use them. It deals with both large and small scale systems. This is the base of advanced embedded	ed
systems, that profit from their specialized structure for effective computation and acceleration. Design of fast custom computing machines is discussed, including standardized mea	
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 effective	vitv
and efficiency in the form of writing maintainable and portable source code and creating correct programs with low memory and processor time requirements.	,
NI-ESC Experimental Project Course KZ 8	
"The Design Project course offers a holistic exploration of the design process, providing students with a well-rounded understanding of the principles, methodologies, and tools us	ed
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-relevant.	
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 ar	
user experience evaluation, as well as gain experience working in a team to design and prototype a functional solution."	
NI-ESW Embedded Software Z,ZK 5	
Embedded software course acquainted students with the specifics of software development for embedded systems. The course covers the areas from the basic techniques of programm	nina
in C language and code optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing, up to sophisticated technique	- 1
combined with artificial intelligence.	
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 access time and memory complex	xity.
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 pro-	ove
basic properties of software.	
NI-FMT Finite model theory 7.7K 4	
NI-FMT Finite model theory 5, 2, 2, 4 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 databate	ase
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NI-GOL	Programming of distributed systems in GO	KZ	5
NI-GPU	GPU Architectures and Programming	Z,ZK	5
	nowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CUI		
which is already a w	videspread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.	putational structur	es, students
NI-GRI	Grid Computing	Z,ZK	5
	Grid computing and gain knowledge about the world-wide network and computing infrastructure.	<u>_,_</u> , _, <	Ŭ
NI-HCM	Mind Hacking	ZK	5
	is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, info		
-	nitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive securi		-
the context of inform	nation warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet impacts such as disruption of social cohesion, threats to democracy or war.	environment nave	real societai
NI-HMI2	History of Mathematics and Informatics	ZK	3
	esented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithms		-
	functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its develop	ment.	
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
	dicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attack de channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and	-	
	hey also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel	-	-
NI-HWB	Hardware Security	Z,ZK	5
The course provide	es the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguard	,	the system
-	eans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Studer	-	edge about
	ptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions		
NI-IAM	Internet and Multimedia be is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acq	Z,ZK	4
	signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical u	•	
	issions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the effe		
the quality and late	ncy of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording the	e scene up to the p	presentation
	for audience.		
NI-IBE	Information Security	ZK	2
	rmation and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and international d methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g.		-
NI-IKM	Internet and Classification Methods	Z,ZK	^{19).}
	students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering	,	1
in malware detecti	on systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving	these four kinds o	f problems.
-	l of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle w		
NI-IOS	During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consul Advanced techniques in iOS applications	KZ	sks.
	the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the bit		inners class
	BI-IOS.	Ū.	
NI-IOT	Internet of Things	Z,ZK	4
	boused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is fa		available
	development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (G		4
NI-IVS	Intelligent embedded systems ed systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The	KZ	1
e e	mbedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot programmed and the students in the student of the student students humanoid robot programmed and the student student students humanoid robot programmed and the student students humanoid robot programmed and the student students humanoid robot programmed and the student student student student students humanoid robot programmed and the student st		
development. Lectu	res provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students of	develop advanced	applications
	combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web tech	-	
NI-KOD	Data Compression	Z,ZK	5
	duced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data ne overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stude	-	-
	lossy data compression methods used in image, audio, and video compression.		
NI-KOP	Combinatorial Optimization	Z,ZK	6
The students will g	ain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not on	y to select and imp	blement but
	also to apply and evaluate heuristics for practical problems.	7 71/	_
NI-KRY	Advanced Cryptology	Z,ZK	5
	n the essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know the generators. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they c	-	-
	their own systems or to the creation of their own software solutions.		- <u>g</u>
NI-KTH	Combinatorial Theories of Games	Z,ZK	4
-	theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory stud		-
	ain competitive process by designinng a mathematical model and investigating the strategies. The traditional task of classical game to	-	-
	s of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-playe onway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is		
	atible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The thi	-	
	established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force tra	-	-
	introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory of		-
-	n theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course required to the third user who attended introduction to graph theory		-
to mathematically	analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory looking for research topics.	, as well as for Ph	U SIUDENTS

will also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CERT team NI-LOM Linear Optimization and Methods Z,	,ZK	5
Students learn the applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear and integer	·	-
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 practical miportance of mineral and medge		
science (such as scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelling sales	-	
issues from economics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. They get original	entation in algo	orithms
in linear programming.		
o	KZ	5
The topic of LSM2 is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presence of clur We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli) filters.	itter, or video tra	acking.
	,ZK	5
Students will get acquainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on multicore pr	· I	-
and virtually shared memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowledge of arc		
optimization techniques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and memory	/ interface throu	ughput.
On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.		
	,ZK	5
The subject is focused on introduction to the discipline of Enterprise Engineering. Students learn the importance of a proper methodological approach for (re	e)engineering a	and
implementation of processes, organisation structures and information support in big enterprises and institutions. NI-MKY Mathematics for Cryptology Z.	.ZK	5
NI-MKY Mathematics for Cryptology Z, Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In particular	· I	-
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 logarith		
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NI-MLP Machine Learning in Practice Z,	,ZK	5
Applying machine learning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ideally, tech		
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		
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 understa		
NI-MOP Modern Object-Oriented Programming in Pharo	KZ	4 traction
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 desig		
of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to students, their development needs and	, ,	
addition to deepening object programming skills, which are generally applicable in other OO languages, students will also gain the opportunity to work on interest	sting projects a	ind OO
technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, postgraduate our direct involvement in the		
	,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, smoo		
I multi variate integration. The third large tenic is computer arithmetics and number representation in a computer along with error manipulation. The last tenic include	-	
multi-variate integration. The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last topic include algorithm and their stability analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear presentation	es selected nur	merical
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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 number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as well as a number of the construction and training of neural networks as a number of the construction and training of neural networks as a number of the construction and training of neural networks as a number of the construction and training of neural networks as a number of the construction and training of neural networks as a number of the construction and training of neural networks as a number		0
models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networ		-
randomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general structure and the structure of the stru		•
neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including neuronal networks and machine learning, machine learning models, including neuronal statements and the mast important applications of randomness transformation primitization methods, which include a graphication of randomness transformations and machine learning.		used in one
of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algo NI-NMU New media in art and design		2
NI-NMU New media in art and design The course introduces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game an	ZK	3
familiarize the students with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially		
art projects.		r to specific
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	these algorithms se	equentially
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	, such as stability f	rom system
theory 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	-	
functionality 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	Z,ZK	4
The Linux operating system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining po- increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development		
course provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practica		ents. The
		5
NI-OSY Operating Systems and Systems Programming The course covers system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel d	Z,ZK	
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 labs,	-	
focused on development of LINUX kernel modules.		
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	sary to solve these	problems
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	-	
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 exponent	e can find a commontially in this (small	on property) parameter
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NI-PIV Computer Vision	Z,ZK	5		
The Computer Vision course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data proces	0 1			
the basic principles of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on t	-			
practical applications and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color representations, object detection and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (including CNN, RCNN, YOLO, ViT),				
and recognition and segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision motion detection, visual expressiveness (saliency).	(Including CINN, RCINN, Y	OLO, VIT),		
NI-PLS1 Programming Language Seminar	Z	2		
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group i	n which we discuss scienti			
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate	in the discussions. The rea	ading group		
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming la	nguages.			
NI-PLS2 Programming Language Seminar	Z	2		
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group i				
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate		ading group		
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming la				
NI-PLS3 Programming Language Seminar	Z	2		
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group i				
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming la		aung group		
NI-PLS4 Programming Language Seminar	Z	2		
The Programming Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group i	1 1			
about programming languages and related fields. Participating students are expected to present a paper of their interest and actively participate				
is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming la				
NI-PON Selected Topics in Optimization and Numerical mathematics	Z,ZK	5		
The course focuses on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowled		-		
in the course Mathematics for informatics. The methods are explained and described along with the details on how they are implemented on cor				
of numerical matematics, mainly numerical linear algebra, are explained too.	<u>.</u>			
NI-PSD Public Services Design	KZ	4		
The course will introduce students to specifics of UX, Service design and development for public sector. We will look into the design and develop	ment process from the pe	rspective of		
suppliers (devs and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out colla	boration with client represe	entatives.		
Course is aimed at students-designers as well as clients.				
NI-PSL Programming in Scala	Z,ZK	4		
The course introduces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language				
advance standard library. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful framework	orks and libraries e.g. Play,	Cassandra,		
Scalaz, etc.				
NI-PVR Advanced Virtual Reality	KZ	4		
The course introduces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3I		-		
things, it introduces students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and in available 3D engines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to appl	-			
in virtual reality, or directly create a complex game for VR.	y the knowledge gamed in	this subject		
NI-PVS Advanced embedded systems	Z.ZK	4		
The course is focused on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of a		=		
working with mass storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also				
systems.				
NI-PYT Advanced Python	KZ	4		
The goal of this course is to learn various advanced techniques and methods in Python. The course indirectly continues where Programming in	Python (BI-PYT) left of. Th	e course is		
very hands-on and it has only tutorials, everything is demonstrated on examples. Classification is based on work in class as well as semestral cour	sework. The course is lead	by external		
teachers from Red Hat.				
NI-REV Reverse Engineering	Z,ZK	5		
Students will get acquainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happ				
is called. Students will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is	•			
applications written in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also debuggers and debugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the co				
the course is on the seminars, where students will solve practically oriented tasks from the real world.	mputer maiware scene. IT			
	7.7%	5		
NI-ROZ Pattern Recognition The aim of the module is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of	T,ZK			
recognition. Students will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimated and applications of pattern recognition.		-		
NI-RUB Programming in Ruby	KZ	4		
This course is presented in Czech.		-		
NI-RUN Runtime Systems	Z,ZK	5		
This course is an introduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on ex		-		
of a compiler and a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC				
Just-in-time compilation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and impler		•		
Dynamic optimizations, speculations, and deoptimizations Language implementation frameworks Read-world	VMs			
NI-SBF System Security and Forensics	Z,ZK	5		
Students will get familiar with aspects of system security (principles of end station security, principles of security policies, security models, aut	nentication concepts). Furt	hermore,		
students will get familiar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and		ues and the		
importance of operating system/operating system artifacts or file system for attack analysis and detection).				
NI-SCE1 Computer Engineering Seminar Master I	Z	4		
The Seminar of Computer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resis				
are approached individually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Pa	-			
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 n	ew for each		
semester.				

NI-SCE2	Computer Engineering Seminar Master II	Z	4		
	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to				
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 p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher	s. The topics are n	ew for each		
	semester.	(
NI-SCR	Statistical Analysis of Time Series	Z,ZK	5		
The course deals	with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices	, employment) and	d industrial		
problems (modellin	ig of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conve	nient process mod	lel, estimate		
its parameters, ana	lyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the mai	n principles based	on practical		
real-world example	is. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfe	er of students' know	wledge from		
	the academic to the real world.				
NI-SEP	World Economy and Business	Z,ZK	4		
This course is p	presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students o	f technical univers	ity to the		
international busi	iness. It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about dif	ferent religions and	d cultures,		
necessary for doin	g business in diverse societies as well as indexes of economic freedom, corruption and economic development, which are needed for	the right investme	ent decision.		
Seminars help to	o 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 pre-	requisite.		
NI-SIB	Network Security	Z,ZK	5		
NI-SIM	Digital Circuit Simulation and Verification	Z,ZK	5		
	Irse is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level	· · ·	-		
	properties of proper tools. The course covers recent verification methods, too.	wodening) levels a			
		7 71/	<i>г</i>		
NI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5		
	learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web tech	-			
practices for mod	delling, integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	graphs and their s	systematic		
	quality assurance.	(
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 va	rious variants and	applications		
	of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.				
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4		
On this semina	r you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research	arch labs around th	e world.		
Additionally, you wi	Il learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top maching	ne learning and AI (conferences		
	and summer schools, as well as FIT's own Summer Research Program (VyLet).	-			
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4		
	r you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research		-		
	Il learn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top maching				
, idulionalij, jou m	and summer schools, as well as FIT's own Summer Research Program (VyLet).	io ioaning ana / i o			
NI-TES	Systems Theory	Z,ZK	5		
	d has the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). However		-		
	ensuring the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of m				
	tems that are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and alg		-		
aspects of the sys					
	the modeling and analysis of complex systems.				
NI-TKA	Category Theory	Z,ZK	4		
NI-TNN	Theory of Neural Networks	Z,ZK	5		
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 bas	sic concepts		
pertaining to artific	ial neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission,	network topology, s	somatic and		
synaptic mappings	s, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transforma	tion into a canonic	al topology,		
and in connectio	n with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with trai	ning, we pay attent	tion to the		
problem of overtra	ining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most im	portant optimizatic	on methods		
employed for neura	al network training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within the	topic approximatic	on approach		
to neural netwo	rks, we first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko	mogorov theorem.	, Vituškin		
theorem). Afterwar	ds, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings	computed by neur	ral networks		
being dense in in	nportant Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to	o a finite measure,	spaces of		
functions with con	tinuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expec	tation and training	based on a		
random sample, ar	nd with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how i	t is possible to get	an estimate		
of the condition	al expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak la	w of large numbers	s and get		
acquainted with a	n analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the centra	l 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 sear	ch for the		
	topology of the network.				
NI-TS1	Theoretical Seminar Master I	Z	4		
	ar 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				
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.		paporo ana		
		7	4		
NI-TS2	Theoretical Seminar Master II		-		
	ar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic				
are treated individu	ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a vertex scholarly literature. The conscience is limited by the the potentials of the teachers of the sominar	NOTK WITH SCIENTIFIC	papers and		
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	-	4		
NI-TS3	Theoretical Seminar Master III	Z	4		
	ar is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic				
are treated individu	ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a v	vork with scientific	papers and		
1	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.				

NI-TS4	Theoretical Seminar Master IV	Z	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic		
are treated individu	ally and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is a	work with scientific	papers and
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.		
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	lit-in-seif-test equip	oment. They
	will be able to compute, analyze, and control the reliability and availability of the designed circuits.	1/7	4
NI-TSW	Software Product Development	KZ	4
	The course is presented in Czech.	7 71/	0
NI-TVR	Virtual Reality Technology roduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of cont	Z,ZK	3
	cking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of	•	
tracking, nana tra	reality will be presented.	using virtual and a	agmentea
NI-UMI	Artificial intelligence	Z,ZK	5
	search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programn		-
	The main principles and practical applications of discussed techniques will be illustrated.	ing and automator	a pianing.
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
	n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and		
-	tualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie	-	
	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effect		
	nplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills in		
	and development tools (Continuous integration and development).		
NI-VGA	Video Games Architecture	Z,ZK	5
The course covers	a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of vie	w, but also from a	design and
philosophical point	of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and fu	unctional architectu	re typical of
game development	, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, in	ncluding ways of im	plementing
	some game mechanics, in the form of practical demonstrations.		
NI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtains	general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of fear	ture extraction from	multimedia
	objects, indexing, and structure of distributed search engines.		
NI-VOL	Elections	Z,ZK	5
	We will cover the basics of (committee) elections and, in general, opinion aggregation.	_	
NI-VPR	Research Project	Z	5
	Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.		
		7 71/	7
NI-VSM	Selected statistical Methods	Z,ZK	7
The course leads	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with me	ultivariate normal d	istribution,
The course leads	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with more opy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random	ultivariate normal d	istribution,
The course leads application of entr	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with more opy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rank Markov chains. The high point of the course is the Queuing theory and its application in networks.	ultivariate normal d dom processes with	istribution, n focus on
The course leads	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with me opy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rank Markov chains. The high point of the course is the Queuing theory and its application in networks. Computability	ultivariate normal d	istribution,
The course leads application of entr NI-VYC	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with me opy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rank Markov chains. The high point of the course is the Queuing theory and its application in networks. Computability Classical theory of recursive functions and effective computability.	ultivariate normal d dom processes with	istribution, n focus on 4
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The course leads application of entr NI-VYC NI-ZS10 Each student can of	Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with me opy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rank Markov chains. The high point of the course is the Queuing theory and its application in networks. Computability Classical theory of recursive functions and effective computability. Master internship abroad for 10 credits	ultivariate normal d dom processes with Z,ZK Z tion. Before the inte	istribution, n focus on 4 10 ernship the
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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

 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 <u>http://bilakniha.cvut.cz/en/FF.html</u> Generated: day 2025-06-07, time 05:22.