# Study plan

# Name of study plan: Master specialization System Programming, in Czech, version from 2023

Faculty/Institute/Others: Department: Branch of study guaranteed by the department: Welcome page Garantor of the study branch: Program of study: Informatika Type of study: Follow-up master full-time **Required credits: 98** Elective courses credits: 22 Sum of credits in the plan: 120 Note on the plan: Garant: doc. Ing. Jan Janoušek, Ph.D., email: jan.janousek@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-DIP	Diploma Thesis Zden k Muziká Zden k Muziká Zden k Muziká (Gar.)	Z	30	270ZP	L,Z	PP
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-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-DIP	Diploma Thesis	Z	30
NI-KOP	Combinatorial Optimization	Z,ZK	6
The students will gain k	nowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not	only to select and	implement but
also to apply and evaluation	ate heuristics for practical problems.		
NI-MPR	Master Project	Z	7
1. At the beginning of th	e semester, a student reserves her/his final thesis topic and gets together with its supervisor. Together they decide on partial	tasks that should	be carried out
during the semester. If the	ne requirements they agreed upon are met, the supervisor awards the student an assessment for the course MI-MPR at the e	nd of the semeste	r. 2. The external
supervisor enters the in	formation on granting the credit using the form "Granting credit from the external supervisor of the final thesis" (http://fit.cvut.	cz/student/studijn	i/formulare). The
completed and signed for	orm 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 t	opic that the stude	ent has reserved
is rather general, the im	mediate tasks the supervisor assigns to the student for the upcoming semester should aim at fine-tuning the FT topic so that	t the FTT will be c	complete and
approvable at the end o	f the semester.		
NI-MPI	Mathematics for Informatics	Z,ZK	7
The course comprises t	opics from general algebra with focus on finite structures used in computer science. It includes topics from multi-variate analy	ysis, smooth optir	nization and
multi-variate integration	The third large topic is computer arithmetics and number representation in a computer along with error manipulation. The last	topic includes se	lected numerical
algorithm and their stab	ility analysis. The topics are completed with demonstration of applications in computer science. The course focuses on clear	presentation and	argumentation.

#### NI-PDP Parallel and Distributed Programming

Z.ZK 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.

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#### 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-SP.23

Name of the group: Compulsory Courses of Master Specialization System Programming, v.2023, 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:

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-EPC	Effective C++ programming Daniel Langr Daniel Langr (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-GEN	Code Generators Petr Máj, Jan Janoušek <b>Petr Máj</b> Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-OSY	<b>Operating Systems and Systems Programming</b> Petr Zemánek, Tomáš Martinec <b>Petr Zemánek</b> Petr Zemánek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-APT	Advanced Program Testing Pierre Donat-Bouillud Pierre Donat-Bouillud (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-RUN	Runtime Systems Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	L	PS
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	PS
NI-APR	Selected Methods for Program Analysis Filip K ikava Filip K ikava Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	PS

#### Characteristics of the courses of this group of Study Plan: Code=NI-PS-SP.23 Name=Compulsory Courses of Master Specialization System Programming, v.2023, in Czech

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 for	ocuses on prograi	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	irements.	
NI-GEN	Code Generators	Z,ZK	5
Advanced techniques of	translating programs written in high-level programming languages are essential for understanding the field of systems progr	amming. This prir	narily involves
understanding the algor	ithms and techniques used to translate more complex programming constructs of modern languages employed in systems pr	ogramming. Stud	ents will become
familiar with both the th	eoretical and practical aspects of implementing the back-end of optimizing compilers for programming languages.		
NI-OSY	Operating Systems and Systems Programming	Z,ZK	5
The course covers syst	ern programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kerne	el data structures.	Key topics are:
process management,	nemory management, file operations and architecture of modern file systems, device drivers and network programming. The	course also addre	esses kernel
development process, u	ipgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portabili	ity. Specifics of ke	rnel architecture
in embedded and real-t	me operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within la	abs, students will	work on projects
focused on developmer	t of LINUX kernel modules.		
NI-APT	Advanced Program Testing	Z,ZK	5
Testing a program is es	sential to ensure that a program respects its specification, that changes do not introduce regressions or security issues. The	goal of the course	is to present
advanced program test	ng techniques, beyond writing unit tests, especially fuzzing and symbolic execution.		
NI-RUN	Runtime Systems	Z,ZK	5
This course is an introdu	ction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experi	ence in design and	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 compi	ilation Memory ma	anagement
Just-in-time compilation	and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implement	ations of real-wor	d VMs, including
Dynamic optimizations,	speculations, and deoptimizations Language implementation frameworks Read-world VMs		
NI-SYP	Parsing and Compilers	Z,ZK	5
The module builds upon	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of	of various variants	and applications
of LR parsing and are in	ntroduced to special applications of parsers, such as incremental and parallel parsing.		

 NI-APR
 Selected Methods for Program Analysis
 Z,ZK
 5

 This course introduces you to program analysis, i.e., the automated reasoning about the behavior of a computer program. We will cover static and dynamic analysis. In Static Analysis, we will look at the art of reasoning about computer programs without running them. We will look at the analyses for program understanding, optimizations, error detection. In Dynamic Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.
 NI-APR
 Z,ZK
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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.

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Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members)	Completion	Credits	Scope	Semester	Role
	Tutors, <b>authors</b> and guarantors (gar.)					
NI-AOA	Completing a professional event Zden k Muziká	Z	1			V
NI-ATH	AlgorithmicTheories of Games Dušan Knop, Tomáš Valla Tomáš Valla (Gar.)	Z,ZK	4	2P+2C	L	V
NI-AFP	Applied Functional Programming Robert Pergl, Marek Suchánek, Daniel N mec Robert Pergl Robert Pergl (Gar.)	ΚZ	5	2P+1C	L	V
NI-APH	Architecture of computer games Adam Vesecký Adam Vesecký (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	КZ	4	3C	L	V
NI-PAM	Efficient Preprocessing and Parameterized Algorithms Ond ej Suchý Ond ej Suchý Ond ej Suchý (Gar.)	Z,ZK	4	2P+1C	L	V
NI-ESC	Experimental Project Course Jan Matoušek, Ond ej Brém Ond ej Brém Ond ej Brém (Gar.)	КZ	8	0P#31R#520	L	V
NI-GLR	Games and reinforcement learning Juan Pablo Maldonado Lopez	Z,ZK	4	2P+2C	L	V
NI-GNN	Graph Neural Networks Miroslav epek Miroslav epek (Gar.)	Z,ZK	4	1P+1C	L	V
NI-GRI	Grid Computing André Sopczak, Petr Fiedler <b>Pavel Tvrdík</b> André Sopczak (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-HCM	Mind Hacking Marcel Ji ina, Josef Holý Marcel Ji ina Marcel Ji ina (Gar.)	ZK	5	2P+1C	Z	V
NI-HSC	Side-Channel Analysis in Hardware Vojt ch Miškovský, Petr Socha Petr Socha Vojt ch Miškovský (Gar.)	Z,ZK	4	2P+2C	Z	V
NI-HMI2	History of Mathematics and Informatics Alena Šolcová Alena Šolcová Alena Šolcová (Gar.)	ZK	3	2P+1C	Z	V
NI-IBE	Information Security Igor ermák	ZK	2	2P	Z	V

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

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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 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 (n Daniel Vašata Daniel Vašata (Gar.)	Z,ZK	5	2P+1C	Z	V
FIT-SEP	World Economy and Business Tomáš Evan	Z,ZK	4	2P+2C	L	V
NI-SEP	World Economy and Business Tomáš Evan Tomáš Evan (Gar.)	Z,ZK	4	2P+1C	Z,L	V
NI-TVR	Virtual Reality Technology Tomáš Nová ek Tomáš Nová ek (Gar.)	Z,ZK	3	1P+1C	L,Z	V
NI-TS1	Theoretical Seminar Master I Dušan Knop, Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	Z	V
NI-TS2	Theoretical Seminar Master II Ond ej Suchý, Tomáš Valla Tomáš Valla Tomáš Valla (Gar.)	Z	4	2C	L	V
NI-TS3	Theoretical Seminar Master III Ond ej Suchý, Tomáš Valla 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=P	urely Electiv	ve Maste	r Courses	5	
l i	vanced Program Testing				,ZK	5
	al to ensure that a program respects its specification, that changes do not introduce re	gressions or sec	urity issues		·	-
	chniques, beyond writing unit tests, especially fuzzing and symbolic execution.			-		
NI-AOA Co	mpleting a professional event				Z	1
	n a one-off professional event, usually a lecture by a foreign guest of the FIT CTU, con-	cluded with a wo	rkshop, a te	est, drafting a		Such an event
	e by the vice-dean for pedagogical activities or the vice-dean for science and research					
	porithmicTheories of Games				ZK	4
	branch of mathematics, which has broad applications in economy, biology, politics and	computer scions	A This that	1	· ·	•
		-		-		-
	titive process by designinng a mathematical model and investigating the strategies. The			• •		•
-	ame where no player wants to deviate from his strategy. Due to the recent development of					-
	er concepts the algorithmic point of view is gaining attention. In addition to existential qu				-	on of various
solution concepts. In this cou	urse we introduce the basics of game theory of many players, solution concept (usually	equilibria) and r	nethods of	their computa	ation.	
NI-AFP Ap	plied Functional Programming				KZ	5
	Czech. Functional programming represents one of the traditional programming paradigi	ms. Traditional ar	nd novel fur			-
	Inctional paradigm becomes an important construct of traditionally imperative language					
	software engineer: the theory and especially the practice.	(- ·,, eav	,	,		
noocooury competence of a	סטורוייניס טואוויטרי. וויט וויטטיץ מויע בסףכטמווץ וויב אומטונטל.					

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 gain experience in drawing and painting.	-	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 in the second to work allow to work allow the second to work allow the second to work allow the second to work allow to work allow the second to work allow to work allow the second to work allow to work a		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

	Z,ZK	4
Mathematical semantics of programming languages. Data types as continous lattices, Scott topology. Procedures as continue	ious mappings. The Scott model of lamb	da calculus.
Introduction to category theory.		
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 metho	-	-
include mainly: linear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation wit	n constraints, duality principle, gradient m	nethods) and
selected notions from probability theory and statistics.		1
FIT-ITI Modern IT infrastructure	Z,ZK	5
with a very limited and time-invariable range of software or hardware, this subject tries to explain the issue as a whole and in		
is understood here as a complex whole, the individual parts of which must be reconciled from different aspects of the view of the second parts of	ising current technologies. The proposed	solution should
thus be capable of continuous and economically optimal operation.		
NI-MOP Modern Object-Oriented Programming in Pharo	KZ	4
Object-oriented programming is currently one of the most widespread paradigms of software creation, especially enterprise		
is used to build complex modern applications. In this course, we build on the knowledge acquired in the course BI-OOP and ai		-
of object systems in modern pure object system Pharo (https://pharo.org). The course focuses on individual approach to stu addition to deepening object programming skills, which are generally applicable in other OO languages, students will also g	-	
technologies in terms of semestral work with the possibility of cooperation with practice and related bachelor, diploma, post		
NI-NLM Neural Language Models		5
In this course, students will learn the technical foundations of the Transformer architecture as well as the practical aspects of	using language models. The goal of the	-
students how to use language models to solve problems, make informed risk assessments, and work critically with the scie		
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		1 -
models. The course "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of speci		-
randomness, as well as a number of specific stochastic methods for neural networks and machine learning. In the final two to		-
neural networks and shows that, in addition to the use of randomness in neural networks and machine learning, machine le		-
of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary	<b>e</b>	,
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, in	1	
familiarize the student with the largest possible range of creative approaches in new media. The subject emphasizes dialog		-
art projects.		
NI-OLI Linux Drivers	Z,ZK	4
The Linux operating system is an important operating system for personal computer and also for embedded systems. System	ns on chip and combining powerful proce	ssors and FPGAs
increase the variability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the		
course provides knowledge of Linux operating system architecture, principles of development of various types drivers, inclu	ding practical experience.	
NIE-PML Personalized Machine Learning	Z,ZK	5
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based of	n the unique characteristics and behavio	rs of individual
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users bas	ed on their nersonal interests, its principl	as son he englied
	eu on men personar interests, its principi	es can be applied
to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the late		
to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the late perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial cor	st PML methods from theoretical, algorith	
	st PML methods from theoretical, algorith	
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial con	st PML methods from theoretical, algorith mmunities.	mic, and practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial commercial communication of the second se	st PML methods from theoretical, algorith mmunities.	mic, and practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial con         NI-ARI       Computer arithmetic         Students will learn various data representations used in digital devices and will be able to design arithmetic operations implied	st PML methods from theoretical, algorith nmunities. Z,ZK ementation units.	amic, and practical
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial c	st PML methods from theoretical, algorith munities. Z,ZK ementation units. ZK ate-of-the-art knowledge. The course is o	A A A A A A A A A A A A A A A A A A A
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perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial c	st PML methods from theoretical, algorith munities. Z,ZK ementation units. ZK tate-of-the-art knowledge. The course is of tods. An integral part of the course is the ti PG1 on other areas and topics of comp Z,ZK of image data processing. Students will go	4 4 4 4 4 4 4 4 4 8 5 8 1 5 9 1 4 4 4 1 4 1 5 1 1 5 1 1 1 1 1 1 1 1 1
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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 attributes and second here interested in programming longuages.	he discussions. Th	e reading group
NI-PLS4	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.	7	2
-	Programming Language Seminar juage Seminar aims to introduce students to research in programming languages. It has the format of a reading group in whi	Ch we discuss said	_
	guages and related fields. Participating students are expected to present a paper of their interest and actively participate in the		
	n FIT and MFF CUNI. It is open to all students and researchers interested in programming languages.		lo rouding group
NI-SCE1	Computer Engineering Seminar Master I	Z	4
	ter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance	1 1	ttacks. Students
are approached individu	ually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of	the subject is worl	k with scientific
articles and other profes	ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	chers. The topics a	are new for each
semester.			
NI-SCE2	Computer Engineering Seminar Master II	Z	4
	ter Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance with the selected expression of the selected expression.		
	Jally within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of ssional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar tea	-	
semester.		chers. The topics a	are new ior each
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4
	I present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top rese	1 1	
-	rn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top ma		
and summer schools, a	s well as FIT's own Summer Research Program (VyLet).		
NI-SZ2	Knowledge Engineering Seminar Master II	Z	4
On this seminar you wil	I present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top rese	arch labs around t	he world.
	rn how to properly present and read scientific papers. The work in the seminar will prepare you to attend (and profit from) top ma	achine learning and	d AI conferences
	s well as FIT's own Summer Research Program (VyLet).		
PI-SCN	Seminars on Digital Design	ZK	4
-	problems of realization and implementation of digital circuits - both combinational and sequential. Basic means of description	-	-
	ion algorithms are described. Basics of EDA (Electronic Design Automation) systems are given, together with combinatorial		-
NI-MLP	Machine Learning in Practice ing methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to	Z,ZK	5 implementation
	ents through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practic	-	
-	arn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and un	-	
FIT-SEP	World Economy and Business	Z,ZK	4
-	d in Czech. The course introduces students of technical university to the international business. It does that predominantly by	1 ' 1	dual countries
and key regions of world	economy. Students get to know about different religions and cultures, necessary for doing business in diverse societies as we	Il as indexes of eco	onomic freedom,
	ic development, which are needed for the right investment decision. Seminars help to improve on the knowledge in the form	of discussions bas	ed on individual
	b take bachelor level of this course BIE-SEP as a prerequisite.		
NI-SEP	World Economy and Business	Z,ZK	4
	d in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students in the description of the second students of the second students and the second students are the second students and the second students are the se		-
	It does that predominantly by comparing individual countries and key regions of world economy. Students get to know about a single so indexes of economic freedom, corruption and economic development, which are needed	-	
	siness in diverse societies as well as indexes of economic freedom, corruption and economic development, which are neede ve on the knowledge in the form of discussions based on individual readings. It is advised to take bachelor level of this cours	-	
		<b>c_</b> . uo u pi	

NI-TVR	Virtual Reality Technology	Z,ZK	3
	iced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of c		
	eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways o	of using virtual and	d augmented
reality will be presented		-	4
NI-TS1	Theoretical Seminar Master I		4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a clas and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		-
-	e. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS2	Theoretical Seminar Master II	Z	4
-	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a cla	-	-
	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is		
other scholarly literatur	e. The capacity is limited by the the potentials of the teachers of the seminar.		
NI-TS3	Theoretical Seminar Master III	Z	4
Theoretical seminar is i	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classifier of the students which want to come in deeper contact with contemporary theoretical computer science.	ssical reading gro	up. The students
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is	s a work with scie	ntific papers and
	e. The capacity is limited by the the potentials of the teachers of the seminar.	_	
NI-TS4	Theoretical Seminar Master IV		4
	ntended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classified and an active the second bin the second		
-	and concern themselves with interesting topics from the latest research in the area. Therefore, an integral part of the course is e. The capacity is limited by the the potentials of the teachers of the seminar.	s a work with scie	nunc papers and
NI-TKA	Category Theory	Z,ZK	4
	Theory of Neural Networks	Z,ZK Z,ZK	4 5
NI-TNN	reural networks from the point of view of the theory of function approximation and from the point of view of probability theory	· ·	÷
	eural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmissi		
	work training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transfor		
	somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with tra		
	and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most		
employed for neural ne	work training. We will see the meaninig of all these concepts in the context of common kinds of forward neural networks. Within	the topic approxi	mation approach
to neural networks, we	first notice the connection of neural networks to expressing functions of many variables using functions of fewer variables (Ko	olmogorov theorer	n, Vituškin
theorem). Afterwards, v	ve will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mapp	ings computed by	neural networks
	nt Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect		
	us derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on exp		-
	th probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see h	-	-
	ctancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak la logy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the cen	-	-
	ral networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can b		• •
topology of the network			
		7 7K	5
NI-CPX	Complexity Theory	Z,ZK	5 ing practical
NI-CPX	Complexity Theory ut the fundamental classes of problems in the complexity theory and different models of algoritms and about implications of the		
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## Code of the group: NI-SP-VS.20 Name of the group: Elective Vocational Courses for Master Specialization System Programming Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0

Note on the group:

Povinné předměty všech specializací s výjimkou této specializace.

Note on the g						
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
NI-ADM	Data Mining Algorithms Pavel Kordík, Daniel Vašata, Rodrigo Augusto Da Silva Alves Daniel Vašata Pavel Kordík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-AIB	Algorithms of Information Security Martin Jure ek, Róbert Lórencz, Olha Jure ková Martin Jure ek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ADP	Architecture and Design patterns Filip K ikava, Jan Kurš, Jan Zimolka, Tomáš Chvosta, Ji í Borský Jan Kurš Filip K ikava (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM1	Middleware Architectures 1 Jaroslav Kucha , Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-AM2	Middleware Architectures 2 Jaroslav Kucha , Tomáš Vitvar Jaroslav Kucha Tomáš Vitvar (Gar.)	Z,ZK	5	2P+1C	L	V
NI-BML	Bayesian Methods for Machine Learning Ond ej Tichý, Kamil Dedecius Ond ej Tichý Kamil Dedecius (Gar.)	KZ	5	2P+1C	L	V
NI-BVS	Embedded Security Martin Novotný Martin Novotný 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 Tvrdik Jan Fesl Pavel Tvrdik (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DDW	Web Data Mining Jaroslav Kucha, Milan Doj inovski Jaroslav Kucha Jaroslav Kucha (Gar.)	Z,ZK	5	2P+1C	L	V
NI-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 (Gar.)	Z,ZK	5	2P+1C	L	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 <b>Jií Bu ek</b> Jií Bu ek (Gar.)	Z,ZK	5	2P+2C	L	V
NI-KOD	Data Compression Jan Holub 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-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 (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-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 <b>Ji í Bu ek</b> Róbert Lórencz (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-PAS	Advanced Aspects of Business David Buchtela, St pánka Havlíková, Dominik Vítek, Ji í Maršál, Jana Soukupová, Zden k Ku era David Buchtela Zden k Ku era (Gar.)	Z,ZK	4	2P+1C	z	V
NI-PDB	Advanced Database Systems Yelena Trofimova, Michal Valenta Michal Valenta (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-GPU	GPU Architectures and Programming Ivan Šime ek Ivan Šime ek 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-SWE	Semantic Web and Knowledge Graphs Milan Doj inovski, Jakub Klímek Milan Doj inovski (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SIM	Digital Circuit Simulation and Verification Martin Kohlík Martin Kohlík (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SIB	Network Security Ji í Dostál, Simona Forn sek, Martin Šutovský, Martin Holec Simona Forn sek Ji í Dostál (Gar.)	Z,ZK	5	2P+1C	L	V
NI-SCR	Statistical Analysis of Time Series Kamil Dedecius Kamil Dedecius (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SYP	Parsing and Compilers Jan Janoušek Jan Janoušek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-SBF	System Security and Forensics Simona Forn sek, Marián Svetlík Simona Forn sek Róbert Lórencz (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-DSS	Decision Support Systems Petra Pavlí ková, Robert Pergl, David Buchtela David Buchtela Robert Pergl (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TES	Systems Theory Ji í Vysko il, Stefan Ratschan Stefan Ratschan (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-TSP	Testing and Reliability Petr Fišer Martin Da hel Petr Fišer (Gar.)	Z,ZK	5	2P+2C	Z	V
NI-TSW	Software Product Development Petra Pavlí ková Ond ej Pluha Petra Pavlí ková (Gar.)	KZ	4	1P+2C	Z	V
NI-UMI	Artificial intelligence Pavel Surynek Pavel Surynek (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-EHW	Embedded Hardware Jan Schmidt Jan Schmidt (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-ESW	Embedded Software Hana Kubátová, Miroslav Skrbek Miroslav Skrbek Hana Kubátová (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-VCC	Virtualization and Cloud Computing Tomáš Vondra, Jan Fesl <b>Tomáš Vondra</b> Tomáš Vondra (Gar.)	Z,ZK	5	2P+1C	L	V
NI-PON	Selected Topics in Optimization and Numerical mathematics Karel Klouda, Št pán Starosta, Daniel Vašata Daniel Vašata Št pán Starosta (Gar.)	Z,ZK	5	2P+1C	L	V
NI-VMM	Retrieval from Multimedia Ji í Novák, Tomáš Skopal Jaroslav Kucha Tomáš Skopal (Gar.)	Z,ZK	5	2P+1C	Z	V
NI-MCC	Multicore CPU Computing Daniel Langr, Ivan Šime ek Ivan Šime ek Ivan Šime ek (Gar.)	Z,ZK	5	2P+1C	Z	V

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

NI-SYP	Parsing and Compilers	Z,ZK	5
The module builds upor	the knowledge of fundamentals of automata theory, formal language and formal translation theories. Students gain knowledge of	f various variants	and applications
of LR parsing and are i	ntroduced to special applications of parsers, such as incremental and parallel parsing.		
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 studer	nts should know n	nachine learning
basics. The emphasis i	s put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation s	systems) and mo	dels (e.g., kernel
methods).			
NI-AIB	Algorithms of Information Security	Z,ZK	5
Students will get acqua	nted with the algorithms of secure key generation and cryptographic error (not only biometric) data processing. Furthermore, st	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 sy	stems. The last topic includes practical steganographic methods and attacks on steganographic systems.		
NI-ADP	Architecture and Design patterns	Z,ZK	5
The objective of this co	urse is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis	as well as with u	nderstanding of
the challenges, issues,	and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledg	e of object-orient	ed programming
and get familiar with the	commonly used object-oriented design patterns that represent the best practices for solving common software design problem	ns. In the second p	part the students
will be introduced to the	principles of software architecture design and analysis. This includes the classical architectural styles, component based syste	ms, and some ad	vanced software
architectures used in la	rge-scale distributed systems.		
NI-AM1	Middleware Architectures 1	Z,ZK	5
Students will study nev	trends, concepts, and technologies in the area of service-oriented architectures. The will gain an overview of information sys	tem architecture,	web service
architecture and aplicat	ion servers. The will also study principles and technologies for middleware focused on application integrations, asynchronous co	mmunications and	d high availability
of applications.			
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, distr	ubuted cache and databases, smart contracts, realtime communication and web security.		
NI-BML	Bayesian Methods for Machine Learning	KZ	5
The subject is focused	on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studi	es the construction	on of appropriate
models providing desc	iption of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidde	n variables (true o	object position
from noisy observation	etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose	, a number of real	world examples
and applications will be	presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging	g. The students w	ill try to solve
some of them.			

NI-BVS Embedded Security	Z,ZK	5
Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of		
and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resc	urces for securing i	internal functions
of computer systems.		1
NI-BKO Error Control Codes	Z,ZK	5
The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted	via channels.	
NI-DSV Distributed Systems and Computing	Z,ZK	5
Students are introduced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of comp	uting processes an	d communication
channels. They learn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms	that support high a	vailability of both
data and services, and safety in case of failures.		-
NI-DDW Web Data Mining	Z,ZK	5
Students will learn latest methods and technologies for web data acquisition, analysis and utilization of the discovered knowledge. Students will ga	1 '	-
techniques for Web crawling, Web structure analysis, Web usage analysis, Web content mining and information extraction. Students will also gain an ov		•
in the field of social web and recommendation systems.	erview of most rece	sin developments
	7 71/	
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 a	iccess time and me	mory complexity.
They will be able to use the knowledge in design of applications that utilize pattern matching.		
NI-FME Formal Methods and Specifications	Z,ZK	5
Students are able to describe semantics of software formally and to use sound reasoning for construction of correct software. They learn to use sor	ne software tools th	hat allow to prove
basic properties of software.		
NI-GAK Graph theory and combinatorics	Z,ZK	5
The goal of the class is to introduce the most important topics in graph theory, combinatorics, combinatorial structures, discrete models and algorit		-
on undestanding the basic principles but also on applications in problem solving and algorithm design. The topics include: generating functions, selected	•	
coloring, Ramsey theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The the		
of combinatorics on words, formal languages and bioinformatics.		
	7 71/	F
	Z,ZK	5
The course provides the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeg	e e	
using hardware means. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. St	-	owledge about
the cryptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions of the	computer.	
NI-KOD Data Compression	Z,ZK	5
Students are introduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of d	data compression r	nethods being
used in practice. The overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition,	students learn the	fundamentals of
lossy data compression methods used in image, audio, and video compression.		
NI-MKY Mathematics for Cryptology	Z,ZK	5
Students will gain deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of cipher	1 1	course focuses
on the problem of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of dis	-	
factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on lattices.		
NI-MVI Computational Intelligence Methods	Z,ZK	5
		-
Students will understand methods and techniques of computational intelligence that are mostly nature-inspired, parallel by nature, and applicable t how these methods work and how to apply them to problems related to data mining, control, intelligen games, optimizations, etc.	o many problems.	They will learn
	7 71/	
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 appro	ach for (re)enginee	ring and
implementation of processes, organisation structures and information support in big enterprises and institutions.		
NI-MTI Modern Internet Technologies	Z,ZK	5
SYNOPSIS The subject "Modern Internet Technologies" is designed on four major pillars of networking: 1. Unified Communication and Collaboration	on - A single netwo	rk, oriented on
TCP/IP is able to carry whatever types of protocols for whatever purposes. This architecture is able to be protocol independent and carries voice, w	ideo and data to a	chieve seamless
integrated services. 2. Design of Extremely Scalable Networks - This provides the insights of network architectures which can accommodate hund	reds of millions of u	users and billions
of devices. Thus, there is a paradigm switch from LANs (Local Area Networks) to SPs (Service Providers). 3. Traffic Segregation, Traffic Matching a	and Traffic Prioritisa	ation - These
technologies allow service providers to create private channels of communication between customers, with guaranteed parameters (bandwidth, de	alay, jitter, type of p	rotocol). 4.
Acceleration Technologies - They allow traffic to be carried at the optimal speed and allow for graceful degradation of service parameters in case o	f failures.	
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, f		-
notions and processures. They get acquainted with graphical, speech, and multimodal UIs. Thanks to the gained knowledge, the students will be ab		
	-	
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 m		
will also learn the finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering.	-	-
linear algebraic equations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implem	ient these algorithm	ns sequentially
as well as in parallel.		
NI-NSS Normalized Software Systems	ZK	5
Students will learn the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engine	ering, such as stat	oility from system
theory and entropy from thermodynamics. Students will understand a set of principles that indicate where violations of stability and entropy-related	issues occur in an	iy given software
architecture. In the second part of the course, students learn how to construct software architectures using a set of 5 design patterns called element	ts. These elements	provide the core
functionality of information systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the sta	ability and entropy-r	elated principles.
This knowledge allows students to realize new levels of evolvability in software architectures.		
NI-BUI Business Informatics	Z,ZK	5
The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the area		1
ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITIL, COBIT) in IT management and the principles in the standard st	-	-
of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Govern		-
business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT manager		
management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).	,	

NI-PIS	Enterprise Information Systems	Z,ZK	5
	on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of		
	ence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication and the second statement of the second statem		-
	nore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the nted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and oper		
company / organization			in systems in the
NI-KRY	Advanced Cryptology	Z,ZK	5
	essentials of cryptanalysis and the mathematical principles of constructing symmetric and asymmetric ciphers. They will know	1 '	-
	tors. They will have an overview of cryptanalysis methods, elliptic curve cryptography and quantum cryptography, which they		
their own systems or to	the creation of their own software solutions.		-
NI-PAS	Advanced Aspects of Business	Z,ZK	4
The aim of the course i	s to provide students with advanced (compared to the bachelor's degree) knowledge and skills needed to establish and run t	heir own business	s or business
	y in law, administration (necessary steps and documents), business economics, foreign trade and related aspects.	,	
NI-PDB	Advanced Database Systems	Z,ZK	5
	lves in problems of evaluation and optimization of SQL queries. The next part of the course deals with new concepts of databases		
	ated new data models (XML, graph databases, column databases) and languages for working with them (XQuery, XPath, C) erformance evaluation of database machines.	TFREEK, Greinlin).	The last part of
NI-GPU	GPU Architectures and Programming	Z,ZK	5
	ledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the		-
-	spread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical		-
will also learn optimizat	ion programming techniques and methods of programming multiprocessor GPU systems.		
NI-PDD	Data Preprocessing	Z,ZK	5
	re raw data for further processing and analysis. They learn what algorithms can be used to extract information from various da		-
	arn the skills to apply these theoretical concepts to solve specific problems in individual projects - e.g., extraction of characte	eristics from image	es or from web
pages.			
NI-REV	Reverse Engineering	Z,ZK	5
	inted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dev		
	C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be c		
	ing work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the comput		
the course is on the set	ninars, where students will solve practically oriented tasks from the real world.		
NI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5
	the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web t	-	
-	integration, publishing, querying and consumption of semantic data. The students will also gain skills in creation of knowledge	ge graphs and the	ir systematic
quality assurance.			
	Disited Oracuit Oraculation and Marification	7 71/	-
NI-SIM	Digital Circuit Simulation and Verification	Z,ZK	5 els and with the
The aim of the course i	s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le	1	-
The aim of the course i properties of proper too	s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le ils. The course covers recent verification methods, too.	evel Modeling) lev	els and with the
The aim of the course i properties of proper too NI-SIB	s to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Le ls. The course covers recent verification methods, too. Network Security	evel Modeling) lev	els and with the
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The aim of the course i properties of proper too NI-SIB NI-SCR The course deals with t problems (modelling of its parameters, analyze real-world examples. But the academic to the rea NI-SBF Students will get familia importance of operating NI-DSS The aim of the course is and knowledge-orienter of conceptually and ont NI-TES Today, humankind has complexity and of ensu aspects of the systems the modeling and analy NI-TSP Students will gain know the intuitive path sensit will be able to compute NI-TSW The course is presente NI-UMI The course covers sea The main principles an NI-EHW	to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Levels, The course covers recent verification methods, too. Network Security Statistical Analysis of Time Series he practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange price signals and processes) to computer networks (network components load, attacks detection). The students learn to select a co its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the the the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward tra a world. System Security and Forensics r with aspects of system security (principles of end station security, principles of security policies, security models, authentic r with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and fore system/operating system artifacts or file system for attack analysis and detection). Decision Support Systems to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principle decision support systems. Students will also gain knowledge of multicriterial decision-making methods and agame theory. They ologically oriented decision support systems and the basics of distribution, optimization and evolution methods and algorithm System Sheory the ability to develop systems of incredible complexity (e.g., trains, microprocessors, airplanes, nuclear power plants). Howev fing the correct behavior of a given system have become critical. A key technique for mastering this complexity is the usage of atta are important for the task at hand, and automated tools for analyzing those models. This subject will present theory and sis of complex systems. Software Product Development d in Czech. Artificial intelligence ch and inference algorith	Z,ZK         Z,ZK         z,ZK         ces, employment)         onvenient process         main principles brainsfer of students'         Z,ZK         ation concepts). Fensic analysis tec         Z,ZK         as of data-oriented y will also learn about the costs of models that des         algorithms that for         Z,ZK         rer, the costs of models that des         algorithms that for         X,ZK         prepare a test set         built-in-self-test of         KZ         Z,ZK         mming and autom         Z,ZK	els and with the 5 and industrial model, estimate ased on practical knowledge from 5 urthermore, hniques and the 5 , model-oriented out the principles 5 anaging this scribe only those orm the basis for 5 with the help of equipment. They 4 5 ated planning. 5
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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 th	e basic techniques	of programming
in C language and code	e optimizations, through typical areas as the reliable software development, embedded operating systems, signal processing,	, up to sophisticate	ed techniques
combined with artificial	intelligence.		
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
Students will gain know	ledge 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 virtuali	zation 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	rs of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effect	tive technology too	day for the
management of comple	x computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical ski	ills in the use of mo	odern integration
and development tools	(Continuous integration and development).		
NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
The course focuses on	ptimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge c	of continuous optim	nization obtained
in the course Mathema	tics for informatics. The methods are explained and described along with the details on how they are implemented on comput	ters. Hence, the re	elevant concepts
of numerical matematic	s, mainly numerical linear algebra, are explained too.		
NI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtains ger	neral knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of	feature extraction	from multimedia
objects, indexing, and s	tructure of distributed search engines.		
NI-MCC	Multicore CPU Computing	Z,ZK	5
Students will get acqua	inted 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 architectur	rally specific
optimization techniques	s 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 r	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	Z	2
publications can be write a scientific art	portant and required part of research activity. It is not only about obtaining research results but also about applying them in the form of a 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 council, what parts such an article should have, and how the peer review process works. Students will also try their hand at presenting an accourse will be taught in blocks, with one lecture at the beginning of the semester and one practicum in the middle of the semester. Date on the availability of enrolled students.	rse, students will le article and reviewir	earn how to
FIT-ITI	Modern IT infrastructure	Z,ZK	5
	nd time-invariable range of software or hardware, this subject tries to explain the issue as a whole and in the context of the time. A more as a complex whole, the individual parts of which must be reconciled from different aspects of the view using current technologies. thus be capable of continuous and economically optimal operation.	•	•
FIT-SEP	World Economy and Business	Z,ZK	4
and key regions of v	sented in Czech. The course introduces students of technical university to the international business. It does that predominantly by control of the conomy. 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 di readings. It is advised to take bachelor level of this course BIE-SEP as a prerequisite.	indexes of econom	nic freedom,
FITE-EHD	Introduction to European Economic History	Z,ZK	3
	ices a selection of themes from the European economic history. It gives the student basic knowledge about forming of the global eco	· ·	-
	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 instituti tailed economic history of particular European countries but rather the impact of trade and role of particular events, institutions and c meetings will consist of a mixture of lecture and discussion.		
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 students	should know mach	ine learning
basics. The emphas	sis is put on advanced algorithms (e.g., gradient boosting) and non-basic kinds of machine learning tasks (e.g., recommendation syst methods).	tems) and models	(e.g., kernel
NI-ADP	Architecture and Design patterns	Z,ZK	5
the challenges, issu and get familiar with	s course is to provide students with both work knowledge about the underlying foundations of object-oriented design and analysis as ues, and tradeoffs of advanced software design. In the first part of the course, the students will refresh and deepen their knowledge o the commonly used object-oriented design patterns that represent the best practices for solving common software design problems. I the principles of software architecture design and analysis. This includes the classical architectural styles, component based systems architectures used in large-scale distributed systems.	f object-oriented p n the second part t	rogramming the students
NI-AFP	Applied Functional Programming	KZ	5
This course is pres	ented in Czech. Functional programming represents one of the traditional programming paradigms. Traditional and novel functional p	rogramming langu	ages are on
the rise nowadays	and the functional paradigm becomes an important construct of traditionally imperative languages (C++, C#, Java). As such, master necessary competence of a software engineer: the theory and especially the practice.	ing this paradigm I	ecomes a
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		
principles of cryp	tographic protocols (identification, authentication, and signature schemes). Another part of the course is dedicated to malware detec		machine

Students of study rev fierds, concept. and etchnologies in the are of serio-strings et course or the analysis in requirements and the study principles and the study of study. The study of study. The study of study. The study of	NI-AM1	Middleware Architectures 1	Z,ZK	5
arakterized and packation serves. The will also easy principles and behindighest in maddrese focuse to application integrations, seynchronous communications and high availability of application and with application application and with appl			I ' I	
NI-ARZ         Middleware Architectures 2         ZZK         5           NI-ARZ         NI-ARZ         NI-ARZ         NI-ARZ         ZZK         5           NI-ARZ         NI-ARZ         NI-ARZ         ZZK         5           NI-ARZ         NI-ARZ         NI-ARZ         ZZK         5           NI-ARZ         NI-ARZ         NI-ARZ         NI-ARZ         5           NI-ARZ         NI-ARZ         NI-ARZ         1         NI-ARZ         1         NI-ARZ         NI-ARZ         1         NI-ARZ				
Students will have need need technologies on the Web including meenting facurations. They will grain an overview of Web application undercurring, managers and technologies for microscrees. Building and end of databases, managers and contractions, entertore will be early in the second technologies and technologies and technologies. The second technologies and te		of applications.	-	-
Students will have need need technologies on the Web including meenting facurations. They will grain an overview of Web application undercurring, managers and technologies for microscrees. Building and end of databases, managers and contractions, entertore will be early in the second technologies and technologies and technologies. The second technologies and te	NI-AM2	Middleware Architectures 2	Z.ZK	5
NH-ML         Advanced matchine learning         ZZK         5           The course introduces subjects a subject advanced population with the field of matchine learning that and the exercise is to subject advanced population of the field of matchine learning that and in the exercise is to subject and interconnection of population with the field of matchine learning that and in the exercise is to subject and interconnection of population with the field of matchine learning that and in the product matchine learning that and interview is allowed to subject and the product advanced matchine learning that and the product advanced population of the vice data for subject and the product advanced matchine learning that and the product advanced population of the vice data for subject advanced population of a subject advanced population of the vice data for subject advanced population of a subject advanced population of advanced population of a subject advanced population of a subject advanced population of advanced population				
The course introduces subseries selected avanced topics of maxime sering and articlal integrees. The topics present techniques in the test of concentration systems, image processing, courted and traceorometer of physical laws with the set of machine sensing. The and on the services is to funding sensitives with the set of machine sensitives and the sensitive sets and the sensitive sets and the sensitive and the sensitive sets and the senset			<i>·</i>	Ū
The course introduces subseries selected avanced topics of maxime sering and articlal integrees. The topics present techniques in the test of concentration systems, image processing, courted and traceorometer of physical laws with the set of machine sensing. The and on the services is to funding sensitives with the set of machine sensitives and the sensitive sets and the sensitive sets and the sensitive and the sensitive sets and the senset	NI-AML	Advanced machine learning	Z.ZK	5
Introduction of physical laws with the field of machine learning. The aim of the searcies its familiatrice suctions with the methods discussed.           Ni-ROA         Completing a processional event.         I           The subject is participation in a one-off probasional event.         Intel the approved with the number of the second processional event.         IXEX         4           Subdets will gain a basic understanding of the various issues in the field of computer agarnes.         IXEX         4           Subdets will gain a basic understanding of the various issues in the field of computer agarnes.         IXEX         5           Ni-ROM         Selected Methods for program naming processes and basic mutual the approxeme.         IXEX         5           The compart is estanding approxement and uncome - centred activity agarnes.         IXEX         5         5           The compart is estanding approxement and uncome activity agarnes.         IXEX         5         5           The compart is estanding approxement and uncome activity agarnes.         IXEX         5         5           The compart is estanding approxement and uncome activity agarnes.         IXEX         5         5           The compart is estanding approxement and uncome activity agarnes.         IXEX         5         5           The compart is estanding approxement and uncome activity agarnes.         IXEX         5         5         5		5	· · ·	-
The subject is parhicipation in a one-off potessional event, usually a lecure by storeing upset of the FIT CTU, concluded with a workstop, attest, darling a report, esc, darling a rep			-	-
The estagets is participation in a one-off podesional event, usually a lecure by is foreing guest of the FIT CTU, oncludes with a workstop, attesting, during a regort, etc., studies and event of estaget and event of estaget and event of estaget and event of estaget and	NI-AOA	Completing a professional event	Z	1
must be approved in advance by the vice-dens for prdiagogical activities or the vice-dens for solution and reserved with the FIT Brough a vestale, informal iso, the SIT Brough a vestale, informal iso, and photosphilad preserved within and the information of the set of the set of the output is a super discretion of the set of the output is a super discretion. Buy the methanics, design methanics, desind methanics, design methanics, design methanics, desig	-		ng a report, etc.Su	
Students will gain a basic understanding of the various issues in the field computer games development, expectably from a technical point of vices, and philosophila part on roots againes. They will are again of composite method and inclusion environments, developmentations, deve				
Students will gain a basic understanding of the various issues in the field computer games development, expectably from a technical point of vices, and philosophila part on roots againes. They will are again of composite method and inclusion environments, developmentations, deve	NI-APH	Architecture of computer games	Z.7K	4
perspector. They will grid ages and component oriented and functional-individual, agener mothanics, descision-making processes and base components that form a integral part of nost games. They will also understand the bases of program managely herm in practical exercises (bab). An important part of the curule is a neglementation of a sample game, with a storeg days herm in practical exercises (bab). An important part of the curule is a neglementation of a sample game, with a storeg days herm in practical exercises (bab). An important part of the curule is a neglementation of a sample game, with a store days herm in practical exercises. The practical exercises of the store				-
net or org games. They will also understand the basics of pathnform, networking and scripting and apply them is practical services (libe). An important part of the course is an implementation of a simple game, with a storeg force on nontrivial game mechanics.           NI-APR         Selected Methods for Program Analysis         ZZK         5           NI-BAR         Advanced Program Testing         ZZK         5           NI-APT         Advanced Program Testing         ZZK         5           NI-APT         Advanced Program Testing         ZZK         4           Statents that appears on the advapes considering individual program runs using a concrete environment and inputs.         NI-APT         Advanced Program Testing         ZZK         4           NI-APT         Advanced Program Testing         ZZK         4           Statents will earn various data representations used in adjuid divices and will be after to design antimetic operations in patienteristion usits.         NI-APT         Adjuit divises and will be after to the course is to represent adjuit divises and will be after to devise form his strategy. Due to the course is to represent adjuit divises and will be after to represent adjuit divises and will be	-			
NI-RR         Selected Methods for Program Analysis         ZZK         5           The source infoldues you to program enargies, i.e., the natured unneed the source of a computer program, we will cover static and queries. The source infoldues and program is using a concrute environment and input.         ZZK         5           The segment is the segment of the source of the analyses or segment in the source of the compare environment and input.         ZZK         4           NI-RPT         Advanced Program Testing         ZZK         4           Students will kern various. data regressmentations used in a concrute environment and input.         Advanced program is significance environmentation units.         4           NI-RPT         Advanced program is significance and will be right to exist and upper stude environmentation.         4         4           NI-RT         Advanced program is significance and will be right to exist and upper stude is the babasition of a gents and analysis.         4         4           NI-RT         Adjointimum Theories of Cames         ZZK         4           Resting a program is significance and will be right to exist and upper stude is the babasition of a weight significance in analysis and enviros is not the equilibria, and methods, is on the equilibria, and methods and the equilibria and method is the equ			•	0
This course introduces you to program analysis, i.e. the automated reasoning about the bahavior of a comjuter program. We will cover the and of manine analysis, we will cover the and reasoning about the bahavior of a comjuter program understanding, applications, and reasoning about the analyses for program understanding, applications, and the analyses for program understanding, applications, that the analyses for program understanding, applications, that the analyses for program understanding, applications, that the analyses for program using a concrete environment and repus.           NI-APT         Advanced program tesis specification, that changes do not introduce representors or security issues. The goal of the course is to present advanced program the leadence program understanding, applications, that changes do not introduce representors recently issues. The goal of the course is to present advanced program to express the design antithmetic coprations mellow-martation under the about the bab to advance program integrations in computer shares.         IV.APK         4           NI-APT         AlgorithmicTheories of Games         Z,ZK         4           Ni-HAH         AlgorithmicTheories of Games         Z,ZK         4           Ni-HAH         AlgorithmicTheories of Games         Z,ZK         5           Ni-HAH         BagorithmicTheories of Games         Z,ZK         5           Ni-HAH         BagorithmicTheories of Games         Z,ZK         5           Ni-HAG         Error Control Codes         Z,ZK         5           Ni-BKO         Error Control Codes         Salored into morestic and promotions or theores			·	
This course introduces you to program analysis, i.e. the automated reasoning about the bahavior of a comjuter program. We will cover the and of manine analysis, we will cover the and reasoning about the bahavior of a comjuter program understanding, applications, and reasoning about the analyses for program understanding, applications, and the analyses for program understanding, applications, that the analyses for program understanding, applications, that the analyses for program understanding, applications, that the analyses for program using a concrete environment and repus.           NI-APT         Advanced program tesis specification, that changes do not introduce representors or security issues. The goal of the course is to present advanced program the leadence program understanding, applications, that changes do not introduce representors recently issues. The goal of the course is to present advanced program to express the design antithmetic coprations mellow-martation under the about the bab to advance program integrations in computer shares.         IV.APK         4           NI-APT         AlgorithmicTheories of Games         Z,ZK         4           Ni-HAH         AlgorithmicTheories of Games         Z,ZK         4           Ni-HAH         AlgorithmicTheories of Games         Z,ZK         5           Ni-HAH         BagorithmicTheories of Games         Z,ZK         5           Ni-HAH         BagorithmicTheories of Games         Z,ZK         5           Ni-HAG         Error Control Codes         Z,ZK         5           Ni-BKO         Error Control Codes         Salored into morestic and promotions or theores	NI-APR	Selected Methods for Program Analysis	Z.ZK	5
we will look at the and of exacting about computer programs without running them. We will look at the analyses for program more using a concrete environment and mpots.         NI-APT         Advanced Program Testing         Z,ZK         5           Testing a program is seenal to ensure that a program respects its specification. That Analyses do not introduce regressions or security issues the pool of the course is to present advanced program testing techniques. Bayond withing unit tests, especially fuzzing and symbolic execution.         Z,ZK         4           NI-APT         Advanced program testing techniques. Bayond will be able to design arithmetic operations implementation units.         Z,ZK         4           NI-APT         Algorithmic Theories of Games         Z,ZK         4           Totational game theory is a branch of mathematics, mich and the able to design antihmetic operations implementation units.         Z,ZK         4           Totational game theory is a branch of mathematics, mich and the advance of computers, inter-advanced and theories of data computers is the distocid and investigating the stateles.         The traditional game theory is a branch of mathematics, mich and the advance of computers, interactions, adventage, multiple and theore compets is a brance of objeer or motio to evalue of an other adventage.         The traditional game theory is to find the equilibrial on mathematics.           NI-BKO         Error Control Codes         Z,ZK         5           The subject is to couse on to preservation to mobile methods and their consels is the treadvend tasampies and abrone estimating, o eplaintens on the disses			. , .	-
Analysis, we will look at the analyses considering individual program runs using a concrete environment and inputs.           NI-APT         Advanced Program Testing         Z.ZK         5           Testing a program is essential to ensure that a program respectin is updefication, that changes do not infolduce regressions or succinfy issues. The goal of the course is to present advanced program respects in using a concent environment is used.         Z.ZK         4           NI-APT         Students will earn various data representations used in digital devices and will be die to design arithmetic operations implementation units.         NI-APT         Algorithmetic         Z.ZK         4           Traditional game theory is a branch of mathematics. which has brade applications in economy. biology, policis and computer science. This theory studies to behaviour of agamets (pages) at a cristing and where no player wants to deviate from is strateg. Due to the recent develapment of computer, inclusion we devinite from the satistics.         NI-BKO         EXCK         5           NI-BKO         Error Control Codes         Z.ZK         4         5           NI-BKD         Error Control Codes         Z.ZK         5           The agaid of the course is to present various ways to detect or correal individual erross and burst errors in data steed in meentions or transmitted via channels.         NI-BKD         Error Control Codes         Z.ZK         5           The agaid of the course is to present various ways to detete coreant individual erross mandia bursth their compatibies for			-	-
Testing a program is essential to ensure that a program mespects its specification, that change do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beynowd writing unit tests, especiality uzing and symbolic execution.           NI-ARI         Computer arithmetic         Z,ZK         4           Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory Studies the behaviour of agents for the states of the game where no player wants to deviate from his strategy. Due to the recent development of computer, science. This is behaviour of agents and other conceases by designing a mathematical mining attention. In addition to existent and cause a program is a subtomice computation or hold with signing attention. In addition to existent addition to existent and other conceases by designing on that we addition to existent addition to existence. This is there, science retroduces the algorithmic point of with signing attention. In addition to existent addition to existent and conceases to the segment on the strategy. Due to the recent development of computers of the accomputation of various solution concepts. It is also that the existence on the strategy. Due to the recent development of computers of the accomptation of various solution concepts. It is also present various ways to detect or correct individual errors and burst errors, in data strategy. Due to the science of the accomptation ways to detect or correct individual errors and burst errors, in data strategy on the hidden variations of appropriate and explicitors will be presented to students, for instance, 2DOD being tracking, radiation source term estimation, or separation in medicinal manging. The students will be the observation of appropriate and the course is to focus on operational. Backet a compatibility present advarded aregresent on s				,
Testing a program is essential to ensure that a program mespects its specification, that change do not introduce regressions or security issues. The goal of the course is to present advanced program testing techniques, beynowd writing unit tests, especiality uzing and symbolic execution.           NI-ARI         Computer arithmetic         Z,ZK         4           Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory Studies the behaviour of agents for the states of the game where no player wants to deviate from his strategy. Due to the recent development of computer, science. This is behaviour of agents and other conceases by designing a mathematical mining attention. In addition to existent and cause a program is a subtomice computation or hold with signing attention. In addition to existent addition to existent and other conceases by designing on that we addition to existent addition to existence. This is there, science retroduces the algorithmic point of with signing attention. In addition to existent addition to existent and conceases to the segment on the strategy. Due to the recent development of computers of the accomputation of various solution concepts. It is also that the existence on the strategy. Due to the recent development of computers of the accomptation of various solution concepts. It is also present various ways to detect or correct individual errors and burst errors, in data strategy. Due to the science of the accomptation ways to detect or correct individual errors and burst errors, in data strategy on the hidden variations of appropriate and explicitors will be presented to students, for instance, 2DOD being tracking, radiation source term estimation, or separation in medicinal manging. The students will be the observation of appropriate and the course is to focus on operational. Backet a compatibility present advarded aregresent on s	NI-APT	Advanced Program Testing	7 7K	5
advanced program testing testing testing uses, beyond writing unit tests, especially tuzing and symbolic esseution.         ZZK         4           NI-ARI         Students will learn various data representations used in digital divises and will be able to design arithmetic operations implementation units.         A         A           NI-ARIH         AlgorithmicTheories of Games         Z,ZK         4           Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, policies and computer science. This theory studies the behaviour of agents (plexers) of a certain competitive process by designing a mathematical model and investigating the strategies. The traditions coll networks, on infini auxions, advertising, multiagent to basies of game theory is to find the equilibria, which are the states of game theory of many players, solution concept (usually equilibria) and methods of their computation.           NI-BRO         Error Control Codes         Z,ZK         5           The boal of the course is to present various ways to detect or correct Individual ensuring theory in may principar, it studies the computation of various data stored into memories or transmutution of appropriate and applications. The enotyper variants modeling methods of the science is to present undividue ways and store and theory data play to counderstanding of explayers of theory counse of the unit and the advertes mature of a splay and the model and the science and theory and the play to a splay the advertes of the unit and the advertes of theore advertes of the unit and the tota advertes of theore advertes				
NI-ARI         Computer arithmetic         ZZK         4           Students will learn various data representations used in digital devices and will be able to design arithmetic operations implementation units.         ZZK         4           Traditional game theory is a branch of mathematics, which has toroal applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (blaver) of a carcina competite porcess by designing a mathematical model and investigning the strategios. The traditional task of design and models and investigning the strategios. The traditional task of design and models on problem of of thickes and politic no constrates on the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers of models or onvolution compet. In strategy, Due to the recent development of computers of and models of their computation.           NI-BKO         Error Control Codeds         ZZK         5           The poal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.         5           NI-BKD         Bayesian Methods for Machine Learning         KZ         5           Ni-BRML         Bayesian Methods for Machine Learning the use of about the indiva variabies (true object position or noisy observations et al.)         5           Ni-BPS         Wireless Computer Networks. The weight in devices antering theory. In particular, it studes the course of the avaidable strue object position mon oby observatis et al. (to creasting a of turne evolution or indivate	iooang a program			to procent
Students will learn various data representations used in digital devices and will be able to design anithmetic operations implementation units.         IXI-INT	NI_A DI		7 7K	1
NI-RH         Algorithmic Theories of Games         Z,ZK         4           Traditional game theory is a branch of mathematics, which has bread applications in econony, biology, polices and computer science. This theory studies the behaviour of agents (players) at a cartain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, which are the states of the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social network, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of various solution concept teads. In this course we introduce the basic of game theory of many players, solution concept (usually equilibria) and methods of their computation.           NI-BKO         Error Control Codes         Z,ZK         5           The subject is focused on practical use of basic Bayesian modeling methods in the dynamically exolution or learning about the hidden variables frue object position from noisy observators etc.). The emphasis is put on understanding of explored principles and methods and their practical adoption. For this purpose, a mumber of real world examples and placitations will be presented to students, for instance, 20.02 Opiciet tracking, radiation source term estimation, or separation in medical imaging. The students will be advertise in the equilibria, which are then equilibria, will be an about the model on overtains about principles of communication in steres networks. They get how/dege of socurity mechanisms in ad-hoc networks, mumber of real world examples and applicatintos will be arealise space and adustate or deviate anot intervia		I		4
Traditional game theory is a branch of mathematics, which has broad applications in economy, biology, politics and computer science. This theory studies the behaviour of agents (players) of a cortexia compositive process by designing mathematical model and investigning the strategies. The traditional task of classical game theory is to find the oscillation of a wine subscience to exist the game where no player wants to deviate from his strategy. Due to the recent development of computers, internet, social networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions on occept (usual) equilibria, and methods of their computation. IN-BKO Tengoal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channets. IN-BML Bayesian MethodS for Machine Learning Ka Ka S The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning about the hidden variables (true obligot or lead burst). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real vorid examples and applications will be presented to suddents, or instance, 2D:3D obligs of contractions of users and explication or learning about the hidden variables (true obligs or addeption. For this purpose, a number of real vorid examples or the suddents will be addeption. For this purpose, a number of real vorid examples of their output explicits of transmitters. They will addeption for the subject will be subject trading, addaption source terre addaption. For this purpose, a number of real vorid examples or the obligs. Protocols, and standards for wireless networks. They will understand the transmitter or the subject week of the complexity or advess and their complexity. The subject week of the course is to bous on operational, tactical and strate				4
players) of a certain competitive process by designing a mathematical model and investigating the strategies. The traditional task of classical game theory is to find the equilibria, within are the states of the game where no player wants to deviate from the strategy. Due to the recent development of computers, internet, scolar herrorks, confine autorius, advertising, multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existential questions we study the problems of efficient computation of views solution concept (usually equilibria) and methods of their computation.           NI-BIK         Error Control Codes         Z,ZK         5           The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted valce hannels.         NI-BIK         Z,ZK         5           The sublect is focused on practical use of basic. Bayesian modeling methods in the dynamically evolving machine learning about the hidre variables (true object postino from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications. Will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.         NI-BPS         Z,ZK         4           Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-foc networks, multicast and the indexide. (TIL, OSR)         Z,ZK         5           NI-BPS         Vireless to focus a		<b>0</b>	· · ·	-
which are the states of the game where no player vants to deviate from his strategy. Due to the recent development of computers, internet, scolal networks, online auctions, advertising, multiagent systems and other concepts the algorithmic point of view is gaming attention. In addition to evisitential questions we study the problems of efficient computation. If we have a strategy is a strategy of the correct individual errors and burst errors in data stored into memories or transmitted via channels.          NI-BKO       Error Control Codes       Z,ZK       5         The goal of the course is to present visious ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.       NI-BML       Bayesian Methods' for Machine Learning       KZ       5         The subject is footised on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning about the hidden variables (true object position trom noisy observations act). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D30 object tracking, radation source term estimation, or separation in medical imaging. The students will very to solve a state of the outrols in solve atterne solves. They eff knowledge of security mechanisms. for vireless networks and get skills of configuration of wireless networks. They eff knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. The simplementing information of suitable tools.       Z,ZK       5         NI-BUS       Business informatics. Students will apple knowledge in the areas of business process management, ICT services and archite	-			-
multiagent systems and other concepts the algorithmic point of view is gaining attention. In addition to existenial questions we study the problems of efficient computation.           NI-BKO         Error Control Codes         Z,ZK         5           The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.         5           The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and policidons will be presented to students, for instance, 2D/SD object tracking, radiation source term estimation, or separation in medical imaging. The students will by to solve some of them.           NL-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 broadstast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks using suitable tools.         Z,ZK         5           The stim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas o			-	-
solution concepts. In this course we introduce the basics of game theory of many players, solution concept (usually equilibria) and methods of their computation.           NI-BRO         Z,ZK         5           The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.         NI-BML         KZ         5           The subject is focused on practical use of basic Bayesian Mediang membods in the dynamically evolving machine learning theory. In particular, its durates the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/30 beject tracking, readiation source term estimation, or separation in medical imaging. The students will be rose some of them.           NI-BPS         Wifeless Computer Networks         Z,ZK         4           Students will be readiation source here mestimation of wieless network sements and simulation of wieless networks and the students, multicast and broadest mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wieless networks and methods and their provemation.         Z,ZK         5           NI-BUI         Business Informatics. Students will approximate manipument prevante and simulation of wireless networks algones process managem				-
NI-BKO         Error Control Codes         Z,ZK         5           The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.         5           The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models poweling description of real phenomena, as well as their subsequent use, e.g. of forecasating of thure evolution or tearining about the indicen variables (rue object position from holigy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.           NI-BPS         Wireless Computer / Networks         Z,ZK         4           Students will learn about the modern technologies, protocols, and standards for wireless network learnets using suitable tools.         Z,ZK         5           IN-BU         Business Informatics         Z,ZK         5           The aim of the course is to focus on operational, tactical and strategic management, the principles, models and standards or wireless network sulf and nowledge in the areas of business process management. To business informatics         Z,ZK         5           NI-BU         Business strategy. The course is to focus on operational, tactical and strategic management, the workedge of ec			-	
The goal of the course is to present various ways to detect or correct individual errors and burst errors in data stored into memories or transmitted via channels.         NI-BML       Bayesian Methods for Machine Learning       KZ       5         The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning about the hidden variables (true object position from noicy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.         NI-BPS       Wireless Computer Networks       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 broadcoast mechanisms. They will also learn about principles of communication in senso retworks using suitable tools.       NI-BUI       Z,ZK       4         NI-BUI       Business Informatics.       Z,ZK       5         Ni-BUI       Business Informatics. Students will gain knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (TLL, COBIT) in T management, and lilecycle management of a computer subation and human resources management in T (roles CIO, CEO, CPO).         NI-BVS       Embeded Security       Z,ZK				
NI-BML         Bayesian Methods for Machine Learning         KZ         5           The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.           NI-BPS         Wireless Computer Networks         Z/ZK         4           Students will learn about the modern technologies, protocols, and standrads for wireless networks. They will understand the routing mechanisms in ad-hon entworks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless network elements and simulation of wireless network elements and simulation of wireless and worked in the areas of business process management. (If services and architectures in enterprise informatics. They will also learn about the principles, models and standards (TIL, COBIT) in IT management, revenue and investment dual for admany to the unana resources management in formatics. Students will gain knowledge in the areas of business process management of ICT services and resource management. (Bourcing). Students will learn the process of crasting and implementing information strategy. IT Governance,	-			
The subject is focused on practical use of basic Bayesian modeling methods in the dynamically evolving machine learning theory. In particular, it studies the construction of appropriate models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.           NI-BPS         Wireless Computer Networks         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 bioradcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They yell solvedge of security mechanisms for wireless networks and get skills of configuration of vireless network sensing suitable tools.           NI-BUI         Business Informatics         Z,ZK         5           The aim of the course is to focus on operational, tactical and strategic management of business informatics. They will also learn about the principles, models and standards (TIL, COBIT) in IT management, and lifecycle management of ICT services and rechinectures of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, and investment management, in threatment in the dynamicality of thardware (remerbasing, indowedde systems). Students gain a good overview of functio	-			
models providing description of real phenomena, as well as their subsequent use, e.g., for forecasting of future evolution or learning about the hidden variables (true object position from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.         NI-BPS       Wireless Computer Networks       Z,ZK       4         Students will kern about the modern technologies, protocols, and standards for wireless networks. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks and get skills of configuration of wireless networks using suitable tools.       Z,ZK       5         The ain of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management. If CI services and resource management, surface, here will also learn about the principles, models and standards (TILL, CORT) in T management, and lifecych emanagement. If CI services and resource management, surface management of business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment management, IT investment evaluation and numan resources management in T (cios CIO, CE, CPC).         NI-BVS       Embedded Security       Z,ZK       5         Students will be an about principles of computer of the areas of economic IT management, revenue and investment management, IT investment evaluatio				-
from noisy observations etc.). The emphasis is put on understanding of explained principles and methods and their practical adoption. For this purpose, a number of real world examples and applications will be presented to students, for instance, 2D/3D object tracking, radiation source term estimation, or separation in medical imaging. The students will try to solve some of them.         NI-BPS       Wireless Computer Networks       Z,ZK       4         Students will learn about the modern technologies, protocols, and standards for wireless networks. They get throwskes. They get throwskes, They will also learn about principles of communication in sensor networks. They get throwskes do exeruity mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks. They get throwskes to business process management, ICT services and architectures in otherynise informatics. Students will gain knowledge in the areas of business process management of ICT services and architectures in enterprise informatics. They will also learn about threighes, models and standards (ITLL, COBIT) in IT management, and lifecycle management of ICT services and resource management, revenue and investment management, IT investment evaluation and numan resources management in IT (roles CIO, CEO, CFO).       NI-BVS       Z,ZK       5         NI-BVS       Creative Coding and Computational Art       KZ       4         Students gain basic knowledge in selected topics of cryptography and cryptanalysis. The course focuse particularly on efficient implementations of cryptographic primitives in hardware and solver enterprise informatics. Sudents gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal funct	-			
NI-BVS       Z,ZK       4         NI-BVS       Z,ZK       4         NI-BVS       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 knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.         NI-BUI       Business Informatics       Z,ZK       5         The aim of the course is to focus on operational, tactical and strategic management of business informatios. Students will gain knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (ITLL, COBIT) in IT management, the importance of ICT for business and the context of information strategy. With global business strategy. They will also gain knowledge in the areas of economic IT management, reverue and investment management. The were and and cryptography and cryptographic paralysis. The course focuses particularly on efficient Implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems.         NI-CCC       Creative Coding and Computat				
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 knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.           NI-BUI         Business Informatics         Z,ZK         5           The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management, ICT services and escourse management (sourcing). Students will learn about the principles, models and standards (TIL, COBT) in IT management, and lifecycle management (ICT services and resources management (Sourcing). Students will learn about the principles for creating and implementing information strategy. IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment management, IT investment valuation and human resources management in IT (roles CIO, CEO, CFO).         NI-BVS         Z,ZK         5           Students gain basic knowledge is selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good verview of functionality of thardware(or cryptographic accelerators, smart cards, and resources for				•
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 knowledge of security mechanisms for wireless networks and get skills of configuration of wireless network elements and simulation of wireless networks using suitable tools.         NI-BUI         Z,ZK         5           NI-BUI         Business Informatics         Students will gain knowledge in the areas of business process management, ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (TIL, COBIT) in IT management, and lifecycle management of ICT services and resource management (sourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, revenue and investment waluation and human resources particularly on efficient implementations of cryptographic primitives in hardware and software (in embedded systems). Students gain a good overview of functionality of (hardware) cryptographic accelerators, smart cards, and resources for securing internal functions of computer systems.         KI         4           Students work on practical tasks, get acquainted with creative and yet proven methods of visualizing various types of data. The course freely follows the basic graphics coursers (in) retraditional as well as for open data. It combines well-known vi	and applications		The students will t	ry to solve
Students will learn about the modern technologies, protocols, and standards for wireless networks. They will understand the routing mechanisms in ad-hoc networks, multicast and broadcast mechanisms, and data flow control mechanisms. They will also learn about principles of communication in sensor networks. They get knowledge of security mechanisms for wireless networks using suitable tools.         NI-BUI       Business Informatics       Z,ZK       5         The aim of the course is to focus on operational, tactical and strategic management of business informatics. Students will gain knowledge in the areas of business process management, of ICT services and architectures in enterprise informatics. They will also learn about the principles, models and standards (TILL COBIT) in IT management, and life/cole management of ICT services and resource management, isourcing). Students will learn the process of creating and implementing information strategy, IT Governance, the importance of ICT for business and the context of information strategy with global business strategy. They will also gain knowledge in the areas of economic IT management, in threestment management, IT investment evaluation and human resources management in IT (roles CIO, CEO, CFO).         NI-BVS       Embedded Security       Z,ZK       5         Students wilk again assic knowledge in selected topics of cryptography and cryptanalysis. The course focuses particularly on efficient implementations of cryptography and cryptanalysis. The course kolese particularly on efficient implementations of cryptography and cryptanalysis. The course is deal and to the absic graphics courses (MGA, BLE,) and introduces students to suitable visualization methods of visualizing various types of data. The course freely follows the basic graphics courses (MGA, BLE,) and introduces stu			7 71	4
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	add processing in	approaches to parallelize other algorithms. The course is prezented in czech language.	na wiii be capable	o highose

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 of most recent de	evelopments
NI-DID	Digital drawing	Z	2
	roduce students to the basic principals of digital drawing and graphical design. Students will gain understanding of composition, persp	_	I I
	apply in their own design works. Students will also gain experience in drawing and painting with digital and analog tools. The course		-
practice of	r learn drawing and painting. The course is organized as a thematic practices covering parts of theory and practical exercise to practic	ce gained knowled	ge.
NI-DIP	Diploma Thesis	Z	30
NI-DNP	Advanced .NET	Z,ZK	4
	ire an overview of platform .NET and will gain knowledge about technologies ASP.NET Core, Entity Framework Core, .NET MAUI (WF		
get notions of Azu	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.	technologies ASP	NET Core,
NI-DPH	Game Design	Z,ZK	5
	ements the NI-APH (Architecture of Computer Games) and BI-VHS (Virtual gaming worlds) course, while focusing primarily on game c	· · ·	-
	per knowledge of the principles used for games design, such as: level design, gameplay design, character design, game mechanics d	-	
development cycle	. The students will get an overview of game development from the designer's perspective, from theoretical concepts to practical impler projects.	mentation applied t	o semestral
NI-DSS	Decision Support Systems	Z,ZK	5
	rse is to provide students with knowledge and skills in decision support systems, their classification (Powerova), selected principles of		
	ented decision support systems. Students will also gain knowledge of multicriterial decision-making methods and game theory. They will		ne principles
	conceptually and ontologically oriented decision support systems and the basics of distribution, optimization and evolution methods a		
NI-DSV Students are introd	Distributed Systems and Computing uced to methods for coordination of processes in distributed environment characterised by nondeterministic time responses of computing	Z,ZK	5
	rn basic algorithms that assure correctness of computations realized by a group of loosely coupled processes and mechanisms that s	•	
Liamolo, mey ica	data and services, and safety in case of failures.		
NI-DSW	Design Sprint	Z	2
	on projects using the Design Sprint method, developed by Google. THanks to this method the teams are able to go from idea to validate	ted prototype in 5 d	days. During
the course the st	udents will get familiar with the method as participants. Through practical challenges they will try the whole 5 day process starting with testing the prototypes (plus final presentation).	h research and fini	shing with
NI-DVG	Introduction to Discrete and Computational Geometry	Z,ZK	5
The course intends	s to introduce the students to the discipline of Discrete and Computational Geometry. The main goal of the course is to get familiar with of this discipline, and to be able to solve simple algorithmic problems with a geometric component.	the most fundame	ental notions
NI-DZO	Digital Image Processing	Z,ZK	4
This course prese	ents a comprehensive overview of modern methods for interactive editing of digital images and video. It mainly deals with practical alg	· ·	oth easy to
implement and hav	re an interesting theoretical basis. Visually attractive applications provide better understanding of basic theoretical background that is als	o voluoblo outoido	
		so valuable outside	the domain
of digital image	processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR	compression, de-t	olurring in
of digital image frequency domain,	processing. This course will introduce algorithms solving the following practical applications: edge-aware editing, tone mapping, HDR, abstraction, hybrid images, gradient domain editing, seamless image stitching and cloning, digital photo-montage, color-to-gray conv	compression, de-b version, context en	olurring in hancement,
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coloring, Ramsey	theory, introduction to probabilistic method, properties of various special classes of graphs and combinatorial structures. The theory v of combinatorics on words, formal languages and bioinformatics.	vill be also applied	in the fields
NI-GEN	Code Generators	Z,ZK	5
	ques of translating programs written in high-level programming languages are essential for understanding the field of systems program		-
understanding the	algorithms and techniques used to translate more complex programming constructs of modern languages employed in systems progr familiar with both the theoretical and practical aspects of implementing the back-end of optimizing compilers for programming lan	-	will become
NI-GLR	Games and reinforcement learning	Z,ZK	4
The field of reinfo	recement learning is very hot recently, because of advances in deep learning, recurrent neural networks and general artificial intelliger give you both theoretical and practical background so you can participate in related research activities. Presented in Englis		intended to
NI-GNN	Graph Neural Networks	Z,ZK	4
The course intr	roduces students to advanced artificial intelligence techniques for working with graphs. Lectures will focus on the latest graph neural r		ng vector
representations	of nodes, edges and entire graphs. The techniques discussed cover various types of graphs, including time-varying graphs. The last p		also covers
	graph generation and interpretability of graph neural networks. In the exercises, students will try out selected techniques and pro		E
NI-GOL NI-GPU	Programming of distributed systems in GO GPU Architectures and Programming	KZ Z,ZK	5 5
	knowledge of the internal architecture of modern massively parallel GPU processors. They will learn to program them mainly in the CU		1
-	widespread programming technology of GPU processors. As an integral part of the effective computational use of these hierarchical com		
	will also learn optimization programming techniques and methods of programming multiprocessor GPU systems.		
NI-GRI	Grid Computing Grid computing and gain knowledge about the world-wide network and computing infrastructure.	Z,ZK	5
NI-HCM	Mind Hacking	ZK	5
	is an emerging discipline that is closely related to cyber security. While the domain of cyber security is the protection of networks, inf	1	-
the domain of cog	nitive security is the protection of the human mind from intentional and unintentional digital manipulation. The topic of cognitive secur	ity is growing in im	portance in
the context of infor	mation warfare, increasing digital dependence and the development of artificial intelligence, where these phenomena from the Internet	environment have	real societal
	impacts such as disruption of social cohesion, threats to democracy or war.	71/	3
NI-HMI2 This course is p	History of Mathematics and Informatics resented in Czech. Selected topics {Infinitesimal calculus, probability, number theory, general algebra, different examples of algorithm	ZK s. transformations.	-
	functions, eliptic curves, etc.) note on possibilities of applications of some mathematical methods in informatics and its develop		,
NI-HSC	Side-Channel Analysis in Hardware	Z,ZK	4
	edicated to so-called side-channel information leakage in hardware devices. It focuses on both theoretical analysis and practical attac	-	
	side channels and they get deeper insight in power attacks. Students learn to implement various profiled and non-profiled attacks and They also get practice in both designing the SCA countermeasures and analyzing the amount and characteristics of the side-channel	-	-
NI-HWB	Hardware Security	Z,ZK	5
	les the knowledge needed for the analysis and design of computer systems security solutions. Students get an overview of safeguard	1 '	-
	neans. They will be able to safely use and integrate hardware components into systems and test them for resistance to attacks. Stude	-	-
the cr	yptographic accelerators, PUF, random number generators, smart cards, biometric devices, and devices for internal security functions	s of the computer.	
NI-IAM	Internet and Multimedia	Z,ZK	4
	se is focused on principles and modern technologies for network transmissions of audiovisual (AV) signals. The syllabus includes acquire interfaces and second targets and targets and the second s		
1.	signals (output), network communication protocols, device interfaces, codecs, data formats and stereoscopy. We will look at practical u missions. Within the labs, students will practically assemble AV transmission chains using HW and SW technologies and verify the eff		
	ency of AV transmissions. Students will learn how to build Internet infrastructure for end-to-end AV transmissions from the recording th for audience.		-
NI-IBE	Information Security	ZK	2
	ormation and IS/ICT security management systems (ISMS), methods for information access control, and basic norms and internation		-
	nd methods for management of internal and external security threats, for IS/IT security audits, and for application security testing (e.g.	-	
NI-IKM	Internet and Classification Methods students get acquainted with classification methods used in four important internet, or generally network applications: in spam filtering	Z,ZK	4
	tion systems and in intrusion detection systems. However, they will learn more than only how classification is performed when solving	-	-
-	d of these applications, they get an overview of the fundamentals of classification methods. The course is taught in a 2-weeks cycle w		
	During the exercises, the students on the one hand implement simple examples to topics from the lectures, on the other hand consul		
NI-IOS	Advanced techniques in iOS applications the latest trends in mobile development technologies for iOS platform. Class covers advanced topics, students need to know all the b	KZ	4
Students will learn	BI-IOS.	asics norn the beg	JIIII EIS CIASS
NI-IOT	Internet of Things	Z,ZK	4
The subject is	focused on the area of hardware and software technologies for the strongly growing computer support of various devices. Its goal is fa		available
	development elements (Raspberry Pi, Arduino Due) and with the language for efficient application development and modification (G		
NI-IVS	Intelligent embedded systems ded systems course for master's degree is focused on high-level technology embedded systems integrating artificial intelligence. The	KZ	
-	embedded system fundamentals course for the bachelor degree. The aim of the course is to teach students humanoid robot program		
-	ures provide basis of motion control, sensor reading, application interfaces, robot navigation and development tools. In labs, students	-	
	combining knowledge of various courses like nature inspired algorithms, data mining algorithms, image recognition and web tech	nologies	
NI-KOD	Data Compression	Z,ZK	5
	oduced to the basic principles of data compression. They will learn the necessary theoretical background and get an overview of data he overview covers principles of integer coding and of statistical, dictionary, and context data compression methods. In addition, stud-		-
	lossy data compression methods used in image, audio, and video compression methods. In addition, studi		
NI-KOP	Combinatorial Optimization	Z,ZK	6
	gain knowledge and understanding necessary deployment of combinatorial heuristics at a professional level. They will be able not on	1	plement but
	also to apply and evaluate heuristics for practical problems.		-
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 t 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.	· · · · · · · · · · · · · · · · · · ·	J

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 the	-	-
	s of the game where no player wants to deviate from his strategy. Historically, the second big development in game theory of two-player onway, Berlekamp and Guy. They developed a theory, originally used for solving end-games in Go, into a full fledged field. The idea is		
	batible games can be added, that is, played simultaneously. This led to the algrebraic approach to study combinatorial games. The thir	•	
	established the theory of positional games (like tic-tac-toe and hex). In analysis of these game, one cannot escape the brute-force tra	-	-
	k introduced the "false probabilistic method", which aims to tackhle this problem. In this course we build the foundation of the theory o	-	
	n theoretical analysis of games and building the theory, not on the programming aspects of game solving algorithms. The course requ		-
to mathematically	analyse, think and proof. The course is also suitable for bachelors student in the third year, who attended introduction to graph theory	, as well as for Ph	D students
	looking for research topics.		
NI-KYB	Cybernality	ZK	5
	uainted with the fundamentals of legislation and international activities in the area of fighting cybercrime. Students will understand the		
	f systems for computer surveillance and traffic monitoring in the cyberspace. Students will also familiarize themselves with hacker activ		The course
	vill also discuss the cooperation of the state agencies and subjects dealing with defence of the cyberspace (especially CSIRT and CE	,	
NI-LOM	Linear Optimization and Methods	Z,ZK	5
	applications of optimization methods in computer science, economics, and industry. They are aware of practical importance of linear a th optimization software and are familiar with languages used in programming of that software. They get skills in formalization of optin		
	scheduling of tasks to processors, analysis of network flows), distribution and allocation of resources (transportation problems, travelli		
	mics, and modelling of conflicts via the game theory. They get an overview of computational complexity of optimization problems. The		
	in linear programming.		0
NI-LSM2	Statistical Modelling Lab	KZ	5
	is advanced multiple target tracking (MTT). This domain covers simultaneous tracking of multiple targets using radar under the presen	ce of clutter, or vid	eo tracking.
	We aim at the state-of-the-art filters, in particular the PHD (Probability Hypothesis Density) and PMBM (Poisson Multi-Bernoulli)	filters.	
NI-MCC	Multicore CPU Computing	Z,ZK	5
-	quainted in detail with hardware support and programming technologies for the creation of parallel multithreaded computations on mu		
	red memories, which are today the most common computing nodes of powerful (super)computer systems. Students will gain knowled	•	
optimization techni	ques used to reduce the performance drop due to the widening gap between the computational requirements of multi-core CPUs and	memory interface	throughput.
	On specific non-trivial multithreaded programs, students will also learn the basics of the art of creating these applications.	7 71/	
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 approar implementation of processes, organisation structures and information support in big enterprises and institutions.	ch for (re)engineer	ing and
NI-MKY		Z,ZK	5
	Mathematics for Cryptology deeper knowledge of algebraic procedures solving the most important mathematical problems concerning the security of ciphers. In		-
-	of solving a system of polynomial equations over a finite field, the problem of factorization of large numbers and the problem of discret		
	······································		
	factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on	lattices.	
NI-MLP		lattices. Z,ZK	5
	factorization will also be solved on elliptic curves. Students will further become familiar with modern encryption systems based on Machine Learning in Practice earning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ide	Z,ZK	-
Applying machine I	Machine Learning in Practice	Z,ZK ally, technical impl	ementation.
Applying machine I The course guides	Machine Learning in Practice earning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ide	Z,ZK ally, technical impl The aim is to exp	ementation. erience real
Applying machine I The course guides data proces NI-MOP	Machine Learning in Practice earning methods to real projects in practice involves many other necessary tasks - from understanding the intentions of the client to, ide students through all phases of a project according to the standard CRISP-DM methodology, not only theoretically but also practically sing and learn how to describe the whole process from exploration to evaluation of the model performance in the form of a clear and Modern Object-Oriented Programming in Pharo	Z,ZK ally, technical impl The aim is to exp understandable re KZ	ementation. erience real port. 4
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	Mathematics for data science	Z,ZK	4
	dents are introduced to those fields of mathematics that are necessary for understanding standard methods and algorithms used in da		
Include mainly:	inear algebra (matrix factorisations, eigenvalues, diagonalization), continuous optimisation (optimisation with constraints, duality princ selected notions from probability theory and statistics.	cipie, gradient metr	nods) and
NI-NLM	Neural Language Models	Z	5
	Jents will learn the technical foundations of the Transformer architecture as well as the practical aspects of using language models. The	-	-
	students how to use language models to solve problems, make informed risk assessments, and work critically with the scientific li	-	
NI-NMS	Neural Networks, Machine Learning and Randomness	Z,ZK	4
	ds, i.e. methods based on randomness, are extremely important for the construction and training of neural networks as well as a num		ne learning
models. The co	urse "Neural networks, machine learning and randomness" will discuss in sufficient depth a number of specific types of neural networ	ks that rely substa	intially on
	ell as a number of specific stochastic methods for neural networks and machine learning. In the final two topics, it explains the general		-
neural networks a	nd shows that, in addition to the use of randomness in neural networks and machine learning, machine learning models, including ne	,	used in one
NI-NMU	of the most important applications of randomness stochastic optimization methods, which include e.g. popular evolutionary algo New media in art and design	ZK	3
_	duces students to the issue of using new media in artistic and design work. Key topics are moving image, internet, computer game and		
	dent with the largest possible range of creative approaches in new media. The subject emphasizes dialogue with students, especially		-
	art projects.		
NI-NON	Nonlinear Continuous Optimization and Numerical Methods	Z,ZK	5
	troduced to nonlinear continuous optimization, principles of the most popular methods of optimization and applications of such method		
	finite element method and the finite difference method used for solving ordinary and partial differential equations in engineering. They		
linear algebraic e	quations that arise from discretization of the continuous problems by direct and iterative algorithms. They will also learn to implement as well as in parallel.	these algorithms s	sequentially
NI-NSS	Normalized Software Systems	ZK	5
	the foundations of normalized systems theory that studies the evolvability of modular structures based on concepts from engineering	1	-
	y 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. The	ese elements prov	vide the core
functionality of info	rmation systems in terms of storing data, executing actions, workflows, connectors, and triggers, while handling violations of the stability	and entropy-relate	ed principles.
	This knowledge allows students to realize new levels of evolvability in software architectures.		
NI-NUR	User Interface Design	Z,ZK	5
	rstand the theorical background of human-computer interaction and user interface (UI) design, will learn formal description of UIs, forma rocesures. 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
-	g system is an important operating system for personal computer and also for embedded systems. Systems on chip and combining po	· · ·	1 -
	iability of peripheral subsystems requiring specific software drivers. This course is an advanced course in the Linux driver development		
	purse provides knowledge of Linux operating system architecture, principles of development of various types drivers, including practice	al experience.	
NI-OSY	Operating Systems and Systems Programming	Z,ZK	5
			-
	s system programming in UNIX environment. Emphasis is given on kernel development with focus on kernel architecture and kernel d		topics are:
process manage	ement, memory management, file operations and architecture of modern file systems, device drivers and network programming. The c	ourse also addres	y topics are: ses kernel
process manage development proce	ement, memory management, file operations and architecture of modern file systems, device drivers and network programming. The c ess, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability.	ourse also address Specifics of kernel	y topics are: ses kernel architecture
process manage development proce	ement, memory management, file operations and architecture of modern file systems, device drivers and network programming. The c	ourse also address Specifics of kernel	y topics are: ses kernel architecture
process manage development proce	ement, memory management, file operations and architecture of modern file systems, device drivers and network programming. The c ess, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. real-time operating systems are also discussed. Theoretical and general principles are demonstrated on the LINUX kernel. Within labs	ourse also address Specifics of kernel	y topics are: ses kernel architecture
process manage development proce in embedded and NI-PAM There are many	ement, memory management, file operations and architecture of modern file systems, device drivers and network programming. The c ess, upgrades of existing kernels, kernel booting, debugging using dynamic instrumentation, and techniques to guarantee portability. 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. Efficient Preprocessing and Parameterized Algorithms optimization problems for which no polynomial time algorithms are known (e.g. NP-complete problems). Despite that it is often necess	ourse also address Specifics of kernel , students will work Z,ZK sary to solve these	y topics are: ses kernel architecture on projects 4 problems
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NI-PIS	Enterprise Information Systems	Z,ZK	5
	sed on the current IT requirements of large companies in the Czech Republic (Top 100). The basis is Data management, storage of b	1 1	nd their use
in BI (Business In	telligence). The principles of solving the overall architecture of information systems in the banking, insurance and telecommunication	s sectors will be ex	plained on
real examples. Fur	thermore, students will get acquainted with the life cycle of information systems in the company / organization and its impact on the bus	siness strategy of th	ie company.
Students will be ac	quainted with technologies that have proven themselves in the elimination of basic risks in the planning, implementation and operatio	n of information sys	stems in the
	company / organization.		
NI-PIV	Computer Vision	Z,ZK	5
	on course focuses on the theoretical and practical mastery of modern methods and algorithms in the field of image data processing. St		
	les of computer vision, gradually move to advanced computer vision techniques using deep learning. Emphasis is placed on theoreti		
	ns and implementation of learned methods during exercises. Topics covered include morphological operations, image filtering, color re		
and recognition a	nd segmentation through classical and recent approaches based on deep learning, deep neural networks for computer vision (includ	ING CNN, RCNN, Y	OLO, VIT),
	motion detection, visual expressiveness (saliency).	<b>7</b>	0
NI-PLS1	Programming Language Seminar	Z	2
-	g Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which g languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the c		
about programmin	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		aung group
NI-PLS2	Programming Language Seminar	Z	2
-	g Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which		
	g languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the c		
	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language		
NI-PLS3	Programming Language Seminar	Z	2
	g Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which		
-	g languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the c		
	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language	s.	
NI-PLS4	Programming Language Seminar	Z	2
The Programmin	g Language Seminar aims to introduce students to research in programming languages. It has the format of a reading group in which	we discuss scienti	fic papers
about programmin	g languages and related fields. Participating students are expected to present a paper of their interest and actively participate in the c	liscussions. The rea	ading group
	is a joint venue between FIT and MFF CUNI. It is open to all students and researchers interested in programming language	÷S.	
NI-PON	Selected Topics in Optimization and Numerical mathematics	Z,ZK	5
The course focuses	s on optimization problems that appear in the field of machine learning and artificial intelligence. Students broaden their knowledge of co	ntinuous optimizati	on obtained
in the course Math	ematics for informatics. The methods are explained and described along with the details on how they are implemented on computers	. Hence, the releva	nt concepts
	of numerical matematics, mainly numerical linear algebra, are explained too.		
NI-PSD	Public Services Design	KZ	4
	roduce students to specifics of UX, Service design and development for public sector. We will look into the design and development p	-	-
suppliers (devs a	and designesr) as well as clients. In small teams students will work on projects from partner organizations and will try out collaboratio	n with client repres	entatives.
	Course is aimed at students-designers as well as clients.		
NI-PSL	Programming in Scala	Z,ZK	4
	uces the modern programming language Scala which exploits object-functional paradigm. Scala comprises advance language featur		-
advance standard	ibrary. Scala enables to use of applications functional patterns e.g. H-List, Monads, etc. Scala is used by many powerful frameworks and Scalaz, etc.	i libraries e.g. Play,	Cassanura,
NI-PVR	Advanced Virtual Reality	КZ	4
	ces advanced parts of the virtual reality. It is a continuation of the already running graphic objects, especially the creation of 3D mode		
	s students to their application in virtual reality. Lectures will focus on virtual reality technology, its use in various applications and will also		•
	ines (mainly Unity3D). The course is freely connected with the subject VHS (virtual game worlds), students will be able to apply the kr		
	in virtual reality, or directly create a complex game for VR.		· · · · · · · · · · · · · · · · · · ·
NI-PVS	Advanced embedded systems	Z,ZK	4
	used on ARM processors and microcontrollers and their usage in wide range of applications. The course includes a series of advance	1 1	
working with mas	s storage devices, motor control, system control and industrial communication. The students obtain both theoretical and also practica	l experiences with	embedded
	systems.		
NI-PYT	Advanced Python	KZ	4
The goal of this co	urse 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 coursework	. The course is lead	by external
	teachers from Red Hat.		
NI-REV	Reverse Engineering	Z,ZK	5
Students will get a	equainted with the essentials of reverse engineering of computer software. They will learn how processes start and what happens bef	ore and after the m	ain function
	will understand how executable files are organized and how they interact with 3rd party libraries. Another part of the course is dedic	-	-
	tten in C++. Students will also understand principles of disassemblers and obfuscation techniques. A part of the course will also be d	00	
debuggers and de	ebugging work and which methods can be used to detect it. One of the lectures will be dedicated to the latest trends on the computer the course is on the compare, where students will solve practically griented tasks from the real world	maiware scene. Ir	ne focus of
	the course is on the seminars, where students will solve practically oriented tasks from the real world.	774	F
NI-ROZ	Pattern Recognition	Z,ZK	5
	nodule is to give a systematic account of the major topics in pattern recognition with emphasis on problems and applications of the st udents will learn the fundamental concepts and methods of pattern recognition, including probability models, parameter estimation, a		-
-			4
NI-RUB	Programming in Ruby This course is presented in Czech.	KZ	4
NI-RUN	Runtime Systems	Z,ZK	5
	roduction to the world of virtual machines (VM) for high-level programming languages. There are two goals: Give you hands-on experienc		-
	d a VM from scratch, including Abstract Syntax Tree (AST) interpretation Byte code (BC) design and interpretation AST to BC compil		
	ation and some optimization techniques Through a series of guest lectures, introduce you to various advanced topics and implementation		-
	Dynamic optimizations, speculations, and depotimizations Language implementation frameworks Read-world VMs		

NI-SBF	System Security and Forensics	Z,ZK	5	
	familiar with aspects of system security (principles of end station security, principles of security policies, security models, authenticat	I ' I	-	
students will get fa	miliar with forensic analysis as a tool for investigating security incidents (techniques used by malicious software/attackers and forensi	ic analysis techniqi	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 Co	mputer Engineering is a (s)elective course for students who want to deal with deeper topics of digital design, reliability and resistance to	o failures and attacl	ks. Students	
are approached in	dividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the	subject is work with	th 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-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			
	idividually within the subject. Each student or group of students solves some interesting topic with the selected supervisor. Part of the	-		
articles and other p	professional literature and/or work in K N laboratories. The capacity of the subject is limited by the possibilities of the seminar teacher semester.	s. The topics are n	ew for each	
		774	5	
NI-SCR	Statistical Analysis of Time Series with the practical use of the basic time series modelling theory in engineering tasks, ranging from economics (stock exchange prices	Z,ZK	-	
	ing of signals and processes) to computer networks (network components load, attacks detection). The students learn to select a conve			
	alyze its properties and use it for forecasting of future or intermediate values. The stress is put on understanding and adoption of the mai			
	es. Both the lab classes and the lectures exploit freely available software packages in order to provide easy and straightforward transfe			
	the academic to the real world.		0	
NI-SEP	World Economy and Business	Z,ZK	4	
	presented in Czech. However, there is an English variant in the program Informatics (N1801 / 4793). The course introduces students of			
international bus	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	nt decision.	
Seminars help t	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	
The aim of the cou	irse is to acquaint the students with principles of digital circuit simulation at RTL (Register Transfer Level) and TLM (Transaction Level	Modeling) levels a	nd with the	
	properties of proper tools. The course covers recent verification methods, too.			
NI-SWE	Semantic Web and Knowledge Graphs	Z,ZK	5	
The students will	learn the most recent concepts and technologies of the Semantic Web. The course will provide an overview of the Semantic Web tec	hnologies, method	s and best	
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	ystematic	
	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	arious variants and	applications	
	of LR parsing and are introduced to special applications of parsers, such as incremental and parallel parsing.			
NI-SZ1	Knowledge Engineering Seminar Master I	Z	4	
	r you will present a research paper from a top institute / research group to your peers. You will learn what is being cooked in top research			
Additionally, you 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 machin	he learning and AI o	conferences	
NII 070	and summer schools, as well as FIT's own Summer Research Program (VyLet).			
NI-SZ2	Knowledge Engineering Seminar Master II		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 and read exist the seminar will preserve us to attend (and prefix from) top marking the seminar will preserve us to attend (and prefix from) top marking the seminar will preserve us to attend (and prefix from) top marking the seminar will preserve us to attend (and prefix from) top marking the seminar will preserve us to attend (and prefix from) top marking to attend			
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 machir and summer schools, as well as FIT's own Summer Research Program (VyLet).	he learning and Al o	conterences	
		7 71/		
NI-TES	Systems Theory	Z,ZK	5	
-	nd 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-TNA NI-TNN	Theory of Neural Networks	Z,ZK Z,ZK	5	
	study neural networks from the point of view of the theory of function approximation and from the point of view of probability theory. At		-	
	ial neural Networks, such as neurons and connections between them, types of neurons from the point of view of signal transmission, i			
-	s, network training, and the role of time in neural networks. In connection with network topology, we get acquainted with its transforma			
	n with somatic and synaptic mappings, with their composition into mappings computed by the Network, Finally in connection with train			
	aining and to the fact that training is actually a specific optimization task, recalling the most typical objective functions and the most im			
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	Imogorov theorem,	Vituškin	
theorem). Afterwards, we will see how the universal approximation capacity of neural networks can be mathematically formalized as the sets of mappings computed by neural networks				
being dense in important Banach spaces of functions, in particular in the spaces of continuous functions, spaces of functions integrable with respect to a finite measure, spaces of				
	tinuous derivatives, and Sobolev spaces. Within the topic probabilistic approach, we first get acquainted with training based on expect	•		
random sample, and with probabilistic assumptions about training data with which those two kinds of neural networks can be employed. We will see how it is possible to get an estimate				
of the conditional expectancy of network outputs conditioned by its inputs using the expectancy based learning. We recall the strong and the weak law of large numbers and get				
acquainted with an analogy of the strong law of large numbers for neural networks and with the assumptions for its validity. Finally, we recall the central limit theorem, get acquinted with its analogy for neural networks, with the assumptions for its validity and with the hypothesis tests based on it. We will see how those tests can be employed to search for the				
with its analogy	topology of the networks, with the assumptions for its validity and with the hypothesis tests based of it. We will see now those tests can be topology of the network.	Simployed to sedi		
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	1 1	-	
	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.				

	Theoretical Seminar Master II	Z	4
	r is intended for students which want to come in deeper contact with contemporary theoretical computer science. It is mostly a classic		
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	work with scientific	papers and
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	Z	4
NI-TS3	Theoretical Seminar Master III Ir 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	00 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 v	work with scientific	papers and
	other scholarly literature. The capacity is limited by the the potentials of the teachers of the seminar.	7 71/	
NI-TSP	Testing and Reliability knowledge about circuit testing and about methods for increasing reliability and security. They will get practical skills to be able to pre	Z,ZK	5
-	ensitization and to use an ATPG for automatic test generation. They will be able to design easily testable circuits and systems with but		
	will be able to compute, analyze, and control the reliability and availability of the designed circuits.		
NI-TSW	Software Product Development	KZ	4
	The course is presented in Czech.		
NI-TVR	Virtual Reality Technology	Z,ZK	3
	troduced to the basic concepts of virtual reality. Techniques for displaying virtual worlds (CAVE, HMD,) and the possibilities of contr	-	
tracking, hand tra	cking, eye tracking) will be discussed. Furthermore, the concepts of mixed and augmented reality will be introduced. Finally, ways of reality will be presented.	using virtual and a	lugmented
NI-UMI	Artificial intelligence	Z,ZK	5
	s search and inference algorithms in major formal paradigms used in artificial intelligence such as logic theories, constraint programm		
	The main principles and practical applications of discussed techniques will be illustrated.	3	5
NI-VCC	Virtualization and Cloud Computing	Z,ZK	5
-	n knowledge of architectures of large computer systems that are used in data centers and computer infrastructure of companies and	-	
	rtualization principles, tools and technologies that serve to facilitate and automate configuration, testing and monitoring, and to efficie		-
	rameters of modern computer systems. Theoretically and practically, they will get acquainted with containerization as the most effection of allowed systems. Theoretically and practically the will be a similar to a similar system of allowed systems.		
management of cor	mplex computer systems and with specific technologies of cloud systems. Finally, they will learn the principles and gain practical skills ir and development tools (Continuous integration and development).	the use of moder	n integration
NI-VGA	Video Games Architecture	Z,ZK	5
-	a wide range of topics, procedures and methodologies related to the development of computer games - from a technical point of vie	, ,	-
	of view. In the lectures, students will be guided through the history of development, the structure of game engines, component and fu		
	t, physics, graphics, artificial intelligence and multiplayer. The exercises will then cover selected technological topics in greater detail, ir		
	some game mechanics, in the form of practical demonstrations.		
NI-VMM	Retrieval from Multimedia	Z,ZK	5
The student obtains	s general knowledge regarding interfaces of portals providing multimedia content, the principles of similarity search, the methods of feat objects, indexing, and structure of distributed search engines.	ture extraction from	n multimedia
NI-VOL			
	Floationa	7 71/	E
INI-VOL	Elections We will cover the basics of (committee) elections and in general opinion aggregation	Z,ZK	5
	We will cover the basics of (committee) elections and, in general, opinion aggregation.		ı
NI-VOL		Z,ZK Z	5 5
	We will cover the basics of (committee) elections and, in general, opinion aggregation. Research Project		ı
NI-VPR NI-VSM	We will cover the basics of (committee) elections and, in general, opinion aggregation. Research Project Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.	Z Z,ZK	5
NI-VPR NI-VSM The course leads	We will cover the basics of (committee) elections and, in general, opinion aggregation.  Research Project  Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.  Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with moreopy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random	Z Z,ZK ultivariate normal c	5 7 distribution,
NI-VPR NI-VSM The course leads application of ent	We will cover the basics of (committee) elections and, in general, opinion aggregation.  Research Project Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.  Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with more provide the output in the course of the course of the course deals with rance Markov chains. The high point of the course is the Queuing theory and its application in networks.	Z Z,ZK ultivariate normal c dom processes wit	5 7 Jistribution, h focus on
NI-VPR NI-VSM The course leads	We will cover the basics of (committee) elections and, in general, opinion aggregation.  Research Project Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.  Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with mu ropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rance Markov chains. The high point of the course is the Queuing theory and its application in networks.  Computability	Z Z,ZK ultivariate normal c	5 7 distribution,
NI-VPR NI-VSM The course leads application of ent NI-VYC	We will cover the basics of (committee) elections and, in general, opinion aggregation.  Research Project  Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.  Selected statistical Methods the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with mu ropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rance 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.	Z Z,ZK ultivariate normal c dom processes wit Z,ZK	5 7 distribution, h focus on 4
NI-VPR NI-VSM The course leads application of ent NI-VYC NI-ZS10	We will cover the basics of (committee) elections and, in general, opinion aggregation.         Research Project         Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.         Selected statistical Methods         the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with murropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rance 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	Z Z,ZK ultivariate normal c dom processes wit Z,ZK Z	5 7 distribution, h focus on 4 10
NI-VPR NI-VSM The course leads application of ent NI-VYC NI-ZS10 Each student can	We will cover the basics of (committee) elections and, in general, opinion aggregation.         Research Project         Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.         Selected statistical Methods         the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with murropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with random 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         order is degree have a foreign internship at a foreign university or other foreign scientific and/or research institute	Z Z,ZK ultivariate normal c dom processes wit Z,ZK Z tion. Before the int	5 7 distribution, h focus on 4 10 ernship the
NI-VPR NI-VSM The course leads application of ent NI-VYC NI-ZS10 Each student can Dean of the FIT, or t	We will cover the basics of (committee) elections and, in general, opinion aggregation.         Research Project         Student obtains the credits for published scientific outputs. The details are at https://courses.fit.cvut.cz/NI-VPR/en.         Selected statistical Methods         the student through advanced probabilistic and statistical methods used in information technology praxis. Particularly it deals with murropy in coding theory, hypothesis testing (T-tests, goodness of fit tests, independence test). Second part of the course deals with rance 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	Z Z,ZK ultivariate normal c dom processes wit Z,ZK Z,TK Z tion. Before the int ctent of the internsh	5 7 distribution, h focus on 4 10 ernship the nip. Auxiliary
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NIE-PDL	Practical Deep Learning	KZ	5		
This course is designed to provide students with a comprehensive understanding of Deep Learning using PyTorch, a popular open-source machine learning framework. Throughout					
the course, students will develop practical skills in building and training deep neural networks, using PyTorch to solve real-world problems in fields such as computer vision and natural					
language processing.					
NIE-PML	Personalized Machine Learning	Z,ZK	5		
Personalized machine learning (PML) is a sub-field of machine learning that aims to create models and predictions based on the unique characteristics and behaviors of individual					
entities. While PML is commonly used in applications such as recommender systems, which recommend items to users based on their personal interests, its principles can be applied					
to a wide range of other fields, including education, medicine, and chemical engineering. In this course, we will explore the latest PML methods from theoretical, algorithmic, and practical					
perspectives. Specifically, we will focus on cutting-edge models that are of interest to both the research and commercial communities.					
PI-SCN	Seminars on Digital Design	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 2025-07-21, time 04:02.