Study plan

Name of study plan: Aplikované matematicko-stochastické metody

Faculty/Institute/Others: Department: Branch of study guaranteed by the department: Welcome page Garantor of the study branch: Program of study: Applied Mathematical Stochastic Methods Type of study: Follow-up master full-time Required credits: 0 Elective courses credits: 120 Sum of credits in the plan: 120 Note on the plan:

Name of the block: Compulsory courses in the program Minimal number of credits of the block: 0 The role of the block: P

Code of the group: NMSPAMSM1 Name of the group: MDP P_AMSMN 1st year Requirement credits in the group: Requirement courses in the group: In this group you have to complete at least 9 courses Credits in the group: 0

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
01MMD	Mathematical Modelling of Traffic Milan Krbálek Milan Krbálek (Gar.)	Z,ZK	5	2P+2C		Р
01RAD	Regression Data Analysis Tomáš Hobza, Ji í Franc Ji í Franc Tomáš Hobza (Gar.)	Z,ZK	5	2P+2C		Р
01SKE	System Reliability and Clinical Experiments Václav K s Václav K s Václav K s (Gar.)	KZ	3	2+0	L	Р
01SU2	Machine Learning 2 Filip Šroubek Filip Šroubek (Gar.)	Z,ZK	4	2P+2C		Р
01TIN	Information Theory Tomáš Hobza Tomáš Hobza (Gar.)	ZK	2	2+0	Z	Р
01NAH	Theory of Random Processes Jan Vybíral Jan Vybíral Jan Vybíral (Gar.)	ZK	3	3+0	Z	Р
01VUAM1	Research Project 1 estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	6	0+6	Z	Р
01VUAM2	Research Project 2 estmír Burdík estmír Burdík estmír Burdík (Gar.)	KZ	8	0+8	L	Р
01ZLMA	Generalized Linear Models and Applications Tomáš Hobza Tomáš Hobza Tomáš Hobza (Gar.)	Z,ZK	5	2P+2C		Р

Characteristics of the courses of this group of Study Plan: Code=NMSPAMSM1 Name=MDP P_AMSMN 1st year

01MMDMathematical Modelling of TrafficZ,ZK51. Basic mathematical description of vehicular traffic - macroscopic and microscopic quantities, relations between them, fundamental diagram and phase map. 2. Empirical knowledge
about traffic flow - meth-odology of traffic data evaluation, 3s-unification procedure, two-phase theory, three-phase theory, VHM and link to capacity calculations in physics of traffic. 3.
Traffic models - general overview, classification of models, examples, Greenbergs macroscopic model and its solution, Montrolls microscopic model and its solution. 4. Lighthill-Whitham
model - formulation and theoretical solution, Cole-Hopf transformation, formulation of associate Cauchy problem and its solution in distributions, Burgers equation. 5. Cellular traffic
models - Nagel-Schreckenberg model, Fukui-Ischibaschi model, model TASEP and its theoretical solution by MPA. 6. Thermodynamic traffic models - variants, classification by range
and type of potential, Hamiltonian description, general solution methodology, solution of short-range model, connection between thermodynamic models and balance particle systems,
solution of middle-ranged model with logarithmic potential. 7. Vehicular Headway Modeling - an insight into the issue, empirical and theoretical knowledge in a given area, criteria for
admissibility of headway distributions, statistical rigidity and changes in its course, derivation of statistical rigidity for thermodynamic gas. 8. Statistical properties of traffic flow - Poisson
and semi-Poisson mode of transport, supra-random traffic states, their detection.Z,K5

01RAD	Regression Data Analysis	Z,ZK	5
1.Simple linear regressi	on: least squares estimation, properties of parameter estimates, hypotheses tests and confi-dence intervals for parameters of t	he model, model-t	ased prediction,
analysis of residuals 2.	Vultiple linear regression: general linear model, least squares estimation, analytical and numerical solutions of the normal ec	uations, propertie	s of parameter
estimates, coefficient o	determination, F-test, prediction intervals 3. Residuals, diagnostics and transformations: residuals and residual plots, norma	lity tests, detection	n of outlying and
influential observations	hat matrix, Cooks distance, transformations of dependent and independent varia-ble, Box-Cox transformation 4. Selection of	f a regression mod	del: criteria
functions, R2 statistics,	Mallows Cp statistics, Akaike and Bayes infor-mation criteria, stepwise regression and backward elimination 5.Multicollinear	ity: impact of multi	collinearity on
precision of the parame	ter estimates, detecting and combatting multicollinearity, ridge regression		
01SKE	System Reliability and Clinical Experiments	KZ	3
The main goal of the su	bject is to provide the mathematical principles of reliability theory and techniques of survival data analysis, reliability of compor	nent systems, asy	mptotic methods
for reliability, concept of	experiments under censoring and their processing in clinical trials (life-time models). The techniques are illustrated and test	ed within practical	examples
originating from lifetime	material experiments and clinical trials.		
01SU2	Machine Learning 2	Z,ZK	4
1.Fundamental topics fr	om the probability theory and machine learning (classical distributions, Bayes theorem, Kullback-Leibler divergence, curse of di	mensionality, over	fitting, maximum
likelihood and maximur	n a posteriori estimators, Principle Component Analysis) 2.Decision trees: general schema, recursive partitioning, optimal pa	rtitioning and prur	ning, ensemble
learning - bagging, boo	sting, random forests. 3.Examples of decision trees: Adaptive boosting AdaBoost, Gradient boosting, Xgboost. 4.Numerical r	nethods for optimi	zation (steepest
descent, conjugate grad	dient, Newton and quasi-Newton, constrained extrema, Lagrangian). 5.Deep feedforward networks (hidden units, nonlinear a	ctivation functions	, output units,
loss functional, stochas	ic gradient descent, back-propagation algorithm) 6. Optimization for training deep models (regularization, algorithms with adap	tive learning rates)	7.Convolutional
neural networks 8.Recu	rrent neural networks 9.Advanced network architectures (autoencoders, Generative Adversarial networks) 10.Applications o	f deep learning (c	lassification,
segmentation, image re	construction)		
01TIN	Information Theory	ZK	2
Information theory expl	ores the fundamental limits of the representation and transmission of information. We will focus on the definition and implicat	ions of (informatio	n) entropy, the
source coding theorem	and the channel coding theorem. These concepts provide a vital background for researchers in the areas of data compressi	on, signal process	sing, controls,
and pattern recognition			
01NAH	Theory of Random Processes	ZK	3
The course is devoted in	part to the basic notions of the general theory of random processes and partially to the theory of stationary processes and se	equences both wea	akly and strongly
stationary ones.			
01VUAM1	Research Project 1	Z	6
Research project on the	selected topic under the supervision. Supervision and regular checking of the research project under preparation.		
01VUAM2	Research Project 2	KZ	8
Research project on the	e selected topic under the supervision. Supervision and regular checking of the research project under preparation.		
01ZLMA	Generalized Linear Models and Applications	Z,ZK	5
1.Generalized linear mo	dels: exponential family, regularity conditions, score function. 2.Estimation of parameters: maximum likelihood estimates, nu	merical methods u	used for their
calculation, Newton-Ra	ohson, Fisher-scoring algorithm. 3. Testing of models: asymptotic distribution of the score function and the MLE estimates, mode	els comparisons, r	esidual analysis,
diagnostic of influential	observations. 4. Analysis of covariance (ANCOVA), general model of analysis of covariance, one factor ANCOVA, multiple co	mparisons. 5.Moc	els for binary
data: logistic model, no	mal model, Gumbel model, model parameters interpretation, odds ratio, tests, residuals. 6. Poisson regression: univariate an	d multivariate Pois	sson regression,
model parameters inter	pretation, tests and residuals. 7. Probability models for contingency tables, log-linear models.		

Code of the group: NMSPAMSM2

Name of the group: MND P_AMSMN 2nd year

Requirement credits in the group:

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

Credits in the group: 0

Note on the group:

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Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
01ADS	Applications of Data Science Ji í Franc Ji í Franc Ji í Franc (Gar.)	KZ	4	1P+2C		Р
01DPAM1	Master Thesis 1 estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	10	0+10		Р
01DPAM2	Master Thesis 2 estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	20	0+20		Р
18HA	Heuristic Algorithms Jaromír Kukal Jaromír Kukal Jaromír Kukal (Gar.)	ZK	4	2P+2C	L	Р
01NAEX	Design of Experiments Jií Franc Ji í Franc Ji í Franc (Gar.)	Z,ZK	3	2P+1C		Р
01DISE	Diploma Seminar estmír Burdík estmír Burdík estmír Burdík (Gar.)	Z	1	0P+2S		Р
01TNM	Random Matrix Theory Jan Vybíral Jan Vybíral Jan Vybíral (Gar.)	ZK	2	2+0	Z	Р

Characteristics of the courses of this group of Study Plan: Code=NMSPAMSM2 Name=MND P_AMSMN 2nd year

01ADS	Applications of Data Science	KZ	4			
Practical application of mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection to design of an appropriate						
method and its division	nethod and its division into units for development and implementation into the production. Last, but not least, the cooperation in group and management of a modern data project is					
crucial. The actual stand	dard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an empha	asis on team colla	boration, project			
planning. At the end of the course, students will present their results to other teams.						
01DPAM1	Master Thesis 1	Z	10			
Master's thesis prepara	aster's thesis preparation.					

	Master Thesis 2	7	
01DPAM2	Master Thesis 2	Z	20
Master's thesis prepara	tion.		
18HA	Heuristic Algorithms	ZK	4
Heuristic algorithms of	potimization operates on discrete or continuous domains. Brutal force, stochastic, greedy, physically, biologically and sociolog	jically motivated h	euristic are
included, used for optim	num finding and compared.		
01NAEX	Design of Experiments	Z,ZK	3
1.Introduction to the de	sign of experiments and data analysis. 2. Completely randomized one-factor experiment: introduction of a fixed-effect model, 1	tests of equality o	f mean values,
choice of number of ob	servations. 3.Methods of multiple comparison: Bonferroni method, Scheffy method, Tukey method 4.Randomized complete bl	lock design: mode	l definition,
equality effects tests, pe	ower of test, determining sample size. 5. Latin and Greco-Latin squares, balanced incomplete block design, model adequacy	checking, residua	ls, multiple
comparisons. 6.Two fac	or factorial design: statistical models and their properties for designs 2^2, 2^3 and 2^k, fractional factorial design, resolutions. 7	.3^k factorial desi	gns, confounding
in 3 ^k factorial design.	3.Models with random effects, factorials with mixed levels.		
01DISE	Diploma Seminar	Z	1
In the first part of the se	minar, students familiarize themselves with the general principles of publishing and presenting scientific work and the formal	requirements for	diploma projects
at the faculty. The secon	nd part is designed as a practical training for the defence of the diploma project. The students give oral presentations of the cu	urrent state of the	research results
achieved during the wo	rk on their projects. Each presentation is followed by a discussion on scientific matters as well as on the possibilities of impro	ving the students	performance.
01TNM	Random Matrix Theory	ZK	2
Theory of random matri	ces appeared first in 60's in the 20th century in connection with statistical physics and the theory of nucleis of atoms of heavy	metals. The main	interest of study
is the distribution of eige	envalues of symmetric random matrices. In the 21st century the results of theory of random matrices were applied in theoretic	al computer scien	ce and numerics
for design of random al	gorithms.		

Name of the block: Compulsory elective courses Minimal number of credits of the block: 0 The role of the block: PV

Code of the group: NMSPAMSMPV1

Name of the group: MDP P_AMSMN Required optional courses 1st year

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 2 courses Credits in the group: 0

Note on the group:

Studenti si volí alespoň dva předměty z této skupiny, přičemž mezi nimi musí být alespoň jeden z dvojice 01SSI a 01MEU

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
01BAPS	Bayesian principles in statistics Václav K s Václav K s Václav K s (Gar.)	ZK	3	3+0		PV
01DIZO	Digital Image Processing Barbara Zitová Barbara Zitová Barbara Zitová (Gar.)	ZK	4	2P+2C		PV
01DYNR1	Dynamic Decision Making 1 Ta jana Gaj, Miroslav Kárný Ta jana Gaj Ta jana Gaj (Gar.)	Z,ZK	3	2P+1C		PV
01MEU	Modelling Extremal Events Václav K s Václav K s Václav K s (Gar.)	ZK	3	2P		PV
01SSI	Social Systems and Their Simulations Milan Krbálek, Marek Buká ek Marek Buká ek Milan Krbálek (Gar.)	KZ	4	2+1		PV

Characteristics of the courses of this group of Study Plan: Code=NMSPAMSMPV1 Name=MDP P_AMSMN Required optional courses 1st year

01BAPS Bayesian principles in statistics	ZK	3			
The main goal of the subject is to provide decision making mathematical principles with random effects, optim	al and robust strategies and their mutual links together w	ith computational			
aspects for the real applications. The techniques are illustrated within practical examples originating from po	int and interval estimation and statistical hypothesis testi	ng.			
01DIZO Digital Image Processing	ZK	4			
image sampling and quantization, Shannon theorem, aliasing basic image operations, histogram, contrast st	retching, noise removal, image sharpening linear filtering	in the spatial and			
frequency domains, convolution, Fourier transform edge detection, corner detection feature detection image	degradations and their modelling, inverse and Wiener filt	ering, restoration			
of motion-blurred and out-of-focus blurred images image segmentation mathematical morphology image reg	istration and matching				
01DYNR1 Dynamic Decision Making 1	Z,ZK	3			
Design, control and analysis of intelligent agents (or systems) that behave appropriately in various circumstances are highly demanded (artificial intelligence and machine learning,					
data mining, financial modelling, natural language processing, bioinformatics, web search and information ret	data mining, financial modelling, natural language processing, bioinformatics, web search and information retrieval, algorithm design, system design, network analysis, and more). Such				
intelligent agents need to reason with uncertain information and limited computational resources. Effective d	ecision making requires the knowledge about: . the agen	t's environment			
and its dynamics (including the presence of other intelligent agents), . the agent's goals and preferences . th	e agent's abilities to observe and influence the environm	ent. This course			
introduces dynamic decision making under uncertainty and computational methods supporting decision-mak	king. The course helps to develop the mathematical reasc	ning skills crucial			
for areas inherently involving uncertainty. These skills can serve as the foundation for further study in any ap	plication area you choose to pursue and may also help y	ou to analyse the			
uncertainty in your everyday life. Course objectives: - Learn the basic ideas and techniques underlying design of intelligent rational agents. A specific emphasis will be on the					
decision-theoretic modelling paradigm Understand state-of-the-art of decision making (DM) Be able to formulate decision making or learning problem and select appropriate method					
for a given task/application Be able to understand research papers in the field (main conferences: IJCAI, N	leurIPS, AAMAS, ICAART, ICM; main journals: AI, JAIR,	JAAMAS, IJAR).			
- Try out some ideas of your own.					

01MEU Mo	odelling Extremal Events				ZK	3
1.Aggregated traffic in comp	uter nets, possible admission control, machine learning, on-off approximation. 2.Distri	ibution-free inequa	lities for tail	probability	estimation, PC	simulation
of traffic. 3.Nonparametric d	ensity estimators and their tails, asymptotic properties, MISE optimality. 4.Semiparamo	etric estimation, re	transformed	l densities,	statistical prop	erties, score
functions. 5. Phi-divergences	, properties, Kolmogorov entropy, vapnik-Unervonenkis dimension, application. 6.Fluc	tuation of random	sums, stabl	e and -stat	te Mean Ever	3, their
its empirical estimator usage	e 9 Return period of (insurance) events, record counting process. Gumbel method of	exceedance 10 F	luctuation of	random m	avima Fisher	Tinnett law
max-stability. maximum dom	ain of attraction. 11. Generalized extreme value distribution, generalized Pareto distrib	ution, properties a	ind utilization	n. 12.Estima	ates of exceed	ance over
threshold, POT methods, es	timator of quantile, application. 13. Applications to real data from hydrology, geology, ir	nsurance, finance,	numerous c	ther examp	les.	
01SSI Social Systems and Their Simulations KZ 4						
The course is devoted to the	e issue of social systems modeling. That includes stochastic methods and methods of	statistical physics	for descripti	on and ana	lytical solution	of social
interaction systems, implem	entation of particular models and comparison of the computer simulations results with	the empirical data	a.			
Code of the arou	p: NMSPAMSMPV2					
Name of the grou	In: MDP P. AMSMN Required optional courses 2n	dvoar				
	IP. MDF F_AMISMIN Required optional courses 21	u year				
Requirement cre	dits in the group:					
Requirement cou	irses in the group: In this group you have to compl	ete at leas	t 2 coui	ses		
Credits in the arc	0 :qu					
Note on the grou	n: Student si volí novinně alesn	oň dva předu	nětv z té	to skuni	nv	
	ρ .				11y.	,
	(in case of groups of courses the list of codes of their					Í
Code	members)	Completion	Credits	Scope	Semester	Role
	Tutors, authors and guarantors (gar.)					
01405	Applications of Data Science	K7	4	1P+2C		D\/
017/20	Ji í Franc Ji í Franc Ji í Franc (Gar.)	112		11 120		
01DAS	Data science	КZ	3	1P+2C		PV
	Ji Franc JI I Franc JI I Franc (Gar.)					
01FIMA	Financial and insurance Mathematics	ZK	2	2P+0C	Z	PV
	Advanced and Robust Regression Models	71/	2	20		
	Tomáš Hobza, Jan Amos Víšek Jan Amos Víšek Jan Amos Víšek (Gar.)		<u> </u>	26		PV

Characteristics of the courses of this group of Study Plan: Code=NMSPAMSMPV2 Name=MDP P_AMSMN Required optional courses 2nd year

ΖK

2

2+0

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Special Functions and Transformations in Image Analysis Jan Flusser Jan Flusser Jan Flusser (Gar.)

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01ADS	Applications of Data Science	KZ	4	
Practical application of	mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection	tion to design of	an appropriate	
method and its division	into units for development and implementation into the production. Last, but not least, the cooperation in group and manager	ment of a modern	data project is	
crucial. The actual stan	dard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an empha	asis on team colla	aboration, project	
planning. At the end of	the course, students will present their results to other teams.			
01DAS	Data science	KZ	3	
Practical application of	mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection	ction to design of	an appropriate	
method and its division	into units for development and implementation into the production. Last, but not least, the cooperation in group and manager	ment of a modern	data project is	
crucial. The actual stan	dard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an empha	asis on team colla	aboration, project	
planning. At the end of	the course, students will present their results to other teams.			
01FIMA	Financial and Insurance Mathematics	ZK	2	
This course is an introc	uction to the problems of life and non-life insurance and financial mathematics.			
01PRR	Advanced and Robust Regression Models	ZK	2	
1.Introduction to robust	regression - M-estimates, qualitative and quantitative robustness, influential functions, outliers, leverage points. 2. The least r	nedian of squares	s, the trimmed	
least squares and the le	east trimmed squares. 3.Weighted least squares and least weighted squares, algorithms, applications. 4.Instrumental weighted	l variables and the	ir robustification.	
5.AR, MA, AR (I) MA, ir	vertibility and stationarity condition. Smoothing of trend using curves, moving averages and exponential. Seasonal and cyclic	components, tests	s of randomness,	
disturbance (Prais-Wins	sten, Cochrane-Orcutt). 6. Introduction to mixed linear models, estimation of parameters (ML, REML), generalized mixed linear m	odels. 7. Repeated	d measurements,	
Longitudinal data, corre	elation structure in data. 8. Philosophical debate on mathematical modeling and regression analysis.			
01SFTO	Special Functions and Transformations in Image Analysis	ZK	2	
The course broadens to	pics of the courses ROZ1 and ROZ2. Main attention will be paid to several special functions and transformations (especially	moment function	s and wavelet	
transform) and their use in selected tasks of image processing - edge detection, noise removal, recognition of deformed objects, image registration, image compression, etc. Both the				
theory and practical ap	plications will be discussed.			

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

01SFTO

Code of the group: NMSPAMSMV Name of the group: MDP P_AMSMN Optional courses Requirement credits in the group: Requirement courses in the group: Credits in the group: 0

Note on the group: Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their Code Completion Credits Scope Semester Role members) Tutors, authors and guarantors (gar.) Analysis and Processing of Diagnostic Signals Zden k P evorovský Zden k P evorovský Zden k P evorovský (Gar.) 01ZASIG ΖK 3 3+0 V Matlab Applications 18AMTL ΚZ 4 2P+2C L V Jaromír Kukal SQL Applications 18SQL Ζ 2 Ζ 0+2 v Jaromír Kukal, Dana Majerová **Dana Majerová** Jaromír Kukal(Gar.) **Applied Data Analysis** 18AAD Ζ 3 1P+1C L Jaromír Kukal, Tomáš Hubínek, Karel Šimánek Jaromír Kukal Jaromír Kukal V (Gar.) **Business Intelligence** 18BI ΚZ 2 1P+1C Ζ V Jaromír Kukal, Matej Mojzeš Jaromír Kukal **Dynamic Decision Making 2** 01DRO2 ΖK 2 2+0v Ta jana Gaj, Miroslav Kárný **Miroslav Kárný** Miroslav Kárný (Gar.) **Hierarchical Bayesian Models** 01HBM ΚZ 2 2+0V Václav Šmídl Václav Šmídl Václav Šmídl (Gar.) Internet and classification methods 01IKLM 2 2P+0C Z,ZK V Martin Hole a Martin Hole a Martin Hole a (Gar.) Compressed Sensing Jan Vybíral Jan Vybíral (Gar.) 01KOS 2 Ζ ΖK 2+0 v Mathematical Modelling of Non-linear Systems 01MMNS 3 1P+1C Ζ ΖK V Michal Beneš Michal Beneš Michal Beneš (Gar.) Mathematical techniques in biology and medicine 01MBM 3 L Z,ZK 2+1 V Václav Klika Václav Klika Václav Klika (Gar.) **Monte Carlo Method** 18MEMC Z,ZK 4 2P+2C Ζ V Jaromír Kukal, Miroslav Virius Miroslav Virius Miroslav Virius (Gar.) **Nonlinear Optimization** 01NELO ΖK 4 3P+0C V Radek Fu ik Radek Fu ik Radek Fu ik (Gar.) **Neural Networks and their Applications 1** 2 01NEUR1 ΖK 2+0 v Martin Hole a, František Hakl František Hakl František Hakl (Gar.) **Probabilistic Models of Artificial Intelligence** 01UMIN ΚZ 2 2+0 Ζ V Ji ina Vejnarová Ji ina Vejnarová Ji ina Vejnarová (Gar.) **Problem Seminar in Mathematical Analysis** 01PSM1 Ζ 2 0P+2S Ζ V Mat j Tušek Mat j Tušek (Gar.) **Problem Seminar in Mathematical Analysis 2** Ζ 01PSM2 2 2S V Mat j Tušek Mat j Tušek (Gar.) Seminar Course on Dynamic Decision Making Ζ 2 01DROS 0+2 v Ta jana Gaj Ta jana Gaj (Gar.) Start-up Project 01SUP 2 ΚZ 2P+0C v P emysl Rubeš P emysl Rubeš P emysl Rubeš (Gar.) Stochastic Differential Equations 2 01SDR ZK 2P+0C v Michal Beneš Michal Beneš Michal Beneš (Gar.) **Student's Scientific Conference** 01SVK 5 dní Ζ 1 v Kate ina Horaisová Ji í Mikyška Ji í Mikyška (Gar.) Student's seminar in mathematics 1 01SMS1 Ζ 2 0P+2C v Václav Klika Václav Klika (Gar.) Student's seminar in mathematics 2 Ζ 2 0P+2C L 01SMS2 v Václav Klika Václav Klika (Gar.) **Theoretical Fundamentals of Neural Networks** 01NEUR2 ΖK 3 2+0v Martin Hole a Martin Hole a Martin Hole a (Gar.) Financial Markets Theory Nichita Vatamaniuc, Quang Van Tran Quang Van Tran Quang Van Tran 18TFT ΚZ 4 2P+2C Ζ v (Gar.) Graph Theory Jan Volec, Petr Ambrož Petr Ambrož (Gar.) 01TG ΖK 5 4P+0C V Game Theory Jan Volec Jan Volec (Gar.) 01TEH ΖK 2 2+0 L V **Financial Markets Data Processing** 18ZDFT ΚZ 4 2P+2C L v Quang Van Tran Quang Van Tran Quang Van Tran (Gar.) Characteristics of the courses of this group of Study Plan: Code=NMSPAMSMV Name=MDP P_AMSMN Optional courses

01ZASIG	Analysis and Processing of Diagnostic Signals	ZK	3		
Digital signal processing	g, signal transformations and filtrations, spectral and time-frequency analysis				
18AMTL	Matlab Applications	KZ	4		
Systematic application	of Matlab optimization toolbox for the solution of linear, quadratic, binary, integer an nonlinear programming tasks. Simulation	of chaotic system	ns an fractal set		
generation. Analysis of	trajectories, attractors and fractal sets including estimation of their properties.				
18SQL	SQL Applications	Z	2		
Practical realization of o	atabase system according to general principles of database analysis.				
18AAD	Applied Data Analysis	Z	3		
A practically focused subject that guides you through the topics of Big Data, neural networks, parallel computing, graph analysis, cloud technologies, deployment, and development of					
software or IoT solution	S.				

18BI	Business Intelligence	KZ	2
The aim of the subject	s to explain to the students different characteristics of production and analytical databases and a set of processes, know-hov	v and tools (not or	nly) to support
decision-making activiti	es within the organization. In addition to the basic concept of BI, listeners will get acquainted with the general methodology of im	plementation of cu	istom algorithms
derived from other theo	ries and subjects into the BI environment.		
01DRO2	Dynamic Decision Making 2	ZK	2
1.Overview of the formation	lised decision-making task and tools for its solution 2. Application of the general fully probabilistic design of decision-making	strategies for Mar	kov chains and
linear-Gaussian models	3. Aproximation and completion of probabilities serving to processing data-based as well as probabilistic knowledge and pre	eferences for Mark	ov chains
4.Introduction into multi	-participants decision making and its formalisation 5. Usability of general tools for knowledge sharing and cooperation within mu	Iltiple-participants	decision making
6.Ilustrative case studie	s of solving decision-making tasks 7.0pen decision-making problems		-
01HBM	Hierarchical Bayesian Models	KZ	2
Keywords: Bayesian the	eory, linear regression, signal separation, mixture models, Bayesian filtering		_
01IKLM	Internet and classification methods	Z,ZK	2
Attending the course, the	e students get acquainted with classification methods used in three important internet or general-network applications: span	n filtering, recomm	nender systems,
and intrusion detection	systems. However, they learn more than only how classification is performed when facing these three problems. On the back	ground of the abo	ve applications,
they get an overall over	view about the fundamentals of classification methods. The course is taught in a 2-week cycle, always a 2h lecture and a 2h	practice at compu	iter labs.
01KOS	Compressed Sensing	K	2
The lecture will introduc	e basic concepts of the theory of compressed sensing an area founded in 2006 in the works of D. Donoho, E. Candes, and T	T. Tao. This theory	studies the
search for sparse soluti	ons of underdetermined systems of linear equations. Due to the applications of sparse representations in electric engeneering	and signal proces	ssing, this theory
was quickly used in ma	ny different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NI	P-completeness o	t the search for
sparse solutions of sys	ems of linear equations, we introduce conditions which ensure also existence or more effective solvers and show, that these	are satisfied for e	xample for
Gaussian random main	ces. As an enective solution method, we will analyze it -minimization and Orthogonal Matching Pulsuit, we will also study stable	inty and robustnes	s of the obtained
	Mothematical Madelling of Nea linear Quaterna	71/	2
The source consists of	Mathematical Modelling of Non-linear Systems	ZN	3 depariation of
bifurcations and observe	uasic terms and results of the theory of minite- and minintedimensional dynamical systems generated by evolutionary different second part is devoted to the evolutionary different second part is devoted to the evolution of basic results of the fractal geometry dealing with attractors of evolutionary different	iai equalions, and	description of
	Second parts devoled to the explanation of basic results of the flactar geometry dealing with attractors of such dynamicals		0
	Mathematical techniques in biology and medicine	Z,ZK	3
Spatially independent n	looeis; enzyme kinetics; excitable system; reaction-airrusion equations; traveiling waves; pattern formation; conditions for furr	ing instability, the	effect of domain
size; the concept of sta	Sinty in PDEs, spectrum of a linear operator, semigroups.		
18MEMC	Monte Carlo Method	Z,ZK	4
This course is devoted t	o the numerical method Monte Carlo and to its selected applications.		
01NELO	Nonlinear Optimization	ZK	4
Nonlinear optimization	problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programmin	ng theory with emp	hasis on convex
optimization and basic	nethods for unconstrained and constrained optimization. The lecture is supplemented by illustrative examples.		
01NEUR1	Neural Networks and their Applications 1	ZK	2
Keywords: Neural netwo	orks, data separation, functional approximation, supervised learning		
01UMIN	Probabilistic Models of Artificial Intelligence	KZ	2
The course is devoted t	Probabilistic Models of Artificial Intelligence o the survey of methods used for uncertainty processing in the field of artificial inteligence. The main attention is paid to so-c	KZ alled graphical Ma	2 arkov models,
The course is devoted to particularly to Bayesian	Probabilistic Models of Artificial Intelligence o the survey of methods used for uncertainty processing in the field of artificial inteligence. The main attention is paid to so-c networks.	KZ alled graphical Ma	2 arkov models,
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18ZDFT	Financial Markets Data Processing	KZ	4			
The course enables stu	dents to combine knowledge of numerical methods, Matlab programming and financial mathematics to solve practical proble	ms in finance suc	h as portfolio			
optimization, risk mana	optimization, risk management and valuation of financial derivatives, especially options of different types. Upon completion of the course the student will be able to formulate and					
numerically solve conc	ete problems in the given field and subsequently implement their solutions in practice.					

List of courses of this pass:

Code	Name of the course	Completion	Credits				
01ADS	Applications of Data Science	KZ	4				
Practical application	on of mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection	on to design of an a	appropriate				
method and its division into units for development and implementation into the production. Last, but not least, the cooperation in group and management of a modern data project is crucial. The actual standard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an emphasis on team collaboration, project planning. At the end of the course, students will present their results to other teams.							
01BAPS	Bayesian principles in statistics	ZK	3				
The main goal of th	e subject is to provide decision making mathematical principles with random effects, optimal and robust strategies and their mutual lin	ks together with co	mputational				
aspects for	the real applications. The techniques are illustrated within practical examples originating from point and interval estimation and statist	tical hypothesis tes	sting.				
01DAS	Data science	KZ	3				
Practical application	on of mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection is into units for development and implementation into the production Last, but not least, the cooperation in group and management	on to design of an a	appropriate				
crucial. The actual	standard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an emphasis	on team collabora	a project is				
	planning. At the end of the course, students will present their results to other teams.		··· / ·/··				
01DISE	Diploma Seminar	Z	1				
In the first part of th	he seminar, students familiarize themselves with the general principles of publishing and presenting scientific work and the formal req	uirements for diplo	ma projects				
at the faculty. The s	econd part is designed as a practical training for the defence of the diploma project. The students give oral presentations of the current of the diploma project.	nt state of the rese	arch results				
achieved during ti	he work on their projects. Each presentation is followed by a discussion on scientific matters as well as on the possibilities of improvir	ng the students per	formance.				
	Digital Image Processing	ZK	4				
frequency domains	convolution. Sourier transform edge detection, corner detection feature detection image degradations and their modelling, inverse a	nd Wiener filtering					
	of motion-blurred and out-of-focus blurred images image segmentation mathematical morphology image registration and matc	hing	,				
01DPAM1	Master Thesis 1	Z	10				
	Master's thesis preparation.	I	I				
01DPAM2	Master Thesis 2	Z	20				
	Master's thesis preparation.		1				
01DRO2	Dynamic Decision Making 2	ZK	2				
1.Overview of the	formalised decision-making task and tools for its solution 2. Application of the general fully probabilistic design of decision-making stra	ategies for Markov	chains and				
4 Introduction into r	models 5. Aproximation and completion of probabilities serving to processing data-based as well as probabilistic knowledge and pre- nulti-participants decision making and its formalisation 5. Usability of general tools for knowledge sharing and cooperation within multipl	e-participants deci	sion making				
	6.Illustrative case studies of solving decision-making tasks 7.Open decision-making problems		elerrinarang				
01DROS	Seminar Course on Dynamic Decision Making	Z	2				
The seminar is de	voted to the actual topics and trends in decision making, machine learning (ML) and artificial intelligence (AI). It will extend the topics	learned in the lect	ure course				
01DRO1, in partice	Juar formalisation of DM problem and its solution incl. techniques to tackle the problem; multi-agent DM and related tasks incl. possibl A sub-selection of relevant articles presented at the main DM, ML and AI conferences will be discussed.	e ways of agents?	interaction.				
01DYNR1	Dynamic Decision Making 1	Z,ZK	3				
Design, control ar	d analysis of intelligent agents (or systems) that behave appropriately in various circumstances are highly demanded (artificial intelli	gence and machin	e learning,				
data mining, financial modelling, natural language processing, bioinformatics, web search and information retrieval, algorithm design, system design, network analysis, and more). Such							
Intelligent agents need to reason with uncertain information and limited computational resources. Effective decision making requires the knowledge about: the agent's environment							
introduces dynamic	c decision making under uncertainty and computational methods supporting decision-making. The course helps to develop the mathe	matical reasoning	skills crucial				
for areas inherently	involving uncertainty. These skills can serve as the foundation for further study in any application area you choose to pursue and ma	ay also help you to	analyse the				
uncertainty in	your everyday life. Course objectives: - Learn the basic ideas and techniques underlying design of intelligent rational agents. A specif	ic emphasis will be	on the				
decision-theoretic modelling paradigm Understand state-of-the-art of decision making (DM) Be able to formulate decision making or learning problem and select appropriate method							
for a given task/ap	plication Be able to understand research papers in the field (main conferences: IJCAI, NeuriPS, AAMAS, ICAAR I, ICM; main journa	ais: AI, JAIR, JAAN	/IAS, IJAR).				
	Financial and Insurance Mathematics	7K	2				
	This course is an introduction to the problems of life and non-life insurance and financial mathematics.	21	2				
01HBM	Hierarchical Bayesian Models	KZ	2				
	Keywords: Bayesian theory, linear regression, signal separation, mixture models, Bayesian filtering	I	1				
01IKLM	Internet and classification methods	Z,ZK	2				
Attending the cours	se, the students get acquainted with classification methods used in three important internet or general-network applications: spam filt	ering, recommend	er systems,				
and intrusion detection systems. However, they learn more than only how classification is performed when facing these three problems. On the background of the above applications, they get an overall overview about the fundamentals of classification methods. The course is taught in a 2-week cycle, always a 2h lecture and a 2h practice at computer labs.							
01KOS	Compressed Sensing	ZK	2				
The lecture will i	ntroduce basic concepts of the theory of compressed sensing an area founded in 2006 in the works of D. Donoho, E. Candes, and T.	Tao. This theory st	udies the				
search for sparse s	olutions of underdetermined systems of linear equations. Due to the applications of sparse representations in electric engeneering and	d signal processing	, this theory				
was quickly used in many different fields. After the first survey lecture, we will study the mathematical foundations of the theory. We prove general NP-completeness of the search for sparse solutions of systems of linear equations. We introduce conditions which ensure also existence of more effective solvers and show, that these are satisfied for example for							

Gaussian random matrices. As an effective solution method, we will analyze I1-minimization and Orthogonal Matching Pursuit. We will also study stability and robustness of the obtained results with respect to the corruption of measurements and the optimality of the results.

OTMM Mathematical lechniques in biology and modeline QLX 3 OTMEST Interview of the status system cancer and the status system status system cancer and the status system cancer and	results with respect to the corruption of measurements and the optimality of the results.		
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101KU Modelling External Events 2.K 3 1 Aggregated tarkin in compare rate, possible admission control, macrine lamming, no.et approximation, 7. Damilution-into insusibilité fort all possible, sourcements, P.C anulators 1 admission de lamming, and the approximation, possible admission control, macrine lambing, and the approximation, possible admission, and the approximation, possible admission, and the approximation, possible admission, and the approximation of attraction, p.P. and Ogle. News. Exceede hordshow, possible admission, and the approximation of attraction, p.P. and Ogle. News. Exceede hordshow, possible admission, and the approximation of attraction, p.P. and Ogle. News. Exceede hordshow, possible admission, and the approximation of attraction of attraction proximation of attraction. The approximation of attraction of attraction proxemines and attraction, proximation of attraction, p.P. and Ogle. News. Exceede hordshow, possible admission, Narrowski admission of attraction proximation of attraction proxemines. Science admission of attraction proximation of attraction proxemines. Science admission of attraction proximation of attraction proxemines. Science admission of attraction proximation attractinter proximation attraction proximatis attraction	Spatially independent models; enzyme kinetics; excitable system; reaction-diffusion equations; travelling waves; pattern formation; conditions for Turing in	nstability, the effect	of domain
OTMEU Modeling External Events ZK 3 A seggest attribute (compater resp. possible demised over compater). Subtribute response to all consults were analytic. Periodical of the set and th	size; the concept of stability in PDEs, spectrum of a linear operator, semigroups.		
1 Aggregated tarbin in computer real, possible admission control, marchine learning, ano-off approximation, 2. Distribution-the inequalities for tail proceeding elevations, tables and the tails, supported in protections. Second and the table during computer second in the table duri	01MEU Modelling Extremal Events	ZK	3
of table. 33 konceptanetic dentity exercises and the fills sepreptice posetine. Mile contrains of selection research mer, such and -state dentification, their dentifies a contrain to the selection. Per and Open mer, such and -state dentification, their dentifies a contrain the selection. Per and Open mer, such and -state dentification, their dentifies a contraint field of the selection of the s	1.Aggregated traffic in computer nets, possible admission control, machine learning, on-off approximation. 2.Distribution-free inequalities for tail probabi	lity estimation, PC	simulation
tunctors. 5 Prividengenese, poperties, Kotmogorov entropy, Vepriko-Chervomerika dimerison, apticacianis of Haucaiation and entropy and positive and entropy description of the entropy of the entro	of traffic. 3. Nonparametric density estimators and their tails, asymptotic properties, MISE optimality. 4. Semiparametric estimation, retransformed densitie	s, statistical prope	rties, score
drausements - Termentade certain limit hovern, domain of attaction, sub-apprential distribution. Betway-all distribution detection, P. Pari G. Dur, Heun Excest function, max-ability, mainum domain of direction 11 Generaled orientmy value diptribution, gramentade frames distribution, programs and maintage. There is a sub-apprentiation of distribution apprentiation of distribution apprentiation of distribution. Burges and the sub-apprentiation of distribution apprentiation of distribution. Burges and the sub-apprentiation of distribution. Burges and the sub-apprentiation of the sub-apprentiation of distribution. Burges and the sub-apprentiation of the sub-apprentiation of distribution. Burges and the sub-apprentiation apprentiation apprentiation. Burges and the sub-apprentiation apprentiation apprentiation apprentiation apprentiation. Burges and the sub-apprentiation apprentiation appre	functions. 5. Phi-divergences, properties, Kolmogorov entropy, Vapnik-Chervonenkis dimension, application. 6. Fluctuation of random sums, stable and	-stable distributio	ns, their
is empirate estimator, utage. Breturn period of (matarine) events, lecoid counting process, Gureal method of eccessance. 10 Thurburstion of matarian maximum, Pather Topell tak, maximability, maximum domain of attaction. 10. Secondare down was during the distribution, roperate and least on, 12. Estimates of escoedance or vere management of the distribution periods of the distribution. 12. Secondare of escoedance or vere management of the distribution to secondare or vere down and the distribution of the distribution periods. Neuroperiods of the distribution to the distribution of	characteristics. 7.Generalized central limit theorem, domains of attraction, sub-exponential distributions. 8.Heavy-tail distribution detections, PP and QQ	plots, Mean Exces	s function,
max-stability, maximum domain of attraction. 11:0 eneralized attraction, generalized Partic distribution, properties and utilization, Carlo Carlos, Tacypications to acid atta from hydrogy exogyr, invariance, innova, runneous contre warryles, OTMMD Carlos C	its empirical estimator, usage. 9. Return period of (insurance) events, record counting process, Gumbel method of exceedance. 10. Fluctuation of random	n maxima, Fisher-T	ïppett law,
Interseld, PCT methods, existing of guine, applications in 24 generation between hen, function, municipations, function, municipation, and the paper intersection of the paper intersection. End of the paper intersection of the paper intersection. End of the paper intersection of the paper intersection of the paper intersection of the paper intersection of the paper intersection. End of the paper intersection of the paper intersection of the paper intersection of the paper intersection. End of the paper intersection of the paper intersection. End of the paper intersection of the paper intersection of the paper intersection of the paper intersection. End of the paper intersection of the paper intersection. End of the paper intersection of thepaper intersection of the paper intersection of thepaper intera	max-stability, maximum domain of attraction. 11.Generalized extreme value distribution, generalized Pareto distribution, properties and utilization. 12.Es	stimates of exceed	ance over
01MMD Mathematical Modelling of Traffic Z,ZK 5 1. basic mathematical decipition of windbar matter - macroscope and microscope uncell and base maps. 2: Emprical modelling and particle and the compact provides and the social colutators in physics of traffic. A traffic model: - generation downlow. Basic Induction Motol Immediator A Uphthel Withmann model - formulation and hexereal adultator. Cole-Hord Interaction. Motol Immediator. A traffic Motol Interaction and the social adultation. Cole-Hord Interaction Motol Immediator Motol Interaction Interaction. Social Interaction Motol Immediator A Interaction Motol Immediator A Interaction Motol Immediator A Interaction Interaction A Interaction Interaction Interaction A Interaction Interactinteraction Interaction Interaction Interaction Intera	threshold, POT methods, estimator of quantile, application. 13. Applications to real data from hydrology, geology, insurance, finance, numerou	is other examples.	
1. Basic mathematical description of whickale traffic - mancescapie quantities, relations between htem, Instamental diagonan applicate Traffic - South Traffic - Marchella - South - Light Mithem Mithem Marchella - South - Light Mithem Mith	01MMD Mathematical Modelling of Traffic	Z,ZK	5
about matter flavs - methodology of traffic date evaluation, Se-unfication procedure, invesphase theory, VHA and link to capacity calculations in physics of traffic. So the set in the evaluation of associated causity process and is solution. A distribution in distributions allower and the solution in distribution in distributions. Burgers equation. 5. Conflict frame frame and the increase of the solution in distribution in distributions. Burgers equation. 5. Conflict frame and the increase in the solution in distribution in distributions. Burgers equation. 5. Conflict frame and the increase in the solution in distribution in distributions. Burgers equation. 5. Conflict frame and the increase in the solution in distribution points at frame casatic and balance particle gaters and prior of the solution. Conflict frame and the increase in the solution of indiversal points and the increase in a gatern and the solution in distribution is distribution of the solution	1. Basic mathematical description of vehicular traffic - macroscopic and microscopic quantities, relations between them, fundamental diagram and phase	map. 2. Empirical	knowledge
Taill: model: -general overview, dassification of models, examples, Generhurgs macroscopic model and the solution. Montrolls microscopic media solution in distributions, Burger action. S. Colluter traffer models: - Regul Schweberburg model, Fokuli Schweberburg methodology, solution in distributions, Burger action. S. Colluter traffer models: - Regul Schweberburg model, Fokuli Schweberburg methodology, solution of a sociatic Carupty problem and its solution. In distributions, Burger action. S. Colluter traffer models: - Regul Schweberburg model, Fokuli Schweberburg methodology, solution of sociatic Carupty problem and its solution in distributions, Burger actions and beam Possion methodology actions of sociatic Carupty problem and its solution in distributions, Burger actions and beam Possion methodology actions of sociatic Carupty problem and its solution in distributions, Burger actions and a distribution action action action of sociatic Carupty problem and its solution in distributions, Burger actions and a distribution action	about traffic flow - methodology of traffic data evaluation, 3s-unification procedure, two-phase theory, three-phase theory, VHM and link to capacity calcu	lations in physics of	of traffic. 3.
model - normalistic and theoretical solution, Cole+Reg transformation, formulation of associated Cauchy problem and its solution in distructure, classification by any and type of potential. Hamiltonian description, general solution rethodology, solution of abit-range model, connection between thermodynamic traffic models - and basine aparticle systems. Calculate traffic description and the solution in distructure classification of abit-range model, connection between thermodynamic gate. Solution and description and the solution in distructure classification problems and the solution in distructure classification and description of these and individual splems generated by evolutionary differential equations, and description of these and individual splems generated by evolutionary differential equations, and description of these and individual splems generated by evolutionary differential equations, and description of these and individual splems generated by evolutionary differential equations, and description of these and individual splems generated by evolutionary differential equations, and description of these and individual splems generated by evolutionary differential equations, and description and these	Traffic models - general overview, classification of models, examples, Greenbergs macroscopic model and its solution, Montrolls microscopic model and its	s solution. 4. Lighthi	ll-Whitham
medels - Nagel Schwedenberg medel. Fukui Ischbasch imodel, medel TASEP and its theoretical activities by MPA. On Thermodynamic traffic and develop in a given and activities of methods of a schweden of a start scheme develop. Connecton betweend methods/martine collaba and activities of transfers of a digite of hermologies, a schweden of a start scheme develop. The activities of transfers of a digite to the methods of a scheme of a start scheme develop. The activities of transfers of a digite to the methods and the scheme is a scheme to the scheme of transfers. The scheme develop of the scheme of transfers of transfers of a digite to the method of a scheme of a scheme of transfers. The scheme develop of the scheme of transfers of transfers of transfers of transfers of transfers. The scheme develop of the scheme of transfers of	model - formulation and theoretical solution, Cole-Hopf transformation, formulation of associate Cauchy problem and its solution in distributions, Burger	rs equation. 5. Cell	ular traffic
and type of potential, Hemitonian description, general solution methodology, solution of addression for the solution and method general solution of addression of statistical rightly or thermodynamic gas. 5. Statistical properties of traffic for Poisson and earth-frameor, super-randomical systems generated by exclutionary differential equations, and decide to the explanation of basic related to the functionary super-randomical systems generated by exclutionary differential equations, and decide to the explanation of basic related to the functionary of finas- and infinite sites, final decides of sub-function and service of the solution of the differential equations, and decide to the explanation of basic related to the function of the solution of the decign of experiments and advected to the explanation of basic related of the function of the decign of experiments and the decign of experiments and an analysis. 2. Completely information de-function of a flow-defined model, tests of equality of method to multiple of the explanation of basic relative of the explanation of basic relative of the experiments in the decign of experiments and the analysis. 2. Completely information de-function of a flow-defined model, relative status of the final systems. Status of the final system is the experiments in the decign of test determining annet sites. The experiments is the experiment interval tests of experiments in the decign of test determining annet sites. The experiments is the experiment interval tests of the experiment interval tests of the experiments of the properiments of the experiments is the experiment interval tests of the experiment is the experiment interval tests of the experiments of the experiment interval tests of the experiments of the experiments of the experiment is the experiment interval tests of the experiments of the experiment experiments of the experiment experiments of the experiment experiments of the experiment experiment experiment experiments of the experimant experiment experiment experime	models - Nagel-Schreckenberg model, Fukui-Ischibaschi model, model TASEP and its theoretical solution by MPA. 6. Thermodynamic traffic models - va	riants, classificatio	n by range
solution of middle-ranged model with logarithmic potential. 7. Vehicular Headway Modeling - an insight into the issue, encircial and theorem and semi-Anson mode of transport, supma-random traffe tables, their detection. 011MINIS Mathematical Model (Manages In the curve, deviation of statistical and properties of traffe tow - Poisson and earn-Rotson mode of transport, supma-random traffe states, their detection. XK 3 011MINIS Mathematical Model (Manage Systems ZK 3 011MINIS Mathematical Model (Manage Systems Z/ZK 3 011MINIS Design of Experiments Z/ZK 3 011MINIS Comparity in mathematical Model (Manage Manage M	and type of potential, Hamiltonian description, general solution methodology, solution of short-range model, connection between thermodynamic models	and balance partic	e systems,
admissibility of headway distributions, statistical rigidity and dranges in its course, derivation of statistical rigidity for thermodynamic gas. Solutistical properties of traffic flow - Poisson mode of transmort, super-amotion attraffic status, how detection. 01MMNS Mathematical Modelling of Non-linear Systems ZK 3 01Mex Design of file-an out file-indenseional dynamical systems generated by evolutionary different equations, and outcompton to basic results of the first and intermetical systems generated by evolutionary different equations, and outcomption. Booking of the course constraints of the fractal generate by evolutionary different equations, and outcomption. Booking of the course constraints and statistical models analysis. 2. Completely indontezed one-factor experiment: introduction of a fits defer factoral design, residuals, multiple effects tests, outcompties block design, model adequacy checking, residuals, multiple effects tests, bacterial design settiatical models or design set. 2, statistical models and biol properties of redsign Set. 2, Statistical models and setting se	solution of middle-ranged model with logarithmic potential. 7. Vehicular Headway Modeling - an insight into the issue, empirical and theoretical knowledge	ge in a given area,	criteria for
and semi-Plassom mode of transport. suphramoden traffic States, their detection. ZK 3 011MMNS Mathematical Modeling of Non-Interact Systems ZK 3 011MAEX Design of Experiments Z,ZK 3 111NdAEX Design of Experiments Z,ZK 3 11NdAEX Design of Experiments Z,ZK 3 11NdA The outper is deviced in part to the soft adors in the soft adors in adors in adors and the soft adors in adors and soft adors adors and the soft adors in adors addres addre	admissibility of headway distributions, statistical rigidity and changes in its course, derivation of statistical rigidity for thermodynamic gas. 8. Statistical pro	perties of traffic flow	v - Poisson
Of MMNS Mathematical Modelling of Non-linear Systems ZK 3 The course consists of the theory of Initia- and Initiademissional systems generated by evolutionary differential equations, and description of basic results of the fincal generity detailing with rationals of such dynamical systems. ZK 3 OTINEX Design of Experiments Academical systems. ZZK X 3 Of MAL Mathematical model and analysis. 2:Completely randomized one-factor experiments. Introduction of the design of experiments and data analysis. 2:Completely randomized one-factor experiments introduction on the design of experiments. X <t< td=""><td>and semi-Poisson mode of transport, supra-random traffic states, their detection.</td><td></td><td></td></t<>	and semi-Poisson mode of transport, supra-random traffic states, their detection.		
The course consist of basic terms and results of the theory of finite-and infinitedimensional dynamical systems generated by evolutionary differential equations, and description of basic results of hasic results of the factal generative dealing with attractors of such dynamical systems. OTNAEX Design of Experiments Z,ZK 3 OTNAEX Design of Experiments Z,ZK 3 Introduction to the design of experiments and data analysis 2.Completely back to segriment: introduction of a faxet effect factorial designs, control and experiments and data analysis 2.Completely back design; model adequacy backding, resolutions, 7.3% factorial designs, Roduked with anome differential factorial designs, control and the served factorial designs, control and the served factorial designs, advacational	01MMNS Mathematical Modelling of Non-linear Systems	ZK	3
biturations and chaos. Second part is devoted to the explanation of basic results of the fractal geometry dealing with tradnots of subt dynamical systems. 01NAEX Design of Experiments Z/X 3 1.1hetoduction to the design of experiments and data analysis. 2.Completely randomized one-factor experiments. Hendbod 14: Analomized complete block design: model adequacy checking, residuals, multiple comparisons. Brieffer for design 24: 02: 04: 04: 04: 04: 04: 04: 04: 04: 04: 04	The course consists of basic terms and results of the theory of finite- and infinitedimensional dynamical systems generated by evolutionary differential of	equations, and des	cription of
OTNEX Design of Experiments Z,ZK 3 1.Introduction to the design of experiments and data analysis 2.Compteter boots experiment introduction of a facet effect letters of equality of mean values, choice of number of observations. 3 Methods of multiple comparison: Borferrorin method. Scheffly method. Txkey method 4.Randmized completer block design; model designs, concluding in 94 X breach designs, the designs, concluding and the design of experiments and designs, concluding and the design of experiments and designs, concluding and the designs, concluding and the designs, concluding and the designs, concluding and the design of experiments and designs, concluding and designs, conc	bifurcations and chaos. Second part is devoted to the explanation of basic results of the fractal geometry dealing with attractors of such dyr	namical systems.	
11.httpd://doi.org Submits of superiments and data analysis. 2.Completely reindomized one-fator experiment: introduction of a found-effect model, tesis of equality of mean values, explored or observations. Submits of mean values, the submit of the submit o	01NAEX Design of Experiments	Z,ZK	3
thoise of number of observations. 3Methods of multiple comparison: Boreferoni method, Schefly method, Taky method A madomized complete block design, model, reductions, residuats, multiple comparisons. 6. Two factor factorial design statule in and the properties for designs 2%, 2% and 2%, fractional factorial design, esclutats, multiple comparisons. 6. Two factor factorial design, defaultation and basis of the properties for designs 2%, 2% and 2%, fractional factorial design, esclutats, multiple comparisons. 6. Two factor factorial design, advisational design, advisating design, advisational	1. Introduction to the design of experiments and data analysis. 2. Completely randomized one-factor experiment: introduction of a fixed-effect model, test	s of equality of me	an values,
equality effects tests, power of test, determining sample size. SLain and Greeo-Lain squares, balanced incomplete block design, model adequacy checking, residuals, multiple in 2% factorial design and existence and design and the adequacy checking. Test design additional to a strained adequacy checking, residuals, multiple in 2% factorial design and the strained set and their application is an average and partially to the theory of stationary processes and sequences both weakly and strongly astronary onces. 01NELO Nonlinear Optimization ZK 3 01NELO Nonlinear Optimization ZK 4 Nonlinear optimization problems find their application in may areas of applied mathematics. The lecture covers the basics of mathematical programming theory with emphasis on convex optimization and basic methods of unconstrained and constrained optimization. The lecture covers the basics of mathematical programming theory with emphasis on convex optimization and basic methods. ZK 2 01NEUR1 Neural networks. and their Applications 1 ZK 2 2 1 2 2 1 1 2 2 1 1 2 2 1 1 1 2 2 1 <td>choice of number of observations. 3. Methods of multiple comparison: Bonferroni method, Scheffy method, Tukey method 4. Randomized complete blo</td> <td>ck design: model d</td> <td>efinition,</td>	choice of number of observations. 3. Methods of multiple comparison: Bonferroni method, Scheffy method, Tukey method 4. Randomized complete blo	ck design: model d	efinition,
comparisons. 6. Two factor factorial design: statistical models and their properties for designs 2°2, 2°3 and 2°K, fractional deciration design, resolutions 7.3°K factorial design, confounding in 3°K factorial design. A Models with random effects, factorial design, and 2°K, in 3 The acurse is devoted in part to the basic notions of the general theory of random processes and partially to the theory of stationary processes and sequences both weakly and strongly stationary ones. 01NELO Nonlinear optimization problems find their application in may areas of applied mathematics. The lecture osvers the basics of mathematical programming theory with emphasis on convex optimization and basic methods for unconstrained and constrained optimization. The lecture is supervised learning ZK 4 01NEURI Nourill Networks and their Applications.1 ZK 2 01NEURI Advanced and Robust Regression Models ZK 2 1.Indoduction to robust regression - M-estimates, qualitative and quantitative robustness, influential functions, outliers, leverage points.2. The least median of squares, the trimmed least squares and here is asseminare in advanced mathematical analysis and tas applications. Seminar task with te delivered by students, departition anod in advanc	equality effects tests, power of test, determining sample size. 5. Latin and Greco-Latin squares, balanced incomplete block design, model adequacy cl	hecking, residuals,	multiple
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01SMS1	Student's seminar in mathematics 1	Z	2			
01SMS2	Student's seminar in mathematics 2	Z	2			
01SSI	Social Systems and Their Simulations	KZ	4			
The course is dev	oted to the issue of social systems modeling. That includes stochastic methods and methods of statistical physics for description and	d analytical solution	n of social			
interaction systems, implementation of particular models and comparison of the computer simulations results with the empirical data.						
01SU2	Machine Learning 2	Z,ZK	4			
1.Fundamental topic	cs from the probability theory and machine learning (classical distributions, Bayes theorem, Kullback-Leibler divergence, curse of dimer	nsionality, overfitting	g, maximum			
learning - bagging	hoosting, random forests, 3 Examples of decision trees: Adaptive boosting, AdaBoost, Gradient boosting, Xuboost, 4 Numerical meth	oning and pruning	n (steenest			
descent, conjugate	e gradient, Newton and quasi-Newton, constrained extrema, Lagrangian). 5.Deep feedforward networks (hidden units, nonlinear activ	vation functions, ou	itput units,			
loss functional, stoc	hastic gradient descent, back-propagation algorithm) 6. Optimization for training deep models (regularization, algorithms with adaptive	learning rates) 7.C	onvolutional			
neural networks 8	Recurrent neural networks 9. Advanced network architectures (autoencoders, Generative Adversarial networks) 10. Applications of o	deep learning (clas	sification,			
	segmentation, image reconstruction)					
01SUP	Start-up Project	KZ	2			
01SVK	Student's Scientific Conference		1			
	s the active participation of the student in one of the approved student conterences. The list of such conterences is defined by the co		2			
1 Combinatorial da	Game Theory mes, normal names - impartial and partizan names, 2. Multidimensional tic-tac-toe, Hales, lewett theorem, 3. Game tree, Zermelo's	∠ ∩ Theorem Strategy	∠ stealing 4			
Arithmetic on nor	mal games, equivalence on games, MEX principle, Sprague-Grundy theorem. 5. Strategic games, pure and mixed strategies, domini	ated strategies. 6.2	Zero-sum			
games, MAX-r	nin principle, von Neumann theorem. 7. Nash equilibrium, Nash theorem. 8. Cooperation of two players, Nash arbitration. 9. Coalition	al games, Shapley	value.			
01TG	Graph Theory	ZK	5			
1. Basic notion of	graph theory. 2. Edge and vertex connectivity (Menger Theorem). 3. Bipartite graphs. 4. Trees and forests. 5. Spanning trees (Matrix-	Tree Theorem). 6. E	Euler tours			
and Hamilton cycle	s. 7. Maximal and perfect matching. 8. Edge coloring. 9. Flows in networks. 10. Vertex coloring. 11. Plannar graphs (Kuratowski theor	em), vertex colorin	g of planar			
	graphs. 12. Spectrum of the adjacency matrix. 13. Extremal graph theory.	71/				
U1 I IN	Information I neory	CK	Z ntropy the			
source coding the	orem, and the channel coding theorem. These concepts provide a vital background for researchers in the areas of data compression	s or (information) e	1. controls.			
coulor couling the	and pattern recognition.	, orginal proceeding	,,,			
01TNM	Random Matrix Theory	ZK	2			
Theory of random n	natrices appeared first in 60's in the 20th century in connection with statistical physics and the theory of nucleis of atoms of heavy me	tals. The main inter	est of study			
is the distribution of	eigenvalues of symmetric random matrices. In the 21st century the results of theory of random matrices were applied in theoretical co	omputer science ar	nd numerics			
	for design of random algorithms.					
01UMIN	Probabilistic Models of Artificial Intelligence	KZ	2			
The course is devi	bled to the survey of methods used for uncertainty processing in the field of artificial metigence. The main alternion is paid to so-call	ed graphical Marko	ov models,			
01VUAM1	Research Project 1	7	6			
	Research project on the selected topic under the supervision. Supervision and regular checking of the research project under pre	paration.	Ū			
01VUAM2	Research Project 2	KZ	8			
	Research project on the selected topic under the supervision. Supervision and regular checking of the research project under pre	paration.				
01ZASIG	Analysis and Processing of Diagnostic Signals	ZK	3			
	Digital signal processing, signal transformations and filtrations, spectral and time-frequency analysis					
01ZLMA	Generalized Linear Models and Applications	Z,ZK	5			
1.Generalized line	ear models: exponential family, regularity conditions, score function. 2. Estimation of parameters: maximum likelihood estimates, nume Papheon, Eichor scoring algorithm, 2 Testing of models: asymptotic distribution of the score function and the MI E estimates, models of the score function and the MI E estimates, models of the score function and the MI E estimates and the score function and the MI E estimates and the score function and the MI E estimates and the score function and the MI E estimates and the score function and the MI E estimates and the score function and the MI E estimates and the score function and the MI E estimates and the score function and the MI E estimates and the score function	erical methods use	d for their			
diagnostic of influe	-reprison, Fisher-sconing algorithm. S. resting of models, asymptotic distribution of the score function and the MLE estimates, models c	parisons 5 Models	for binary			
data: logistic model	, normal model, Gumbel model, model parameters interpretation, odds ratio, tests, residuals. 6.Poisson regression: univariate and m	ultivariate Poisson	regression,			
	model parameters interpretation, tests and residuals. 7. Probability models for contingency tables, log-linear models.					
18AAD	Applied Data Analysis	Z	3			
A practically focuse	d subject that guides you through the topics of Big Data, neural networks, parallel computing, graph analysis, cloud technologies, de	ployment, and dev	elopment of			
404147	software or lo l'solutions.	1/7	4			
18AMTL	Matiab Applications	KZ	4 fractal act			
Systematic applica	generation. Analysis of trajectories, attractors and fractal sets including estimation of their properties.	chaotic systems a	i naciai sei			
18BI	Business Intelligence	KZ	2			
The aim of the sub	ject is to explain to the students different characteristics of production and analytical databases and a set of processes, know-how a	nd tools (not only)	to support			
decision-making act	ivities within the organization. In addition to the basic concept of BI, listeners will get acquainted with the general methodology of impler	mentation of custon	n algorithms			
	derived from other theories and subjects into the BI environment.					
18HA	Heuristic Algorithms	ZK	4			
Heuristic algorithms of optimization operates on discrete or continuous domains. Brutal force, stochastic, greedy, physically, biologically and sociologically motivated heuristic are						
	Monte Carlo Method	774	1			
	This course is devoted to the numerical method Monte Carlo and to its selected applications	<u>ک,۲۲</u>	4			
18501	SQL Applications	7	2			
	Practical realization of database system according to general principles of database analysis.		-			
18TFT	Financial Markets Theory	KZ	4			
Since financial instr	ument prices are unknown in advance to financial market participants, financial derivatives are currently being used as common instru	ments to eliminate	risks arising			
from price instab	lity of financial assets. The theory of financial markets uses the knowledge of mathematical analysis and statistics to manage the po	rtfolio of risk asset	s and the			
	valuation of sophisticated financial instruments in the form of derivatives such as swaps, forwards, futures and options.					

18ZDFT

Financial Markets Data Processing

The course enables students to combine knowledge of numerical methods, Matlab programming and financial mathematics to solve practical problems in finance such as portfolio optimization, risk management and valuation of financial derivatives, especially options of different types. Upon completion of the course the student will be able to formulate and numerically solve concrete problems in the given field and subsequently implement their solutions in practice.

ΚZ

4

For updated information see <u>http://bilakniha.cvut.cz/en/FF.html</u> Generated: day 2025-07-08, time 09:32.