

I_komplex vizsga előtt -- tantárgy leírások

I_General subjects

Title of the subject: Annual report 1 -- 2	Credit value: 10 -- 40
Title of the subject in Hungarian: Éves beszámoló 1 -- 2	
Type of the class: lecture / seminar / laboratory / consultation / <u>report</u> number of classes: <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained It is obligatory for PhD students to give an annual report on their research work before a scientific committee in the form of an English language lecture at the 'PhD Proceedings' conference of the doctoral school. The submission of a full-length conference paper of at least 4 pages in the given format approved by the supervisor is also necessary to complete this subject. See the education plan for more details.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN) according to the specific requirements	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes presentation skills, practice in scientific dispute, practice in summarizing scientific material, thesis extraction from scientific results	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tiny_mce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Education support activity 1 -- 3	Credit value: max. 3
Title of the subject in Hungarian: Oktatást segítő tevékenység 1 -- 3	
Type of the class: lecture / seminar / laboratory / consultation / <u>teaching</u> number of classes: <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained A maximum of 3 credits/semesters can be given for the support of education detailed in the education plan. The supervisor justifies the completion of the activities.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN) according to specific requirements	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes presentation skills, teaching skills, explanation skills, supervision skills	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Independent research study 1 -- 4	Credit value: 10 -- 40
Title of the subject in Hungarian: Önálló témafeldolgozás 1 -- 4	
Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: 12 / semester (weekly consultation) + continuous independent work <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / <u>project work</u> / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
The goal of this subject is the independent study of scientific topics needed to evaluate, compare, extend or contextualize the research methodologies and results of PhD students in agreement with the supervisor. For completing the subject, it is necessary to thoroughly study at least one relevant textbook or alternatively, at least 5 research articles. The completion of the subject is evaluated and justified by the supervisor based on the regular consultations and the submitted work report.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
at least 1 textbook or 5 research articles in agreement with the supervisor	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
independent studying, critical evaluation of scientific materials, summarizing scientific results	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinyMCE/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el-tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Introduction to scientific communication for doctoral students	Credit value: 6
Title of the subject in Hungarian: Bevezetés a tudományos kommunikációba PhD hallgatóknak	
Type of the class: online asynchronous class: 2 lectures + 2 seminars /module number of classes: 9*4=36 in the given semester, <i>language: English</i>	
Form of evaluation (exam / practical mark / project work / other): online exam quiz Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): -	
Required preliminary studies (<i>if any</i>): -	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The course offers a theoretical and practical introduction to scientific communication, intended for students in the broad fields of life sciences and engineering.</p> <p>Main topics include scientific articles, oral presentations, conference posters, review papers, dissertations, and grant proposals. The aim is to help students become conscious and effective scientific communicators—writers and presenters who move beyond imitation and develop a fundamental understanding of the publication process, including peer review, scientometrics, and related concepts.</p> <p>List of covered topics:</p> <ol style="list-style-type: none"> 0. Course overview 1. Introduction: the scientific message 2. Research paper 3. PPT and oral presentation 4. Conference: abstract, poster, participation 5. Dissertation and thesis booklet 6. Review article 7. Grant proposal 8. Course summary <p>In the theoretical lectures, we provide a unified framework for how scientific messages are constructed, transmitted, received, and evaluated. In the practical sessions, students engage in tasks focused on analyzing and producing scientific texts, with particular emphasis on the role of artificial intelligence methodologies.</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Lecture notes to this course (pdf, ppt or mp4 format)</p> <p>Angelika Hoffmann: Scientific Writing and Communication: Papers, Proposals, and Presentations, Oxford University Press (2021, 4th ed.), ISBN: 9780190063283</p> <p>Scott L. Montgomery: The Chicago Guide to Communicating Science, University of Chicago Press (2017, 2nd ed.), ISBN: 9780226144504</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
<ol style="list-style-type: none"> 1. Basics of scientific communication 2. Writing of <ol style="list-style-type: none"> a. scientific paper b. review article c. dissertation d. grant proposal 3. Preparation of <ol style="list-style-type: none"> a. Slideshow b. oral presentation 	

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- c. conference abstract
- d. conference poster

Subject owner (*name, position, scientific degree*): Sándor Pongor, professor, PhD, MHAS

Lecturer(s), instructor(s) involved in the teaching of the subject, if any (*name, position, scien. degree*):
János Juhász, assistant professor, PhD; Csaba István Pongor, research fellow, PhD

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Participation at public PhD defense 1 -- 4	Credit value: 1 -- 4
Title of the subject in Hungarian: Részvétel nyilvános PhD védésen 1 -- 4	
Type of the class: lecture / seminar / laboratory / consultation / <u>defense</u> number of classes: <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
This subject can be fulfilled by the documented participation at a PhD defense and a written summary of the event of 1000-2000 characters.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
n. a.	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
summary of scientific results	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinyMCE/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el-tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Participation at home PhD defense 1 -- 4	Credit value: 1 -- 4
Title of the subject in Hungarian: Részvétel házi vitán 1 -- 4	
Type of the class: lecture / seminar / laboratory / consultation / <u>defense</u> number of classes: <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
This subject can be fulfilled by the documented participation at a preliminary defense and a written summary of the event of 1000-2000 characters.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
n. a.	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
summary of scientific results	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el-tt.pdf?u=1g1CnM	

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Title of the subject: Publication activity 1 -- 4	Credit value: 20/30/50
Title of the subject in Hungarian: Publikációs tevékenység	
Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: continuous work <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): accepted publication Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this subject is to motivate the whole process of research work of PhD students from problem statement and research design through implementation, evaluation, documentation to peer reviewed publication. Credits are given to accepted publications in the following categories (see the education plan for details):</p> <ul style="list-style-type: none"> • journal paper with impact factor: max. 50 credits • Scopus journal paper with Scimago Q1-Q4 rank but without impact factor: max. 30 credits • peer reviewed full length conference paper: max. 20 credits • peer reviewed conference abstract with oral or poster lecture at an international conference: 20 credits only for the presenter student <p>The credits can be approved by the head of the doctoral school or the heads of programmes if the journal/conference is relevant to the research fields of the doctoral school and the publication is properly registered to the official MTMT database.</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
according to the specific requirements	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
research design and implementation, research evaluation, publication skills, publication administration	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

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Title of the subject: Research seminar 1 -- 2	Credit value: 6 -- 12
Title of the subject in Hungarian: Kutatószeminárium 1 -- 2	
Type of the class: lecture / <u>seminar</u> / laboratory / consultation number of classes: 12 seminars / semester <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / <u>project work</u> / other): scientific lecture Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained The main goal of the research seminar for the students is to learn how to present their results in the form of a brief lecture. During the seminars, students listen to the lectures of each other and also to the lectures of invited senior researchers. Through these examples, students learn how to efficiently summarize their scientific work until the formation of appropriate thesis points expected later in the dissertation. Beyond presentation skills, it is also an important aim to improve the organization and clarification of research goals and methods. It is expected from all students to actively participate in the critical discussion after the presentations.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
According to the specific topics of the lectures	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes presentation skills, interdisciplinary thinking, critical thinking, practice in scientific dispute, practice in summarizing broad scientific material, thesis extraction from scientific results	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>): Prof. Dr. Péter Szolgay, DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

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Title of the subject: Teaching practice 1 -- 12	Credit value: 2 -- 16
Title of the in Hungarian: Tanítási gyakorlat 1 -- 12	
Type of the class: lecture / seminar / laboratory / consultation / <u>teaching</u> number of classes: <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained This subject can be completed for the fulfillment of teaching at lab exercises or seminars. 2 credits are given for one contact hour per week.	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN) according to specific requirements	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes presentation skills, teaching skills, explanation skills	
Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>):	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el-tt.pdf?u=1g1CnM	

II_Subjects of the Complex exam / Theoretical part exam, compulsory elective subjects

Title of the subject: Advanced Topics in Systems and Control Theory	Credit value: 6
Title of the subject in Hungarian: A rendszer- és irányításmélet modern eszközei	
Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: 10x 90min in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / practical mark / <u>project work</u> / other): Further (<i>specific</i>) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any): <i>Computer Controlled Systems (BSc)</i>	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight important results in nonlinear systems' and control theory and robotics. The subject of this course will be discussed in weekly consultations on the following topics:</p> <p>I. Preliminaries and missing topics from the linear systems theory</p> <ul style="list-style-type: none"> - Discretization techniques: explicit/implicit Euler approach, the zero-order hold, etc. - System operator, Gram-matrix, observability, controllability of linear time-varying systems - Kalman decomposition and its geometric view, Luenberger normal form - Luenberger observer for MIMO systems - Unknown-input observability, of linear systems - Basic control approaches, load estimation, and servo controller - Optimal control and optimal state observation and the LQG controller loop - Least mean squares parameter estimation (state-space, ARMAX, static models) <p>II. Input-affine state-space models [1, Chapter 1]</p> <ul style="list-style-type: none"> - Mathematical preliminaries: the "Lie-differential algebra" - Distributions - Unobservability, controllability and their geometric view - State-space transformation, relative degree, normal form of SISO models, zero-dynamics - I/O linearization, exact linearization - Model classes and dynamic model extensions <p>III. Dissipativity theory and special cases [2, Chapter 2]</p> <ul style="list-style-type: none"> - Lyapunov theory, Lyapunov functions, domain of attraction - La Salle's theorem, advanced stability criteria - Induced L2 norm, small gain theory - Passivity, feedback equivalence to a passive system, minimum phase systems, - Dynamic invertibility, unknown-input reconstruction, asymptotic output tracking <p>IV. Applications in robotics [3]</p> <ul style="list-style-type: none"> - Feedback linearization of (Port-)Hamiltonian systems - Inversion-based control vs. feedforward compensation control - Actuator dynamics, voltage control vs. back-emf compensation control - Simulation examples on a 4DOF robotic arm <p>V. Advanced Matlab/Simulink tools and techniques and their usage</p> <ul style="list-style-type: none"> - Weekly demonstration and project work 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>[1] Alberto Isidori. Nonlinear control systems. Springer-Verlag London, ed3 edition, 1995.</p> <p>[2] Carsten W. Scherer and Siep Weiland. Linear matrix inequalities in control. Technical University of Delft, The Netherlands, Delft, 2005.</p> <p>[3] Mark W. Spong, Seth Hutchinson, and M. Vidyasagar. Robot modeling and control. John Wiley & Sons, Ltd, 2nd edition edition, 2020.</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Analysis of complex nonlinear systems, understanding and manipulating the behavior of such physical biological, social, etc., process systems.	

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Subject owner (<i>name, position, scientific degree</i>): Prof. Dr. Gábor Szederkényi, DSc
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>): Dr. Péter Polcz, PhD
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

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Title of the subject: BIOINFORMATICS	Credit value: 6
Title of the subject in Hungarian: BIOINFORMATIKA	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 12 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (<u>exam</u> / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): -	
Required preliminary studies (<i>if any</i>): -	
The subject of the course is an advanced theoretical and practical introduction to bioinformatics with special regard to the analysis of DNA and protein sequences. The goal is to provide students a good, up to date understanding of the contemporary cross-cutting issues of bioinformatics as well as knowledge of the main techniques and algorithms. The topics covered will include:	
<ul style="list-style-type: none"> ● Theory of bioinformatics data, core data types, ● Core operations of bioinformatics: aggregation, comparison, annotation ● Concepts of similarity, different similarity searching techniques, ● Pairwise sequence alignment algorithms ● Multiple sequence alignment algorithms, ● BLAST algorithm, its evaluation, and practical applications ● Biological databases ● Fundamentals of phylogenetics analysis ● Next generation sequencing (NGS) techniques ● Genome assembly techniques and algorithms ● Genome annotation techniques and algorithms ● Fundamentals of metagenomics analysis and techniques ● Mutation analysis, variant search techniques ● Contemporary medical applications of NGS ● Modern data representations and frameworks (i.e., network analysis docker containers, working in HPC environment, SPARK). ● Designing capability of complex pipelines. ● Modern machine learning algorithms and visualization in biology (CART, LASSO, T-SNE, PCA, etc.). ● Complex network representations and their applications 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<ol style="list-style-type: none"> 1. Arthur M. Lesk: Introduction to Bioinformatics, 4e, Oxford University Press, 2013, ISBN 9780199651566 2. David W. Mount: Bioinformatics: Sequence and Genome Analysis, 2e, Cold Spring Harbor, 2004, ISBN 0- 879-69712-1 3. Molecular Data Analysis Using R (Csaba Ortutay, Zsuzsanna Ortutay) ISBN: 978-1-119-16502-6 4. Next-Generation Sequencing Data Analysis (Xinkun Wang; CRC Press 2016) ISBN-10: 1482217880 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
<p>a) knowledge</p> <ul style="list-style-type: none"> - understanding the chemical biology of the living matter (the DNA and protein level regulatory processes in living cells and organisms) - knowing the diagnostic tools of living organisms (genome sequencing and sequencing based diagnostic techniques) - knowing the data acquisition and data processing methods (of biotechnology and molecular medicine) 	

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- knowledge of the informatics infrastructure relevant for biotechnology
 - knowledge of bioinformatics applications in diagnostics and bioanalytic
- b) skills
- can design and manage bioinformatics databases, and can apply modern database-management tools
 - capability of designing and developing new algorithms and complex data analysis pipelines

Subject owner (*name, position, scientific degree*): Prof. Dr. PONGOR Sándor, MHAS

Lecturer(s), instructor(s) involved in the teaching of the subject, if any (*name, position, science. degree*):

Dr. LIGETI Balázs PhD, associate the professor,

Dr. JUHÁSZ János PhD, assistant of the professor,

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Title of the subject: Cell technology and experimental cell models	Credit value: 6
Title of the subject in Hungarian: Sejttechnológia és sejtes kísérleti modellek	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 16 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Q & A session after presentation Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): elaboration of specific topics in form of presentations (16)	
Required preliminary studies (<i>if any</i>): NA (NOT compulsory)	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ol style="list-style-type: none"> 1) Common and unique characteristics in the cell cycle of bacteria, yeast, animal/human cells (morphology, regulation, evaluating methods) 2) Common and unique characteristics in gene expression of bacteria, yeast, animal/human cells 3) Organization and regulation of the genetic material in procaryotes and eukaryotes 4) Principles of cell-cell communication in eukaryotes 5) Transformation of and protein expression in bacterial cells 6) Evaluation and modelling of bacterial-expressed transgenic proteins 7) Spatial and temporal organization of bacterial colonies 8) Cell cycle regulation in yeast 9) Population dynamics in yeast cultures 10) Experimental and computational models for cell-cell interactions in yeast colonies 11) Regulation of the circadian clock 12) Evaluation of treatments' effect in experimental tumor models on the level of cell-viability, apoptosis and activation/inhibition of signaling pathways 13) Models for tumor cell migration (experimental setup and evaluation) 14) RNA interference in tumor cell models 15) 3D models of cancer (spheroids, matrices, scaffolds etc.) 16) Translational approaches in life sciences 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Lewins's Genes XII (ISBN: 978-1284104493)</p> <p>Karp's Cell and Molecular Biology 9th Edition (ISBN: 978-1119598169)</p> <p>Castrillo, J.I., Oliver, S.G. (2011). Yeast Systems Biology. Methods in Molecular Biology, vol 759. Humana Press. (PMID: 21863478; DOI: 10.1007/978-1-61779-173-4_1)</p> <p>Alberts, B. (ed): Molecular biology of the cell. (ISBN: 978-1315735368)</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Aim of the course is to provide a general overview of the organization of cells and cell cultures. It puts special emphasis on cell growth and regulation from procaryotic organisms to tumor cells. Accordingly, gathering theoretical background knowledge and technical knowhow as well as improving the ability to make informative and scientifically accurate presentation are stressed during the course.	
Subject owner (<i>name, position, scientific degree</i>): Attila Csikász-Nagy, professor, DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Cellular and Convolutional Neural Networks	Credit value: 6
Title of the subject in Hungarian: Celluláris és Konvolúciós Neurális Hálózatok	
Type of the class: <u>lecture</u> / <u>seminar</u> / laboratory / consultation number of classes: 24 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ol style="list-style-type: none"> 1. Notation, definitions, and mathematical foundation 2. Characteristics and analysis of simple CNN templates 3. Simulation of the CNN dynamics 4. Binary CNN characterization via Boolean functions 5. Uncoupled CNNs: unified theory and applications 6. Introduction to the CNN Universal Machine 7. Back to basics: Nonlinear dynamics and complete stability 8. The CNN Universal Machine (CNN-UM) 9. Template design tools 10. CNNs for linear image processing 11. Coupled CNN with linear synaptic weights 12. Uncoupled standard CNNs with nonlinear synaptic weights 13. Standard CNNs with delayed synaptic weights and motion analysis 14. Visual microprocessors – analog and digital VLSI implementation 15. of the CNN Universal Machine 16. CNN models in the visual pathway and the “Bionic Eye” 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
Cellular Neural Networks and Visual Computing: Foundations and Applications by Leon O. Chua (Author), Tamas Roska (Author) Publisher : Cambridge University Press (August 22, 2005) ISBN-13: 978-0521018630 ISBN-10: 0521018633	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (<i>name, position, scientific degree</i>): Zarándy, Ákos, prof. DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Creation and applications of LLMs	Credit value: 6
Title of the subject in Hungarian: Nagy nyelvmodellek létrehozása és alkalmazásai	
Type of the class: <u>lecture</u> / <u>seminar</u> / laboratory / consultation number of classes: 12. in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (<u>exam</u> / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ul style="list-style-type: none"> - Fundamentals of LLMs: understanding the architecture, training methods, and key components of LLMs - Data preprocessing for LLMs: techniques and best practices for preparing datasets for training LLMs - Model training and fine-tuning: in-depth exploration of training LLMs and fine-tuning them for specific applications - Neural network architectures: examining transformer models and other neural network architectures used in LLMs - Performance optimization: strategies for optimizing LLM performance, including hardware considerations and software optimizations - Natural language understanding and generation: techniques for building applications that understand and generate human language - Integration of LLMs in applications: best practices for integrating LLMs into real-world applications and systems - Language model evaluation metrics: methods for evaluating the performance and accuracy of LLMs - Scalable deployment of LLMs: approaches to deploying LLMs at scale, including cloud-based and edge deployment strategies - Security and privacy in LLMs: ensuring data security and user privacy when developing and deploying LLM-based applications - Future trends and innovations in LLMs: exploring cutting-edge research, emerging trends, and the future direction of LLM technology 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<ul style="list-style-type: none"> - Shervin Minaee, Tomas Mikolov, Narjes Nikzad, Meysam Chenaghlu, Richard Socher, Xavier Amatriain, Jianfeng Gao (2024) Large Language Models: A Survey. arXiv:2401.14423 - Shengyu Zhang, Linfeng Dong, Xiaoya Li, Sen Zhang, Xiaofei Sun, ShuheWang, Jiwei Li, Runyi Hu, Tianwei Zhang, Fei Wu and GuoyinWang (2024) Instruction Tuning for Large Language Models: A Survey. arXiv:2308.10792v8 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
technical knowledge and skills, analytical and problem-solving skills, ethical and responsible ai development, integration and deployment skills, communication and collaboration, innovation and creativity	
Subject owner (<i>name, position, scientific degree</i>): Gábor PRÓSZÉKY, PhD / DSc / MHAS	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>): Attila NOVÁK, PhD	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Language technology and neural networks	Credit value: 6
Title of the subject in Hungarian: Nyelvtechnológia és neurális háló	
Type of the class: lecture / seminar / laboratory / consultation number of classes: N: 3/0/2, L: 0/0/0 pro week in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / practical mark / project work / other): Further (specific) forms to be applied in knowledge testing (if any):--	
Required preliminary studies (if any)--	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ul style="list-style-type: none"> • A különféle nyelvek és írások formai sajátosságai. • A formálisnyelv- és az automataelmélet alkalmazásai a nyelvtechnológiában. • A számítógépes nyelveírás szimbolikus, statisztikai és neurálhálós közelítése. • A neurális háló megjelenése a nyelvtechnológiában. • Vektoros reprezentációk, vektorterek. • A szóbeágyazási módszerek kialakulása. • A szóbeágyazás alkalmazásai. • Magasabb szintű vektorreprezentációk. • Figyelmi mechanizmusok, transzformerek. • Enkóderek és dekóderek. • A generatív MI alkalmazásai a nyelvtechnológiában. • Finomhangolás és nyelvi alkalmazások. • Promptkészítési megfontolások. • A konfabulálás problematikája. 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<ol style="list-style-type: none"> 1. Jurafsky, D., & Martin, J. H. (2021). <i>Speech and Language Processing</i>. Pearson. 2. Mikolov, T., Chen, K., Corrado, G., & Dean, J. (2013). Efficient estimation of word representations in vector space. arXiv preprint arXiv:1301.3781. 3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. <i>Advances in Neural Information Processing Systems</i>. 4. Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding. arXiv preprint arXiv:1810.04805. 5. Radford, A., Wu, J., Child, R., Luan, D., Amodei, D., & Sutskever, I. (2019). Language models are unsupervised multitask learners. <i>OpenAI</i>. 6. Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., ... & Amodei, D. (2020). Language models are few-shot learners. arXiv preprint arXiv:2005.14165. 7. Gao, T., Fisch, A., & Chen, D. (2021). Making pre-trained language models better few-shot learners. arXiv preprint arXiv:2012.15723 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (name, position, scientific degree): Prof. Dr. Prószéky Gábor DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tiny_mce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Nano and Quantum Technology	Credit value: 6
Title of the subject in Hungarian: Nano és kvantum technológia	
Type of the class: lecture / seminar / laboratory / consultation number of classes: 12 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>): Basic knowledge of Physics and Material Science	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>Course Description: Nanotechnology, Nanoelectronics, and Quantum Hardware Foundations</p> <p>This course provides a comprehensive technological and hardware-oriented background for nano and quantum technologies, designed for students with no prior experience in micro- or nanoelectronics. The class explores how controlling matter at the atomic and molecular scale enables both classical and quantum engineering breakthroughs of the 21st century.</p> <p>In the first half of the course, we introduce microelectronic and nanofabrication technologies, exploring how devices are built and measured at the nanometer and even atomic level. In the second half, we expand the discussion to the intersection of nanoscience and quantum science, examining how nanoscale materials and devices form the physical basis of quantum computation, communication, and sensing.</p> <p>By the end of the course, students will be equipped to connect theoretical quantum-information concepts—such as qubits, superposition, and entanglement—to the underlying hardware implementations that make them possible.</p> <p>Topics Covered</p> <ul style="list-style-type: none"> • Feynman’s Vision – “There’s Plenty of Room at the Bottom” • Moore’s Law and the Limits of Scaling – Evolution of microelectronic technologies and the transition from classical to quantum regimes. • Nanofabrication Fundamentals – Layer deposition, lithography, and atomic-scale manipulation techniques. Anatomy of a modern semiconductor and quantum device fabrication facility. • Top-Down and Bottom-Up Approaches – From patterning nanoscale circuits to self-assembly of quantum dots and molecular structures. • Nanomaterials and Quantum Platforms – Nanoparticles, nanotubes, graphene, and 2D materials. • Quantum Devices and Architectures – Introduction to superconducting qubits, spin qubits, Rydberg atoms and photonic quantum circuits. • Nanoscale Interfaces and Quantum Biosystems, Quantum sensing • Cryogenic and Measurement Technologies – Basics of cryogenics and instrumentation for quantum experiments. 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Feynman, R. P. (1960). <i>“There’s Plenty of Room at the Bottom.”</i> — <i>Engineering and Science</i>, 23(5): 22–36.</p> <p>Binns, Chris. <i>Introduction to nanoscience and nanotechnology</i>. John Wiley & Sons, 2021.</p> <p>Waser, Rainer, ed. <i>Nanoelectronics and information technology: advanced electronic materials and novel devices</i>. John Wiley & Sons, 2012.</p> <p>Binns, Chris. <i>Introduction to nanoscience and nanotechnology</i>. John Wiley & Sons, 2021.</p> <p>Devoret, M. H., & Schoelkopf, R. J. (2013). <i>“Superconducting circuits for quantum information: An</i></p>	

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outlook.” Science, 339(6124), 1169–1174.

Easttom, Chuck. *Hardware for Quantum Computing*. New York: Springer, 2024.

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Knowledge of nanotechnologies, Lab technologies, characterization and measurement technologies

Subject owner (*name, position, scientific degree*): Gyorgy Csaba, PhD / DSc / MHAS

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Neurobiology	Credit value: 6
Title of the subject in Hungarian: Neurobiológia	
Type of the class: lecture / seminar / laboratory / consultation number of classes: 60 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The subject provides hints and concepts about the operation of the neuronal networks underlying responses to internal and/or external cues. The responses cover a broad range expanding from simple reactions to complex behavioral manifestations, which are exemplified and characterized by experimental, modeling, and diagnostic tools at both healthy and pathological conditions. The gained knowledge is expected to provide ideas for the developing fields of machine-based information processing, machine-biological tissue interfaces, information technology-based diagnostics, and therapy of neurological diseases. Major topics of the course:</p> <ol style="list-style-type: none"> 1. Olfaction – Being prepared to detect all types of chemical compounds and to figure out the odor by the activity pattern of the neurons. 2. How do we identify the objects we see? Information processing along the visual pathway. 3. Problems to be solved when moving robots are built. Levels of motor control. 4. Involuntary and voluntary movement control. 5. Intercellular communication in the nervous system. Formation of cellular networks. Directions of information flow. 6. Storing information in the central nervous system. 7. The Central Thalamus: Gatekeeper or Processing Hub? 8. The therapeutic potential of neural stem cells. 9. Optogenetics revolutionized how we study the brain. 10. Technological innovations in neurosurgery. 11. What can we learn about network operation by studying neurological diseases? 12. Recording cellular and/or network activity and correlating them with various brain states and/or behavioral manifestations. 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<ol style="list-style-type: none"> 1. Liposits Z, Kallo I (2011) Basics of Neurobiology = Neurobiológia alapjai (ISBN 978-963-308-034-4) Könyvfejezet/Oktatási anyag 2. Imre Kalló with the contribution of Tamás Freund, Zolt Liposits, Zoltán Nusser, László Acsády, Szabolcs Káli, József Haller, Zsófia Maglóczky, Nórbert Hájos, Emilia Madarász, György Karmos, Miklós Palkovits, Anita Kamondi, Lóránd Erőss, Róbert Gábrriel, Zoltán Kisvárday (2011) Introduction to Functional Neurobiology = Bevezetés a funkcionális neurobiológiába (ISBN 978-963-308-041-2) Könyvfejezet/Oktatási anyag 3. Kandel, E.R., Schwartz J.H., and Jessel, T.M.: Principles of Neural Science, Fifth Edition, Elsevier, ISBN-13: 978-0071390118 4. Irwin B. Levitan, Leonard K. Kaczmarek: The Neuron: Cell and Molecular Biology, 2015, ISBN: 9780199773893 5. Per E. Roland: Brain Activation, Second Edition, ISBN-13: 978-0471396307 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
a) Knowledge - Understanding	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

- the basic experimental/examination approaches used to collect data from the CNS for research, diagnostic and therapeutic purposes
 - the structure and function of major subdivisions of the CNS, and the neuronal networks operating within these subdivisions
 - the pathological changes in the operation of CNS and the employed diagnostic/therapeutic approaches
- b) skills
- reviewing the literature and giving short presentations from selected topics

Subject owner (*name, position, scientific degree*): **Imre Kalló**, Associate Professor, MD, PhD

Lecturer(s), instructor(s) involved in the teaching of the subject, if any (*name, position, scien. degree*):

Tamás Freund, Head of the Hungarian Academy of Sciences, PhD, DSc.

Imre Kalló, Associate Professor, MD, PhD

Zsolt Liposits, Professor, MD, PhD, DSc.

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Parallel Computing Architectures	Credit value: 6
Title of the subject in Hungarian: Parallel Computing Architectures	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 24 in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / <u>practical mark</u> / project work / other): Further (<i>specific</i>) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
The goal of this course is to highlight recent results in Parallel Computing Architectures and Array Computing Models of computations, Evaluation criterias, Effect of wiring Systolic processor arrays, Low level Parallelism, pipeline technology To RISC-V Harvard architectures, New DSP architectures CNN arrays, analog computing Emulated digital CNN implementations Neuromorph Computations FPGAs -GPGPUs From HLS to HW - Turing-Church thesis Bus systems Fast memory systems –Cash Memories	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
John L. Hennessy, David A. Patterson, "Computer Architecture: A Quantitative Approach" 6th Edition David A. Patterson, John L. Hennessy, "Computer Organization and Design: The Hardware Software Interface". P.Arató, T.Visegrády,I.Jankovits, High Level Synthesis of Pipelined Datapaths, J.Wiley & Sons, 2001. Fejér, Attila ; Nagy, Zoltán ; Benois-Pineau, Jenny ; Szolgay, Péter ; de Rugy, Aymar ; Domenger, Jean-Philippe Hybrid FPGA–CPU-Based Architecture for Object Recognition in Visual Servoing of Arm Prosthesis JOURNAL OF IMAGING 8 : 2 p. 44 (2022) Zarandy, A ; Horvath, A ; Szolgay, P, CNN Technology-Tools and Applications IEEE CIRCUITS AND SYSTEMS MAGAZINE 18 : 2 pp. 77-89. , 13 p. (2018) Nagy, Z ; Nemes, Cs ; Hiba, A ; Csík, Á ; Kiss, A ; Ruzinkó, M ; Szolgay, P Accelerating unstructured finite volume computations on field-programmable gate arrays CONCURRENCY AND COMPUTATION: PRACTICE AND EXPERIENCE 26 : 3 pp. 615-643. , 29 p. (2014)	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (<i>name, position, scientific degree</i>): Prof. Péter Szolgay, DSc	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>): Zoltán Nagy PhD	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinyMCE/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

III_Subjects of the PhD Supervisors

Title of the subject: Advanced Neural Networks	Credit value: 6
Title of the subject in Hungarian: Új módszerek neurális hálózatok tanításában	
Type of the class: <u>lecture</u> / seminar / <u>laboratory</u> / consultation	
number of classes: 10 in the given semester,	
<i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / <u>project work</u> / other):	
Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>): Python programming, basics of neural network	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight recent advancements in the theory of neural networks and their applications.</p> <p>During the lectures and labs we will discuss, implement and analyze both the basic concepts and advanced research topics in key directions of neural networks. Discussed topics include:</p> <p>Recent architectures in segmentation problem</p> <p>Recent architectures in object detection</p> <p>Transformer networks</p> <p>Adversarial samples</p> <p>Generative adversarial networks and their training</p> <p>Wasserstein GANs</p> <p>Multitasking networks (gradient surgery)</p> <p>Domain adaptation and domain adversarial neural networks</p> <p>Visualization of neural network decisions and explainable AI</p> <p>Training with a low number of input samples: one-shot learning, data augmentation</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Goodfellow, I., Bengio, Y., & Courville, A. (2016). <i>Deep learning</i>. MIT press.</p> <p>Wani, M. A., Bhat, F. A., Afzal, S., & Khan, A. I. (2020). <i>Advances in deep learning</i>. Springer.</p>	
List of those required professional competences, competence elements to the development of which the	

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subject characteristically, materially contributes

Programming

Theoretical knowledge of differentiation and optimization

Neural networks

Subject owner (*name, position, scientific degree*): András Horváth, PhD / DSc / MHAS

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Advanced Sensory Robotics	Credit value: 6
Title of the subject in Hungarian: Advanced Sensory Robotics	
<p>Type of the class: lecture / seminar / laboratory / consultation</p> <p>number of classes: 24 in the given semester,</p> <p><i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
Form of evaluation (exam / practical mark / project work / other): none ;Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): none	
Required preliminary studies (<i>if any</i>): none	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight recent results in sensory robotics-oriented applications. Local and guest lecturers will present the basic concepts and advanced research topics in key directions of systems biology. Discussed topics include:</p> <ul style="list-style-type: none"> Machine learning in robotics Reinforcement learning Memristor crossbar networks Medical signal processing Image processing Deep learning Deep neural networks Prosthetics Rapid prototyping methods Soft robotics Human-machine interfaces Augmented reality Sensors and actuators Swarm intelligence GPU based algorithms Exoskeletons in rehabilitation Simultaneous localization and mapping Depth cameras Distant measurement sensors 	
<p>List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)</p>	
<p>Jafari, Amir, and Nafiseh Ebrahimi, eds. <i>Soft Robotics in Rehabilitation</i>. Academic Press, 2021. Plaat, Aske. "Deep Reinforcement Learning." <i>arXiv preprint arXiv:2201.02135</i> (2022).</p>	
<p>List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes</p>	
<p>Subject owner (name, position, scientific degree): Dr. György Gábor Cserey, habil. associate professor, PhD</p>	
<p>Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM</p>	

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Title of the subject: Advanced Systems Biology	Credit value: 6
Title of the subject in Hungarian: Advanced Systems Biology	
<p>Type of the class: Lecture / seminar / laboratory / consultation</p> <p>number of classes: 24 in the given semester,</p> <p><i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
<p>Form of evaluation (exam / practical mark / project work / other):</p> <p>Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):</p>	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight recent results in systems biology-oriented applications. Local and guest lecturers will present the basic concepts and advanced research topics in key directions of systems biology. Discussed topics include:</p> <p>Dynamical Systems Theory Cell cycle modelling DNA nanotechnology Interaction databases network visualization Signalling network, multiomics Proteomics Metabolic networks Metabolomes: Chromosome segregation Logic approaches Agent-based modeling Parameter Estimation Evolutionary genomics Origin of life Bacterial cell biology Autophagy MAP kinase signaling Computational neuroscience Computational immunology Mutational signatures Circadian clock High content microscopy Systems Ecology</p>	
<p>List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)</p>	
<p>Alon, U. (2019). An introduction to systems biology: design principles of biological circuits. CRC press. Ingalls, B. P. (2013). Mathematical modeling in systems biology: an introduction. MIT press. Klipp, E., Liebermeister, W., Wierling, C., & Kowald, A. (2016). Systems biology: a textbook. John Wiley & Sons.</p>	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Voit, E. (2017). A first course in systems biology. Garland Science.

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Subject owner (*name, position, scientific degree*): Prof. Dr. Csikász-Nagy Attila, full professor, DSc

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinyce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Data processing in a neuropsychiatric approach	Credit value: 6
Title of the subject in Hungarian: Adatfeldolgozás neuropszichiátriai keretben	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation	
number of classes: 12 in the given semester,	
<i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / <u>practical mark</u> / project work / other):	
Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p><Preferably a list of 10-15 topics representing the planned weekly schedule of the course> eye tracking and cognitive engagement; relationship between location and scanning during Rorschach process; the relationship between determinants and eye movement; content and inkblot scanning; different styles of visual scanning based on their personal preferences and psychological traits; different types of visual scanning based on psychiatric symptoms; effort, engagement, and eye movements; average fixations duration; average fixations number; average saccades amplitude</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Ales, F., Giromini, L., & Zennaro, A. (2020). Complexity and cognitive engagement in the Rorschach task: An eye-tracking study. <i>Journal of personality assessment</i>, 102(4), 538-550.</p> <p>Dauphin, B., Greene, H. H., Juve, M., Boyle, M., & Day-Suba, E. (2024). Seeing eye-to-eye: Internal consistencies of eye-tracking variables during Rorschach administration. <i>Rorschachiana</i>, 45(1), 4.</p> <p>Roy, A. K., Nasreen, S., Majumder, D., Mahadevappa, M., Guha, R., & Mukhopadhyay, J. (2019, July). Development of objective evidence in Rorschach ink blot test: an eye tracking study. In <i>2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)</i> (pp. 1391-1394). IEEE.</p> <p>Vitolo, E., Giromini, L., Viglione, D. J., Cauda, F., & Zennaro, A. (2021). Complexity and cognitive engagement in the Rorschach task: An fMRI study. <i>Journal of Personality Assessment</i>, 103(5), 634-644.</p> <p>Schott, G. D. (2014). Revisiting the Rorschach ink-blot: from iconography and psychology to neuroscience. <i>Journal of Neurology, Neurosurgery & Psychiatry</i>, 85(6), 699-706.</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (<i>name, position, scientific degree</i>): Dr Csigó Katalin, PhD	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Domain Specific Languages in High Performance Computing	Credit value: 6
Title of the subject in Hungarian: Domén-Specifikus Nyelvek Nagyteljesítményű Számításokban	
Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: 24 in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / <u>practical mark</u> / project work / other): none; Further (specific) forms to be applied in knowledge testing (if any): none	
Required preliminary studies (if any): none	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>High Performance Computing applications: legacy C/C++/Fortran codes</p> <p>High Performance Computing applications: new generation of Python libraries</p> <p>Parallel Programming models used on CPUs: MPI, OpenMP</p> <p>Parallel Programming models used on GPUs: OpenMP, OpenACC, SYCL, CUDA, etc</p> <p>Defining a domain specific abstraction: embedded in C/Python</p> <p>Mapping a DSL to different hardware: case study of OP2/OPS</p> <p>Automatic code generation: boilerplate code + user code</p> <p>Automatic code generation: traditional text-based scriping</p> <p>Automatic code generation: compiler techniques - case study of OP-CG</p> <p>Automatic code generation: using LLVM and MLIR</p>	
List of the most important 2–5 pieces of required and recommended literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Required: M.B. Giles, G.R. Mudalige, Z. Sharif, G. Markall, P.H.J Kelly. Performance Analysis of the OP2 Framework on Many-core Architectures . (2011). ACM SIGMETRICS Perform. Eval. Rev. 38 (4) ISSN 0163-5999</p> <p>Required: I.Z. Reguly, G.R. Mudalige, M.B. Giles, D. Curran and S. McIntosh-Smith, The OPS Domain Specific Abstraction for Multi-Block Structured Grid Computations . In proceedings of the 4th international workshop on Domain-Specific Languages and High-Level Frameworks for High Performance Computing (WOLFHPC '14).Held in conjunction with IEEE/ACM Supercomputing 2014(SC'14).</p> <p>Recommended: Hager, G., & Wellein, G. (2010). Introduction to high performance computing for scientists and engineers. CRC Press. ISBN 978-1439811924</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
<p>Understanding of the structure of science and engineering codes, the way they are implemented in computer code</p> <p>Ability to understand levels of abstraction provided by various DSLs and libraries</p> <p>Experience with coding up simple parallel algorithms running on parallel architectures</p> <p>Understanding of differences between different hardware and how this is reflected in software</p> <p>Ability to design automated steps from high-level abstraction to low level implementation</p>	
Subject owner (name, position, scientific degree): Dr. István Zoltán Reguly, Professor, PhD	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tiny_mce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Electromagnetic retrodirective reflector engineering	Credit value: 6
Title of the subject in Hungarian: Elektromágneses retrodirektív felületek tervezése	
Type of the class: consultation	
number of classes: 12 in the given semester	
Form of evaluation (exam / practical mark / project work / other): project work	
Further (specific) forms to be applied in knowledge testing (if any): -	
Required preliminary studies (if any): -	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ul style="list-style-type: none"> - Introduction: reflection, refraction and scattering of electromagnetic waves - Van Atta array improvement with checkerboard array - Periodic structures, unit cell engineering and optimization - Checkerboard arrays from microwave to optical frequencies - Retrodirective surface design based on Phase Gradient Metasurfaces - Retrodirective surface design based on Transformation Optics - Comparison and electrical efficiency of different retrodirective solutions 	
List of the most important 2–5 pieces of required and recommended literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN):	
<ul style="list-style-type: none"> - Constantine A. Balanis, Antenna Theory: Analysis and Design, 3rd Edition, ISBN: 0-471-66782-X, p. 393-399 - David M. Pozar, Microwave engineering—4th ed., 2011 - Alharbi, M.; Alyahya, M.A.; Ramalingam, S.; Modi, A.Y.; Balanis, C.A.; Birtcher, C.R. Metasurfaces for Reconfiguration of Multi-Polarization Antennas and Van Atta Reflector Arrays. Electronics 2020, 9, 1262. https://doi.org/10.3390/electronics908126 - Fan Yang; Yahya Rahmat-Samii, “Electromagnetic Band Gap Structures in Antenna Engineering”, ISBN: 9780521889919 - Arbabi, A., Arbabi, E., Horie, Y. et al. Planar metasurface retroreflector. Nature Photon 11, 415–420 (2017). https://doi.org/10.1038/nphoton.2017.96 - Ma, Y., Ong, C., Tyc, T. et al. An omnidirectional retroreflector based on the transmutation of dielectric singularities. Nature Mater 8, 639–642 (2009). https://doi.org/10.1038/nmat2489 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes:	
<ul style="list-style-type: none"> - Electromagnetic theory - Circuit theory - Antenna design - Numerical design tools in electromagnetic engineering (Ansys-HFSS, CST) 	
Subject owner (name, position, scientific degree): Zsolt Szabó, Prof., DSc / MHAS	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Experimental approaches in quantitative biology	Credit value: 5
Category of the subject: required / <u>optional</u> (strike out as appropriate!)	
Extent of the <u>theoretical</u> or practical nature of the subject, "educational character": 100 (credit%)	
Type of the class: <u>lect.</u> / sem. / pract. / cons. and number of classes: ? in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Further (specific) forms, characteristics of the transfer of the given knowledge (if any):	
Form of testing (exam / pract. mark / <u>other</u>): Student essays on selected topics will be marked	
Further (specific) forms to be applied in knowledge testing (if any):	
Position of the subject in the curriculum (number of the semester): ?	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The focus of the course will be on the experimental approaches that are used to approach biology in a quantitative manner: with the use of mathematical models, or just with the quantification of key experimental observables. Scientists giving lectures are all actively performing experiments as well as analyzing data. So, the specificity of the course is on the analysis of quantitative experimental data in biology. In particular, scientists from different European institutions will address single cell analyses, the use of microfluidics, long-term evolution experiments, the dynamics of COVID, mechanisms of cell motion, and others.</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, handbooks) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
Lecturers will provide notes for the students.	
List of those required professional competences, competence elements (<i>knowledge, skill, etc., Section 8 of the Educational and Output Requirements</i>) to the development of which the subject characteristically, materially contributes	
<p>Attendants should have preliminary knowledge in both biology and mathematics. In particular, knowledge in molecular biology, cell biology, evolutionary biology, from the one side. And in statistics and dynamical systems (ordinary differential equations) on the other.</p>	
Subject owner (<i>name, position, scien. degree</i>): Andrea Ciliberto PhD	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Fetal monitoring with multimodal methods	Credit value: 6
Title of the subject in Hungarian: Fetal monitoring with multimodal methods	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 24 in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / <u>practical mark</u> / project work / other): Further (specific) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The main purpose of this course is to highlight the foundation of different fetal monitoring techniques as well as the deepening of the knowledge in the field of biomedical signal processing. Finally recent, innovative technologies are also introduced.</p> <ul style="list-style-type: none"> - Discussed topics include: - Fetal development and the basis of fetal monitoring - Processing and evaluation of raw phonocardiographic signals - Processing and evaluation of raw electrocardiographic signals - Medical ultrasound in a nutshell - Medical and engineering fundamentals of the measurement of fetal breathing movements - Fetal cardiodiagnosical methods and their applicability - Data science point of view in the case of medical data I. - Data science point of view in the case of medical data II. - Practical considerations in the case of multimodal measurements - Short overview in recent advances of fetal monitoring 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>D. Pani, C. Rabotti, M. G. Signorini, L. Burattini “Innovative Technologies and Signal Processing in Perinatal Medicine,” Springer, 2021</p> <p>L. Sörnmo, P. Laguna “Bioelectrical Signal Processing in Cardiac and Neurological Applications,” Elsevier, 2005</p> <p>Z. Tóth, Z. Papp “Szülészet-Nőgyógyászati Ultrahang-Diagnosztika,” White Golden Book Kft., 2006</p> <p>M. Berényi, F. Katona “Fejlődésneurológia, Medicina, 2012</p> <p>D. Gibb, S. Arulkumaran “A magzatmonitorozás gyakorlata,” Oriold és Társai Kft., 2009</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
<p>Subject owner (name, position, scientific degree): Dr. Koller Miklós, PhD, associate professor</p> <p>Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kezsesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM</p>	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Human motor control and neurorehabilitation	Credit value: 6
Title of the subject in Hungarian: Human motor control and neurorehabilitation	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 24 in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (<u>exam</u> / practical mark / project work / other): none; Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): none	
Required preliminary studies (<i>if any</i>): none	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight recent results in Human Movement Science and their applications in neurorehabilitation. Discussed topics include:</p> <p>Biological control Biological learning; Joint spaces, Muscle spaces, Space in the Brain, Dimension reduction Redundancy and Variability of human limb movements Sensorimotor transformation</p> <p>Planning experiments to measure human movement; Performing experiments to measure human movement using motion analyzer systems. Simulation and modeling of human movement</p> <p>Artificial control of human movement Functional Electrical Stimulation (FES)</p> <p>Human-machine interface in neurorehabilitation.</p> <p>Communicate research results in a professional manner with clinicians and patients.</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Laczko J and Latash M.L.(2016) Progress in Motor Control – Theories and Translations, Publ. Springer Enoka R.M. (2008) Neuromechanics of Human Movement, Publ. Human Kinetics , Champaign. IL. Shadmehr R & Mussa-Ivaldi S. (2012) Biological Control and Learning, Publ. MIT Press, Cambridge MA.</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
<p>The course focuses on natural and artificial control of human motion. The students learn how to measure, process and analyze data recorded from human movements. How hidden parameters and features of the studied movements (e.g. limb movements) can be revealed by mathematical and computational approaches? The students get insight into state of the art applications in Human Machine interface and neurorehabilitation.</p>	
Subject owner (<i>name, position, scientific degree</i>): József Laczkó PhD	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>): Botzheim Lilla PhD, Mravcsik Mariann PhD	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Infinite Dimensional Dynamical Systems	Credit value: 6
Title of the subject in Hungarian: Végtelen dimenziós dinamikai rendszerek	
Type of the class: consultation number of classes: 12 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation: <u>exam</u> / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in ¹ knowledge testing (<i>if any</i>):	
Required preliminary studies(<i>if any</i>): a moderate background in functional analysis	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>Topics to be covered include:</p> <ul style="list-style-type: none"> • linear dynamical systems, Cauchy’s functional equation • uniformly continuous, strongly continuous semigroups • generators of semigroups and their resolvents • Hille-Yosida generation theorems • special semigroups: analytic, differentiable, etc. • perturbations of contractive and analytic semigroups • Trotter-Kato approximation theorems 	
List of the most important 2–5 pieces of <i>required and recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Required literature: lecture notes</p> <p>Recommended literature:</p> <ul style="list-style-type: none"> • KJ. Engel, R. Nagel, One-Parameter Semigroups for Linear Evolution Equations, Springer, 2000. • KJ. Engel, R. Nagel, A Short Course on Operator Semigroups, Springer, 2006. 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (<i>name, position, scientific degree</i>): Mihály Kovács, professor, DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Keztesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Introduction to Stochastic Partial Differential Equations	Credit value: 6
Title of the subject in Hungarian: Bevezetés a sztochasztikus parciális differenciálegyenletek elméletébe	
Type of the class: lecture number of classes: 12 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation: project work Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>): a moderate background in functional analysis (mainly Hilbert spaces), some measure theory, and basic finite dimensional stochastic analysis	
Description of the subject: the brief, still informative description of the knowledge to be attained	
Topic to be covered include: <ul style="list-style-type: none"> • Gaussian measures and Gaussian random variables in Hilbert spaces • infinite dimensional Wiener processes in Hilbert spaces • martingales in Banach spaces • measurability of operator valued random variables • stochastic integration with respect to infinite dimensional Wiener processes • the semigroup approach for stochastic evolution equations with additive noise • the stochastic heat equation, the stochastic wave equation 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
Required literature: lecture notes Recommended literature: <ul style="list-style-type: none"> • G. Da Prato and J. Zabczyk, Stochastic Equations in Infinite Dimensions, Cambridge University Press, 1992. • C. Prévôt and M. Röckner, A Concise Course on Stochastic Partial Differential Equations, Springer, 2007. 	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (<i>name, position, scientific degree</i>): Mihály Kovács, professor, DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kezsesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

<p>Title of the subject: Mechanisms of cell division</p>	<p>Credit value: 6</p>
<p>Title of the subject in Hungarian: A sejtosztódás mechanizmusa</p>	
<p>Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: 6... in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
<p>Form of evaluation (exam / practical mark / project work / other): Q & A session after presentation Further (specific) forms to be applied in knowledge testing (if any): journal club presentations (6)</p>	
<p>Required preliminary studies (if any): basics of cell biology</p>	
<p>Description of the subject: the brief, still informative description of the knowledge to be attained</p>	
<p><Preferably a list of 10-15 topics representing the planned weekly schedule of the course></p> <ol style="list-style-type: none"> 1. Cell cycle, the clock model and Xenopus 2. Cell cycle, the domino model and budding yeast 3. Single cell vs population studies 4. Thresholds and transitions in biological systems 5. Synthetic Biology and microfluidics 6. Mitosis and chromosome dynamics 7. Checkpoints as surveillance mechanisms of cell cycle transitions 8. The DNA damage checkpoint 9. The mitotic checkpoint 10. Mechanisms of adaptation and checkpoint override 11. Consequences of adaptation and the threshold model 12. Aneuploidy and its paradox in cancer 	
<p>List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)</p> <ul style="list-style-type: none"> - Cells Escape an Operational Mitotic Checkpoint through a Stochastic Process. Bonaiuti P, Chiroti E, Gross F, Corno A, Vernieri C, Štefl M, Cosentino Lagomarsino M, Knop M, Ciliberto A. <i>Curr Biol.</i> 2018 Jan 8;28(1):28-37.e7 - Implications of alternative routes to APC/C inhibition by the mitotic checkpoint complex. Gross F, Bonaiuti P, Hauf S, Ciliberto A. <i>PLoS Comput Biol.</i> 2018 Sep 10;14(9):e1006449. doi: 10.1371/journal.pcbi.1006449. - A synthetic oscillatory network of transcriptional regulators. Elowitz MB, Leibler S. <i>Nature.</i> 2000 Jan 20;403(6767):335-8. doi: 10.1038/35002125. - Dominoes and clocks: the union of two views of the cell cycle. Murray AW, Kirschner MW. <i>Science.</i> 1989 Nov 3;246(4930):614-21. doi: 10.1126/science.2683077. - Feedback control of mitosis in budding yeast. 	

Li R, Murray AW. Cell. 1991 Aug 9;66(3):519-31. doi: 10.1016/0092-8674(81)90015-5.

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Understanding the process of cell division and especially the possible mistakes occurring during such process that may fuel cancer. The students will learn how to connect historical key discoveries in the field of cell cycle control to current studies in the emergence of resistance to cancer treatment. The course will also show how mathematical models of molecular regulatory networks helped to understand such processes.

Subject owner (*name, position, scientific degree*): Andrea Ciliberto, PhD, Researcher, PhD

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Molecular Biology of Yeast	Credit value: 6
Title of the subject in Hungarian: Élesztők molekuláris biológiája	
Type of the class (lecture / seminar / laboratory / consultation): consultation	
number of classes: 12 in the given semester,	
(if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / <u>practical mark</u> / project work / other): exam	
Further (specific) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ol style="list-style-type: none"> 1. Cell-Cycle Analysis in Diverse Eukaryotes 2. Life Cycles of Budding and Fission Yeasts 3. Genetic Analysis of Cell-Cycle Control in Yeast 4. Cyclins Required for Activation of Replication Origins in Yeast 5. Cyclins that Promote Mitotic Entry in Yeast 6. Control of Late Mitosis in Budding Yeast 7. The Positioning and Timing of Cytokinesis in Yeast 8. Cytokinesis 9. The Actin–Myosin Ring 10. Assembly and Contraction of the Actin–Myosin Ring 11. Membrane and Cell Wall Deposition at the Division Site 12. The Positioning and Timing of Cytokinesis in Yeast 13. Activation of Gene Expression at Start in Budding Yeast 14. Activation of S–Cdks in Budding Yeast 15. Extracellular Control of Start in Yeast: Mating Factor Signaling 16. Coordination of Cell Growth and Division in Yeast 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
David O. Morgan: Cell Cycle: Principles of Control. 2006. New Science Press: London. 297 p. ISBN: (Paperback) 9780878935086.	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
Subject owner (name, position, scientific degree): Dr. Csikász-Nagy Attila, full professor, DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

Title of the subject: Open Set Recognition Methodologies	Credit value: 6
Title of the subject in Hungarian: Open Set Recognition Methodologies	
<p>Type of the class: lecture / seminar / laboratory / consultation</p> <p>number of classes: 24 in the given semester,</p> <p><i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
<p>Form of evaluation (exam / practical mark / project work / other):</p> <p>Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): project work</p>	
Required preliminary studies (<i>if any</i>): Machine Learning	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The objective of the course is to review the fundamentals of i) the open set recognition problem and its mathematical formulation, ii) basic approaches for open set recognition, iii) recent solutions.</p> <p>Discussed topics are</p> <ul style="list-style-type: none"> • Closed-set vs open-set problems (classification and recognition) • Mathematical formulation, open-set risk • Anomaly and novelty detection • Out-of-distribution detection • Open-set recognition approaches <ul style="list-style-type: none"> ○ SVM based solutions ○ Extreme Value Theory ○ Extreme Value Machine ○ Deep Set Networks (OpenMax) ○ Generative Approaches • Datasets for evaluation • Evaluation metrics and protocols 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<ul style="list-style-type: none"> • M. Salehi, H. Mirzaei, D. Hendrycks, Y. Li, M. Rohban, and M. Sabokrou: A Unified Survey on Anomaly, Novelty, Open-Set, and Out-of-Distribution Detection: Solutions and Future Challenges, https://doi.org/10.48550/arXiv.2110.14051 	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

<ul style="list-style-type: none">• Walter J. Scheirer and Anderson Rocha and Archana Sapkota and Terrance E. Boult: Towards Open Set Recognition, IEEE Transactions on Pattern Analysis and Machine Learning, 2013, 35 (7)• Ethan Rudd, Lalit P. Jain, Walter J. Scheirer, Terrance Boult, The Extreme Value Machine, IEEE Transactions on Pattern Analysis and Machine Intelligence (T-PAMI), 2018, 40 (3)• Ethan Rudd, Lalit P. Jain, Walter J. Scheirer, Terrance Boult, Towards Open Set Deep Networks, Ethan Rudd, Lalit P. Jain, Walter J. Scheirer, Terrance Boult,
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes
Subject owner (<i>name, position, scientific degree</i>): Dr. TORNAI Kálmán, PhD
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (<i>name, position, scien. degree</i>): Dr. ZSEDROVITS Tamás, PhD
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

Title of the subject: Physics of Computation	Credit value: 6
Title of the subject in Hungarian: A számítások végzésének fizikája	
Type of the class: lecture / seminar / laboratory / consultation number of classes: ... in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Further (<i>specific</i>) forms to be applied in ¹ knowledge testing (<i>if any</i>):	
Required preliminary studies (<i>if any</i>):none.....	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>An overview of various computing paradigms and the physics that enables them: analog computers, mechanical, chemical computing, digital computing machines, quantum computers. Understanding the physical limits of computation.</p> <p>Analog computing</p> <p>Neural models of computation</p> <p>Mechanical computers,</p> <p>Digital computers and binary switches</p> <p>Magnetoelectronics</p> <p>Optical computing</p> <p>Quantum computers</p> <p>Speed, footprint and von Neumann bottleneck in computing</p> <p>Power dissipation in computing</p>	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>M. Wolf: The Physics of Computing Morgan Kaufmann; 1st edition (November 16, 2016) ISBN-10 : 0128093811</p> <p>Hey, Anthony. Feynman and computation. CRC Press, 2018.</p> <p>Marković, Danijela, Alice Mizrahi, Damien Querlioz, and Julie Grollier. "Physics for neuromorphic</p>	

¹ e.g. hand-in assignments, such as case studies, elaboration of specific topics, compositions, essays, business and organizational plans, etc.

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computing." *Nature Reviews Physics* 2, no. 9 (2020): 499-510.

Bennett, Charles H. "The thermodynamics of computation—a review." *International Journal of Theoretical Physics* 21, no. 12 (1982): 905-940.

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Subject owner (*name, position, scientific degree*): ...György Csaba....., PhD

Lecturer(s), instructor(s) involved in the teaching of the subject, if any (*name, position, scien. degree*):

Adam Papp PhD

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

Title of the subject: Predictive Control of Nonlinear Stochastic Systems	Credit value: 6
Title of the subject in Hungarian: Nemlineáris sztochasztikus rendszerek prediktív irányítása	
<p>Type of the class: lecture / seminar / laboratory / <u>consultation</u></p> <p>number of classes: 10x 90min in the given semester,</p> <p><i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
<p>Form of evaluation (exam / practical mark / <u>project work</u> / other):</p> <p>Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):</p>	
Required preliminary studies (<i>if any</i>): <i>Computer Controlled Systems (BSc)</i>	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight important results in nonlinear systems' and control theory and robotics. The subject of this course will be discussed in weekly consultations on the following topics:</p> <p>I. Model Predictive Controller (MPC) techniques [1], [2]</p> <ul style="list-style-type: none"> - Basic MPC techniques employing linear prediction models - Receding horizon control, offline control, and preliminary control feasibility test - Nonlinear MPC (NMPC) and convex approximations - Stochastic (N) MPC and convex approximations - Unknown-input reconstruction, parameter estimation, and state observation in an MPC framework <p>II. Gaussian process (GP) regression models [3], [4]</p> <ul style="list-style-type: none"> - Multivariate function approximation from measurements using Gps - Hyperparameter tuning using log-likelihood optimization - Sparse GP approximations: FITC, VFE, distance-based dictionaries - Dynamic model calibration using GPs - Prediction models augmented with Gps - Stochastic GP model-based predictions using different model approximations (e.g., Taylor approximation or analytic moment calculations) - MPC approaches employing nonlinear prediction models augmented with GP regressors (GP-MPC) - GP-MPC implementation techniques and approximations: <p>III. Useful numerical methods, available software tools, and their usage</p> <ul style="list-style-type: none"> - Advanced Matlab/Simulink tools and techniques relevant in the field 	

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- Algorithmic differentiation tools (e.g., CasADi) and gradient-based nonlinear optimization solvers (e.g., IPOPT, FORCES PRO)

- GPML Toolbox for GP manipulation

List of the most important 2–5 pieces of *required* and *recommended* literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)

[1] Pablo S. González Cisneros and Herbert Werner. Nonlinear model predictive control for models in quasi-linear parameter varying form. *International Journal of Robust and Nonlinear Control*, 30 (10):3945–3959, 2020.

[2] Ali Mesbah. Stochastic model predictive control: An overview and perspectives for future research. *IEEE Control Systems Magazine*, 36 (6):30–44, December 2016.

[3] Carl Edward Rasmussen and Christopher K. I. Williams. *Gaussian processes for machine learning. Adaptive computation and machine learning.* MIT Press, 2006.

[4] Marc Peter Deisenroth. *Efficient reinforcement learning using Gaussian processes – Revised version.* PhD thesis, Faculty of Informatics Institute for Anthropomatics Intelligent Sensor-Actuator-Systems Laboratory (ISAS), 2017.

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Analysis of complex nonlinear systems, understanding and manipulating the behavior of such physical biological, social, etc., process systems.

Subject owner (name, position, scientific degree): Dr. Péter Polcz, PhD

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/I_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

Title of the subject: Recent Advances in Drug Delivery Research	Credit value: 6
Title of the subject in Hungarian: A gyógyszer beviteli kutatások legújabb eredményei	
Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: 6 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): Q & A session after presentation Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): journal club presentations (6)	
Required preliminary studies (<i>if any</i>): Drug research and development BSc subject (NOT compulsory)	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ol style="list-style-type: none"> 1. Anatomical and molecular properties of the <i>blood-brain barrier</i> 2. Anatomical/cellular properties of <i>nasal</i> drug delivery route 3. Anatomical features of <i>dermal</i> drug delivery route 4. Methodological opportunities for testing <i>dermal</i> drug delivery (in vitro, ex vivo, in vivo) 5. Microfluidic diffusion chambers 6. Drug formulation techniques to enhance <i>dermal</i> drug absorption 7. Physical methods to enhance <i>dermal</i> drug delivery 8. Tricks for overcoming the <i>blood-brain barrier</i> 9. Studying species differences in the skin 10. Opportunities to reduce the number of experimental animals in drug delivery studies 11. Testing <i>dermal</i> barrier permeability in healthy and diseased conditions. 12. Testing <i>blood-brain barrier</i> permeability in healthy and diseased conditions. 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Kocsis D, Klang V, Schweiger EM, Varga-Medveczky Z, Mihály A, Pongor C, Révész Z, Somogyi Z, Erdő F. Characterization and ex vivo evaluation of excised skin samples as substitutes for human dermal barrier in pharmaceutical and dermatological studies. <i>Skin Res Technol.</i> 2022 Jun 21. doi: 10.1111/srt.13165</p> <p>Kocsis D, Horváth S, Kemény Á, Varga-Medveczky Z, Pongor C, Molnár R, Mihály A, Farkas D, Naszlady BM, Fülöp A, Horváth A, Rózsa B, Pintér E, Gyulai R, Erdő F. Drug Delivery through the Psoriatic Epidermal Barrier-A "Skin-On-A-Chip" Permeability Study and Ex Vivo Optical Imaging.</p>	

Int J Mol Sci. 2022 Apr 11;23(8):4237. doi: 10.3390/ijms23084237

Ponmozhi J, Dhinakaran S, Varga-Medveczky Z, Fónagy K, Bors LA, Iván K, Erdő F. Development of Skin-On-A-Chip Platforms for Different Utilizations: Factors to Be Considered. Micromachines (Basel). 2021 Mar 10;12(3):294. doi: 10.3390/mi12030294.

Lukács B, Bajza Á, Kocsis D, Csorba A, Antal I, Iván K, Laki AJ, Erdő F. Skin-on-a-Chip Device for Ex Vivo Monitoring of Transdermal Delivery of Drugs-Design, Fabrication, and Testing.

Pharmaceutics. 2019 Sep 2;11(9):445. doi: 10.3390/pharmaceutics11090445.

Luca Anna Bors and Franciska Erdő Overcoming the Blood–Brain Barrier. Challenges and Tricks for CNS Drug Delivery, Sci. Pharm. 2019, 87(1), 6; <https://doi.org/10.3390/scipharm87010006>

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Analyzing and synthesizing ability to make short, informative presentations on recent scientific results on the field of drug delivery across the physiological barriers.

Getting theoretical background knowledge on the field of physiological barriers and making and evaluating the drug delivery experiments.

Subject owner (name, position, scientific degree): Franciska Vidáné Erdő, PhD, associate professor, PhD

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

Title of the subject: Reinforcement learning in robotics	Credit value: 6
Title of the subject in Hungarian: Reinforcement learning in robotics	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 24 in the given semester, (if the subject is (partially) taught in any language other than Hungarian, then the language: English)	
Form of evaluation (exam / <u>practical mark</u> / project work / other):	
Further (specific) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to highlight the foundations of reinforcement learning (RL) and its general applicability to robotic problems. In addition to reviewing RL-fundamentals, the course includes a brief review of classical approaches to basic robotics computational problems (direct and inverse kinematical problem, etc), in order to help the deeper understanding of how modern RL-approaches work.</p> <p>Discussed topics include:</p> <ul style="list-style-type: none"> - General concepts of deep neural networks - Modern architectures, training strategies and fine details of practical realizations - General formalism of the RL-problem - The main RL-approaches: value-based and policy-based - Latest results on modern value-based and policy-based approaches, hybrid methods I. - Latest results on modern value-based and policy-based approaches, hybrid methods II. - Environmental simulators in a nutshell (pyBullet, MuJoCo, etc) - Baseline algorithms in existing simulated environments - Recap on theoretical aspects of robotic manipulators - Constructional aspects of a new simulated environment, interfacing with a modern RL-algorithm - Training strategies of the realized environment-agent combination, debug opportunities - Sim-to-real considerations and the necessary extensions to the created combination 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	

I. Goodfellow, Y. Bengio, A. Courville, "Deep learning," MIT Press, www.deeplearningbook.org, 2016

R. S. Sutton, A. G. Barto, "Reinforcement Learning: An Introduction," 2nd edition, MIT Press, incompleteideas.net/book/the-book-2nd.html, 2020

Cs. Szepesvári, "Algorithms for Reinforcement Learning," Morgan&Claypool Publishers, <https://sites.ualberta.ca/~szepesva/rlbook.html>, 2009

J. Achiam, "Spinning Up Documentation," <https://spinningup.openai.com>, 2020

L. Sciavicco, B. Siciliano: "Modelling and Control of Robot Manipulators," 2nd edition, Springer, 1999 Lectures of UC Berkeley "Deep Reinforcement Learning" by Sergey Levine, <https://rail.eecs.berkeley.edu/deeprlcourse/2021>

List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Subject owner (*name, position, scientific degree*): Dr. Koller Miklós, PhD, associate professor

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Simulation of biological experiments	Credit value: 6
Title of the subject in Hungarian: Biológiai kísérletek szimulációi	
Type of the class: lecture / seminar / laboratory / <u>consultation</u> number of classes: 6 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / <u>practical mark</u> / project work / other):	
Further (specific) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
Mathematical modelling techniques to simulate experiments in biological systems. Modelling and experimental techniques and how one can move between them will be highlighted. Key topics include: Oscillators: cell cycle, circadian clock, repressilator Biological switches: differentiation, apoptosis Adaptation: chemotaxis Whole cell modelling	
List of the most important 2–5 pieces of required and recommended literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
Klipp, E., Liebermeister, W., Wierling, C., & Kowald, A. (2016). <i>Systems biology: a textbook</i> . John Wiley & Sons. Ingalls, B. P. (2013). <i>Mathematical modeling in systems biology: an introduction</i> . MIT press. Elowitz, M. B., & Leibler, S. (2000). A synthetic oscillatory network of transcriptional regulators. <i>Nature</i> , 403(6767), 335-338. Tyson, J. J., Chen, K. C., & Novak, B. (2003). Sniffers, buzzers, toggles and blinkers: dynamics of regulatory and signaling pathways in the cell. <i>Current opinion in cell biology</i> , 15(2), 221-231. Karr, J. R., Sanghvi, J. C., Macklin, D. N., Gutschow, M. V., Jacobs, J. M., Bolival Jr, B., ... & Covert, M. W. (2012). A whole-cell computational model predicts phenotype from genotype. <i>Cell</i> , 150(2), 389-401.	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
The PhD students will learn to interpret experimental results and design mathematical models to simulate them. They will also understand how to design experiment, which can lead to results contributing to model development.	
Subject owner (name, position, scientific degree): Attila Csikász-Nagy, full professor, DSc	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

Title of the subject: Spatial data analysis	Credit value: 6
Title of the subject in Hungarian: Tér adatok elemzése	
<p>Type of the class: lecture / <u>seminar</u> / laboratory / <u>consultation</u></p> <p>number of classes: 52 in the given semester,</p> <p><i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
<p>Form of evaluation (<u>exam</u> / practical mark / project work / other):</p> <p>Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): -</p>	
Required preliminary studies (<i>if any</i>): -	
<p>Description of the subject:</p> <p>The primary goal of the subject is to obtain basic theoretical and practical knowledge of sensors and algorithmic tools used in spatial information systems focusing on applications of remote sensing and medical imaging. The course provides an overview of the operating principles of the various 3D sensing technologies and their areas of use, the data structures describing the provided measurements, with a special emphasis on the automated data processing methods and algorithms, which nowadays play a prominent role due to the heterogeneity of the available data, and the large and continuously expanding size of current spatial databases.</p> <p>Main topics:</p> <ol style="list-style-type: none"> 1. Concept of spatial information sciences, main types and applications of spatial information systems 2. Operation principles of geospatial and medical 3D data collection sensor technologies and tools 3. Geometric reference systems, spatial geometric transformations, projective geometry 4. Formation and representation of various data types: 2D images (optical visible/infrared, radar, X-ray images), 2.5D distance maps, real 3D Lidar point clouds and 3D voxel models (e.g. CT, MR) 5. Geospatial and medical databases: data acquisition and data storing models 6. Data quality standards and quality assurance. Hardware and software tools in spatial information system, database management issues. 7. Automatic processing and interpretation of spatial data sets: segmentation of data from different sources, separation of different classes, recognition and reconstruction of spatial objects 8. Hierarchical description of complex spatial scenes, stochastic optimization techniques (Markov fields, Markov point processes) 9. Automatic 3D model generation from raw measured data, processing of 3D point clouds (e.g. LIDAR) and voxel models (e.g. computed tomography). 10. Time sequence analysis, registration, and change detection for multitemporal data 11. Basic concepts of augmented and mixed reality systems 	
<p>List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)</p>	
<p>Csaba Benedek: "Multi-level Bayesian Models for Environment Perception," Springer International Publishing, 202 pages, ISBN 978-3-030-83654-2, 2022</p> <p>Pinliang Dong, Qi Chen, "LiDAR Remote Sensing and Applications", CRC Press, 220 pages, ISBN 978-1-138-74724-1, 2017</p> <p>Dougherty Geoff, "Medical Image Processing", Springer, 396 pages, ISBN: 978-1-441-99769-2, 2011</p>	

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List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes

Algorithm development, computer programming, machine learning applications

Subject owner (*name, position, scientific degree*): Csaba Benedek, full professor, DSc

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tiny_mce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Structural biology	Credit value: 6
Title of the subject in Hungarian: Szerkezeti biológia	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation number of classes: 12 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / <u>project work</u> / other): a 3-5 page proposal on the complex structural investigation of a chosen biomacromolecule: rationale, methods, possible difficulties etc. Further (specific) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained The goal of the course is to provide introduction to the structural analysis of biological macromolecules by highlighting the fundamentals and the most recent developments. Topics include: Fundamentals of protein structure Fundamentals of the 3D structure of nucleic acids Low-resolution structure analysis methods: circular dichroism, FT-IR, UV-VIS, SAXS Sample preparation for structural studies Macromolecular X-ray crystallography Macromolecular NMR spectroscopy Solid-state NMR for the investigation of biomolecules Cryo-electron microscopy Fluorescence-based methods to probe the structure and dynamics of proteins and complexes Single-molecule methods Fundamentals of molecular modeling Basics of molecular dynamics calculations Hybrid methods combining calculations with experimental data Interpretation of protein structures to understand biological function	
List of the most important 2 – 5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN) P Moore: Visualizing the invisible. Oxford University Press, 2012, ISBN: SBN13 9780199767090 I Bertini, KS McGreevy, G Parigi: NMR of biomolecules. Wiley-Blackwell, 2012, ISBN:9783527328505. DC Rapaport: The art of molecular dynamics simulation. Cambridge University Press, 2004, ISBN: 978-0521825689 ID Campbell: Biophysical techniques. Oxford University Press, 2012. ISBN 9780199642144	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes Understand and interpret biomacromolecular structures, design experiments to probe functionally important structural features of proteins	
Subject owner (name, position, scientific degree): Zoltán Gáspári, PhD / DSc / MHAS	
Lecturer(s), instructor(s) involved in the teaching of the subject, if any (name, position, scien. degree):	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Tamás Hegedűs, DSc

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Technology of microscale neural interfaces	Credit value: 6
Title of the subject in Hungarian: Mikroméretű implantátumok technológiája	
Type of the class: <u>lecture</u> / seminar / laboratory / consultation	
number of classes: 8 in the given semester,	
<i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (<u>exam</u> / practical mark / project work / other): oral exam	
Further (specific) forms to be applied in knowledge testing (if any):	
Required preliminary studies (if any):	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<ul style="list-style-type: none"> - Micro- and nanotechnologies to create brain-machine interfaces - Overview of state-of-the-art materials of microimplants - Integrated electronics for brain electrodes - Soft, flexible materials used in implantable devices - Integrated optoelectronic features and optical stimulation using neural interfaces - Strategies to mitigate cellular damage on tissue-device interfaces - Longevity and biocompatibility of neural implants - Multimodal brain imaging methods relying on multifunctional brain electrodes 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<p>Wellman, S. M., Eles, J. R., Ludwig, K. A., Seymour, J. P., Michelson, N. J., McFadden, W. E., ... & Kozai, T. D. (2018). A materials roadmap to functional neural interface design. <i>Advanced functional materials</i>, 28(12), 1701269.</p> <p>Ruther, P., & Paul, O. (2015). New approaches for CMOS-based devices for large-scale neural recording. <i>Current opinion in neurobiology</i>, 32, 31-37.</p> <p>Zhang, D., Chen, Q., Shi, C., Chen, M., Ma, K., Wan, J., & Liu, R. (2021). Dealing with the foreign-body response to implanted biomaterials: strategies and applications of new materials. <i>Advanced Functional Materials</i>, 31(6), 2007226.</p> <p>Goncalves, S. B., Ribeiro, J. F., Silva, A. F., Costa, R. M., & Correia, J. H. (2017). Design and manufacturing challenges of optogenetic neural interfaces: a review. <i>Journal of neural engineering</i>, 14(4), 041001.</p> <p>Shin, H., Lee, H. J., Chae, U., Kim, H., Kim, J., Choi, N., ... & Cho, I. J. (2015). Neural probes with multi-drug delivery capability. <i>Lab on a Chip</i>, 15(18), 3730-3737.</p>	
List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes	
material science, microtechnology, biomedical MEMS, implantables, bionic interfaces	
Subject owner (name, position, scientific degree): Kristóf Iván PhD / DSc / MHAS	
Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Translational Oncology	Credit value: 6
Title of the subject in Hungarian: Transzlációs onkológia	
<p>Type of the class: <u>lecture</u> / seminar / laboratory / consultation</p> <p>number of classes: 24 in the given semester,</p> <p><i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i></p>	
<p>Form of evaluation (exam / <u>practical mark</u> / project work / other):</p> <p>Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>):--</p>	
Required preliminary studies (<i>if any</i>):--	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The goal of this course is to demonstrate examples and highlight recent results of translational oncology. Basic concepts and advanced research topics in key directions of translational clinical research will be discussed, including:</p> <p>oncogenesis (oncogenes and tumor suppressor genes)</p> <p>angiogenesis</p> <p>metastasis formation</p> <p>clinical samples (origin and aim)</p> <p>primary cell cultures and cell lines</p> <p>tumor heterogeneity</p> <p>2D cellular models (proliferation, migration)</p> <p>3D cell-models (spheroids, matrices and invasion)</p> <p>animal models (PDX, tumor progression and colonization models)</p>	
<p>List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)</p>	
<p>Beverly A. Teicher (ed): Tumor Models in Cancer Research (2011)</p> <p>ESMO Handbook of Translational Research (2015)</p> <p>Geoffrey M. Cooper: The Cell: A Molecular Approach (2019)</p>	
<p>List of those required professional competences, competence elements to the development of which the subject characteristically, materially contributes</p>	
<p>Subject owner (<i>name, position, scientific degree</i>): Garay Tamás, PhD</p>	
<p>Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Keztesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM</p>	

ROSKA TAMÁS MŰSZAKI ÉS TERMÉSZETTUDOMÁNYI DOKTORI ISKOLA

Title of the subject: Wireless Sensor Networks	Credit value: 6
Title of the subject in Hungarian: Vezeték nélküli érzékelő hálózatok	
Type of the class: lecture / seminar / laboratory / consultation number of classes: 24 in the given semester, <i>(if the subject is (partially) taught in any language other than Hungarian, then the language: English)</i>	
Form of evaluation (exam / practical mark / project work / other): exam Further (<i>specific</i>) forms to be applied in knowledge testing (<i>if any</i>): -	
Required preliminary studies (<i>if any</i>): Information and Coding Theory	
Description of the subject: the brief, still informative description of the knowledge to be attained	
<p>The followings are the main topics:</p> <ul style="list-style-type: none"> - Anatomy of a Sensor Node - Protocol Stack of WSNs - Radio Communications and fading models - Link Management - Multi-Hop Routing, Energy Aware Routing Techniques in WSN - Data Aggregation and Clustering - Time Synchronization - Localization Techniques - Designing and Deploying WSN Applications - Simulators and Emulators for WSNs - WSN applications (predictive maintenance, Industry 4.0....etc.) 	
List of the most important 2–5 pieces of <i>required</i> and <i>recommended</i> literature (lecture notes, textbooks fundamental articles) with bibliographical details (author, title, edition information (or specific pages), ISBN)	
<ul style="list-style-type: none"> - Anna Forster: Introduction to Wireless Sensor Networks, Wiley-IEEE Press, 2016. ISBN: 978-1118993514 - Fahmy, Hossam Mahmoud Ahmad: Concepts, applications, experimentation and analysis of wireless sensor networks. Springer Nature, 2020. ISBN: 9783030580148 - Zagrouba, Rachid, and Amine Kardi. "Comparative study of energy efficient routing techniques in wireless sensor networks." Information 12.1 (2021): 42. 	
List of those required professional competences, competence elements to the development of which the	

subject characteristically, materially contributes

a. Knowledge

- He/she is familiar with the communication protocol development for wireless sensor networks
- In the Infocommunication Technologies, he/she has deeper theoretical and practical knowledge in protocol development and implementation.

b. Skills

- He/she is able to use traditional algorithms in communication protocol development.
- He/she uses the infodommunicaton technology tools and standards at a skill level.

c. Attitude

- He/she is able to perform the development tasks on a professionally high level

Subject owner (*name, position, scientific degree*): András Oláh, PhD, associate professor

Expected learning outcomes -- click here: https://itk.ppke.hu/storage/tinymce/uploads/Doktori-Iskola/Kepzesi-terv/l_kompetenciamatrix-doktori-komplex-vizsga-el--tt.pdf?u=1g1CnM